Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		The 1710-2170 MHz range (“second frequency range”) contains at least twenty-one “frequency bands” shown in Table 2.

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Table 2: Frequency bands within 1710-2170 MHz.

Band	Range (MHz)
DCS1800	1710-1880
PCS1900	1850-1990
UMTS Band I	1920-2170
UMTS Band II	1880-1990
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

Ciais-Quadband, 148 (DCS, PCS, UMTS); ETSI TS 145 005 V4.3.0 (2001-14) Technical Specification: Digital cellular telecommunications system (Phase 2+); Radio transmission and

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		reception (3GPP TS 45.005 version 4.3.0 Release 4), 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")))); ETSI TS 125 308 (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) ("ETSI TS 121"), 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")), 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")), TS 25.308 (ETSI TS 125 308)); ETSI TS 125 101 V6.5, 12-13 (Table 5.0 "UTRA FDD frequency bands"); ETSI TS 125 102, 11 (UTRA/TDD frequency 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, 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). Thus, the Ciais-Quadband antenna is "configured to support at least three frequency bands contained within first and second frequency ranges of the electromagnetic spectrum" because it supports (e.g., is operable to send and receive radiation in) at least four bands in the first frequency range and at least twenty-one bands in the second frequency range, meeting 1[c].

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
1[d]	configured to support at least three frequency bands contained within first and second frequency ranges of the electromagnetic spectrum,	Dou expressly or inherently discloses this claim element. *See* Claim 1[c].
1[e]	the second frequency range being higher in frequency than the first frequency range and	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband meets 1[e] because its second frequency range (1710-2170 MHz) is "higher in frequency" than its "first frequency range" (870-960 MHz) and because as shown below, "at least one" of the at least twenty-five (25) supported frequency bands (supra (1[c]) is "associated with a 4G communication standard." The band associated with a 4G standard is met by Dou+Ciais-Quadband in multiple ways. First, the Ciais-Quadband antenna supports at least seven (7) UMTS frequency bands, each of which is "associated with a 4G communication standard" at least because they support HSDPA. Supra (1[c]), Table 2. HSDPA is part of the Universal Mobile Telecommunications System (UMTS) and supported by the UMTS frequency bands. Dahlman, 139, 599 (ETSI TS 125 308 identifies HSDPA specification); ETSI TS 125 308 (UMTS HSDPA description); ETSI TS 121, 11 (UMTS standard comprises 3GPP TS 25.101 (ETSI TS 125 101 V6.5), 25.102 (ETSI TS 125 102)), 12 (UMTS standard comprises 3GPP TS 25.308 (ETSI TS 125 308)). The '677 patent expressly defines HSDPA as a "4G feature" and "4G service" that it equates with a "4G standard." '677 Patent, 25:1-6. Second, the ISM band at 902-928 MHz, which Ciais's quadband antenna covers, is "associated with a 4G communication standard." Supra 1[c]), Table 1. The '677 patent expressly identifies "WiFi, WiMAX, WiBro, UWB or other high-speed wireless standards" as "4G services." '677 Patent, 25:1-4. As the '677 patent recognizes, Zigbee is a "high-

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		speed wireless standard" for wireless networking like WiFi, Bluetooth, and UWB. ZigBee Specification (Jun. 27, 2005), 17-18 (Zigbee uses IEEE Std. 802.15.4 wireless networking layers, provides wireless peer-to-peer communication in mesh networks), 31; '677 Patent, 10:14-23, 25:1-4. Zigbee is thus a "4G communication standard" because it is a "wireless standard" for "4G services." Zigbee uses the ISM band at 902-928 MHz. ZigBee Specification (Jun. 27, 2005), 17 (IEEE 802.15.4-2003, PHY layer 915 MHz), 18, Fig. 1 (same), 70 (Table 23). Third, Fractus argues in litigation that 1[e] is met by LTE bands. D.I. 1, Complaint, Fractus, S.A., v. Geotab Inc., No. 2:24-cv-01008 (E.D. Tex. Dec. 6, 2024), 21 (excerpt below); Dahlman, 497-502 (describing LTE frequency bands).

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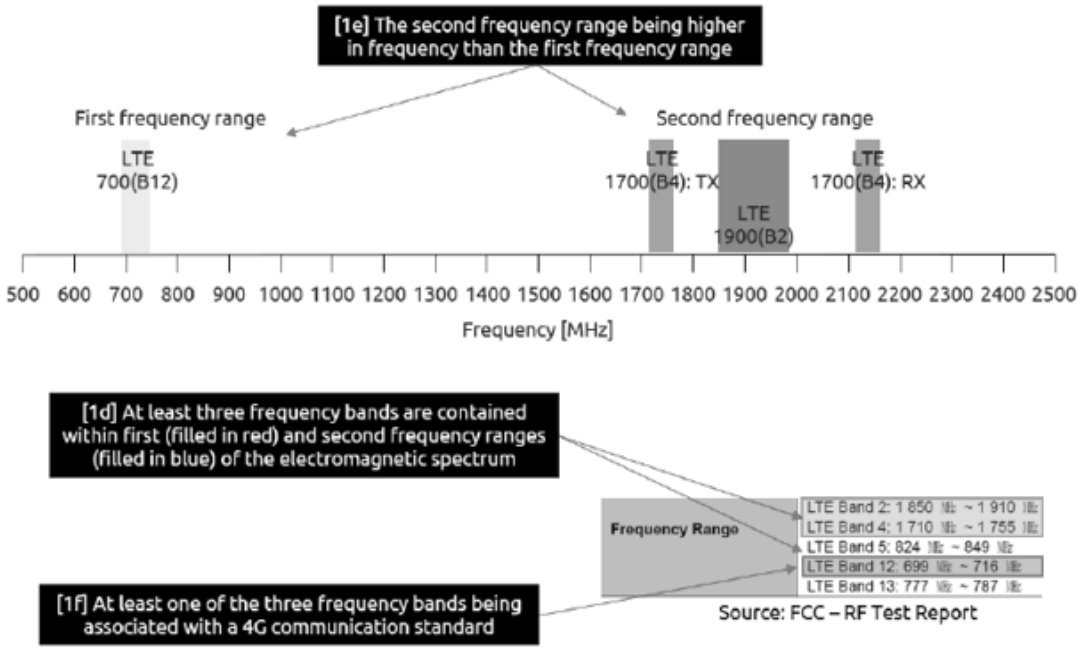
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		 EX1024, 21. The thirteen (13) LTE bands covered by Ciais's antenna—including LTE bands 2 and 4 whose uplink portions Fractus expressly identifies in litigation—are each "associated with a 4G communication standard". Supra (1[c]), Tables 1, 2.
1[f]	at least one of the three frequency bands being	Dou expressly or inherently discloses this claim element.

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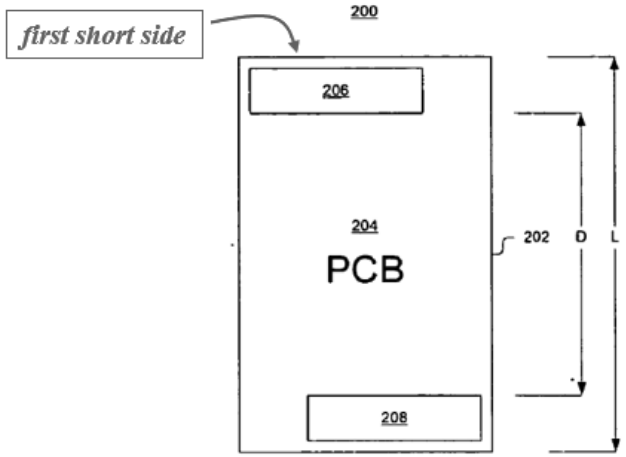
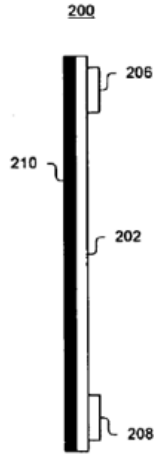
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
	associated with a 4G communication standard,	*See* Claim1[e].
1[g]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband meets 1[g] because it implements Dou's teaching to dispose antenna 206 (first antenna) at the top of PCB 204. Dou, Fig. 2A, [0016]-[0017].  FIG. 2A  FIG. 2B

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		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]. Ciais teaches a rectangular (40.5 mm x 105 mm) PCB, also backed by a ground plane, that Ciais explains is representative of PCBs for typical mobile phones. Ciais-Quadband, Fig. 1, 148. The top/shorter edge of PCB 204 is a "first short side." Disposing antenna 206 at the top of the PCB as taught by Dou places it "proximate to a first short side of a ground plane rectangle" defined by the PCB area. Dou, Figs. 2A-2B (annotated above), [0016]-[0017], [0029]. A POSA would have understood that "entire perimeter" is met by the perimeter of disjoint segments comprising the antenna contour. '677 Patent, 33:50-59, Fig. 12A (contour comprises combination of perimeter of elements 1201 and 1202). The Ciais quadband antenna (first antenna, supra 1[c])) has a planar "main patch" over vertical elements and a 1.2mm long "capacitive load." Ciais-Quadband, Fig. 1(a).

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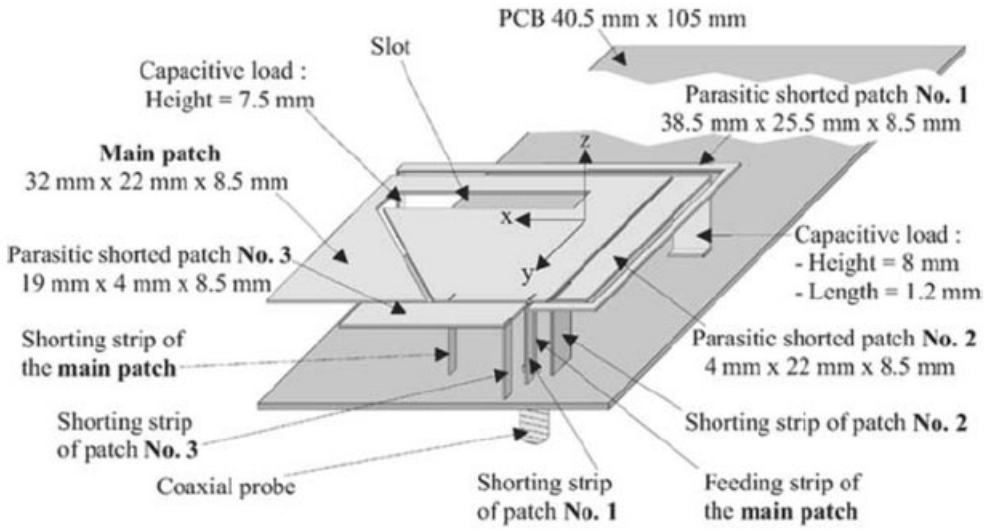
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		 (a) The minimum rectangle enclosing an orthogonal projection of the Ciais quadband antenna ("antenna rectangle") through the main patch is 38.5 mm × 28.5 mm. Ciais-Quadband, Fig. 1(b), 149. Ciais's top planar view in Figure 1(b) (annotated below) shows the antenna contour (blue outline) bounded by the antenna rectangle (purple outline) including "disjoint[ed] segments" from orthogonal projection of the vertical feed and shorting strips and the planar 4 mm × 1.2 mm "capacitive load" segment near the PCB surface. '677 Patent, 15:6-16.

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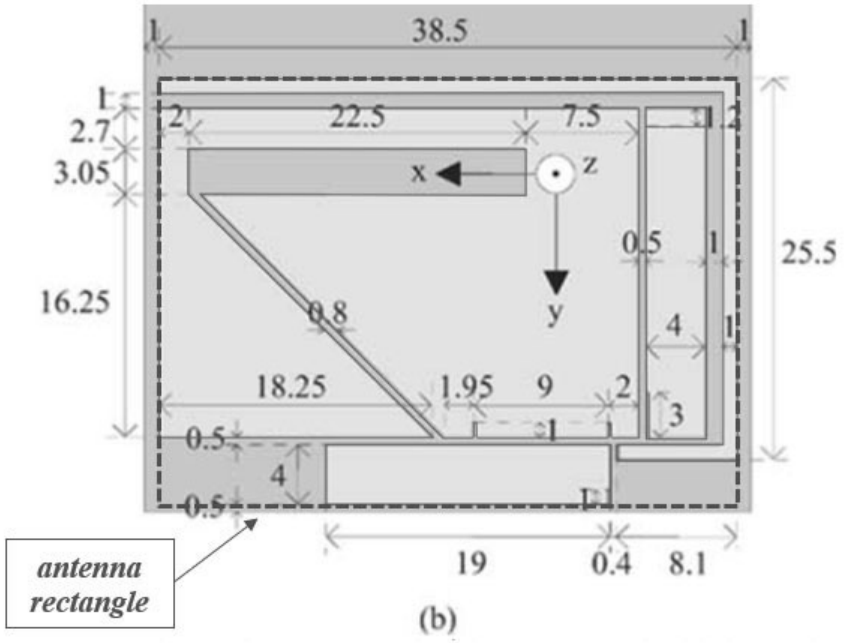
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		 Ciais's quadband antenna thus "defin[es] a first antenna contour comprising an entire perimeter of the first antenna," just like the perimeter of antenna contour 350 in the '677 patent's embodiments in Figure 3 or antenna system 1200 in Figure 12A (below right), meeting 1[g]. '677 Patent, 7:1-2, 53-55, 27:44-28:8, 33:50-63.

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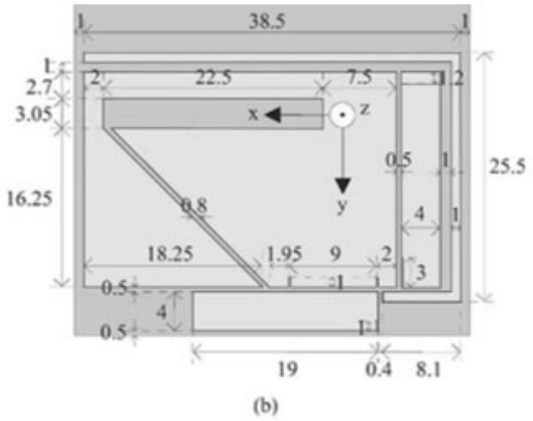
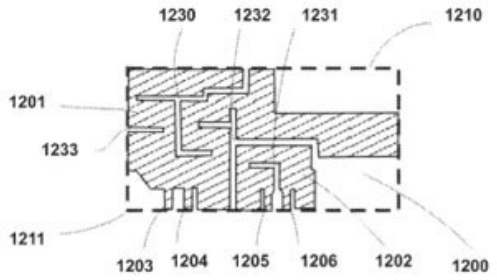
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		 (b)  FIG. 12A Following the ’677 patent’s usage (e.g., Figs. 12A, 13A), the below figure shows the Ciais quadband antenna contour with slant fill marking the main patch conductive elements bounded by the antenna contour.

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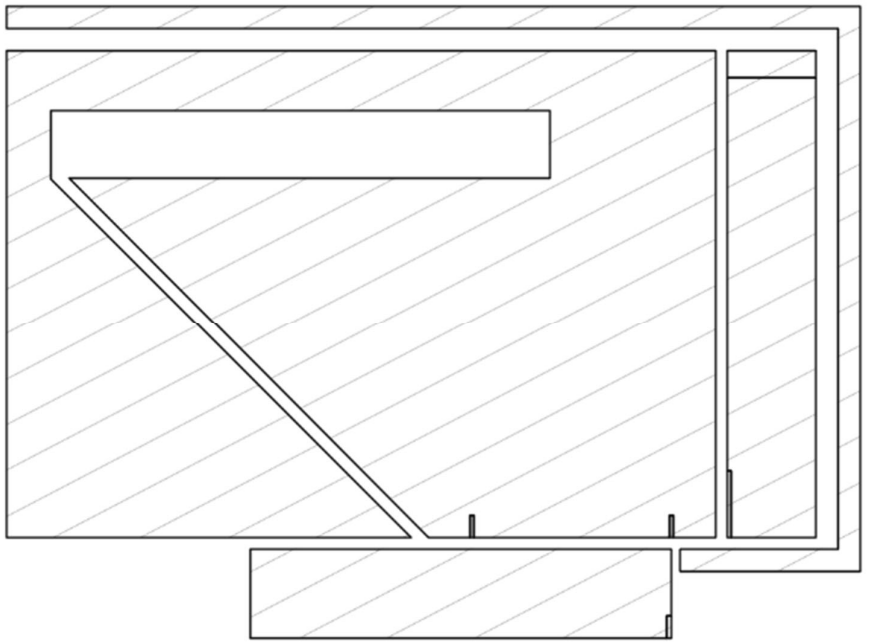
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		
1[h]	defining a first antenna contour comprising an entire perimeter of the first antenna,	Dou expressly or inherently discloses this claim element. *See* Claim 1[g].
1[i]	wherein the first antenna contour has a level of complexity defined by	Dou expressly or inherently discloses this claim element.

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<table>
<tr><th>Claim No.</th><th>U.S. Patent No. 11,031,677 B2</th><th>Dou</th></tr>
<tr><td></td><td>complexity factor F_{21} having a value of at least 1.20 and</td><td>See, e.g.,

Dou+Ciais-Quadband meets 1[i] because as shown below the quadband antenna contour (“first antenna contour”) meeting 1[d] has complexity factor F21 = 1.31 (“at least 1.20”) and F32 = 1.57 (“less than 1.75”).

<u>Calculating F21</u>

Grid G2

The ’677 patent identifies a preferred embodiment wherein second grid G2 has nine columns. ’677 Patent, 17:39-41. With a 38.5 mm × 28.5 mm antenna rectangle (Ciais-Quadband, Fig. 1(b), 149), nine columns yields a cell width ((38.5 mm)/9)=4.28 mm.

Setting an odd number of five, seven, and nine rows yields these results, where aspect ratio is the ratio of cell width to cell height (’677 Patent, 17:19-20):

<table>
<tr><th># rows</th><th>cell height (mm)</th><th>aspect ratio</th></tr>
<tr><td>5</td><td>$\left(\frac{28.5\ mm}{5}\right) = 5.7$</td><td>$\left(\frac{4.28}{5.7}\right) = 0.75$</td></tr>
<tr><td>7</td><td>$\left(\frac{28.5\ mm}{7}\right) = 4.07$</td><td>$\left(\frac{4.28}{4.07}\right) = 1.05$</td></tr>
<tr><td>9</td><td>$\left(\frac{28.5\ mm}{9}\right) = 3.17$</td><td>$\left(\frac{4.28}{3.17}\right) = 1.35$</td></tr>
</table>
</td></tr>
</table>

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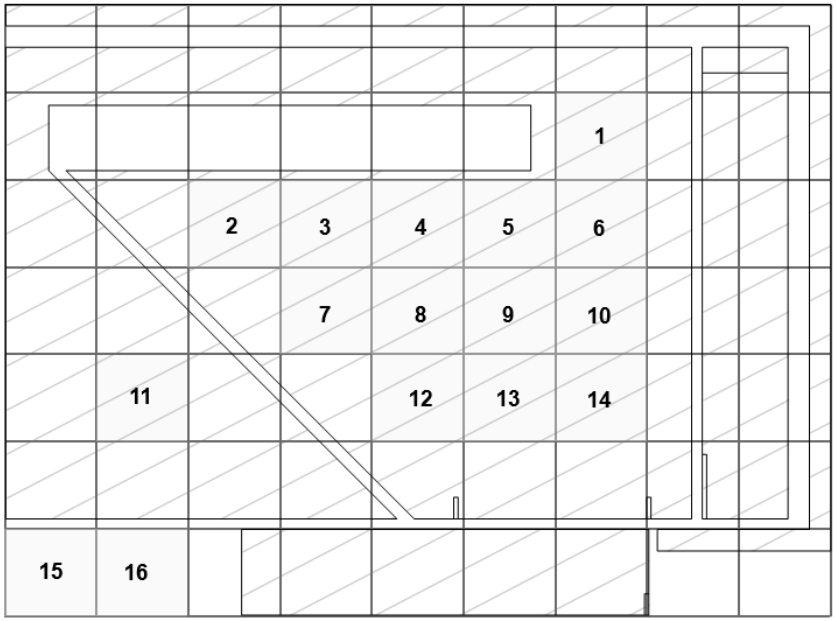
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		Therefore seven rows provides grid cells "as square as possible," e.g., an aspect ratio closest to one. '677 Patent, 16:62-65, 17:18-64. Thus, grid G2 with nine (9) columns and seven (7) rows has cells "as square as possible[.]" **N2 = 47** The 7 x 9 grid G2 (blue outline) is superimposed over the quadband antenna contour below. For visual clarity, the sixteen (16) cells that do not "include at least a point of the antenna contour" are shaded yellow. '677 Patent, 19:1-7. Thus, the G2 cell count N_2=(63-16)=47. 

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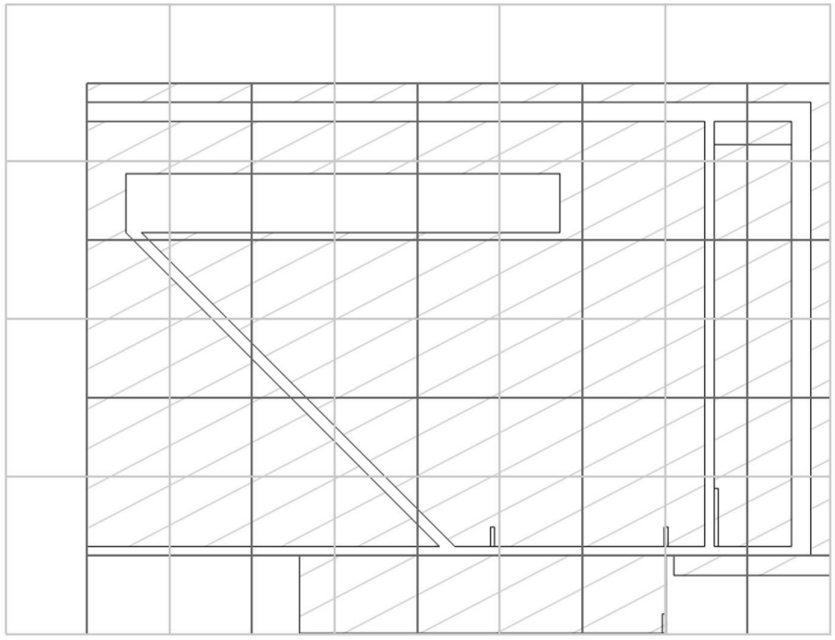
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		Grid G1 The quadband antenna feed for the lowest frequency operation is closest to the bottom right corner ("feed point corner") of the antenna rectangle, so grid G1 is placed from the bottom right corner below. Ciais-Quadband, Fig. 1(a) ("feeding strip of main patch"); '677 Patent, 18:16-54. Grouping four G2 cells (blue grid lines) into a single G1 cell results in the 4 x 5 grid G1 shown below (orange grid lines). '677 Patent, 18:55-61.  **N1 = 19**

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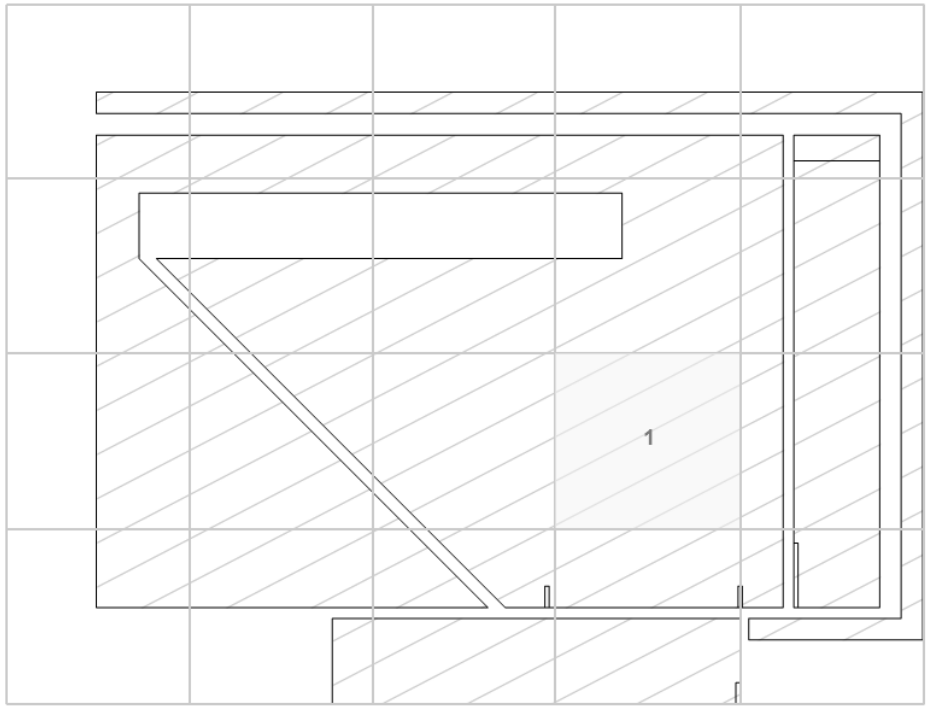
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		A single cell within G1 (yellow below) does not "include at least a point of the antenna contour." '677 Patent, 19:1-7. Thus, the G1 cell count N_1=(20-1)=19.  **Calculation F21 = 1.31** The complexity factor F21 for the quadband antenna contour is thus:

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		$$F_{21} = -\left(\frac{\log(N_2) - \log(N_1)}{\log(1/2)}\right) = -\left(\frac{\log(47) - \log(19)}{(-1)\log(2)}\right)$$ $$= \left(\frac{\log(47/19)}{\log(2)}\right) = \left(\frac{0.393}{0.301}\right) = 1.31.$$ ’677 Patent, 19:8-14. **Calculating F32** **Grid G3** Grid G3 is 14 rows by 18 columns (e.g., twice as many rows and columns as G2) so that a single G2 cell (blue outline) contains four G3 cells (green outline). ’677 Patent, 19:51-60. The G3 cells have width (38.5mm/18)=2.139 mm and height (28.5mm/14)=2.036 mm.

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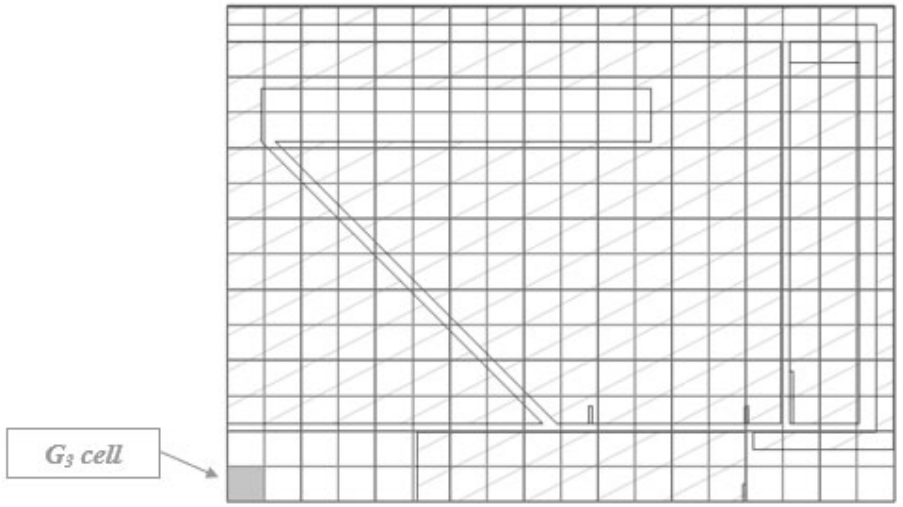
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		 **N3 = 140** As shown below 112 numbered G3 cells do not "include at least a point of the antenna contour." '677 Patent, 19:61-67. Thus, the G3 cell count N_3=(252-112)=140.

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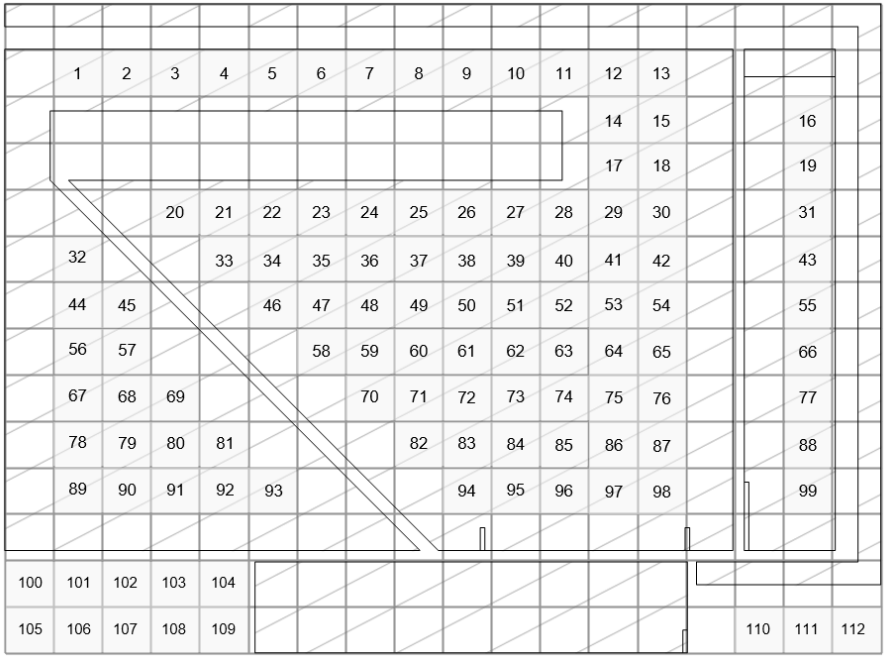
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		 The top edge of cells numbered 1-13 is 2.036 mm (a G3 cell height) from the top of the antenna rectangle. The nearest antenna contour edge is 2 mm from the top of the antenna rectangle and thus lies above and is not included in cells 1-13. Ciais-Quadband, Fig. 1(b), 148. **Calculation F32 = 1.57** The complexity factor F32 for the quadband antenna contour is thus:

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		$$F_{32} = -\left(\frac{\log(N_3) - \log(N_2)}{\log(1/2)}\right) = -\left(\frac{\log(140) - \log(47)}{(-1)\log(2)}\right)$$ $$= \left(\frac{\log(140/47)}{\log(2)}\right) = \left(\frac{0.474}{0.301}\right) = 1.57.$$ '677 Patent, 20:1-5.
1[j]	complexity factor F_{32} having a value less than 1.75; and	Dou expressly or inherently discloses this claim element. *See* Claim 1[i].
1[k]	a second antenna within the wireless device and	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband meets 1[k] at least two ways. As discussed in Claim 1[a], Dou+Ciais-Quadband comprises Dou's GPS antenna (1575 MHz) and an antenna for WiFi and Bluetooth (ISM 2.4 GHz). Dou, [0022], [0040]. ***First***, Dou+Ciais-Quadband meets 1[k] wherein Dou's GPS antenna is the second antenna because the 1575 frequency band for GPS L1 is not covered by and is different from any

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		communication band covered by the Ciais quadband antenna. Ciais-Quadband, Fig. 3, 148-149. ***Second***, Dou+Ciais-Quadband meets 1[k] wherein Dou's antenna for WiFi and Bluetooth is the second antenna because the Ciais quadband antenna does not cover the 2400-2500 MHz (e.g., 2.4 GHz ISM band) used by WiFi or Bluetooth. Ciais-Quadband, Fig. 3, 148-149.
1[l]	configured to support at least one frequency band different from the at least three frequency bands supported by the first antenna,	Dou expressly or inherently discloses this claim element. *See* Claim 1[k].
1[m]	the second antenna being arranged completely within the ground plane rectangle.	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband meets 1[m] for each mapping of a "second antenna" in 1[e]. Dou describes antenna 208, mounted over ground plane 210, within the "ground plane rectangle" defined by the perimeter of PCB 204, covering frequencies for GPS and WiFi/Bluetooth. Dou, Figs. 2A-2B, [0022]. Thus, in that embodiment, Dou shows that it was conventional to provide GPS and WiFi/Bluetooth coverage with an antenna mounted over a ground plane and thus within a "ground plane rectangle." Ollikainen also describes a GPS antenna (64), WLAN antenna 61, and Bluetooth antenna 66 disposed on a PCB 20. Ollikainen, Fig. 9 (below), [0044] (GPS antenna 64, WLAN antenna 61, Bluetooth antenna 66).

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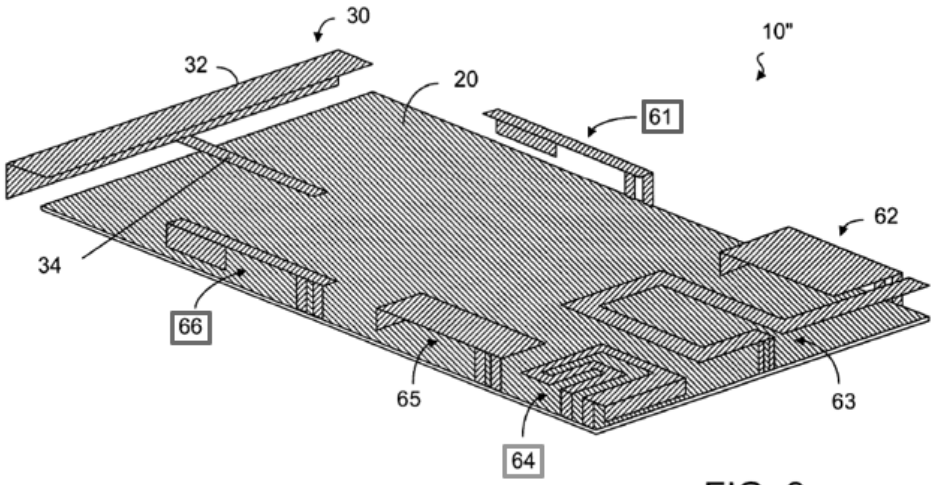
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		 FIG. 9 Ollikainen explains that PCB 20 ("printed wire board (PWB 20)") is a ground plane. Ollikainen, [0035] ("PWB 20 with a ground plane"), [0038] (same), [0047] ("the ground plane (PWB)"). Ollikainen confirms that it was conventional to dispose a GPS antenna and a WiFi (WLAN) or Bluetooth antenna over a rectangular ground plane (e.g., spanning the back of the PCB as taught in Ciais), and hence within a ground plane rectangle defined by the ground plane's boundary. Thus, Dou+Ciais-Quadband would have arranged Dou's GPS and WiFi and Bluetooth antennas "completely within the ground plane rectangle" meeting 1[h] because this was conventional and Dou describes arranging antennas for those frequencies over a ground plane.

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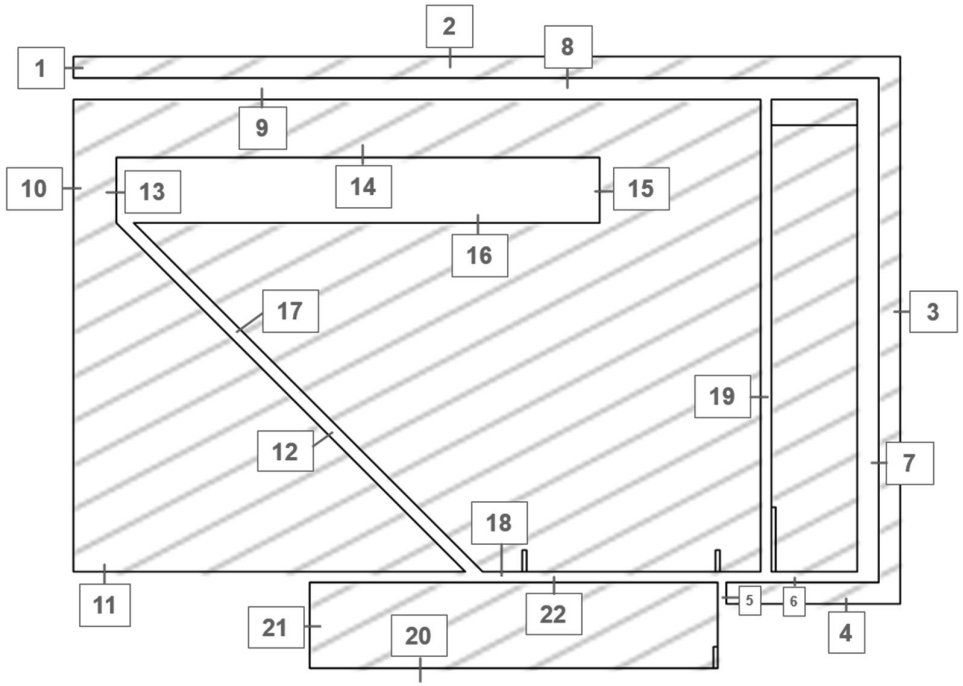
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		Claim 2
2	The wireless device of claim 1, wherein the first antenna contour comprises at least 20 segments.	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband's "first antenna" (the Ciais quadband antenna) meets claims 2 because the antenna contour has "at least 20 segments" (claim 2). 

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
Claim 3		
3	The wireless device of claim 2, wherein the perimeter of the first antenna contour comprises at least 35 segments.	Dou expressly or inherently discloses this claim element. *See, e.g.*, In litigation Fractus argues that counting an antenna contour's interior segments meets claim 3. Plaintiff's Disclosure of Asserted Claims and Infringement Contentions Against Geotab Pursuant to Local Patent Rules 3-1 and 3-2, Fractus, S.A., v. Geotab Inc., No. 2:24-cv-01008 (E.D. Tex.), served March 12, 2025, Chart 45 at 11 (counting segments 11-13, 15-18, 20-30, 34, detail below).

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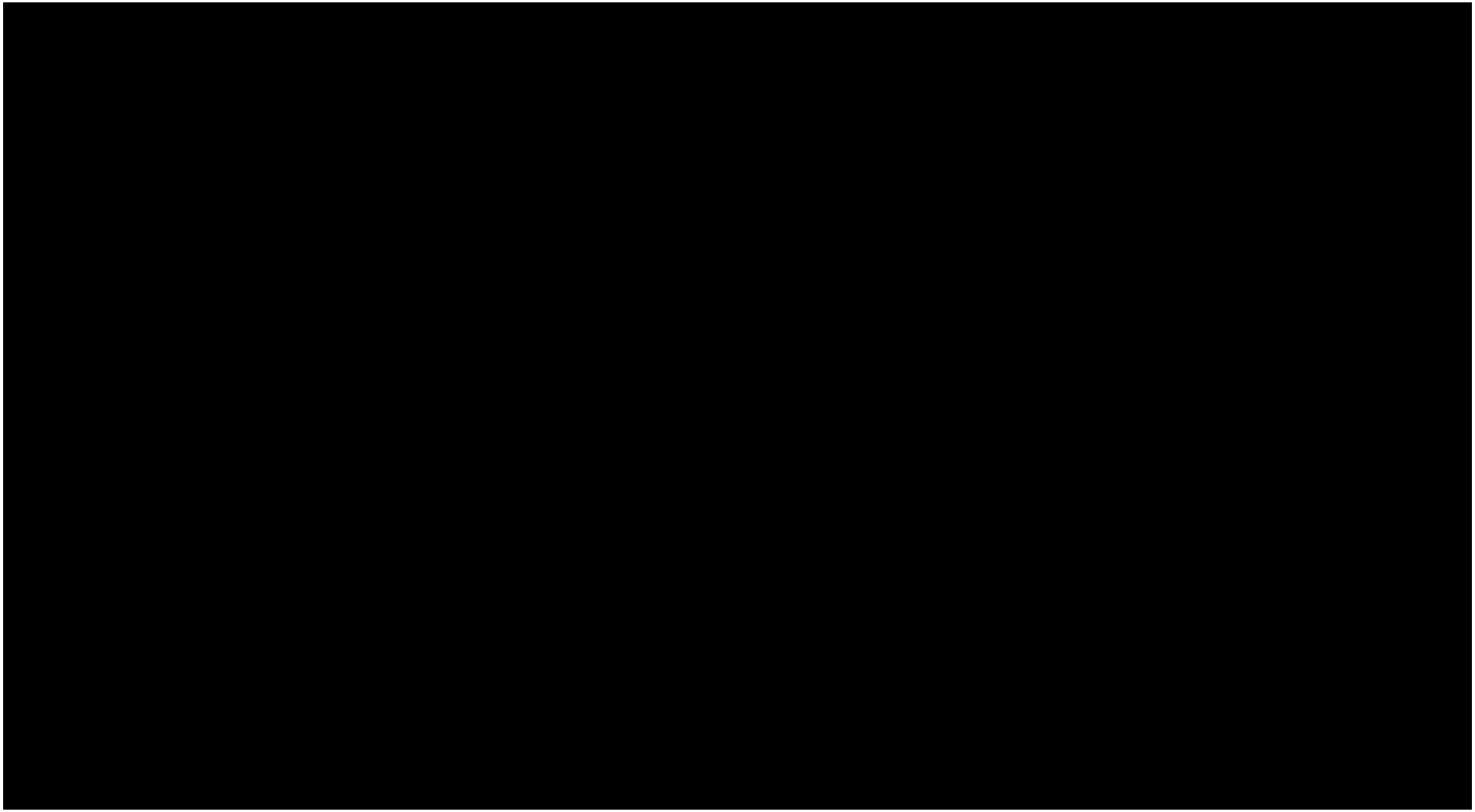
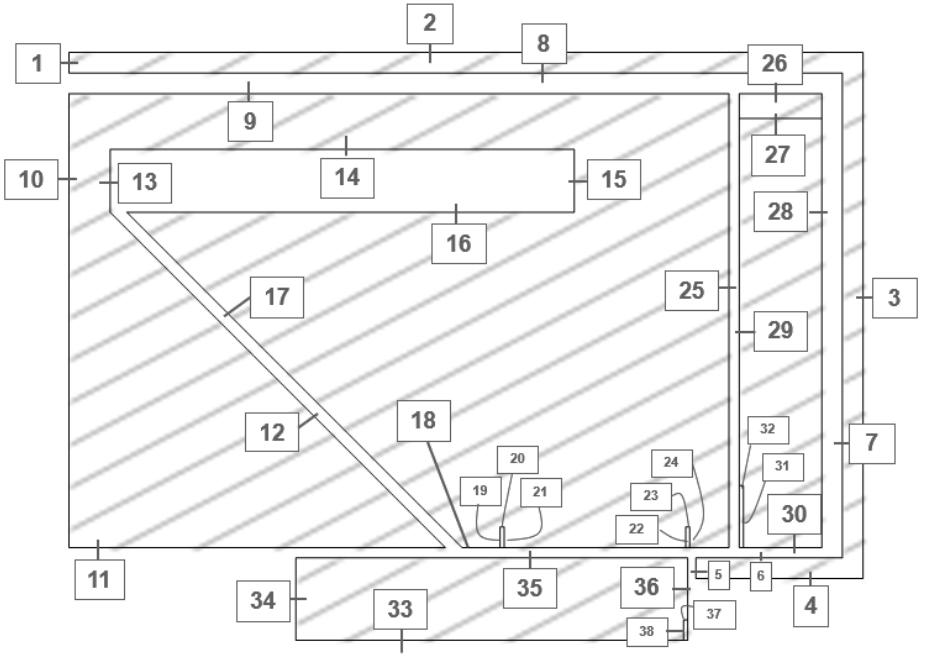


Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		
Claim 4		
4	The wireless device of claim 1, wherein the antenna system comprises a third antenna configured to receive signals	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband meets claim 4 at least two ways.

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
	employing a 4G communication standard.	First, Dou+Ciais-Quadband uses a Ciais quadband antenna as antenna 208. The quadband antenna is "configured to receive signals employing a 4G communication standard" as explained supra (1[c]). Thus, Dou+Ciais-Quadband meets claim 4 wherein the second Ciais quadband antenna, implementing Dou antenna 208, is the "third antenna." Second, Dou+Ciais-Quadband comprises a Dou WiFi/Bluetooth antenna. Supra 1[a]. The '677 patent expressly describes WiFi as a "4G service" having a corresponding "4G standard" ('677 Patent, 25:1-6). Thus, Dou+Ciais-Quadband meets claim 4 wherein Dou's WiFi antenna is the "third antenna."
Claim 5		
5[a]	The wireless device of claim 4, wherein the third antenna defines an antenna contour comprising an entire perimeter of the third antenna, and	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband meets claim 5 when the Ciais quadband antenna (Dou antenna 208) is mapped to the "third antenna" because the quadband has an "entire perimeter" that defines an antenna contour (supra (1[d])) with F21 > 1.2 and F32 > 1.35 as explained supra ([1[d]).
5[b]	wherein the antenna contour of the third antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	Dou expressly or inherently discloses this claim element. *See* Claim 5[a].
5[c]	a complexity factor F_{32} having a value of at least 1.35.	Dou expressly or inherently discloses this claim element.

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		See Claim 5[a].
Claim 6		
6[pre]	A wireless device comprising:	To the extent the preamble is limiting, Dou expressly or inherently discloses this claim element. *See* Claim 1[pre].
6[a]	an antenna system comprising:	Dou expressly or inherently discloses this claim element. *See* Claim 1[a].
6[b]	[*the antenna system comprising*] a ground plane;	Dou expressly or inherently discloses this claim element. *See* Claim 1[b].
6[c]	[*the antenna system comprising*] a first antenna within the wireless device and	Dou expressly or inherently discloses this claim element. *See* Claim 1[c].

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
6[d]	configured to support at least two frequency bands contained within first and second frequency ranges of the electromagnetic spectrum,	Dou expressly or inherently discloses this claim element. *See* Claim 1[d].
6[e]	the second frequency range being higher in frequency than the first frequency range,	Dou expressly or inherently discloses this claim element. *See* Claim 1[e].
6[f]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	Dou expressly or inherently discloses this claim element. *See* Claim 1[g].
6[g]	defining a first antenna contour comprising an entire perimeter of the first antenna,	Dou expressly or inherently discloses this claim element. *See* Claim 1[h].
6[h]	wherein the first antenna contour has a level of complexity defined by	Dou expressly or inherently discloses this claim element.

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
	complexity factor F_{21} having a value of at least 1.20 and	*See* Claim 1[i].
6[i]	complexity factor F_{32} having a value less than 1.75; and	Dou expressly or inherently discloses this claim element. *See* Claim 1[i].
6[j]	[*the antenna system comprising*] a second antenna within the wireless device and	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband's Ciais quadband antenna that implements Dou antenna 208 within the wireless device (supra (1[c]) defines a "second antenna contour comprising an entire perimeter of the second antenna" for the reasons the first Ciais quadband antenna (Dou antenna 206) meets 1[d].
6[k]	defining a second antenna contour comprising an entire perimeter of the second antenna,	Dou expressly or inherently discloses this claim element. *See* Claim 6[j].
6[l]	the second antenna being proximate to a second short side of the ground plane rectangle that is opposite to the	Dou expressly or inherently discloses this claim element. *See, e.g.*,

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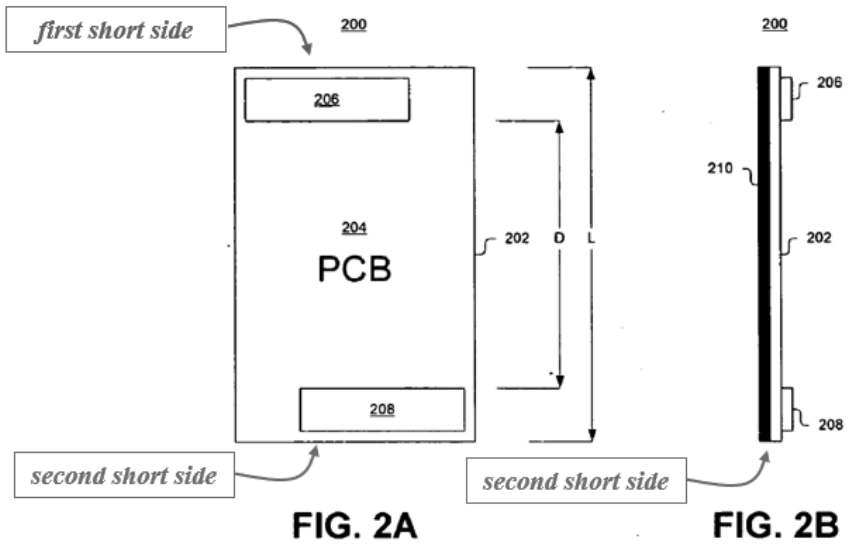
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
	first short side of the ground plane rectangle,	Dou+Ciais-Quadband's antenna 208 ("second antenna") is positioned along (proximate to) "a second short side" of PCB 204 that is opposite to the first short side, which is also the "second short side of the ground plane rectangle." Supra (1[d]); Dou, Fig. 2A, [0016]-[0017].  FIG. 2A FIG. 2B
6[m]	a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband meets 6[i] because it has an "antenna box" defined by "a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the" Ciais

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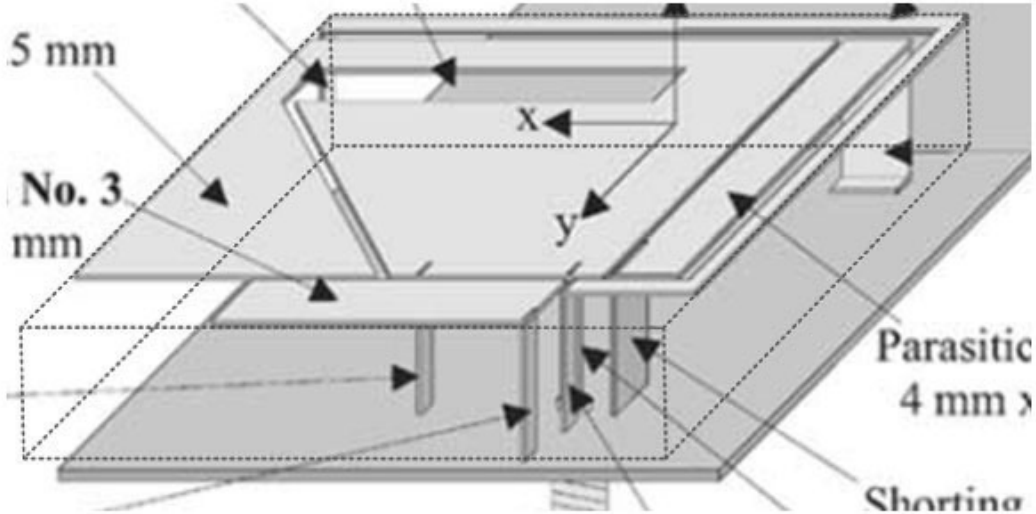
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
	antenna defining an antenna box, and	quadband antenna ("second antenna") as shown by the dotted red outline in Ciais-Quadband Fig. 1(a) (annotated below). 
6[n]	an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining	Dou expressly or inherently discloses this claim element. *See, e.g.*, Limitation 6[g] recites in part the specification's "antenna contour" definition. Dou+Ciais-Quadband meets 6[n] because the second Ciais quadband antenna has an "antenna contour" formed by this orthogonal projection step through the quadband antenna "main patch" as explained supra (1[g]).

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
6[o]	an antenna rectangle,	Dou expressly or inherently discloses this claim element. *See* Claim 6[n].
6[p]	wherein a length of the second antenna contour is greater than four times a diagonal of the antenna rectangle.	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband's second antenna (the quadband antenna) has a 38.5 mm × 28.5 mm antenna rectangle with a diagonal of ((38.5)^2+(28.5)^2)^0.5=47.9 mm, and 4×47.9 mm=191.6 mm. The quadband antenna contour is longer than 191.6 mm, meeting [6.k]. The segments bounding regions A, B, and C alone (denoted below) are 240.2 mm > 191.6 mm long. Ciais-Quadband, Fig. 1(b).

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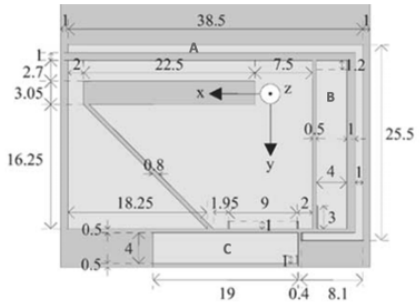
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		 **Region** / **Feature** / **mm** **A** top leg 38.5 37.5 1 right leg 25.5 23.5 bottom leg 8.1 1 7.1 **B** top 4 bottom 4 sides 22 22 **C** top 19 bottom 19 sides 4 4 **TOTAL: 240.2**
Claim 7		
7	The wireless device of claim 6, wherein the first antenna contour comprises at least 20 segments.	Dou expressly or inherently discloses this claim element. *See* Claim 2.
Claim 8		
8	The wireless device of claim 6, wherein the first antenna	Dou expressly or inherently discloses this claim element.

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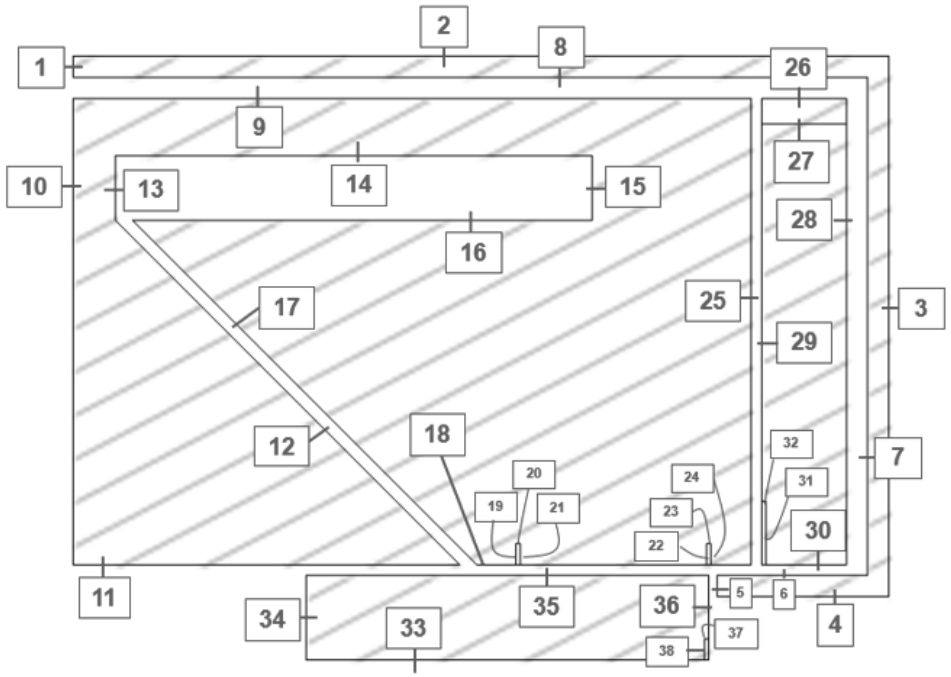
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
	contour comprises at least 35 segments.	*See, e.g.*, Dou+Ciais-Quadband meets claim 8 because for Ciais's quadband antenna the "antenna contour" has "at least 35 segments" (claim 3) as shown below. 

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
Claim 9		
9[a]	The wireless device of claim 6, wherein the second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	Dou expressly or inherently discloses this claim element. *See, e.g.*, The "second antenna" is a Ciais quadband antenna. Supra (6[j]). Dou+Ciais-Quadband meets claim 9 for the reasons the Ciais quadband antenna meets the same complexity factor limitations in 5[a] (where the Ciais quadband antenna is mapped to a "third antenna"). Supra Claim 5.
9[b]	a complexity factor F_{32} having a value of at least 1.35.	Dou expressly or inherently discloses this claim element. *See* Claim 9[b].
Claim 12		
12[pre]	A wireless device comprising:	To the extent the preamble is limiting, Dou expressly or inherently discloses this claim element. *See* Claim 1[pre]. 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 POSITA would have understood it to implicitly disclose it or would have found the claim limitation obvious.

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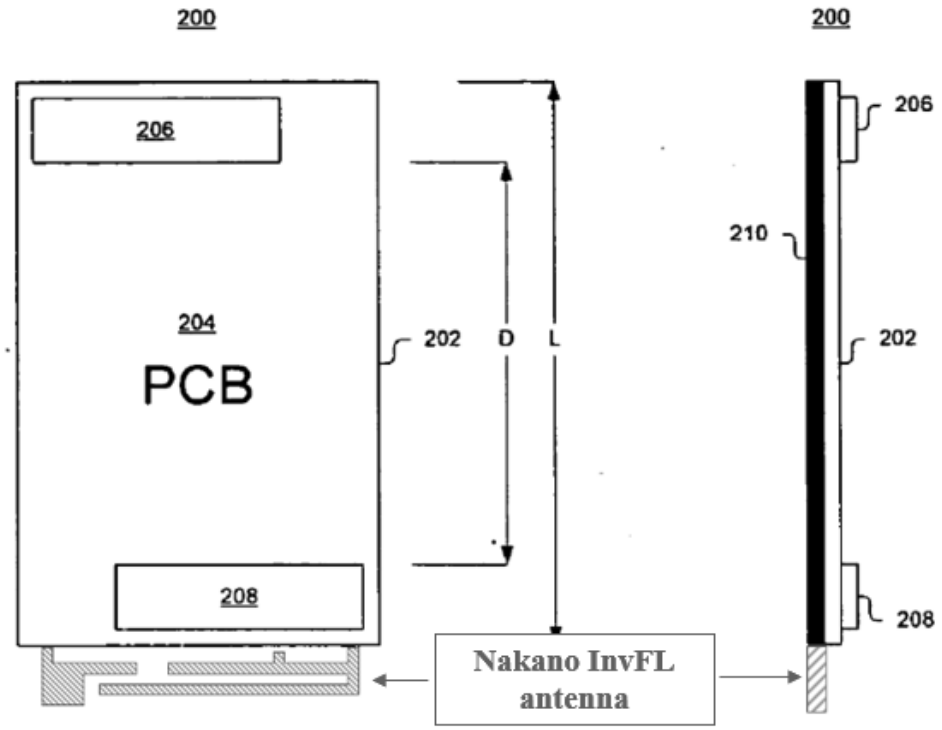
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		***See, e.g.*, Nakano:** A POSA would have had reasons to use Ciais's quadband antenna to implement Dou's antennas 206 and 208, alongside Dou's GPS antenna, as explained supra 1[a]. A POSA would have had reasons to use Nakano's WLAN antenna in Dou—instead of the Dou WiFi/Bluetooth antenna in Dou+Ciais-Quadband—because Nakano's antenna covered the 5.2 GHz band as 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 (which Dou's antenna covered). 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), 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), 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 reasons to include Nakano's antenna in Dou's wireless device. 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 preserved this placement in Dou's wireless device by placing the InvFL antenna coplanar with ground plane 210 (Dou, Fig. 2B) and extending it from the ground plane as shown below, similar to Dou's Figure 3B

Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		laterally offsetting antenna 308 below ground plane 310. Dou, Figs. 2A-2B (modified below), 3B, [0016]-[0017].  A POSA would have had a reasonable expectation of success in combining Ciais and Nakano's teachings with Dou (hereinafter "Dou+Ciais-Quadband+Nakano") for the reasons explained supra 1[a], and because Nakano's antenna was designed for internal use in "mobile phone handsets" like Dou's wireless device. Nakano, 2417. Combining multiple antennas

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		within a single wireless device was conventional and within the POSA's ordinary skill. Supra 1[a]; Ollikainen, Fig. 9. 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.
12[a]	an antenna system comprising:	Dou expressly or inherently discloses this claim element. *See* Claim 1[a].
12[b]	[*the antenna system comprising*] a ground plane;	Dou expressly or inherently discloses this claim element. *See* Claim 1[b].
12[c]	[*the antenna system comprising*] a first antenna within the wireless device and	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets 12[c] because Ciais's quadband antenna (first antenna) is disposed within Dou's device and is "configured to provide operation" in at least 25 frequency bands as explained supra (1[c]). The quadband antenna covers a first frequency

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		range 870-960 MHz (supporting at least 4 frequency bands) and a second frequency range 1710-2170 MHz (supporting at least 21 frequency bands). *Id*.
12[d]	configured to provide operation in at least four frequency bands,	Dou expressly or inherently discloses this claim element. *See* Claim 12[c].
12[e]	at least one of the at least four frequency bands is contained within a first frequency range and	Dou expressly or inherently discloses this claim element. *See* Claim 12[c].
12[f]	at least one other of the four frequency bands is contained within a second frequency range,	Dou expressly or inherently discloses this claim element. *See* Claim 12[c].
12[g]	the first frequency range being lower in frequency than the second frequency range,	Dou expressly or inherently discloses this claim element. *See* Claim 1[e].
12[h]	the first antenna being proximate to a first short side	Dou expressly or inherently discloses this claim element.

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
	of a ground plane rectangle enclosing the ground plane,	*See* Claim 1[g].
12[i]	the first antenna defining a first antenna contour comprising an entire perimeter of the first antenna, and	Dou expressly or inherently discloses this claim element. *See* Claim 12[h].
12[j]	wherein the first antenna 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* Claim 1[i].
12[k]	complexity factor F_{32} having a value less than 1.75; and	Dou expressly or inherently discloses this claim element. *See* Claim 12[j].
12[l]	wherein the first antenna is configured to transmit and receive signals from a 4G communication standard; and	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets 12[l] because the Ciais quadband antenna is operable to "transmit and receive" signals that correspond to a "4G communication standard" as explained supra (1[e]), and for the reasons that the quadband antenna (as a third antenna in

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		claim 4) meets claim 4 (receive signals…) supra Claim 4. Ciais-Quadband, 148 ("antenna can operate from 880 to 960 MHz and 1710-2170 MHz").
12[m]	[*the antenna system comprising*] a second antenna within the wireless device and configured to receive signals from a 4G communication standard,	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets 12[m] because Nakano's InvFL antenna (second antenna) covers (is configured to receive signals) "2.45 GHz" (e.g., 2400-2500 MHz) and 5.2 GHz, which are "frequencies used for wireless LAN communications." Nakano, 2417. The WLAN standards (e.g., (IEEE Std. 802.11a), 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))—which are used for "WiFi" ('677 Patent, 25:1-6)—are "4G communication standards" as Fractus argued in litigation. '677 Patent, 10:14-23 ("WiFi (IEEE802.11 standards)"); 25:1-18 (WiFi is "4G service" corresponding to a "4G standard[]").
12[n]	a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second antenna defining an antenna box,	Dou expressly or inherently discloses this claim element. *See, e.g.*, Limitation 12[n] recites the specification's definition of "antenna box." Dou+Ciais-Quadband+Nakano meets 12[n] because a POSA could define an "antenna box" comprising "a minimum-sized parallelepiped of rectangular faces that completely encloses a volume" of Nakano's InvFL antenna with planar dimensions as described in Nakano and thickness of a conventional ground plate (e.g., the thickness of Dou's ground plane 210).

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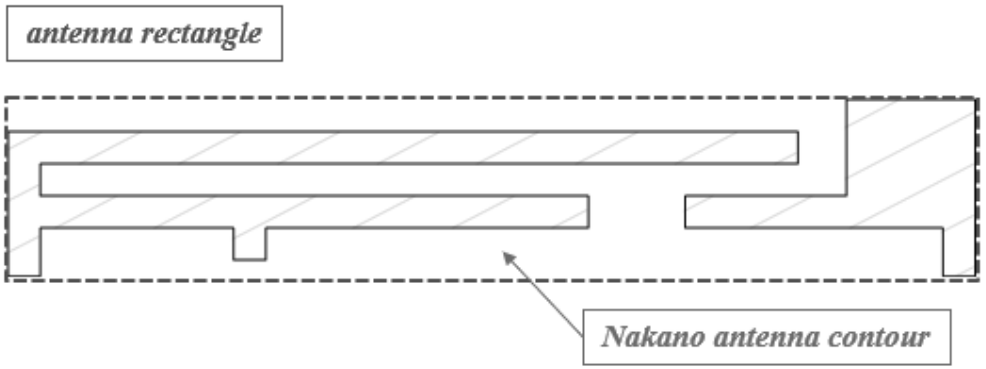
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
12[o]	an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining	Dou expressly or inherently discloses this claim element. *See, e.g.*, Limitation 12[o] recites the specification's definition of "antenna rectangle." Dou+Ciais-Quadband+Nakano meets 12[o] because Nakano's InvFL antenna has an "antenna contour," and the antenna contour is bounded by an antenna rectangle and is formed by orthogonal projection through the antenna box meeting 12[o]. 
12[p]	an antenna rectangle,	Dou expressly or inherently discloses this claim element. *See* Claim 12[o].

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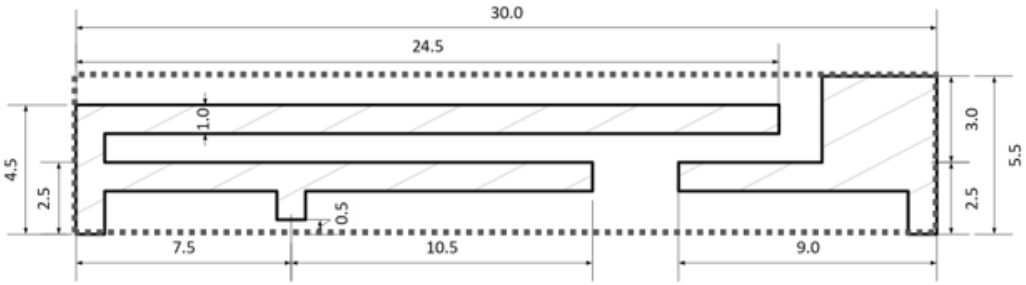
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
12[q]	an aspect ratio of the antenna rectangle being defined as a ratio between a width and a height of the antenna rectangle, and wherein the aspect ratio has a value of at least 2.	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets 12[q] because the InvFL antenna's 30 mm × 5.5 mm antenna rectangle (purple outline below) has an "aspect ratio" (30/5.5)=5.45>2. Nakano, Fig. 1, 2417-2418. 
Claim 13		
13	The wireless device of claim 12, wherein the first antenna contour comprises at least 20 segments.	Dou expressly or inherently discloses this claim element. *See* Claim 2.
Claim 14		

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
14	The wireless device of claim 13, wherein the first antenna contour comprises at least 35 segments.	Dou expressly or inherently discloses this claim element. *See* Claim 8.
Claim 15		
15	The wireless device of claim 12, wherein the second antenna is proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle.	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets claim 15 because Nakano's InvFL extends from a "co-planar ground plate" on the "short side" of a rectangular "card-type structure." Nakano, 2417, Fig. 1. A POSA would have preserved this placement in Dou's wireless device by placing the InvFL antenna coplanar with ground plane 210 (Dou, Fig. 2B) and extending it from the "second short side" of the ground plane rectangle (which is opposite to the first short side) enclosing the ground plane, similar to Dou's Figure 3B laterally offsetting antenna 208 below ground plane 310. Supra 1[g]; Dou, Figs. 2A-2B (modified below), [0016]-[0017].

