

SmartWitness AP1

Infringement where the main antenna is
considered the first antenna

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1

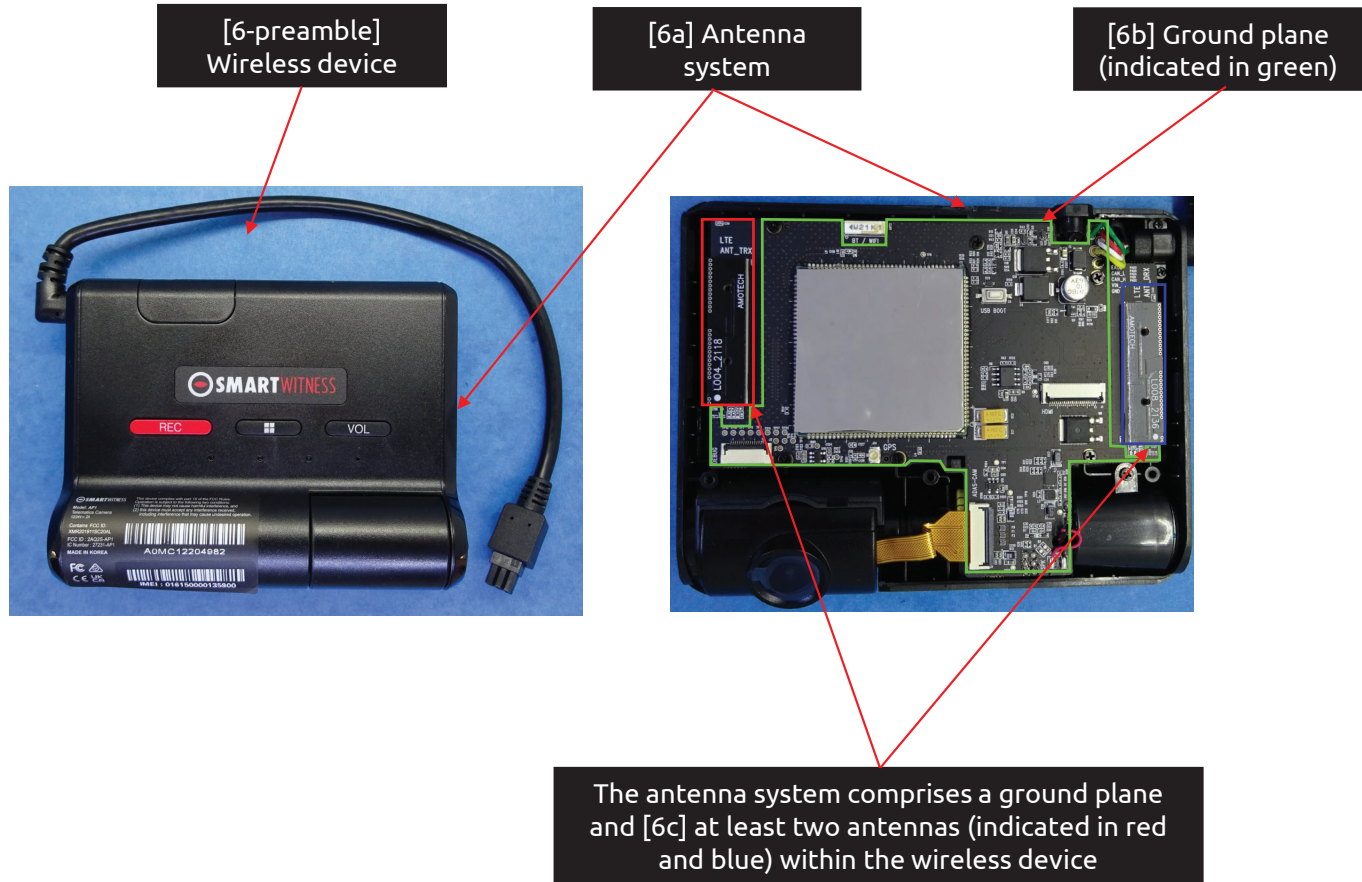
Geotab Exhibit 1056
Geotab v. Fractus

~~CONFIDENTIAL - PROTECTIVE ORDER MATERIAL~~

US 11,349,200 - SmartWitness AP1

Claim 6

[6-preamble] A wireless device comprising [6a] an antenna system comprising [6b] a ground plane and [6c] at least two antennas within the wireless device, the antenna system comprising:

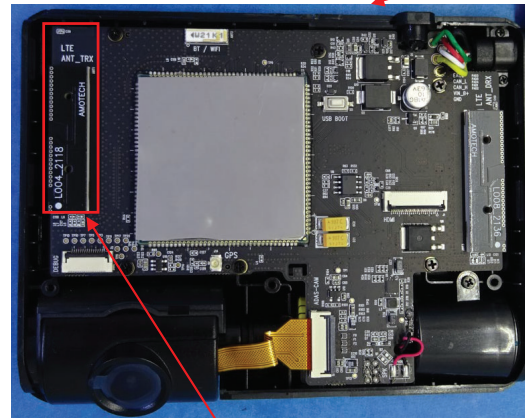


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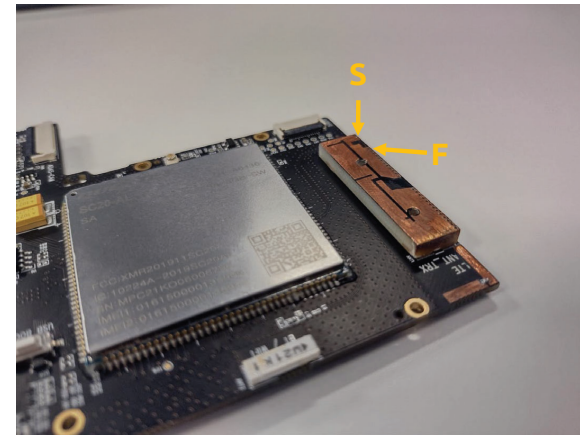
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Claim 6

[6d] a first antenna configured to provide operation in at least four frequency bands being used by 4G communication standards, wherein



Antenna system



[6d] The antenna system comprises a first antenna (indicated in red) configured to provide operation in at least LTE 700(B12)/850(B5)/1700-2100(B4)/1900(B2)

Communications

Antenna	LTE Main, LTE DRX, GNSS, Wi-Fi/BT
US	LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26
	3G Bands: B1, B2, B5, B8
Wireless	EMEA
	LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A
	3G Bands: B1, B2, B5, B8
	Wi-Fi: IEEE 802.11a/b/g/n
	Bluetooth: BT4.2 (BR/EDR+BLE)

Source: device datasheet

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Claim 6

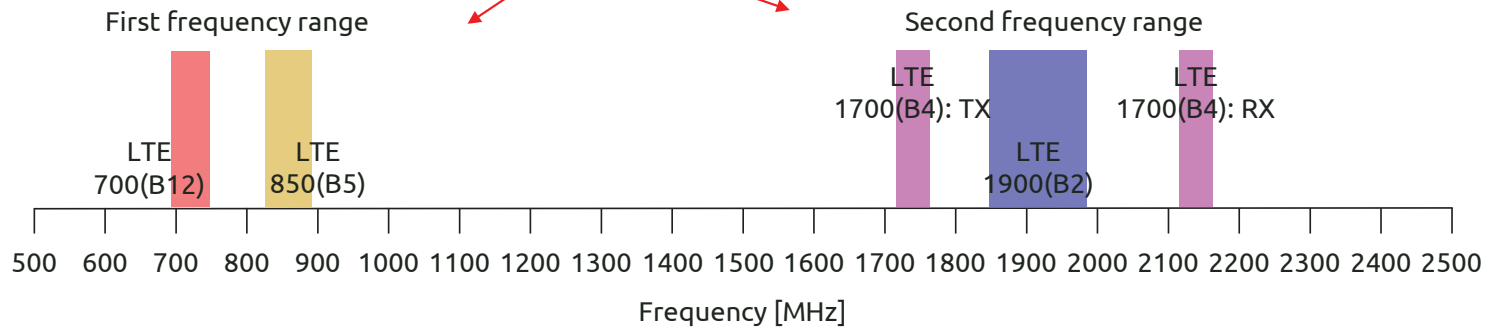
[6e] at least two of the at least four frequency bands are contained within a first frequency range and [6f] at least two of the at least four frequency bands are contained within a second frequency range (filled in blue) and [6f] at least two of the at least four frequency bands are contained within a second frequency range (filled in blue) and [6g] the first frequency range being lower in frequency than the second frequency range,