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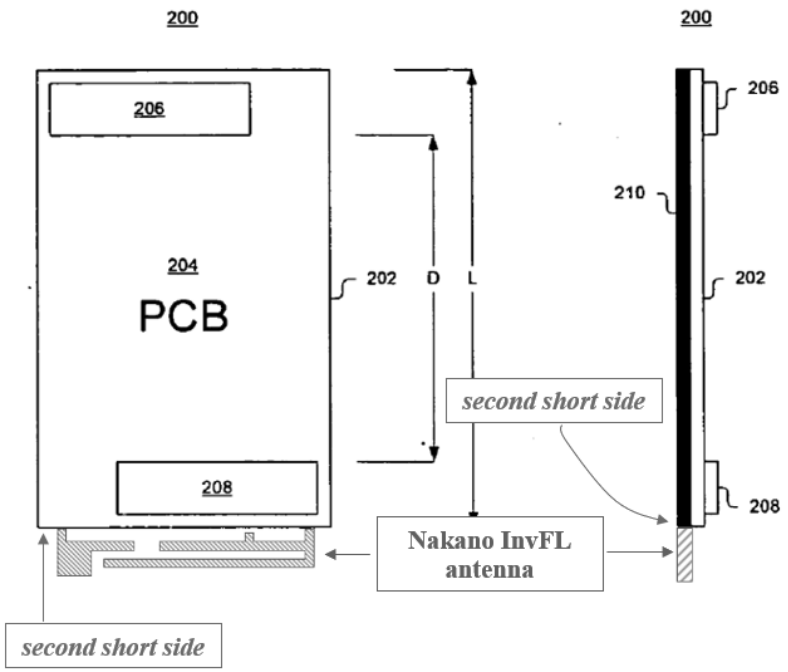
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		
		Claim 16
16[a]	The wireless device of claim 12, wherein the second antenna defines a second antenna contour comprising an	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets 16[a] wherein Nakano's inverted FL ("InvFL") antenna is the "third antenna" because Nakano's InvFL antenna defines a third antenna contour

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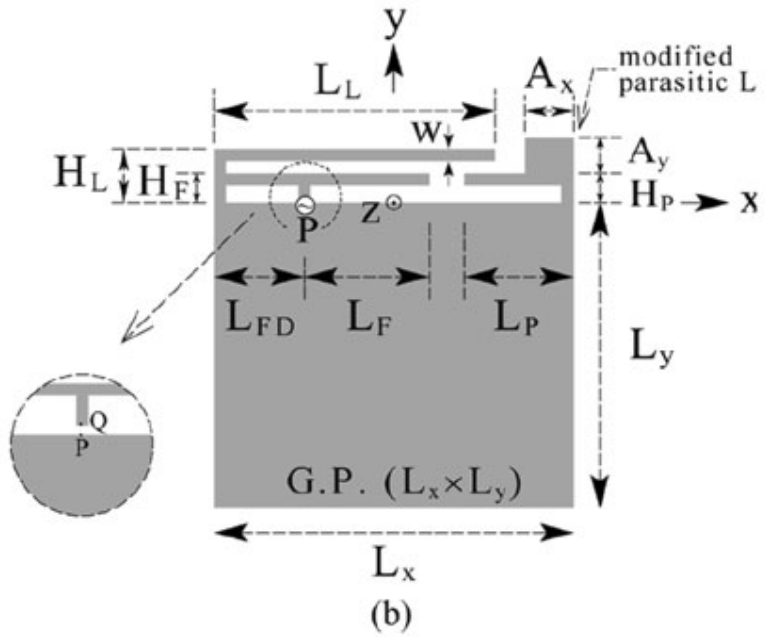
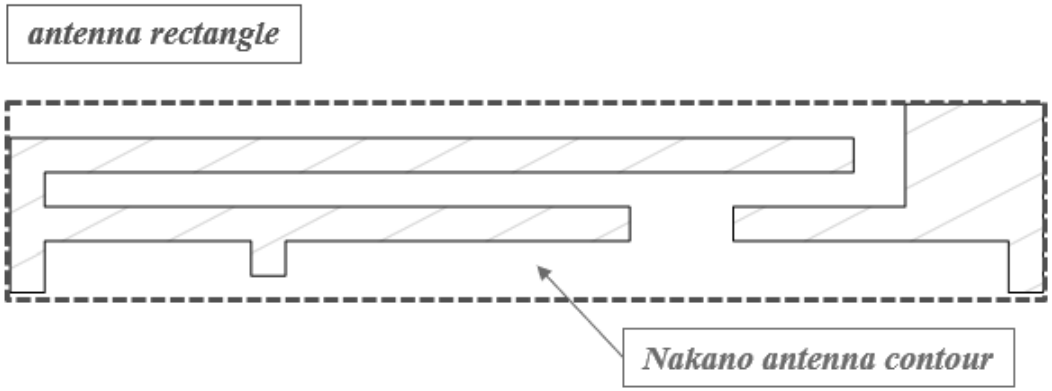
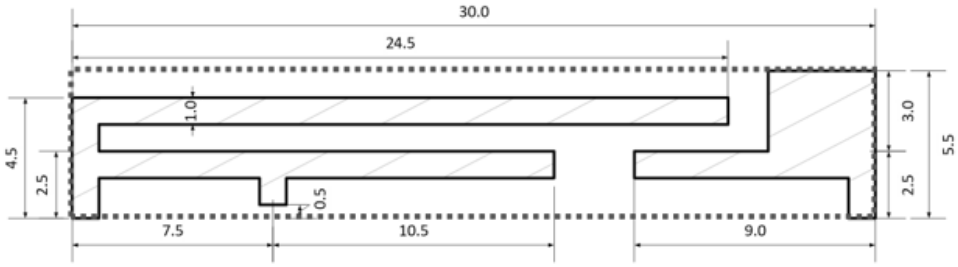
Claim No.	U.S. Patent No. 11,031,677 B2	Dou
	entire perimeter of the second antenna,	comprising the entire perimeter of the InvFL antenna. Nakano's contour is based on Figure 1(b) (detail below) and the dimensions provided in the caption to Figure 4. Nakano, 2417, 2419, Fig. 1(b). 

Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		
16[b]	and wherein the second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets 16[b] because as shown below, the InvFL antenna contour ("third antenna contour") meeting 16[a] has complexity factor F21 = 1.49 ("at least 1.20") and F32 = 1.46 ("less than 1.75"). **<u>Calculating F21</u>** **Grid G2** Nakano's InvFL antenna has a 30 mm × 5.5 mm antenna rectangle (purple outline below).

Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		 The ’677 specification states that grid G2 is formed by tessellating the antenna contour with an odd number of rows and columns. ’677 Patent, 17:18-22. As the ADT court recognized, “a skilled artisan would not understand the patent to require G2 to be constructed using 9 columns. To the contrary, the patents expressly contemplate the use of a different number of columns.” D.I. 115, Claim Construction Order, Fractus, S.A. v. ADT LLC, No. 2:22-cv-00412 (E.D. Tex. Feb. 25, 2024) (Payne, M.J.), 27 (emphasis in original); see also ’677 Patent, 17:18-22 (“the size of a cell and its aspect ratio… are first chosen so that the antenna rectangle is perfectly tessellated with an odd number of columns and an odd number of rows.”); 17:39-42 (explaining “setting to nine (9) the number of columns that tessellate the antenna rectangle provides an advantageous compromise, for the preferred sizes of [a wireless device],” but omitting any measurements for those “preferred sizes”). Here, a grid G2 with 15 columns yields a cell width ((30 mm)/15)=2 mm. Evaluating one, three and five rows provides:

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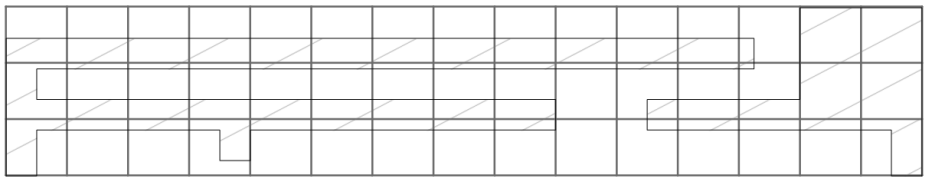
Claim No.	U.S. Patent No. 11,031,677 B2	Dou

# rows	cell height (mm)	aspect ratio
1	$\left(\frac{5.5\ mm}{1}\right) = 5.5$	$\left(\frac{2}{5.5}\right) = 0.36$
3	$\left(\frac{5.5\ mm}{3}\right) = 1.83$	$\left(\frac{2}{1.83}\right) = 1.09$
5	$\left(\frac{5.5\ mm}{5}\right) = 1.1$	$\left(\frac{2}{1.1}\right) = 1.82$

Therefore three rows provides grid cells "as square as possible," e.g., an aspect ratio closest to one. '677 Patent, 16:62-65, 17:18-64. Thus, grid G2 with fifteen (15) columns and three (3) rows has cells "as square as possible[.]"

N2 = 45

Below the 3 x 15 grid G2 (blue outline) tessellates the antenna rectangle bounding the quadband antenna contour. Each cell "include[s] at least a point of the antenna contour," so that the G2 cell count N_2=45. '677 Patent, 19:1-7.



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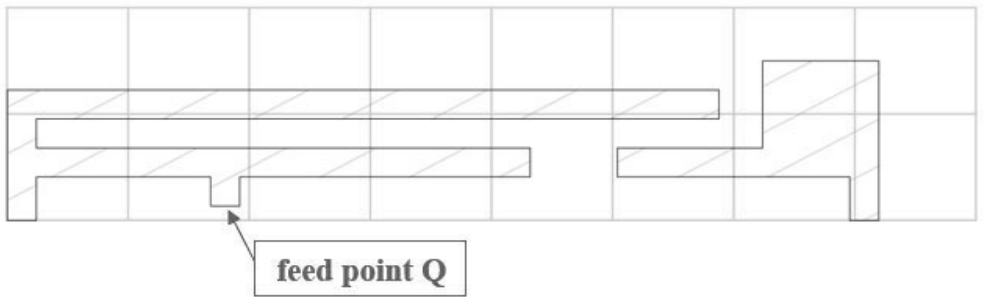
		Grid G1 The InvFL antenna feed for the lowest frequency operation at point Q is closest to the bottom left corner ("feed point corner") of the antenna rectangle. Nakano, Fig. 1, 2417-2418 ("feed point location LFD"). Grouping four G2 cells (blue grid lines) into a single G1 cell results in the 2 x 8 grid G1 shown below (orange grid lines).  **N1 = 16** Each G1 cell "include[s] at least a point of the antenna contour." '677 Patent, 19:1-7. Thus, the G1 cell count N_1=16. **Calculation F21 = 49** The complexity factor F21 for the InvFL antenna contour is thus:

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Claim No.	U.S. Patent No. 11,031,677 B2	Dou

$$F_{21} = -\left(\frac{\log(N_2) - \log(N_1)}{\log(1/2)}\right) = -\left(\frac{\log(45) - \log(16)}{(-1)\log(2)}\right)$$

$$= \left(\frac{\log(45/16)}{\log(2)}\right) = \left(\frac{0.449}{0.301}\right) = 1.49.$$

'677 Patent, 19:8-14.

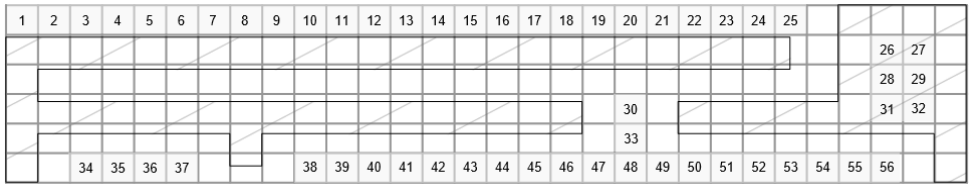
Calculating Grid F32

Grid G3

Grid G3 is 6 rows by 30 columns so that four G3 cells comprise a single G2 cell. '677 Patent, 19:51-60. The G3 cells have width ((30 mm)/30)=1 mm and height (5.5mm/6)=0.917 mm.

N3 = 124

As shown below 56 G3 cells (shaded yellow) do not "include at least a point of the antenna contour." Supra '677 Patent, 19:61-67. Thus, the G3 cell count N_3=(180-56)=124.



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Claim No.	U.S. Patent No. 11,031,677 B2	Dou
		The horizontal antenna contour segment at top left is 1 mm from the top of the antenna rectangle and thus not contained within cells numbers 1-25, which only extend 0.917 mm from the top of the antenna rectangle. **Calculation F32 = 1.46** The complexity factor F32 for the quadband antenna contour is thus: $$F_{32} = -\left(\frac{\log(N_3) - \log(N_2)}{\log(1/2)}\right) = -\left(\frac{\log(124) - \log(45)}{(-1)\log(2)}\right)$$ $$= \left(\frac{\log(124/45)}{\log(2)}\right) = \left(\frac{0.440}{0.301}\right) = 1.46.$$ '677 Patent, 20:1-5.
16[c]	a complexity factor F_{32} having a value of at least 1.35.	Dou expressly or inherently discloses this claim element. *See* Claim 16[b].
Claim 17		
17	The wireless device of claim 16, wherein the second	Dou expressly or inherently discloses this claim element.

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Exhibit – D – 08

INVALIDITY CONTENTIONS FOR U.S. PATENT NO. 11,031,677 B2
BASED ON THE SIEMENS SX66/HTC BLUE ANGEL ("SIEMENS SX66")

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 claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, and 17 ("the '677 Asserted Claims")[1]. These invalidity contentions are not an admission by the Defendants 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 '677 Patent was filed on March 27, 2020, after the AIA came into force on March 16, 2013.

High Tech Computer Corporation's ("HTC") Siemens SX66 product, including also known and sold under the names HTC Blue Angel BSM Windows Mobile 2003 Second Edition PDA-phone, the i-mate PDA2k, the O2 XDA IIs, the Orange SPV M2000, the Dopod 700, the Qtek 9090, the T-Mobile MDA III, the Vodafone VPx, the Verizon XV6600 (Harrier), and the Sprint PPC-6601 (Harrier)[2] (commonly understood and referred to herein as the "Siemens SX66" or "HTC Blue Angel"), was approved for use in the United States on August 27, 2004, and was available for purchase in the United States from Cingular/ AT&T Wireless no later than December 31, 2004[3], which is prior to the critical date of the '677 Patent. Thus, the Siemens SX66 is available as prior art at least under pre-AIA 35 U.S.C. § 102(a)-(b), (g)(2) and/or AIA 35 U.S.C. § 102(a)(1). At least the following documents provide evidence as to the date the Siemens SX66 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"[4]:

[1] Defendants understand that that, by not charting claims 10-11 and 18-20 in its Infringement Contentions, Plaintiff does not assert these claims against Defendants.
[2] *See* Wikipedia.com, Siemens SX66, https://en.wikipedia.org/wiki/HTC_Blue_Angel (last accessed June 13, 2025).
[3] *See* Mobile Tracker Website, "Siemens SX66 Launched by Cingular (Dec. 11, 2004) at: http://www.mobiletracker.net/archives/2004/12/11/siemens_sx66_la.php (last accessed June 16, 2025).
[4] 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 Siemens SX66 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 Siemens SX66. 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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- FCC ID Search, https://www.fcc.gov/oet/ea/fccid (Grantee Code: "NM8"; Product Code: BLUEANGEL"; Record Option: 3/4 "Detail"; Attachment: "antenna spec" (last accessed June 11, 2025) ("FCC Antenna Spec")
- FCC ID Search, https://www.fcc.gov/oet/ea/fccid (Grantee Code: "NM8"; Product Code: BLUEANGEL"; Record Option: 1/4 "Detail"; Attachment: "test report" (last accessed June 11, 2025) ("FCC Bluetooth Test Report")
- FCC ID Search, https://www.fcc.gov/oet/ea/fccid (Grantee Code: "NM8"; Product Code: BLUEANGEL"; Record Option: 1/4 "Detail"; Attachment: "Internal Photo" (last accessed June 11, 2025) ("FCC Internal Photos")
- Phone Scoop Website, "Siemens SX66 / MDA III / PDA2K (HTC Blue Angel)," at: https://www.phonescoop.com/phones/phone.php?p=569 (last accessed June 11, 2025)
- Amazon.com Website; archived February 19, 2005 at: http://web.archive.org/web/20050219103319/http:/www.amazon.com/exec/obidos/tg/detail/-/B0007N3IYK?v=glance (last accessed June 16, 2025).
- Mobile Tracker Website, "Siemens SX66 Launched by Cingular (Dec. 11, 2004) at: http://www.mobiletracker.net/archives/2004/12/11/siemens_sx66_la.php (last accessed June 16, 2025)
- Wikipedia.com, *Siemens SX66*, https://en.wikipedia.org/wiki/HTC_Blue_Angel (last accessed June 13, 2025)

As described in the following claim chart, the asserted claims of U.S. Patent No. 11,031,677 (the "'677 Patent"), are invalid as anticipated by Siemens SX66. To the extent that Siemens SX66 is found not to anticipate one or more of the asserted claims of the '677 Patent, these claims are invalid as obvious in view of Siemens SX66 alone or as modified in view of or in combination with other prior art references disclosed in Defendant's Invalidity Contentions and accompanying charts, including without limitation as set forth below.

- Cingular 8125/HTC Wizard

One of ordinary skill in the art, as of the priority date of the '677 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.[5]

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

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
Claim 1		
1[pre]	A wireless device comprising:	To the extent the preamble is limiting, the Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, *See* Phone Scoop Website, "Siemens SX66 / MDA III / PDA2K (HTC Blue Angel)," at: https://www.phonescoop.com/phones/phone.php?p=569 (last accessed June 11, 2025)

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
1[a]	an antenna system comprising:	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*,

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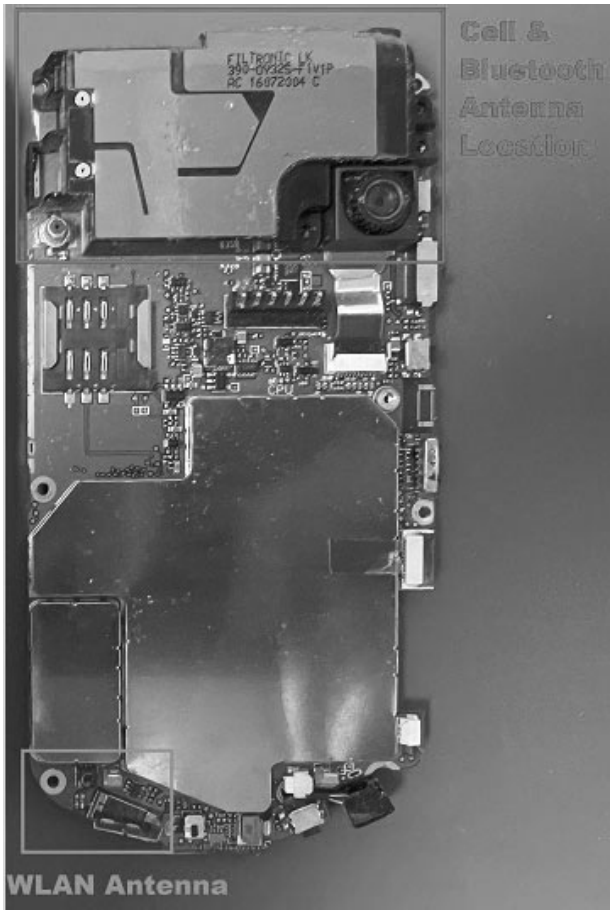
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		

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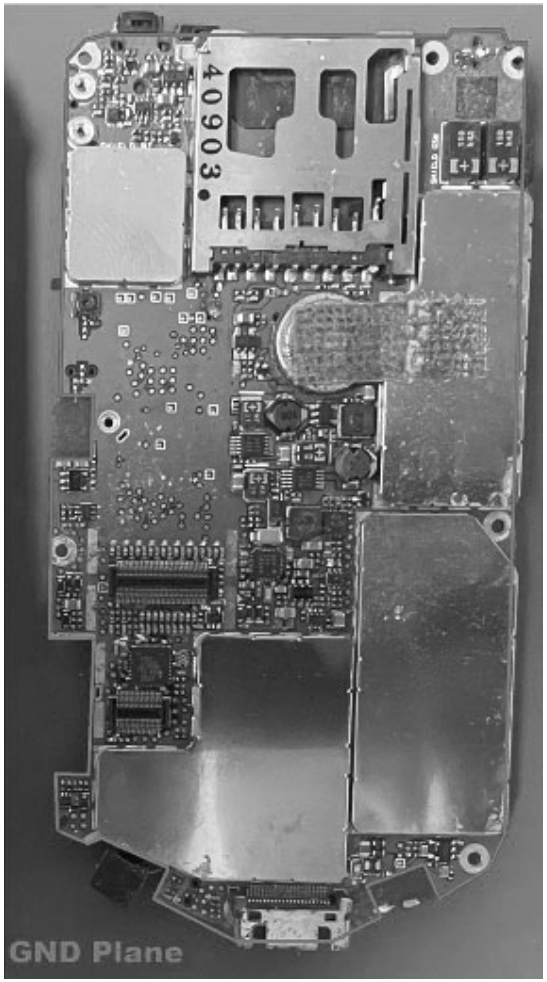
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
1[b]	[*the antenna system comprising*] a ground plane;	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, The ground plane is a metal layer embedded in a printed circuit board that is housed within the plastic housing of the device.

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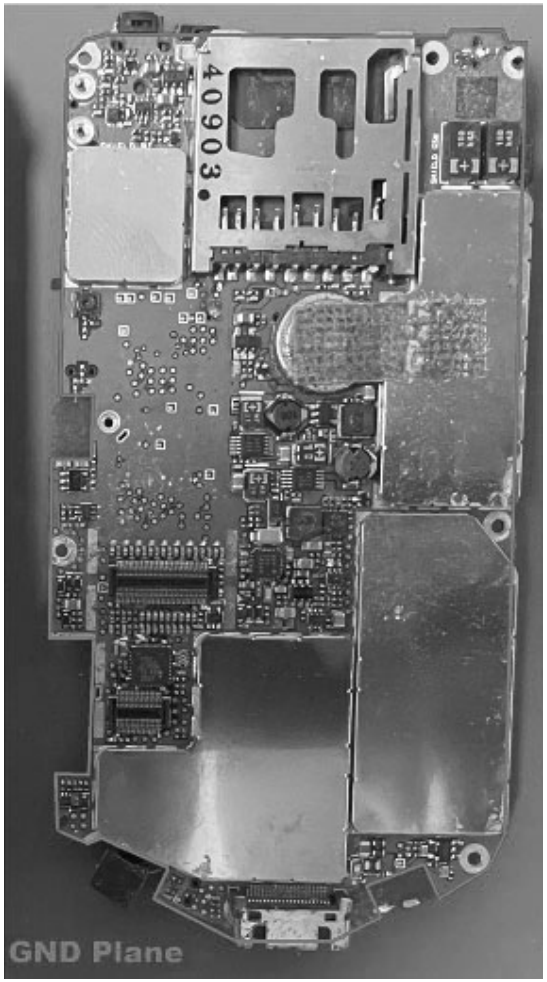
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
1[c]	[*the antenna system comprising*] a first antenna within the wireless device and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the Siemens SX66 has a first antenna (cellular antenna labeled below) within the Siemens SX66.

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
1[d]	[*the antenna system*] configured to support at least three frequency bands contained within first and second frequency ranges of the electromagnetic spectrum,	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, **GSM antenna：** **Antenna Information** Type: **PIFA** Location of antenna: **The top of the system** Dimensions: **Length: 43 mm , Width 30 mm** Configuration: Peak Gain: GSM 850 = -2.5 dBi GSM 900 = -1.5dBi DCS 1800 = -1.5 dBi PCS 1900 = -1.5 dBi *See* FCC Antenna Spec at 1. The at least three frequency bands are contained within first and second frequency ranges of the electromagnetic spectrum, e.g., 824 MHz – 960 MHz and 1710 MHz – 1990 MHz, respectively.
1[e]	the second frequency range being higher in frequency than the first frequency range and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, The second frequency range, e.g., 1710 MHz – 1990 MHz, is higher than the first frequency range, e.g., 824 MHz – 960 MHz.

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
1[f]	at least one of the three frequency bands being associated with a 4G communication standard,	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, At least one of the three frequency bands is associated with a 4G communication standard, e.g., E. Dahlman et al., 3G Evolution: HSPA and LTE for Mobile Broadband (Academic Press 2d ed. 2008).
1[g]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna is proximate to a first short side of a ground plane rectangle enclosing the ground plane.

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		First Short Side

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
1[h]	defining a first antenna contour comprising an entire perimeter of the first antenna,	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*,
1[i]	wherein the first antenna contour has a level of complexity defined by	The Siemens SX66 expressly or inherently discloses this claim element.

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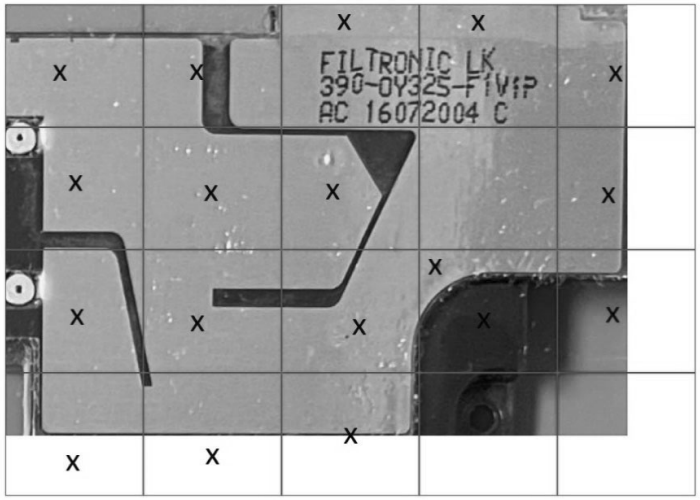
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
	complexity factor F_{21} having a value of at least 1.20 and	*See, e.g.*, The complexity factor calculation is performed according to the method in the patent.  N1=17

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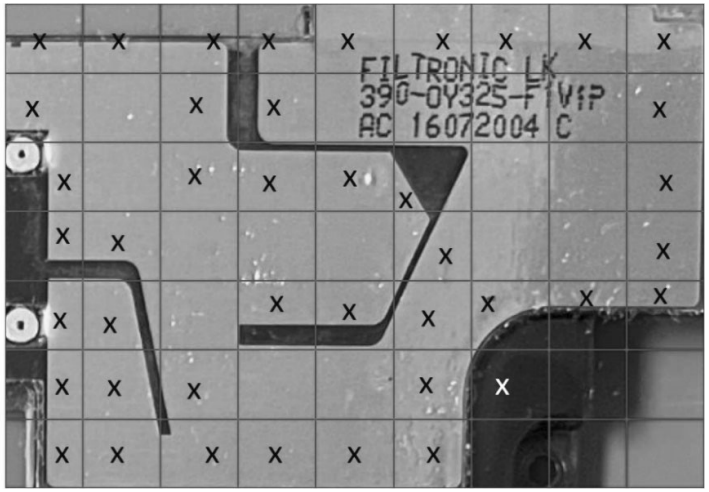
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		 N2=42 F21=log(42/17)/log(2)=1.30
1[j]	complexity factor F_{32} having a value less than 1.75; and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*,

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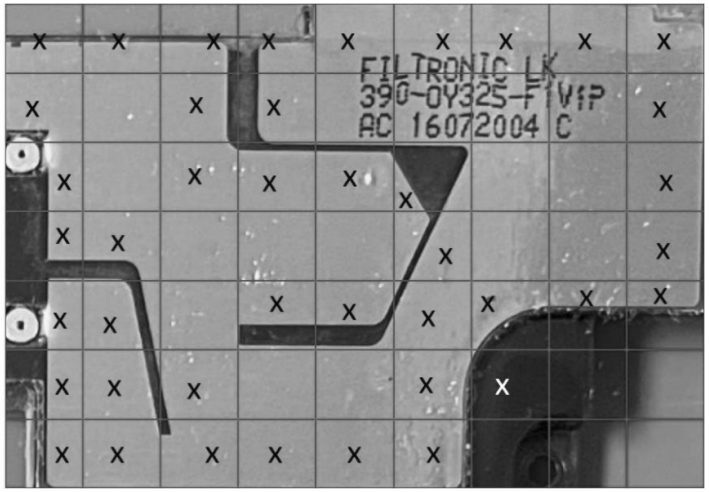
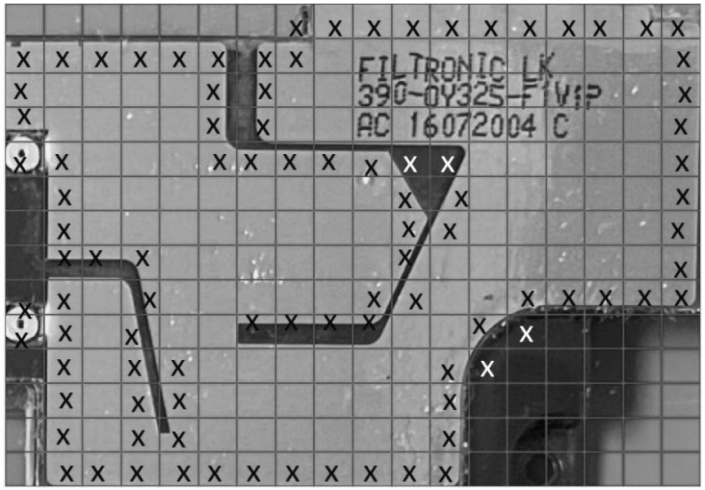
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		 N2=42

Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		 N3=94 F32=log(94/42)/log(2)=1.16
1[k]	a second antenna within the wireless device and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, The Siemens SX66 has a second antenna (Bluetooth antenna labeled below) within the Siemens SX66.

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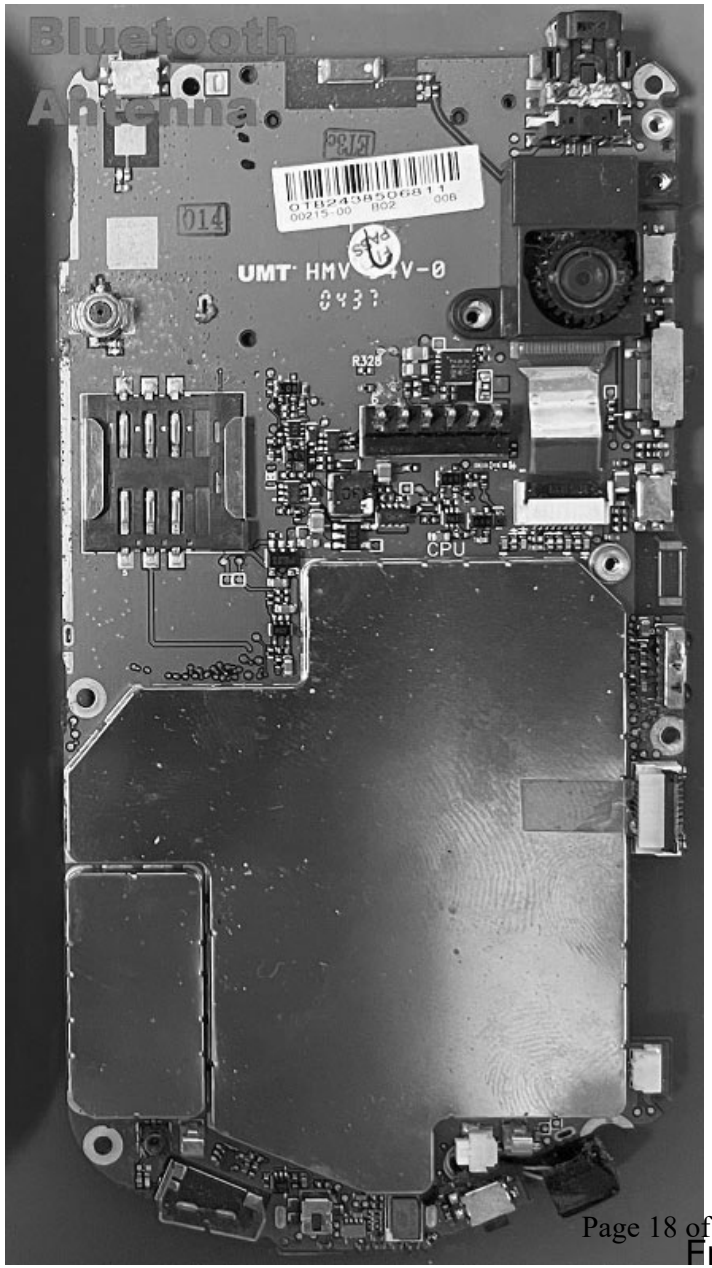

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<table>
<tr><th>Claim No.</th><th>U.S. Patent No. 11,031,677 B2</th><th>Siemens SX66/HTC Blue Angel</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>1[l]</td><td>configured to support at least one frequency band different from the at least three frequency bands supported by the first antenna,</td><td>The Siemens SX66 expressly or inherently discloses this claim element.

See, e.g.,

The second antenna is configured to support at least one frequency band from 2402-2480 MHz, which is different from the at least three frequency bands supported by the first antenna.

<table><tr><td>Frequency Range</td><td>WLAN: 2412 – 2462 MHz
Bluetooth: 2402 MHz – 2480 MHz</td></tr></table>
See FCC Bluetooth Test Report at 4.</td></tr>
<tr><td>1[m]</td><td>the second antenna being arranged completely within the ground plane rectangle.</td><td>The Siemens SX66 expressly or inherently discloses this claim element.

See, e.g.,</td></tr>
</table>

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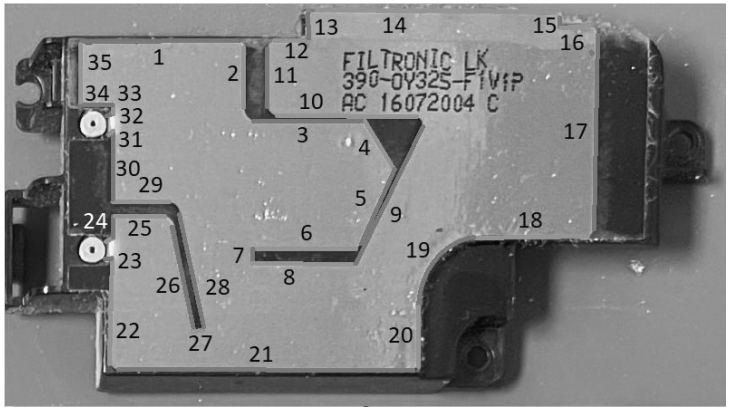
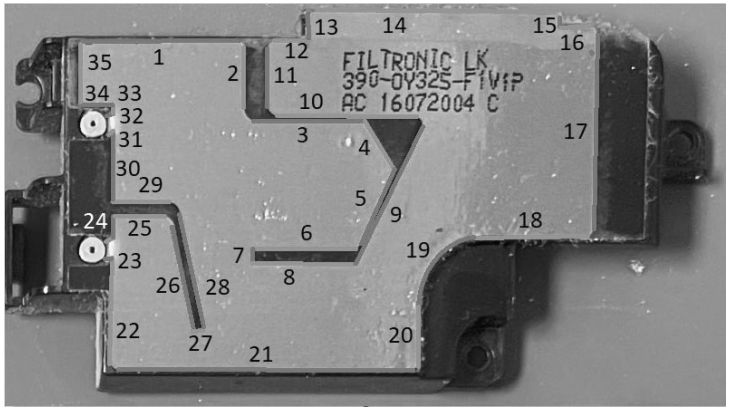
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		Claim 2
2	The wireless device of claim 1, wherein the first antenna contour comprises at least 20 segments.	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna contour comprises at least 20 segments. 
		Claim 3
3	The wireless device of claim 2, wherein the perimeter of the first antenna contour comprises at least 35 segments.	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, The perimeter of the first antenna contour comprises at least 35 segments.

Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		
Claim 4		
4	The wireless device of claim 1, wherein the antenna system comprises a third antenna configured to receive signals employing a 4G communication standard.	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the Siemens SX66 comprises a third antenna (WLAN antenna labeled below) configured to receive signals employing a 4G communication standard.

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		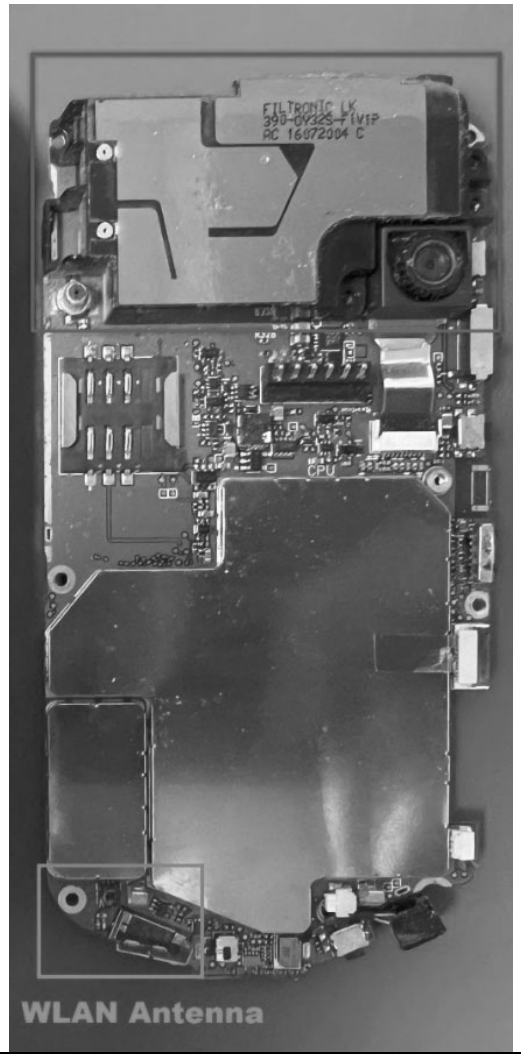

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		  See FCC Bluetooth Test Report at 4.
Claim 5		
5[a]	The wireless device of claim 4, wherein the third antenna defines an antenna contour comprising an entire perimeter of the third antenna, and	The Siemens SX66 expressly or inherently discloses this claim element. To the extent the Siemens SX66 does not expressly or inherently disclose this claim element, it would have been obvious for the WLAN antenna of the Siemens SX66 to be configured as shown below for the WLAN antenna of the Cingular 8125, which expressly or inherently discloses this claim element. For example, the Cingular 8125 WLAN antenna and its respective placement on the circuit board would have facilitated using a different sliding configuration for the device while mitigating blocking by the user's hand.

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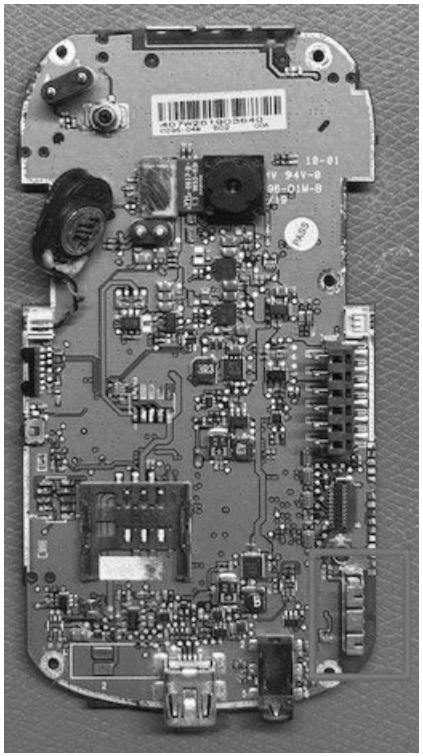
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		 As shown below, the Siemens SX66 has a keyboard that slides out from the bottom of the device. One of ordinary skill in the art would have recognized that, when using the keyboard, a user holds the Siemens SX66 from the long sides of the device, which leaves the bottom short side of the device relatively free of blockage from the user's hands.

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		 In contrast, the Cingular 8125 has a keyboard that slides out from the side of the device. One of ordinary skill in the art would have recognized that a user rotates the device to use the keyboard, thereby holding the short sides of the device, which leaves the long sides of the device relatively

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		free of blockage from the user's hands. Thus, one of ordinary skill in the art would have been motivated to select the WLAN antenna of the Cingular 8125 in order to use a laterally-sliding keyboard configuration rather than a vertically-sliding keyboard configuration while minimizing blockage of the WLAN antenna by the user's hands. The change from one keyboard configuration to the other would have addressed market demand for one aesthetic design over the other based on user preferences, and further would have been a mere design choice among physical configurations that were well known in the art. To minimize re-design efforts, one of ordinary skill in the art would further have used the WLAN antenna of the Cingular 8125 in place of the WLAN antenna of the Siemens SX66. The result would have included: (1) the cellular antenna and Bluetooth antenna of the Siemens SX66 as

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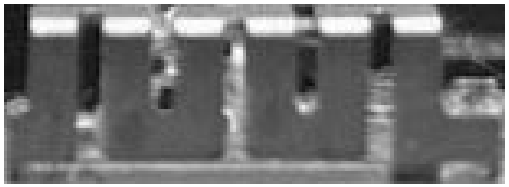
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		shown above, and (2) the WLAN antenna of the Cingular 8125 on the circuit board of the Siemens SX66 in the same relative location as in the Cingular 8125. One of ordinary skill in the art would have had a reasonable expectation of success in using the WLAN antenna of the Cingular 8125 in this manner because each antenna in the resulting configuration would have operated in substantially the same way as in the individual devices. No significant amount of interference between the antennas would have been expected because the WLAN antenna would be situated in the same position relative to the cellular and Bluetooth antennas in the resulting configuration as in the Cingular 8125. *See, e.g.*, 
5[b]	wherein the antenna contour of the third antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	The Siemens SX66 expressly or inherently discloses this claim element. To the extent the Siemens SX66 does not expressly or inherently disclose this claim element, the Siemens SX66 renders this claim element obvious in view of the Cingular 8125 as discussed above. *See, e.g.*, The complexity factor calculation is performed according to the method in the patent. N1=10

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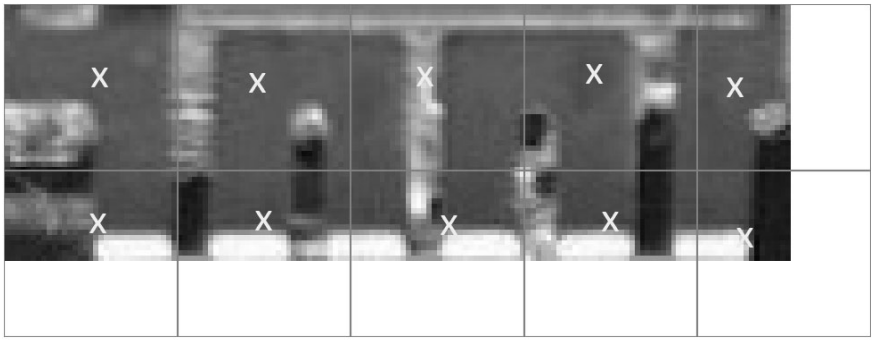
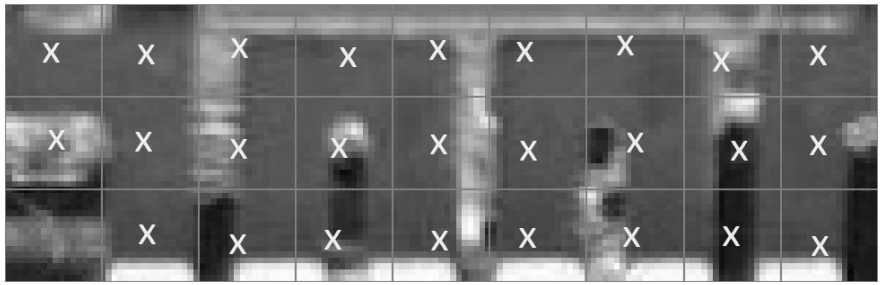
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		 N2=26  F21=log(26/10)/log(2)=1.38
5[c]	a complexity factor F_{32} having a value of at least 1.35.	The Siemens SX66 expressly or inherently discloses this claim element. To the extent the Siemens SX66 does not expressly or inherently disclose this claim element, the Siemens SX66 renders this claim element obvious in view of the Cingular 8125 as discussed above.

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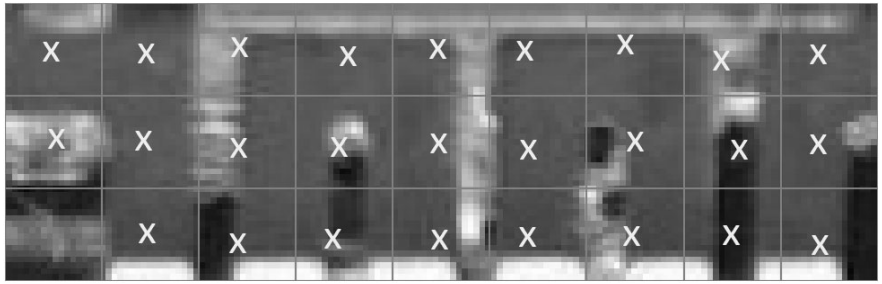
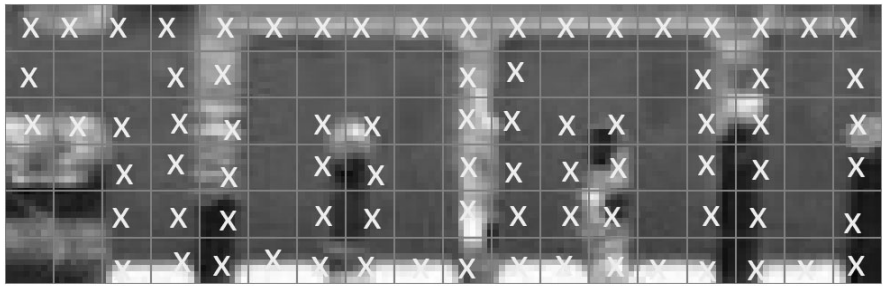
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		See, e.g., The complexity factor calculation is performed according to the method in the patent. N2=26  N3=80  F32=log(80/26)/log(2)=1.62
Claim 6		

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
6[pre]	A wireless device comprising:	To the extent the preamble is limiting, the Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[pre] above.
6[a]	an antenna system comprising:	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[a] above.
6[b]	[*the antenna system comprising*] a ground plane;	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[b] above.
6[c]	[*the antenna system comprising*] a first antenna within the wireless device and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[c] above.
6[d]	configured to support at least two frequency bands contained within first and second frequency ranges of	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[d] above.

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
	the electromagnetic spectrum,	
6[e]	the second frequency range being higher in frequency than the first frequency range,	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[e] above.
6[f]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[g] above.
6[g]	defining a first antenna contour comprising an entire perimeter of the first antenna,	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[h] above.
6[h]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[i].

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
6[i]	complexity factor F_{32} having a value less than 1.75; and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[j]. To the extent the Siemens SX66 does not expressly or inherently disclose this claim element, the Siemens SX66 renders this claim element obvious in view of the Cingular 8125 as discussed above. The antenna system of the Cingular 8125 has a second antenna (Bluetooth antenna) within the Cingular 8125 and configured to support at least one frequency band different from the at least three frequency bands supported by the first antenna, the second antenna being arranged completely within the ground plane rectangle. The at least one frequency band is at least from 2.4 GHz to 2.48 GHz. *See* Cingular Website; archived on February 15, 2006 at: https://web.archive.org/web/20060215183508/http://www.cingular.com/8125_consumer (last accessed June 11, 2025). *See* FCC Internal Photos at 5 (annotated). *See also* 5[a] (motivation to combine).
6[j]	[*the antenna system comprising*] a second antenna within the wireless device and	The Siemens SX66 expressly or inherently discloses this claim element. To the extent the Siemens SX66 does not expressly or inherently disclose this claim element, the Siemens SX66 renders this claim element obvious in view of the Cingular 8125 as discussed above. *See, e.g.*,

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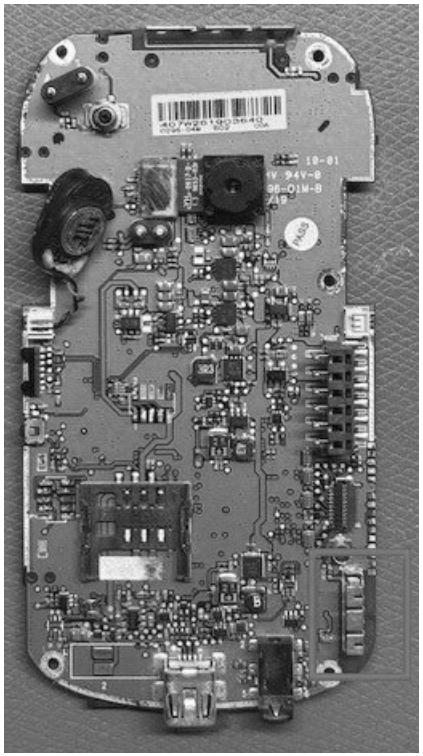
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		 *See also* 5[a] (motivation to combine).
6[k]	defining a second antenna contour comprising an	The Siemens SX66 expressly or inherently discloses this claim element.

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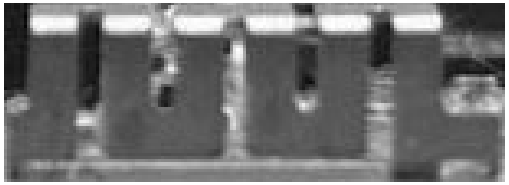
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
	entire perimeter of the second antenna,	To the extent the Siemens SX66 does not expressly or inherently disclose this claim element, the Siemens SX66 renders this claim element obvious in view of the Cingular 8125 as discussed above. *See, e.g.*, limitation 6[j] above.
6[l]	the second antenna being proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle,	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*,  To the extent the Siemens SX66 does not expressly or inherently disclose this claim element, the Siemens SX66 renders this claim element obvious in view of the Cingular 8125 as discussed above. *See, e.g.*, The second antenna of the Cingular 8125 is proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle.

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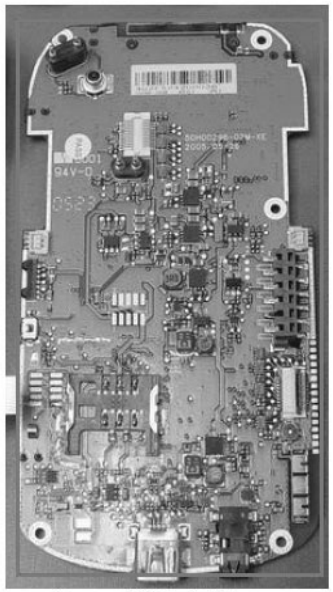
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		First Short Side  Second Short Side *See* FCC Internal Photos at 5 (annotated). *See also* 5[a] (motivation to combine).
6[m]	a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*,

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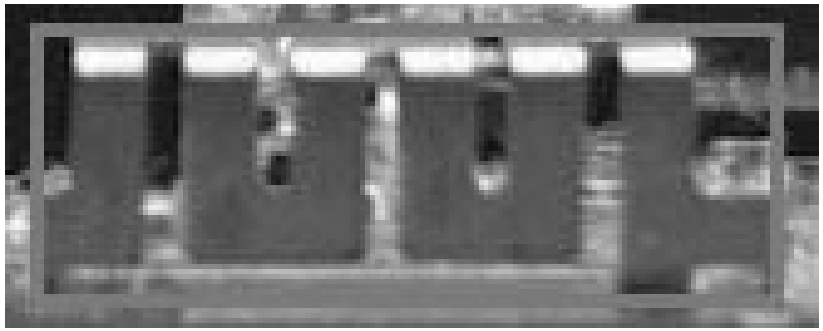
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
	antenna defining an antenna box, and	 To the extent the Siemens SX66 does not disclose or render obvious this limitation alone, it would have been obvious to include this claim element in view of the Cingular 8125. *See, e.g.*, In the Cingular 8125, a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second antenna defines an antenna box, and an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defines an antenna rectangle. A length of the second antenna contour is greater than four times a diagonal (D, above) of the antenna rectangle. A length of the second antenna contour is greater than four times a diagonal (D, above) of the antenna rectangle.

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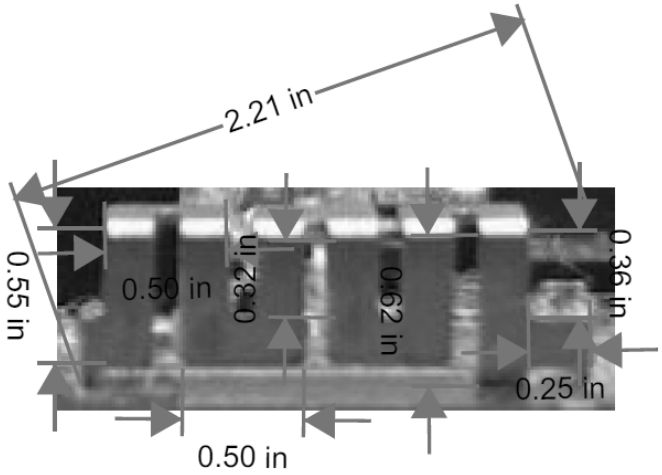
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		 4xD=2.21*4=8.84 L>6(0.55)+5(0.5)+4(.32)+6(.36)>9.24 *See also* 5[a] (motivation to combine).
6[n]	an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*,

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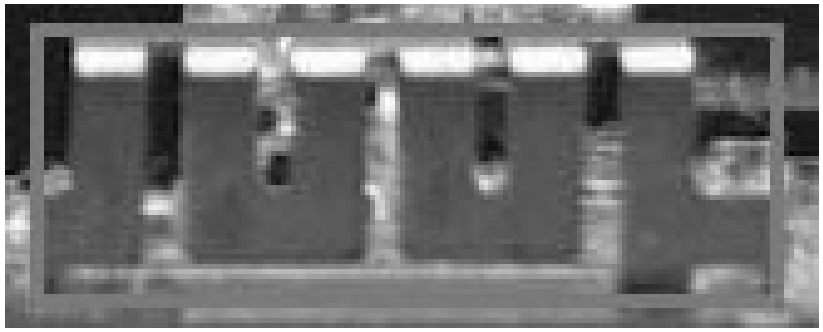
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		 To the extent the Siemens SX66 does not expressly or inherently disclose this claim element, the Siemens SX66 renders this claim element obvious in view of the Cingular 8125 as discussed above. *See, e.g.*, limitation 6[m] above.
6[o]	an antenna rectangle,	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*,

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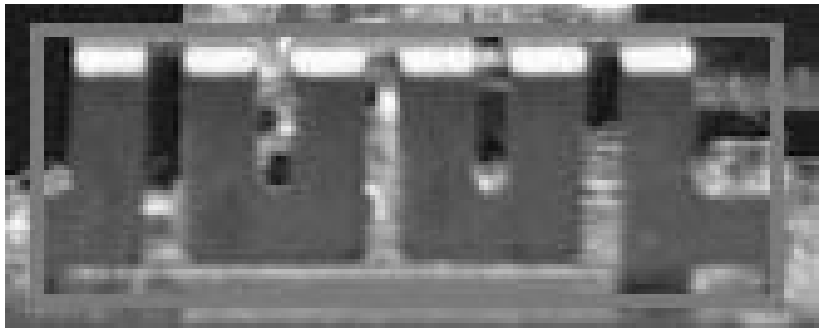
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		 To the extent the Siemens SX66 does not expressly or inherently disclose this claim element, the Siemens SX66 renders this claim element obvious in view of the Cingular 8125 as discussed above. *See, e.g.*, limitation 6[m] above.
6[p]	wherein a length of the second antenna contour is greater than four times a diagonal of the antenna rectangle.	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 6[m].

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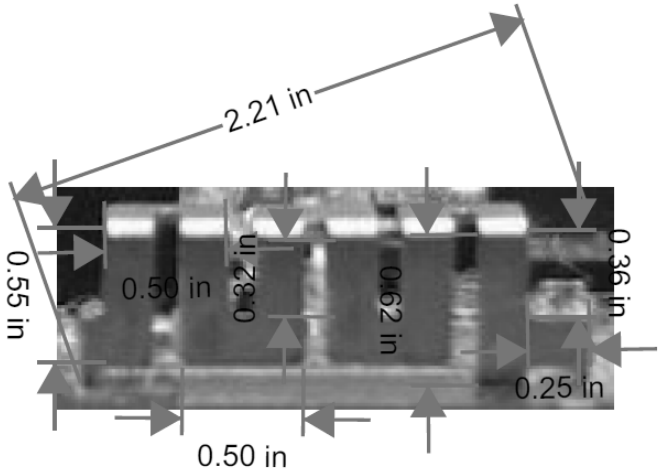
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		 4xD=2.21*4=8.84 L>6(0.55)+5(0.5)+4(.32)+6(.36)>9.24
Claim 7		
7	The wireless device of claim 6, wherein the first antenna contour comprises at least 20 segments.	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, claim 2 above.

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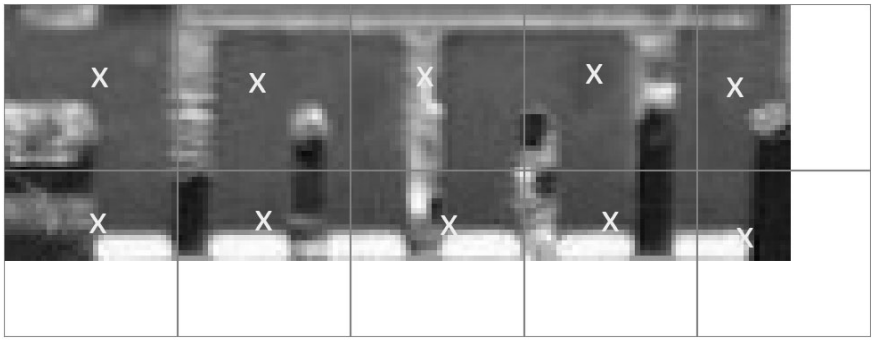
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		Claim 8
8	The wireless device of claim 6, wherein the first antenna contour comprises at least 35 segments.	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, claim 3 above.
		Claim 9
9[a]	The wireless device of claim 6, wherein the second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, The complexity factor calculation is performed according to the method in the patent. N1=10 

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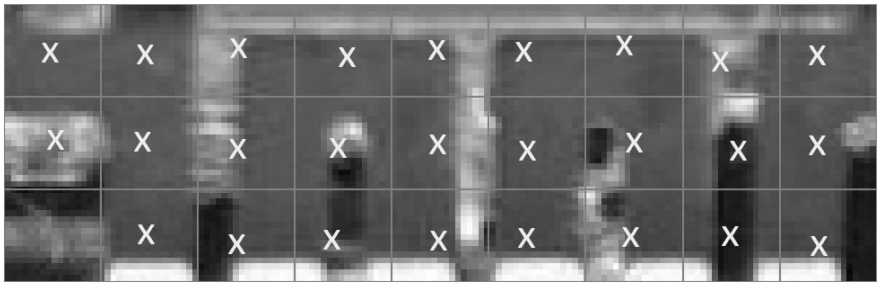
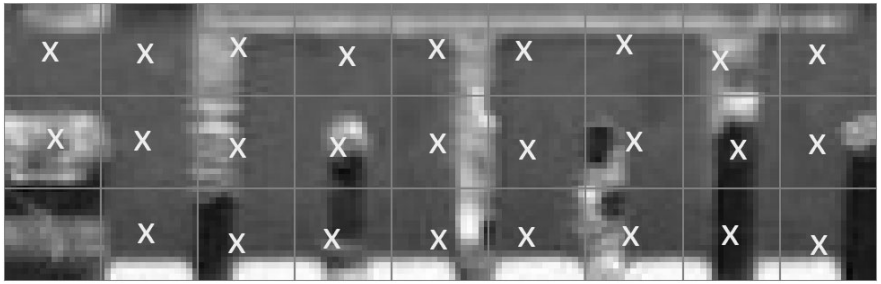
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		N2=26  F21=log(26/10)/log(2)=1.38
9[b]	a complexity factor F_{32} having a value of at least 1.35.	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, N2=26 

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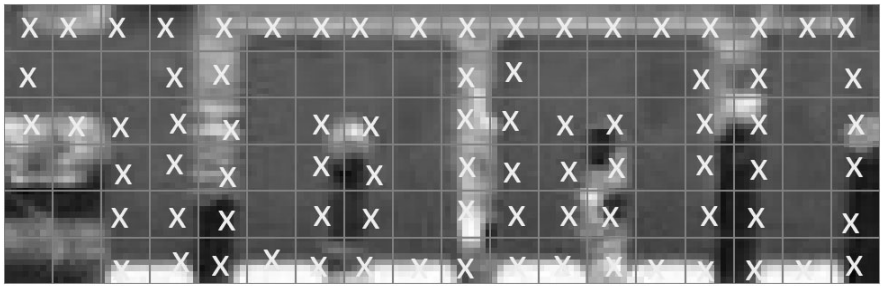
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		N3=80  F32=log(80/26)/log(2)=1.62
Claim 12		
12[pre]	A wireless device comprising:	To the extent the preamble is limiting, The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitations 1[pre], 6[pre] above.
12[a]	an antenna system comprising:	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitations 1[a] and 6[a] above.

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
12[b]	[*the antenna system comprising*] a ground plane;	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitations 1[b] and 6[b] above.
12[c]	[*the antenna system comprising*] a first antenna within the wireless device and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitations 1[c] and 6[c] above.
12[d]	configured to provide operation in at least four frequency bands,	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[d] above.
12[e]	at least one of the at least four frequency bands is contained within a first frequency range and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[e] above.
12[f]	at least one other of the four frequency bands is contained within a second frequency range,	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[e] above.

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
12[g]	the first frequency range being lower in frequency than the second frequency range,	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[e] above.
12[h]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane,	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[g] above.
12[i]	the first antenna defining a first antenna contour comprising an entire perimeter of the first antenna, and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitations 1[h], 6[h] above.
12[j]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[i] above.
12[k]	complexity factor F_{32} having a value less than 1.75; and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[j] above.

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
12[l]	wherein the first antenna is configured to transmit and receive signals from a 4G communication standard; and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[f] above.
12[m]	[*the antenna system comprising*] a second antenna within the wireless device and configured to receive signals from a 4G communication standard,	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitations 1[f] and claims 4, 6 above.
12[n]	a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second antenna defining an antenna box,	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 6[m] above.
12[o]	an orthogonal projection of the antenna box along a normal to a face with a	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitations 6[m], 6[n] above.

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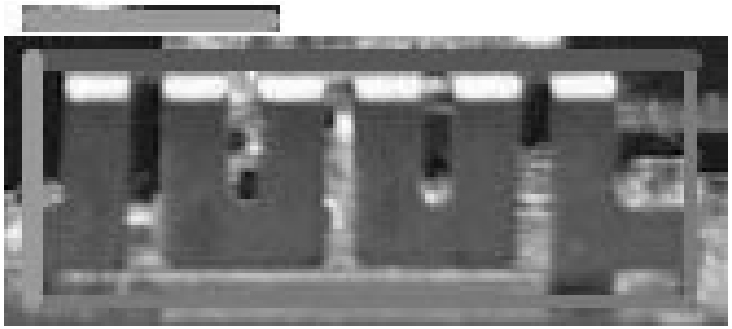
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
	largest area of the second antenna defining	
12[p]	an antenna rectangle,	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*,
12[q]	an aspect ratio of the antenna rectangle being defined as a ratio between a width and a height of the antenna rectangle, and wherein the aspect ratio has a value of at least 2.	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*,  A width (blue above) of the antenna rectangle is more than twice a height (green above) of the antenna rectangle, and thus the aspect ratio has a value of at least 2.

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
Claim 13		
13	The wireless device of claim 12, wherein the first antenna contour comprises at least 20 segments.	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, claims 2, 12 above.
Claim 14		
14	The wireless device of claim 13, wherein the first antenna contour comprises at least 35 segments.	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, claims 3, 13 above.
Claim 15		
15	The wireless device of claim 12, wherein the second antenna is proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle.	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, claims 12,

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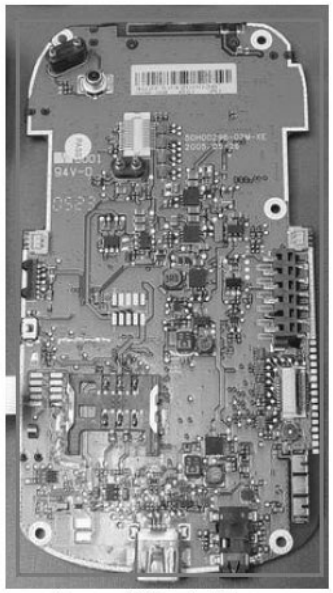
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		First Short Side  Second Short Side
		Claim 16
16[a]	The wireless device of claim 12, wherein the second antenna defines a second antenna contour comprising an entire	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, claims 12, and limitations 6[j], 6[k] above.

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Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
	perimeter of the second antenna,	
16[b]	and wherein the second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[i] above.
16[c]	a complexity factor F_{32} having a value of at least 1.35.	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, limitation 1[j] above.
Claim 17		
17	The wireless device of claim 16, wherein the second antenna contour comprises at least 20 segments.	The Siemens SX66 expressly or inherently discloses this claim element. *See, e.g.*, claims 2, 16 above.

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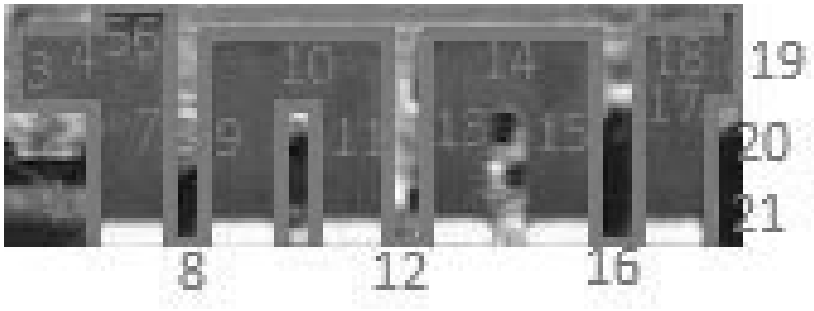
Claim No.	U.S. Patent No. 11,031,677 B2	Siemens SX66/HTC Blue Angel
		

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Exhibit – D – 09

INVALIDITY CONTENTIONS FOR U.S. PATENT NO. 11,031,677 B2
BASED ON THE BLACKBERRY 7290 ("BLACKBERRY 7290")

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, 6, 7, 8, 9, 12, 13, 14, 15, 16, and 17 ("the '677 Asserted Claims")[1]. These invalidity contentions are not an admission by the Defendants 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 '677 Patent was filed on March 27, 2020, after the AIA came into force on March 16, 2013.

Research in Motion's ("RIM") Blackberry 7290, as publicly demonstrated, known, offered for sale, sold, and/or used by RIM and/or customers of RIM, or otherwise available to the public, including in this country, ("Blackberry 7290") was in public use and/or on sale in the U.S. at least by 2004. Specifically, the Blackberry 7290 was approved for use in the United States on September 29, 2004[2], and was available for purchase in the United States from AT&T Wireless no later than December 31, 2004, which is prior to the critical date of the '200 Patent. Thus, the Blackberry 7290 is available as prior art at least under at least 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 Blackberry 7290 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 that, by not charting claims 10-11 and 18-20 in its Infringement Contentions, Plaintiff does not assert these claims against Defendants.
[2] *See* Cingular Wireless Website, archived on December 7, 2005 at: https://web.archive.org/web/20041207142355/http://www.attwireless.com/smallbusiness/products/all_phones.jhtml (last accessed June 16, 2025); *see also* Blackberry Website - Press Release (Sept. 28, 2004): http://www.blackberry.com/news/press/2004/pr-28_09_2004-04.shtml (last accessed June 11, 2025); AT&T Wireless Website, Archived December 7, 2004 at: https://web.archive.org/web/20041207142355/http://www.attwireless.com/smallbusiness/products/all_phones.jhtml (last accessed June 11, 2025); Blackberry Website - Press Release (Sept. 28, 2004): http://www.blackberry.com/news/press/2004/pr-28_09_2004-04.shtml (last accessed June 11, 2025).
[3] Geotab does 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. Geotab anticipates that the actual dates, circumstances, and identities of individuals will be the subject of third party discovery during this lawsuit. Geotab therefore reserves the right to amend and/or supplement its Invalidity Contentions and this chart if additional information becomes available during the course of discovery. The date the Blackberry 7290 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

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- AT&T Wireless Website, archived on December 7, 2005 at: https://web.archive.org/web/20041207142355/http://www.attwireless.com/smallbusiness/products/all_phones.jhtml (last accessed June 16, 2025)
- Blackberry Website - Press Release (Sept. 28, 2004): http://www.blackberry.com/news/press/2004/pr-28_09_2004-04.shtml (last accessed June 11, 2025)
- Phonescoop.com, *Blackberry 7290*, https://www.phonescoop.com/phones/phone.php?p=625 (last accessed June 13, 2025)
- GSMArena.com, *Blackberry 7290*, https://www.gsmarena.com/blackberry_7290-1348.php (last accessed June 13, 2025)
- PhoneDB.com, *Blackberry 7290*, https://phonedb.net/index.php?m=device&id=1476&c=rim_blackberry_7290 (last accessed June 13, 2025)
- PhoneArena.com. *Blackberry 7290*, https://www.phonearena.com/phones/BlackBerry-7290_id963 (last accessed June 13, 2025)
- Wikipedia.com, *Blackberry 7290*, https://en.wikipedia.org/wiki/List_of_BlackBerry_products (last accessed June 13, 2025)
- Keith Elder, "Cingular Blackberry 7290 First Impression – Review (Nov. 29, 2004): http://keithelder.net/2004/11/29/blackberry-7290-arrived/ (last accessed June 11, 2025)
- FCC ID Search, https://www.fcc.gov/oet/ea/fccid (Grantee Code: "L6A"; Product Code: "RAP40GW"; Record Option: 3/5 "Detail"; Attachment: "Manual Statements" (last accessed June 16, 2025) ("FCC User Manual Safety and Product Info")
- FCC ID Search, https://www.fcc.gov/oet/ea/fccid (Grantee Code: "L6A"; Product Code: "RAP40GW"; Record Option: 3/5 "Detail"; Attachment: "Internal Photos" (last accessed June 16, 2025) ("FCC Internal Photos")

As described in the following claim chart, the asserted claims of U.S. Patent No. 11,031,677 (the "'677 Patent"), are invalid as anticipated by Blackberry 7290. To the extent that Blackberry 7290 is found not to anticipate one or more of the asserted claims of the '677 Patent, these claims are invalid as obvious in view of Blackberry 7290 alone or as modified in view of or in combination with other prior art references disclosed in Defendant's Invalidity Contentions and accompanying charts, including without limitation as set forth below.

- U.S. Patent No. 7,548,208 ("Dou '208")
- Blackberry 7130e

documents associated with each version on the Blackberry 7290. Geotab also reserves the right to rely on the public use, offer for sale, sale, or installation of the devices described in the publications identified herein once Geotab has had a fair opportunity to take discovery on these subjects.

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One of ordinary skill in the art, as of the priority date of the ’677 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. 11,031,677 B2	Blackberry 7290
Claim 1		
1[pre]	A wireless device comprising:	To the extent the preamble is limiting, Blackberry 7290 expressly or inherently discloses this claim element. *See, e.g.*, The Blackberry 7290 is a wireless device.

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

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 See Keith Elder, "Cingular Blackberry 7290 First Impression – Review (Nov. 29, 2004): http://keithelder.net/2004/11/29/blackberry-7290-arrived/ (last accessed June 11, 2025)
1[a]	an antenna system comprising:	Blackberry 7290 expressly or inherently discloses this claim element. *See, e.g.*, The Blackberry 7290 includes an antenna system comprising a ground plane and at least two antennas within the Blackberry 7290.

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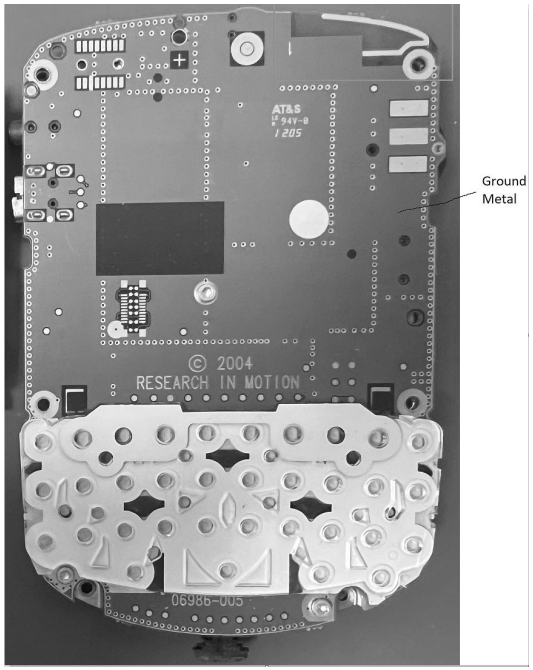
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 The at least two antennas within the Blackberry 7290 include a cellular antenna and a Bluetooth antenna.

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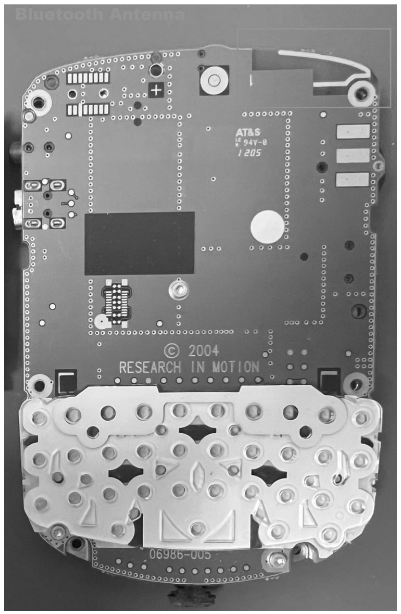
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290

Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		
1[b]	[*the antenna system comprising*] a ground plane;	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[a].
1[c]	[*the antenna system comprising*] a first antenna within the wireless device and	Blackberry 7290 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the Blackberry 7290 includes a first antenna within the 7290 (red below).

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
1[d]	[*the antenna system*] configured to support at least three frequency bands contained within first and second frequency ranges of the electromagnetic spectrum,	Blackberry 7290 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the Blackberry 7290 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. At least one of the three frequency bands being associated with a 4G communication standard.

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<table>
<tr><th>Claim No.</th><th>U.S. Patent No. 11,031,677 B2</th><th>Blackberry 7290</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><th colspan="2">Radio specifications</th></tr>
<tr><td colspan="2">BlackBerry 7290 Wireless Handheld</td></tr>
<tr><td>Quad-band support</td><td>GSM 850, GSM 900, DCS 1800, PCS 1900 MHz</td></tr>
<tr><td>Power class</td><td>Class 1 (DCS 1800, PCS 1900), Class 4 (GSM 850) as defined in GSM 5.05, Class 4 (GSM 900) as defined in GSM 02.06</td></tr>
<tr><td>Transmitting frequency</td><td>GSM 824 to 849 MHz, GSM 880-915 MHz, DCS 1710 to 1785 MHz, PCS 1850 to 1910 MHz</td></tr>
<tr><td>Receiving frequency</td><td>GSM 869 to 894 MHz, GSM 925-960 MHz, DCS 1805 to 1880 MHz, PCS 1930 to 1990 MHz</td></tr>
</table>

See FCC User Manual Safety and Product Info – Blackberry 7290 at 10.</td></tr>
<tr><td>1[e]</td><td>the second frequency range being higher in frequency than the first frequency range and</td><td>Blackberry 7290 expressly or inherently discloses this claim element.

See Claim 1[d].</td></tr>
<tr><td>1[f]</td><td>at least one of the three frequency bands being associated with a 4G communication standard,</td><td>Blackberry 7290 expressly or inherently discloses this claim element.

See Claim 1[d].</td></tr>
<tr><td>1[g]</td><td>the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and</td><td>Blackberry 7290 expressly or inherently discloses this claim element.

See, e.g.,

The first antenna of the Blackberry 7290 is proximate to a first short side of a ground plane rectangle enclosing the ground plane.</td></tr>
</table>

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290

Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		First Short Side
1[h]	defining a first antenna contour comprising an entire perimeter of the first antenna,	Blackberry 7290 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the Blackberry 7290 defines a first antenna contour comprising an entire perimeter of the first antenna.

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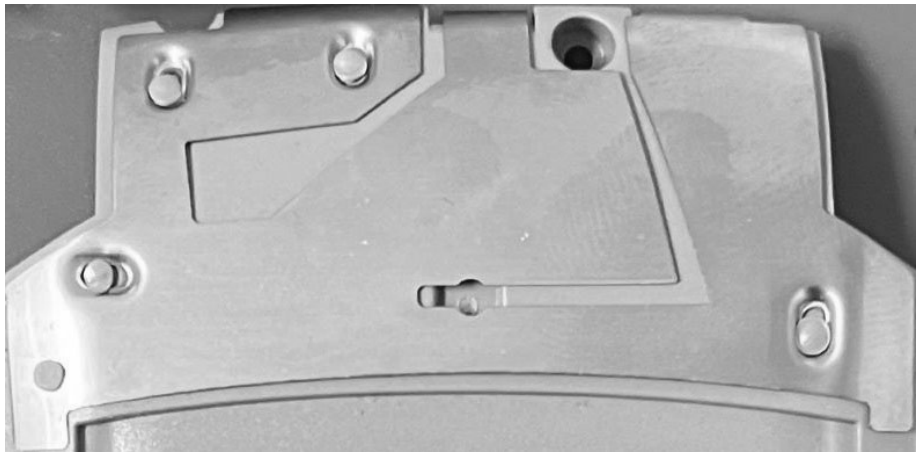
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		
1[i]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	Blackberry 7290 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna contour 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 less than 1.75. The complexity factor calculation is performed according to the method in the patent.

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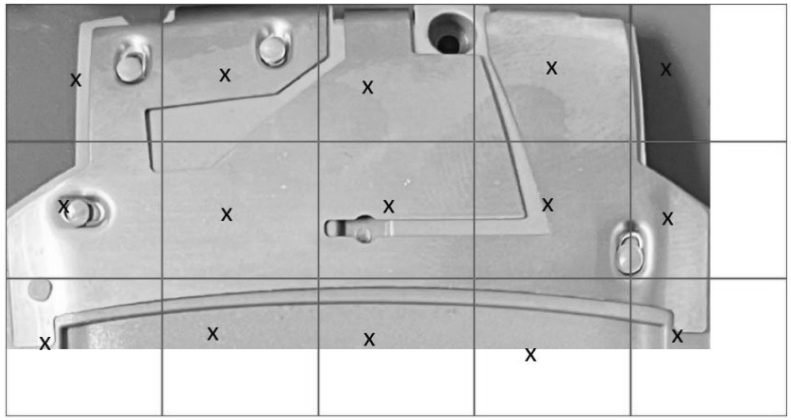
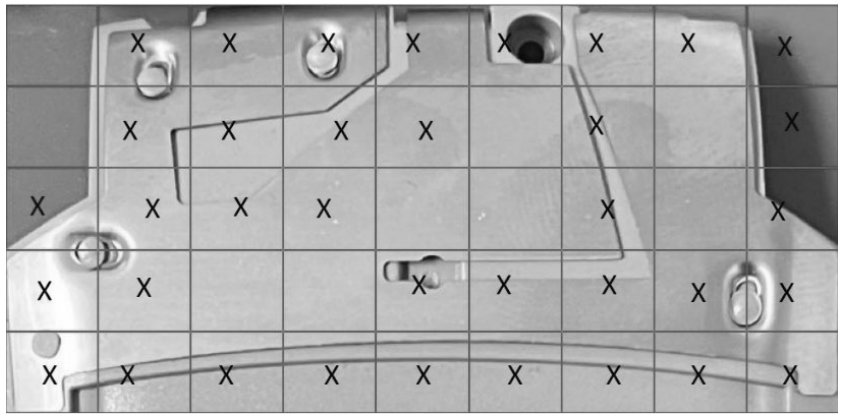
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 N1 = 15  N2=36

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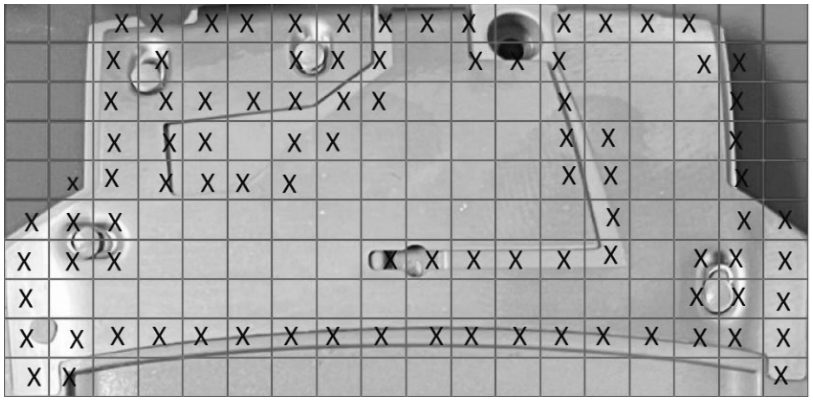
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 N3 = 92 F21=log(36/15)/log(2)=1.26 F32=log(92/36)/log(2)=1.35
1[j]	complexity factor F_{32} having a value less than 1.75; and	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[i].
1[k]	a second antenna within the wireless device and	Blackberry 7290 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the Blackberry 7290 includes a second antenna (blue below) within the 7290.

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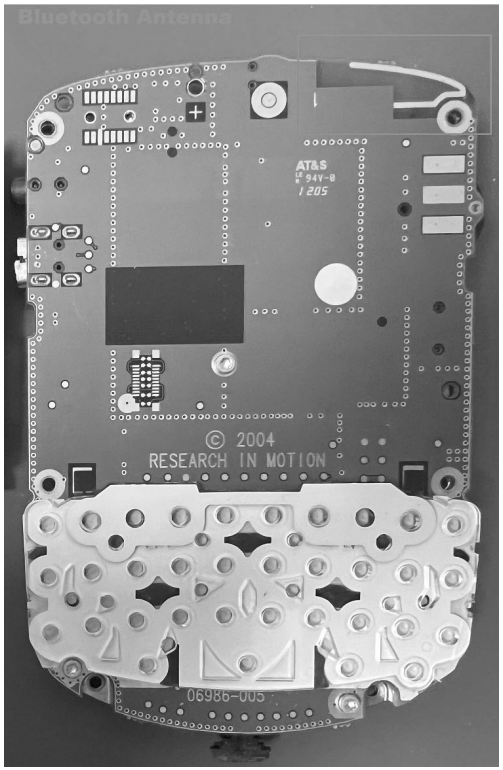
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		
1[l]	configured to support at least one frequency band different from the at least three frequency bands supported by the first antenna,	Blackberry 7290 expressly or inherently discloses this claim element. *See, e.g.*,

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<table>
<tr><th>Claim No.</th><th>U.S. Patent No. 11,031,677 B2</th><th>Blackberry 7290</th></tr>
<tr><td></td><td></td><td>The second antenna of the Blackberry 7290 is configured to support at least one frequency band different from the at least three frequency bands supported by the first antenna.

<table><tr><th colspan="2">Bluetooth Radio</th></tr><tr><td>Single-band support</td><td>ISM 2.4 GHz</td></tr><tr><td>Power class</td><td>Bluetooth class 2(1 mW)</td></tr><tr><td>Transmitting and receiving frequency</td><td>2402 to 2480 MHz</td></tr></table>

See FCC User Manual Safety and Product Info – Blackberry 7290 at 10.</td></tr>
<tr><td>1[m]</td><td>the second antenna being arranged completely within the ground plane rectangle.</td><td>Blackberry 7290 expressly or inherently discloses this claim element.

The second antenna of the Blackberry 7290 is arranged completely within the ground plane rectangle.

See, e.g.,</td></tr>
</table>

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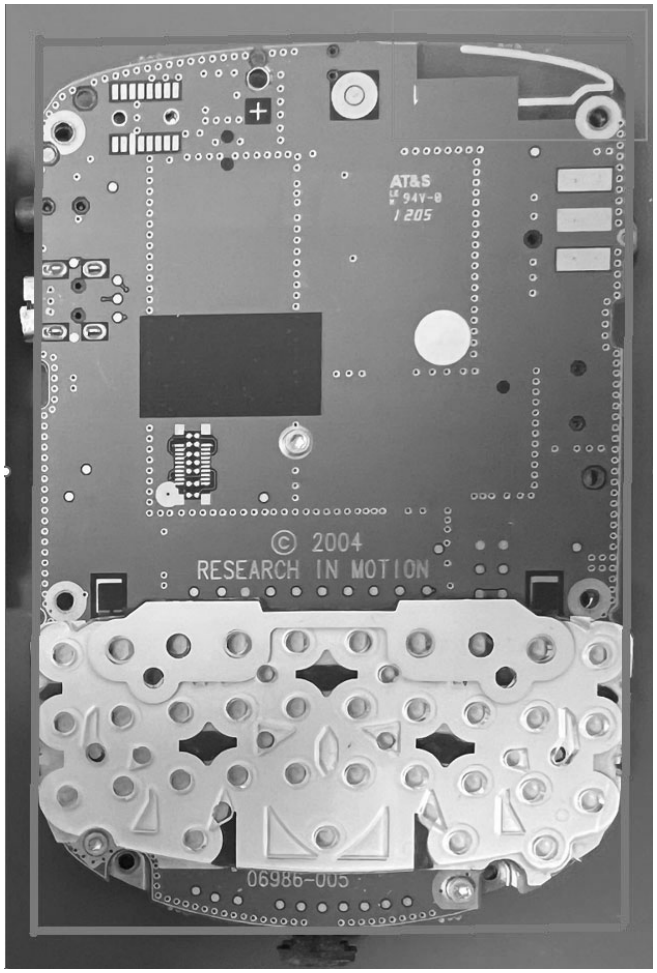
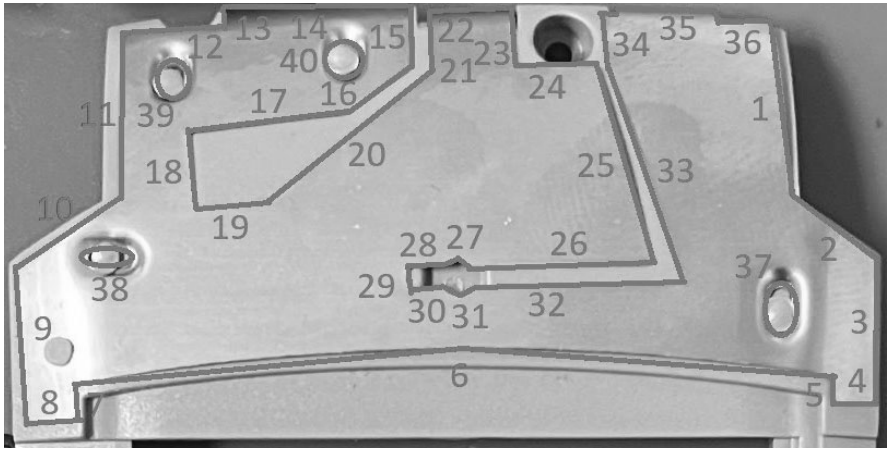
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		

Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
Claim 2		
2	The wireless device of claim 1, wherein the first antenna contour comprises at least 20 segments.	Blackberry 7290 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna contour of the Blackberry 7290 comprises at least 38 segments. 
Claim 3		
3	The wireless device of claim 2, wherein the perimeter of the first antenna contour comprises at least 35 segments.	Blackberry 7290 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna contour of the Blackberry 7290 comprises at least 38 segments.

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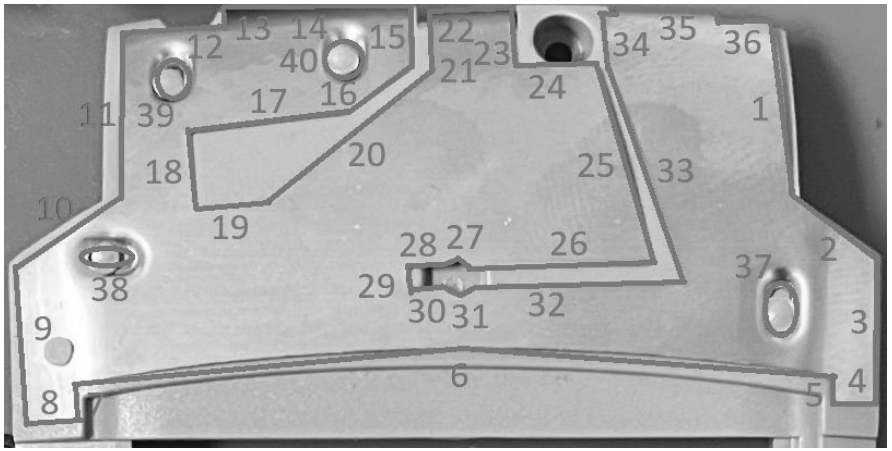
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		
Claim 4		
4	The wireless device of claim 1, wherein the antenna system comprises a third antenna configured to receive signals employing a 4G communication standard.	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou ’208. The Blackberry 7130e is a wireless device that was available for purchase in the United States no later than December 1, 2005, which is prior to the critical date of the ’677 patent.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		  See Mobile Tracker Website, BlackBerry 7130e with EV-DO on Verizon Wireless, http://www.mobiletracker.net/archives/2005/11/21/blackberry-7130e-verizon (last accessed June 16, 2025). The Blackberry 7130e includes a third antenna configured to receive signals employing a 4G communication standard.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 See FCC Internal Photos – Blackberry 7130e at 2. It would have been obvious to include the third antenna of the Blackberry 7130e in the Blackberry 7290 to achieve cellular antenna diversity for improving the data rate, as taught by Dou '208:

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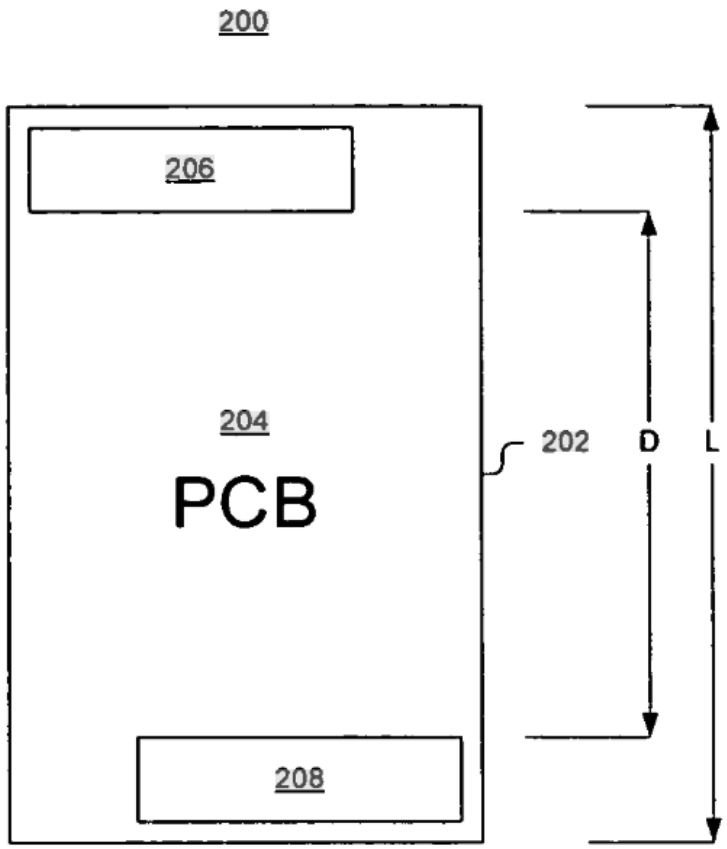
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 Dou '208 (Abstract) teaches "an internal diversity antenna architecture." According to Dou '208 (3:54-58), "first internal antenna 206 and the second internal antenna 208 may be used to implement various spatial diversity techniques to improve communication of wireless signals across one or more wireless frequency bands of wireless shared media." For example (3:26-31),

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		"the primary antenna (e.g., first internal antenna 206) may be configured for transmission and both the primary antenna (e.g., first internal antenna 206) and the secondary antenna (e.g., second internal antenna 208) may be configured for reception. Such an arrangement may be used in a cellular phone for improving data rate. As another example (3:32-35), "the primary antenna (e.g., first internal antenna 206) and the secondary antenna (e.g., second internal antenna 208) may be configured for both transmission and reception." The result of the modification would have included the cellular antenna of the BlackBerry 7290 as the first internal antenna 206 and the cellular antenna of the Blackberry 7130e as the second internal antenna 208.

Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 There would have been a reasonable expectation of success because the Blackberry 7290 and 7130e implement cellular service using each cellular antenna individually, and Dou ’208 further teaches how to implement the two antennas together in a diversity architecture, such as how far

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		apart to space the two antennas from one another, and circuitry to operate the two cellular antennas in a diversity architecture. There is also considerable technical overlap between the Blackberry 7290, the Blackberry 7130e, and Dou'208. For example, the cellular antennas of the Blackberry 7290 and 7130e are located at the top and bottom of the devices, respectively, as taught for the internal antennas 206, 208, respectively, in Dou '208. Also, Dou '208 (3:42-47) teaches that the internal antennas 206, 208 may operate in the GSM 800 and PCS 1900 frequency bands, in which the cellular antennas of the Blackberry 7290 and 7130e already operate. Moreover, Dou '208 (3:50-62) teaches that the internal antennas 206, 208 may be designed for Evolution Data Optimized (EVDO) diversity in the 800 MHz and 1900 MHz bands, and the Blackberry 7130e is designed for EVDO cellular service. *See* Mobile Tracker Website, *BlackBerry 7130e with EV-DO on Verizon Wireless*, http://www.mobiletracker.net/archives/2005/11/21/blackberry-7130e-verizon (last accessed June 16, 2025).
Claim 5		
5[a]	The wireless device of claim 4, wherein the third antenna defines an antenna contour comprising an entire perimeter of the third antenna, and	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou '208. *See, e.g.*, The third antenna of the Blackberry 7130e defines an antenna contour comprising an entire perimeter of the third antenna. The third antenna includes first and second sides including the perimeter of the third antenna. Third antenna, first side:

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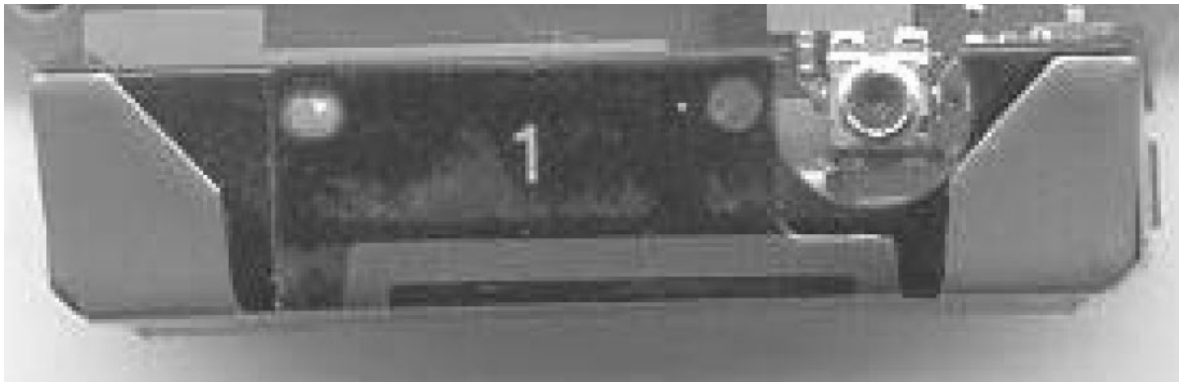
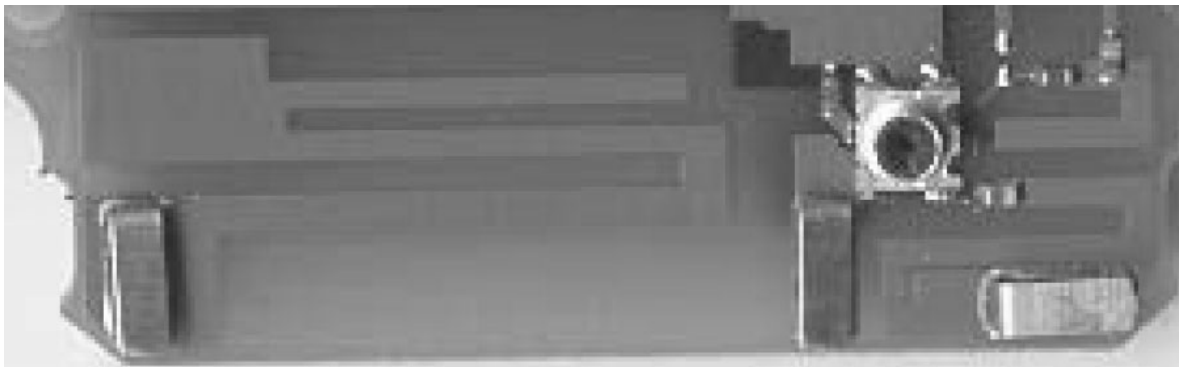
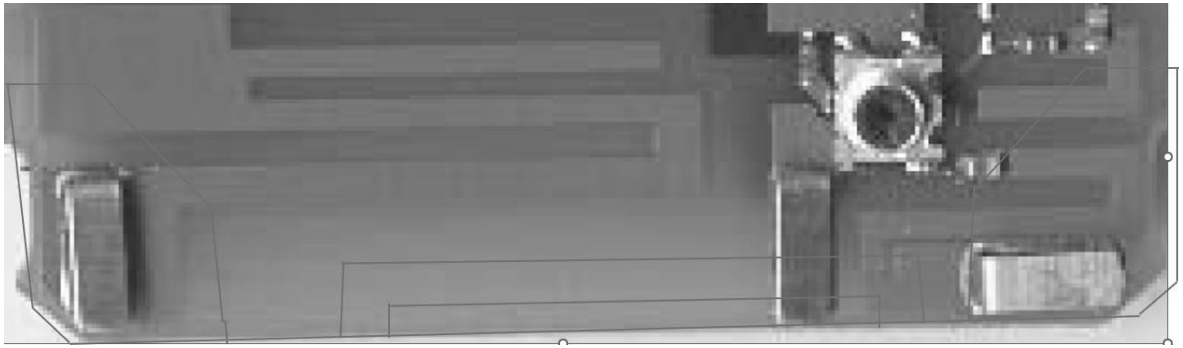
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 Third antenna, second side:  The third antenna contour includes parts of the perimeter that are on the first side and the orthogonal projection onto the plane of the first side of the parts of the perimeter that are on the second side.

Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		
5[b]	wherein the antenna contour of the third antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	Blackberry 7290 expressly or inherently discloses this claim element. *See, e.g.*, The antenna contour of the third antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and a complexity factor F_{32} having a value of at least 1.35. The complexity factor calculation is performed according to the method in the patent. N1=10

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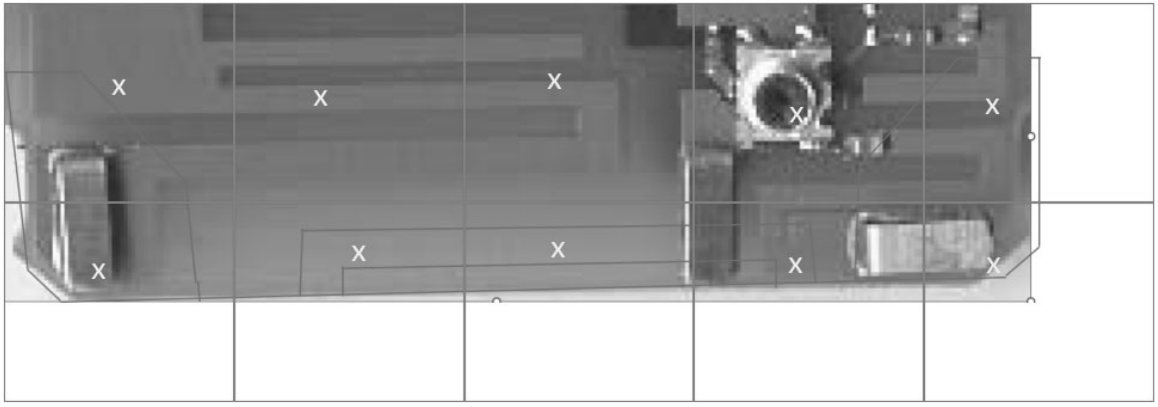
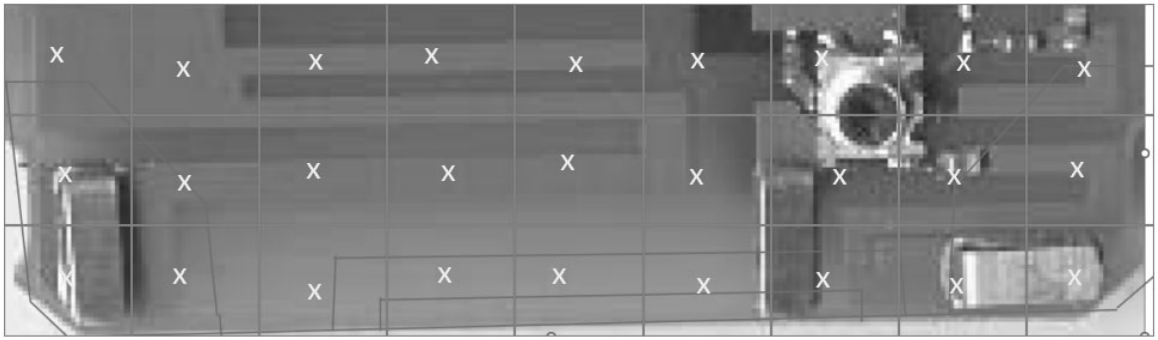
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 N2=27  N3=94

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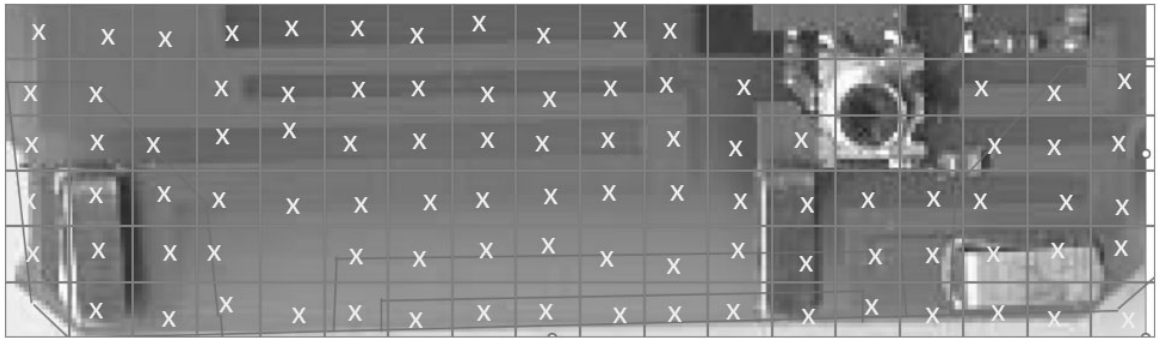
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 F21=log(27/10)/log(2)=1.43 F32=log(94/27)/log(2)=1.8
5[c]	a complexity factor F_{32} having a value of at least 1.35.	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 5[b].
Claim 6		
6[pre]	A wireless device comprising:	To the extent the preamble is limiting, Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[pre].

Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
6[a]	an antenna system comprising:	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[a].
6[b]	[*the antenna system comprising*] a ground plane;	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[a].
6[c]	[*the antenna system comprising*] a first antenna within the wireless device and	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[c].
6[d]	configured to support at least two frequency bands contained within first and second frequency ranges of the electromagnetic spectrum,	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[d].

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
6[e]	the second frequency range being higher in frequency than the first frequency range,	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[d].
6[f]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[g].
6[g]	defining a first antenna contour comprising an entire perimeter of the first antenna,	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[h].
6[h]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[i].
6[i]	complexity factor F_{32} having a value less than 1.75; and	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[i].

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
6[j]	[*the antenna system comprising*] a second antenna within the wireless device and	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou '208. The Blackberry 7130e is a wireless device that was available for purchase in the United States no later than December 1, 2005, which is prior to the critical date of the '677 patent. *See* Mobile Tracker Website, BlackBerry 7130e with EV-DO on Verizon Wireless, http://www.mobiletracker.net/archives/2005/11/21/blackberry-7130e-verizon (last accessed June 16, 2025). The Blackberry 7130e includes a second antenna configured to receive signals employing a 4G communication standard.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 See FCC Internal Photos – Blackberry 7130e at 2. It would have been obvious to include the second antenna of the Blackberry 7130e in the Blackberry 7290 to achieve cellular antenna diversity for improving the data rate, as taught by Dou '208:

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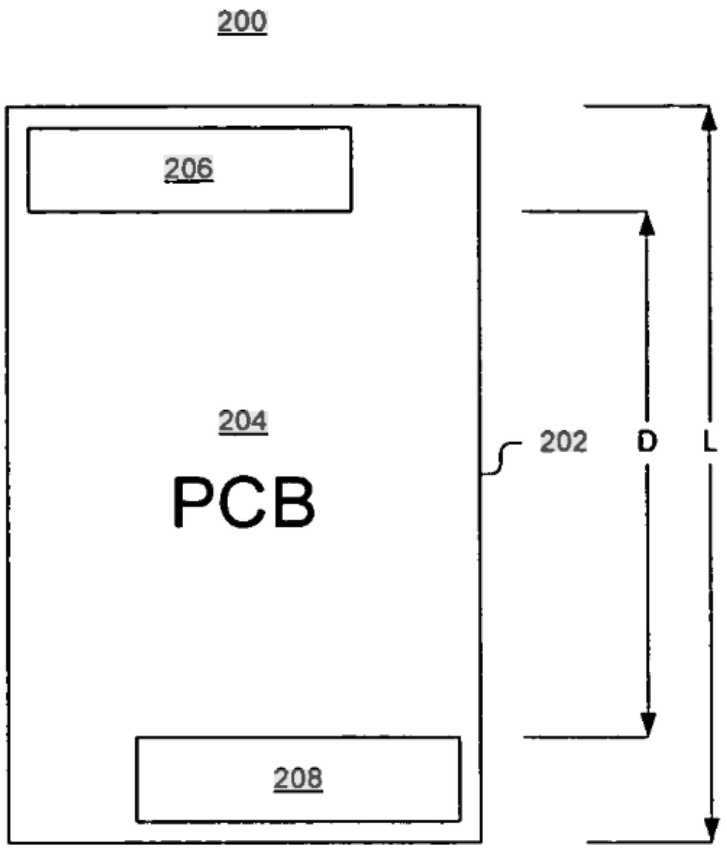
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 Dou '208 (Abstract) teaches "an internal diversity antenna architecture." According to Dou '208 (3:54-58), "first internal antenna 206 and the second internal antenna 208 may be used to implement various spatial diversity techniques to improve communication of wireless signals across one or more wireless frequency bands of wireless shared media." For example (3:26-31),

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		"the primary antenna (e.g., first internal antenna 206) may be configured for transmission and both the primary antenna (e.g., first internal antenna 206) and the secondary antenna (e.g., second internal antenna 208) may be configured for reception. Such an arrangement may be used in a cellular phone for improving data rate. As another example (3:32-35), "the primary antenna (e.g., first internal antenna 206) and the secondary antenna (e.g., second internal antenna 208) may be configured for both transmission and reception." The result of the modification would have included the cellular antenna of the BlackBerry 7290 as the first internal antenna 206 and the cellular antenna of the Blackberry 7130e as the second internal antenna 208.

Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 There would have been a reasonable expectation of success because the Blackberry 7290 and 7130e implement cellular service using each cellular antenna individually, and Dou '208 further teaches how to implement the two antennas together in a diversity architecture, such as how far apart to space the two antennas from one another, and circuitry to operate the two cellular antennas in a diversity architecture.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		There is also considerable technical overlap between the Blackberry 7290, the Blackberry 7130e, and Dou'208. For example, the cellular antennas of the Blackberry 7290 and 7130e are located at the top and bottom of the devices, respectively, as taught for the internal antennas 206, 208, respectively, in Dou '208. Also, Dou '208 (3:42-47) teaches that the internal antennas 206, 208 may operate in the GSM 800 and PCS 1900 frequency bands, in which the cellular antennas of the Blackberry 7290 and 7130e already operate. Moreover, Dou '208 (3:50-62) teaches that the internal antennas 206, 208 may be designed for Evolution Data Optimized (EVDO) diversity in the 800 MHz and 1900 MHz bands, and the Blackberry 7130e is designed for EVDO cellular service. *See* Mobile Tracker Website, *BlackBerry 7130e with EV-DO on Verizon Wireless*, http://www.mobiletracker.net/archives/2005/11/21/blackberry-7130e-verizon (last accessed June 16, 2025).
6[k]	defining a second antenna contour comprising an entire perimeter of the second antenna,	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou '208. *See, e.g.*, The second antenna of the Blackberry 7130e defines a second antenna contour comprising an entire perimeter of the second antenna. The second antenna includes first and second sides including the perimeter of the second antenna. Third antenna, first side:

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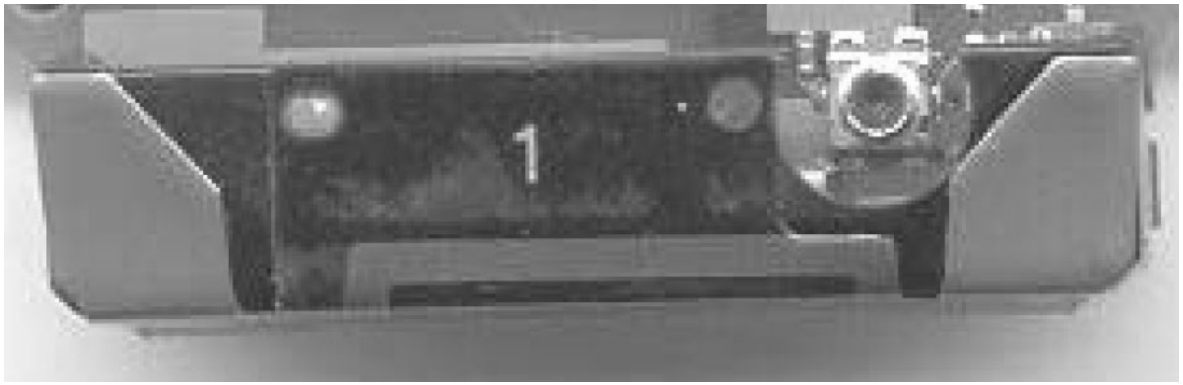
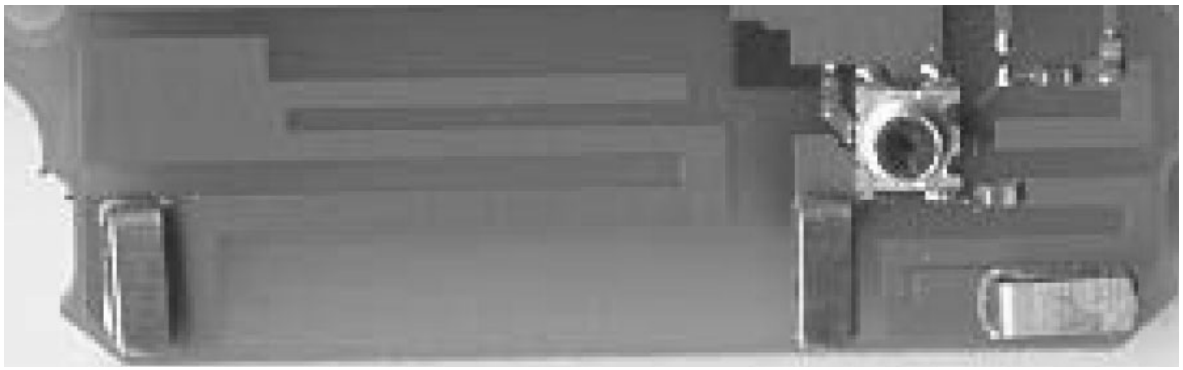
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 Third antenna, second side:  The second antenna contour includes parts of the perimeter that are on the first side and the orthogonal projection onto the plane of the first side of the parts of the perimeter that are on the second side.

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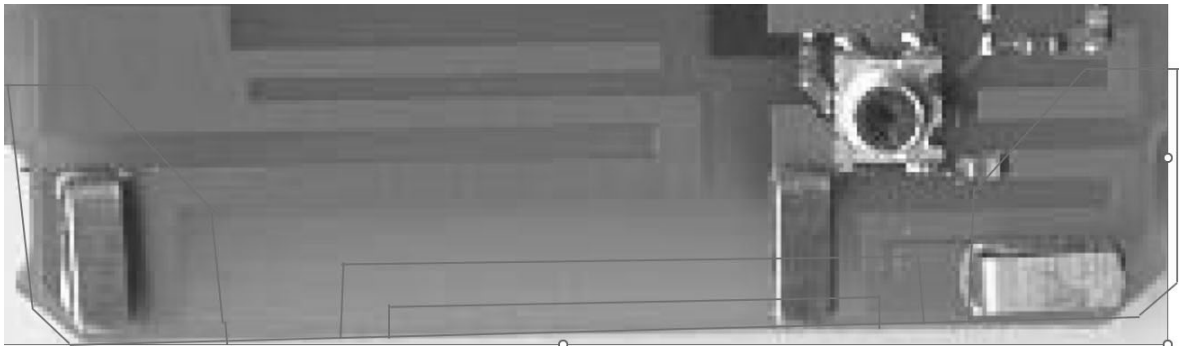
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		
6[l]	the second antenna being proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle,	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou '208. *See, e.g.*, The second antenna of the Blackberry 7130e is proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle.

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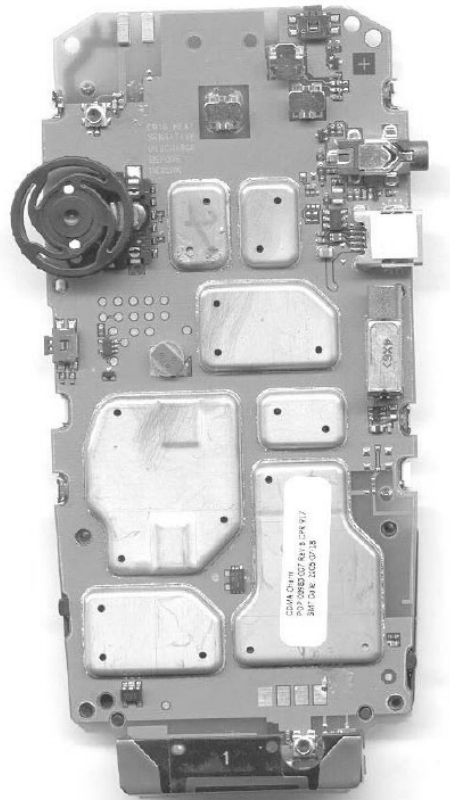
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		
6[m]	a minimum-sized parallelepiped of rectangular faces that completely encloses	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou ’208.

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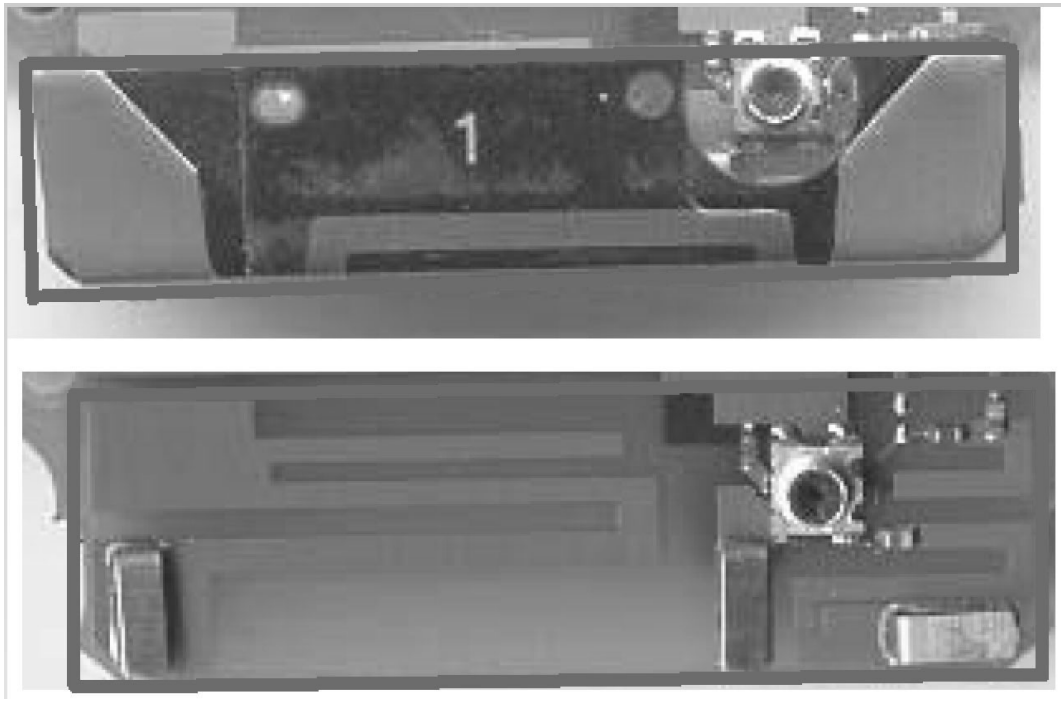
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
	a volume of the second antenna defining an antenna box, and	*See, e.g.*, A minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second antenna defines an antenna box (purple below). 

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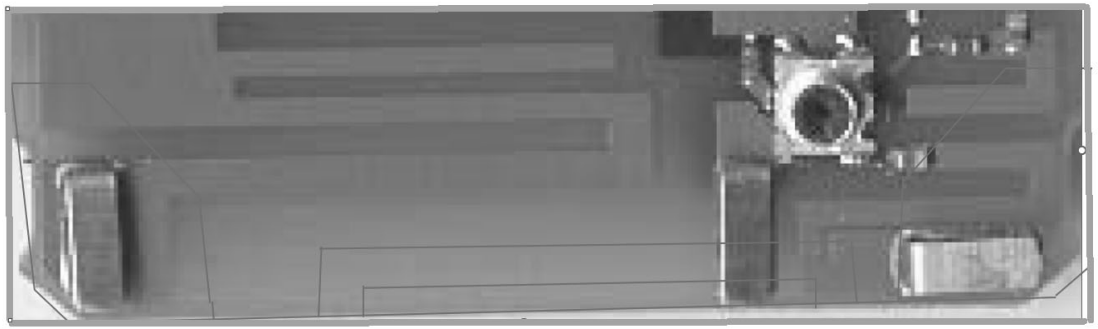
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
6[n]	an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou '208. *See, e.g.*, An orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna is shown below in orange. 
6[o]	an antenna rectangle,	Blackberry 7290 expressly or inherently discloses this claim element. *See, e.g.*, The orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defines an antenna rectangle (orange below).

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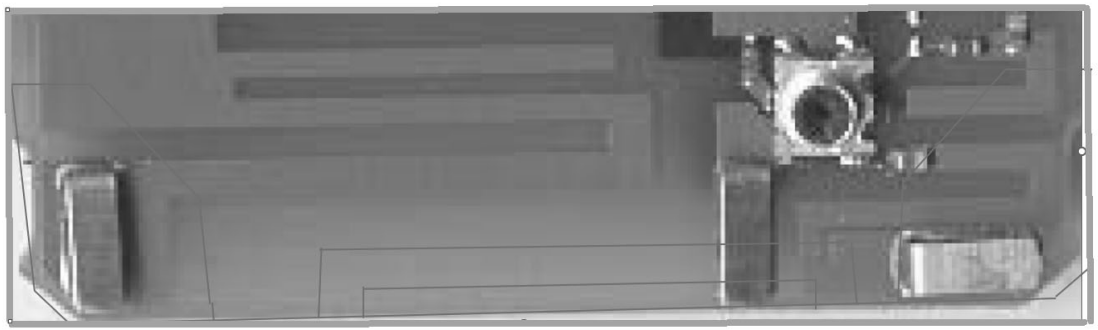
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		
6[p]	wherein a length of the second antenna contour is greater than four times a diagonal of the antenna rectangle.	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou '208. *See, e.g.*, A length of the second antenna contour is greater than four times a diagonal of the antenna rectangle.

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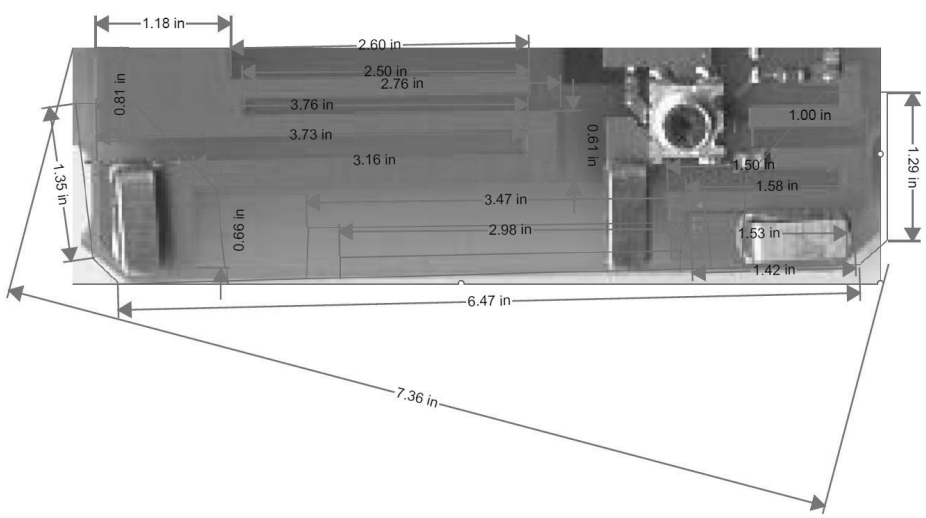
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 4D=7.36(4)=29.44 L>1.18+2.6+2.5+2.76+.3.76+3.73+.81+.61 +3.16+.66+1+1.5+1.58+1.53+1.42+1.29+3.47+2.98+6.47+1.3>44.36>29.44
		Claim 7
7	The wireless device of claim 6, wherein the first antenna contour comprises at least 20 segments.	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 2.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
Claim 8		
8	The wireless device of claim 6, wherein the first antenna contour comprises at least 35 segments.	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 3.
Claim 9		
9[a]	The wireless device of claim 6, wherein the second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou '208. *See, e.g.*, The second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and a complexity factor F_{32} having a value of at least 1.35. The complexity factor calculation is performed according to the method in the patent. N1=10

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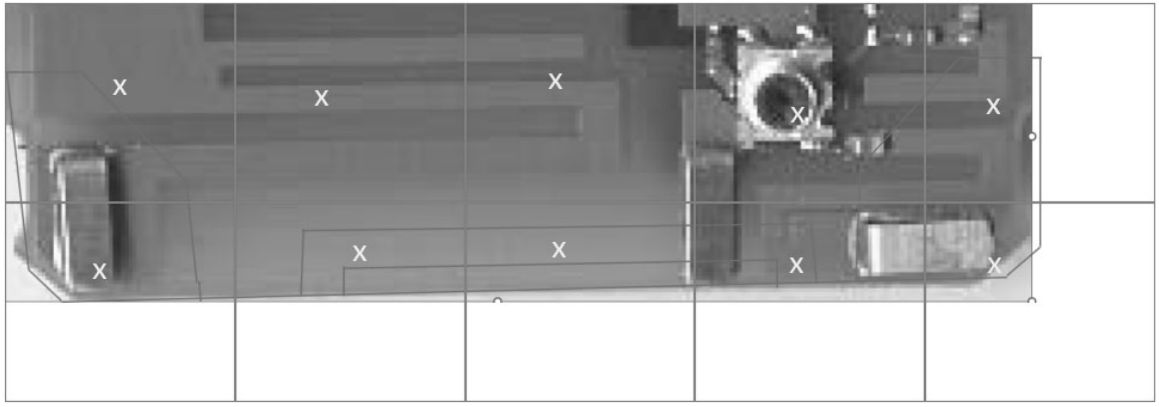
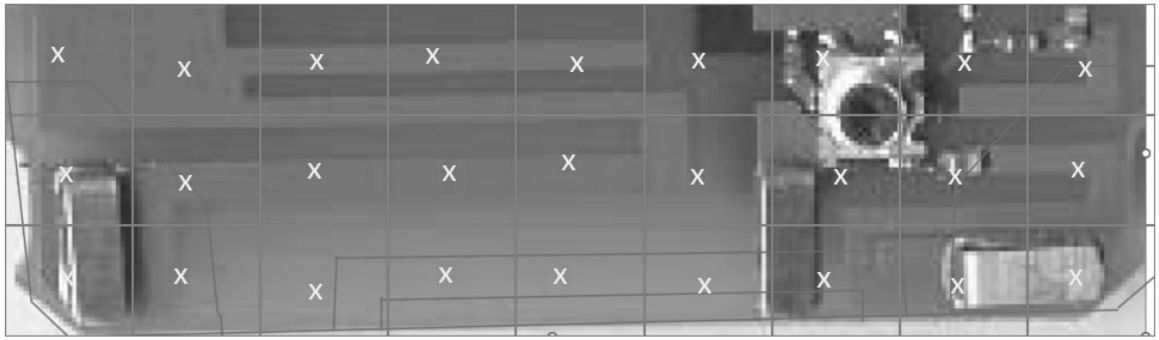
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 N2=27  N3=94

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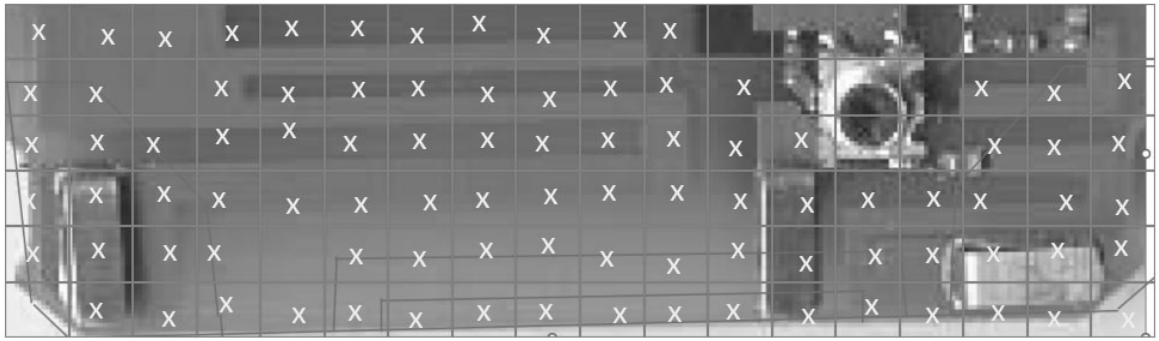
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 F21=log(27/10)/log(2)=1.43 F32=log(94/27)/log(2)=1.8
9[b]	a complexity factor F_{32} having a value of at least 1.35.	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 9[a].
		Claim 12
12[pre]	A wireless device comprising:	To the extent the preamble is limiting, Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[pre].

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
12[a]	an antenna system comprising:	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[a].
12[b]	[*the antenna system comprising*] a ground plane;	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[a].
12[c]	[*the antenna system comprising*] a first antenna within the wireless device and	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[c].
12[d]	configured to provide operation in at least four frequency bands,	Blackberry 7290 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the Blackberry 7290 is configured to provide operation in at least four frequency bands. At least one of the at least four frequency bands is contained within a first frequency range. At least one other of the four frequency bands is contained within a second frequency range. The first frequency range is lower in frequency than the second frequency range.

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<table>
<tr><th>Claim No.</th><th>U.S. Patent No. 11,031,677 B2</th><th>Blackberry 7290</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><th colspan="2">Radio specifications</th></tr>
<tr><td colspan="2">BlackBerry 7290 Wireless Handheld</td></tr>
<tr><td>Quad-band support</td><td>GSM 850, GSM 900, DCS 1800, PCS 1900 MHz</td></tr>
<tr><td>Power class</td><td>Class 1 (DCS 1800, PCS 1900), Class 4 (GSM 850) as defined in GSM 5.05, Class 4 (GSM 900) as defined in GSM 02.06</td></tr>
<tr><td>Transmitting frequency</td><td>GSM 824 to 849 MHz, GSM 880-915 MHz, DCS 1710 to 1785 MHz, PCS 1850 to 1910 MHz</td></tr>
<tr><td>Receiving frequency</td><td>GSM 869 to 894 MHz, GSM 925-960 MHz, DCS 1805 to 1880 MHz, PCS 1930 to 1990 MHz</td></tr>
</table>

See FCC User Manual Safety and Product Info – Blackberry 7290 at 10.</td></tr>
<tr><td>12[e]</td><td>at least one of the at least four frequency bands is contained within a first frequency range and</td><td>Blackberry 7290 expressly or inherently discloses this claim element.

See Claim 12[d].</td></tr>
<tr><td>12[f]</td><td>at least one other of the four frequency bands is contained within a second frequency range,</td><td>Blackberry 7290 expressly or inherently discloses this claim element.

See Claim 12[d].</td></tr>
<tr><td>12[g]</td><td>the first frequency range being lower in frequency than the second frequency range,</td><td>Blackberry 7290 expressly or inherently discloses this claim element.

See Claim 12[d].</td></tr>
</table>

Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
12[h]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane,	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[g].
12[i]	the first antenna defining a first antenna contour comprising an entire perimeter of the first antenna, and	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[h].
12[j]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[i].
12[k]	complexity factor F_{32} having a value less than 1.75; and	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 1[i].
12[l]	wherein the first antenna is configured to transmit and receive signals from a 4G communication standard; and	Blackberry 7290 expressly or inherently discloses this claim element. *See, e.g.*,

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<table>
<tr><th>Claim No.</th><th>U.S. Patent No. 11,031,677 B2</th><th>Blackberry 7290</th></tr>
<tr><td></td><td></td><td>The first antenna of the Blackberry 7290 is configured to transmit and receive signals from a 4G communication standard.

<table><tr><th colspan="2">Radio specifications</th></tr><tr><td colspan="2">BlackBerry 7290 Wireless Handheld</td></tr><tr><td>Quad-band support</td><td>GSM 850, GSM 900, DCS 1800, PCS 1900 MHz</td></tr><tr><td>Power class</td><td>Class 1 (DCS 1800, PCS 1900), Class 4 (GSM 850) as defined in GSM 5.05, Class 4 (GSM 900) as defined in GSM 02.06</td></tr><tr><td>Transmitting frequency</td><td>GSM 824 to 849 MHz, GSM 880-915 MHz, DCS 1710 to 1785 MHz, PCS 1850 to 1910 MHz</td></tr><tr><td>Receiving frequency</td><td>GSM 869 to 894 MHz, GSM 925-960 MHz, DCS 1805 to 1880 MHz, PCS 1930 to 1990 MHz</td></tr></table>
See FCC User Manual Safety and Product Info – Blackberry 7290 at 10.</td></tr>
<tr><td>12[m]</td><td>[the antenna system comprising] a second antenna within the wireless device and configured to receive signals from a 4G communication standard,</td><td>Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou ’208.

The Blackberry 7130e is a wireless device that was available for purchase in the United States no later than December 1, 2005, which is prior to the critical date of the ’677 patent.</td></tr>
</table>

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		  See Mobile Tracker Website, BlackBerry 7130e with EV-DO on Verizon Wireless, http://www.mobiletracker.net/archives/2005/11/21/blackberry-7130e-verizon (last accessed June 16, 2025). The Blackberry 7130e includes a second antenna within the 7130e and configured to receive signals from a 4G communication standard.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 See FCC Internal Photos – Blackberry 7130e at 2. It would have been obvious to include the second antenna of the Blackberry 7130e in the Blackberry 7290 to achieve cellular antenna diversity for improving the data rate, as taught by Dou '208:

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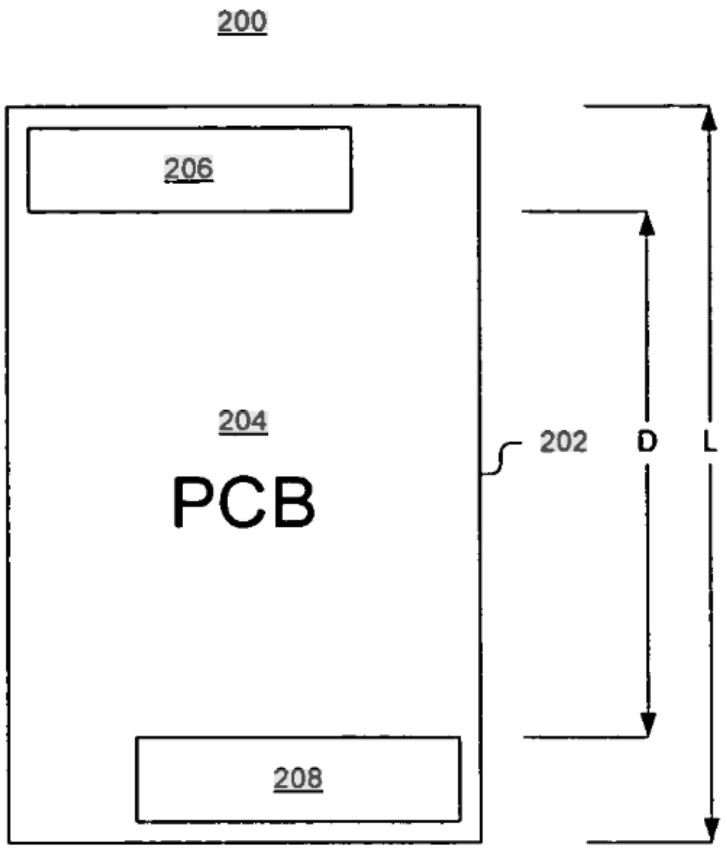
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 Dou '208 (Abstract) teaches "an internal diversity antenna architecture." According to Dou '208 (3:54-58), "first internal antenna 206 and the second internal antenna 208 may be used to implement various spatial diversity techniques to improve communication of wireless signals across one or more wireless frequency bands of wireless shared media." For example (3:26-31),

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		"the primary antenna (e.g., first internal antenna 206) may be configured for transmission and both the primary antenna (e.g., first internal antenna 206) and the secondary antenna (e.g., second internal antenna 208) may be configured for reception. Such an arrangement may be used in a cellular phone for improving data rate. As another example (3:32-35), "the primary antenna (e.g., first internal antenna 206) and the secondary antenna (e.g., second internal antenna 208) may be configured for both transmission and reception." The result of the modification would have included the cellular antenna of the BlackBerry 7290 as the first internal antenna 206 and the cellular antenna of the Blackberry 7130e as the second internal antenna 208.

Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		 There would have been a reasonable expectation of success because the Blackberry 7290 and 7130e implement cellular service using each cellular antenna individually, and Dou '208 further teaches how to implement the two antennas together in a diversity architecture, such as how far apart to space the two antennas from one another, and circuitry to operate the two cellular antennas in a diversity architecture. There is also considerable technical overlap between the Blackberry 7290, the Blackberry 7130e, and Dou'208 . For example, the cellular antennas of the Blackberry 7290 and 7130e are located at the top and bottom of the devices, respectively, as taught for the internal antennas 206, 208,

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		respectively, in Dou ’208. Also, Dou ’208 (3:42-47) teaches that the internal antennas 206, 208 may operate in the GSM 800 and PCS 1900 frequency bands, in which the cellular antennas of the Blackberry 7290 and 7130e already operate. Moreover, Dou ’208 (3:50-62) teaches that the internal antennas 206, 208 may be designed for Evolution Data Optimized (EVDO) diversity in the 800 MHz and 1900 MHz bands, and the Blackberry 7130e is designed for EVDO cellular service. *See* Mobile Tracker Website, *BlackBerry 7130e with EV-DO on Verizon Wireless*, http://www.mobiletracker.net/archives/2005/11/21/blackberry-7130e-verizon (last accessed June 16, 2025).
12[n]	a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second antenna defining an antenna box,	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou ’208. *See* Claim 6[m].
12[o]	an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou ’208. *See* Claim 6[n].
12[p]	an antenna rectangle,	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou ’208.

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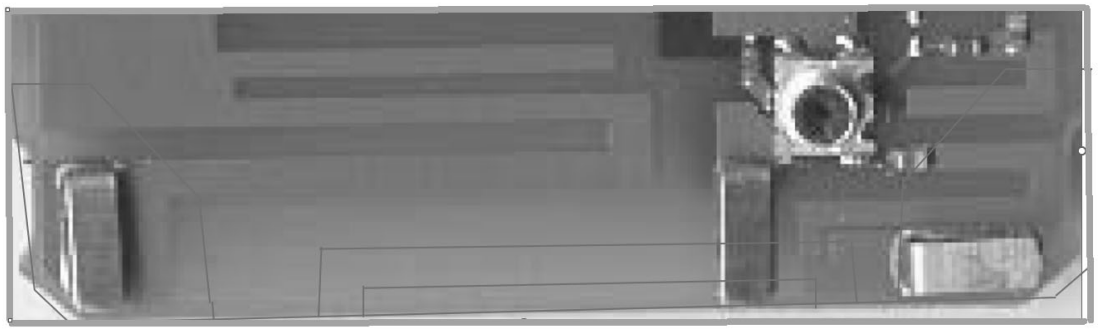
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
		See Claim 6[o].
12[q]	an aspect ratio of the antenna rectangle being defined as a ratio between a width and a height of the antenna rectangle, and wherein the aspect ratio has a value of at least 2.	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou '208. *See, e.g.*, An aspect ratio of the antenna rectangle is defined as a ratio between a width and a height of the antenna rectangle. The aspect ratio has a value of at least 2. A width of the antenna rectangle is at least twice a height of the antenna rectangle. 
Claim 13		

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
13	The wireless device of claim 12, wherein the first antenna contour comprises at least 20 segments.	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 2.
Claim 14		
14	The wireless device of claim 13, wherein the first antenna contour comprises at least 35 segments.	Blackberry 7290 expressly or inherently discloses this claim element. *See* Claim 3.
Claim 15		
15	The wireless device of claim 12, wherein the second antenna is proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle.	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou '208. *See* Claim 6[l].
Claim 16		

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
16[a]	The wireless device of claim 12, wherein the second antenna defines a second antenna contour comprising an entire perimeter of the second antenna,	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou '208. *See* Claim 6[k].
16[b]	and wherein the second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou '208. *See* Claim 9[a].
16[c]	a complexity factor F_{32} having a value of at least 1.35.	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou '208. *See* Claim 9[a].
Claim 17		

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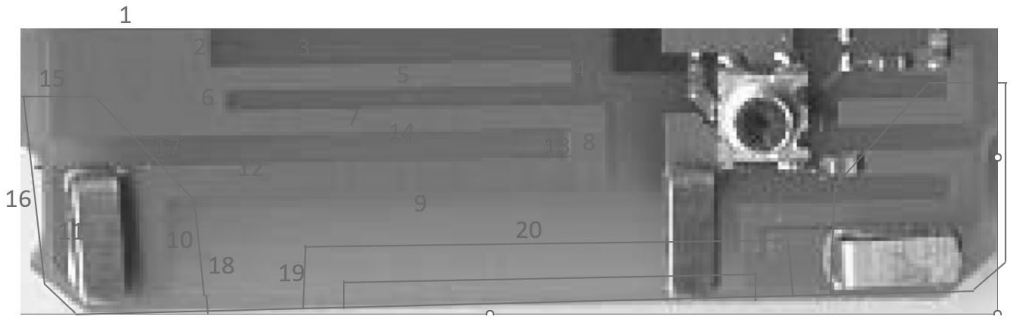
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7290
17	The wireless device of claim 16, wherein the second antenna contour comprises at least 20 segments.	Blackberry 7290 expressly or inherently discloses this claim element. To the extent the Blackberry 7290 does not disclose or render obvious this limitation, this limitation would have been obvious in view of the Blackberry 7130e and Dou '208. *See, e.g.*, The second antenna contour of the Blackberry 7130e comprises at least 20 segments. 

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Exhibit – D – 10

INVALIDITY CONTENTIONS FOR U.S. PATENT NO. 11,031,677 B2
BASED ON THE BLACKBERRY 7130c ("Blackberry 7130c")

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, 6, 7, 8, 9, 12, 13, 14, 15, 16, and 17 ("the '677 Asserted Claims")[1]. These invalidity contentions are not an admission by the Defendants 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 '677 Patent was filed on March 27, 2020, after the AIA came into force on March 16, 2013.