[6e] At least two of the at least four frequency bands are contained within a first frequency range (filled in red) and [6f] at least two of the at least four frequency bands are contained within a second frequency range (filled in blue)

Communications	
Antenna	LTE Main, LTE DRX, GNSS, Wi-Fi/BT
US	LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26 3G Bands: B1, B2, B5, B8
EMEA	LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A 3G Bands: B1, B2, B5, B8
Wi-Fi	IEEE 802.11a/b/g/n
Bluetooth	BT4.2 (BR/EDR+BLE)

Source: device datasheet

[6g] The first frequency range being lower in frequency than the second frequency range

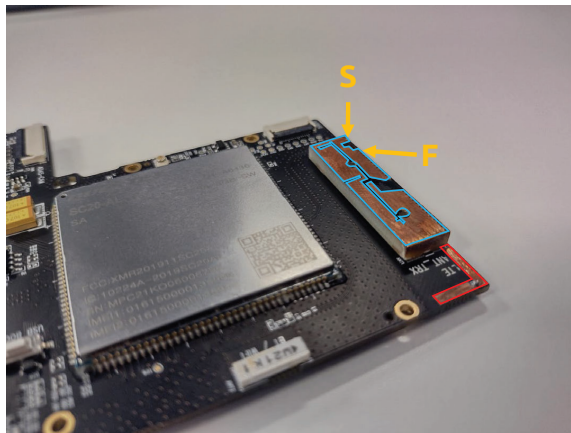


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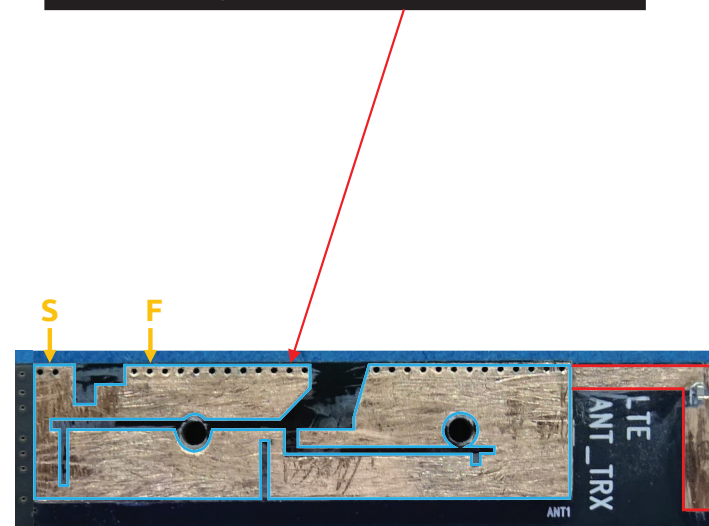
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Claim 6

[6h] the first antenna defining a first antenna contour comprising an entire perimeter of the first antenna, and



[6h] The first antenna defines a first antenna contour (indicated in blue and red) comprising an entire perimeter of the first antenna



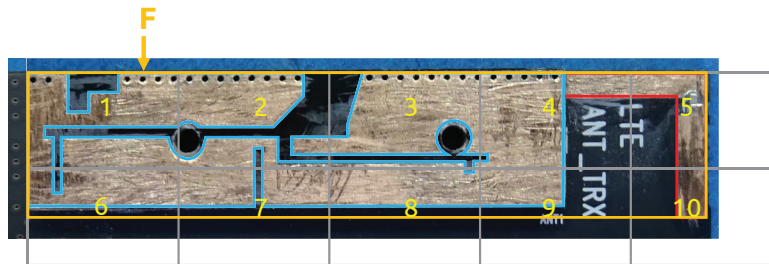
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Claim 6

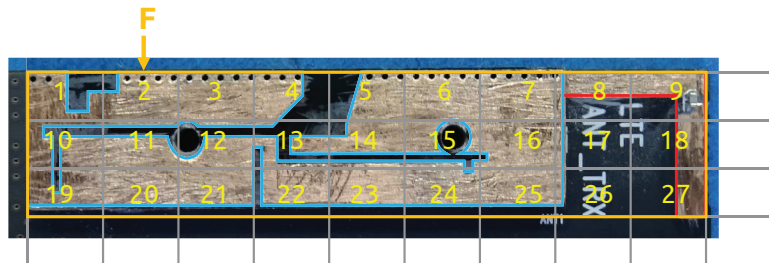
[6i] wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and

[6i] The first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20



$N_1 = 10$ cells

$$F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log\left(\frac{1}{2}\right)} = \frac{\log(27/10)}{\log(2)} = 1.43 \geq 1.20$$



$N_2 = 27$ cells

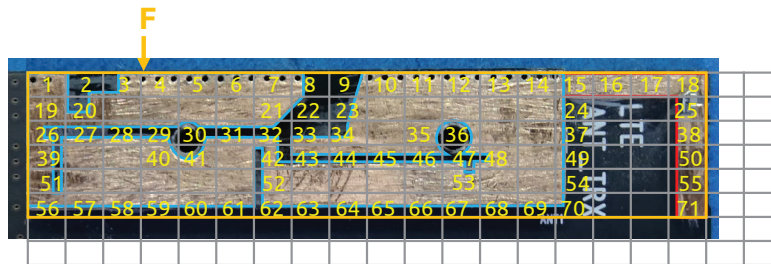
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Claim 6

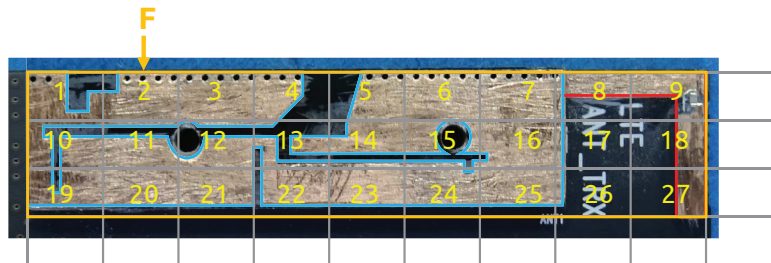
[6j] complexity factor F_{32} having a value of at least 1.35; and

[6j] The first antenna contour has a level of complexity defined by complexity factor F_{32} having a value of at least 1.35



$N_3 = 71 \text{ cells}$

$$F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log\left(\frac{1}{2}\right)} = \frac{\log(71/27)}{\log(2)} = 1.39 \geq 1.35$$



$N_2 = 27 \text{ cells}$

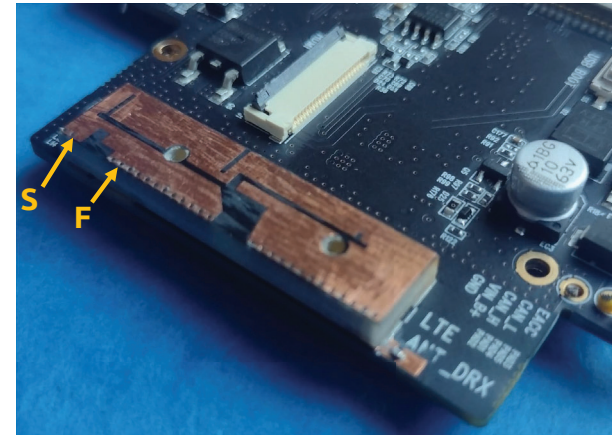
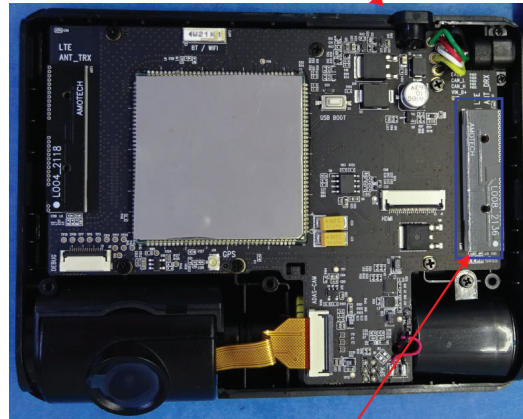
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Claim 6

[6k] a second antenna configured to operate in at least one frequency band being used by a 4G communication standard,

Antenna system



[6k] The antenna system comprises a second antenna (indicated in blue) configured to operate in at least LTE 700(B12)

Communications

Antenna	LTE Main, LTE DRX, GNSS, Wi-Fi/BT
US	LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26
	3G Bands: B1, B2, B5, B8
EMEA	LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A
	3G Bands: B1, B2, B5, B8
Wireless	Wi-Fi: IEEE 802.11a/b/g/n
	Bluetooth: BT4.2 (BR/EDR+BLE)

Source: device datasheet

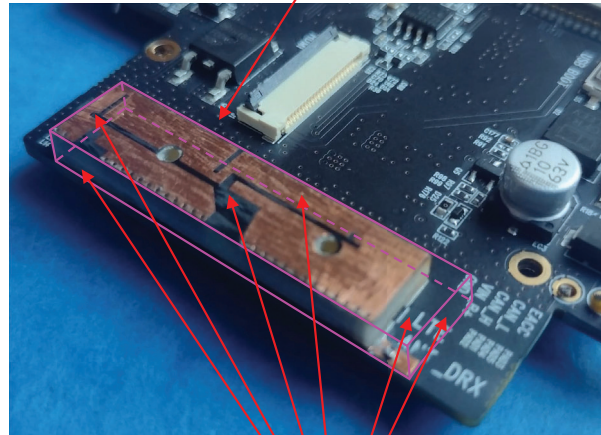
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Claim 6

[6l] the second antenna defining an antenna box that is a minimum-sized parallelepiped that completely encloses a volume of the second antenna and [6m] wherein each face of the minimum-sized parallelepiped is tangent to at least one point of the volume of the second antenna,

[6l] The second antenna defines an antenna box (outlined in pink) that is a minimum-sized parallelepiped that completely encloses a volume of the second antenna



[6m] Each face of the minimum-sized parallelepiped is tangent to at least one point of the volume of the second antenna

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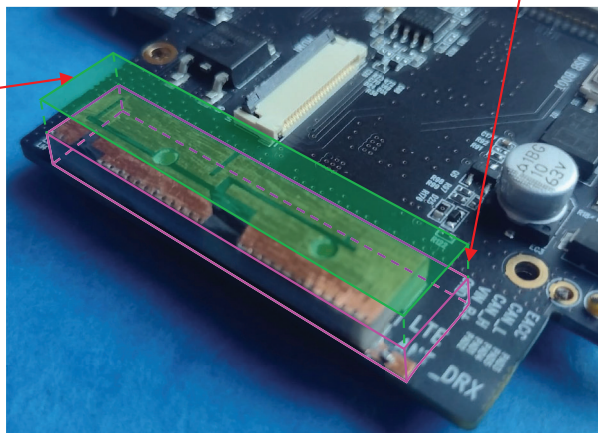
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Claim 6

[6n] an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining [6o] an antenna rectangle,

[6o] Antenna rectangle (filled in green)

[6n] An orthogonal projection of the antenna box along a normal to a face* with a largest area of the second antenna



*Normal to a face means perpendicular to the face

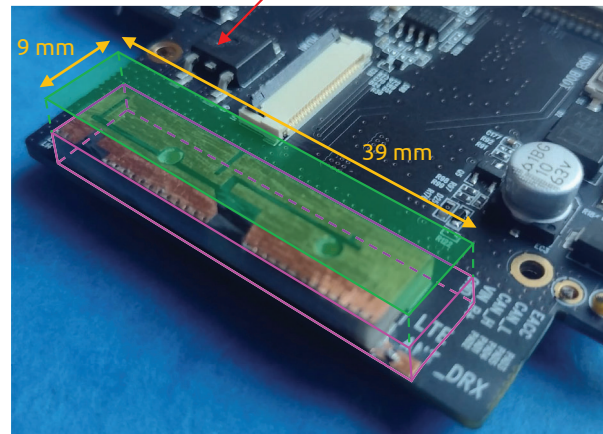
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Claim 6

[6p] 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, and

[6p] 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 $39/9 = 4.33 \geq 2$



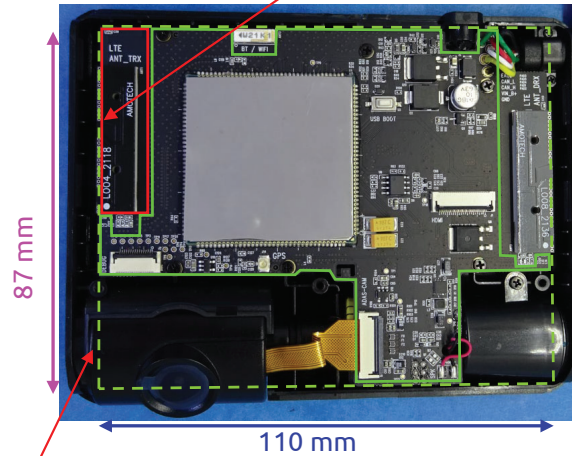
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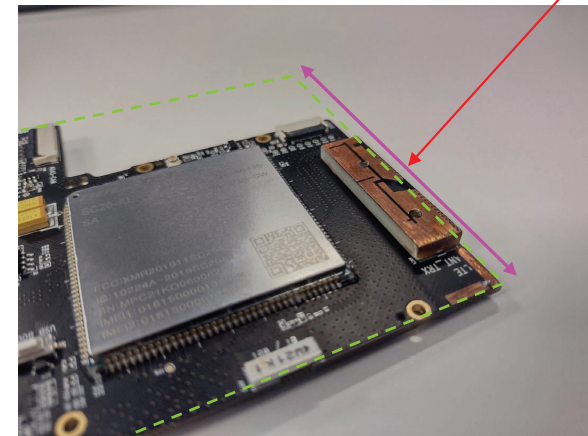
Claim 6

[6q] wherein at least one of the first and second antennas is close to a first short side of a ground plane rectangle enclosing the ground plane.

[6q] At least the first antenna is close to a first short side of a ground plane rectangle (indicated with a dashed green line) enclosing the ground plane



First short side (indicated in pink)



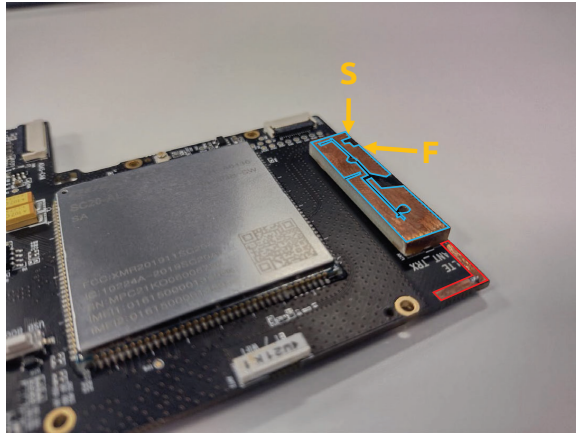
First short side (indicated in pink)

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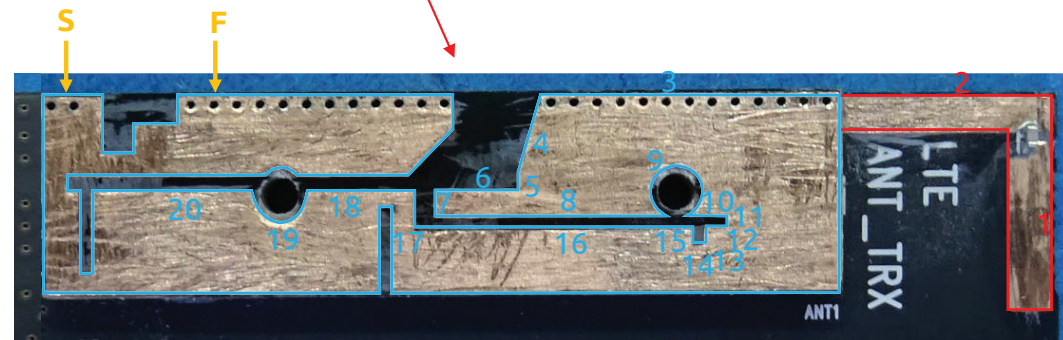
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Claim 7

[7a] The wireless device of claim 6, wherein the first antenna contour comprises at least 20 segments.