Research in Motion's ("RIM") Blackberry 7130c, as publicly demonstrated, know, offered for sale, sold, and/or used by RIM and/or customers of RIM, ("Blackberry 7130c") was approved by the FCC on May 2, 2006[2] and first announced in June 2006[3]. Thus, the Blackberry 7130c is available as prior art at least under at least 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 Blackberry 7130c 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" [4]:

- PhoneScoop.com, *Blackberry 7130c*, https://www.phonescoop.com/phones/phone.php?p=963 (last accessed June 18, 2025)
- PhoneArena.com, *Blackberry 7130c*, https://www.phonearena.com/phones/BlackBerry-7130c_id1587 (last accessed June 18, 2025)

[1] Defendants understand that, by not charting claims 10-11 and 18-20 in its Infringement Contentions, Plaintiff does not assert these claims against Defendants.
[2] *See* PhoneScoop.com, *Blackberry 7130c*, https://www.phonescoop.com/phones/phone.php?p=963 (last accessed June 18, 2025); PhoneArena.com, Blackberry 7130c, https://www.phonearena.com/phones/BlackBerry-7130c_id1587 (last accessed June 18, 2025).
[3] *See* GSMArena.com, *Blackberry 7130c*, https://www.gsmarena.com/blackberry_7130c-1623.php (last accessed June 18, 2025).
[4] 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 Blackberry 7130c 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 Blackberry 7130c. 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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- GSMArena.com, *Blackberry 7130c*, https://www.gsmarena.com/blackberry_7130c-1623.php (last accessed June 18, 2025)
- Endgadget, "Cingular launches BlackBerry 7130c" (June 8, 2006) at: https://www.engadget.com/2006-06-08-cingular-launches-blackberry-7130c.html?guccounter=1 (last accessed June 18, 2025).
- Wikipedia, "List of BlackBerry products" at: https://en.wikipedia.org/wiki/List_of_BlackBerry_products (last accessed June 18, 2025).
- CNET Website, "Cingular and RIM announce BlackBerry 7130c" (June 8 2006): https://www.cnet.com/tech/mobile/cingular-and-rim-announce-blackberry-7130c/ (last accessed June 18, 2025).
- Cingular, "BlackBerry handheld comparison," archived on June 13, 2006 at: https://web.archive.org/web/20060613170143/http://cingular.com:80/business/blackberry_comparison_popup (last accessed June 18, 2025).
- FCC ID Search, https://www.fcc.gov/oet/ea/fccid (Grantee Code: "L6A"; Product Code: "RBA40GW"; Record Option: 1/3 "Detail"; Attachment: "Internal Photos" (last accessed June 17, 2025) ("FCC Internal Photos")
- FCC ID Search, https://www.fcc.gov/oet/ea/fccid (Grantee Code: "L6A"; Product Code: "RBA40GW"; Record Option: 1/3 "Detail"; Attachment: "External Photos" (last accessed June 17, 2025) ("FCC External Photos")
- FCC ID Search, https://www.fcc.gov/oet/ea/fccid (Grantee Code: "L6A"; Product Code: "RBA40GW"; Record Option: 1/3 "Detail"; Attachment: "Test Report" (last accessed June 17, 2025) ("FCC Test Report")
- FCC ID Search, https://www.fcc.gov/oet/ea/fccid (Grantee Code: "L6A"; Product Code: "RBA40GW"; Record Option: 1/3 "Detail"; Attachment: "User Manual 3 of 3" (last accessed June 17, 2025) ("FCC User Manual and Product Info")

As described in the following claim chart, the asserted claims of U.S. Patent No. 11,031,677 (the "'677 Patent"), are invalid as anticipated by Blackberry 7130c. To the extent that Blackberry 7130c is found not to anticipate one or more of the asserted claims of the '677 Patent, these claims are invalid as obvious in view of Blackberry 7130c 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.

- Cingular 8125/HTC Wizard[5]
- Blackberry 7290e
- U.S. Patent No. 7,548,208 (Dou)

[5] The Cingular 8125 is a wireless device that was available for purchase in the United States no later than February 15, 2006. *See* Cingular Website, Archived on February 15, 2006 at: https://web.archive.org/web/20060215183508/http://www.cingular.com/8125_consumer (last accessed June 16, 2025).

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One of ordinary skill in the art, as of the priority date of the ’677 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.[6]

Claim No.	**U.S. Patent No. 11,031,677 B2**	**Blackberry 7130c**
Claim 1		
1[pre]	A wireless device comprising:	To the extent the preamble is limiting, 7130c expressly or inherently discloses this claim element. *See, e.g.*,

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

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		 See FCC External Photos at 1.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		See also Endgadget, "Cingular launches BlackBerry 7130c" (June 8, 2006) at: https://www.engadget.com/2006-06-08-cingular-launches-blackberry-7130c.html?guccounter=1 (last accessed June 18, 2025); CNET Website, "Cingular and RIM announce BlackBerry 7130c" (June 8 2006) a: https://www.cnet.com/tech/mobile/cingular-and-rim-announce-blackberry-7130c/ (last accessed June 18, 2025); Cingular, "BlackBerry handheld comparison," archived on June 13, 2006 at: https://web.archive.org/web/20060613170143/http://cingular.com:80/business/blackberry_comparison_popup (last accessed June 18, 2025).
1[a]	an antenna system comprising:	7130c expressly or inherently discloses this claim element. *See, e.g.*, The Blackberry 7130c includes an antenna system including a ground plane (red below) and at least two antennas (blue and green below) within the 7130c.

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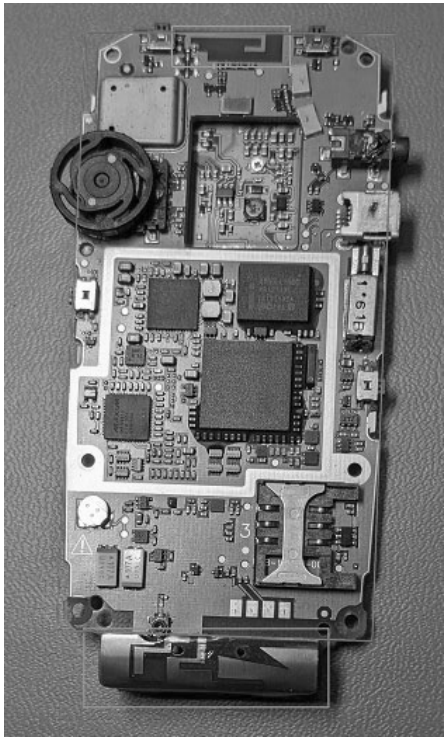
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		
1[b]	[*the antenna system*	7130c expressly or inherently discloses this claim element.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	comprising] a ground plane;	*See* Claim 1[a].
1[c]	[*the antenna system comprising*] a first antenna within the wireless device and	7130c expressly or inherently discloses this claim element. *See, e.g.*, The Blackberry 7130c includes a first antenna (blue box below) within the wireless device.

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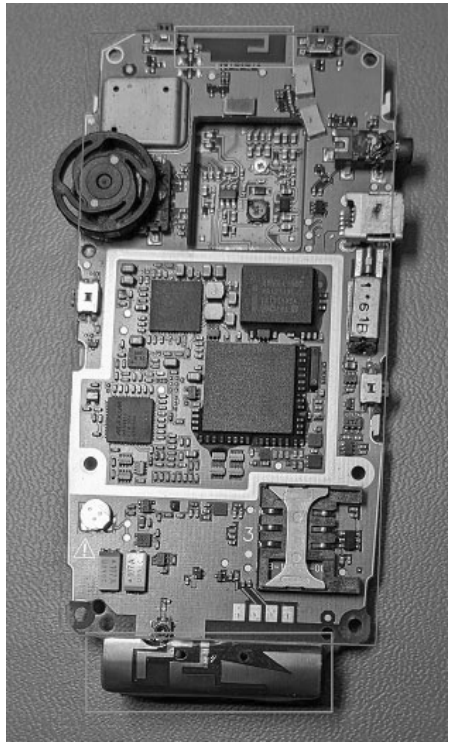
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		
1[d]	[*the antenna system*] configured to	7130c expressly or inherently discloses this claim element.

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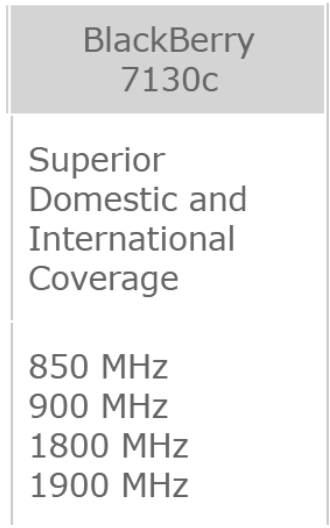
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	support at least three frequency bands contained within first and second frequency ranges of the electromagnetic spectrum,	*See, e.g.*, The first antenna of the Blackberry 7130c is configured to support at least three frequency bands contained within first and second frequency ranges of the electromagnetic spectrum. The second frequency range is higher in frequency than the first frequency range.  *See* Cingular Website, archived June 13, 2006 at: https://web.archive.org/web/20060613170143/http://cingular.com:80/business/blackberry_comparison_popup (last accessed June 18, 2025).

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
1[e]	the second frequency range being higher in frequency than the first frequency range and	7130c expressly or inherently discloses this claim element. *See* Claim 1[d].
1[f]	at least one of the three frequency bands being associated with a 4G communication standard,	7130c expressly or inherently discloses this claim element. *See, e.g.*,

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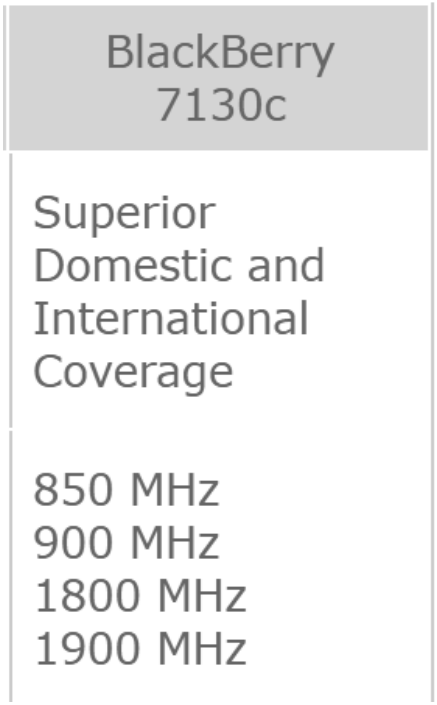
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 *See* Cingular Website, Archived on June 13, 2006 at: https://web.archive.org/web/20060613170143/http://cingular.com:80/business/blackberry_comparison_popup (last accessed June 18, 2025).

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		The first antenna of the Blackberry 7130c is configured to support at least three frequency bands where at least one of the three frequency bands is associated with a 4G communication standard.
1[g]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	7130c expressly or inherently discloses this claim element. *See, e.g.*, The Blackberry 7130c includes a first antenna (blue box below) proximate to a first short side of a ground plane rectangle (red below) enclosing the ground plane.

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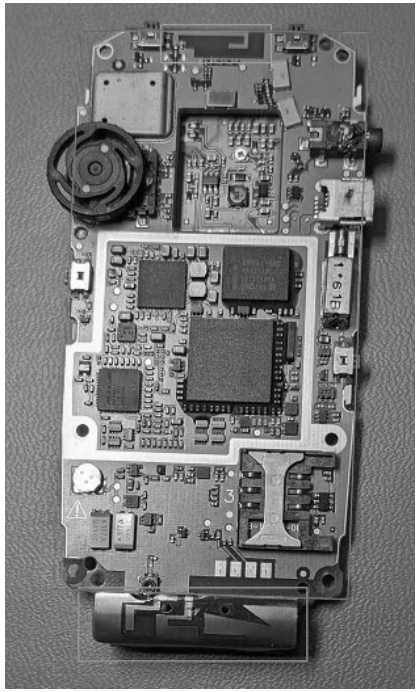
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		
1[h]	defining a first antenna contour comprising an	7130c expressly or inherently discloses this claim element. *See, e.g.*,

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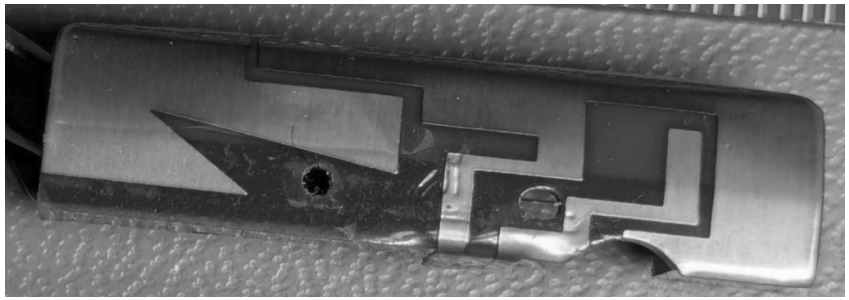
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	entire perimeter of the first antenna,	The first antenna of the Blackberry 7130c defines a first antenna contour comprising an entire perimeter of the first antenna. The first antenna of the Blackberry 7130c includes first and second sides including the perimeter of the first antenna: First antenna, first side:  First antenna, second side:

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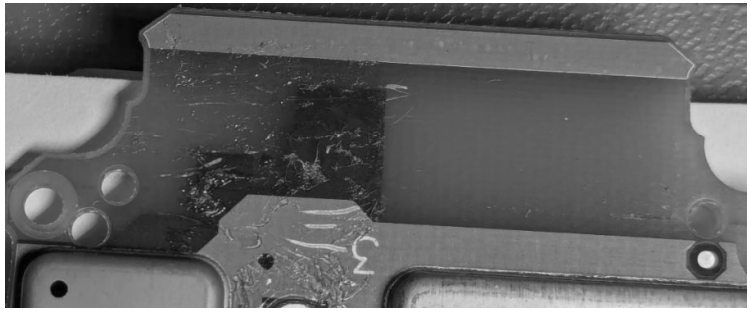
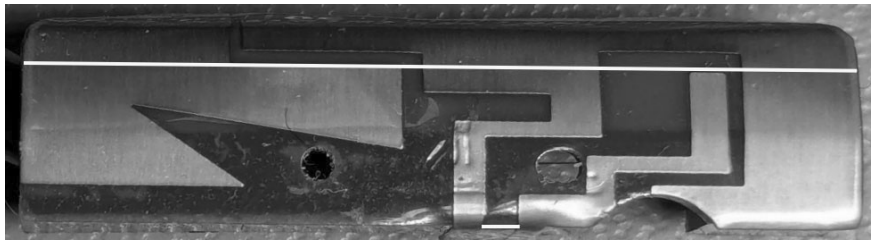
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 The first antenna contour includes parts of the perimeter that are on the first side and the orthogonal projection onto the plane of the first side of the parts of the perimeter that are on the second side: 
1[i]	wherein the first antenna contour has a level of complexity defined by complexity	7130c expressly or inherently discloses this claim element. *See, e.g.*, The first antenna 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 less than 1.75.

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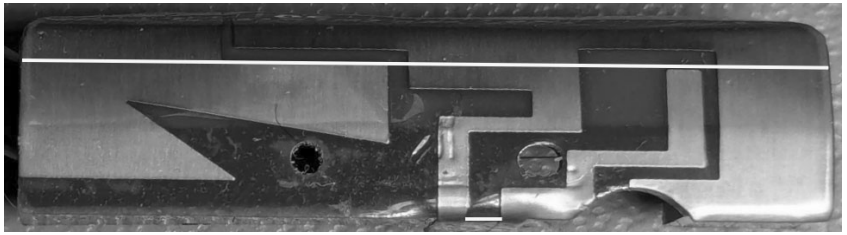
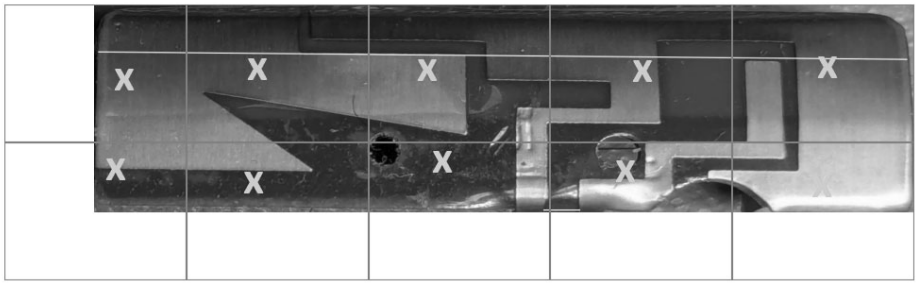
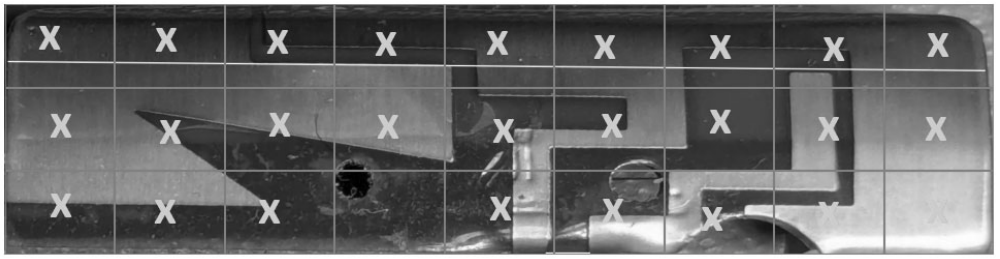
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	factor F_{21} having a value of at least 1.20 and	 N_1=10  N_2=26 

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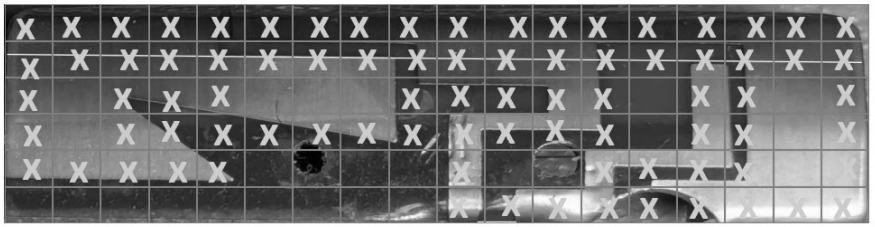
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		N_3=83  F_{21}=log(26/10)/log(2)=1.38 F_{32}=log(83/26)/log(2)=1.67
1[j]	complexity factor F_{32} having a value less than 1.75; and	7130c expressly or inherently discloses this claim element. *See* Claim 1[i].
1[k]	[*the antenna system comprising*] a second antenna within the wireless device and	7130c expressly or inherently discloses this claim element. *See, e.g.*, The Blackberry 7130c includes a second antenna (green box below) within the wireless device.

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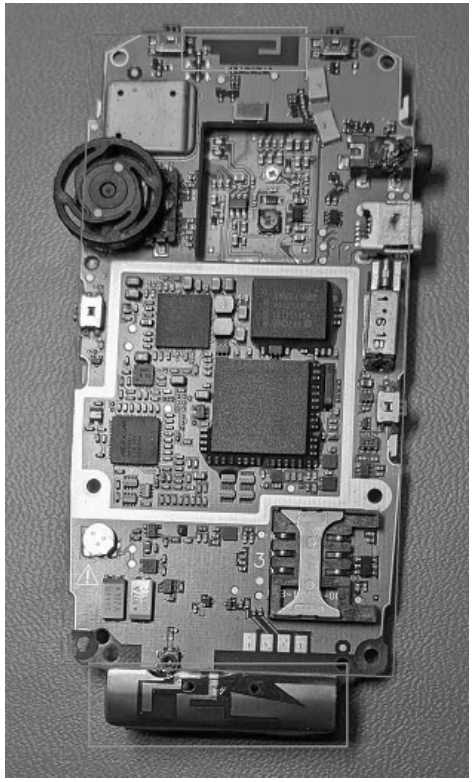
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		
1[l]	configured to support at	7130c expressly or inherently discloses this claim element.

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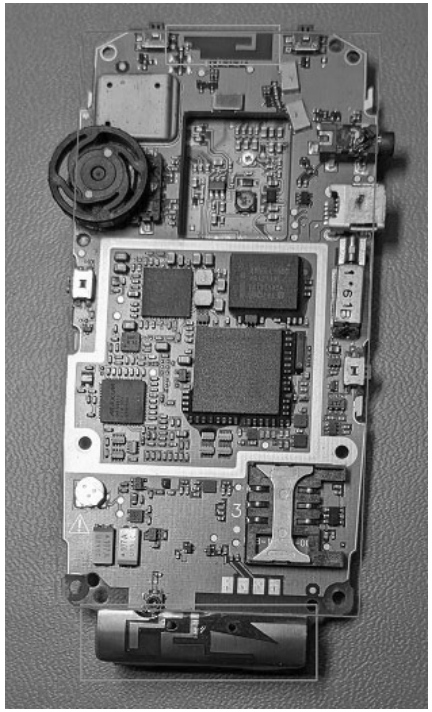
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	least one frequency band different from the at least three frequency bands supported by the first antenna,	*See, e.g.*, The second antenna of the Blackberry 7130c is configured to support at least one frequency band (e.g., 2402 to 2480 MHz), which is different from the at least three frequency bands supported by the first antenna. 

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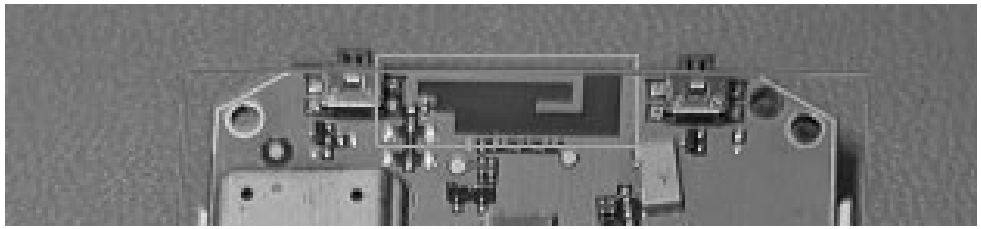
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		The transmit frequency bands operating in North America for the Handheld are: GSM 824 to 849 MHz, PCS 1850 to 1910 MHz and Bluetooth 2402 to 2480 MHz. *See* FCC Test Report at 4.
1[m]	the second antenna being arranged completely within the ground plane rectangle.	7130c expressly or inherently discloses this claim element. *See, e.g.*, The Blackberry 7130c's second antenna (green below) is arranged completely within the ground plane rectangle (red below). 
Claim 2		
2	The wireless device of claim 1, wherein the first antenna	7130c expressly or inherently discloses this claim element. *See, e.g.*,

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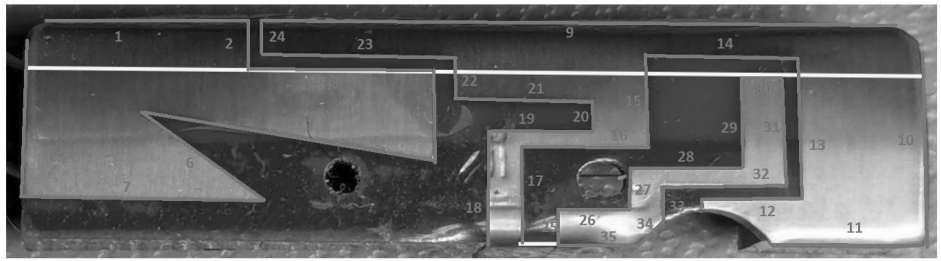
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	contour comprises at least 20 segments.	The first antenna contour comprises at least 35 segments. 
Claim 3		
3	The wireless device of claim 2, wherein the perimeter of the first antenna contour comprises at least 35 segments.	7130c expressly or inherently discloses this claim element. *See* Claim 2
Claim 4		

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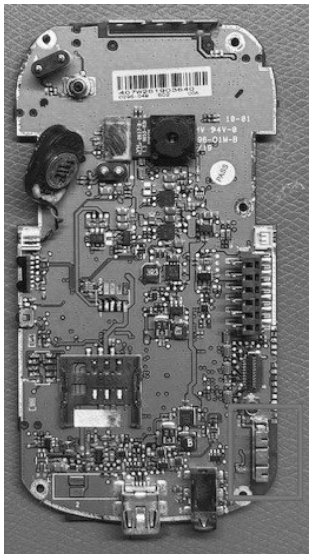
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
4	The wireless device of claim 1, wherein the antenna system comprises a third antenna configured to receive signals employing a 4G communication standard.	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Cingular 8125, or in view of the Blackberry 7290. *See, e.g.*, The antenna system of the Cingular 8125 includes a third antenna (red below) configured to receive signals employing a 4G communication standard. 

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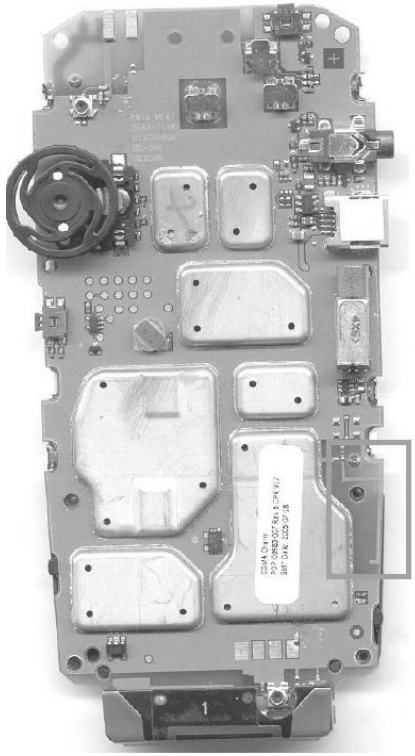
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 Integrated 802.11b support

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		See Cingular Website; archived on February 15, 2006 at: https://web.archive.org/web/20060215183508/http://www.cingular.com/8125_consumer (last accessed June 11, 2025). It would have been obvious to include the third antenna of the Cingular 8125 in the Blackberry 7130c to add WLAN functionality to the 7130c. The Blackberry 7130c and Cingular 8125 were both smartphone devices in which WLAN functionality was well known and desired by users, e.g., for Internet access. There would have been a reasonable expectation of success at least in view of the Blackberry 7130e, which has a Bluetooth antenna operating in the same frequency range and in the same relative location as the WLAN antenna of the Cingular 8125, and is located near a cellular antenna that is similar to the first antenna of the Blackberry 7130e. Alternatively or additionally, the Blackberry 7290 includes a third antenna (red below) configured to operate in at least one frequency band being used by a 4G communication standard.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 Radio specifications **BlackBerry 7290 Wireless Handheld** Quad-band support: GSM 850, GSM 900, DCS 1800, PCS 1900 MHz Power class: Class 1 (DCS 1800, PCS 1900), Class 4 (GSM 850) as defined in GSM 5.05, Class 4 (GSM 900) as defined in GSM 02.06 Transmitting frequency: GSM 824 to 849 MHz, GSM 880-915 MHz, DCS 1710 to 1785 MHz, PCS 1850 to 1910 MHz Receiving frequency: GSM 869 to 894 MHz, GSM 925-960 MHz, DCS 1805 to 1880 MHz, PCS 1930 to 1990 MHz *See* FCC User Manual Safety and Product Info at 10.

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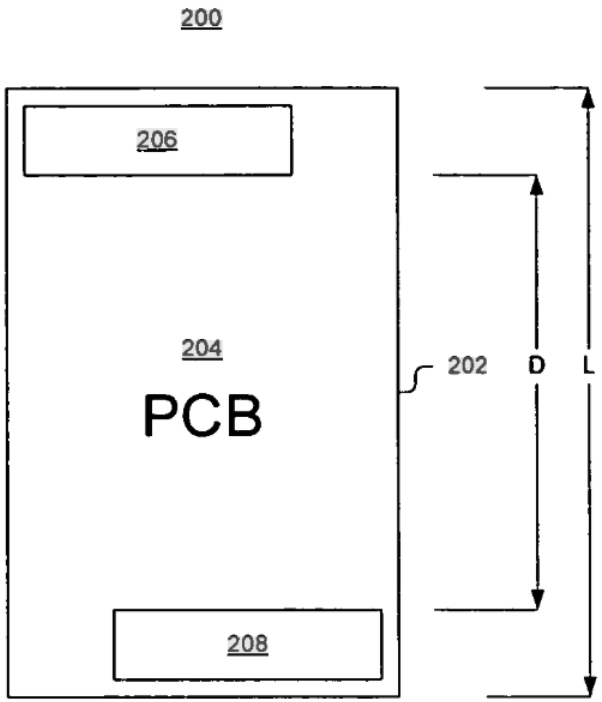
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		It would have been obvious to include the third antenna of the Blackberry 7290 in the Blackberry 7130c to achieve cellular antenna diversity for improving the data rate, as taught by Dou (U.S. Pat. 7,548,208):  Dou (Abstract) teaches "an internal diversity antenna architecture." According to Dou (3:54-58), "first internal antenna 206 and the second internal antenna 208 may be used to implement various spatial diversity techniques to improve communication of wireless signals across one or more wireless frequency bands of wireless shared

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		media." For example (3:26-31), "the primary antenna (e.g., first internal antenna 206) may be configured for transmission and both the primary antenna (e.g., first internal antenna 206) and the secondary antenna (e.g., second internal antenna 208) may be configured for reception. Such an arrangement may be used in a cellular phone for improving data rate. As another example (3:32-35), "the primary antenna (e.g., first internal antenna 206) and the secondary antenna (e.g., second internal antenna 208) may be configured for both transmission and reception." The result of the modification would have included the second (cellular) antenna of the BlackBerry 7290 as the first internal antenna 206 and the cellular antenna of the Blackberry 7130e as the second internal antenna 208.

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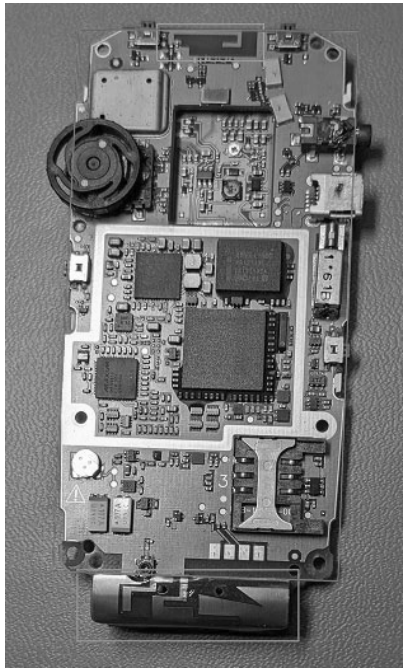
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 There would have been a reasonable expectation of success because the Blackberry 7130c and 7290 implement cellular service using each cellular antenna individually, and Dou further teaches how to implement the two antennas together in a diversity architecture, such as how far apart to space the two antennas from one another, and circuitry to operate the two cellular antennas in a diversity architecture. There is also considerable technical overlap between the Blackberry 7130c, the Blackberry 7290, and Dou. For example, the cellular antennas of the Blackberry 7130c and 7290 are located at the top and bottom of the devices,

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		respectively, as taught for the internal antennas 206, 208, respectively, in Dou. Also, Dou (3:42-47) teaches that the internal antennas 206, 208 may operate in the GSM 800 and PCS 1900 frequency bands, in which the cellular antennas of the Blackberry 7290 and 7130e already operate. Moreover, Dou (3:50-62) teaches that the internal antennas 206, 208 may be designed for Evolution Data Optimized (EVDO) diversity in the 800 MHz and 1900 MHz bands, which would be achievable using the frequencies at which the Blackberry 7130c and 7290 cellular antennas already operate.
Claim 5		
5[a]	The wireless device of claim 4, wherein the third antenna defines an antenna contour comprising an entire perimeter of the third antenna, and	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Cingular 8125, or in view of the Blackberry 7290. *See, e.g.*, The complexity factor calculation is performed according to the method in the patent. The third antenna of the Cingular 8125 defines an antenna contour comprising an entire perimeter of the third antenna, and the antenna contour of the third antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and a complexity factor F_{32} having a value of at least 1.35. N_1=10

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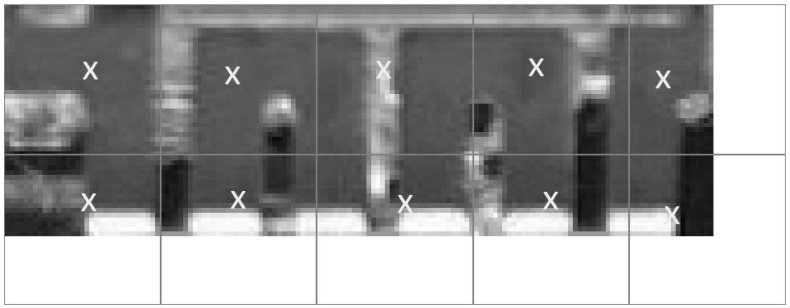
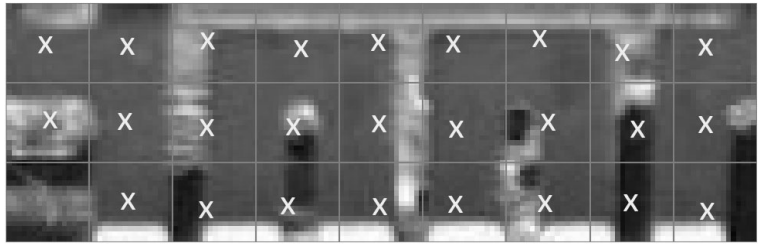
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 N_2=26  N_3=80

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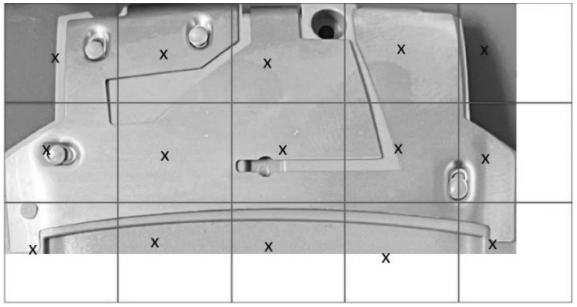
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 F_{21}=log(26/10)/log(2)=1.38 F_{32}=log(80/26)/log(2)=1.62 Alternatively or additionally, the third antenna of the Blackberry 7290 defines an antenna contour comprising an entire perimeter of the second antenna, wherein the antenna contour of the first antenna of the Blackberry 7290 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.  N_1 = 15

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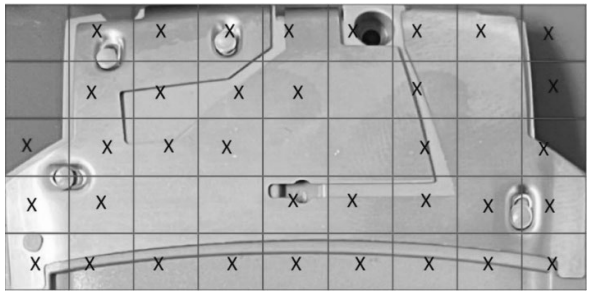
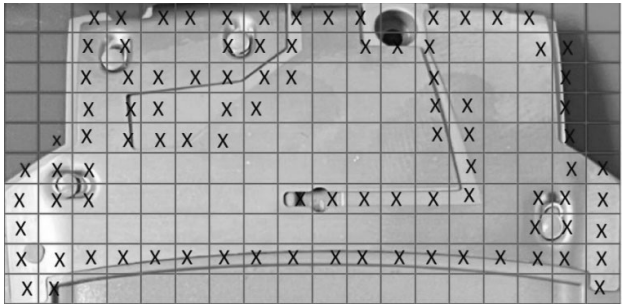
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 $N_2 = 36$  $N_3=92$ $F_{21}=1.26$ $F_{32}=1.35$

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
5[b]	wherein the antenna contour of the third antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Cingular 8125, or in view of the Blackberry 7290. *See* Claim 5[a].
5[c]	a complexity factor F_{32} having a value of at least 1.35.	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Cingular 8125, or in view of the Blackberry 7290. *See* Claim 5[a].
Claim 6		
6[pre]	A wireless device comprising:	To the extent the preamble is limiting, 7130c expressly or inherently discloses this claim element. *See* claim 1[pre].

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
6[a]	an antenna system comprising:	7130c expressly or inherently discloses this claim element. *See* claim 1[a].
6[b]	[*the antenna system comprising*] a ground plane;	7130c expressly or inherently discloses this claim element. *See* claim 1[b].
6[c]	[*the antenna system comprising*] a first antenna within the wireless device and	7130c expressly or inherently discloses this claim element. *See* claim 1[c].
6[d]	configured to support at least two frequency bands contained within first	7130c expressly or inherently discloses this claim element. *See, e.g.*,

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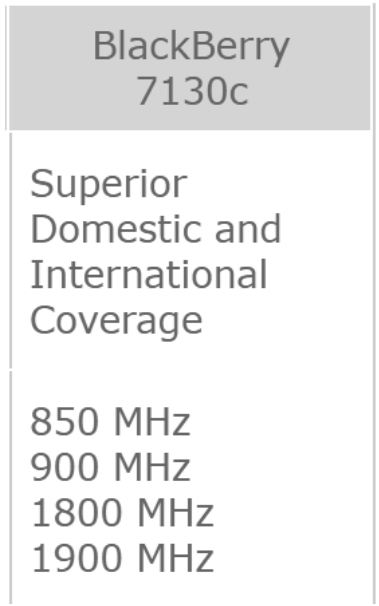
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	and second frequency ranges of the electromagnetic spectrum,	The first antenna of the Blackberry 7130c is configured to support at two frequency bands contained within first and second frequency ranges of the electromagnetic spectrum. The second frequency range is higher in frequency than the first frequency range.  *See* Cingular Website, Archived on June 13, 2006 at: https://web.archive.org/web/20060613170143/http://cingular.com:80/business/blackberry_comparison_popup (last accessed June 18, 2025).

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
6[e]	the second frequency range being higher in frequency than the first frequency range,	7130c expressly or inherently discloses this claim element. *See* claim 1[e]
6[f]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	7130c expressly or inherently discloses this claim element. *See* claim 1[g].
6[g]	defining a first antenna contour comprising an entire perimeter of	7130c expressly or inherently discloses this claim element. *See* claim 1[h].

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	the first antenna,	
6[h]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	7130c expressly or inherently discloses this claim element. *See* claim 1[i].
6[i]	complexity factor F_{32} having a value less than 1.75; and	7130c expressly or inherently discloses this claim element. *See* claim 1[i]-1[j].
6[j]	[*the antenna system comprising*] a second antenna within the	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Blackberry 7290. *See, e.g.*,

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	wireless device and	The Blackberry 7290 includes a second antenna (red below) within the wireless device. **Radio specifications** **BlackBerry 7290 Wireless Handheld** Quad-band support: GSM 850, GSM 900, DCS 1800, PCS 1900 MHz Power class: Class 1 (DCS 1800, PCS 1900), Class 4 (GSM 850) as defined in GSM 5.05, Class 4 (GSM 900) as defined in GSM 02.06 Transmitting frequency: GSM 824 to 849 MHz, GSM 880-915 MHz, DCS 1710 to 1785 MHz, PCS 1850 to 1910 MHz Receiving frequency: GSM 869 to 894 MHz, GSM 925-960 MHz, DCS 1805 to 1880 MHz, PCS 1930 to 1990 MHz See FCC User Manual Safety and Product Info at 10.

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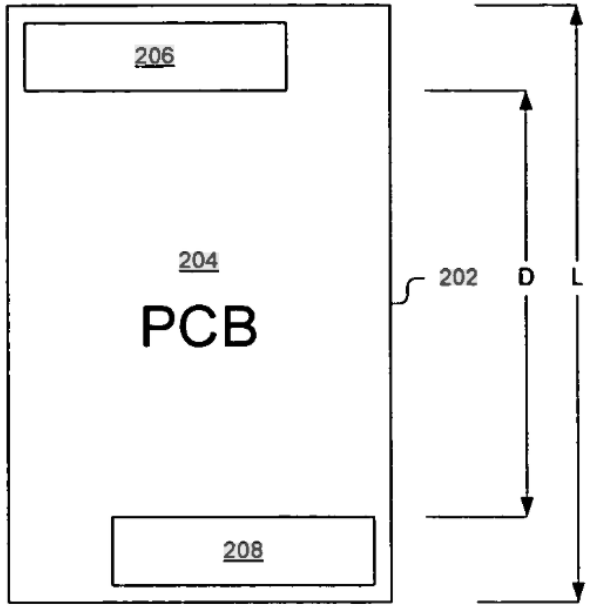
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		It would have been obvious to include the second antenna of the Blackberry 7290 in the Blackberry 7130c to achieve cellular antenna diversity for improving the data rate, as taught by Dou (U.S. Pat. 7,548,208):  Dou (Abstract) teaches "an internal diversity antenna architecture." According to Dou (3:54-58), "first internal antenna 206 and the second internal antenna 208 may be used to implement various spatial diversity techniques to improve communication of wireless signals across one or more wireless frequency bands of wireless shared media." For example (3:26-31), "the primary antenna (e.g., first internal antenna 206) may be configured for

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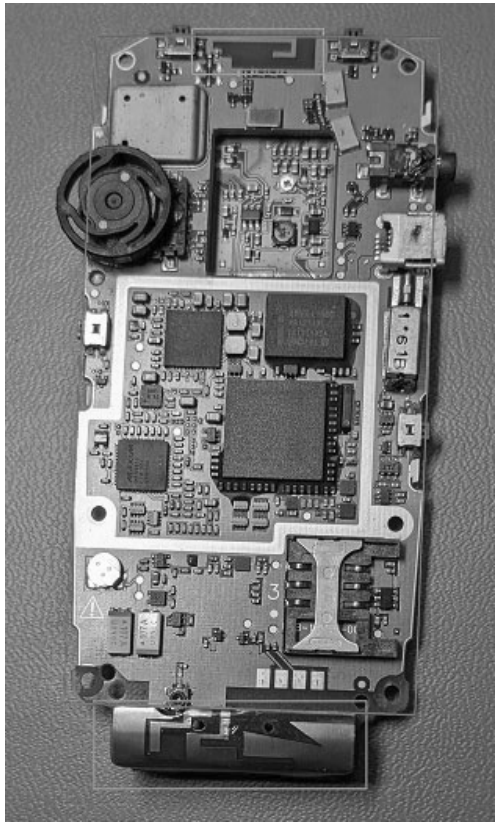
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		transmission and both the primary antenna (e.g., first internal antenna 206) and the secondary antenna (e.g., second internal antenna 208) may be configured for reception. Such an arrangement may be used in a cellular phone for improving data rate. As another example (3:32-35), "the primary antenna (e.g., first internal antenna 206) and the secondary antenna (e.g., second internal antenna 208) may be configured for both transmission and reception." The result of the modification would have included the cellular antenna of the BlackBerry 7290 as the first internal antenna 206 and the cellular antenna of the Blackberry 7130e as the second internal antenna 208.

Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 There would have been a reasonable expectation of success because the Blackberry 7130c and 7290 implement cellular service using each cellular antenna individually, and Dou further teaches how to implement the two

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		antennas together in a diversity architecture, such as how far apart to space the two antennas from one another, and circuitry to operate the two cellular antennas in a diversity architecture. There is also considerable technical overlap between the Blackberry 7130c, the Blackberry 7290, and Dou. For example, the cellular antennas of the Blackberry 7130c and 7290 are located at the top and bottom of the devices, respectively, as taught for the internal antennas 206, 208, respectively, in Dou. Also, Dou (3:42-47) teaches that the internal antennas 206, 208 may operate in the GSM 800 and PCS 1900 frequency bands, in which the cellular antennas of the Blackberry 7290 and 7130e already operate. Moreover, Dou (3:50-62) teaches that the internal antennas 206, 208 may be designed for Evolution Data Optimized (EVDO) diversity in the 800 MHz and 1900 MHz bands, which would be achievable using the frequencies at which the Blackberry 7130c and 7290 cellular antennas already operate.
6[k]	defining a second antenna contour comprising an entire perimeter of the second antenna,	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Blackberry 7290. *See, e.g.*, The second antenna of the Blackberry 7290 defines an antenna contour comprising an entire perimeter of the second antenna.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
6[l]	the second antenna being proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle,	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Blackberry 7290. *See* claim 6[j].

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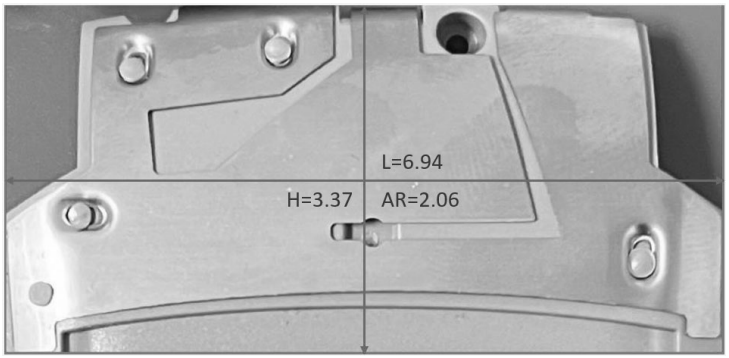
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
6[m]	a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second antenna defining an antenna box, and	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Blackberry 7290. *See, e.g.*, The second antenna of the Blackberry 7290 defines an antenna box that is a minimum-sized parallelepiped that completely encloses a volume of the second antenna, an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining an antenna rectangle. 
6[n]	an orthogonal projection of the antenna box along a normal to a face with a	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Blackberry 7290. *See* claim 6[m].

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	largest area of the second antenna defining	
6[o]	an antenna rectangle,	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Blackberry 7290. *See* claim 6[m].
6[p]	wherein a length of the second antenna contour is greater than four times a diagonal of the antenna rectangle.	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Blackberry 7290. *See, e.g.*, In the Blackberry 7290, the second antenna defines a second antenna contour comprising an entire perimeter of the second antenna, wherein a length of the second antenna contour is greater than four times a diagonal of the antenna rectangle.

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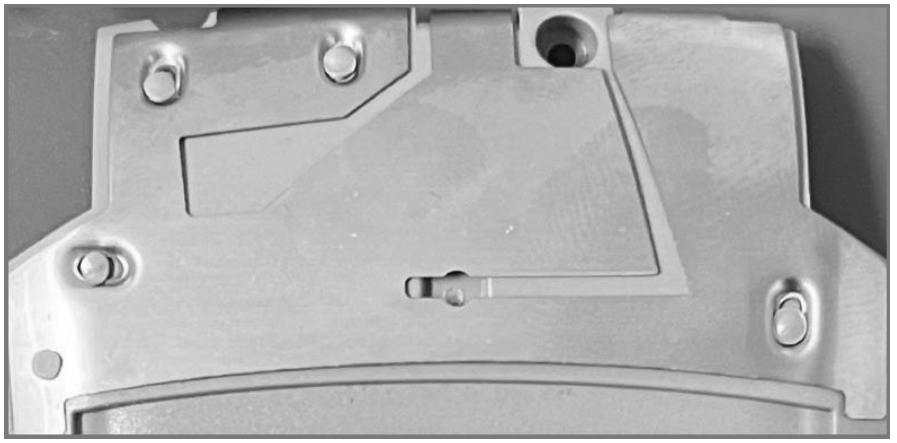
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		

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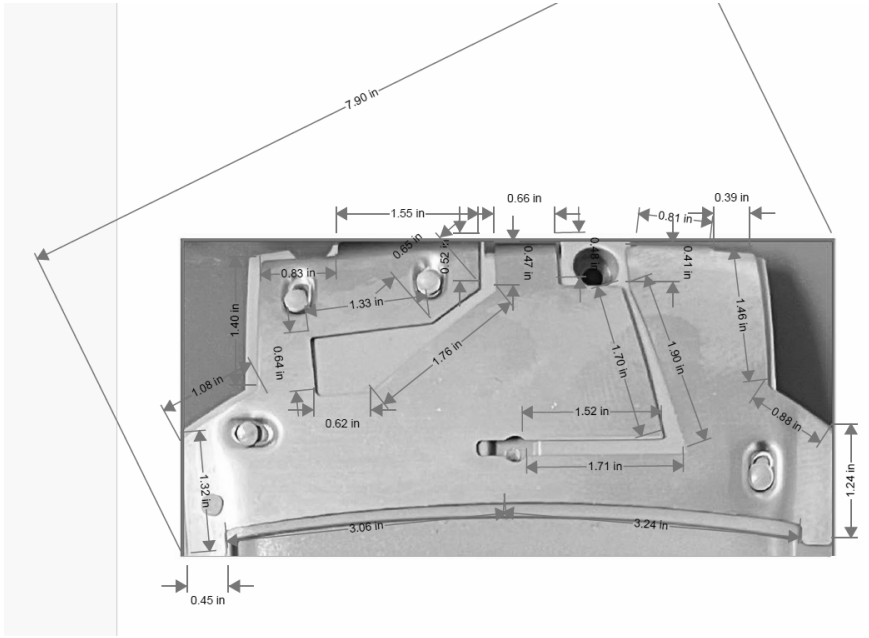
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 D=7.9 4D=4*7.9=31.6 L>1.4+.83+1.55+.52+.65+1.33+.64+.62+1.76+.47+.66+.48+1.7+1.52+1.71+1.9+.41+.81+.39+1.46+.88+1.24+3.24+3.06+.45+1.32+1.08>32.08

Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
Claim 7		
7	The wireless device of claim 6, wherein the first antenna contour comprises at least 20 segments.	7130c expressly or inherently discloses this claim element. *See* claim 2.
Claim 8		
8	The wireless device of claim 6, wherein the first antenna contour comprises at least 35 segments.	7130c expressly or inherently discloses this claim element. *See* claim 3.
Claim 9		

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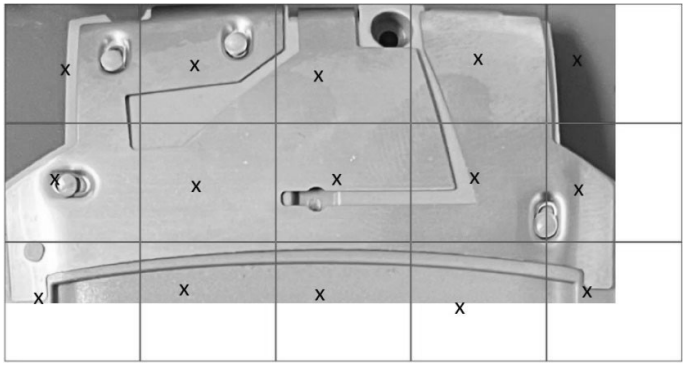
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
9[a]	The wireless device of claim 6, wherein the second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Blackberry 7290. *See, e.g.*, The complexity factor calculation is performed according to the method in the patent. The antenna contour of the second antenna of the Blackberry 7290 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.  $N_1 = 15$

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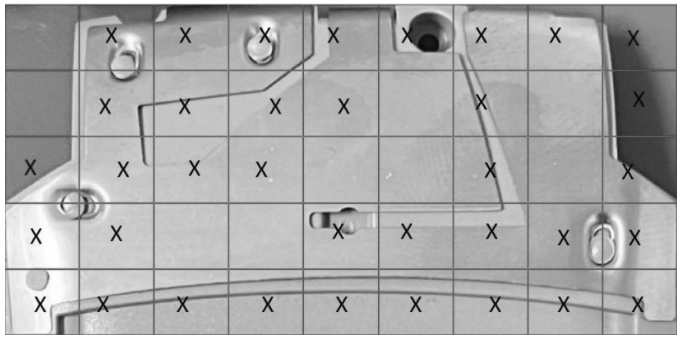
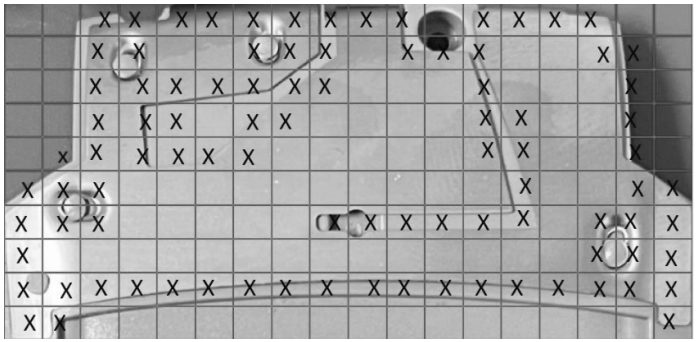
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 $N_2 = 36$  $N_3 = 92$ $F_{21} = 1.26$ $F_{32} = 1.35$

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
9[b]	a complexity factor F_{32} having a value of at least 1.35.	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Blackberry 7290. *See* claim 9[a].
Claim 12		
12[pre]	A wireless device comprising:	To the extent the preamble is limiting, 7130c expressly or inherently discloses this claim element. *See* claim 1[pre].
12[a]	an antenna system comprising:	7130c expressly or inherently discloses this claim element. *See* claim 1[a].
12[b]	[*the antenna system comprising*] a ground plane;	7130c expressly or inherently discloses this claim element. *See* claim 1[b].

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
12[c]	[*the antenna system comprising*] a first antenna within the wireless device and	7130c expressly or inherently discloses this claim element. *See* claim 1[c].
12[d]	configured to provide operation in at least four frequency bands,	7130c expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the Blackberry 7130c is configured to support at least four frequency bands, wherein at least one of the at least four frequency bands is contained within a first frequency range and at least one other of the four frequency bands is contained within a second frequency range. The first frequency range is lower in frequency than the second frequency range.

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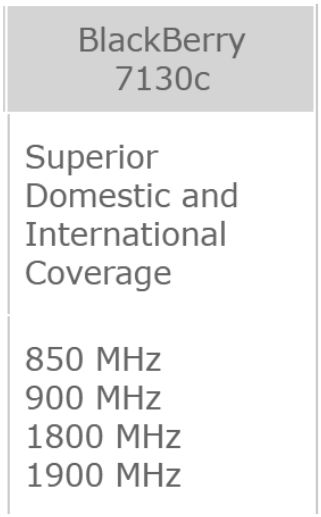
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 *See* Cingular Website, Archived on June 13, 2006 at: https://web.archive.org/web/20060613170143/http://cingular.com:80/business/blackberry_comparison_popup (last accessed June 18, 2025).
12[e]	at least one of the at least four frequency bands is contained within a first	7130c expressly or inherently discloses this claim element. *See* claim 12[d].

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	frequency range and	
12[f]	at least one other of the four frequency bands is contained within a second frequency range,	7130c expressly or inherently discloses this claim element. *See* claim 12[d].
12[g]	the first frequency range being lower in frequency than the second frequency range,	7130c expressly or inherently discloses this claim element. *See* claim 12[d].
12[h]	the first antenna being proximate to	7130c expressly or inherently discloses this claim element.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	a first short side of a ground plane rectangle enclosing the ground plane,	*See* claim 1[g].
12[i]	the first antenna defining a first antenna contour comprising an entire perimeter of the first antenna, and	7130c expressly or inherently discloses this claim element. *See* claim 1[h].
12[j]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a	7130c expressly or inherently discloses this claim element. *See* claim 1[i].

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	value of at least 1.20 and	
12[k]	complexity factor F_{32} having a value less than 1.75; and	7130c expressly or inherently discloses this claim element. *See* claim 1[i]-1[j].
12[l]	wherein the first antenna is configured to transmit and receive signals from a 4G communication standard; and	7130c expressly or inherently discloses this claim element. *See* claim 1[f].
12[m]	[*the antenna system comprising*] a second antenna within the wireless	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Cingular 8125, or in view of the Blackberry 7290. *See, e.g.*,

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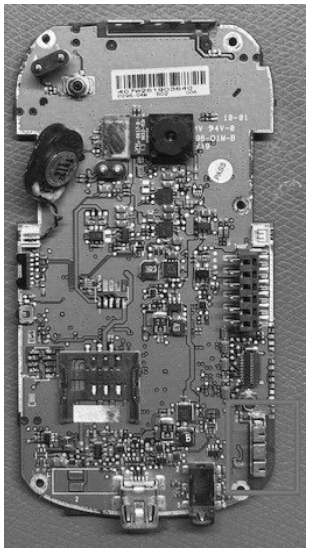
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	device and configured to receive signals from a 4G communication standard,	The antenna system of the Cingular 8125 includes a second antenna (red below) within the wireless device and configured to receive signals from a 4G communication standard. 

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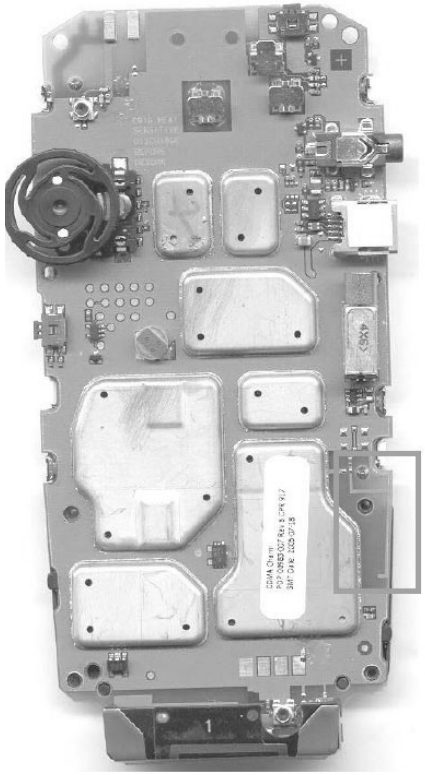
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 Integrated 802.11b support

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		See Cingular Website; archived on February 15, 2006 at: https://web.archive.org/web/20060215183508/http://www.cingular.com/8125_consumer (last accessed June 11, 2025). It would have been obvious to include the second antenna of the Cingular 8125 in the Blackberry 7130c to add WLAN functionality to the 7130c. The Blackberry 7130c and Cingular 8125 were both smartphone devices in which WLAN functionality was well known and desired by users, e.g., for Internet access. There would have been a reasonable expectation of success at least in view of the Blackberry 7130e, which has a Bluetooth antenna operating in the same frequency range and in the same relative location as the WLAN antenna of the Cingular 8125, and is located near a cellular antenna that is similar to the first antenna of the Blackberry 7130e. Alternatively or additionally, the Blackberry 7290 includes a second antenna (red below) within the wireless device and configured to receive signals from a 4G communication standard.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c

Radio specifications	
BlackBerry 7290 Wireless Handheld	
Quad-band support	GSM 850, GSM 900, DCS 1800, PCS 1900 MHz
Power class	Class 1 (DCS 1800, PCS 1900), Class 4 (GSM 850) as defined in GSM 5.05, Class 4 (GSM 900) as defined in GSM 02.06
Transmitting frequency	GSM 824 to 849 MHz, GSM 880-915 MHz, DCS 1710 to 1785 MHz, PCS 1850 to 1910 MHz
Receiving frequency	GSM 869 to 894 MHz, GSM 925-960 MHz, DCS 1805 to 1880 MHz, PCS 1930 to 1990 MHz

See FCC User Manual Safety and Product Info at 10.

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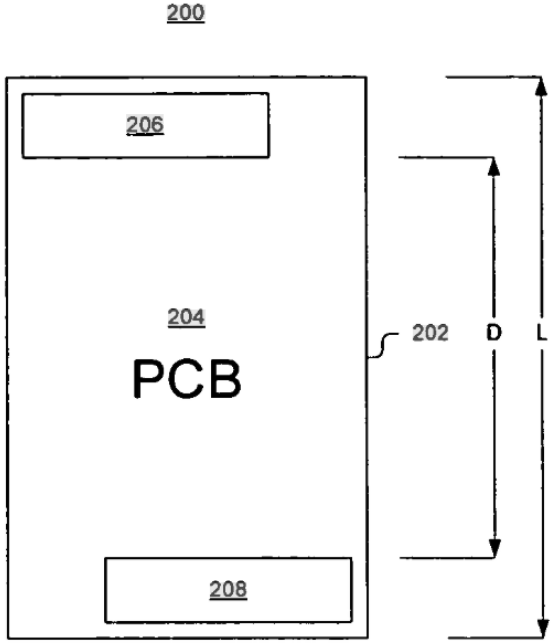
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		It would have been obvious to include the second antenna of the Blackberry 7290 in the Blackberry 7130c to achieve cellular antenna diversity for improving the data rate, as taught by Dou (U.S. Pat. 7,548,208):  Dou (Abstract) teaches "an internal diversity antenna architecture." According to Dou (3:54-58), "first internal antenna 206 and the second internal antenna 208 may be used to implement various spatial diversity techniques to improve communication of wireless signals across one or more wireless frequency bands of wireless shared media." For example (3:26-31), "the primary antenna (e.g., first internal antenna 206) may be configured for transmission and both the primary antenna (e.g., first internal antenna 206) and the secondary antenna (e.g.,

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		second internal antenna 208) may be configured for reception. Such an arrangement may be used in a cellular phone for improving data rate. As another example (3:32-35), "the primary antenna (e.g., first internal antenna 206) and the secondary antenna (e.g., second internal antenna 208) may be configured for both transmission and reception." The result of the modification would have included the second (cellular) antenna of the BlackBerry 7290 as the first internal antenna 206 and the cellular antenna of the Blackberry 7130e as the second internal antenna 208.

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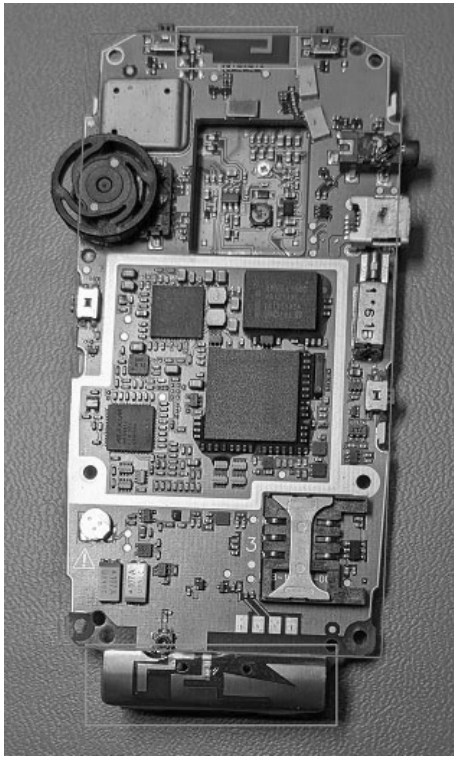
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 There would have been a reasonable expectation of success because the Blackberry 7130c and 7290 implement cellular service using each cellular antenna individually, and Dou further teaches how to implement the two antennas together in a diversity architecture, such as how far apart to space the two antennas from one another, and circuitry to operate the two cellular antennas in a diversity architecture.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		There is also considerable technical overlap between the Blackberry 7130c, the Blackberry 7290, and Dou. For example, the cellular antennas of the Blackberry 7130c and 7290 are located at the top and bottom of the devices, respectively, as taught for the internal antennas 206, 208, respectively, in Dou. Also, Dou (3:42-47) teaches that the internal antennas 206, 208 may operate in the GSM 800 and PCS 1900 frequency bands, in which the cellular antennas of the Blackberry 7290 and 7130e already operate. Moreover, Dou (3:50-62) teaches that the internal antennas 206, 208 may be designed for Evolution Data Optimized (EVDO) diversity in the 800 MHz and 1900 MHz bands, which would be achievable using the frequencies at which the Blackberry 7130c and 7290 cellular antennas already operate.
12[n]	a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second antenna defining an antenna box,	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Cingular 8125, or in view of the Blackberry 7290. In the Cingular 8125, a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second antenna defines an antenna box, and an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defines an antenna rectangle. Alternatively or additionally, *see* claim 6[m] regarding the Blackberry 7290.
12[o]	an orthogonal projection of the antenna box along a	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Cingular 8125, or in view of the Blackberry 7290.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	normal to a face with a largest area of the second antenna defining	*See* claim 12[n].
12[p]	an antenna rectangle,	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Cingular 8125, or in view of the Blackberry 7290. *See* claim 12[n].
12[q]	an aspect ratio of the antenna rectangle being defined as a ratio between a width and a height of the antenna rectangle, and wherein the aspect ratio	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Cingular 8125, or in view of the Blackberry 7290. *See, e.g.*, In the Cingular 8125, an aspect ratio of the antenna rectangle of the second antenna is defined as a ratio between a width and a height of the antenna rectangle, and wherein the aspect ratio has a value of at least 2.

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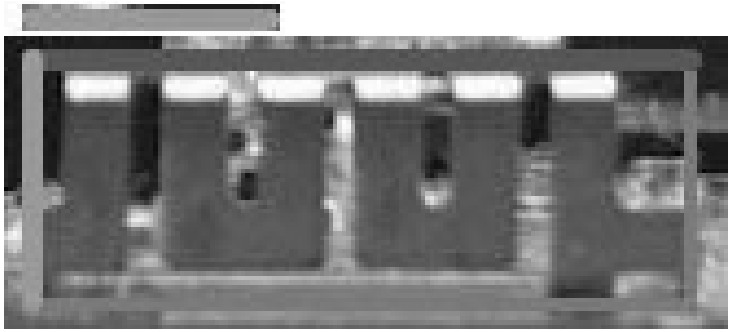
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	has a value of at least 2.	 A width (blue above) of the antenna rectangle is more than twice a height (green above) of the antenna rectangle, and thus the aspect ratio has a value of at least 2. Alternatively or additionally, in the Blackberry 7290 an aspect ratio of the antenna rectangle of the second antenna is defined as a ratio between a width and a height of the antenna rectangle, and wherein the aspect ratio has a value of at least 2.

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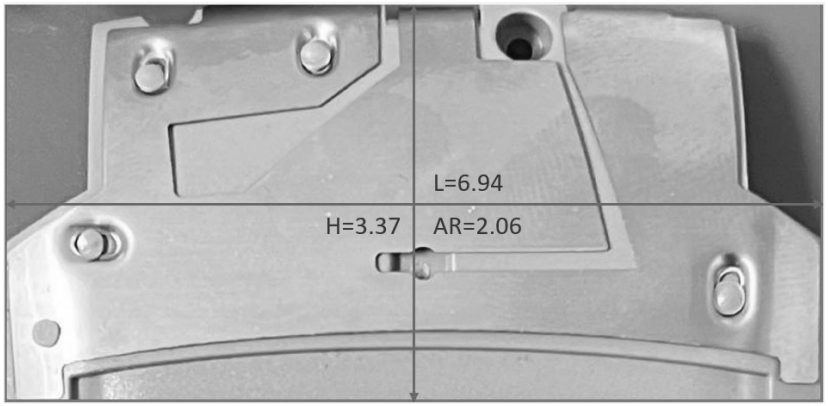
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		
		Claim 13
13	The wireless device of claim 12, wherein the first antenna contour comprises at least 20 segments.	7130c expressly or inherently discloses this claim element. *See* claim 2.

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
Claim 14		
14	The wireless device of claim 13, wherein the first antenna contour comprises at least 35 segments.	7130c expressly or inherently discloses this claim element. *See* claim 3.
Claim 15		
15	The wireless device of claim 12, wherein the second antenna is proximate to a second short side of the ground plane rectangle that is opposite to the first short	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Cingular 8125, or in view of the Blackberry 7290. *See, e.g.*, The second antenna of the Cingular 8125 is proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle.

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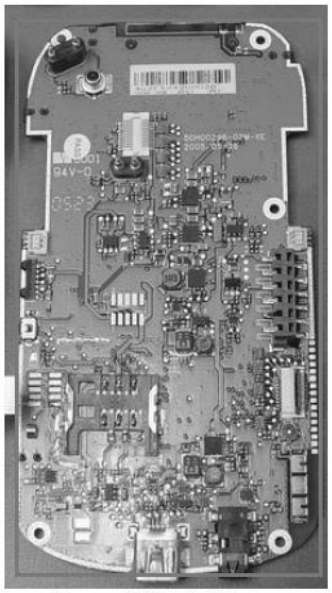
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	side of the ground plane rectangle.	First Short Side  Second Short Side *See* FCC Internal Photos at 5 (annotated). Alternatively or additionally, *see* claim 6[j], 6[l] regarding the second antenna of the Blackberry 7290.
Claim 16		

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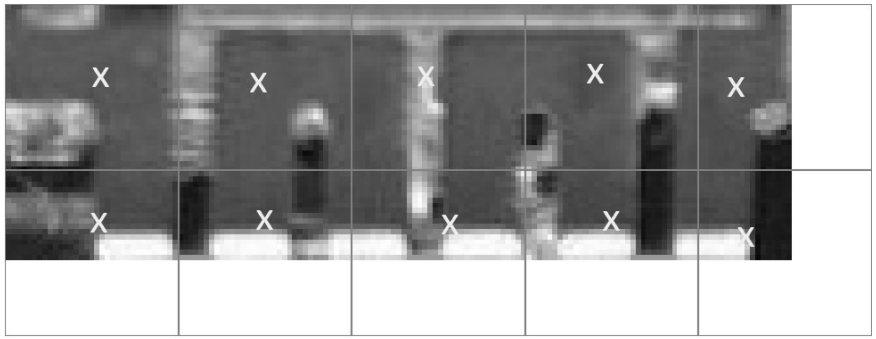
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
16[a]	The wireless device of claim 12, wherein the second antenna defines a second antenna contour comprising an entire perimeter of the second antenna,	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Cingular 8125, or in view of the Blackberry 7290. *See, e.g.*, The complexity factor calculation is performed according to the method in the patent. The second antenna of the Cingular 8125 defines an antenna contour comprising an entire perimeter of the second antenna, and the antenna contour of the second antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and a complexity factor F_{32} having a value of at least 1.35. N_1=10  N_2=26

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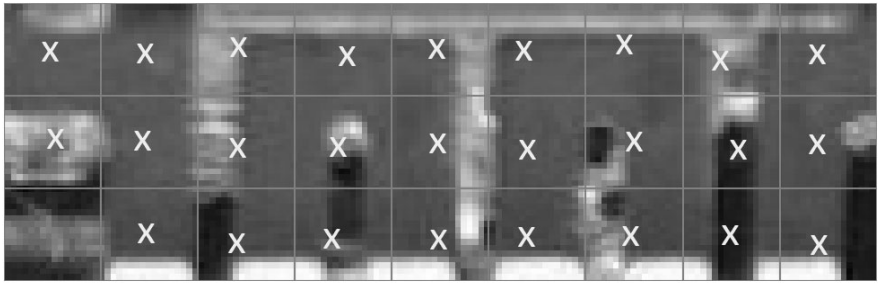
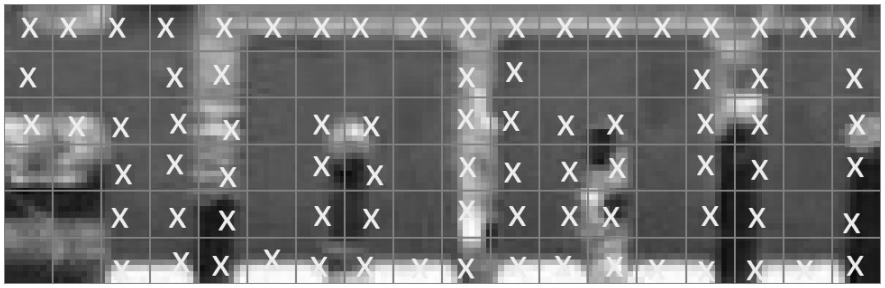
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 N_3=80  F_{21}=log(26/10)/log(2)=1.38 F_{32}=log(80/26)/log(2)=1.62 Alternatively or additionally, the second antenna of the Blackberry 7290 defines an antenna contour comprising an entire perimeter of the second antenna, wherein the antenna contour of the first antenna of the Blackberry 7290 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.

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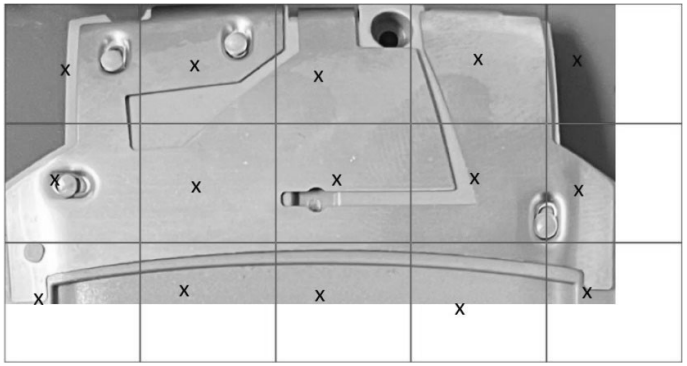
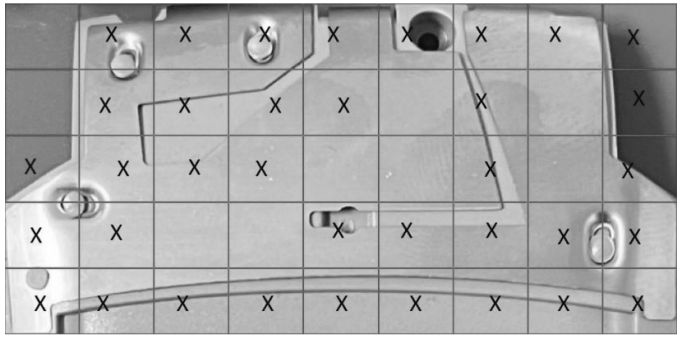
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 $N_1 = 15$  $N_2 = 36$

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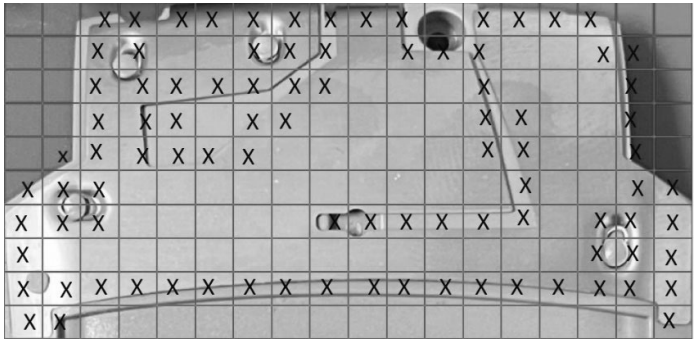
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 N_3=92 F_{21}=1.26 F_{32}=1.35
16[b]	and wherein the second antenna contour has a level of complexity defined by complexity factor F_{21} having a	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Cingular 8125, or in view of the Blackberry 7290. *See* claim 16[a].

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Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
	value of at least 1.2 and	
16[c]	a complexity factor F_{32} having a value of at least 1.35.	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Cingular 8125, or in view of the Blackberry 7290. *See* claim 16[a].
Claim 17		
17	The wireless device of claim 16, wherein the second antenna contour comprises at least 20 segments.	7130c expressly or inherently discloses this claim element. To the extent the Blackberry 7130c does not expressly or inherently disclose this claim element, this claim limitation would have been obvious in view of the Cingular 8125, or in view of the Blackberry 7290. *See, e.g.*, The second antenna contour of the second antenna of the Cingular 8125 has at least 20 segments.

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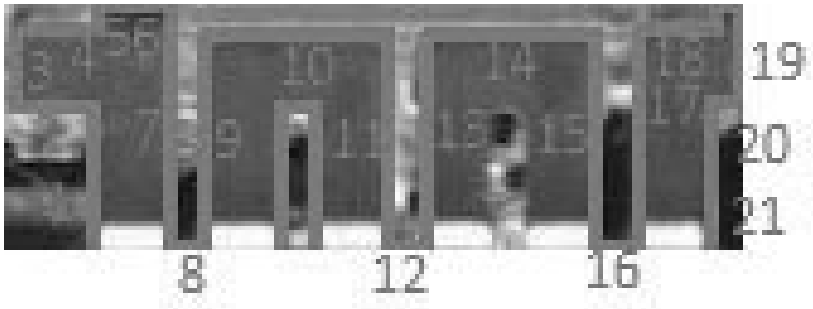
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		 The second antenna contour of the second antenna of the Cingular 8125 has at least 21 segments. Alternatively or additionally, the second antenna contour of the second antenna of the Blackberry 7290 includes at least 20 segments.

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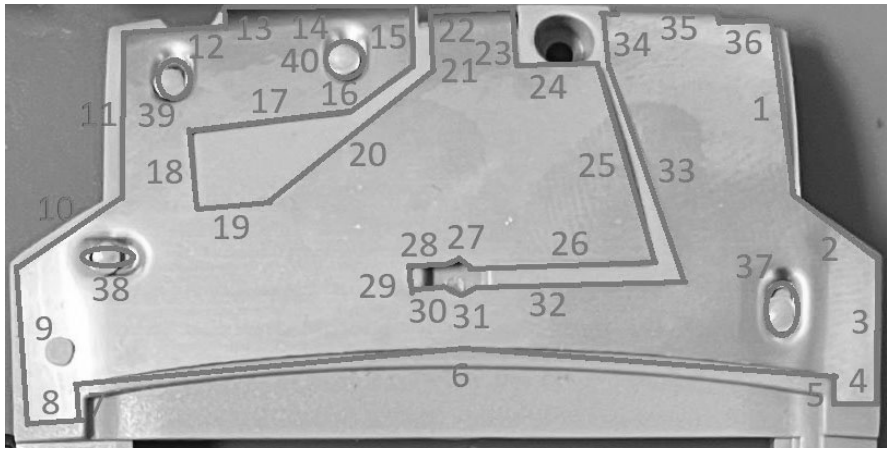
Claim No.	U.S. Patent No. 11,031,677 B2	Blackberry 7130c
		

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Exhibit – D – 11

INVALIDITY CONTENTIONS FOR U.S. PATENT NO. 11,031,677 B2
BASED ON THE HP COMPAQ nc6400 ("nc6400")

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 claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, and 17 ("the '677 Asserted Claims")[1]. These invalidity contentions are not an admission by the Defendants 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 '677 Patent was filed on March 27, 2020, after the AIA came into force on March 16, 2013.

The Hewlett Packard Company's ("HP") Compaq nc6400, 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 "nc6400") the HP 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 '200 patent. Thus, the nc6400 is available as prior art at least under at least pre-AIA 35 U.S.C. § 102(a)-(b), or AIA 35 U.S.C. § 102(a)(1). At least the following documents provide evidence as to the date the 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 that, by not charting claims 10-11 and 18-20 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] Geotab does 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. Geotab anticipates that the actual dates, circumstances, and identities of individuals will be the subject of third party discovery during this lawsuit. Geotab therefore reserves 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 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 nc6400. Geotab also reserves the right to rely on the public use, offer for sale, sale, or installation of the devices described in the publications identified herein once Geotab has 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. 11,031,677 (the "'677 Patent"), are invalid as anticipated by nc6400. To the extent that nc6400 is found not to anticipate one or more of the asserted claims of the '677 Patent, these claims are invalid as obvious in view of nc6400 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.

One of ordinary skill in the art, as of the priority date of the '677 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. 11,031,677 B2	HP Compaq nc6400
Claim 1		
1[pre]	A wireless device comprising:	To the extent the preamble is limiting, the nc6400 expressly or inherently discloses this claim element.

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

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		See, e.g., The HP 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).
1[a]	an antenna system comprising:	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The HP Compaq nc6400 includes an antenna system comprising a ground plane (red below) and at least two antennas (blue, purple, and green below) within the wireless device.

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
1[b]	[*the antenna system comprising*] a ground plane;	The nc6400 expressly or inherently discloses this claim element. *See Claim 1[a].*
1[c]	[*the antenna system comprising*] a first antenna within the wireless device and	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*,

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		The antenna system of the HP Compaq nc6400 includes a first antenna (blue below) within the nc6400.

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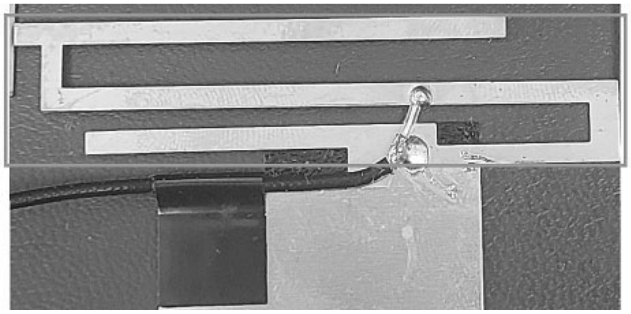
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		
1[d]	[*the antenna system*] configured to support at least three frequency bands contained within first and second frequency ranges of the electromagnetic spectrum,	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the HP Compaq nc6400 is configured to support at least three frequency bands contained within first and second frequency ranges of the electromagnetic spectrum. The second frequency range is higher in frequency than the first frequency range. The first antenna is configured to support at least frequency bands within the ranges of 824-894 MHz and 1710-2170 MHz.

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400

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

Jing, 2658 (DCS, PCS, UMTS); ETSI TS 145 005 V4.3.0 (2001-14) Technical Specification: Digital cellular telecommunications system (Phase 2+); Radio transmission and reception (3GPP

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		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. 11,031,677 B2	HP Compaq nc6400
1[e]	the second frequency range being higher in frequency than the first frequency range and	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[d].
1[f]	at least one of the three frequency bands being associated with a 4G communication standard,	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[d].
1[g]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	The nc6400 expressly or inherently discloses this claim element. To the extent the HP Compaq nc6400 does not disclose a first antenna proximate to a first short side of a ground plane rectangle enclosing the ground plane, it would have been obvious for the first antenna to be disposed proximate to a first short side of the ground plane rectangle as taught in Gaucher et al. (U.S. 2006/0082503) to achieve polarization diversity.

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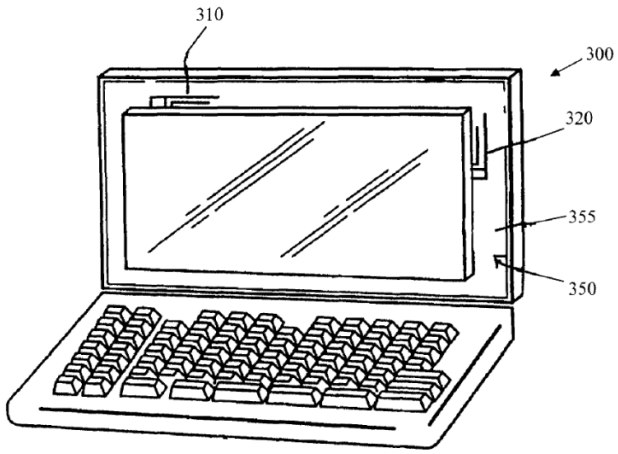
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		 FIG. 3 Gaucher teaches "a laptop computer 300 including a laptop display unit 350 and a plurality of multiband antennas 310, 320 mounted on the upper frame 355 of the laptop display unit 350." Like the HP Compaq nc6400, "As shown in FIG. 3, 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 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], whereby providing antenna polarization diversity, depending on the antenna design used."

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		Like in the HP 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." Similar to the multiband cellular antennas of the HP 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

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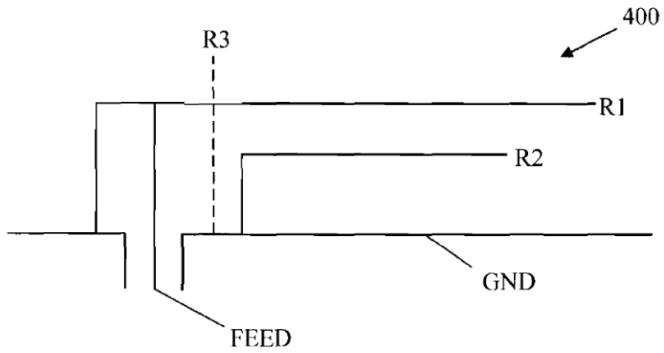
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		MHz for the upper band of Europe, and 1850-1990 MHz for the upper band of the United States."  There would have been a reasonable expectation of success in having the first antenna of the HP Compaq nc6400 disposed proximate a first short side 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 antennas. Gaucher and the HP Compaq nc6400 place the antennas on a grounded display frame for use as a ground plane. The Gaucher antennas and the 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 HP Compaq because Gaucher contemplates that the laptop computer may be

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		additionally "equipped with integrated wireless local area network (WLAN) and devices of the known Bluetooth technology." 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 of one of ordinary skill in the art and for the reasons articulated in Geotab's Invalidity Contentions Cover Pleading.
1[h]	defining a first antenna contour comprising an entire perimeter of the first antenna,	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The complexity factor calculation is performed according to the method in the patent. The first antenna of the HP Compaq nc6400 defines a first antenna contour comprising an entire perimeter of the first antenna, wherein 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 1.75.

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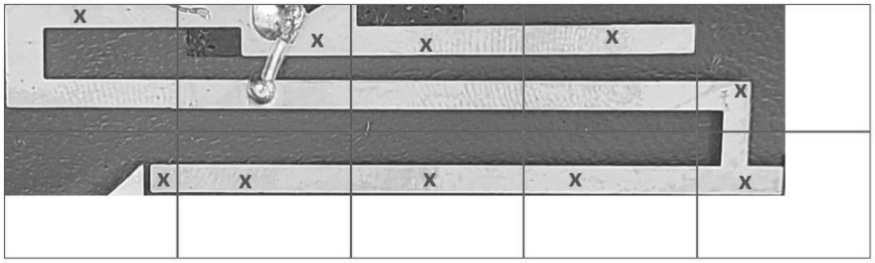
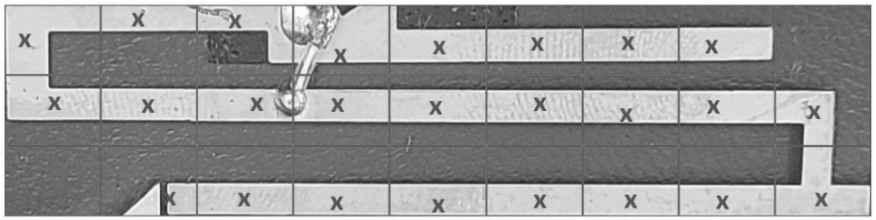
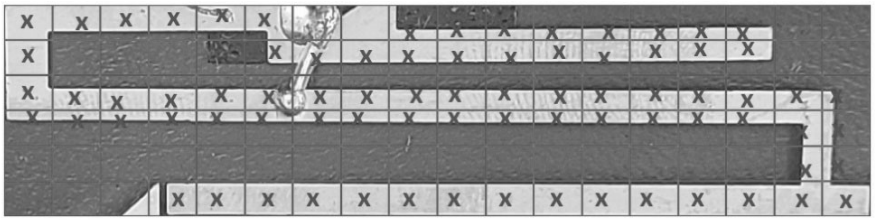
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		 N1=10  N2=25  N3=79 F21=log(25/10)/log(2)=1.32 F32=log(79/25)/log(2)=1.66

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
1[i]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[h].
1[j]	complexity factor F_{32} having a value less than 1.75; and	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[h].
1[k]	a second antenna within the wireless device and	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the HP Compaq nc6400 includes a second antenna (purple below) within the nc6400.

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
1[l]	configured to support at least one frequency band different from the at least three frequency bands supported by the first antenna,	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The second antenna of the nc6400 is configured to support at least one frequency band different from the at least three frequency bands supported by the first antenna. The second antenna is configured to support at least frequency bands within ranges of 2.4-2.484 GHz, 5.15-5.25 GHz, 5.25-5.35 GHz, and 5.725-5.825 GHz.

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400

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

Jing, 2658 (DCS, PCS, UMTS); ETSI TS 145 005 V4.3.0 (2001-14) Technical Specification: Digital cellular telecommunications system (Phase 2+); Radio transmission and reception (3GPP

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		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)[6]; 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).

[6] 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. 11,031,677 B2	HP Compaq nc6400
1[m]	the second antenna being arranged completely within the ground plane rectangle.	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The second antenna of the nc6400 is arranged completely within the ground plane rectangle.

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
Claim 4		
4	The wireless device of claim 1, wherein the antenna system comprises a third antenna configured to receive signals employing a 4G communication standard.	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the HP Compaq nc6400 includes a third antenna (green below) configured to receive signals employing a 4G communication standard.

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400

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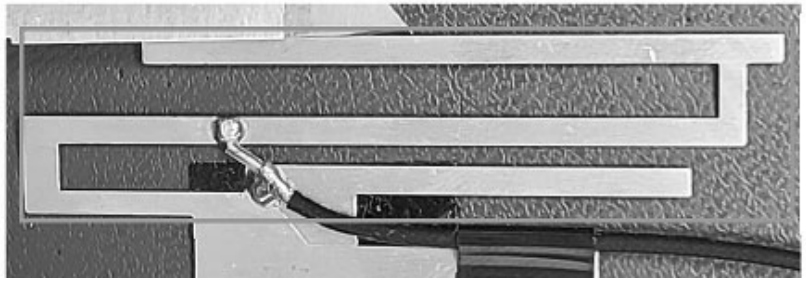
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		 The third antenna is configured to receive signals at least within the ranges of 880-960 MHz and 1710-2170 MHz.
Claim 5		
5[a]	The wireless device of claim 4, wherein the third antenna defines an antenna contour comprising an entire perimeter of the third antenna, and	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The third antenna of the HP Compaq nc6400 defines an antenna contour comprising an entire perimeter of the third antenna.

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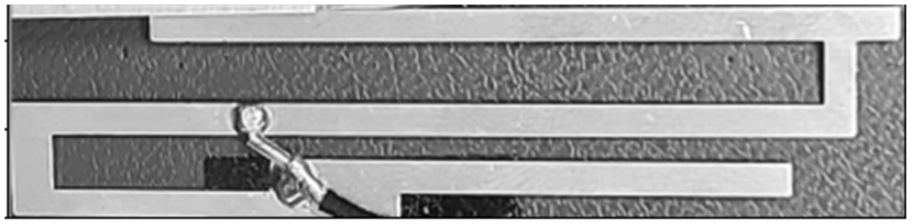
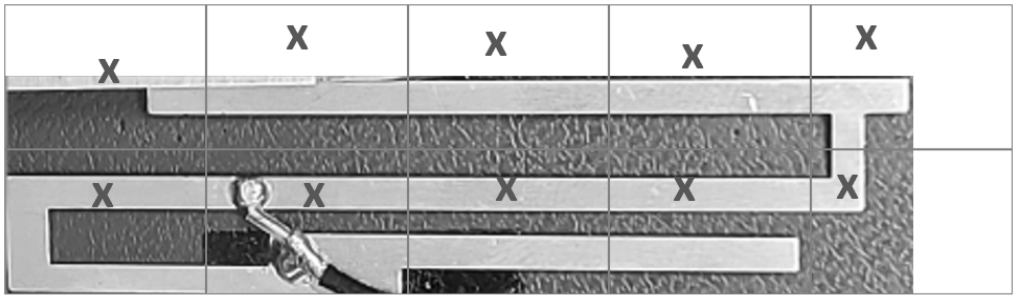
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		
5[b]	wherein the antenna contour of the third antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The complexity factor calculation is performed according to the method in the patent. The antenna contour of the third antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and a complexity factor F_{32} having a value of at least 1.35. N1=10  N2=25

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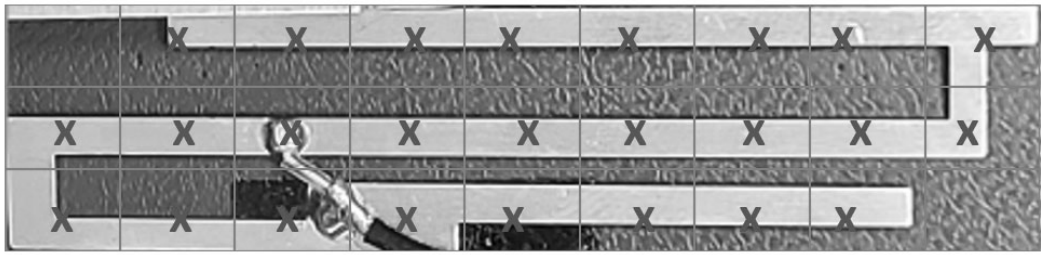
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		 N3=81 F21=log(25/10)/log(2)=1.32 F32=log(81/25)/log(2)=1.69
5[c]	a complexity factor F_{32} having a value of at least 1.35.	The nc6400 expressly or inherently discloses this claim element. *See* Claim 5[b].

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
Claim 6		
6[pre]	A wireless device comprising:	To the extent the preamble is limiting, the nc6400 expressly or inherently discloses this claim element. *See* Claim 1[pre].
6[a]	an antenna system comprising:	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[a].
6[b]	[*the antenna system comprising*] a ground plane;	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[a].
6[c]	[*the antenna system comprising*] a first antenna within the wireless device and	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[c].
6[d]	configured to support at least two frequency bands contained within first and second frequency ranges of the electromagnetic spectrum,	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[d].

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
6[e]	the second frequency range being higher in frequency than the first frequency range,	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[d].
6[f]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	The nc6400 expressly or inherently discloses this claim element. To the extent the HP Compaq nc6400 does not disclose a first antenna proximate to a first short side of a ground plane rectangle enclosing the ground plane, it would have been obvious for the first antenna to be disposed proximate to a first short side of the ground plane rectangle as taught in Gaucher et al. (U.S. 2006/0082503) to achieve spatial diversity and reduce blockage caused by the laptop display.

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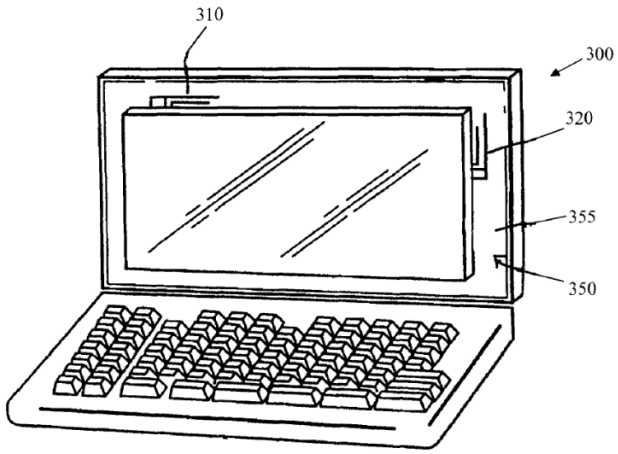
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		 FIG. 3 Gaucher discloses "a laptop computer 300 including a laptop display unit 350 and a plurality of multiband antennas 310, 320 mounted on the upper frame 355 of the laptop display unit 350." Like the HP Compaq nc6400, "As shown in FIG. 3, 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." 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."

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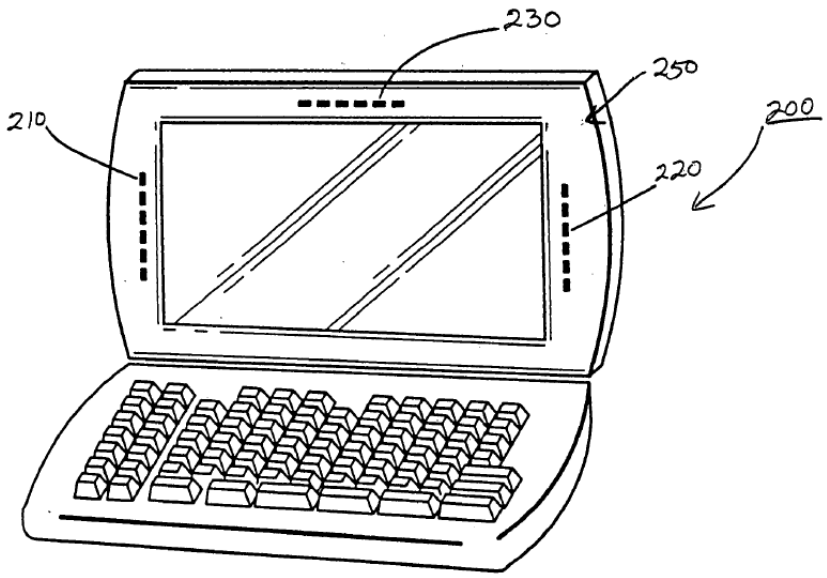
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		 FIG. 2 Like in the HP Compaq nc6400, Gaucher's "display frame or the metal display supporters provide the ground element to the antenna design. For example, the ground element may be provided by the display frame, or metal supports, or the shielding foil on the back of the display."

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		  Similar to the multiband cellular antennas of the HP 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."

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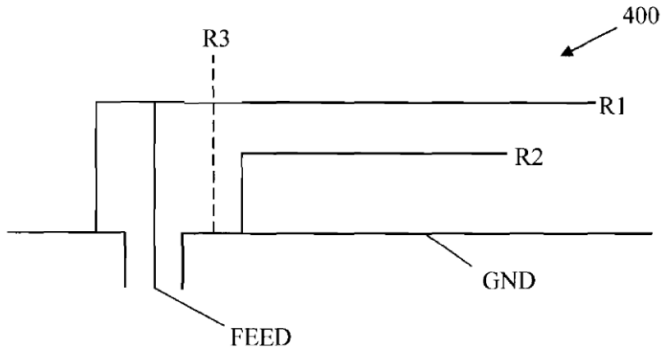
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		 There would have been a reasonable expectation of success in having the first antenna of the HP Compaq nc6400 disposed proximate a first short side of the ground plane rectangle because a similarly configured antenna is taught in a similarly configured laptop device in Gaucher. For instance, Gaucher's example antennas are based on an inverted-F antenna design like the HP Compaq nc6400 antennas. Gaucher and the HP Compaq nc6400 place the antennas on a grounded display frame for use as a ground plane. The Gaucher antennas and the 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 HP 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."

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		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 of one of ordinary skill in the art and for the reasons articulated in Geotab's Invalidity Contentions Cover Pleading.
6[g]	defining a first antenna contour comprising an entire perimeter of the first antenna,	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[h].
6[h]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[h].
6[i]	complexity factor F_{32} having a value less than 1.75; and	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[h].
6[j]	[*the antenna system comprising*] a second antenna within the wireless device and	The nc6400 expressly or inherently discloses this claim element. *See*, e.g.,

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		The antenna system of the HP Compaq nc6400 includes a second antenna (green below) within the nc6400.

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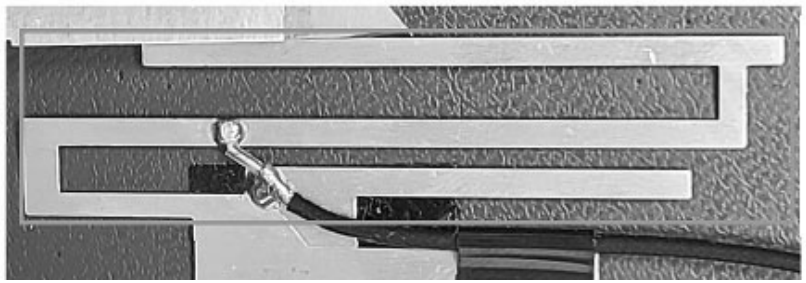
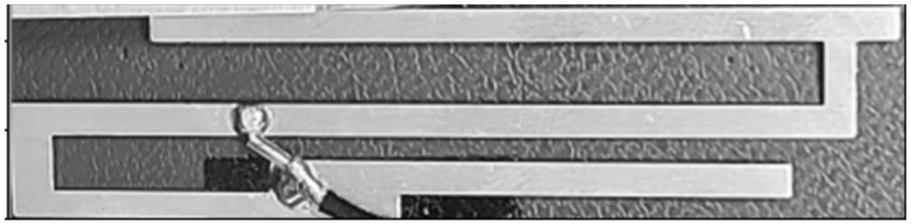
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		
6[k]	defining a second antenna contour comprising an entire perimeter of the second antenna,	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The second antenna of the HP Compaq nc6400 defines a second antenna contour comprising an entire perimeter of the second antenna. 
6[l]	the second antenna being proximate to a second short	The nc6400 expressly or inherently discloses this claim element. To the extent the HP Compaq nc6400 does not disclose a second antenna proximate to a second short side of the ground plane

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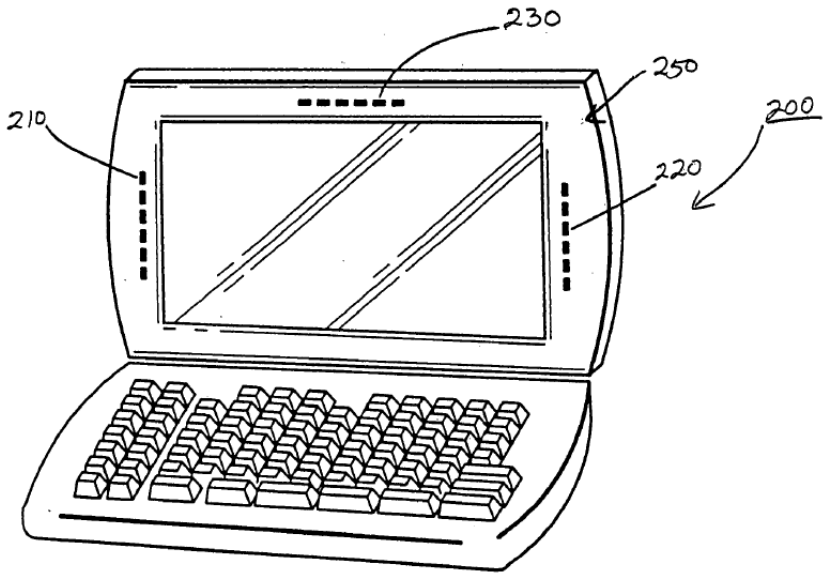
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
	side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle,	rectangle that is opposite to the first short side, it would have been obvious for the second antenna to be disposed proximate to a second short side of the ground plane rectangle that is opposite to the first short side as taught in Gaucher et al. (U.S. 2006/0082503) to achieve spatial diversity and reduce blockage caused by the laptop display. *See, e.g.*,  **FIG. 2**
6[m]	a minimum-sized parallelepiped of rectangular	The nc6400 expressly or inherently discloses this claim element.

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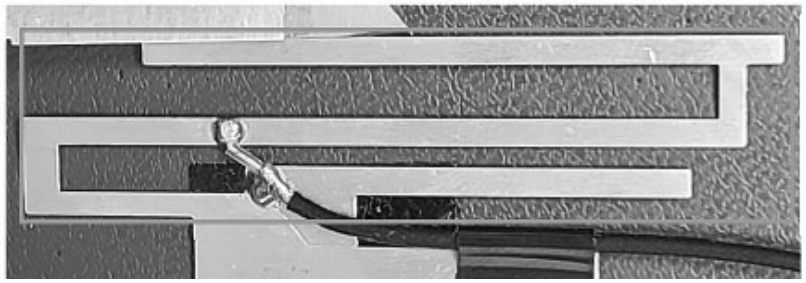
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
	faces that completely encloses a volume of the second antenna defining an antenna box, and	*See, e.g.*, The second antenna of the HP Compaq nc6400 defines an antenna box that is a minimum-sized parallelepiped that completely encloses a volume of the second antenna and wherein each face of the minimum-sized parallelepiped is tangent to at least one point of the volume of the second antenna. An orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defines an antenna rectangle. 
6[n]	an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining	The nc6400 expressly or inherently discloses this claim element. *See* Claim 6[m].
6[o]	an antenna rectangle,	The nc6400 expressly or inherently discloses this claim element. *See* Claim 6[m].

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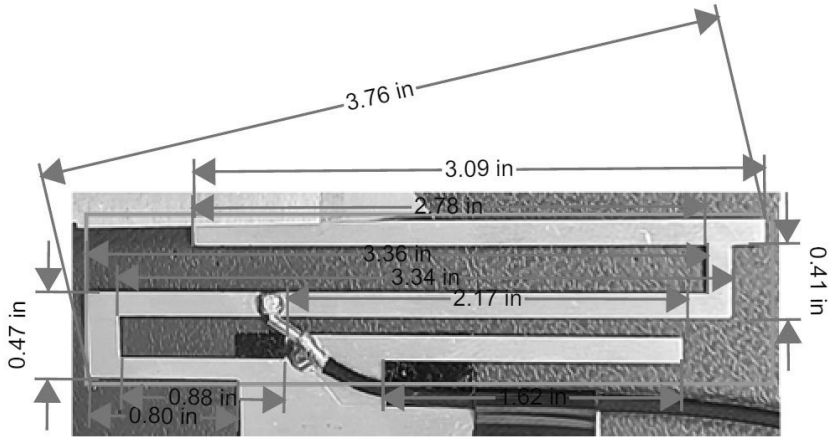
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
6[p]	wherein a length of the second antenna contour is greater than four times a diagonal of the antenna rectangle.	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The second antenna of the HP Compaq nc6400 defines a second antenna contour comprising an entire perimeter of the second antenna. A length of the second antenna contour is greater than four times a diagonal of the antenna rectangle.  4xDiagonal=4(3.76)=15.04 L>3.09+2.78+.41+3.36+3.34+.47+2.17+1.62+.88+.8>18.92
Claim 9		

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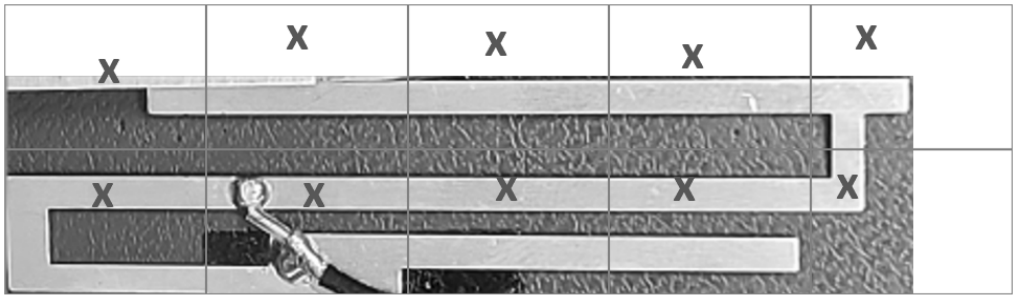
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
9[a]	The wireless device of claim 6, wherein the second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The complexity factor calculation is performed according to the method in the patent. The second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and a complexity factor F_{32} having a value of at least 1.35. N1=10  N2=25

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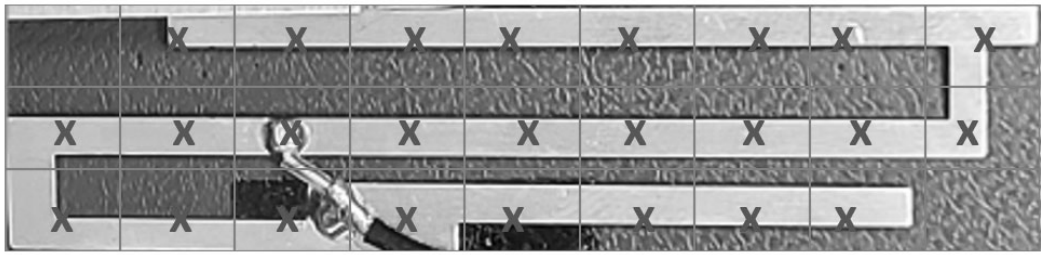
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		 N3=81 F21=log(25/10)/log(2)=1.32 F32=log(81/25)/log(2)=1.69
9[b]	a complexity factor F_{32} having a value of at least 1.35.	The nc6400 expressly or inherently discloses this claim element. *See* Claim 9[a].

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
Claim 12		
12[pre]	A wireless device comprising:	To the extent the preamble is limiting, nc6400 expressly or inherently discloses this claim element. *See* Claim 1[pre].
12[a]	an antenna system comprising:	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[a].
12[b]	[*the antenna system comprising*] a ground plane;	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[a]
12[c]	[*the antenna system comprising*] a first antenna within the wireless device and	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[c].

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
12[d]	configured to provide operation in at least four frequency bands,	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[d].

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		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

Jing, 2658 (DCS, PCS, UMTS); ETSI TS 145 005 V4.3.0 (2001-14) Technical Specification: Digital cellular telecommunications system (Phase 2+); Radio transmission and reception (3GPP

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		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)[7]; 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).

[7] 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. 11,031,677 B2	HP Compaq nc6400
12[e]	at least one of the at least four frequency bands is contained within a first frequency range and	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[d].
12[f]	at least one other of the four frequency bands is contained within a second frequency range,	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[d].
12[g]	the first frequency range being lower in frequency than the second frequency range,	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[d].
12[h]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane,	The nc6400 expressly or inherently discloses this claim element. To the extent the HP Compaq nc6400 does not disclose a first antenna proximate to a first short side of a ground plane rectangle enclosing the ground plane, 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 spatial diversity and reduce blockage caused by the laptop display.

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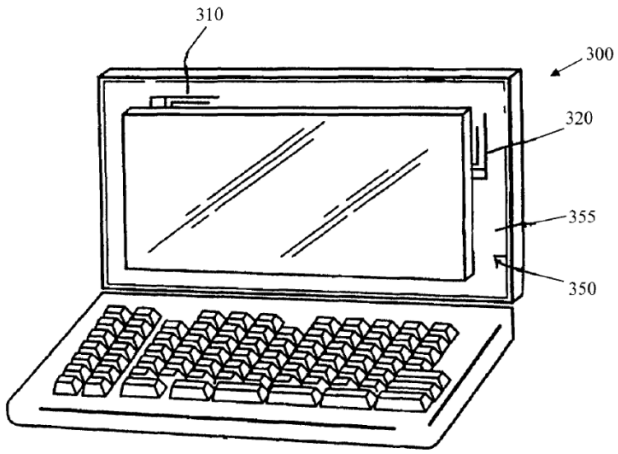
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		 FIG. 3 Gaucher discloses "a laptop computer 300 including a laptop display unit 350 and a plurality of multiband antennas 310, 320 mounted on the upper frame 355 of the laptop display unit 350." Like the HP Compaq nc6400, "As shown in FIG. 3, 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." 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."

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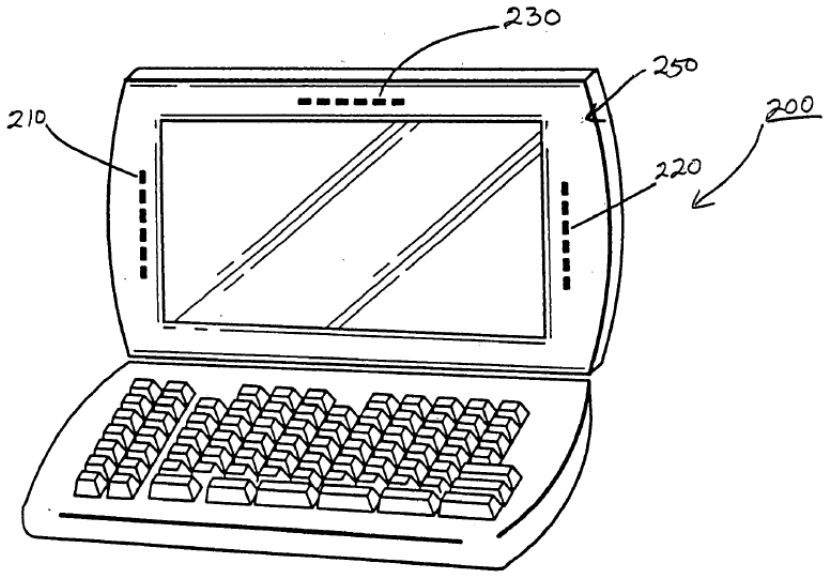
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		 FIG. 2 Like in the HP Compaq nc6400, Gaucher's "display frame or the metal display supporters provide the ground element to the antenna design. For example, the ground element may be provided by the display frame, or metal supports, or the shielding foil on the back of the display."

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		  Similar to the multiband cellular antennas of the HP 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."

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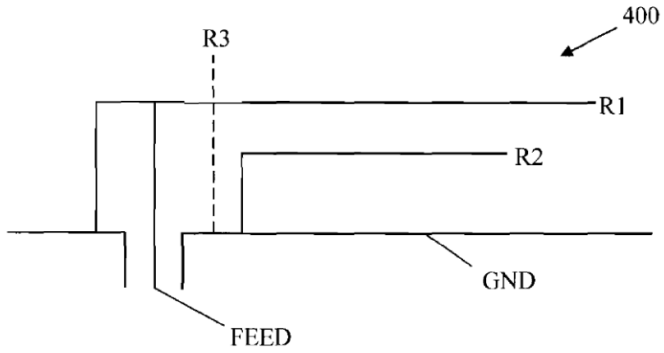
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		 There would have been a reasonable expectation of success in having the first antenna of the HP Compaq nc6400 disposed proximate a first short side of the ground plane rectangle because a similarly configured antenna is taught in a similarly configured laptop device in Gaucher. For instance, Gaucher's example antennas are based on an inverted-F antenna design like the HP Compaq nc6400 antennas. Gaucher and the HP Compaq nc6400 place the antennas on a grounded display frame for use as a ground plane. The Gaucher antennas and the 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 HP 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."

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		Additionally, it would have been obvious to a person of ordinary skill in the art to modify this reference as discussed above in connection with Claim 1[g]. 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 of one of ordinary skill in the art and for the reasons articulated in Geotab's Invalidity Contentions Cover Pleading.
12[i]	the first antenna defining a first antenna contour comprising an entire perimeter of the first antenna, and	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[h].
12[j]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[h].
12[k]	complexity factor F_{32} having a value less than 1.75; and	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[h].

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
12[l]	wherein the first antenna is configured to transmit and receive signals from a 4G communication standard; and	The nc6400 expressly or inherently discloses this claim element. *See* Claim 1[d].
12[m]	[*the antenna system comprising*] a second antenna within the wireless device and configured to receive signals from a 4G communication standard,	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the HP Compaq nc6400 includes a second antenna (green below) within the HP Compaq nc6400 and configured to receive signals from a 4G communication standard.

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400

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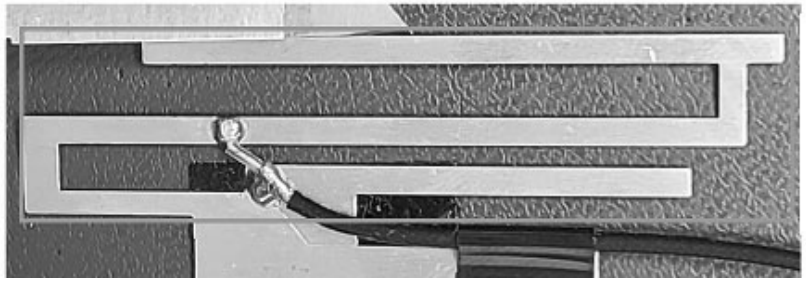
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		 The second antenna is configured to receive signals at least within the ranges of 880-960 MHz and 1710-2170 MHz.
12[n]	a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second antenna defining an antenna box,	The nc6400 expressly or inherently discloses this claim element. *See* Claim 6[m].
12[o]	an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining	The nc6400 expressly or inherently discloses this claim element. *See* Claim 6[m].
12[p]	an antenna rectangle,	The nc6400 expressly or inherently discloses this claim element. *See* Claim 6[m].

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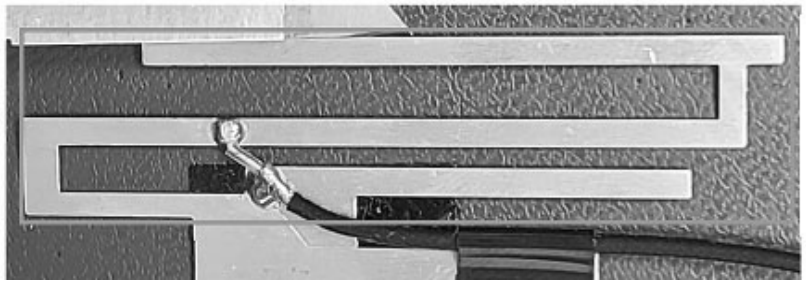
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
12[q]	an aspect ratio of the antenna rectangle being defined as a ratio between a width and a height of the antenna rectangle, and wherein the aspect ratio has a value of at least 2.	The nc6400 expressly or inherently discloses this claim element. *See, e.g.*, An aspect ratio of the antenna rectangle is defined as a ratio between a width and a height of the antenna rectangle. The aspect ratio has a value of at least 2.  The antenna rectangle is at least twice as wide as it is tall.
Claim 15		
15	The wireless device of claim 12, wherein the second antenna is proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle.	The nc6400 expressly or inherently discloses this claim element. To the extent the HP Compaq nc6400 does not disclose a second antenna proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle, it would have been obvious for the second antenna to be disposed proximate to a second short side of the ground plane rectangle that is opposite to the first short side as taught in Gaucher et al. (U.S. 2006/0082503) to achieve spatial diversity and reduce blockage caused by the laptop display. *See, e.g.*,

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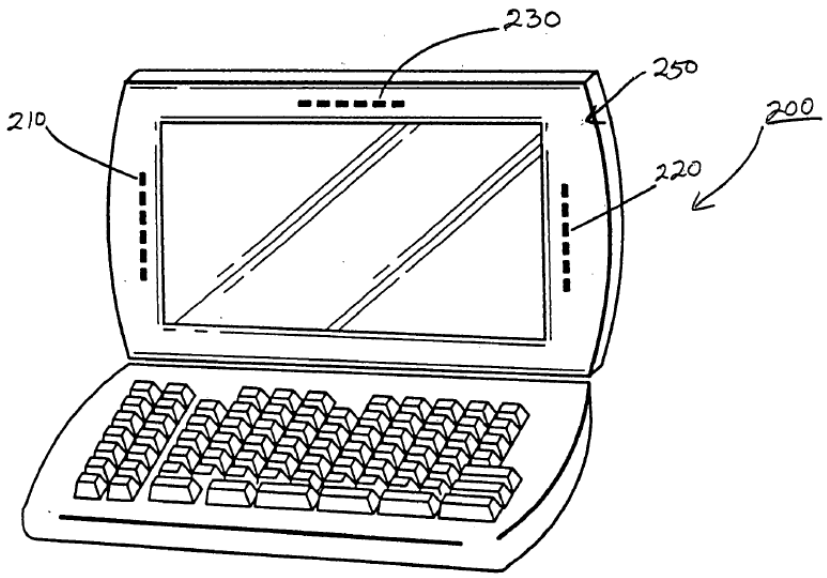
Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
		 FIG. 2
		Claim 16
16[a]	The wireless device of claim 12, wherein the second antenna defines a second antenna contour comprising an entire	The nc6400 expressly or inherently discloses this claim element. *See* Claim 6[k].

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Claim No.	U.S. Patent No. 11,031,677 B2	HP Compaq nc6400
	perimeter of the second antenna,	
16[b]	and wherein the second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	The nc6400 expressly or inherently discloses this claim element. *See* Claim 9[a].
16[c]	a complexity factor F_{32} having a value of at least 1.35.	The nc6400 expressly or inherently discloses this claim element. *See* Claim 9[a].

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Exhibit – D – 12

INVALIDITY CONTENTIONS FOR U.S. PATENT NO. 11,031,677 B2
BASED ON THE SONY ERICSSON Z520A ("Z520A")

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, 6, 7, 8, 9, 12, 13, 14, 15, 16, and 17 ("the '677 Asserted Claims")[1]. These invalidity contentions are not an admission by the Defendants 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 '677 Patent was filed on March 27, 2020, after the AIA came into force on March 16, 2013.

Sony Ericsson Mobile Communications AB's ("Sony Ericsson") Sony Ericsson Z520a, as publicly demonstrated, known, offered for sale, sold, and/or used by Sony Ericsson and/or customers of Sony Ericsson, or otherwise available to the public, including in this country, ("z520a") was announced and released in June 2005.[2] Thus, the z520a 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 z520a 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]:

- GSMArena.com, *Sony Ericsson Z520a*, https://www.gsmarena.com/sony_ericsson_z520-1202.php (last accessed June 18, 2025)

[1] Defendants understand that that, by not charting claims 10-11 and 18-20 in its Infringement Contentions, Plaintiff does not assert these claims against Defendants.
[2] *See* GSMArena.com, *Sony Ericsson Z520a*, https://www.gsmarena.com/sony_ericsson_z520-1202.php (last accessed June 18, 2025); PowerPage.org, "Sony Ericsson Releases First Quad-Band Phone" (June 20, 2005) https://www.powerpage.org/sony-ericsson-releases-first-quad-band-phone/ (last accessed June 18, 2025).
[3] Geotab does 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. Geotab anticipates that the actual dates, circumstances, and identities of individuals will be the subject of third party discovery during this lawsuit. Geotab therefore reserves the right to amend and/or supplement its Invalidity Contentions and this chart if additional information becomes available during the course of discovery. The date the z520a 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 z520a. Geotab also reserves the right to rely on the public use, offer for sale, sale, or installation of the devices described in the publications identified herein once Geotab has had a fair opportunity to take discovery on these subjects.

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- PowerPage.org, "Sony Ericsson Releases First Quad-Band Phone" (June 20, 2005) https://www.powerpage.org/sony-ericsson-releases-first-quad-band-phone/ (last accessed June 18, 2025)
- Phonescoop.com, *Sony Ericsson Z520*, https://www.phonescoop.com/phones/phone.php?p=765 (last accessed June 18, 2025)
- FCC ID Search, https://www.fcc.gov/oet/ea/fccid (Grantee Code: "PYA"; Product Code: "AC052014"; Record Option: 1/3 "Detail"; Attachment: "08 User Manual 1" (last accessed June 11, 2025) ("FCC User Manual")
- FCC ID Search, https://www.fcc.gov/oet/ea/fccid (Grantee Code: "PYA"; Product Code: "AC052014"; Record Option: 2/3 "Detail"; Attachment: "03 External Photos" (last accessed June 11, 2025) ("FCC External Photos")
- FCC ID Search, https://www.fcc.gov/oet/ea/fccid (Grantee Code: "PYA"; Product Code: "AC052014"; Record Option: 2/3 "Detail"; Attachment: "06 Test Report" (last accessed June 11, 2025) ("FCC Test Report")

As described in the following claim chart, the asserted claims of U.S. Patent No. 11,031,677 (the "'677 Patent"), are invalid as anticipated by z520a. To the extent that z520a is found not to anticipate one or more of the asserted claims of the '677 Patent, these claims are invalid as obvious in view of z520a alone or as modified in view of or in combination with other prior art references disclosed in Defendant's Invalidity Contentions and accompanying charts, including without limitation as set forth below.

- U.S. Patent No. 7,109,924 to Vance ("Vance")
- Motorola V360

One of ordinary skill in the art, as of the priority date of the '677 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.

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
	Claim 1	
1[pre]	A wireless device comprising:	To the extent the preamble is limiting, Z520a expressly or inherently discloses this claim element. *See, e.g.*,

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		See FCC External Photos at 7.
1[a]	an antenna system comprising:	Z520a expressly or inherently discloses this claim element. *See, e.g.*, The Z520a includes an antenna system including a ground plane (red below) and a first antenna within the z520a (blue below).

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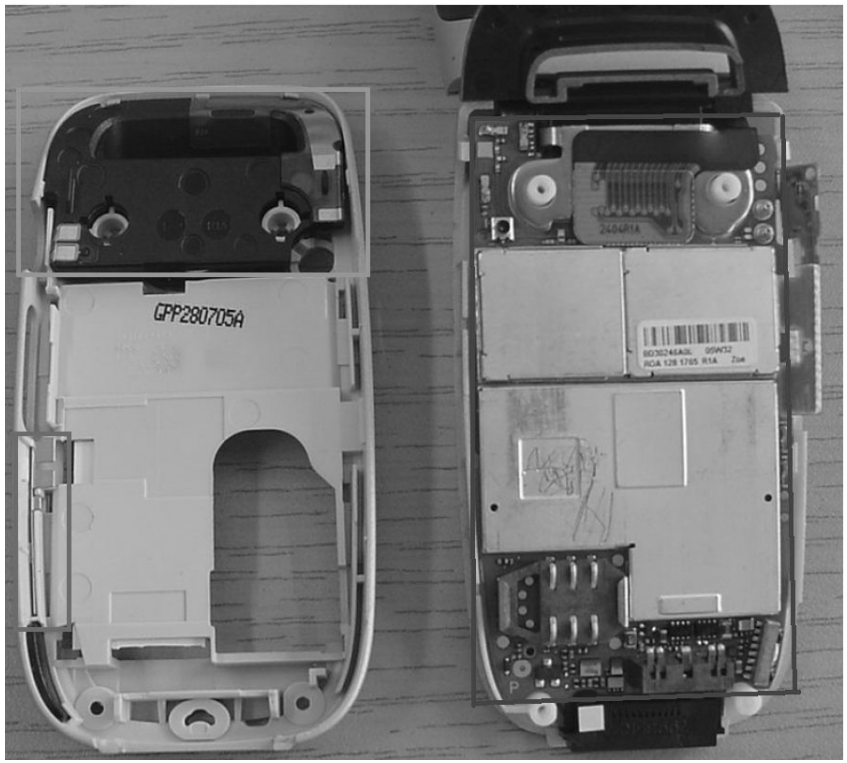
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		

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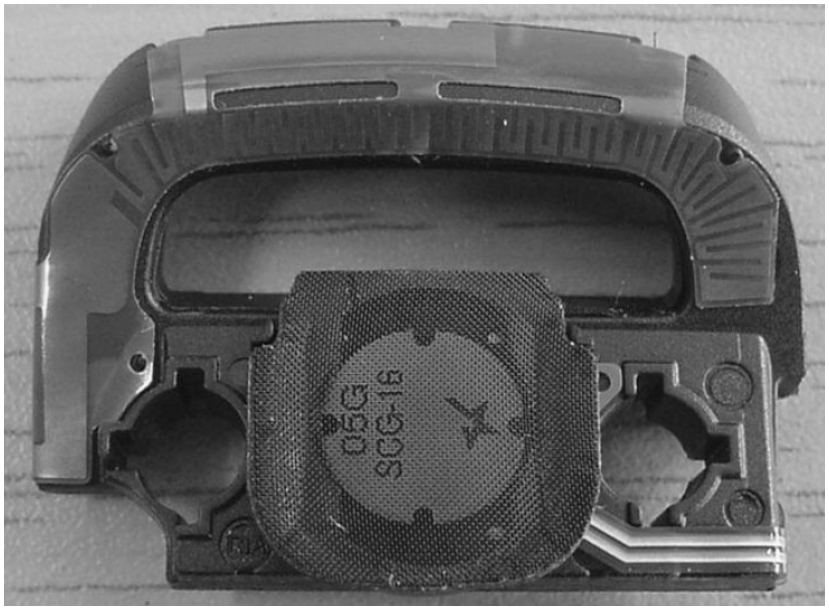
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		
1[b]	[*the antenna system comprising*] a ground plane;	Z520a expressly or inherently discloses this claim element. *See* Claim 1[a].
1[c]	[*the antenna system comprising*] a first antenna within the wireless device and	Z520a expressly or inherently discloses this claim element. *See* Claim 1[a].

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
1[d]	[*the antenna system*] configured to support at least three frequency bands contained within first and second frequency ranges of the electromagnetic spectrum,	Z520a expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the z520a 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 and at least one of the three frequency bands is associated with a 4G communication standard. **Sony Ericsson** GSM 850/900/1800/1900 *See* FCC User Manual at 2.
1[e]	the second frequency range being higher in frequency than the first frequency range and	Z520a expressly or inherently discloses this claim element. *See* Claim 1[d].
1[f]	at least one of the three frequency bands being associated with a 4G communication standard,	Z520a expressly or inherently discloses this claim element. *See* Claim 1[d].

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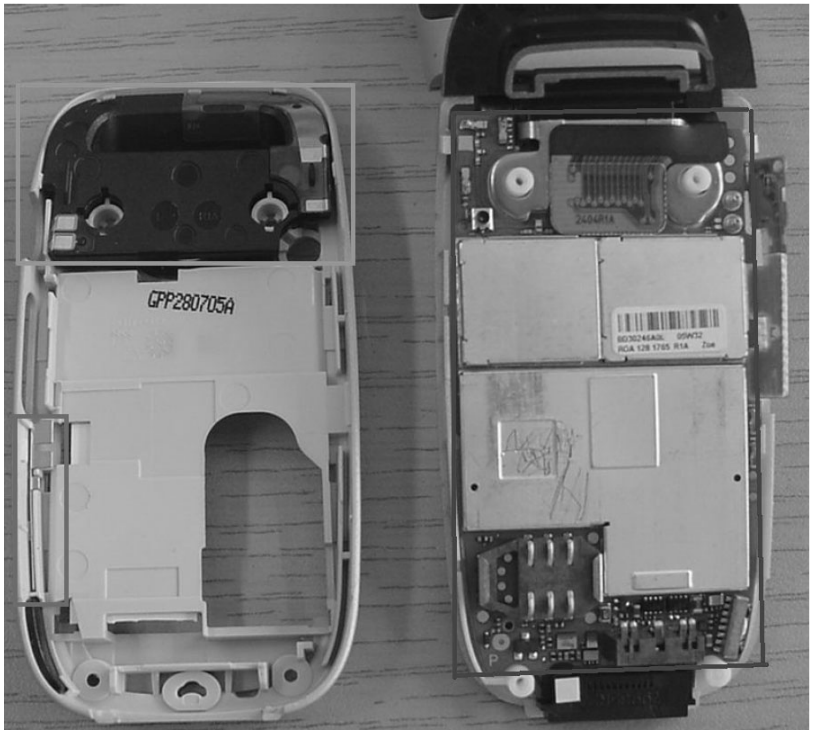
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
1[g]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	Z520a expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the z520a is proximate to a first short side of a ground plane rectangle enclosing the ground plane. 

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
1[h]	defining a first antenna contour comprising an entire perimeter of the first antenna,	Z520a expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the z520a defines a first antenna contour comprising an entire perimeter of the first antenna. The first antenna includes first and second sides including the perimeter of the first antenna: First antenna, first side:

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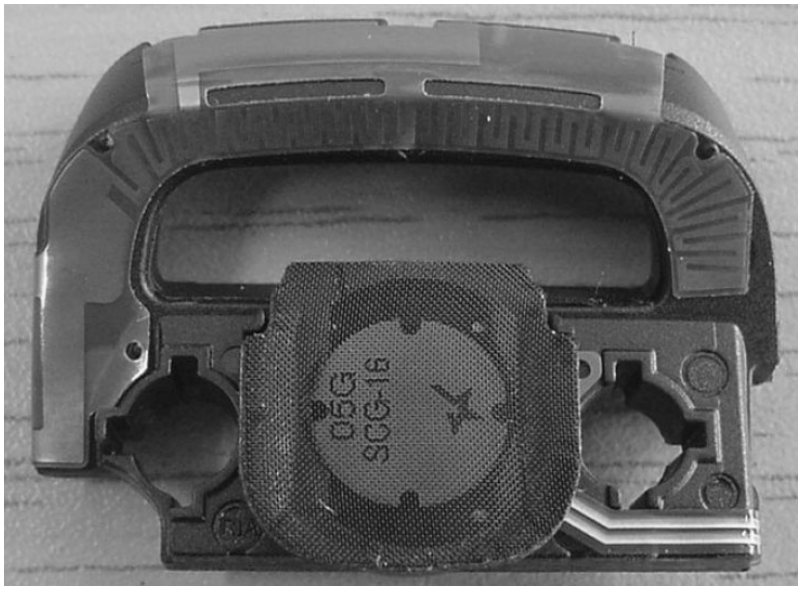
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		 First antenna, second side:

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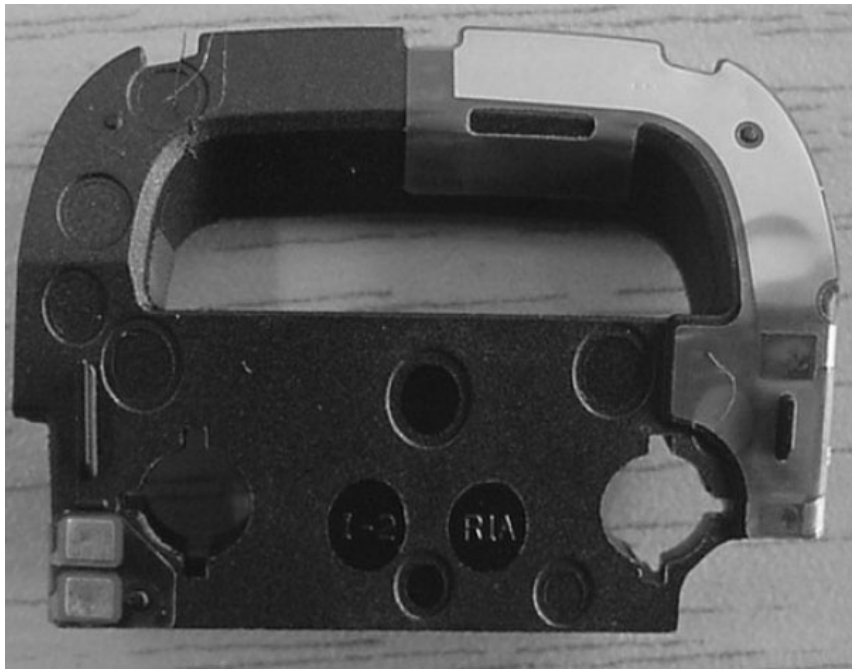
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		 The first antenna contour includes parts of the perimeter that are on the first side and the orthogonal projection onto the plane of the first side of the parts of the perimeter that are on the second side onto the first side:

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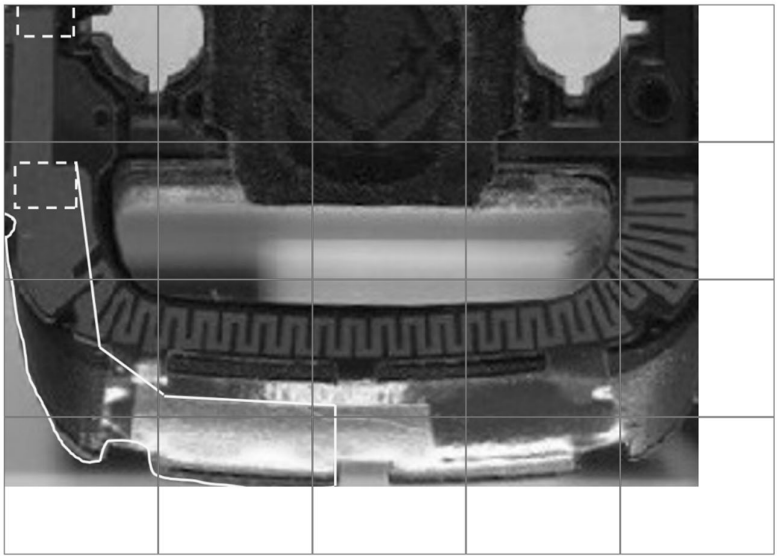
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		
1[i]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	Z520a expressly or inherently discloses this claim element. *See, e.g.*, The first antenna contour has 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 less than 1.75. The complexity factor calculation is performed according to the method in the patent. N1=12

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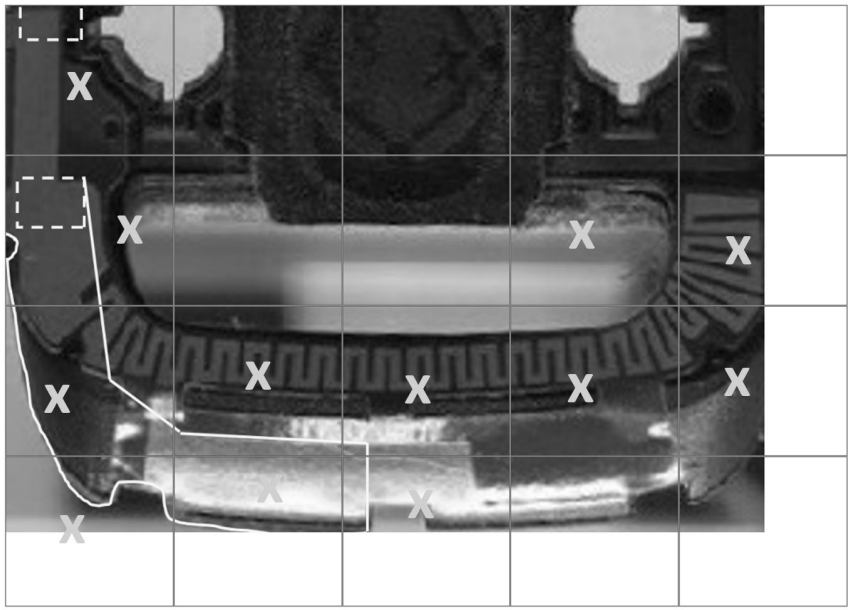
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		 N2=31

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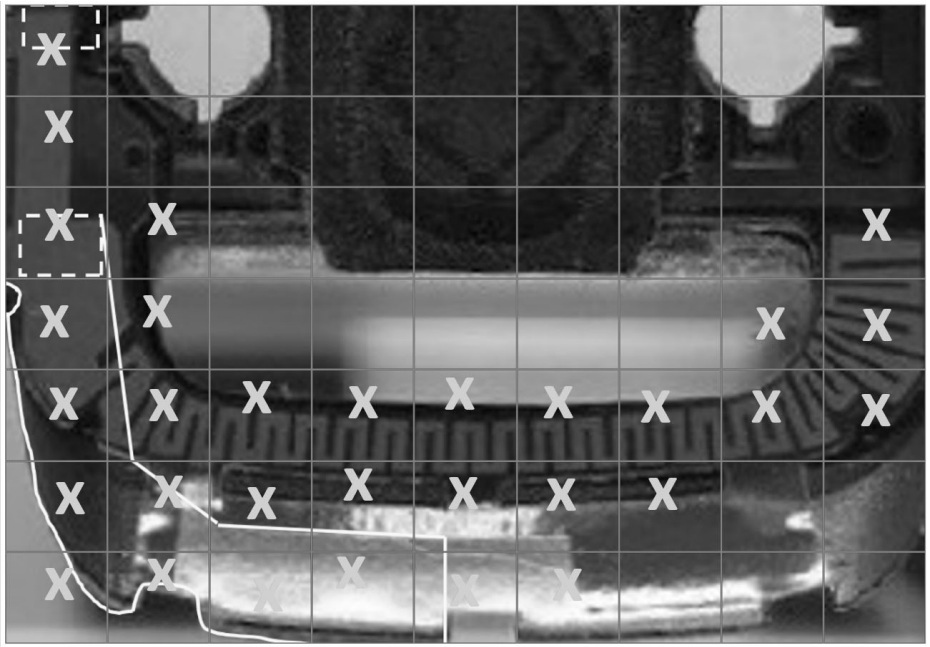
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		 N3=97

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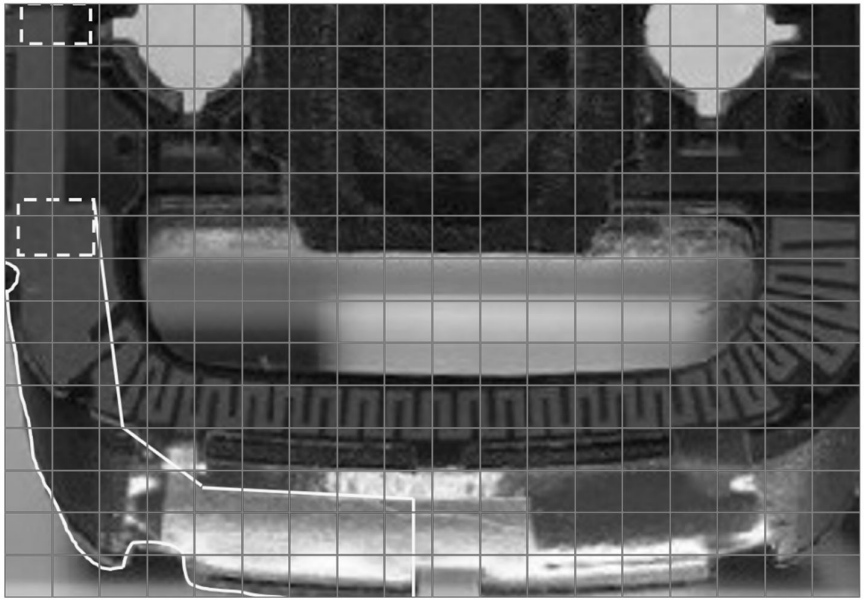
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		 F21=log(31/12)/log(2)=1.37 F32=log(97/31)/log(2)=1.64
1[j]	complexity factor F_{32} having a value less than 1.75; and	Z520a expressly or inherently discloses this claim element. *See* Claim 1[i].