[7a] The first antenna contour (indicated in blue and red) comprises at least 20 segments



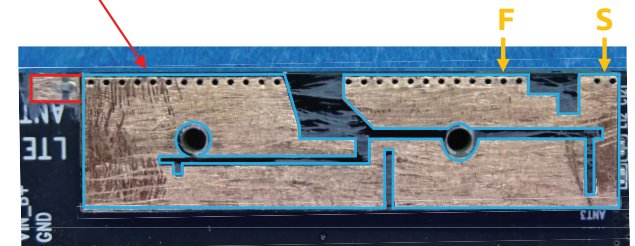
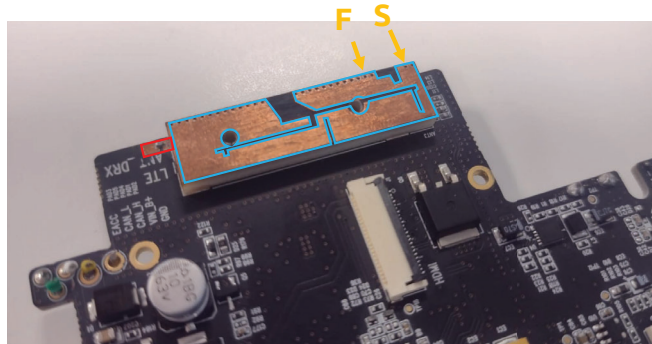
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Claim 9

[9a] The wireless device of claim 6, wherein the second antenna defines a second antenna contour comprising an entire perimeter of the second antenna,

[9a] The second antenna defines a second antenna contour (indicated in blue and red) comprising an entire perimeter of the second antenna

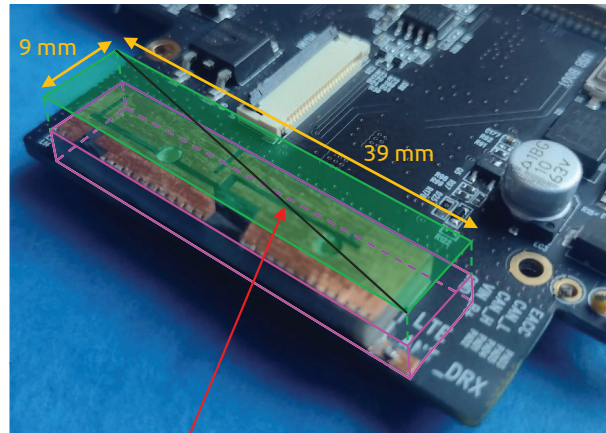


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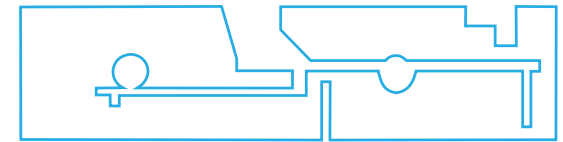
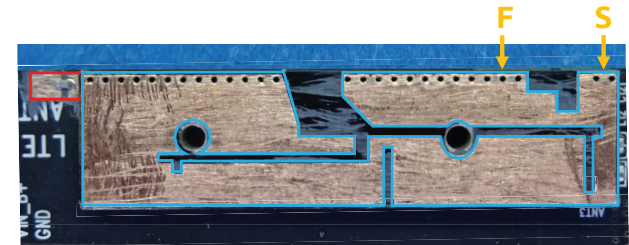
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Claim 9

[9b] wherein a length of the second antenna contour is greater than four times a diagonal of the antenna rectangle.



Diagonal of the antenna rectangle = 40.02 mm



182.3 mm

9.6 mm

Length of the second antenna contour = $(182.3 + 9.6) = 191.9$ mm

[9b] The length of the second antenna contour (191.9 mm) > 4*Diagonal of the antenna rectangle (4*40.02 = 160.08 mm)

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Claim 10

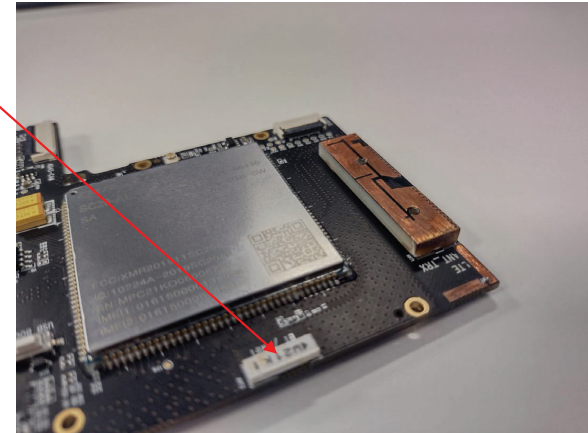
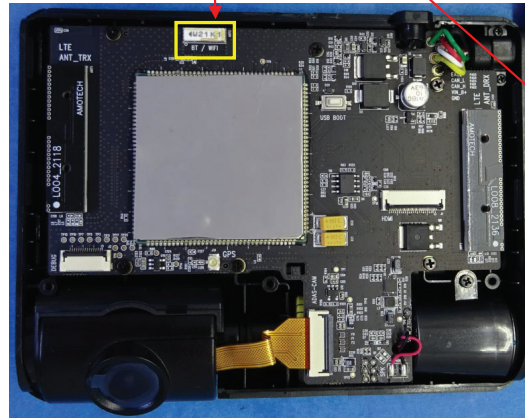
[10a] The wireless device of claim 6, wherein the antenna system comprises a third antenna configured to provide operation in a wireless communication standard.

[10a] The antenna system comprises a third antenna (indicated in yellow) configured to provide operation in at least a wireless communication standard: WiFi

Communications

Antenna	LTE Main, LTE DRX, GNSS, WiFi/BT
	US LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26 3G Bands: B1, B2, B5, B8
	EMEA LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A 3G Bands: B1, B2, B5, B8
Wireless	Wi-Fi: IEEE 802.11a/b/g/n
	Bluetooth: BT4.2 (BR/EDR+BLE)