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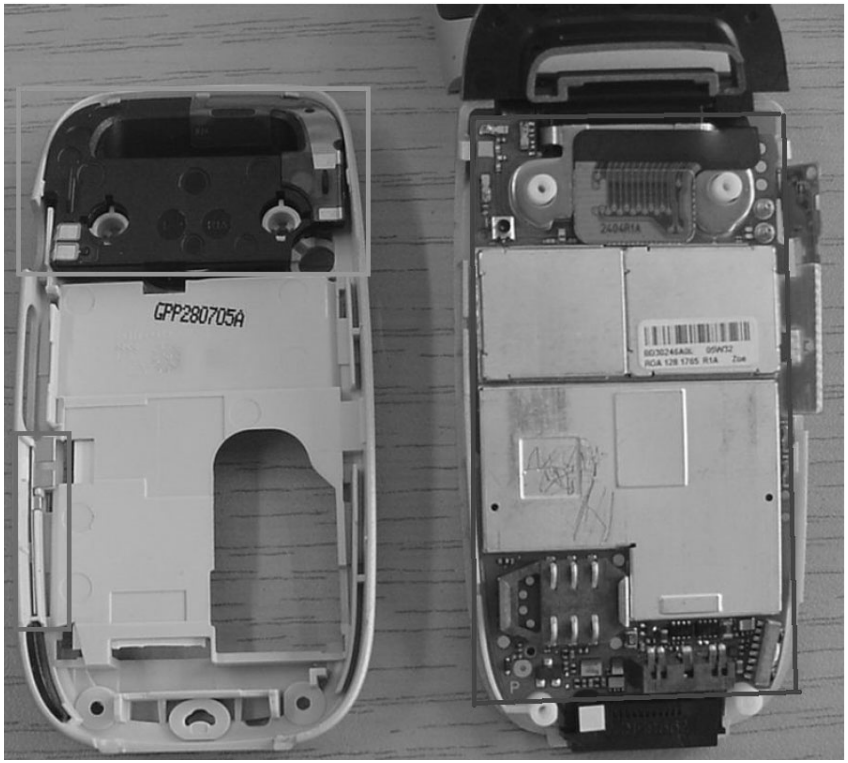
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
1[k]	a second antenna within the wireless device and	Z520a expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the z520a includes a second antenna (purple below) within the z520a. 

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
1[l]	configured to support at least one frequency band different from the at least three frequency bands supported by the first antenna,	Z520a expressly or inherently discloses this claim element. *See, e.g.*, The second antenna of the z520a is configured to support at least one frequency band different from the at least three frequency bands supported by the first antenna. **1.5 Test Item** Type of equipment : Quad band Mobile Phone with Bluetooth (850/900/1800/1900 MHz) *See* FCC Test Report at 5.
1[m]	the second antenna being arranged completely within the ground plane rectangle.	Z520a expressly or inherently discloses this claim element. *See, e.g.*, The second antenna (purple below) is arranged completely within the ground plane rectangle (red below).

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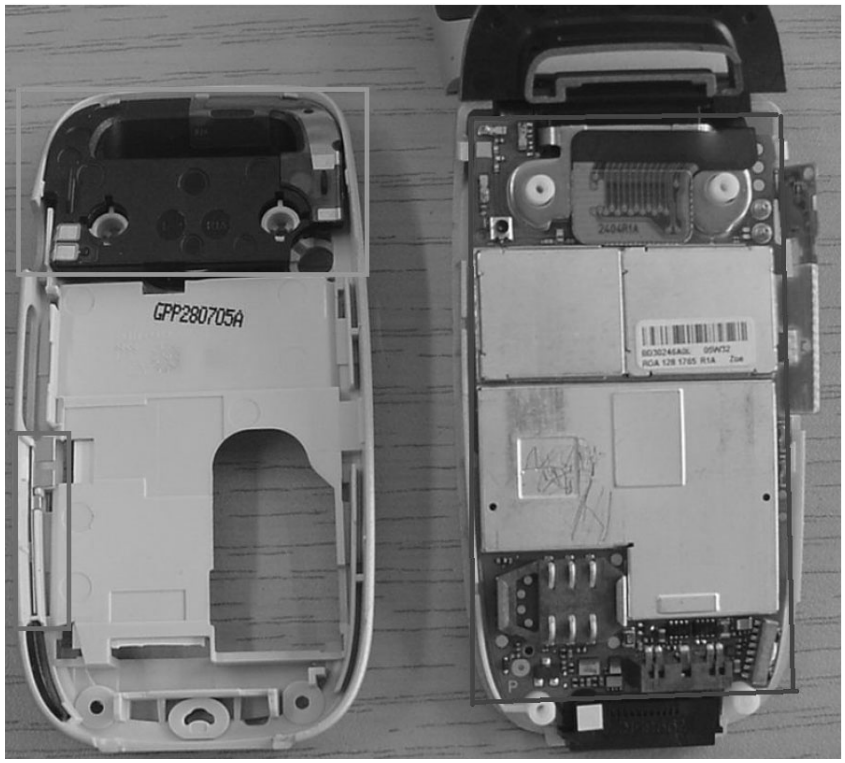
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		
	Claim 2	
2	The wireless device of claim 1, wherein the first antenna	Z520a expressly or inherently discloses this claim element. *See, e.g.*,

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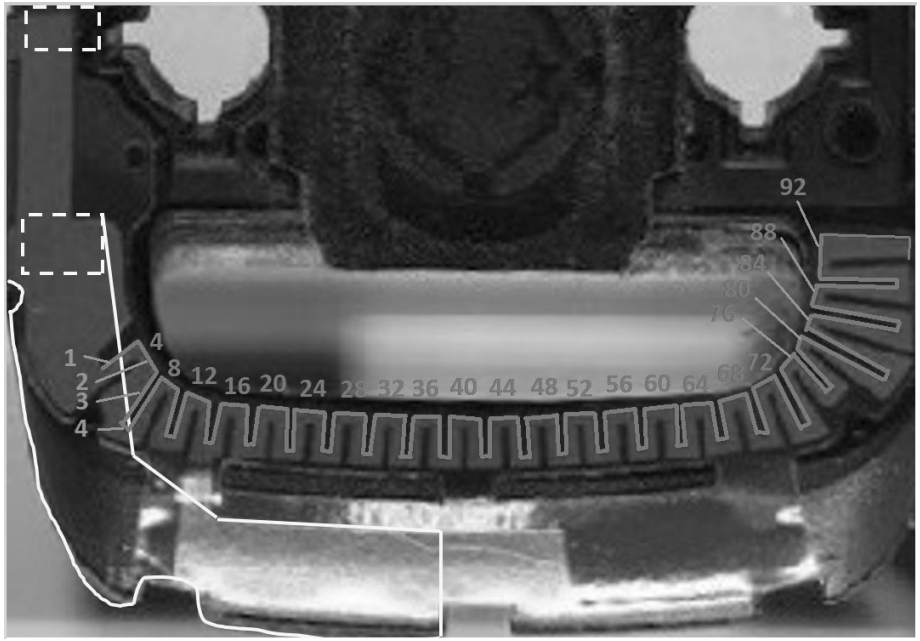
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
	contour comprises at least 20 segments.	The first antenna contour comprises at least 92 segments. 
Claim 3		
3	The wireless device of claim 2, wherein the perimeter of the first antenna contour comprises at least 35 segments.	Z520a expressly or inherently discloses this claim element. *See, e.g.*, The first antenna contour comprises at least 92 segments.

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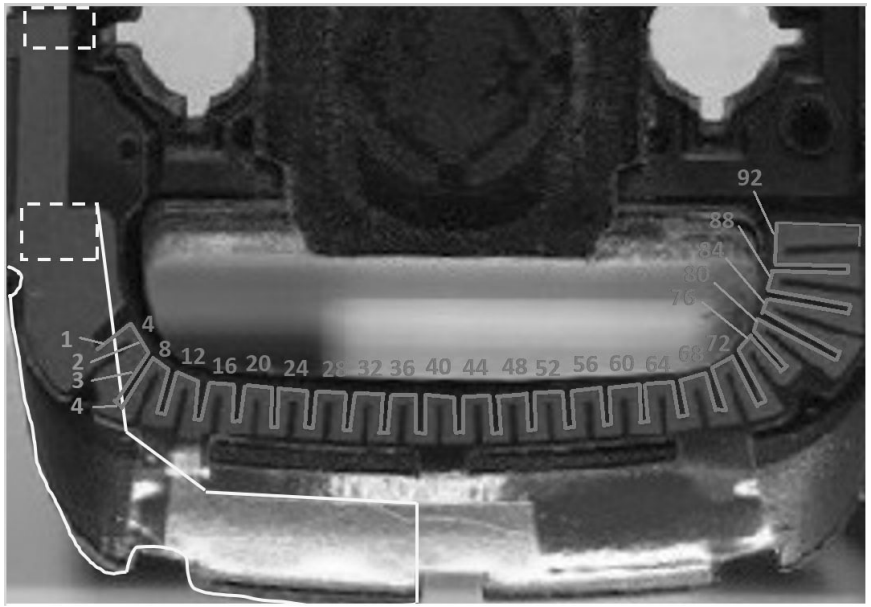
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		
Claim 4		
4	The wireless device of claim 1, wherein the antenna system comprises a third antenna configured to receive signals employing a 4G communication standard.	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. The Motorola V360 includes a third antenna (yellow below) configured to receive signals employing a 4G communication standard.

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a

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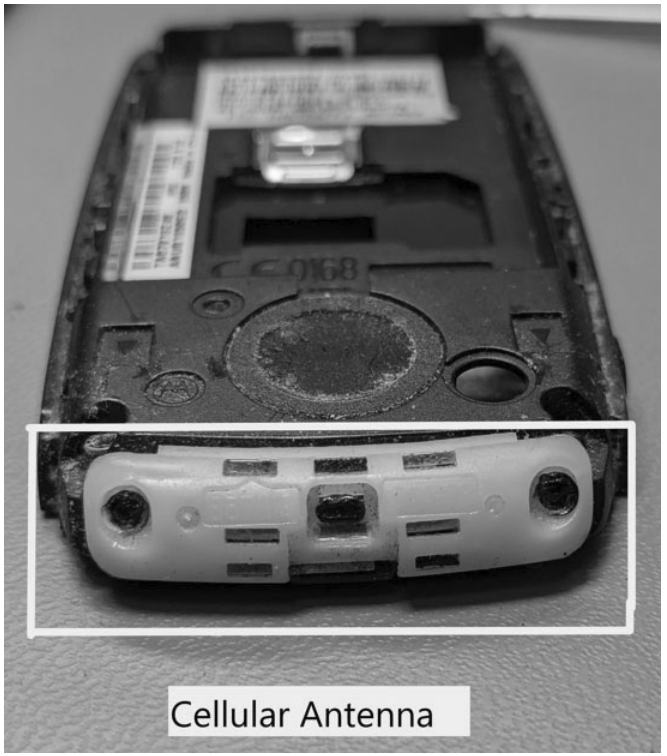
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		 It would have been obvious to include the third antenna of the Motorola V360 in the z520a to reduce variation in performance of the z520a between the open and closed states as taught in Vance. Vance teaches “clamshell type wireless terminals,” in which “a first low-band antenna 1420 is located approximate to the intermediate portion 1410 of the multi-band clamshell type wireless

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		terminal 1400. A second low-band antenna 1425 is located proximate to the bottom portion 1415, which is distal from the first low-band antenna 1420 and separate therefrom." (11:35-44) According to Vance "'clamshell' type radiotelephones (radiotelephones that open/close) may present particular design challenges in providing effective multi-band performance. In particular, in the case of a clamshell type radiotelephone, it is known that placing an internal antenna at the bottom of the radiotelephone may allow for relatively small shifts in performance of the radiotelephone between the open and closed states. However, the bandwidth for such antennas (located at the bottom of these clamshell telephones) may tend to be rather narrow. In contrast, when the antenna is placed near an intermediate portion of the clamshell (e.g., near the hinge) the bandwidth may be improved, but the performance in the open and closed states may vary dramatically." (1:29-42).

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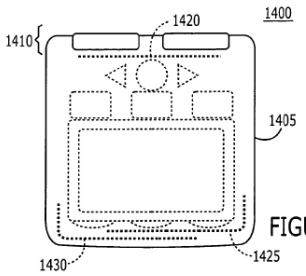
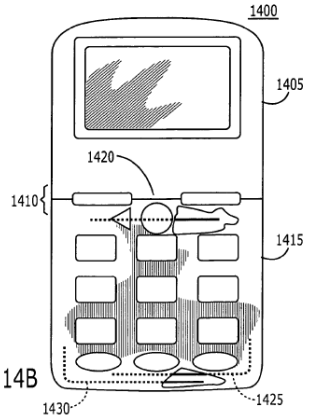
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		 FIGURE 14A  FIGURE 14B One of ordinary skill in the art would have included the third antenna of the Motorola V360 in the bottom portion of the clamshell, with the first antenna of the z520a near the intermediate portion of the clamshell. Doing so would have benefitted from the wide bandwidth of the z520a first antenna and from the consistent performance of the third antenna of the V360 as taught in Vance.

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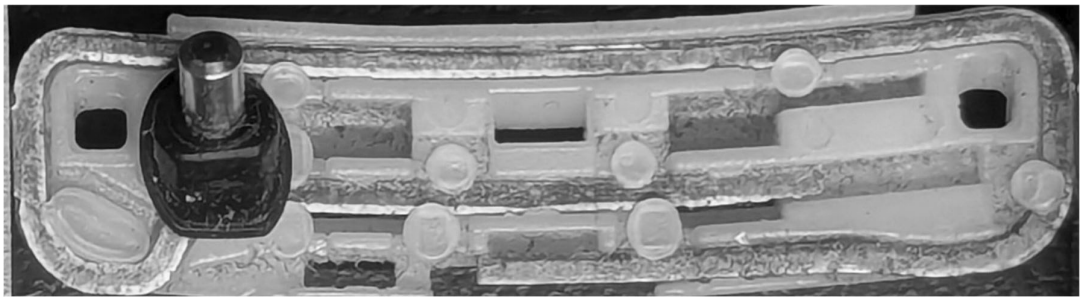
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		There would have been a reasonable expectation of success in including the third antenna of the Motorola V360 in the z250a because each antenna is located in the same relative position in the resulting device as in the individual devices. Moreover, Vance teaches how to position the two cellular antennas in the device. Thus, this claim limitation would have been obvious in view of the Motorola V360 and Vance.
Claim 5		
5[a]	The wireless device of claim 4, wherein the third antenna defines an antenna contour comprising an entire perimeter of the third antenna, and	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of Vance. *See, e.g.*, The third antenna of the Motorola V360 defines an antenna contour comprising an entire perimeter of the third antenna. 

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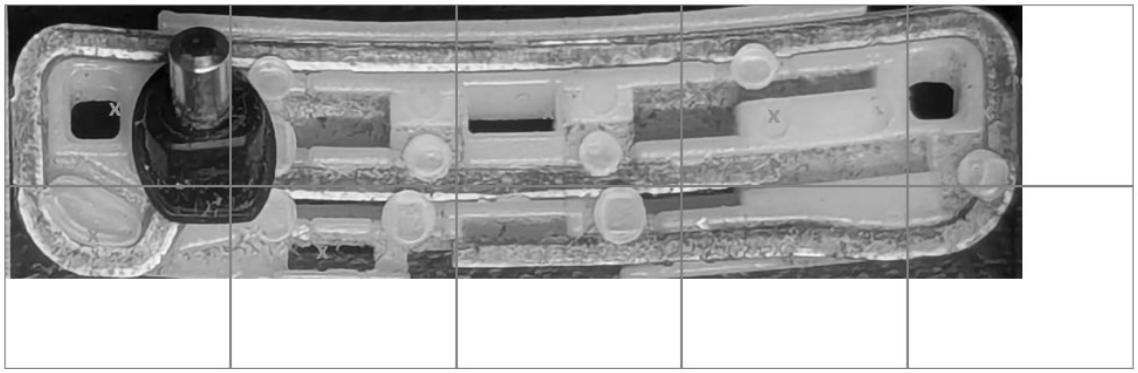
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
5[b]	wherein the antenna contour of the third antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of Vance. *See, e.g.*, The antenna contour of the third antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and a complexity factor F_{32} having a value of at least 1.35. The complexity factor calculation is performed according to the method in the patent. N1=10  N2=26

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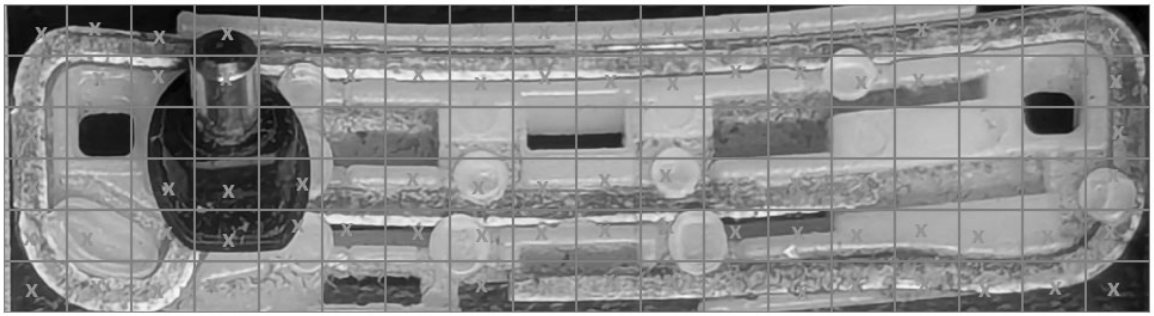
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		 F21=log(26/10)/log(2)=1.37 F32=log(83/26)/log(2)=1.67
5[c]	a complexity factor F_{32} having a value of at least 1.35.	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of Vance. *See* Claim 5[b].
Claim 6		
6[pre]	A wireless device comprising:	To the extent the preamble is limiting, Z520a expressly or inherently discloses this claim element. *See* Claim 1[pre].

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
6[a]	an antenna system comprising:	Z520a expressly or inherently discloses this claim element. *See* Claim 1[a].
6[b]	[*the antenna system comprising*] a ground plane;	Z520a expressly or inherently discloses this claim element. *See* Claim 1[a].
6[c]	[*the antenna system comprising*] a first antenna within the wireless device and	Z520a expressly or inherently discloses this claim element. *See* Claim 1[a].
6[d]	configured to support at least two frequency bands contained within first and second frequency ranges of the electromagnetic spectrum,	Z520a expressly or inherently discloses this claim element. *See* Claim 1[d].

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
6[e]	the second frequency range being higher in frequency than the first frequency range,	Z520a expressly or inherently discloses this claim element. *See* Claim 1[d].
6[f]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	Z520a expressly or inherently discloses this claim element. *See* Claim 1[g].
6[g]	defining a first antenna contour comprising an entire perimeter of the first antenna,	Z520a expressly or inherently discloses this claim element. *See* Claim 1[h].
6[h]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	Z520a expressly or inherently discloses this claim element. *See* Claim 1[i].
6[i]	complexity factor F_{32} having a value less than 1.75; and	Z520a expressly or inherently discloses this claim element. *See* Claim 1[i].

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
6[j]	[*the antenna system comprising*] a second antenna within the wireless device and	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. The Motorola V360 includes a second antenna (yellow below).

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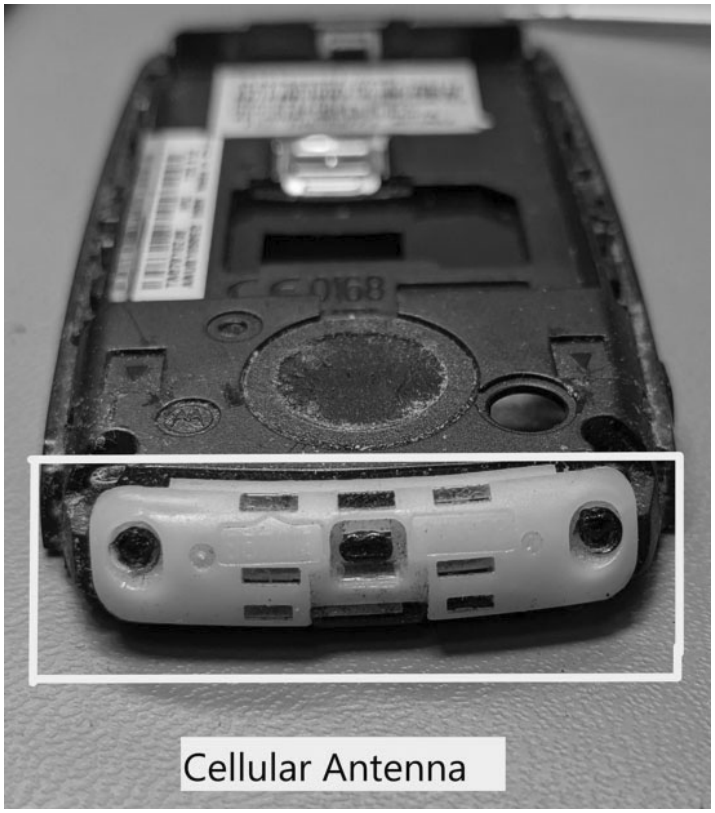
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		 It would have been obvious to include the second antenna of the Motorola V360 in the z520a to reduce variation in performance of the z520a between the open and closed states as taught in Vance.

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		Vance teaches "clamshell type wireless terminals," in which "a first low-band antenna 1420 is located approximate to the intermediate portion 1410 of the multi-band clamshell type wireless terminal 1400. A second low-band antenna 1425 is located proximate to the bottom portion 1415, which is distal from the first low-band antenna 1420 and separate therefrom." (11:35-44) According to Vance "'clamshell' type radiotelephones (radiotelephones that open/close) may present particular design challenges in providing effective multi-band performance. In particular, in the case of a clamshell type radiotelephone, it is known that placing an internal antenna at the bottom of the radiotelephone may allow for relatively small shifts in performance of the radiotelephone between the open and closed states. However, the bandwidth for such antennas (located at the bottom of these clamshell telephones) may tend to be rather narrow. In contrast, when the antenna is placed near an intermediate portion of the clamshell (e.g., near the hinge) the bandwidth may be improved, but the performance in the open and closed states may vary dramatically." (1:29-42).

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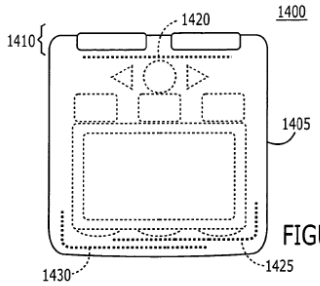
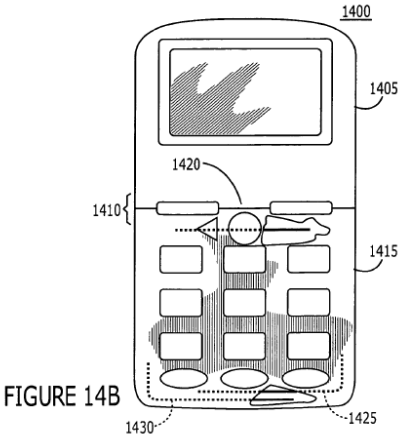
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		 FIGURE 14A  FIGURE 14B One of ordinary skill in the art would have included the second antenna of the Motorola V360 in the bottom portion of the clamshell, with the first antenna of the z520a near the intermediate portion of the clamshell. Doing so would have benefitted from the wide bandwidth of the z520a first antenna and from the consistent performance of the second antenna of the V360 as taught in Vance.

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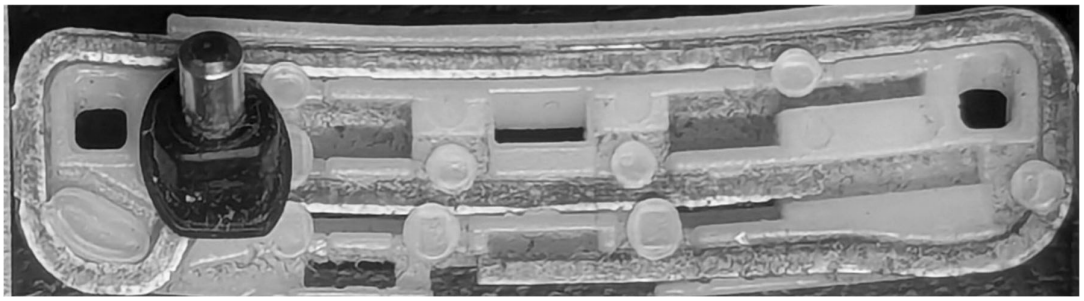
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		There would have been a reasonable expectation of success in including the second antenna of the Motorola V360 in the z250a because each antenna is located in the same relative position in the resulting device as in the individual devices. Moreover, Vance teaches how to position the two cellular antennas in the device. Thus, this claim limitation would have been obvious in view of the Motorola V360 and Vance.
6[k]	defining a second antenna contour comprising an entire perimeter of the second antenna,	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. *See, e.g.*, The second antenna of the Motorola V360 defines an antenna contour comprising an entire perimeter of the second antenna. 

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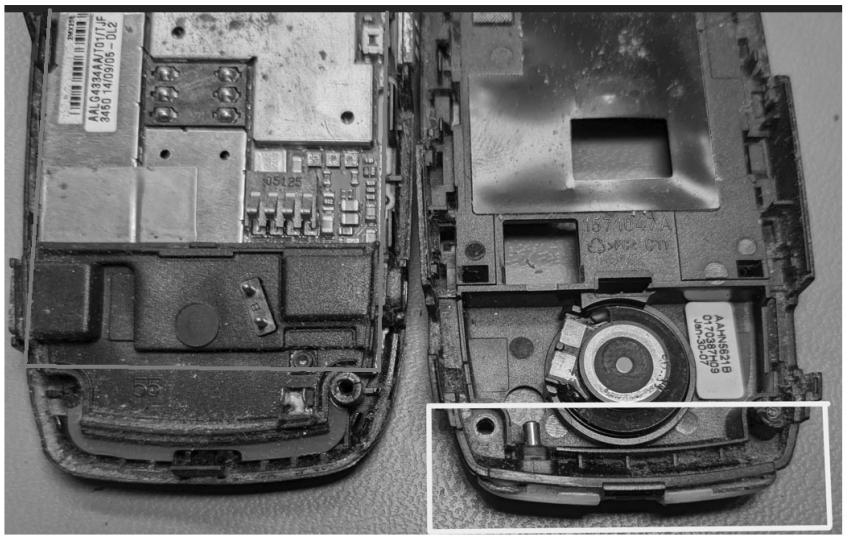
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
6[l]	the second antenna being proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle,	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. *See, e.g.*, The second antenna (yellow below) of the Motorola V360 is proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle (red below). 
6[m]	a minimum-sized parallelepiped of rectangular faces that completely encloses	Z520a expressly or inherently discloses this claim element.

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
	a volume of the second antenna defining an antenna box, and	*See, e.g.*, A minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second antenna defines an antenna box (purple below).
6[n]	an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. *See, e.g.*, An orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna is shown below (in orange).

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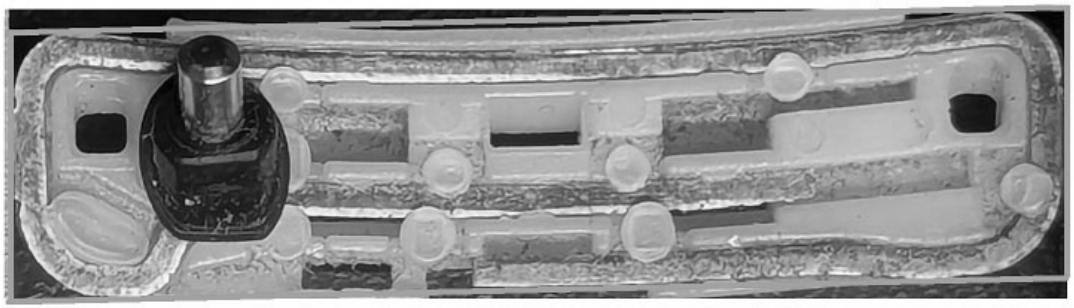
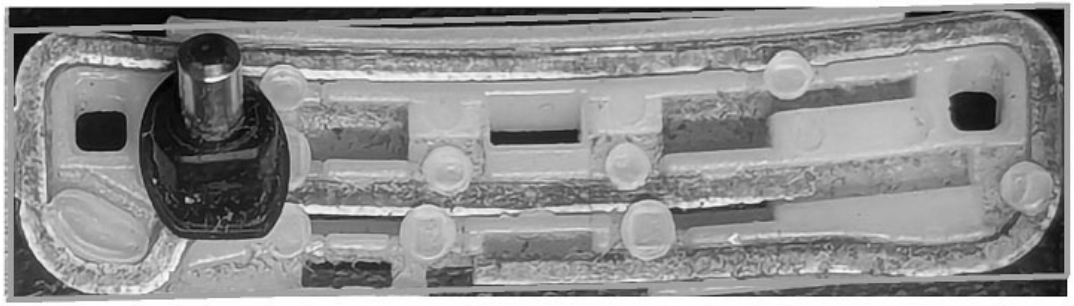
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		
6[o]	an antenna rectangle,	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. *See, e.g.*, The orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defines an antenna rectangle (orange below). 

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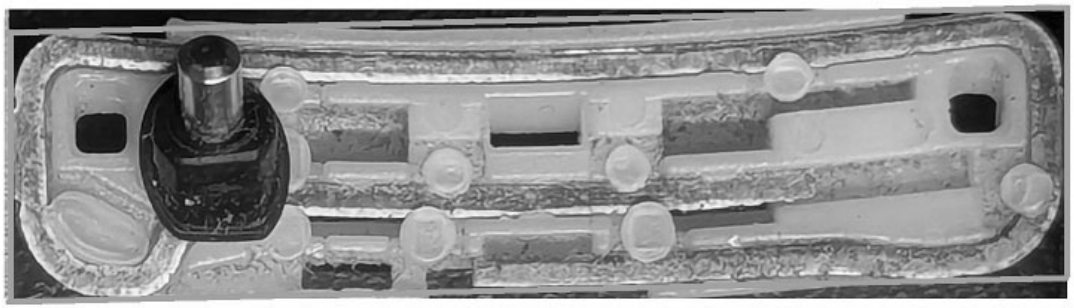
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
6[p]	wherein a length of the second antenna contour is greater than four times a diagonal of the antenna rectangle.	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. *See, e.g.*, 

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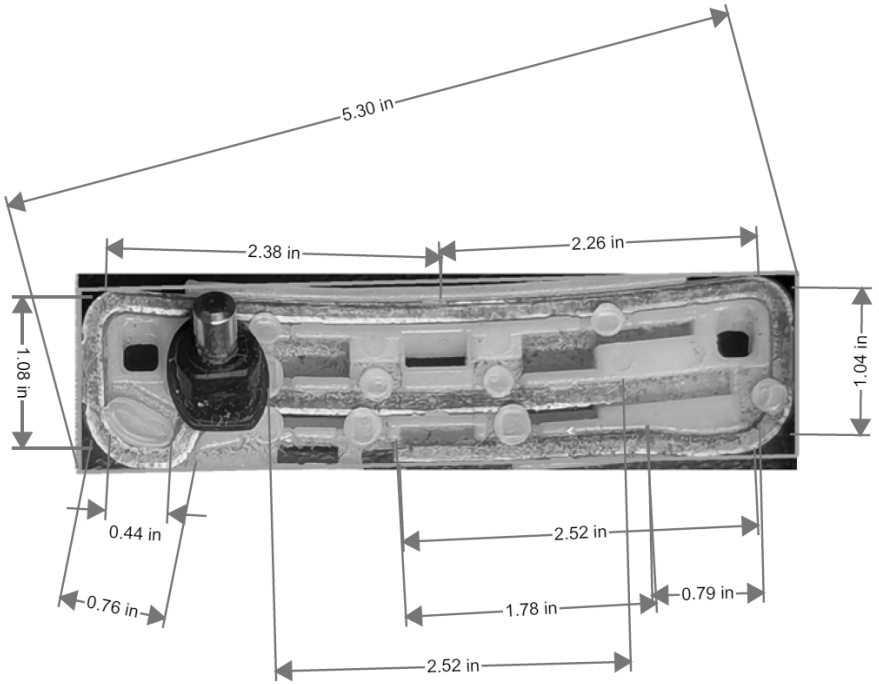
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		 D=5.3 4D=4*5.3=21.2 L>2.38+2.26+1.04+.79+1.78+2.52+1.04+2.26+2.38+1.08+.44+2.52+2.52>23.01
Claim 7		

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
7	The wireless device of claim 6, wherein the first antenna contour comprises at least 20 segments.	Z520a expressly or inherently discloses this claim element. *See* Claim 2.
Claim 8		
8	The wireless device of claim 6, wherein the first antenna contour comprises at least 35 segments.	Z520a expressly or inherently discloses this claim element. *See* Claim 3.
Claim 9		
9[a]	The wireless device of claim 6, wherein the second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of Vance. *See, e.g.*, The second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and a complexity factor F_{32} having a value of at least 1.35. The complexity factor calculation is performed according to the method in the patent. N1=10

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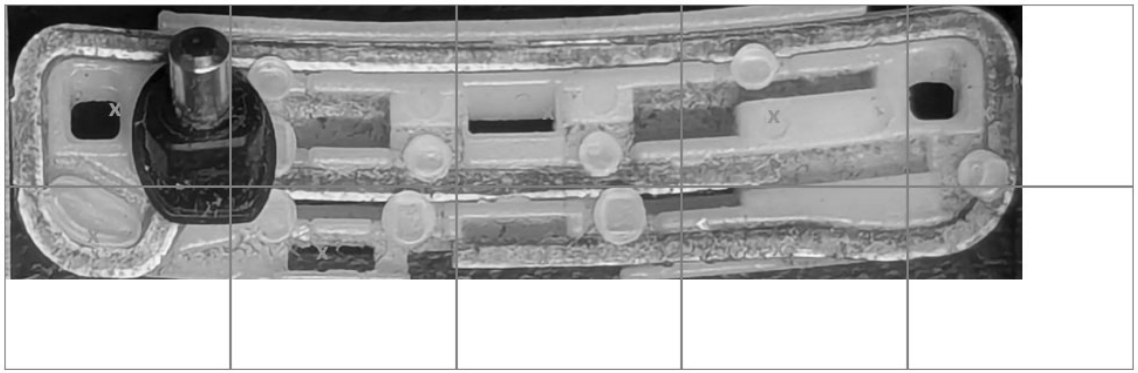
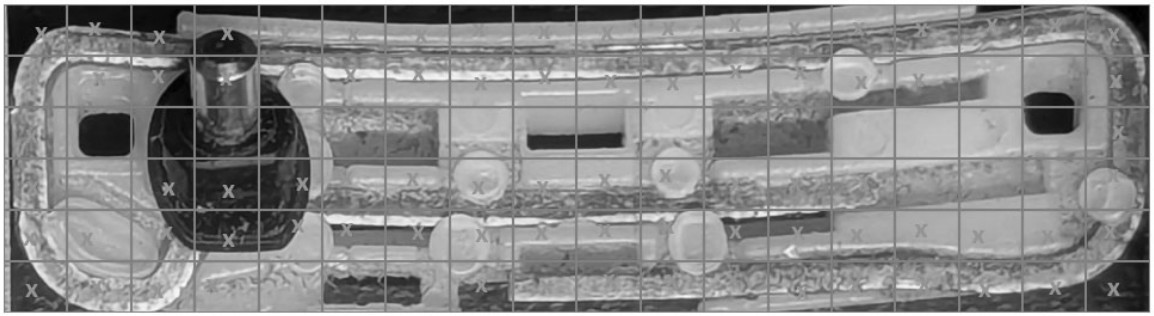
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		 N2=26  F21=log(26/10)/log(2)=1.37 F32=log(83/26)/log(2)=1.67

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
9[b]	a complexity factor F_{32} having a value of at least 1.35.	Z520a expressly or inherently discloses this claim element. *See* Claim 9[a].
Claim 12		
12[pre]	A wireless device comprising:	To the extent the preamble is limiting, Z520a expressly or inherently discloses this claim element. *See* Claim 1[pre].
12[a]	an antenna system comprising:	Z520a expressly or inherently discloses this claim element. *See* Claim 1[a].
12[b]	[*the antenna system comprising*] a ground plane;	Z520a expressly or inherently discloses this claim element. *See* Claim 1[a].

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
12[c]	[*the antenna system comprising*] a first antenna within the wireless device and	Z520a expressly or inherently discloses this claim element. *See* Claim 1[a].
12[d]	configured to provide operation in at least four frequency bands,	Z520a expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the z520a is configured to provide operation in at least four frequency bands. At least one of the at least four frequency bands is contained within a first frequency range. At least one other of the four frequency bands is contained within a second frequency range. The first frequency range is lower in frequency than the second frequency range. **Sony Ericsson** GSM 850/900/1800/1900 *See* FCC User Manual at 2.
12[e]	at least one of the at least four frequency bands is contained within a first frequency range and	Z520a expressly or inherently discloses this claim element. *See* Claim 12[d].
12[f]	at least one other of the four frequency bands is contained	Z520a expressly or inherently discloses this claim element.

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
	within a second frequency range,	*See* Claim 12[d].
12[g]	the first frequency range being lower in frequency than the second frequency range,	Z520a expressly or inherently discloses this claim element. *See* Claim 12[d].
12[h]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane,	Z520a expressly or inherently discloses this claim element. *See* Claim 1[g].
12[i]	the first antenna defining a first antenna contour comprising an entire perimeter of the first antenna, and	Z520a expressly or inherently discloses this claim element. *See* Claim 1[h].
12[j]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	Z520a expressly or inherently discloses this claim element. *See* Claim 1[i].

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
12[k]	complexity factor F_{32} having a value less than 1.75; and	Z520a expressly or inherently discloses this claim element. *See* Claim 1[i].
12[l]	wherein the first antenna is configured to transmit and receive signals from a 4G communication standard; and	Z520a expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the z520a is configured to transmit and receive signals from a 4G communication standard. **Sony Ericsson** GSM 850/900/1800/1900 *See* FCC User Manual at 2.
12[m]	[*the antenna system comprising*] a second antenna within the wireless device and configured to receive signals from a 4G communication standard,	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. *See, e.g.*, The Motorola V360 includes a second antenna (yellow below) within the V360 and configured to receive signals from a 4G communication standard.

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a

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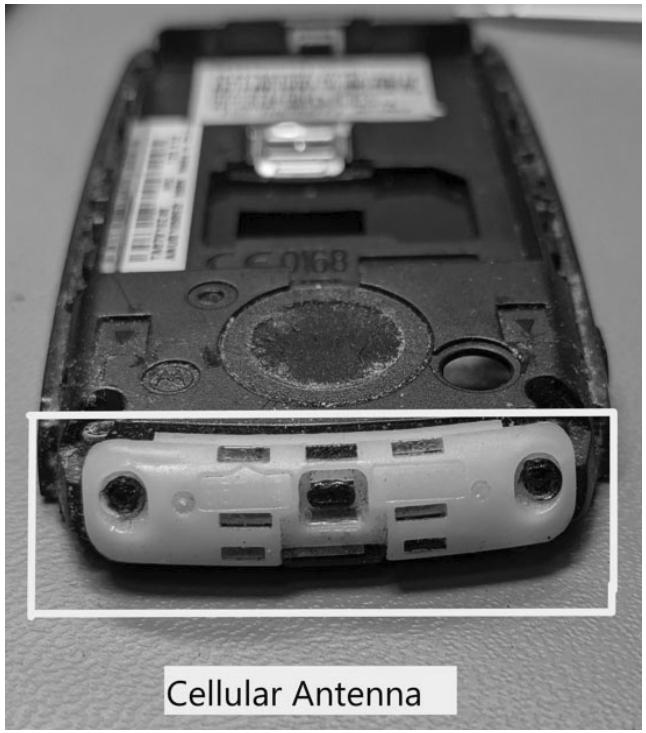
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		 It would have been obvious to include the second antenna of the Motorola V360 in the z520a to reduce variation in performance of the z520a between the open and closed states as taught in Vance. Vance teaches "clamshell type wireless terminals," in which "a first low-band antenna 1420 is located approximate to the intermediate portion 1410 of the multi-band clamshell type wireless

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		terminal 1400. A second low-band antenna 1425 is located proximate to the bottom portion 1415, which is distal from the first low-band antenna 1420 and separate therefrom." (11:35-44) According to Vance "'clamshell' type radiotelephones (radiotelephones that open/close) may present particular design challenges in providing effective multi-band performance. In particular, in the case of a clamshell type radiotelephone, it is known that placing an internal antenna at the bottom of the radiotelephone may allow for relatively small shifts in performance of the radiotelephone between the open and closed states. However, the bandwidth for such antennas (located at the bottom of these clamshell telephones) may tend to be rather narrow. In contrast, when the antenna is placed near an intermediate portion of the clamshell (e.g., near the hinge) the bandwidth may be improved, but the performance in the open and closed states may vary dramatically." (1:29-42).

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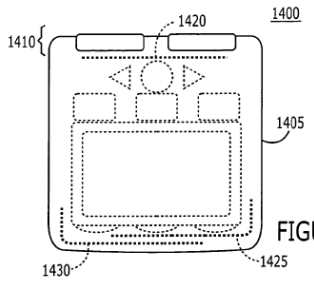
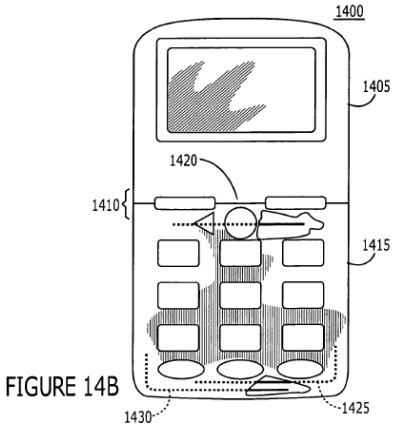
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		 FIGURE 14A  FIGURE 14B One of ordinary skill in the art would have included the second antenna of the Motorola V360 in the bottom portion of the clamshell, with the first antenna of the z520a near the intermediate portion of the clamshell. Doing so would have benefitted from the wide bandwidth of the z520a first antenna and from the consistent performance of the second antenna of the V360 as taught in Vance.

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		There would have been a reasonable expectation of success in including the second antenna of the Motorola V360 in the z250a because each antenna is located in the same relative position in the resulting device as in the individual devices. Moreover, Vance teaches how to position the two cellular antennas in the device. Thus, this claim limitation would have been obvious in view of the Motorola V360 and Vance.
12[n]	a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second antenna defining an antenna box,	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. *See* Claim 6[m].
12[o]	an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. *See* Claim 6[n].
12[p]	an antenna rectangle,	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. *See* Claim 6[o].

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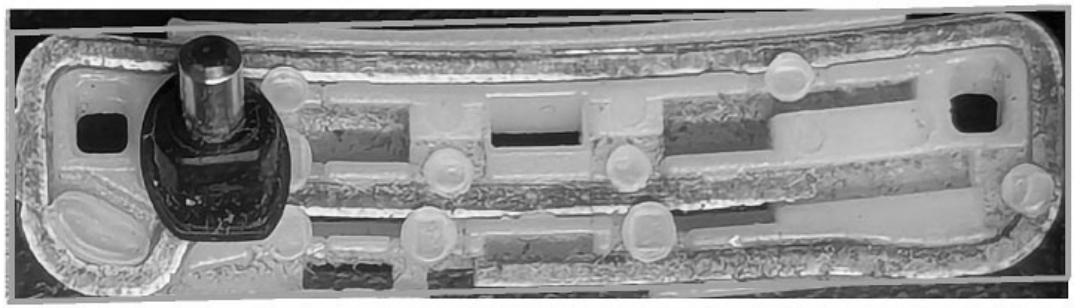
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
12[q]	an aspect ratio of the antenna rectangle being defined as a ratio between a width and a height of the antenna rectangle, and wherein the aspect ratio has a value of at least 2.	Z520a expressly or inherently discloses this claim element. *See, e.g.*, An aspect ratio of the antenna rectangle is defined as a ratio between a width and a height of the antenna rectangle. The aspect ratio has a value of at least 2. A width of the antenna rectangle is at least twice a height of the antenna rectangle. 
Claim 13		
13	The wireless device of claim 12, wherein the first antenna contour comprises at least 20 segments.	Z520a expressly or inherently discloses this claim element. *See* Claim 2.

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
Claim 14		
14	The wireless device of claim 13, wherein the first antenna contour comprises at least 35 segments.	Z520a expressly or inherently discloses this claim element. *See* Claim 3
Claim 15		
15	The wireless device of claim 12, wherein the second antenna is proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle.	Z520a expressly or inherently discloses this claim element. *See* Claim 1[g].
Claim 16		
16[a]	The wireless device of claim 12, wherein the second antenna defines a second antenna contour comprising an entire perimeter of the second antenna,	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. *See* Claim 6[k].

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Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
16[b]	and wherein the second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. *See* Claim 9[a].
16[c]	a complexity factor F_{32} having a value of at least 1.35.	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. *See* Claim 9[a].
Claim 17		
17	The wireless device of claim 16, wherein the second antenna contour comprises at least 20 segments.	Z520a expressly or inherently discloses this claim element. To the extent the z520a does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the Motorola V360 and further in view of U.S. Patent No. 7,109,924 to Vance. *See, e.g.*, The second antenna contour comprises at least 20 segments.

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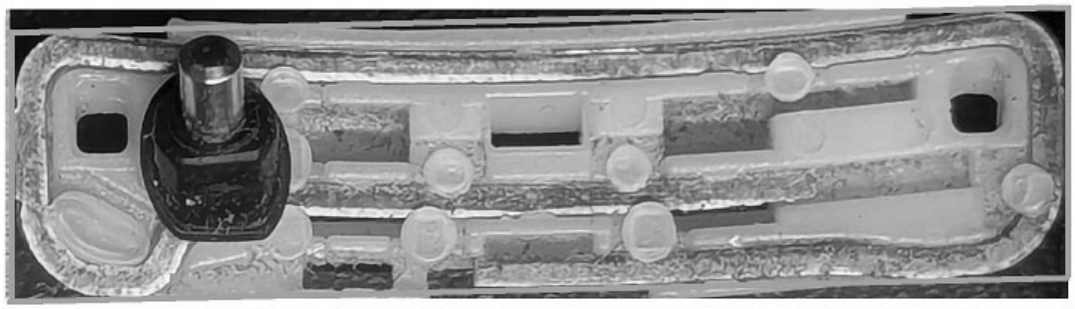
Claim No.	U.S. Patent No. 11,031,677 B2	Sony Ericsson Z520a
		

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Exhibit – D – 13

INVALIDITY CONTENTIONS FOR U.S. PATENT NO. 11,031,677 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 claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, and 17 ("the '677 Asserted Claims")[1]. These invalidity contentions are not an admission by the Defendants 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 '677 Patent was filed on March 27, 2020, 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 '200 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]:

- 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)

[1] Defendants understand that that, by not charting claims 10-11 and 18-20 in its Infringement Contentions, Plaintiff does not assert these claims against Defendants.
[2] *See* https://www.cnet.com/reviews/dell-latitude-d820-review/
[3] Geotab does 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. Geotab anticipates that the actual dates, circumstances, and identities of individuals will be the subject of third party discovery during this lawsuit. Geotab therefore reserves 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. Geotab also reserves the right to rely on the public use, offer for sale, sale, or installation of the devices described in the publications identified herein once Geotab has had a fair opportunity to take discovery on these subjects.

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- 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. 11,031,677 (the "'677 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 '677 Patent, these claims are invalid as obvious in view of D820 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.

One of ordinary skill in the art, as of the priority date of the '677 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.

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Claim No.	U.S. Patent No. 11,031,677 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* Dell Website, Archived on April 25, 2006 at: http://web.archive.org/web/20060425030931/http://www1.us.dell.com/content/products/productdetails.aspx/latit_d820?c=us&cs=04&l=en&s=bsd&~section=specs#tabtop (last accessed June 17, 2025).
1[a]	an antenna system comprising:	D820 expressly or inherently discloses this claim element. *See, e.g.*,

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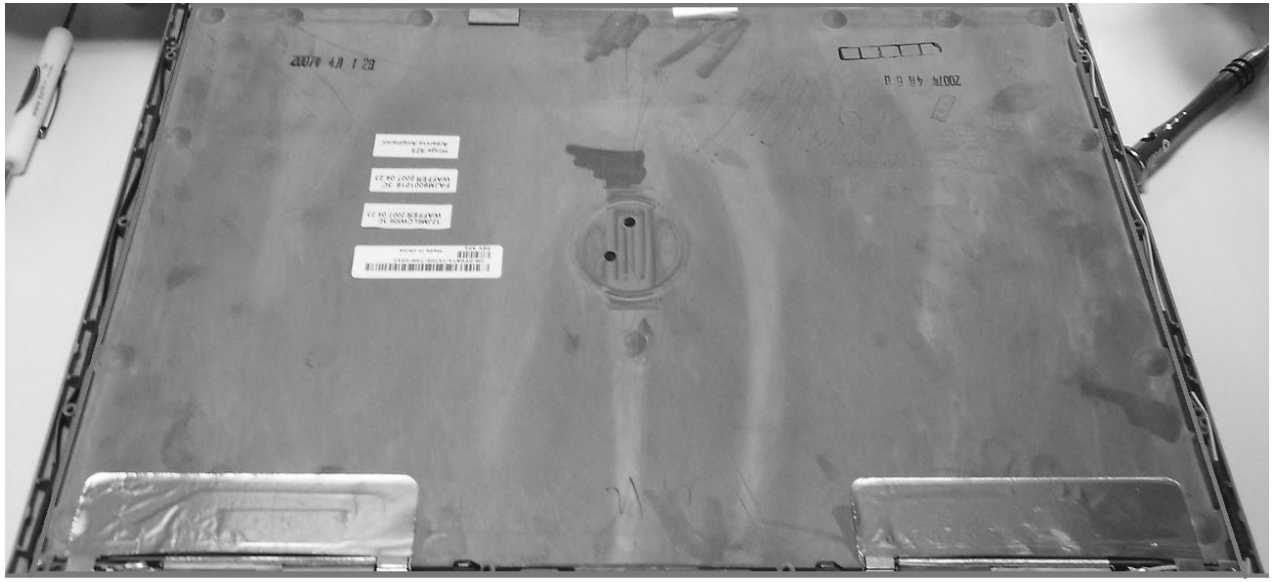
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		The Dell D820 includes an antenna system comprising a ground plane (red below) and at least two antennas (blue and purple below) within the wireless device. 

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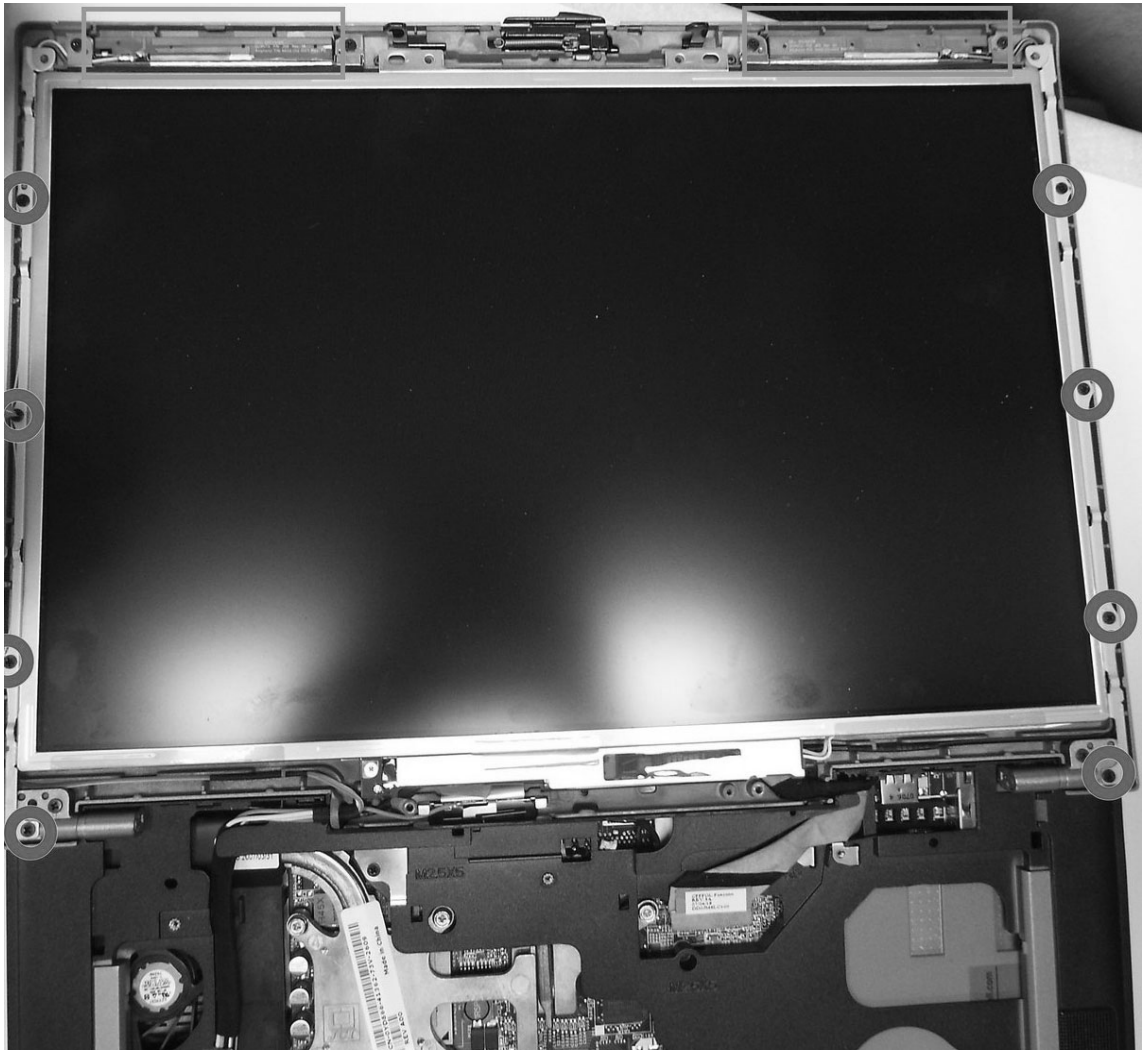
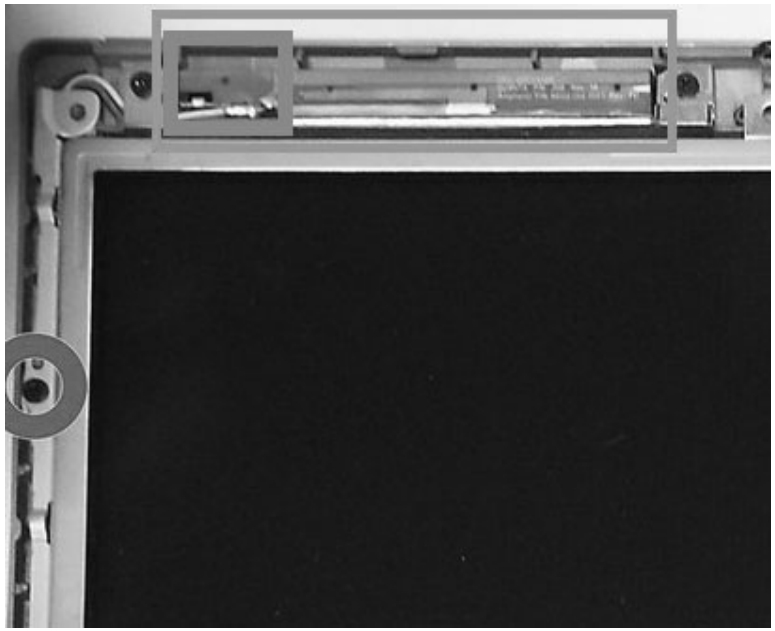
		

Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		
1[b]	[*the antenna system comprising*] a ground plane;	D820 expressly or inherently discloses this claim element. *See* Claim 1[a].
1[c]	[*the antenna system comprising*] a	D820 expressly or inherently discloses this claim element.

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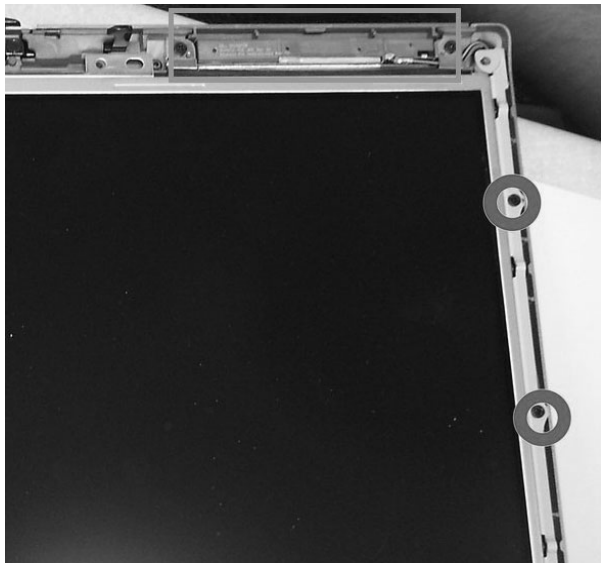
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
	first antenna within the wireless device and	*See, e.g.*, The antenna system of the Dell D820 includes a first antenna (blue below) within the D820. 

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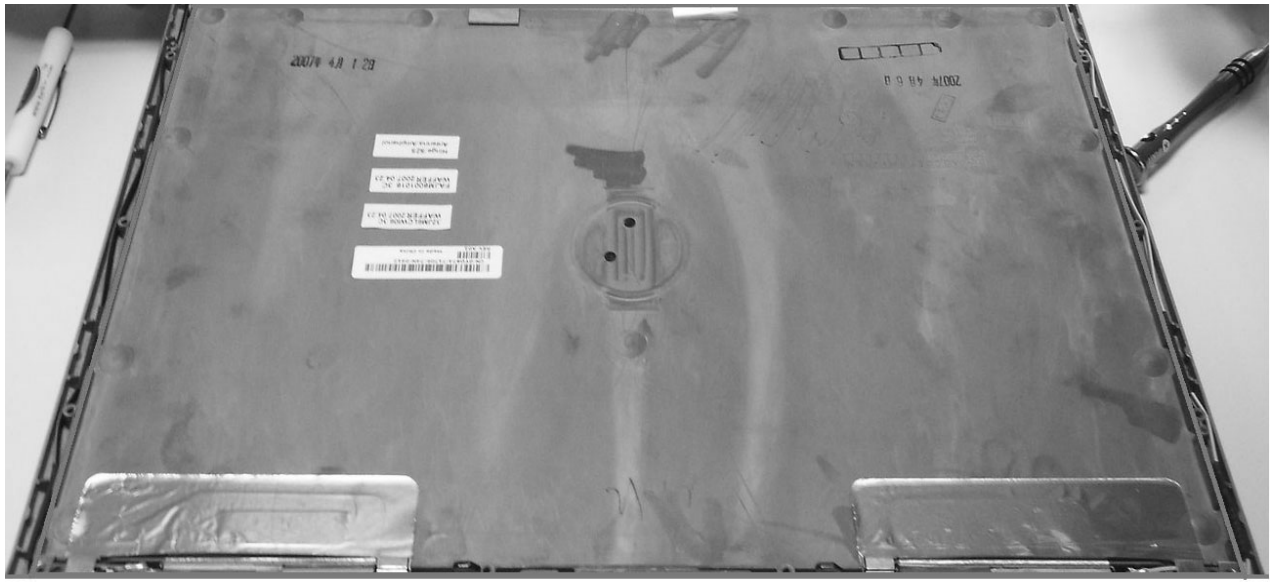
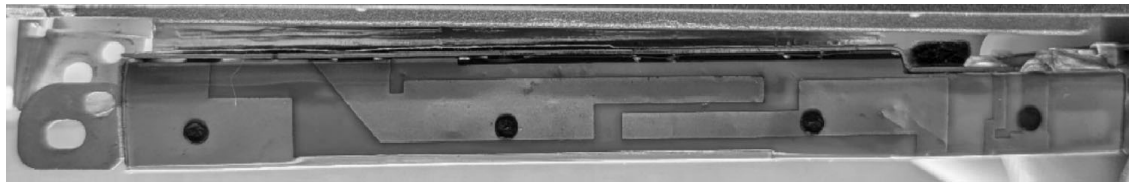
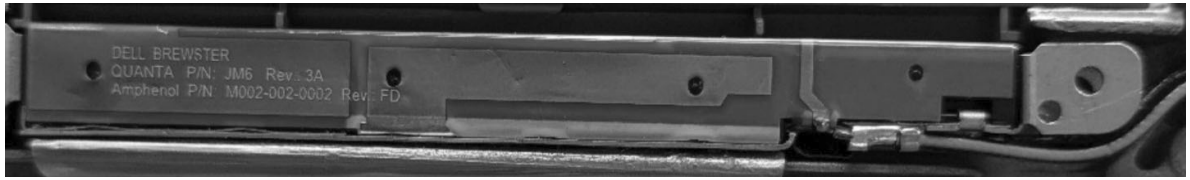
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		  

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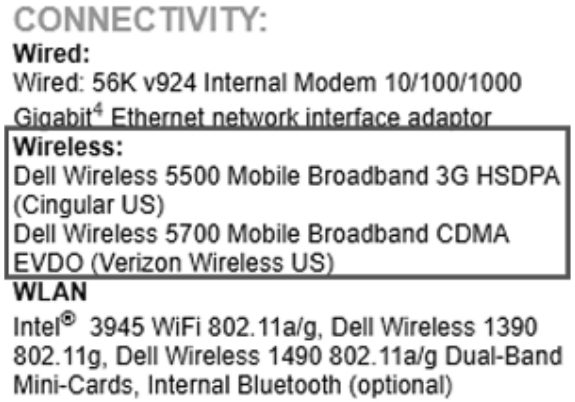
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
1[d]	[*the antenna system*] configured to support at least three frequency bands contained within first and second frequency ranges of the electromagnetic spectrum,	D820 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the Dell D820 is configured to support at least three frequency bands contained within first and second frequency ranges of the electromagnetic spectrum, the second frequency range being higher in frequency than the first frequency range.  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 880-960 MHz, 1710-1990 MHz, and 2010-2025 MHz.

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820

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

Jing, 2658 (DCS, PCS, UMTS); 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

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		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. 11,031,677 B2	Dell Latitude D820
1[e]	the second frequency range being higher in frequency than the first frequency range and	D820 expressly or inherently discloses this claim element. *See* Claim 1[d].
1[f]	at least one of the three frequency bands being associated with a 4G communication standard,	D820 expressly or inherently discloses this claim element. *See* Claim 1[d].
1[g]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	D820 expressly or inherently discloses this claim element. To the extent the Dell D820 does not disclose a first antenna proximate to a first short side of a ground plane rectangle, it would have been obvious for the first antenna to be disposed proximate to a first short side of the ground plane rectangle as taught in Gaucher et al. (U.S. 2006/0082503) to achieve spatial diversity and reduce blockage caused by the laptop display.

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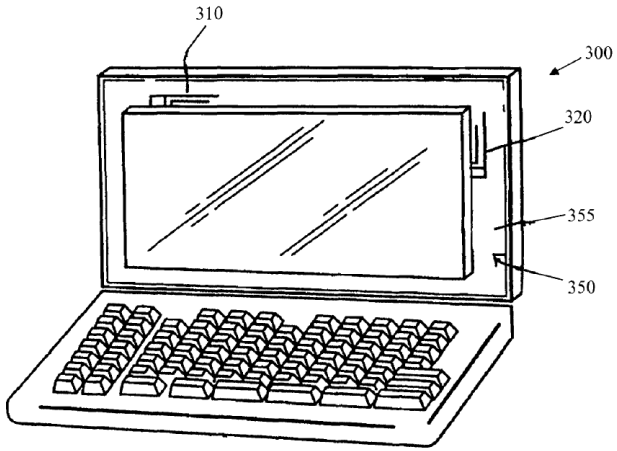
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 FIG. 3 Gaucher teaches "a laptop computer 300 including a laptop display unit 350 and a plurality of multiband antennas 310, 320 mounted on the upper frame 355 of the laptop display unit 350." Like the Dell D820, "As shown in FIG. 3, the pair 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]

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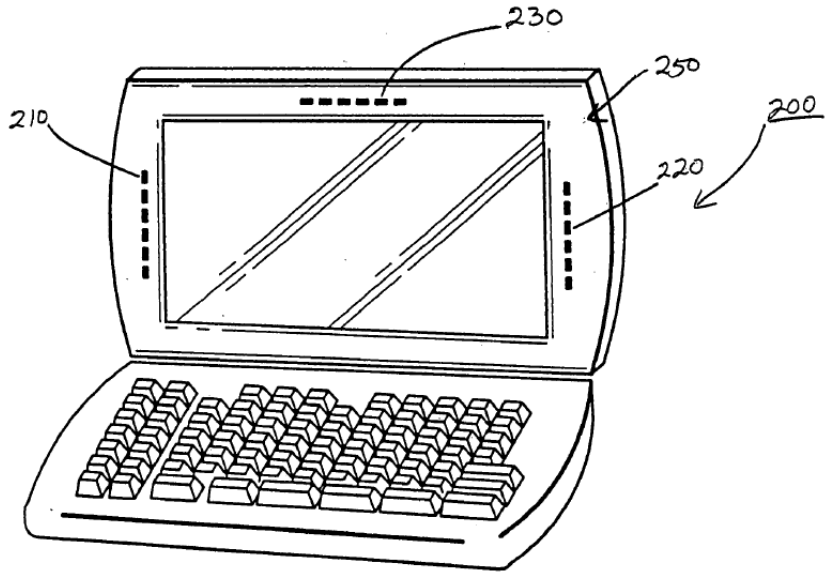
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 FIG. 2 Like in the Dell D820, Gaucher's "display frame or the metal display supporters provide the ground element to the antenna design. For example, the ground element may be provided by the display frame, or metal supports, or the shielding foil on the back of the display." Gaucher, [0045].

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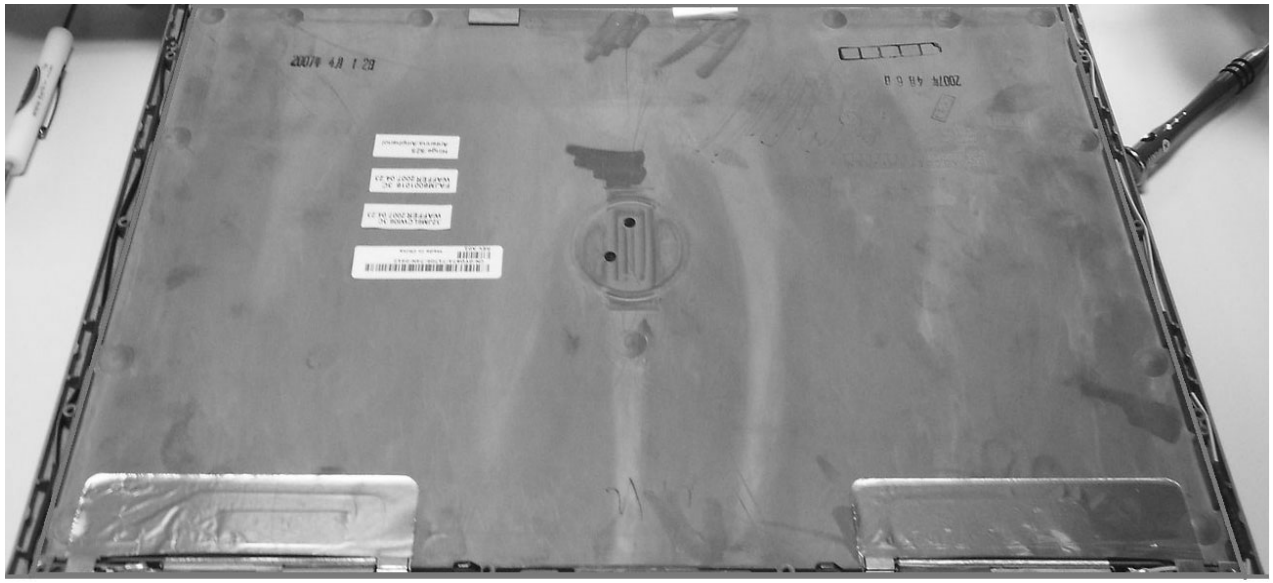
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 Similar to the multiband cellular antennas of the Dell D820, Gaucher's antennas are "quadband antenna[s] covering the four most popular frequency bands, namely, 824-894 MHz for the lower band of the United States, 880-960 MHz for the lower 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].

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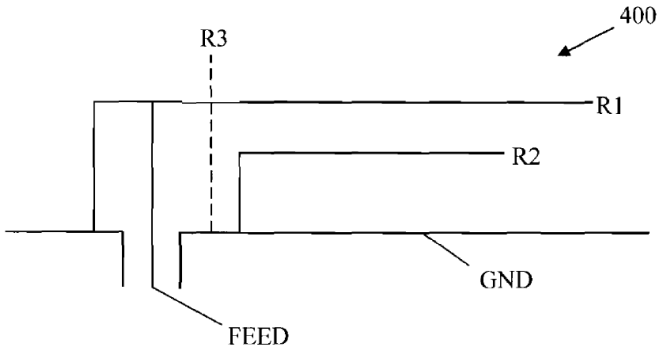
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 There would have been a reasonable expectation of success in having the first antenna of the Dell D820 disposed proximate a first short side of the ground plane rectangle because a similarly configured antenna is taught in a similarly configured laptop device in Gaucher. For instance, Gaucher and the Dell D820 place the antennas on a grounded display frame for use as a ground plane. The Gaucher antennas and the Dell 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 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 Dell 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 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.