Source: device datasheet

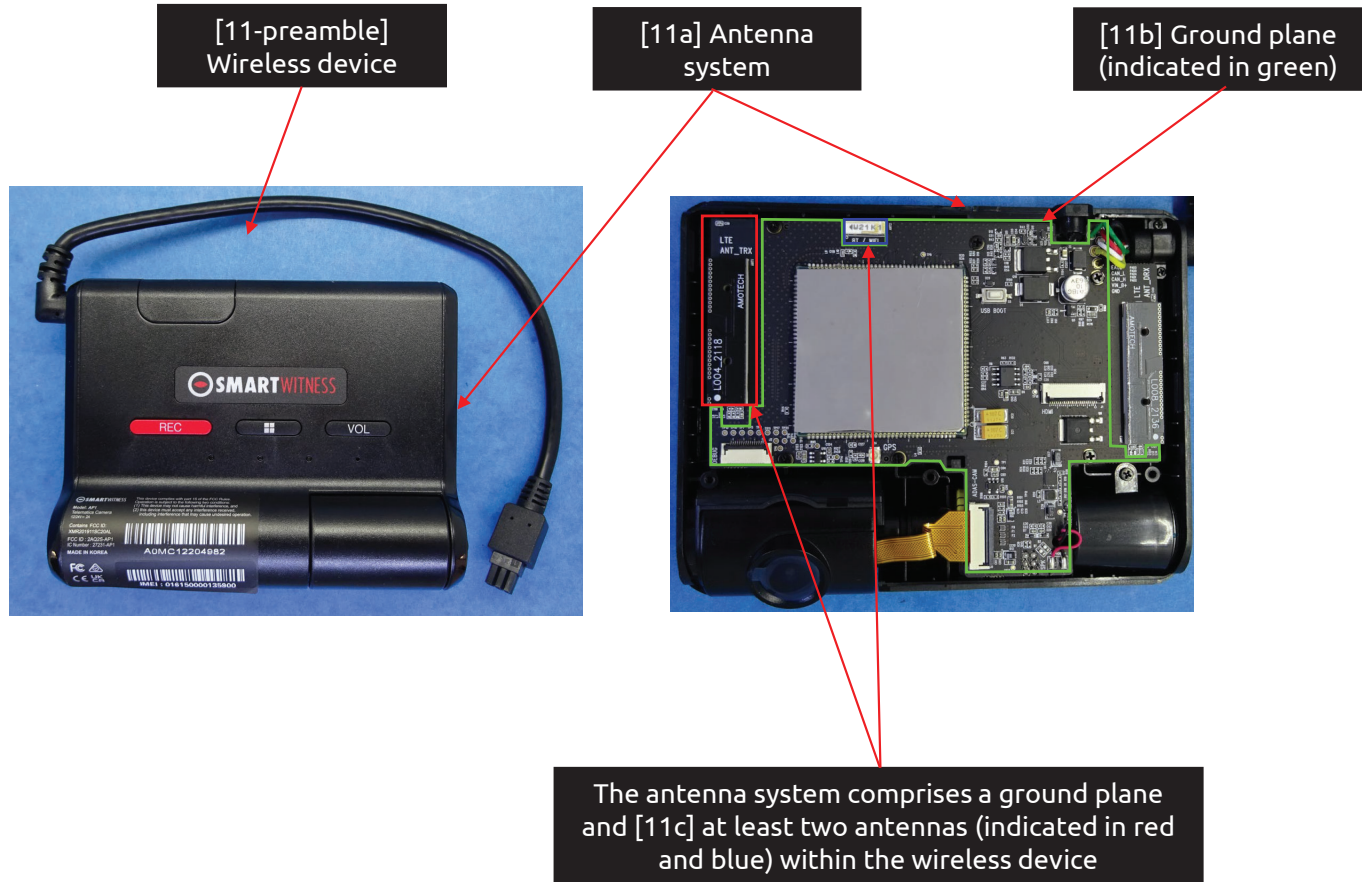


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Claim 11

[11-preamble] A wireless device comprising:
[11a] an antenna system comprising
[11b] a ground plane and
[11c] at least two antennas within the wireless device, the antenna system comprising:



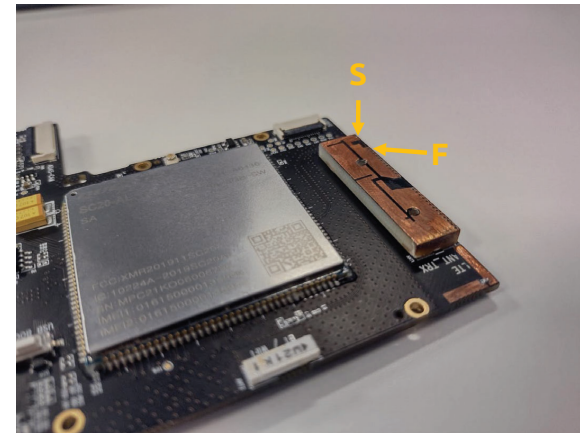
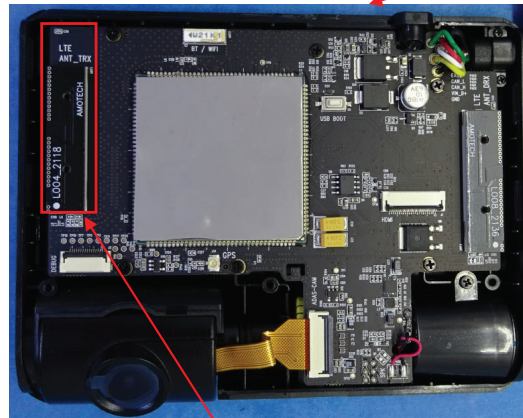
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Claim 11

[11d] a first antenna configured to provide operation in at least three frequency bands being used by 4G communication standards,

Antenna system



[11d] The antenna system comprises a first antenna (indicated in red) configured to provide operation in at least LTE 700(B12)/1700-2100(B4)/1900(B2)

Communications

Antenna	LTE Main, LTE DRX, GNSS, Wi-Fi/BT
US	LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26
	3G Bands: B1, B2, B5, B8
Wireless	EMEA
	LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A
	3G Bands: B1, B2, B5, B8
	Wi-Fi: IEEE 802.11a/b/g/n
	Bluetooth: BT4.2 (BR/EDR+BLE)

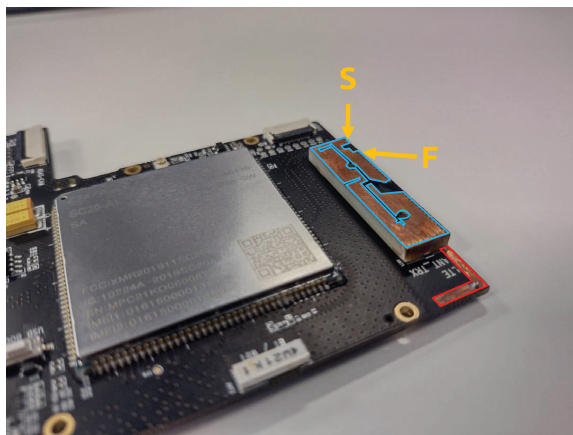
Source: device datasheet

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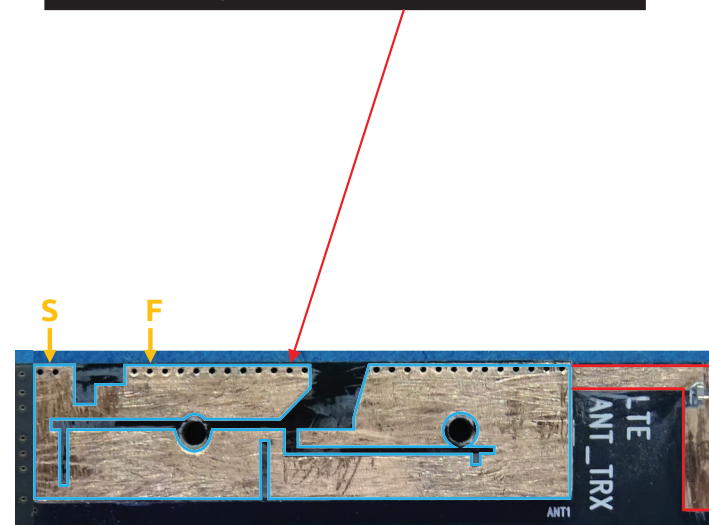
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Claim 11

[11e] the first antenna defining an antenna contour comprising an entire perimeter of the first antenna,



[11e] The first antenna defines a first antenna contour (indicated in blue and red) comprising an entire perimeter of the first antenna

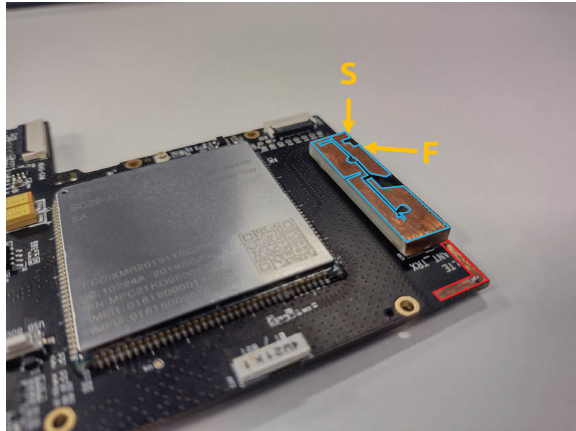


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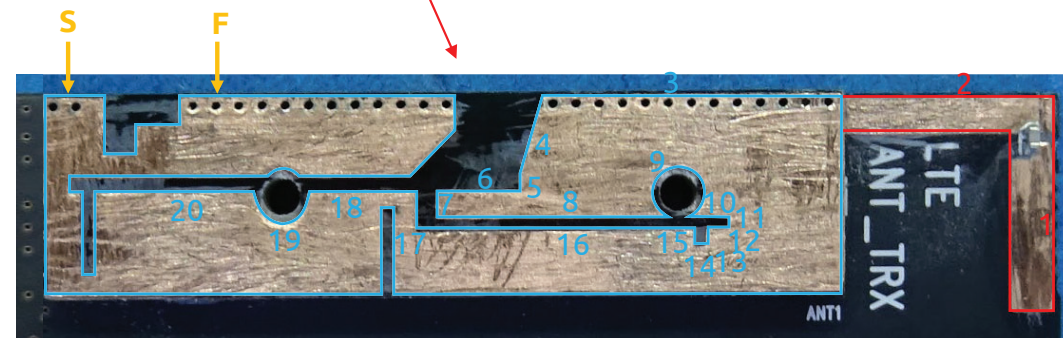
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Claim 11

[11f] the antenna contour comprising at least twenty segments,



[11f] The first antenna contour (indicated in blue and red) comprises at least 20 segments



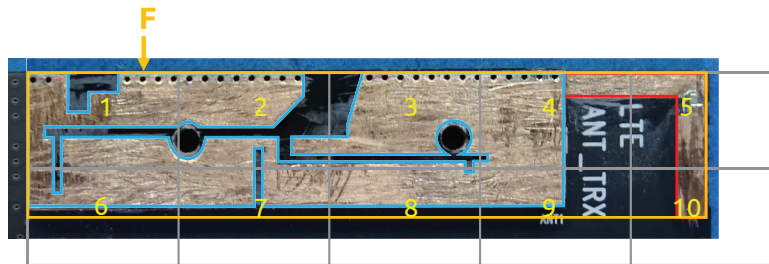
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Claim 11

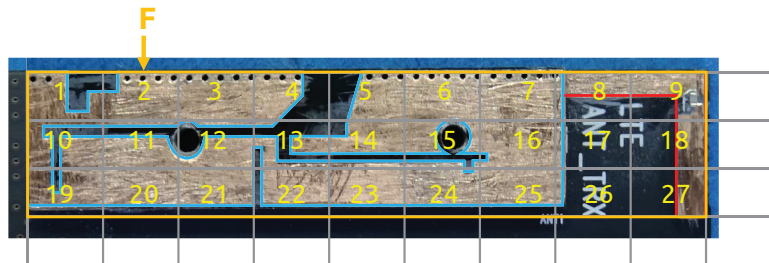
[11g] wherein the antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and

[11g] The first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20



$N_1 = 10 \text{ cells}$

$$F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log\left(\frac{1}{2}\right)} = \frac{\log(27/10)}{\log(2)} = 1.43 \geq 1.20$$



$N_2 = 27 \text{ cells}$

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Claim 11

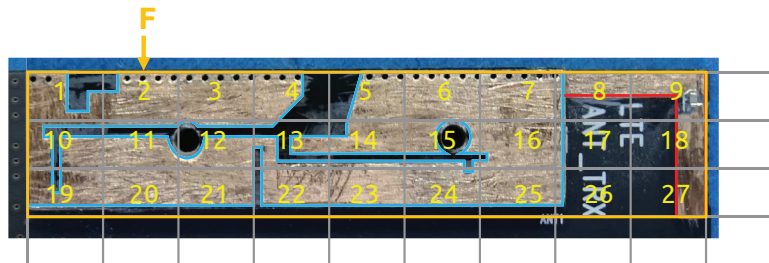
[11h] complexity factor F_{32} having a value of at least 1.35, and

[11h] The first antenna contour has a level of complexity defined by complexity factor F_{32} having a value of at least 1.35



$N_3 = 71$ cells

$$F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log\left(\frac{1}{2}\right)} = \frac{\log(71/27)}{\log(2)} = 1.39 \geq 1.35$$



$N_2 = 27$ cells

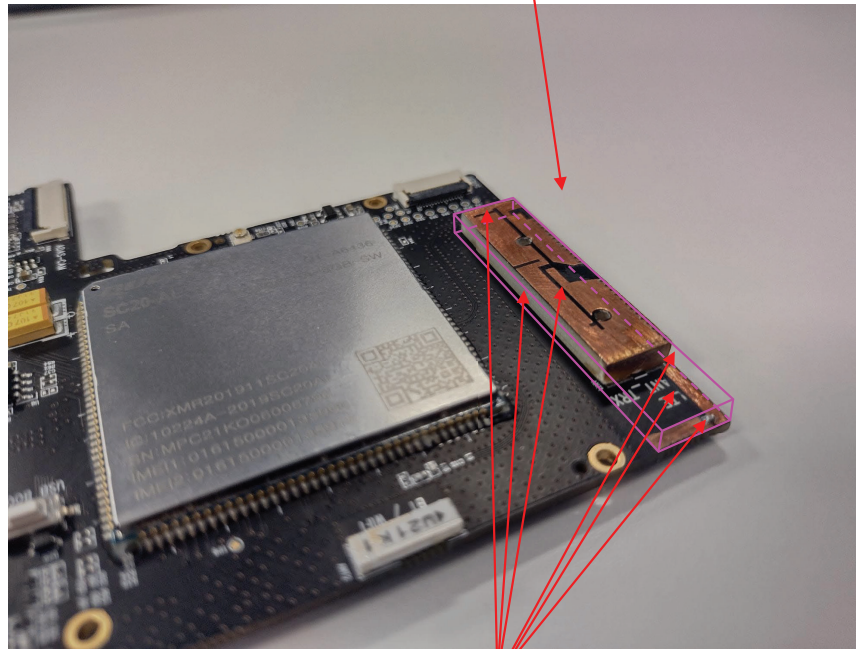
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Claim 11

[11i] wherein the first antenna defines an antenna box that is a minimum-sized parallelepiped that completely encloses a volume of the first antenna and
[11j] wherein each face of the minimum-sized parallelepiped is tangent to at least one point of the volume of the first antenna,

[11i] The first antenna defines an antenna box (outlined in pink) that is a minimum-sized parallelepiped that completely encloses a volume of the first antenna



[11j] Each face of the minimum-sized parallelepiped is tangent to at least one point of the volume of the first antenna

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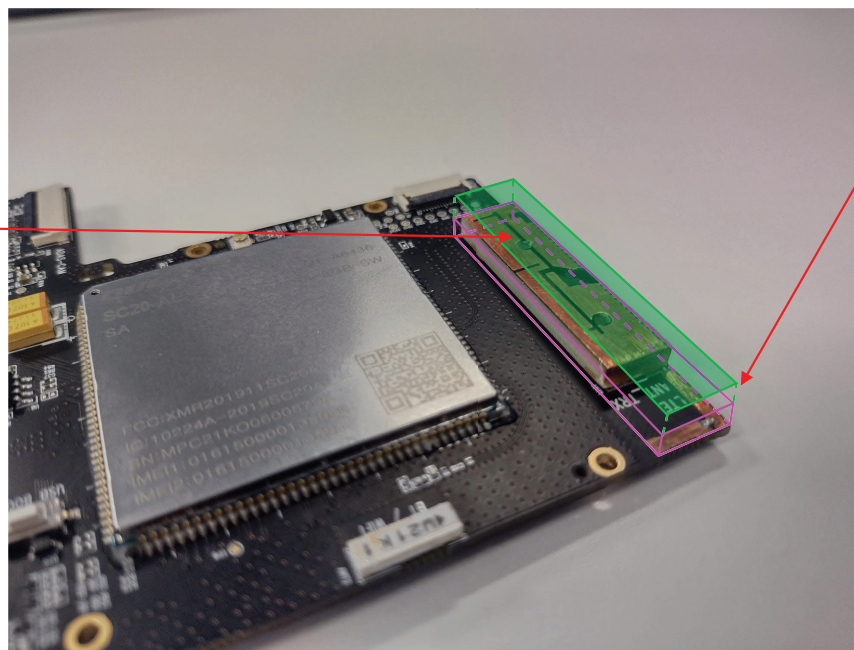
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Claim 11

[11k] an orthogonal projection of the antenna box along a normal to a face with a largest area of the first antenna defining [11l] an antenna rectangle,

[11k] An orthogonal projection of the antenna box along a normal to a face* with a largest area of the first antenna

[11l] Antenna rectangle (filled in green)



*Normal to a face means perpendicular to the face

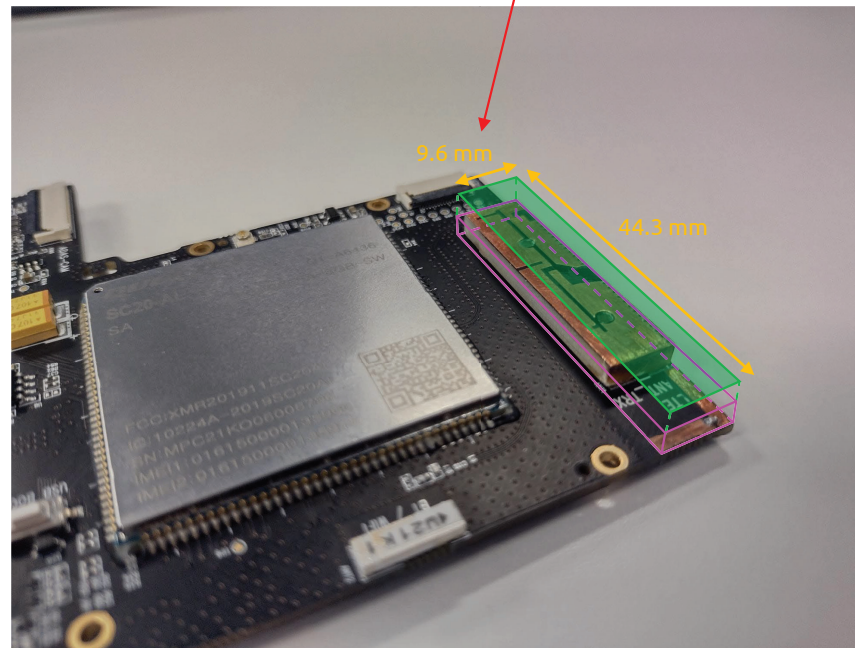
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Claim 11