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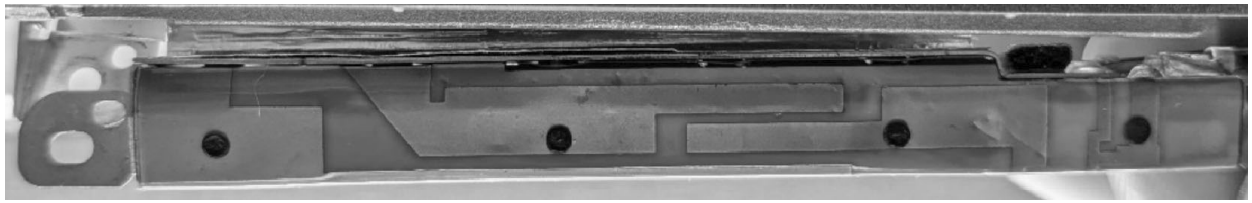
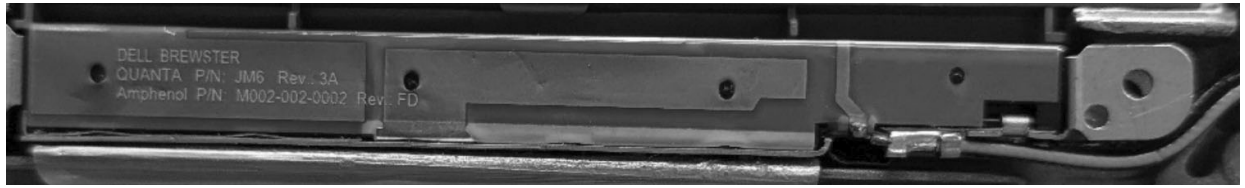
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
1[h]	defining a first antenna contour comprising an entire perimeter of the first antenna,	D820 expressly or inherently discloses this claim element. *See, e.g.*, The complexity factor calculation is performed according to the method in the patent. The first antenna of the Dell D820 defines a first antenna contour comprising an entire perimeter of the first antenna. The first antenna includes first and second sides including the perimeter of the first antenna: First antenna, first side:  First antenna, second side:  The first antenna contour includes parts of the perimeter that are on the first side and the orthogonal projection onto the plane of the first side of the parts of the perimeter that are on the second side onto the first side:

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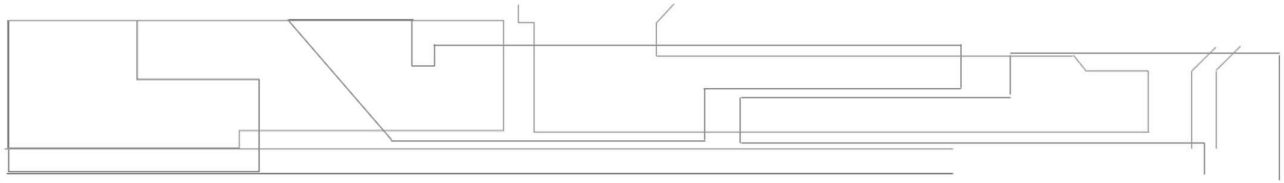
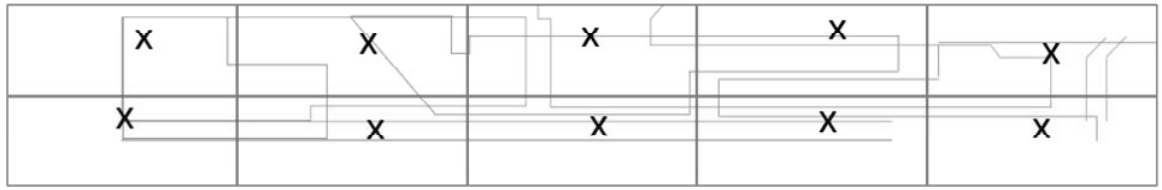
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		
1[i]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	D820 expressly or inherently discloses this claim element. *See e.g.,* The first antenna contour has a 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. N1=10  N2=27

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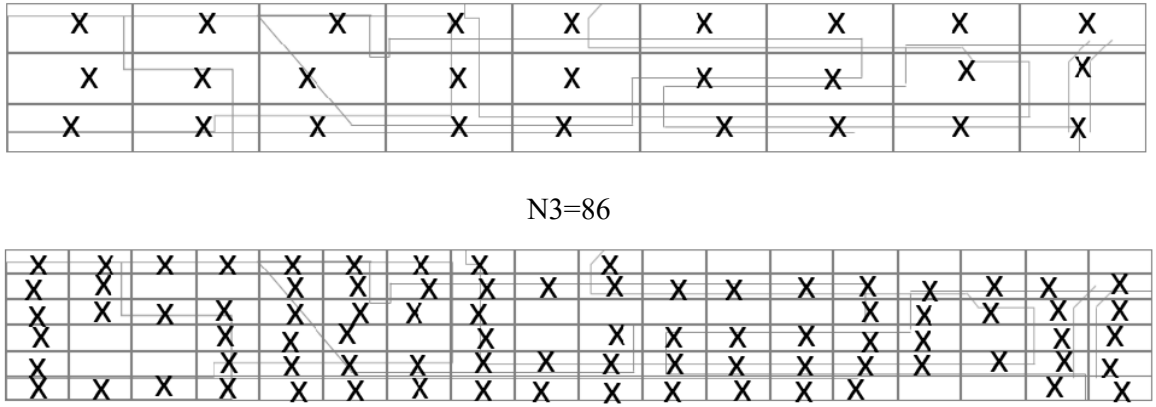
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 N3=86 F21=log(27/10)/log(2)=1.43 F32=log(83/27)/log(2)=1.62
1[j]	complexity factor F_{32} having a value less than 1.75; and	D820 expressly or inherently discloses this claim element. *See* Claim 1[j].
1[k]	a second antenna within the wireless device and	D820 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the Dell D820 includes a second antenna (brown below) within the D820.

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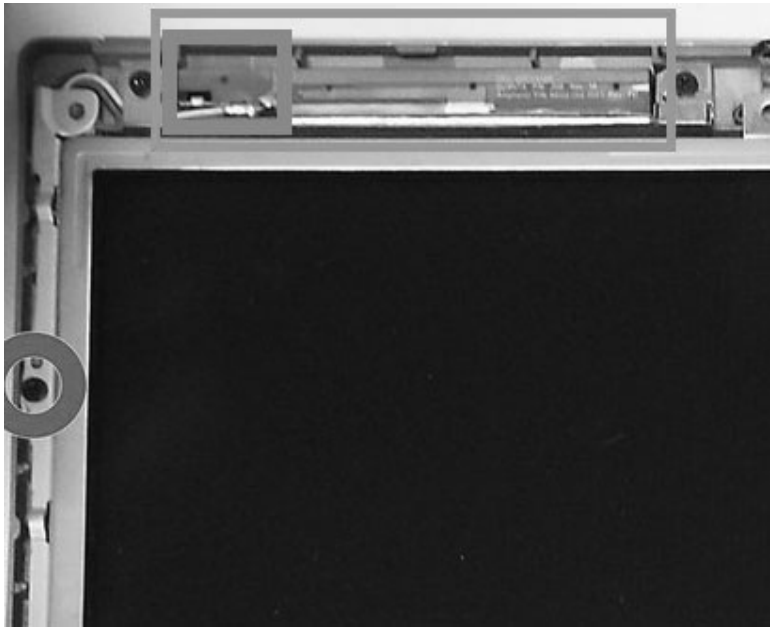
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		
1[l]	configured to support at least one frequency band different from the at least three frequency bands supported by the first antenna,	D820 expressly or inherently discloses this claim element. *See, e.g.*, The second antenna of the D820 is configured to support at least one frequency band different from the at least three frequency bands supported by the first antenna. The second antenna of the D820 is configured to support at least frequency bands in the ranges of 2.4-2.484 GHz, 5.15 GHz to 5.25 GHz, and 5.25-5.35 GHz.

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820

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

Jing, 2658 (DCS, PCS, UMTS); 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

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		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)[6]; 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).

[6] 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. 11,031,677 B2	Dell Latitude D820
1[m]	the second antenna being arranged completely within the ground plane rectangle.	D820 expressly or inherently discloses this claim element. *See, e.g.*, The second antenna (brown below) is arranged completely within the ground plane rectangle (red below).

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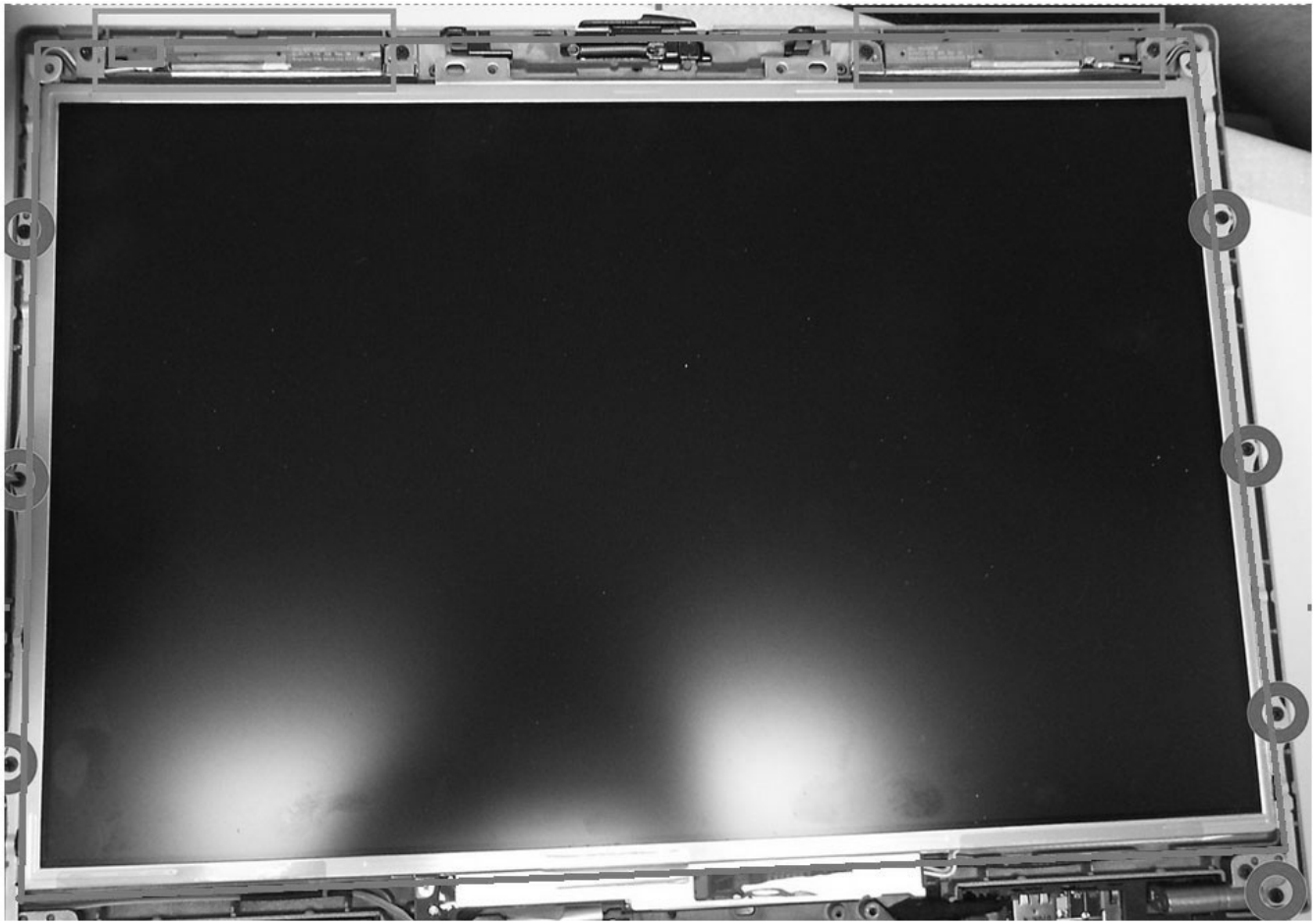
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		

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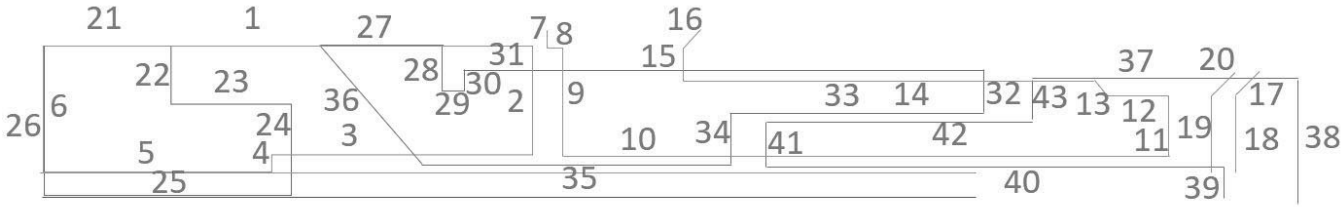
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		Claim 2
2	The wireless device of claim 1, wherein the first antenna contour comprises at least 20 segments.	D820 expressly or inherently discloses this claim element. *See, e.g.*,  The first antenna contour has at least 43 segments.
		Claim 3
3	The wireless device of claim 2, wherein the perimeter of the first antenna contour comprises at least 35 segments.	D820 expressly or inherently discloses this claim element. *See, e.g.*,

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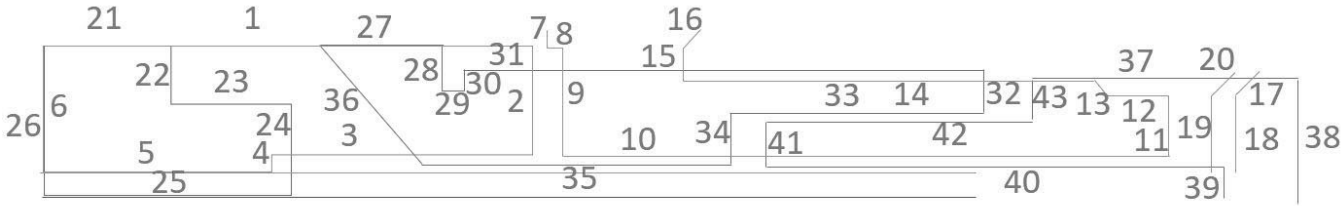
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 The first antenna contour has at least 43 segments.
Claim 4		
4	The wireless device of claim 1, wherein the antenna system comprises a third antenna configured to receive signals employing a 4G communication standard.	D820 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the Dell D820 includes a third antenna (green below) configured to receive signals employing a 4G communication standard.

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		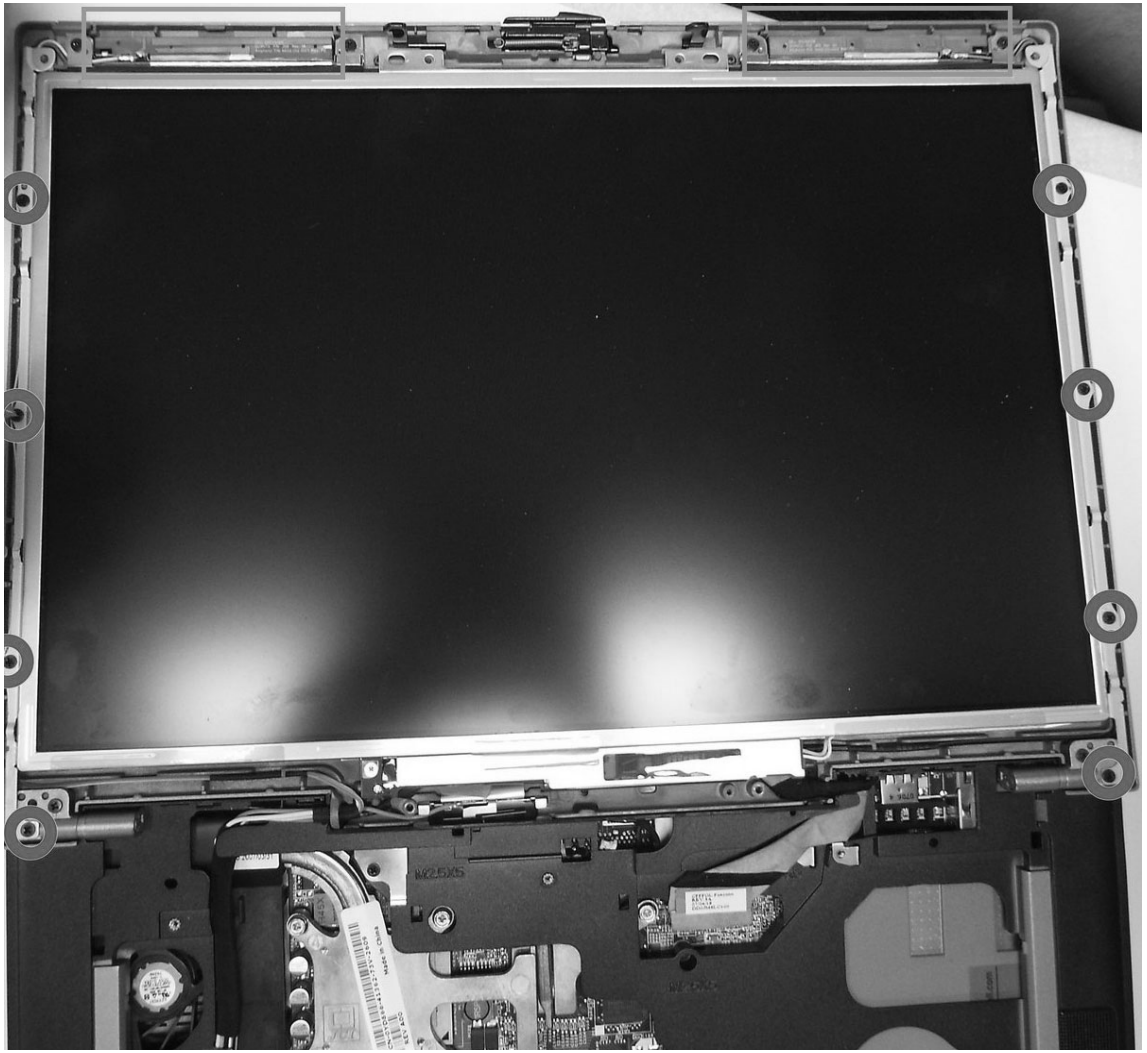

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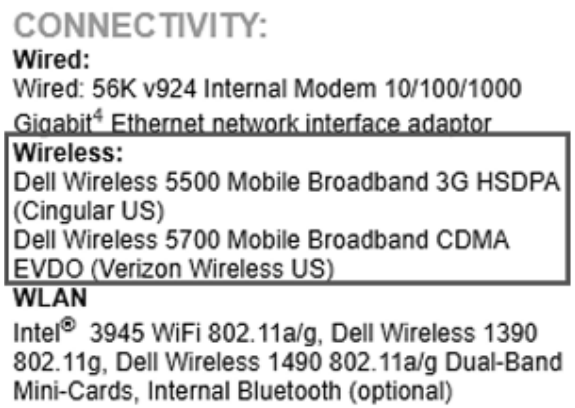
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 The third antenna is configured to receive signals at least in the ranges of 824-894 MHz and 1850-1990 MHz.
Claim 5		
5[a]	The wireless device of claim 4, wherein the third antenna defines an antenna contour comprising an entire perimeter	D820 expressly or inherently discloses this claim element. *See, e.g.*, The third antenna defines an antenna contour comprising an entire perimeter of the third antenna. The third antenna includes first and second sides including the perimeter of the third antenna. Third antenna, first side:

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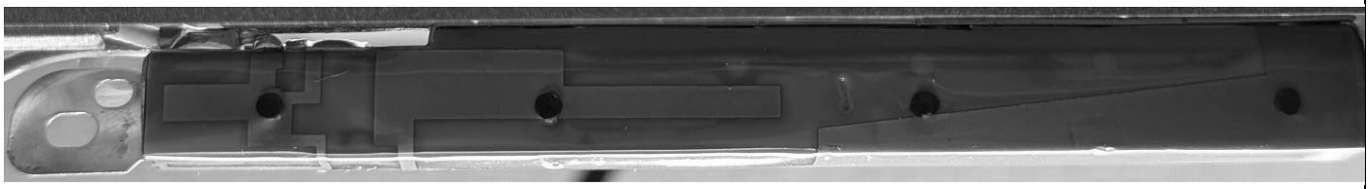
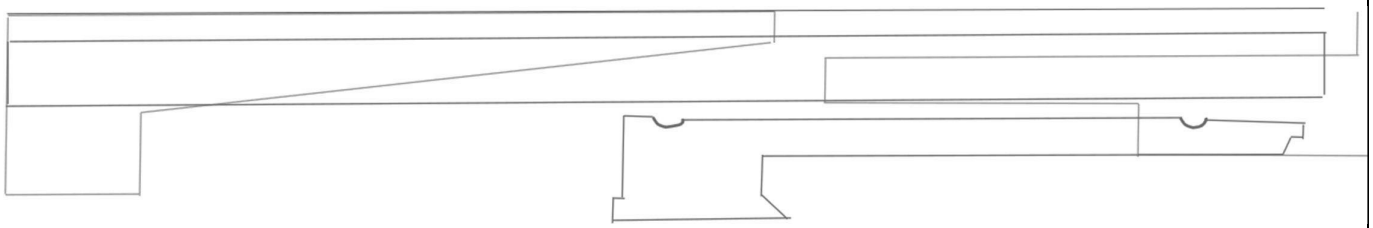
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
	of the third antenna, and	 Third antenna, second side: The third antenna contour includes parts of the perimeter that are on the first side and the orthogonal projection onto the plane of the first part of the parts of the perimeter that are on the second side. 

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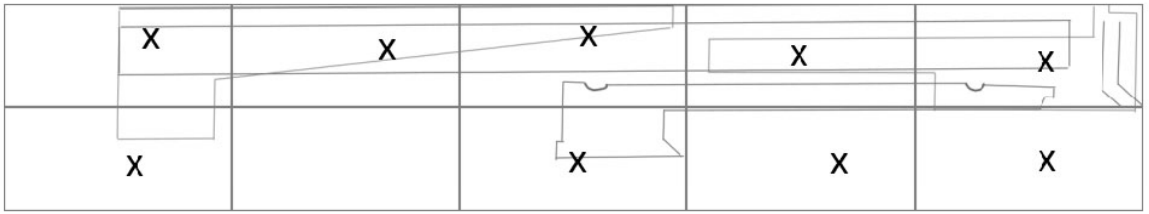
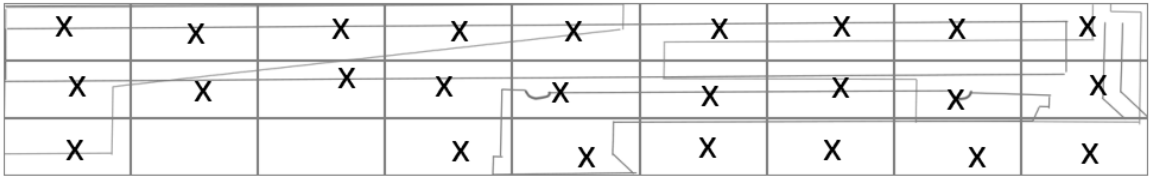
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
5[b]	wherein the antenna contour of the third antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	D820 expressly or inherently discloses this claim element. *See e.g.,* The complexity factor calculation is performed according to the method in the patent. The antenna contour of the third antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and a complexity factor F_{32} having a value of at least 1.35. N1=9  N2=25  N3=78

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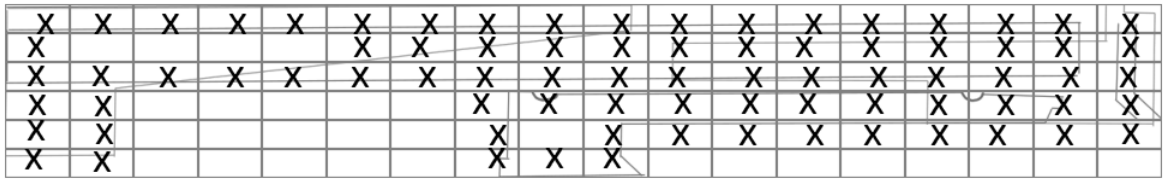
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 F21=log(25/9)/log(2)=1.47 F32=log(78/35)/log(2)=1.64
5[c]	a complexity factor F_{32} having a value of at least 1.35.	D820 expressly or inherently discloses this claim element. *See* Claim 5[b].
Claim 6		
6[pre]	A wireless device comprising:	To the extent the preamble is limiting, D820 expressly or inherently discloses this claim element. *See* Claim 1[pre].

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
6[a]	an antenna system comprising:	D820 expressly or inherently discloses this claim element. *See* Claim 1[a].
6[b]	[*the antenna system comprising*] a ground plane;	D820 expressly or inherently discloses this claim element. *See* Claim 1[a].
6[c]	[*the antenna system comprising*] a first antenna within the wireless device and	D820 expressly or inherently discloses this claim element. *See* Claim 1[c].
6[d]	configured to support at least two frequency bands contained within first and second frequency ranges of the	D820 expressly or inherently discloses this claim element. *See* Claim 1[d].

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
	electromagnetic spectrum,	
6[e]	the second frequency range being higher in frequency than the first frequency range,	D820 expressly or inherently discloses this claim element. *See* Claim 1[e].
6[f]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	D820 expressly or inherently discloses this claim element. To the extent the Dell D820 does not disclose a first antenna proximate to a first short side of a ground plane rectangle, it would have been obvious for the first antenna to be disposed proximate to a first short side of the ground plane rectangle as taught in Gaucher et al. (U.S. 2006/0082503) to achieve spatial diversity and reduce blockage caused by the laptop display. *See* Claim 1[g]. 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.
6[g]	defining a first antenna contour comprising an entire perimeter of the first antenna,	D820 expressly or inherently discloses this claim element. *See* Claim 1[h].

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
6[h]	wherein the first antenna 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* Claim 1[i].
6[i]	complexity factor F_{32} having a value less than 1.75; and	D820 expressly or inherently discloses this claim element. *See* Claim 1[i].
6[j]	[*the antenna system comprising*] a second antenna within the wireless device and	D820 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the Dell D820 includes a second antenna (green below) within the D820.

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		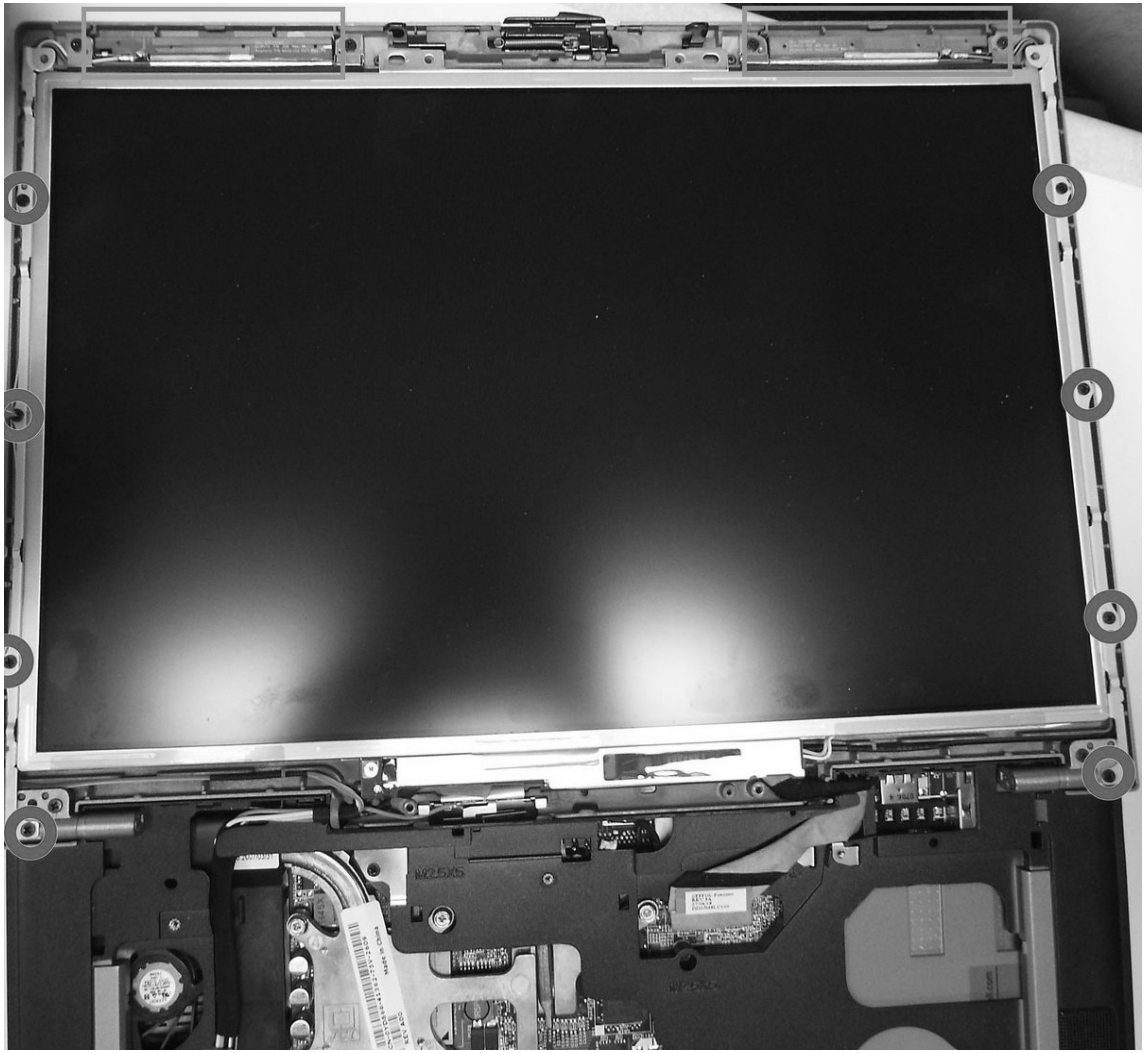

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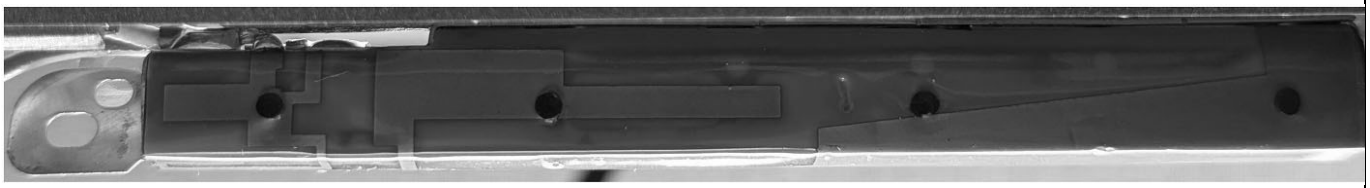
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
6[k]	defining a second antenna contour comprising an entire perimeter of the second antenna,	D820 expressly or inherently discloses this claim element. *See, e.g.*, The second antenna of the Dell D820 defines a second antenna contour comprising an entire perimeter of the second antenna. The second antenna includes first and second sides including the perimeter of the second antenna: Second antenna, first side:  Second antenna, second side: The second antenna contour includes parts of the perimeter that are on the first side and the orthogonal projection onto the plane of the first part of the parts of the perimeter that are on the second side.

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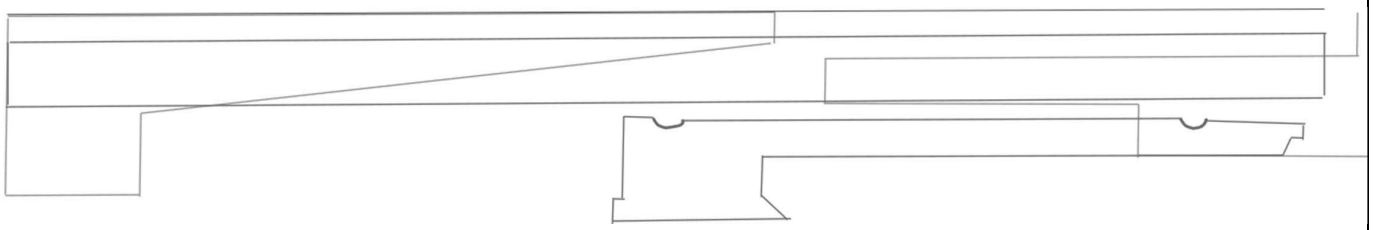
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		
6[l]	the second antenna being proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle,	D820 expressly or inherently discloses this claim element. To the extent the D820 does not disclose a second antenna proximate to a second short side of the ground plane rectangle that is opposite to the first short side, it would have been obvious for the second antenna to be disposed proximate to a second short side of the ground plane rectangle that is opposite to the first short side as taught in Gaucher et al. (U.S. 2006/0082503) to achieve spatial diversity and reduce blockage caused by the laptop display. *See, e.g.,*

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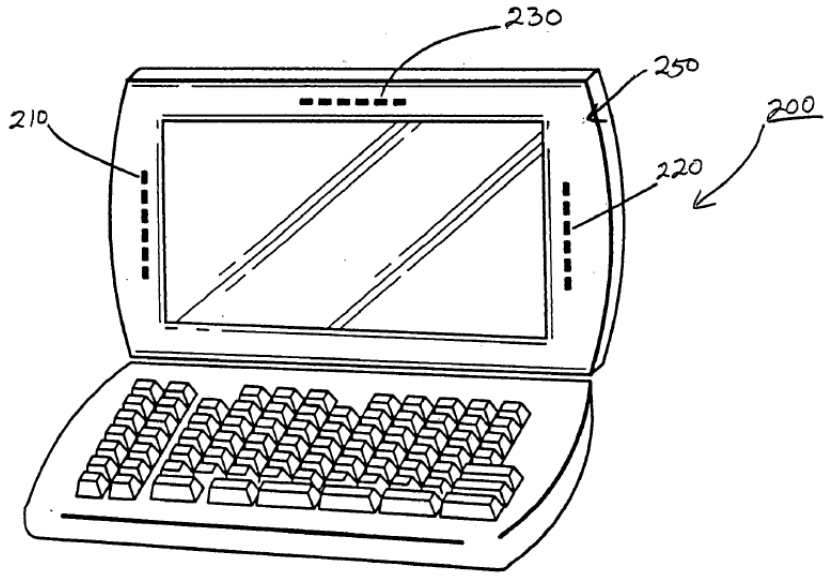
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 FIG. 2 Additionally, it would have been obvious to a person of ordinary skill in the art to modify this reference with any one or more of the references disclosed in Geotab's Invalidity Contentions based on knowledge of one of ordinary skill in the art and for the reasons articulated in Geotab's Invalidity Contentions Cover Pleading.
6[m]	a minimum-sized parallelepiped of	D820 expressly or inherently discloses this claim element. *See, e.g.*,

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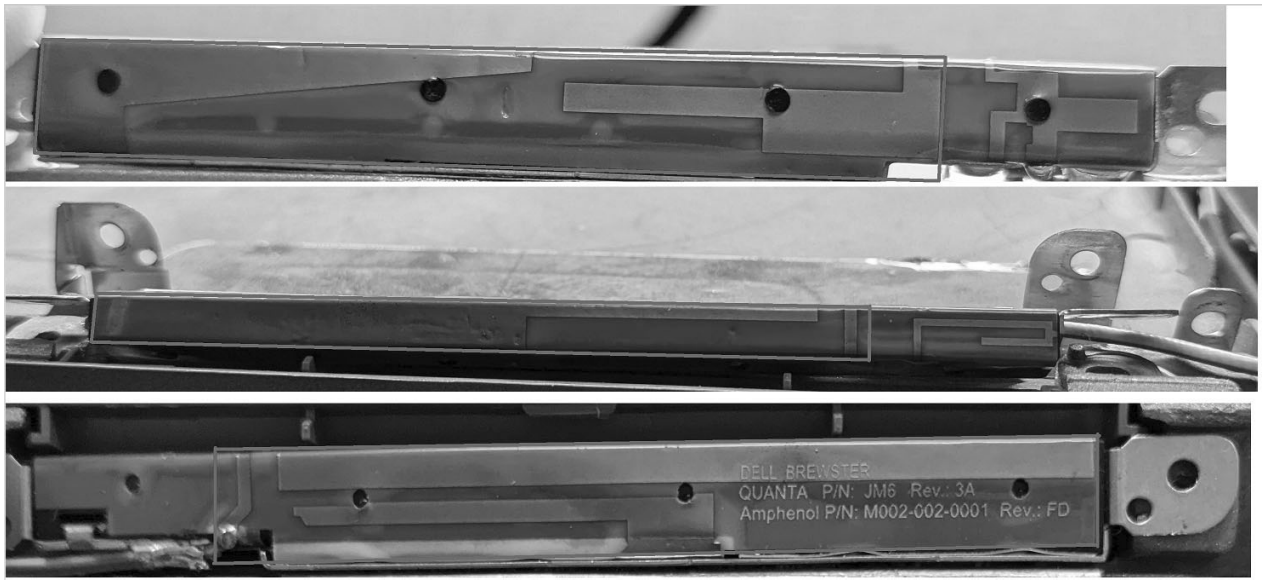
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
	rectangular faces that completely encloses a volume of the second antenna defining an antenna box, and	An antenna box (purple below) that is a minimum-sized parallelepiped that completely encloses a volume of the second antenna and wherein each face of the minimum-sized parallelepiped is tangent to at least one point of the volume of the second antenna. 
6[n]	an orthogonal projection of the antenna box along a normal to a face with a largest area of	D820 expressly or inherently discloses this claim element. *See, e.g.*, An orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna is shown here (orange below).

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
	the second antenna defining	
6[o]	an antenna rectangle,	D820 expressly or inherently discloses this claim element. *See, e.g.*, The orthogonal projection of the antenna box along a normal to a face with a largest area of the second defines an antenna rectangle (orange below).
6[p]	wherein a length of the second antenna contour is greater than four times a diagonal of the antenna rectangle.	D820 expressly or inherently discloses this claim element. *See, e.g.*,

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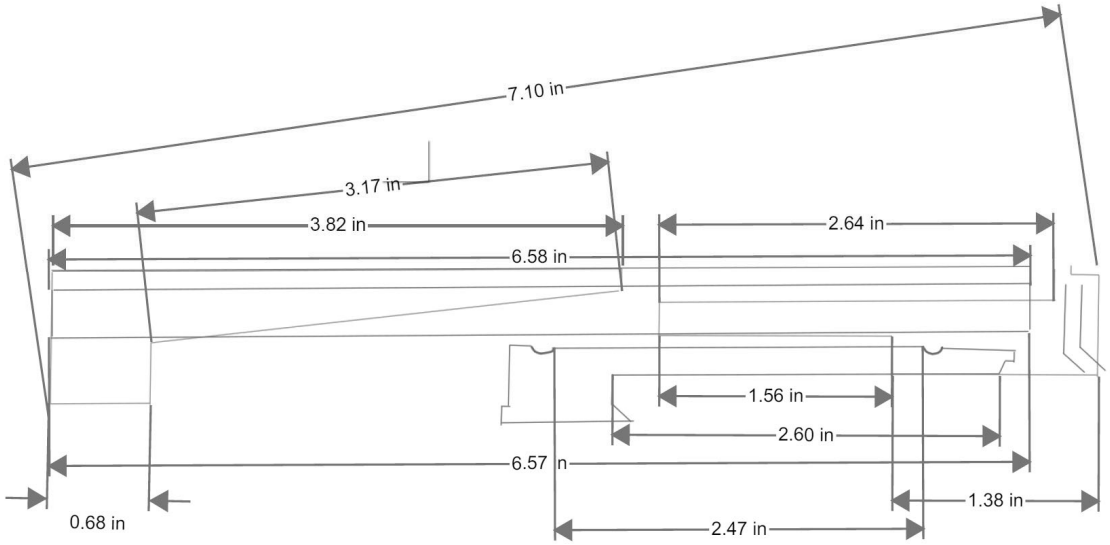
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 4xDiagonal = 4(7.10) = 28.4 L> = 3.17 + 3.82 + 2.64 + 6.58 + 1.56 + 2.6 + 6.57 + 1.38 + 2.47 + 0.68 >= 31.74
Claim 7		
7	The wireless device of claim 6, wherein the first antenna contour comprises at	D820 expressly or inherently discloses this claim element. *See, e.g.*,

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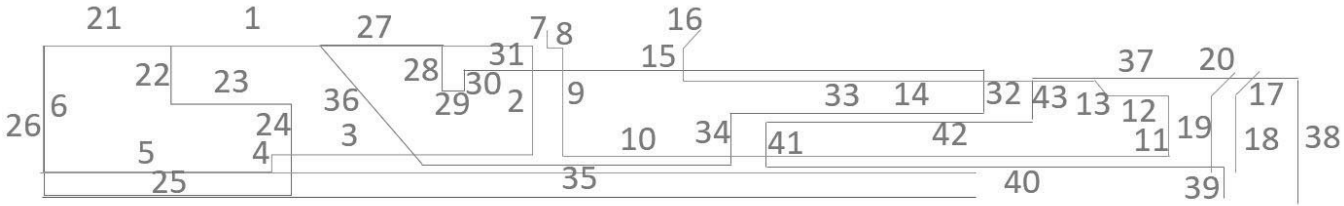
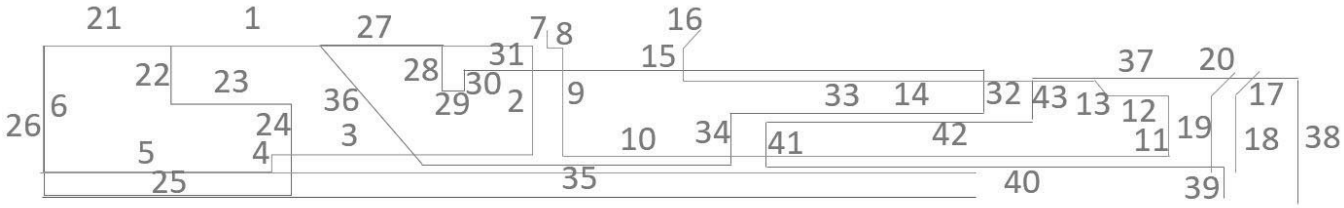
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
	least 20 segments.	 The first antenna contour has at least 43 segments.
Claim 8		
8	The wireless device of claim 6, wherein the first antenna contour comprises at least 35 segments.	D820 expressly or inherently discloses this claim element. *See, e.g.*,  The first antenna contour has at least 43 segments.
Claim 9		

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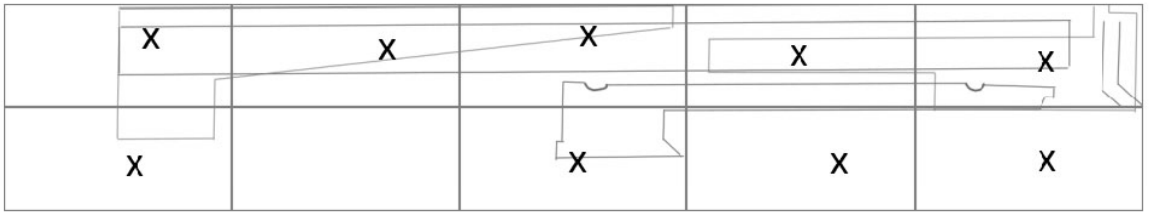
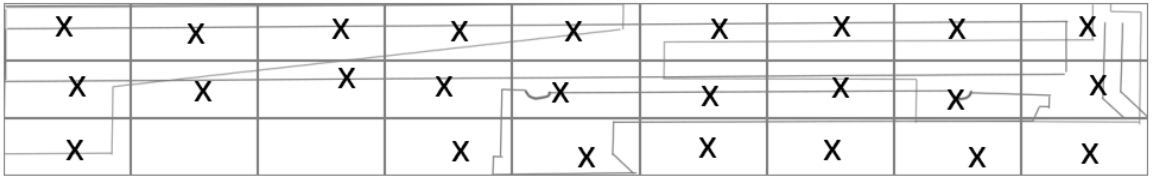
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
9[a]	The wireless device of claim 6, wherein the second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	D820 expressly or inherently discloses this claim element. *See, e.g.*, The complexity factor calculation is performed according to the method in the patent. The second antenna contour of the second antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and a complexity factor F_{32} having a value of at least 1.35. N1=9  N2=25  N3=78

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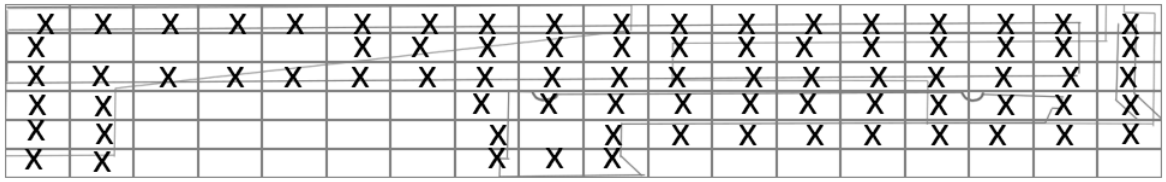
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 F21=log(25/9)/log(2)=1.47 F32=log(78/35)/log(2)=1.64
9[b]	a complexity factor F_{32} having a value of at least 1.35.	D820 expressly or inherently discloses this claim element. *See* Claim 9[a].
	Claim 12	
12[pre]	A wireless device comprising:	To the extent the preamble is limiting, D820 expressly or inherently discloses this claim element. *See* Claim 1[pre].
12[a]	an antenna system comprising:	D820 expressly or inherently discloses this claim element. *See* Claim 1[a].

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
12[b]	[*the antenna system comprising*] a ground plane;	D820 expressly or inherently discloses this claim element. *See* Claim 1[a].
12[c]	[*the antenna system comprising*] a first antenna within the wireless device and	D820 expressly or inherently discloses this claim element. *See* Claim 1[c].
12[d]	configured to provide operation in at least four frequency bands,	D820 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the Dell D820 is configured to provide operation in at least four frequency bands.

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Claim No.	U.S. Patent No. 11,031,677 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 four frequency bands within the ranges of 880-960 MHz, 1710-1990 MHz, and 2010-2025 MHz.

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820

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

Jing, 2658 (DCS, PCS, UMTS); 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

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		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)[7]; 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).

[7] 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. 11,031,677 B2	Dell Latitude D820
12[e]	at least one of the at least four frequency bands is contained within a first frequency range and	D820 expressly or inherently discloses this claim element. *See* Claim 12[d].
12[f]	at least one other of the four frequency bands is contained within a second frequency range,	D820 expressly or inherently discloses this claim element. *See* Claim 12[d].
12[g]	the first frequency range being lower in frequency than the second frequency range,	D820 expressly or inherently discloses this claim element. *See* Claim 12[d].
12[h]	the first antenna being proximate to a first short side of a ground plane rectangle	D820 expressly or inherently discloses this claim element. To the extent the Dell D820 does not disclose a first antenna proximate to a first short side of a ground plane rectangle, it would have been obvious for the first antenna to be disposed proximate to a first short side of the ground plane rectangle as taught in Gaucher et al. (U.S. 2006/0082503) to achieve spatial diversity and reduce blockage caused by the laptop display.

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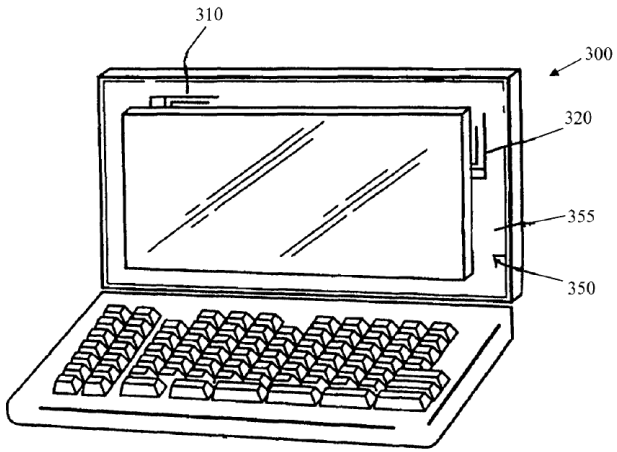
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
	enclosing the ground plane,	 FIG. 3 Gaucher teaches "a laptop computer 300 including a laptop display unit 350 and a plurality of multiband antennas 310, 320 mounted on the upper frame 355 of the laptop display unit 350." Like the Dell D820, "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." 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."

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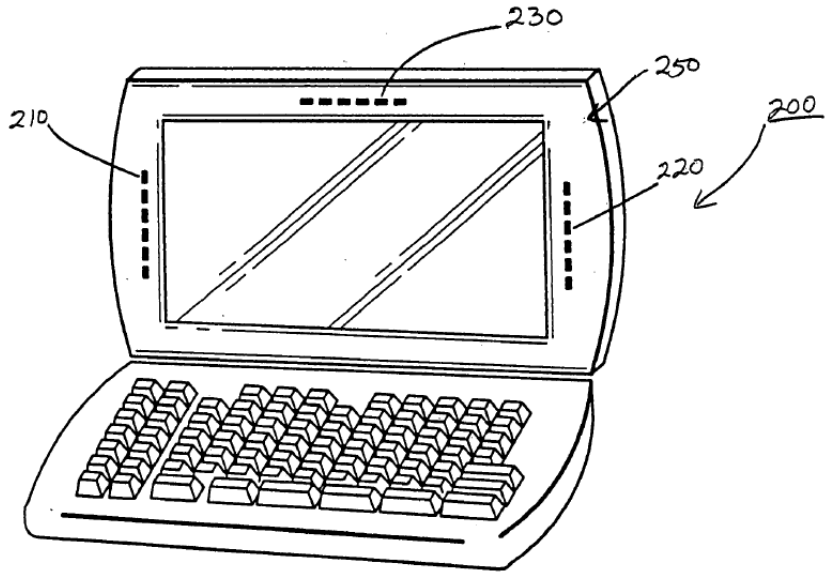
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 FIG. 2 Like in the Dell D820, Gaucher's "display frame or the metal display supporters provide the ground element to the antenna design. For example, the ground element may be provided by the display frame, or metal supports, or the shielding foil on the back of the display."

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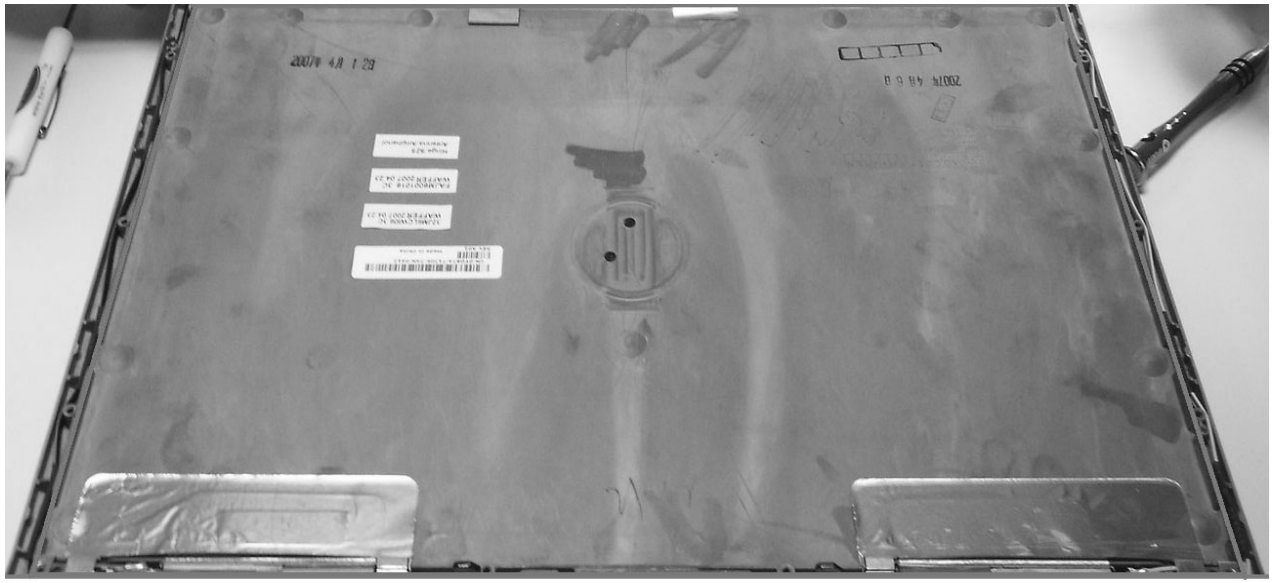
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 Similar to the multiband cellular antennas of the Dell D820, Gaucher's antennas are "quadband antenna[s] covering the four most popular frequency bands, namely, 824-894 MHz for the lower band of the United States, 880-960 MHz for the lower band of Europe 1710-1880 MHz for the upper band of Europe, and 1850-1990 MHz for the upper band of the United States."

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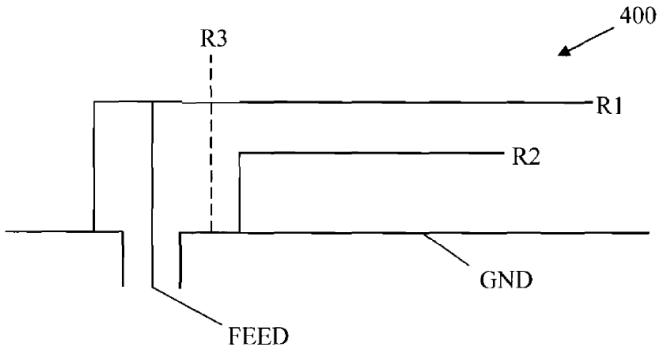
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 There would have been a reasonable expectation of success in having the first antenna of the Dell D820 disposed proximate a first short side of the ground plane rectangle because a similarly configured antenna is taught in a similarly configured laptop device in Gaucher. For instance, Gaucher and the Dell D820 place the antennas on a grounded display frame for use as a ground plane. The Gaucher antennas and the Dell 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 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 Dell 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." 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.

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
12[i]	the first antenna defining a first antenna contour comprising an entire perimeter of the first antenna, and	D820 expressly or inherently discloses this claim element. *See* Claim 1[h].
12[j]	wherein the first antenna 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* Claim 1[i].
12[k]	complexity factor F_{32} having a value less than 1.75; and	D820 expressly or inherently discloses this claim element. *See* Claims 1[i]-[k].
12[l]	wherein the first antenna is configured to transmit and receive signals	D820 expressly or inherently discloses this claim element. *See* Claim 12[d].

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
	from a 4G communication standard; and	
12[m]	[*the antenna system comprising*] a second antenna within the wireless device and configured to receive signals from a 4G communication standard,	D820 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the Dell D820 includes a second antenna (green below) within the D820 and configured to receive signals from a 4G communication standard.

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		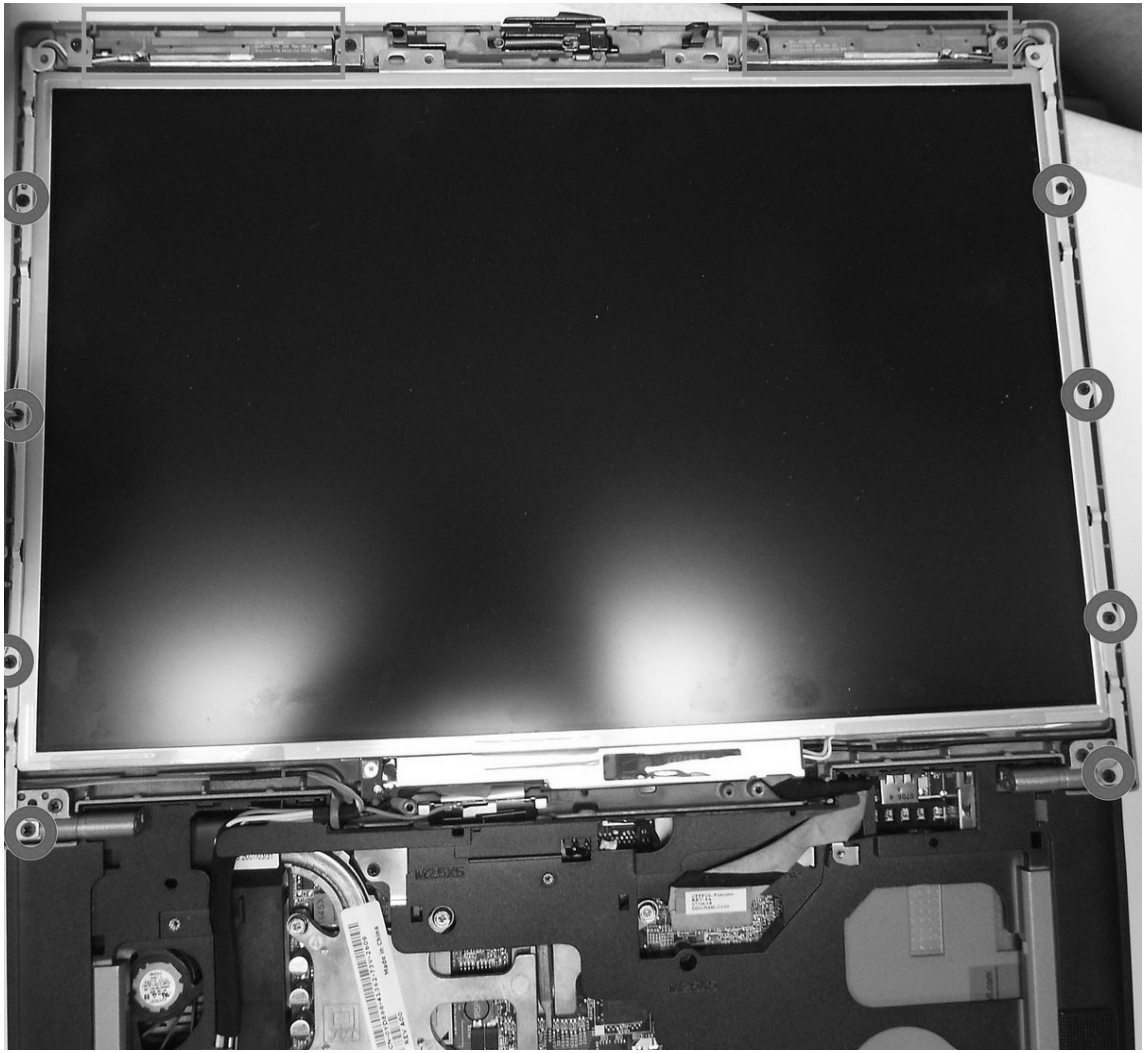

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		The second antenna is configured to receive signals at least in the ranges of 824-894 MHz and 1850-1990 MHz.
12[n]	a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second antenna defining an antenna box,	D820 expressly or inherently discloses this claim element. *See* Claim 6[m].
12[o]	an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining	D820 expressly or inherently discloses this claim element. *See* Claim 6[n].
12[p]	an antenna rectangle,	D820 expressly or inherently discloses this claim element. *See* Claim 6[o].

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
12[q]	an aspect ratio of the antenna rectangle being defined as a ratio between a width and a height of the antenna rectangle, and wherein the aspect ratio has a value of at least 2.	D820 expressly or inherently discloses this claim element. *See, e.g.*, An aspect ratio of the antenna rectangle being defined as a ratio between a width and a height of the antenna rectangle, and wherein the aspect ratio has a value of at least 2. A width of the antenna rectangle is at least twice a height of the antenna rectangle.
Claim 13		
13	The wireless device of claim 12, wherein the first antenna contour comprises at least 20 segments.	D820 expressly or inherently discloses this claim element. *See, e.g.*,
Claim 14		

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
14	The wireless device of claim 13, wherein the first antenna contour comprises at least 35 segments.	D820 expressly or inherently discloses this claim element. *See, e.g.*,
Claim 15		
15	The wireless device of claim 12, wherein the second antenna is proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle.	D820 expressly or inherently discloses this claim element. To the extent the D820 does not disclose a second antenna proximate to a second short side of the ground plane rectangle that is opposite to the first short side, it would have been obvious for the second antenna to be disposed proximate to a second short side of the ground plane rectangle that is opposite to the first short side as taught in Gaucher et al. (U.S. 2006/0082503) to achieve spatial diversity and reduce blockage caused by the laptop display. *See, e.g.,*

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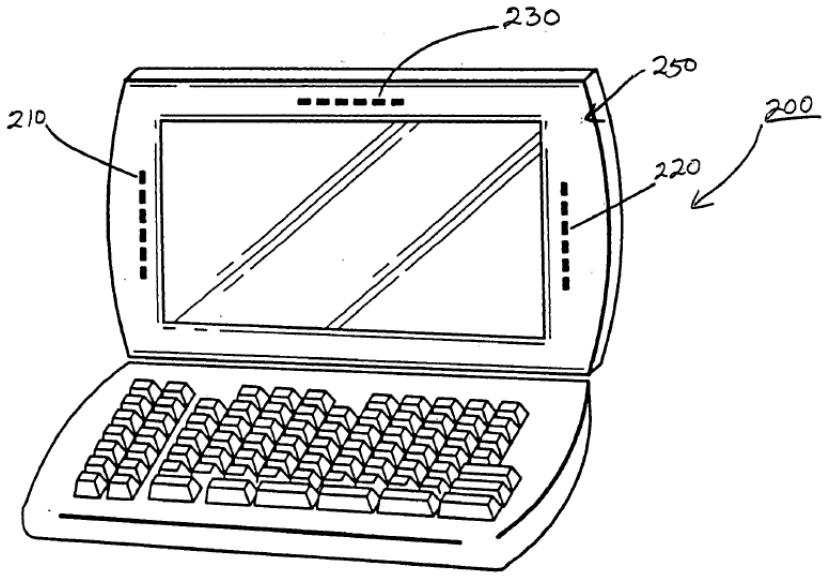
Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
		 FIG. 2 Additionally, it would have been obvious to a person of ordinary skill in the art to modify this reference with any one or more of the references disclosed in Geotab's Invalidity Contentions based on knowledge of one of ordinary skill in the art and for the reasons articulated in Geotab's Invalidity Contentions Cover Pleading.
Claim 16		

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
16[a]	The wireless device of claim 12, wherein the second antenna defines a second antenna contour comprising an entire perimeter of the second antenna,	D820 expressly or inherently discloses this claim element. *See* Claim 6[k].
16[b]	and wherein the second antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	D820 expressly or inherently discloses this claim element. *See* Claim 9[a].
16[c]	a complexity factor F_{32} having a value of at least 1.35.	D820 expressly or inherently discloses this claim element. *See* Claim 9[a].
Claim 17		

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Claim No.	U.S. Patent No. 11,031,677 B2	Dell Latitude D820
17	The wireless device of claim 16, wherein the second antenna contour comprises at least 20 segments.	D820 expressly or inherently discloses this claim element. *See, e.g.*,

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Exhibit – D – 14

INVALIDITY CONTENTIONS FOR U.S. PATENT NO. 11,031,677 B2
BASED ON THE LENOVO T60 ("LENOVO 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, 6, 7, 8, 9, 12, 13, 14, 15, 16, and 17 ("the '677 Asserted Claims")[1]. These invalidity contentions are not an admission by the Defendants 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 '677 Patent was filed on March 27, 2020, 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, ("Lenovo T60") was released by at least February 2006[2]. Thus, the Lenovo 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 Lenovo 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 that, by not charting claims 10-11 and 18-20 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 Lenovo 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 Lenovo 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.

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- 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. 11,031,677 (the "'677 Patent"), are invalid as anticipated by Lenovo T60. To the extent that Lenovo T60 is found not to anticipate one or more of the asserted claims of the '677 Patent, these claims are invalid as obvious in view of Lenovo T60 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.

One of ordinary skill in the art, as of the priority date of the '677 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

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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. 11,031,677 B2	Lenovo T60
	Claim 1	
1[pre]	A wireless device comprising:	To the extent the preamble is limiting, Lenovo 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.

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Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		Image Source: https://web.archive.org/web/20060407172813/ http://www.notebookreview.com/default.asp?newsID=2864&Review=Lenovo+ThinkPad+T60p
1[a]	an antenna system comprising:	Lenovo 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.

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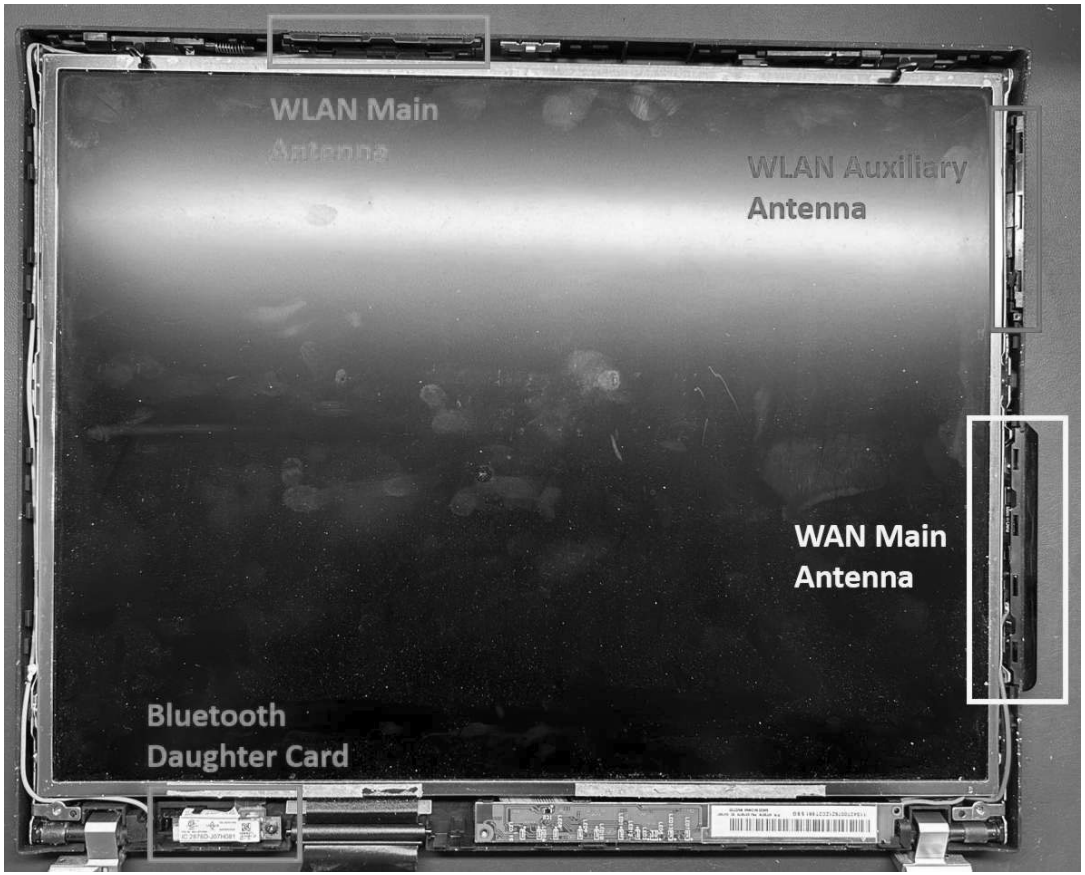
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		

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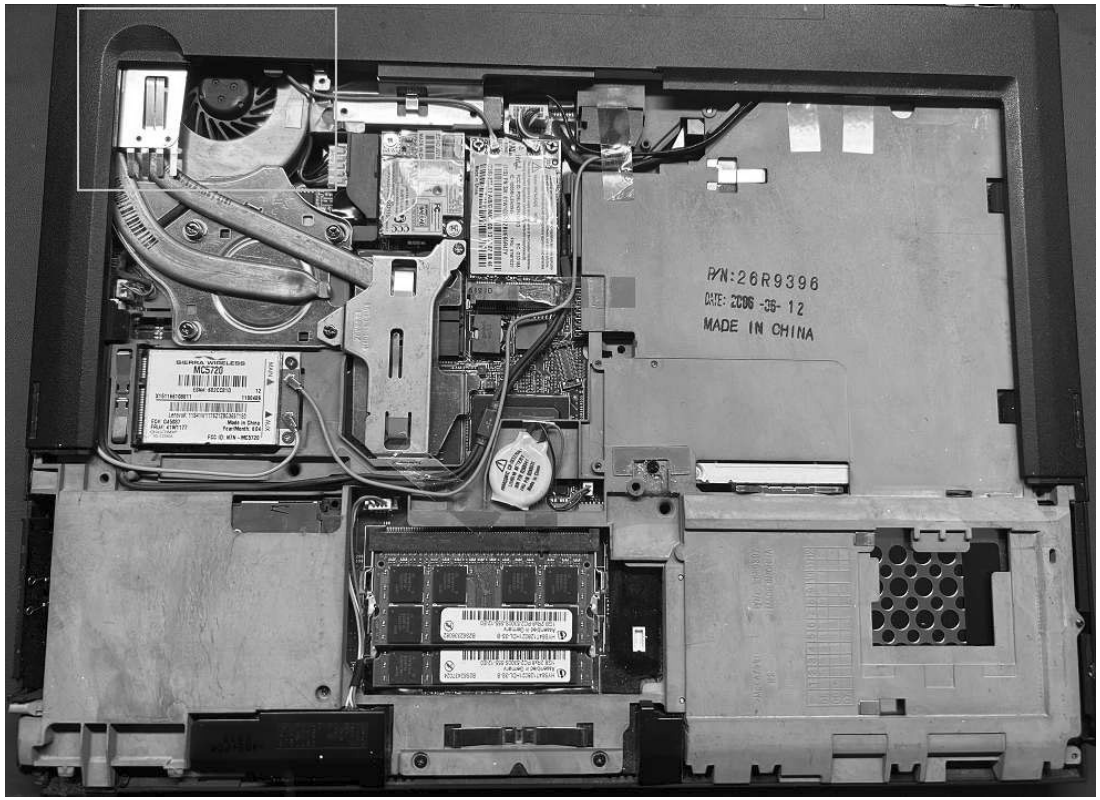
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		

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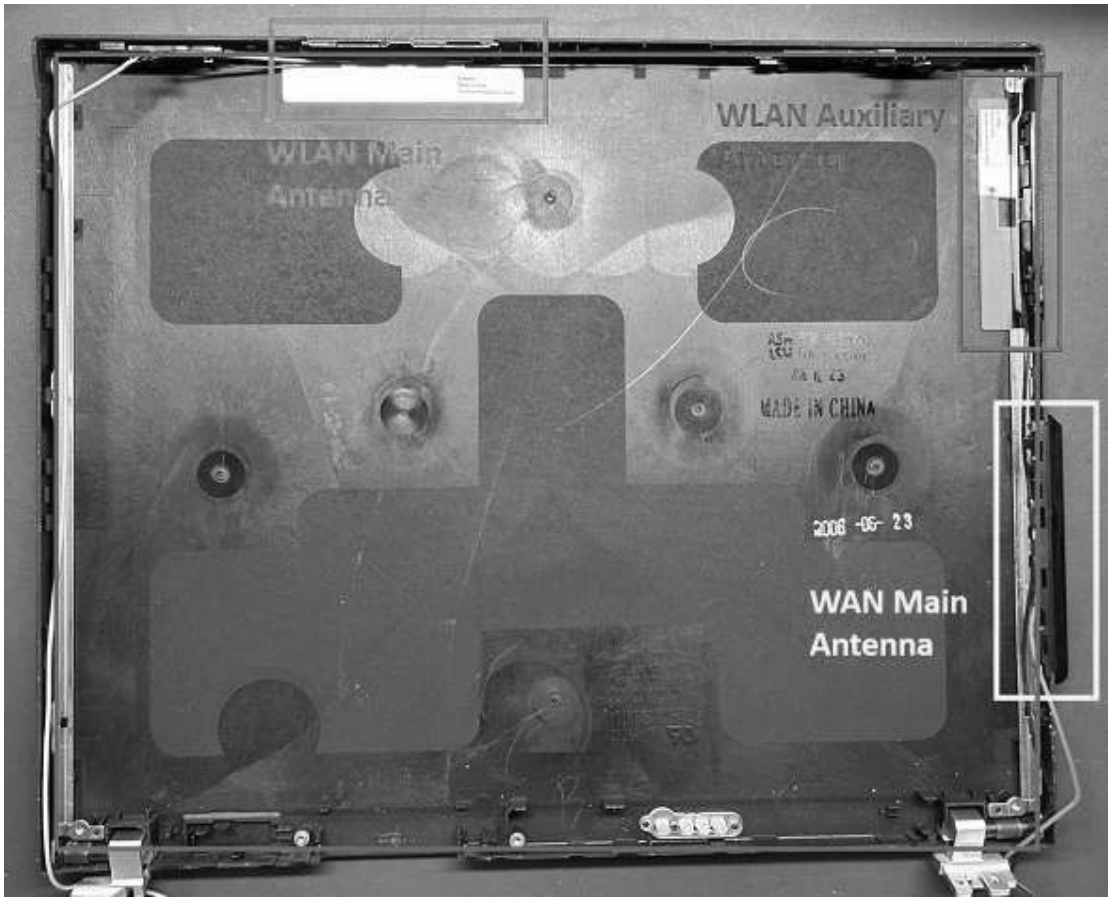
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		

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Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
1[b]	[*the antenna system comprising*] a ground plane;	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[a]
1[c]	[*the antenna system comprising*] a first antenna within the wireless device and	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the Lenovo T60 includes a first antenna (yellow below) within the T60.