[11m] an aspect ratio of the antenna rectangle being defined as a ratio between a width and a height of the antenna rectangle, wherein the aspect ratio has a value of at least 2; and

[11m] 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 $44.3/9.6 = 4.61 \geq 2$



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Claim 11

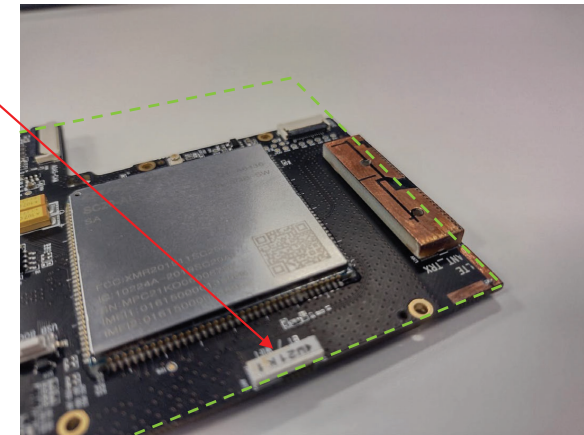
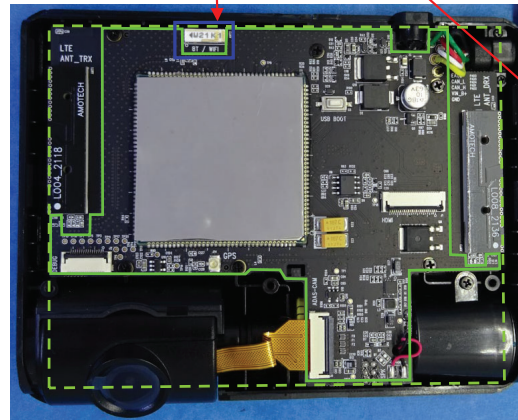
[11n] a second antenna configured to provide operation in a first wireless service, [11o] the second antenna being proximate to a side of a ground plane rectangle enclosing the ground plane.

[11n] The antenna system comprises a second antenna (indicated in blue) configured to provide operation in at least a first wireless service: WiFi 2.4GHz, and [11o] is proximate to a side of a ground plane rectangle (indicated with a dashed green line) enclosing the ground plane

Communications

Antenna	LTE Main, LTE DRX, GNSS, WiFi/BT
US	LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26
	3G Bands: B1, B2, B5, B8
EMEA	LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A
	3G Bands: B1, B2, B5, B8
Wireless	Wi-Fi: IEEE 802.11a/b/g/n
	Bluetooth: BT4.2 (BR/EDR+BLE)

Source: device datasheet

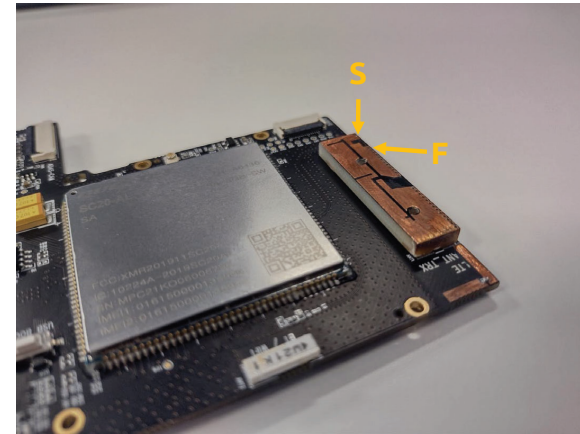
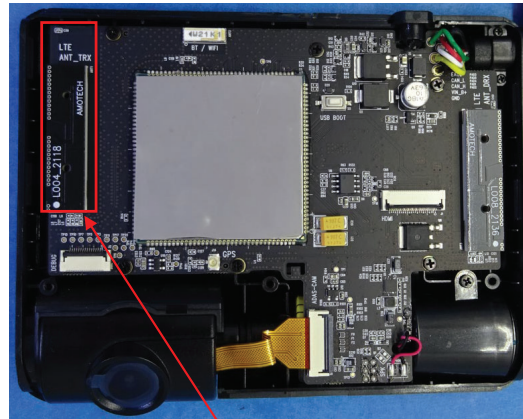


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Claim 12

[12a] The wireless device of claim 11, wherein the first antenna is configured to support at least four frequency bands.



[12a] The first antenna (indicated in red) is configured to support at least LTE 700(B12)/850(B5)/1700-2100(B4)/1900(B2)

Communications	
Antenna	LTE Main, LTE DRX, GNSS, Wi-Fi/BT
	US LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26 3G Bands: B1, B2, B5, B8
	EMEA LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A 3G Bands: B1, B2, B5, B8
Wireless	Wi-Fi: IEEE 802.11a/b/g/n Bluetooth: BT4.2 (BR/EDR+BLE)

Source: device datasheet

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Claim 13

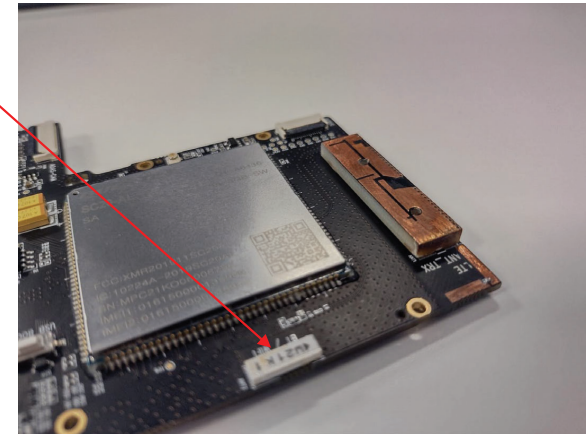
[13a] The wireless device of claim 11, wherein the first wireless service is a WiFi communication standard.

[13a] The first wireless service is a WiFi communication standard

Communications

Antenna	LTE Main, LTE DRX, GNSS, WiFi/BT	
Wireless	US	LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26 3G Bands: B1, B2, B5, B8
	EMEA	LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A 3G Bands: B1, B2, B5, B8
		Wi-Fi: IEEE 802.11a/b/g/n Bluetooth: BT4.2 (BR/EDR+BLE)

Source: device datasheet

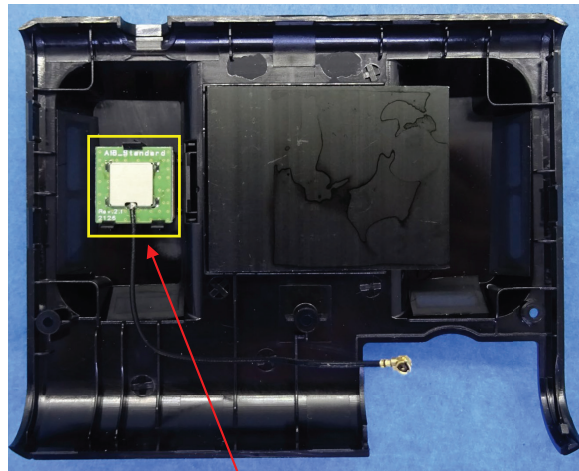


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Claim 15

[15a] The wireless device of claim 11, wherein the antenna system comprises a third antenna.



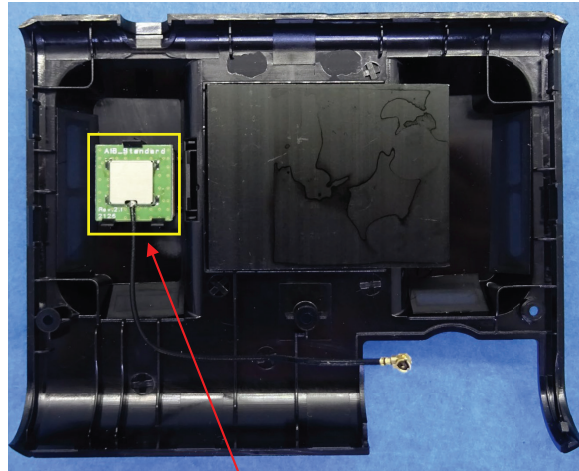
[15a] The antenna system comprises a third antenna (indicated in yellow)

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Claim 17

[17a] The wireless device of claim 15, wherein the third antenna is configured to provide operation in a second wireless service.