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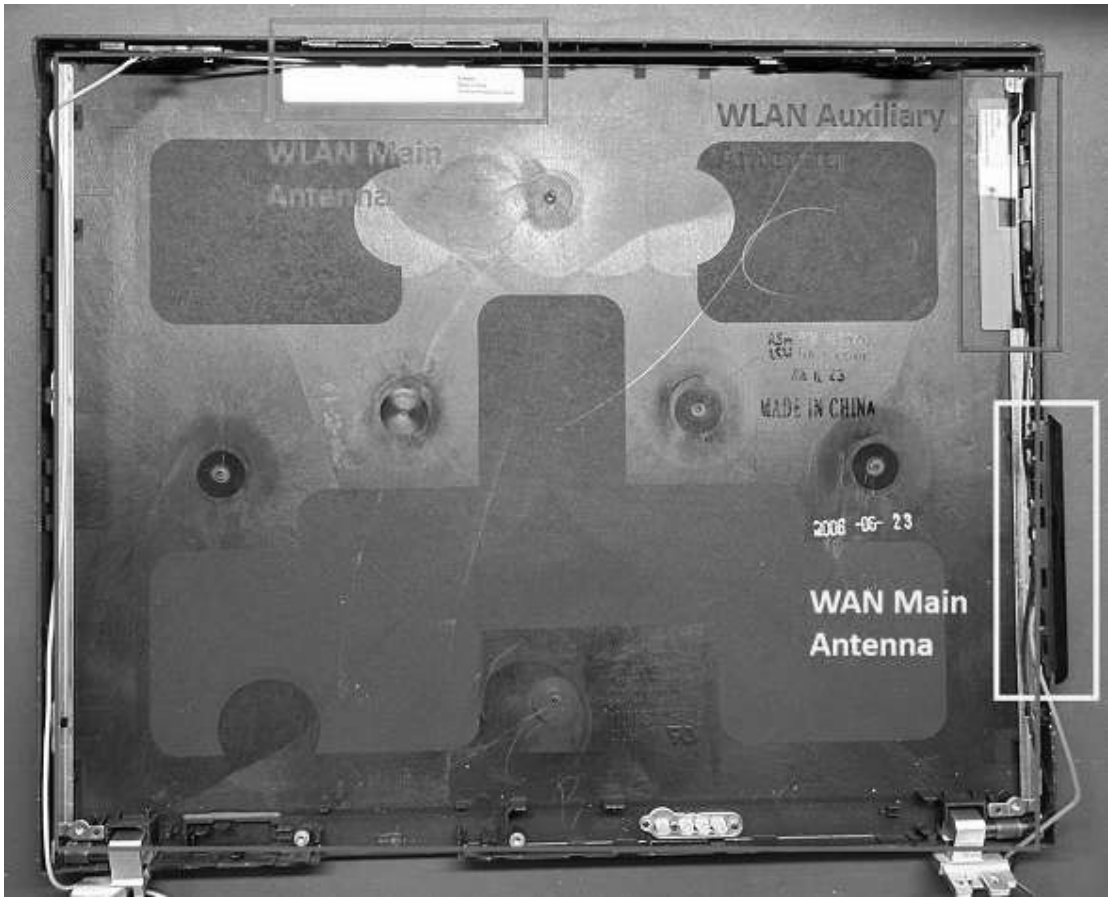
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		

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Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		 First antenna – side view
1[d]	[*the antenna system*] configured to support at least three frequency bands contained within first and second frequency ranges of the electromagnetic spectrum,	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, The first 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. Source: https://support.lenovo.com/us/en/solutions/pd008795-detailed-specifications-thinkpad-t60-t60p The first antenna is configured to support at least three frequency bands contained within 824-894 MHz and 1710-2170 MHz.

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Claim No.	U.S. Patent No. 11,031,677 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

Jing, 2658 (DCS, PCS, UMTS); 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

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Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		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. 11,031,677 B2	Lenovo T60
1[e]	the second frequency range being higher in frequency than the first frequency range and	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[e].
1[f]	at least one of the three frequency bands being associated with a 4G communication standard,	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, At least one of the three frequency bands is associated with a 4G communication standard. The first antenna is configured to transmit and receive signals at least in frequency bands contained within 824-894 MHz and 1710-2170 MHz. *See* Claim 1[d].
1[g]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the Lenovo T60 includes a first antenna (yellow below) proximate to a first short side of a ground plane rectangle (purple below) enclosing the ground plane.

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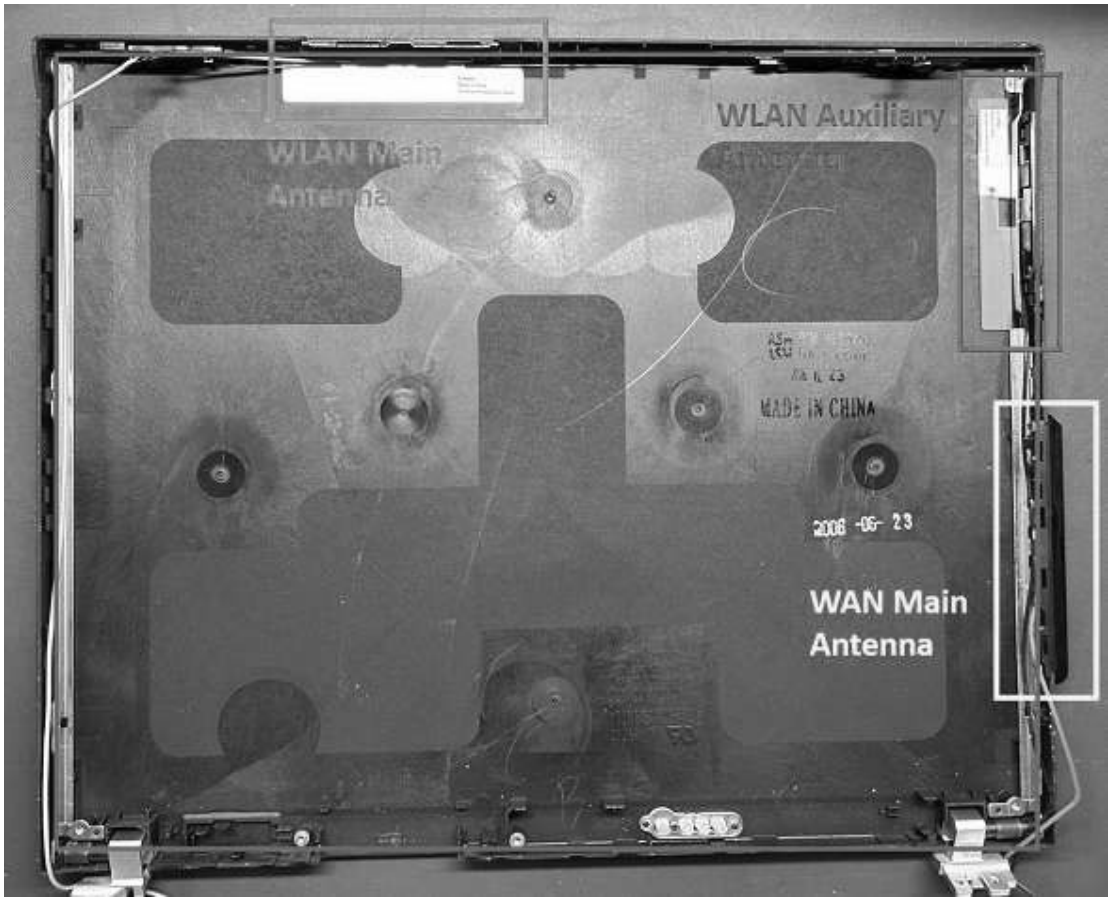
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		

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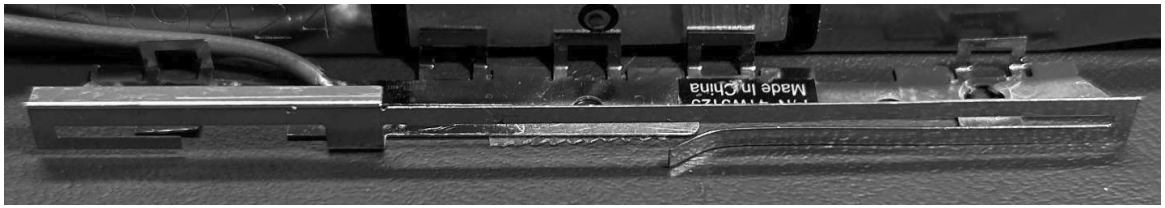
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		 First antenna – side view
1[h]	defining a first antenna contour comprising an entire perimeter of the first antenna,	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, 
1[i]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, 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 of at least 1.35. N1=10

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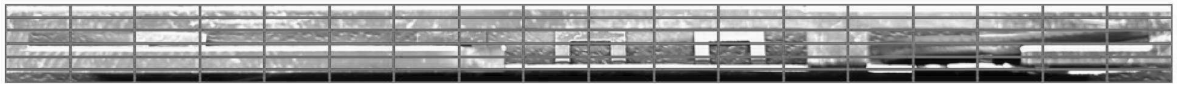
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		 N2=23 N3=67  F21=log(23/10)/log(2)=1.2 F32=log(67/23)/log(2)=1.54 The complexity factor calculation is performed according to the method in the patent.
1[j]	complexity factor F_{32} having a value less than 1.75; and	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[i]
1[k]	a second antenna within the wireless device and	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*,

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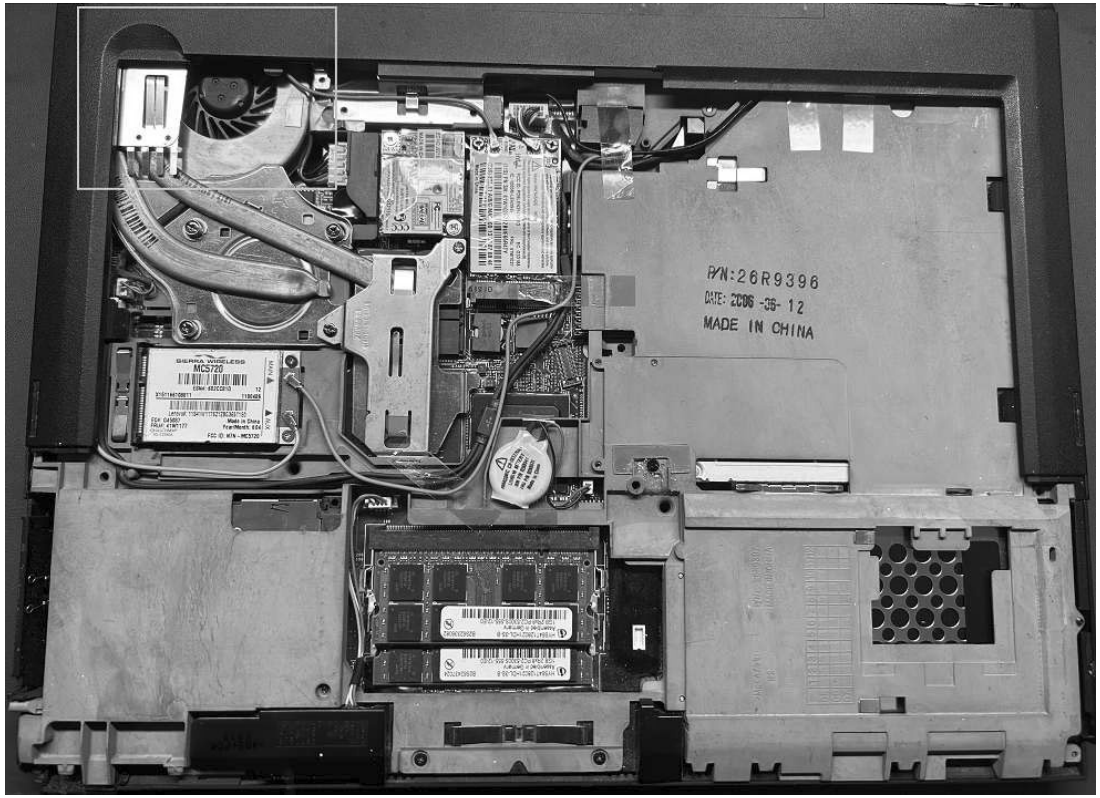
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		The antenna system of the Lenovo T60 includes a second antenna (pink below) proximate to a second side of the ground plane rectangle (purple below). 

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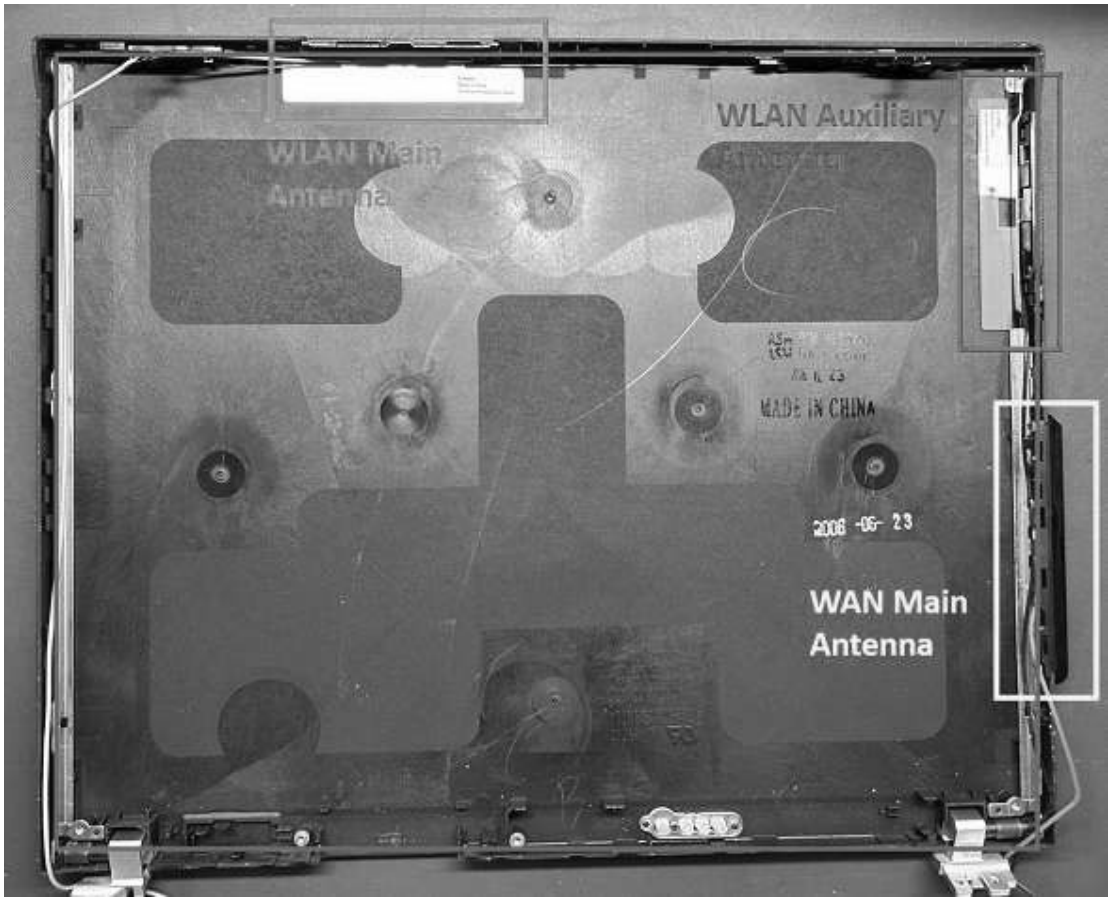
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		

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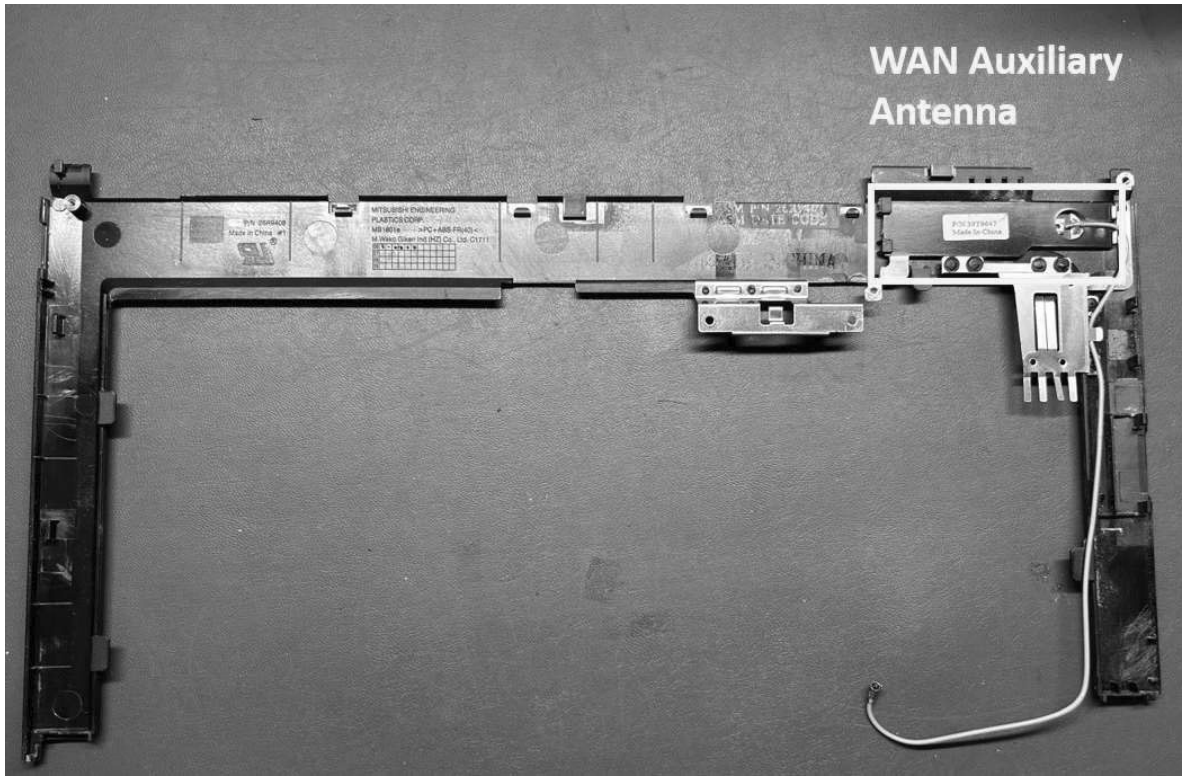
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		

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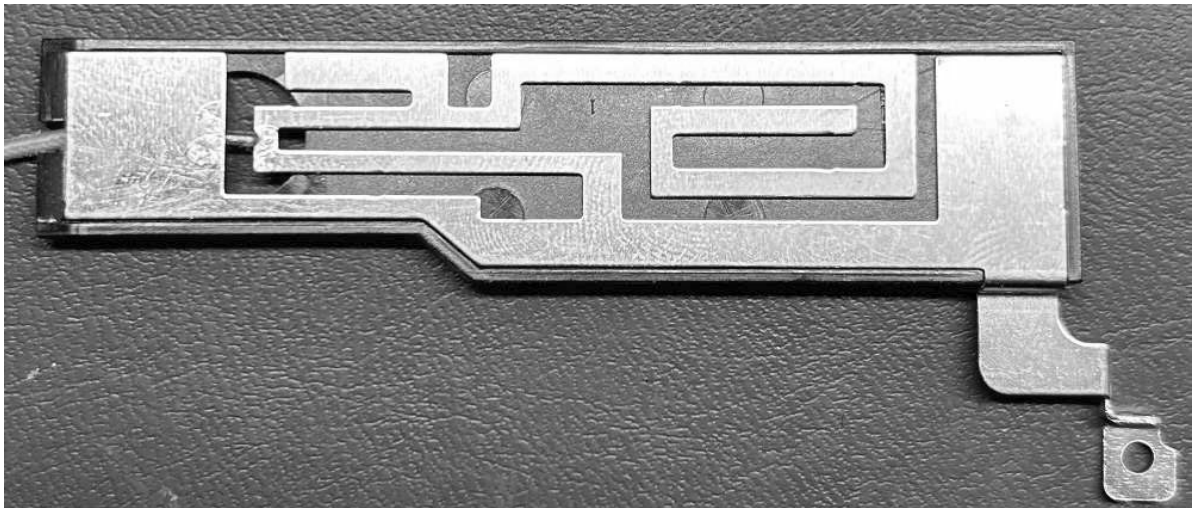
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		
1[l]	configured to support at least one frequency band different from the at least three frequency bands supported by the first antenna,	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, The second antenna of the Lenovo T60 is configured to support at least one frequency band different from the at least three frequency bands supported by the first antenna. The second antenna of the Lenovo T60 is configured to support at least one frequency band within 880-960 MHz and 1850-1990 MHz. *See* Claim 1[d].
1[m]	the second antenna being arranged	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*,

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Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
	completely within the ground plane rectangle.	The second antenna of the Lenovo T60 is arranged completely within the ground plane rectangle. *See* Claim 1[k].
Claim 4		
4	The wireless device of claim 1, wherein the antenna system comprises a third antenna configured to receive signals employing a 4G communication standard.	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the Lenovo T60 comprises a third antenna (blue below) configured to receive signals employing a 4G communication standard (e.g., a WiFi communication standard).

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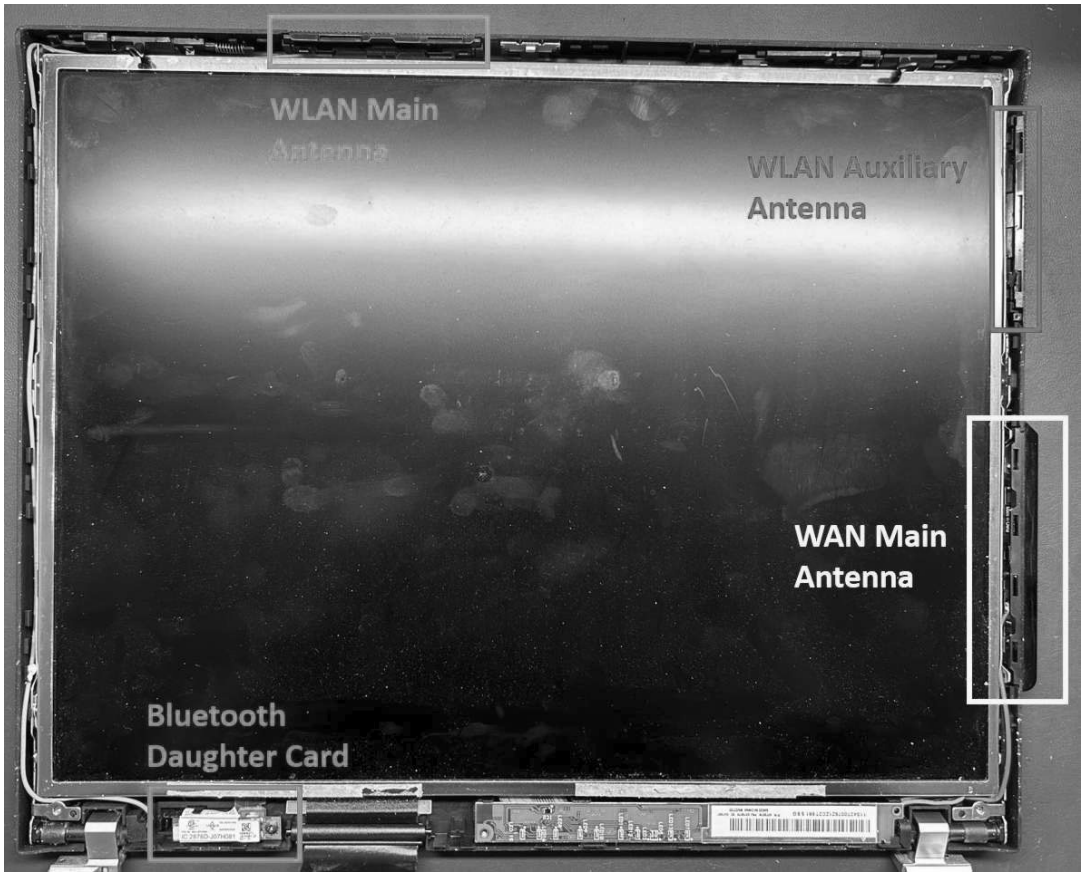
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		

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Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		 The third antenna is configured to receive signals within at least 2.4-2.484 GHz, 5.15-5.25 GHz, 5.25-5.35 GHz, and 5.725-5.875 GHz.
Claim 5		
5[a]	The wireless device of claim 4, wherein the third antenna defines an antenna contour comprising an entire perimeter of the third antenna, and	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, The T60's third antenna defines an antenna contour comprising an entire perimeter of the third antenna.

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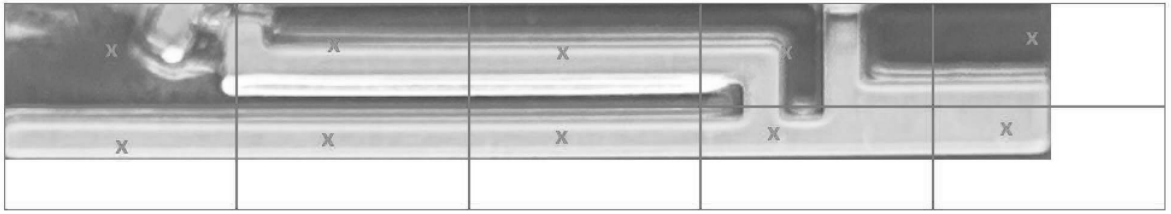
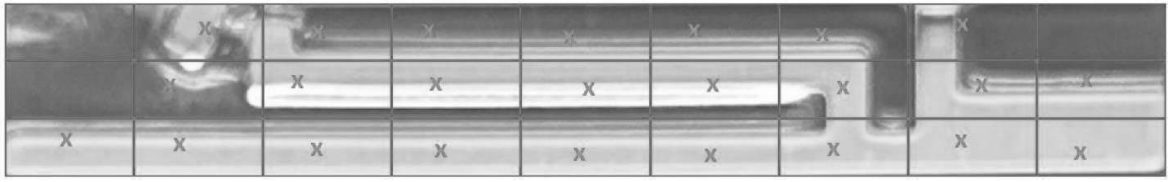
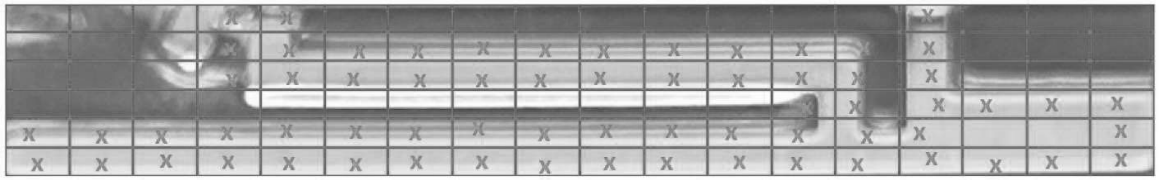
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
5[b]	wherein the antenna contour of the third antenna has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, The complexity factor calculation is performed according to the method in the patent. N1=10  N2=24  N3=67 

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Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		F21=log(24/10)/log(2)=1.26 F32=log(67/24)/log(2)=1.48
5[c]	a complexity factor F_{32} having a value of at least 1.35.	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 5[b].
Claim 6		
6[pre]	A wireless device comprising:	To the extent the preamble is limiting, Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[pre].
6[a]	an antenna system comprising:	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[a].
6[b]	[*the antenna system comprising*] a ground plane;	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[c].

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Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
6[c]	[*the antenna system comprising*] a first antenna within the wireless device and	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[c].
6[d]	configured to support at least two frequency bands contained within first and second frequency ranges of the electromagnetic spectrum,	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[d].
6[e]	the second frequency range being higher in frequency than the first frequency range,	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[e].
6[f]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane and	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[g].
6[g]	defining a first antenna contour comprising an	Lenovo T60 expressly or inherently discloses this claim element.

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Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
	entire perimeter of the first antenna,	*See* Claim 1[h].
6[h]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[i].
6[i]	complexity factor F_{32} having a value less than 1.75; and	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[i].
6[j]	[*the antenna system comprising*] a second antenna within the wireless device and	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[k].
6[k]	defining a second antenna contour comprising an entire perimeter of the second antenna,	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*,

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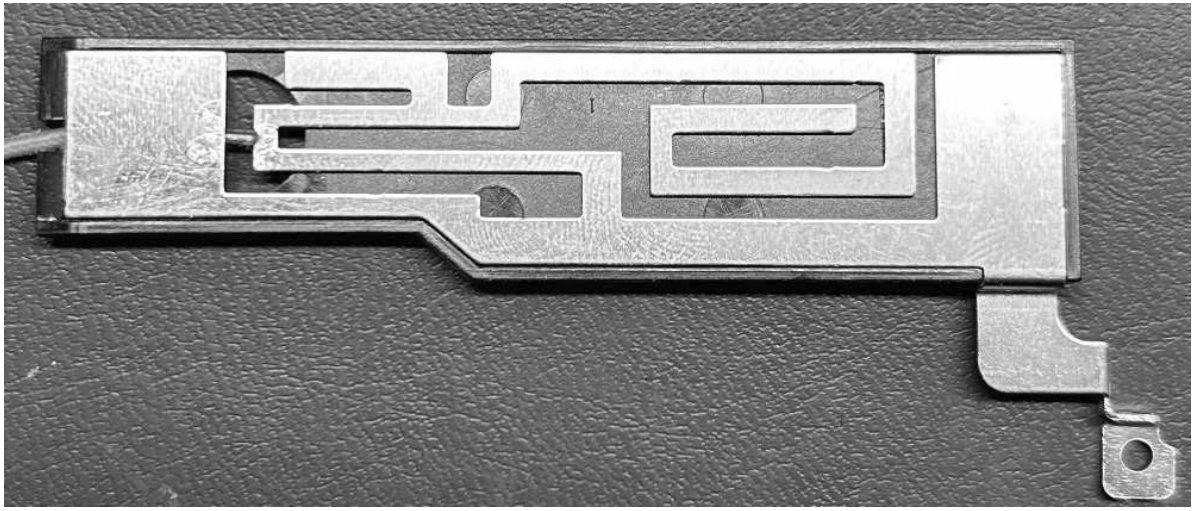
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		The second antenna of the T60 defines a second antenna contour comprising an entire perimeter of the second antenna. 
6[l]	the second antenna being proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle,	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the Lenovo T60 includes a second antenna (pink below) proximate to a second short side of the ground plane rectangle (purple below) that is opposite to the first short side of the ground plane rectangle.

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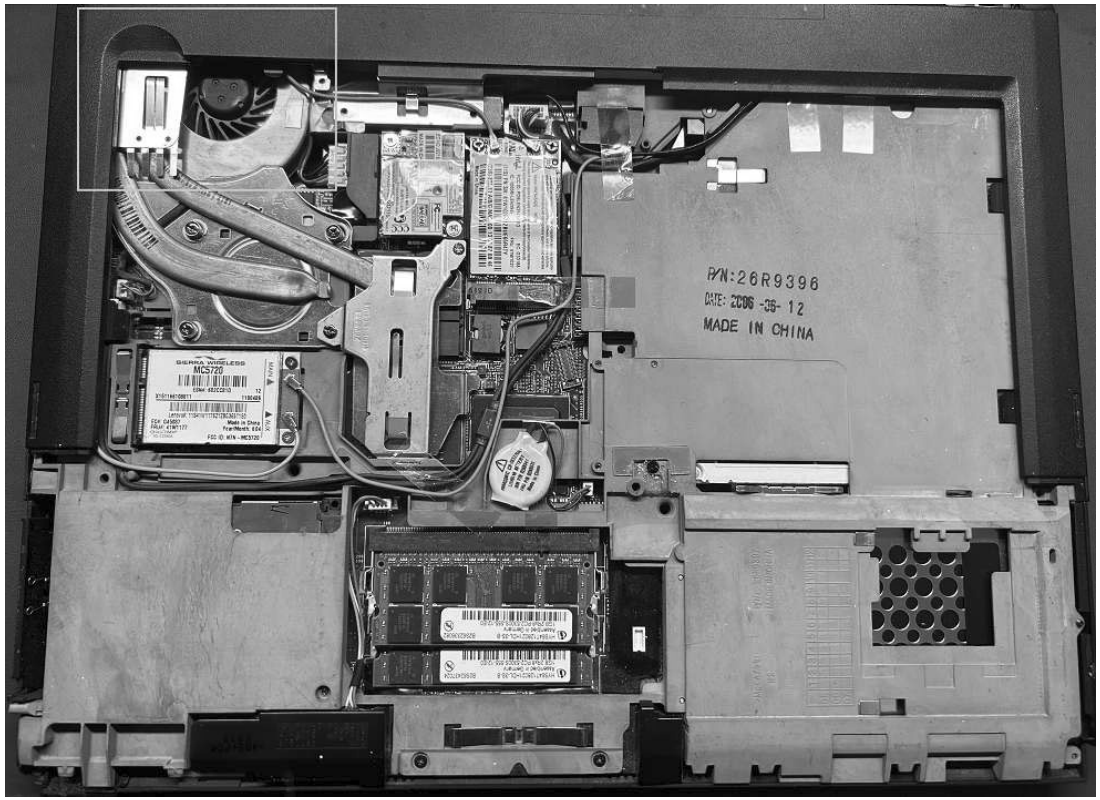
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		

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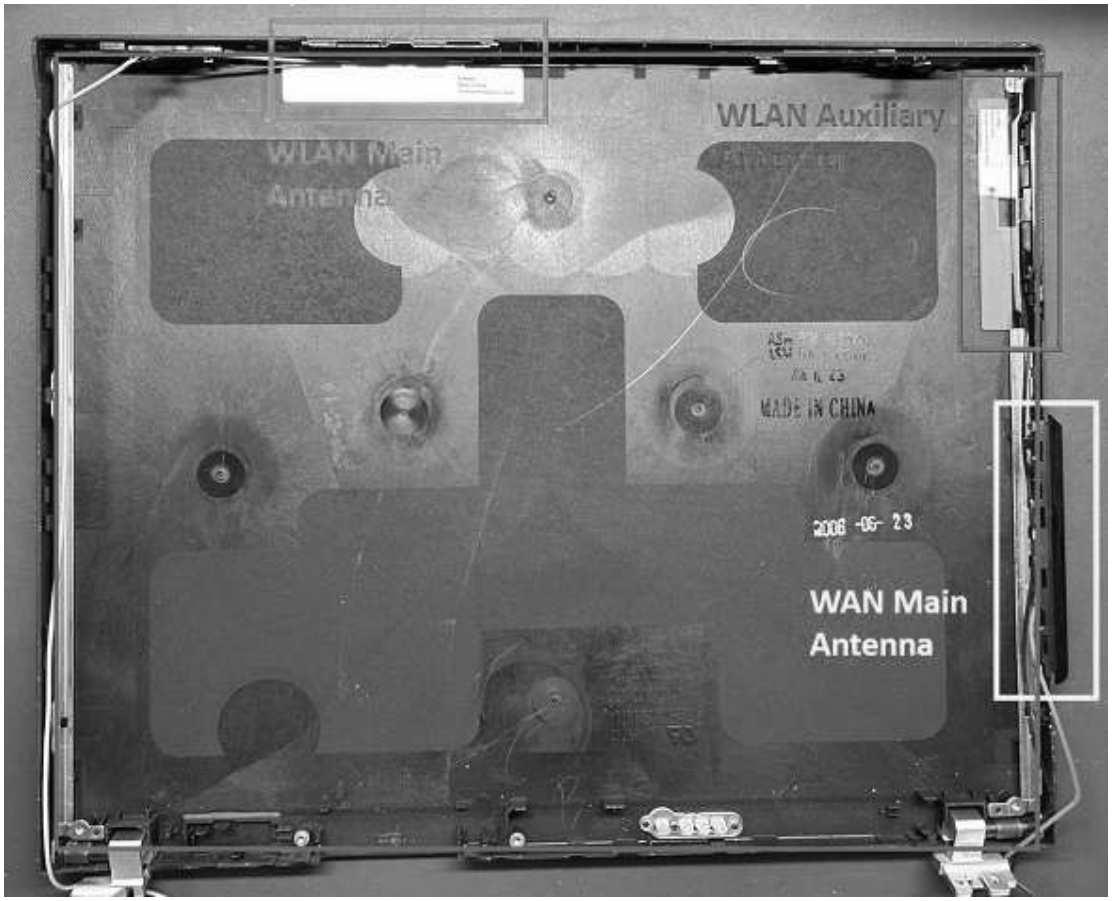
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		

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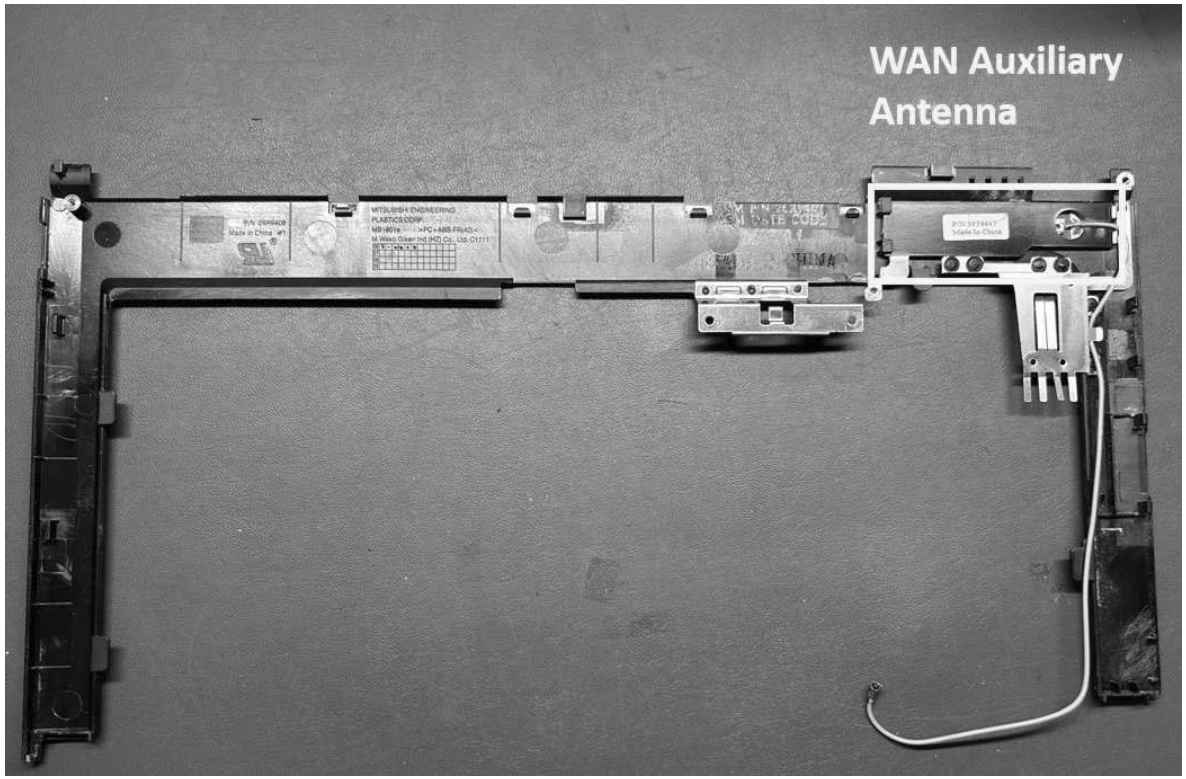
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		

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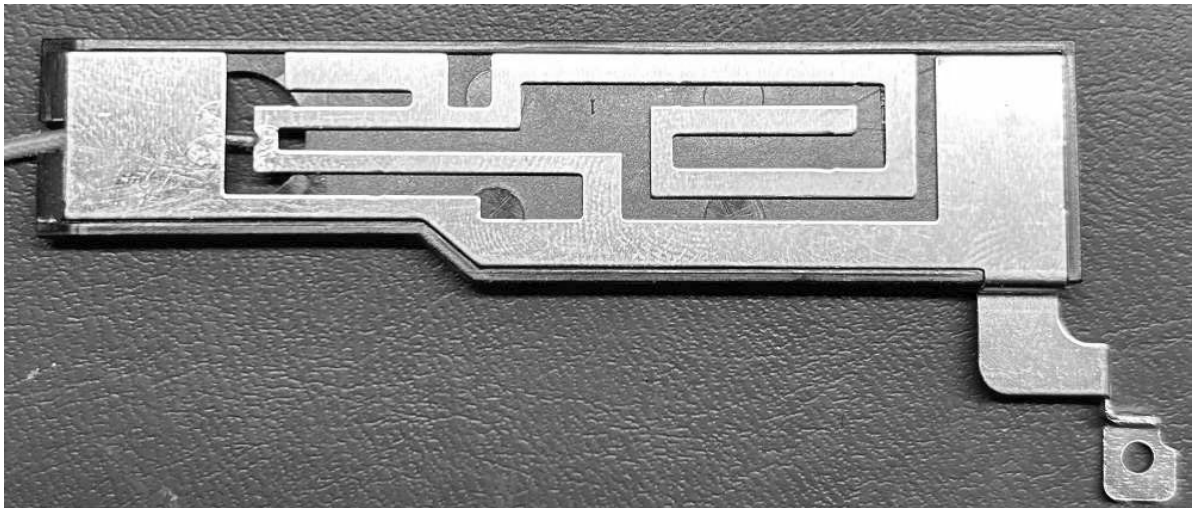
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		
6[m]	a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second antenna defining an antenna box, and	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, The second antenna of the Lenovo T60 defines an antenna box that is a minimum-sized parallelepiped that completely encloses a volume of the second antenna and wherein each face of the minimum-sized parallelepiped is tangent to at least one point of the volume of the second antenna. An orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defines an antenna rectangle (purple below).

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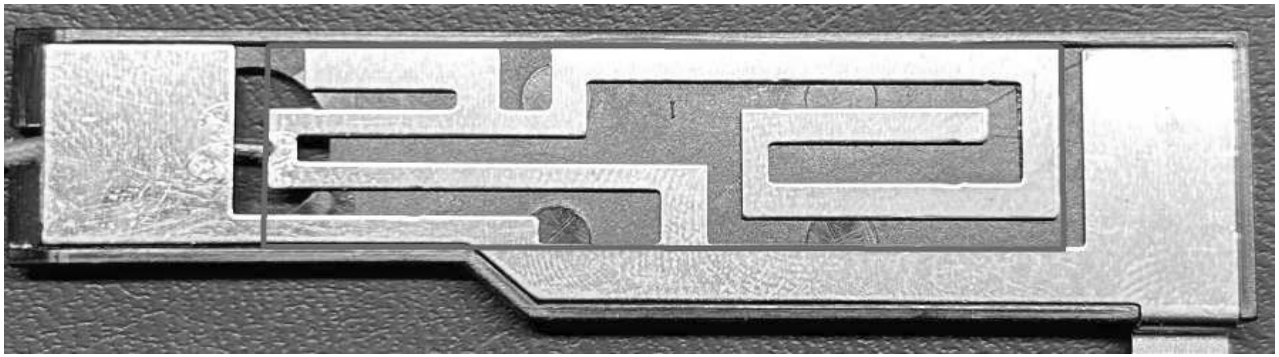
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		
6[n]	an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 6[m].
6[o]	an antenna rectangle,	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 6[m].
6[p]	wherein a length of the second antenna contour is greater than four	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*,

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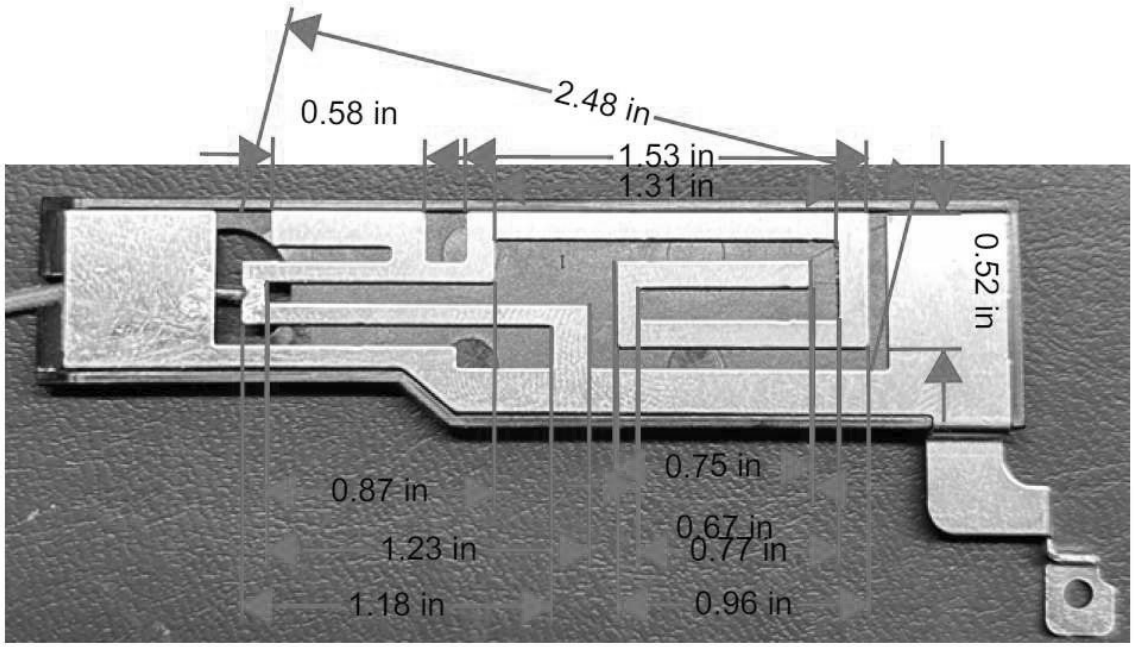
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
	times a diagonal of the antenna rectangle.	The second antenna of the Lenovo T60 defines a second contour comprising an entire perimeter of the second antenna, wherein a length of the second antenna contour is greater than four times a diagonal of the antenna rectangle. 
	Claim 9	
9[a]	The wireless device of claim 6, wherein the second antenna contour	Lenovo T60 expressly or inherently discloses this claim element.

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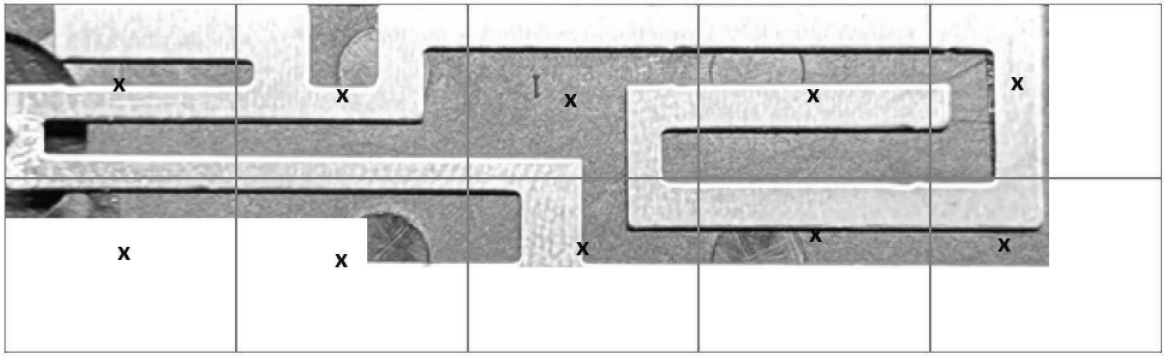
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
	has a level of complexity defined by complexity factor F_{21} having a value of at least 1.2 and	*See, e.g.*, The complexity factor calculation is performed according to the method in the patent. The antenna contour has a level of complexity defined by complexity factor F21 having a value of at least 1.20 and complexity factor F32 having a value of at least 1.35. N1=10  N2=27

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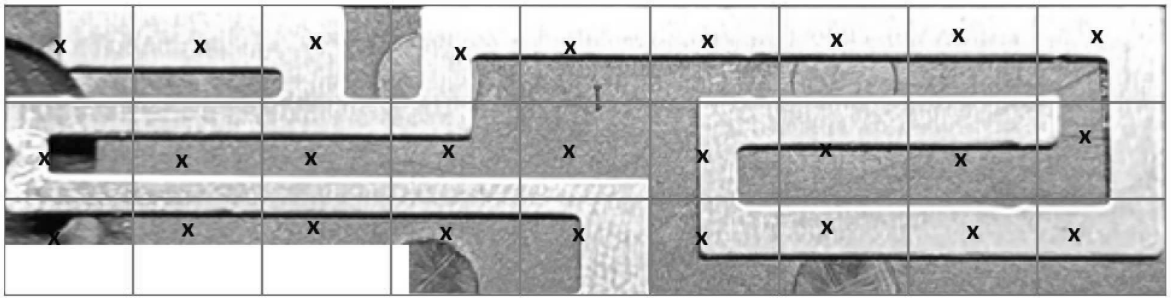
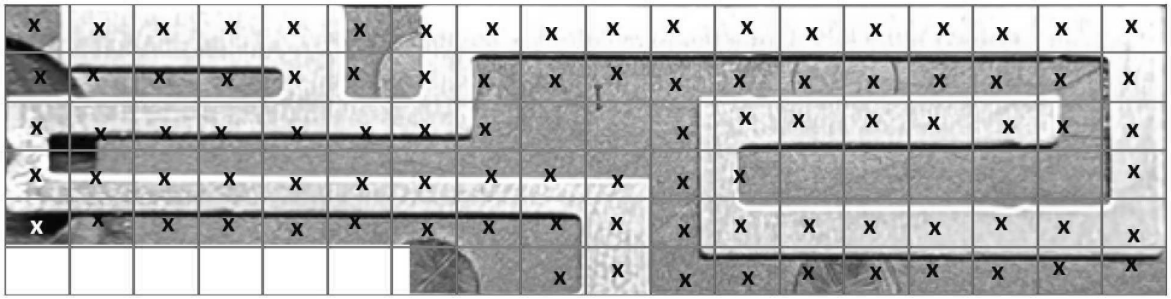
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		 N3=93  F21=log(27/10)/log(2)=1.43 F32=log(93/27)/log(2)=1.78
9[b]	a complexity factor F_{32} having a value of at least 1.35.	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 9[a].

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Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
Claim 12		
12[pre]	A wireless device comprising:	To the extent the preamble is limiting, Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[pre].
12[a]	an antenna system comprising:	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[a].
12[b]	[*the antenna system comprising*] a ground plane;	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[a].
12[c]	[*the antenna system comprising*] a first antenna within the wireless device and	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[c].
12[d]	configured to provide operation in at least four frequency bands,	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the Lenovo T60 is configured to provide operation in at least four frequency bands.

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Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		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. Source: https://support.lenovo.com/us/en/solutions/pd008795-detailed-specifications-thinkpad-t60-t60p The first antenna is configured to provide operation in at least four frequency bands contained within 824-894 MHz and 1710-2170 MHz. *See* Claim 1[d].
12[e]	at least one of the at least four frequency bands is contained within a first frequency range and	Lenovo T60 expressly or inherently discloses this claim element. *See* Claims 1[d], 12[d].
12[f]	at least one other of the four frequency bands is contained within a second frequency range,	Lenovo T60 expressly or inherently discloses this claim element. *See* Claims 1[d], 12[d].

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Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
12[g]	the first frequency range being lower in frequency than the second frequency range,	Lenovo T60 expressly or inherently discloses this claim element. *See* Claims 1[d], 12[d].
12[h]	the first antenna being proximate to a first short side of a ground plane rectangle enclosing the ground plane,	Lenovo T60 expressly or inherently discloses this claim element. *See* Claims 1[c], 1[g], 6[f], 6[l].
12[i]	the first antenna defining a first antenna contour comprising an entire perimeter of the first antenna, and	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[h].
12[j]	wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 1[i].

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Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
12[k]	complexity factor F_{32} having a value less than 1.75; and	Lenovo T60 expressly or inherently discloses this claim element. *See* Claims 1[i]-[k].
12[l]	wherein the first antenna is configured to transmit and receive signals from a 4G communication standard; and	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 12[d].
12[m]	[*the antenna system comprising*] a second antenna within the wireless device and configured to receive signals from a 4G communication standard,	Lenovo T60 expressly or inherently discloses this claim element. *See* Claims 1[k]-1[l] The antenna system of the T60 includes a second antenna (green below) within the D820 and configured to receive signals from a 4G communication standard. The second antenna of the Lenovo T60 is configured to receive signals within at least 880-960 MHz and 1850-1990 MHz.

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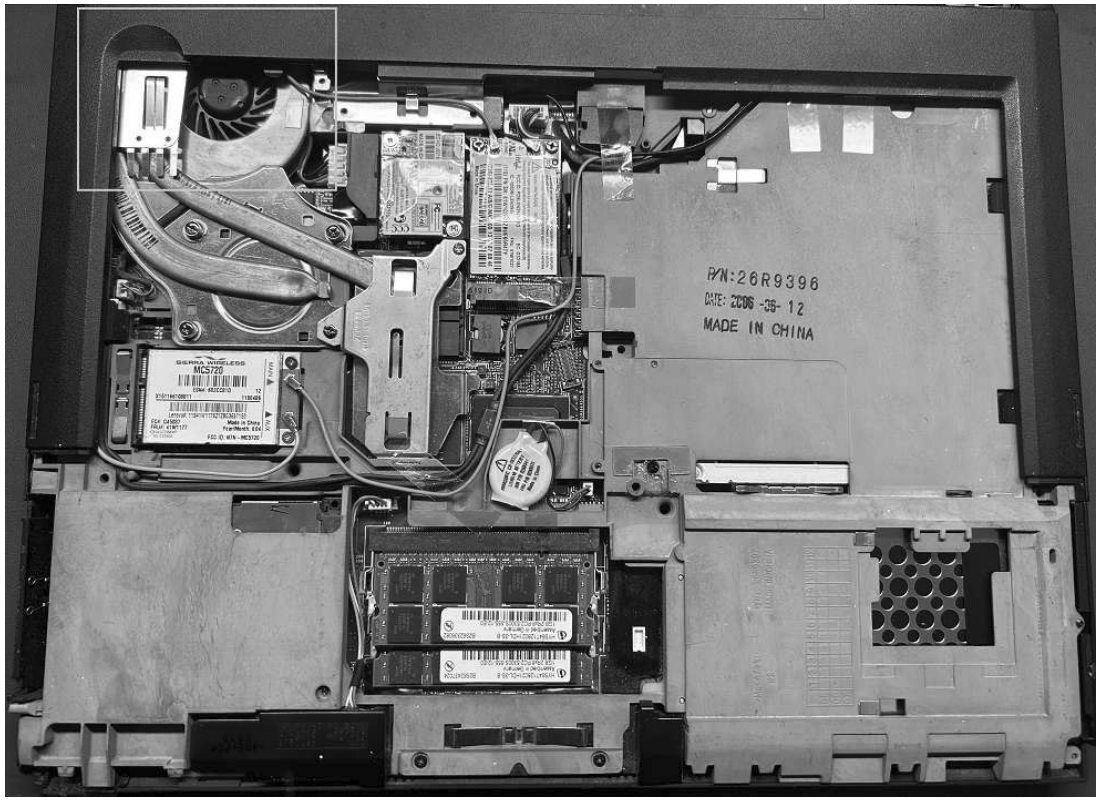
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		
12[n]	a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the second	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 6[m].

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Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
	antenna defining an antenna box,	
12[o]	an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 6[n].
12[p]	an antenna rectangle,	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 6[o].
12[q]	an aspect ratio of the antenna rectangle being defined as a ratio between a width and a height of the antenna rectangle, and wherein the aspect ratio has a value of at least 2.	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, An aspect ratio of the antenna rectangle being defined as a ratio between a width and a height of the antenna rectangle, and wherein the aspect ratio has a value of at least 2.

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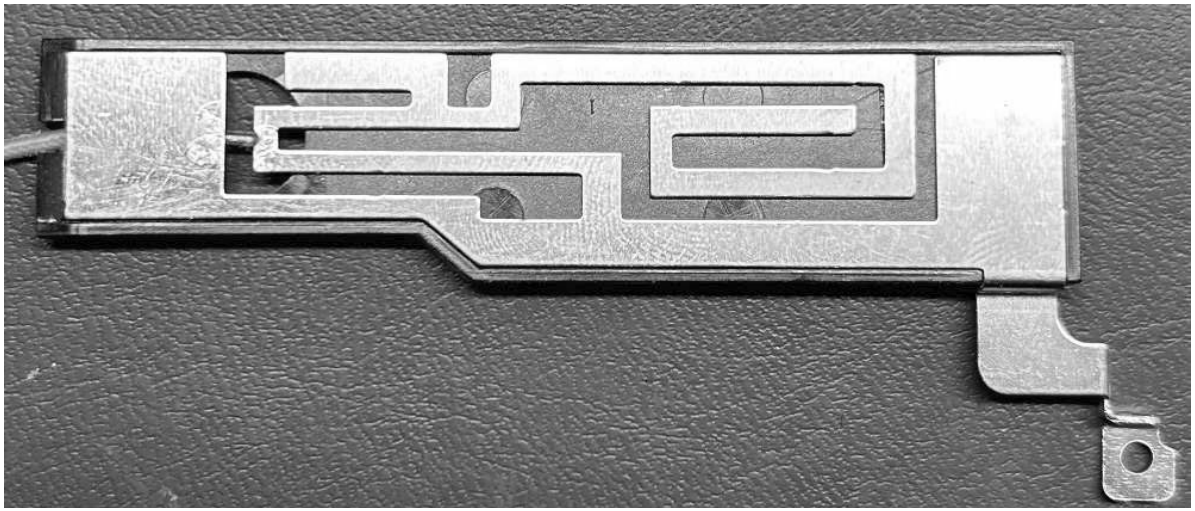
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		 A width of the antenna rectangle is at least twice a height of the antenna rectangle.
		Claim 15
15	The wireless device of claim 12, wherein the second antenna is proximate to a second short side of the ground plane rectangle that is opposite to the first short side of the ground plane rectangle.	Lenovo T60 expressly or inherently discloses this claim element. *See* Claims 1[c], 1[g], 6[f], 6[l].

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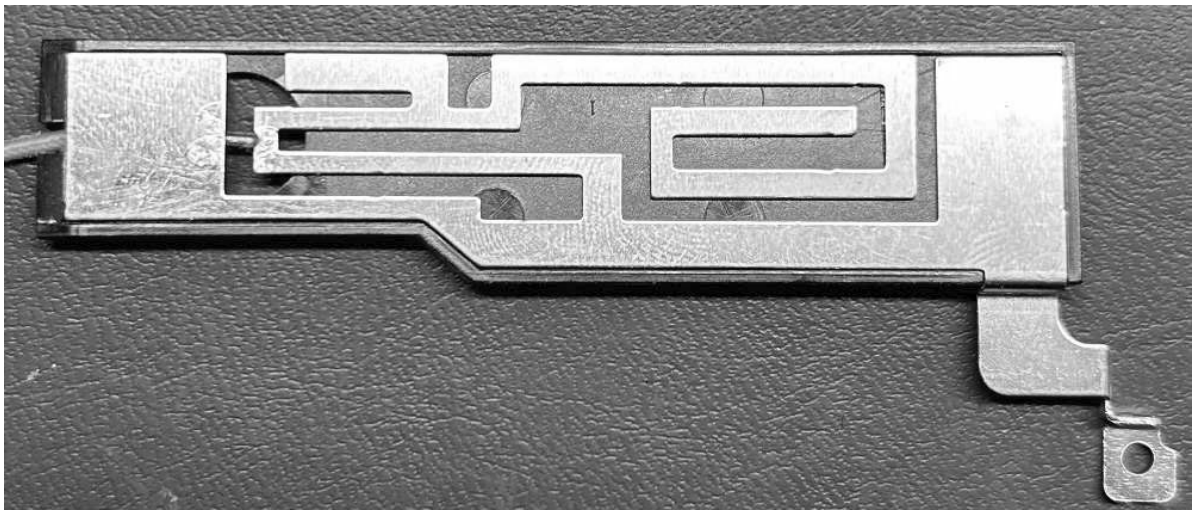
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		Claim 16
16[a]	The wireless device of claim 12, wherein the second antenna defines a second antenna contour comprising an entire perimeter of the second antenna,	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, The second antenna defines a second antenna contour comprising an entire perimeter of the second antenna. 
16[b]	and wherein the second antenna contour has a level of complexity defined by complexity	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*,

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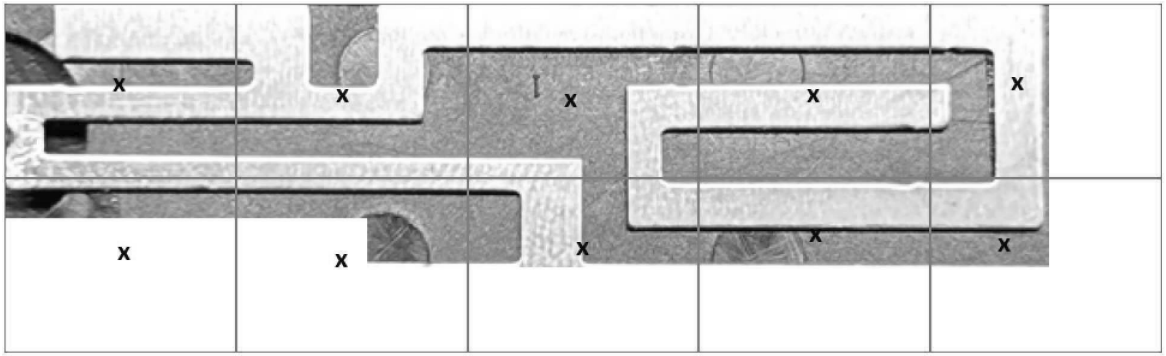
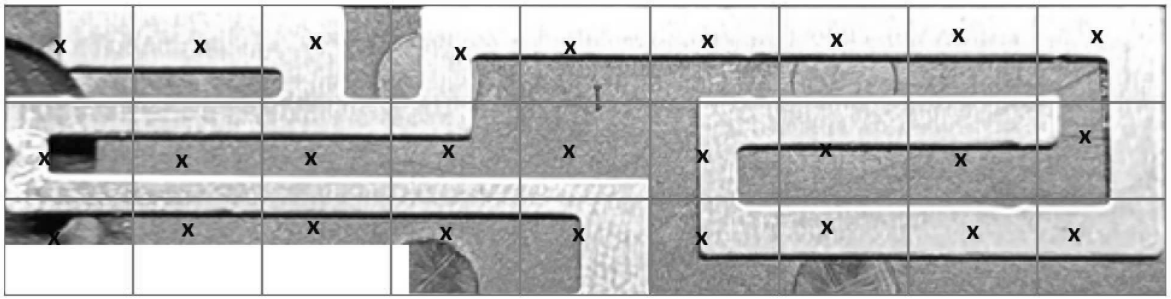
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
	factor F_{21} having a value of at least 1.2 and	The antenna contour has a level of complexity defined by complexity factor F21 having a value of at least 1.20 and complexity factor F32 having a value of at least 1.35. N1=10  N2=27  N3=93

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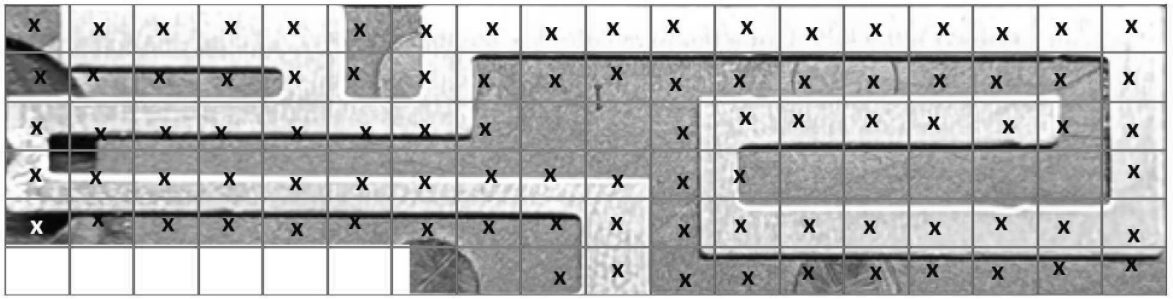
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		 F21=log(27/10)/log(2)=1.43 F32=log(93/27)/log(2)=1.78
16[c]	a complexity factor F_{32} having a value of at least 1.35.	Lenovo T60 expressly or inherently discloses this claim element. *See* Claim 16[b]
Claim 17		
17	The wireless device of claim 16, wherein the second antenna contour comprises at least 20 segments.	Lenovo T60 expressly or inherently discloses this claim element. *See, e.g.*, The second antenna contour includes at least 27 segments.

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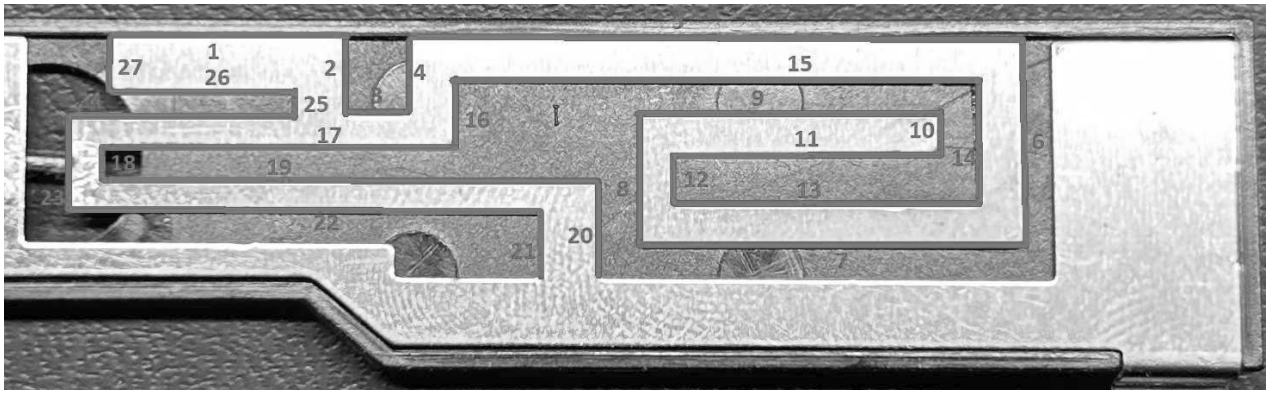
Claim No.	U.S. Patent No. 11,031,677 B2	Lenovo T60
		

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