[17a] The third antenna (indicated in yellow) configured to provide operation in at least a second wireless service: GPS

Positioning	
GNSS	GPS, GLONASS, BeiDou
G-Sensor	Digital, Tri-Axial Acceleration Sensor

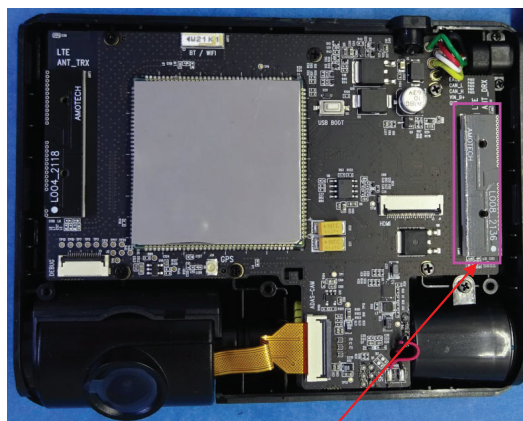
Source: device datasheet

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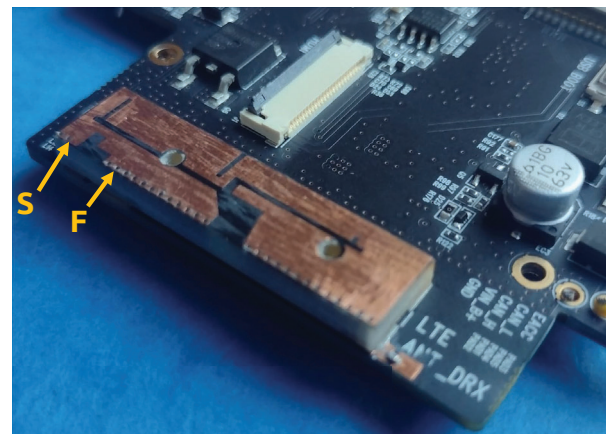
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Claim 19

[19a] The wireless device of claim 15, wherein the antenna system comprises a fourth antenna.



[19a] The antenna system comprises a fourth antenna (indicated in pink)



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Infringement where the diversity antenna is considered the first antenna

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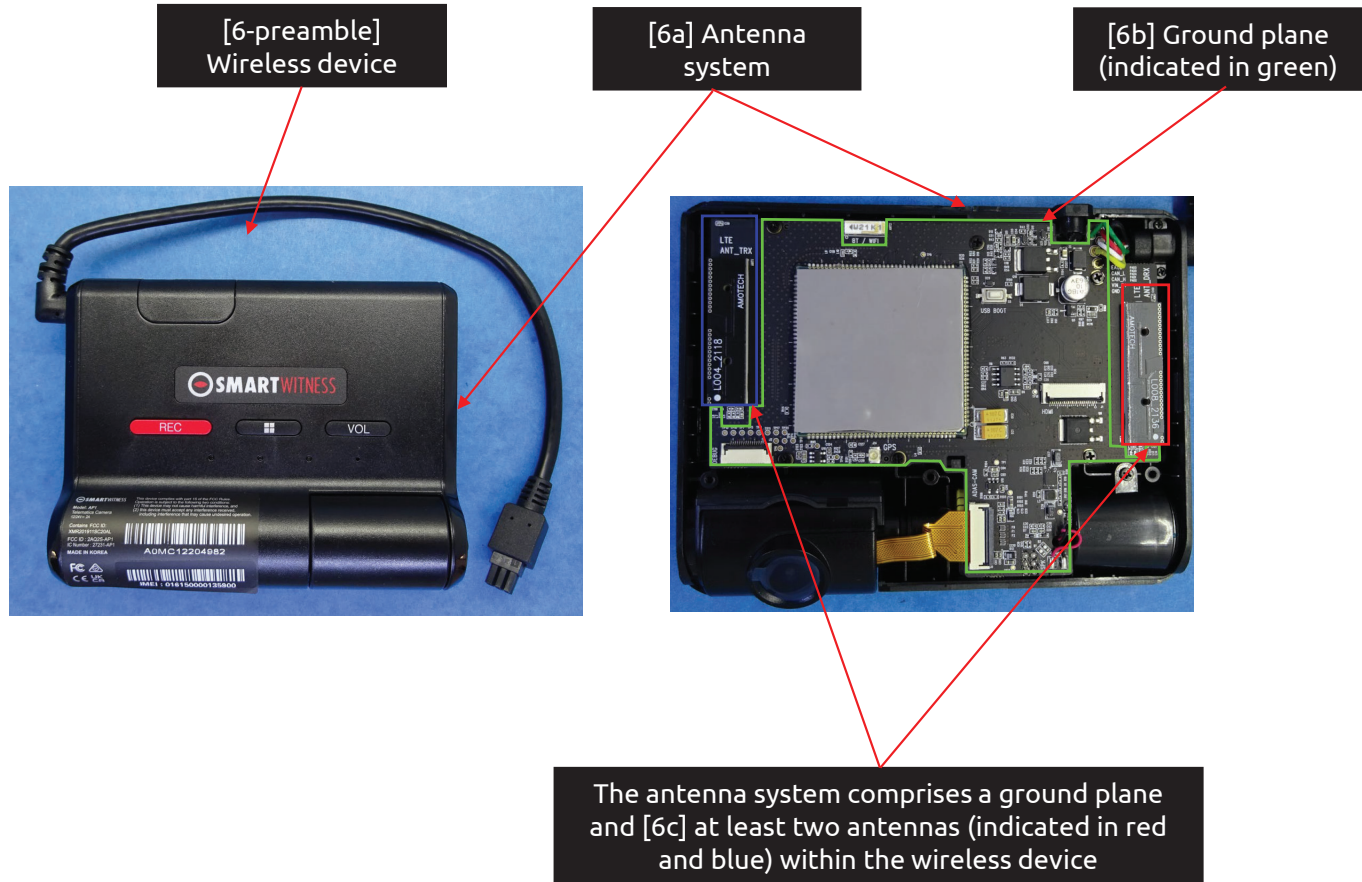
32

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Claim 6

[6-preamble] A wireless device comprising [6a] an antenna system comprising [6b] a ground plane and [6c] at least two antennas within the wireless device, the antenna system comprising:



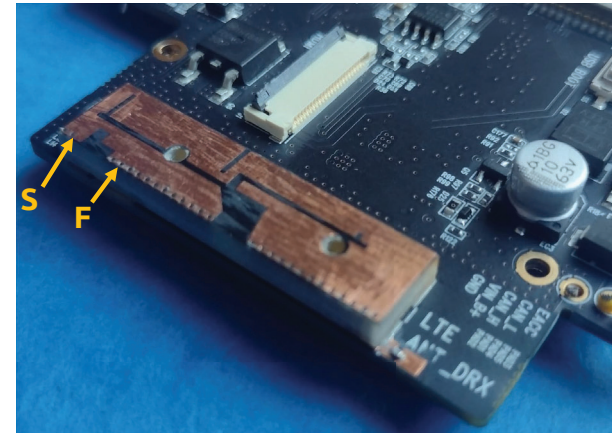
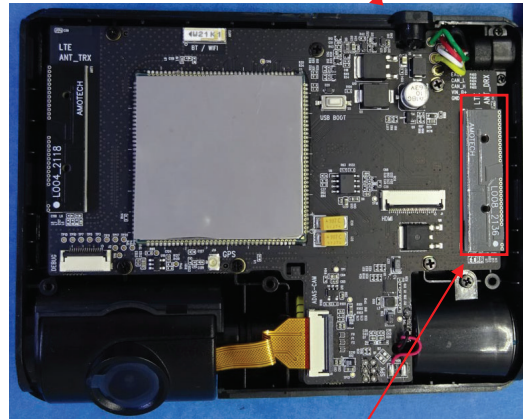
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Claim 6

[6d] a first antenna configured to provide operation in at least four frequency bands being used by 4G communication standards, wherein

Antenna system



[6d] The antenna system comprises a first antenna (indicated in red) configured to provide operation in at least LTE 700(B12)/850(B5)/2100(B4)/1900(B2)

Communications	
Antenna	LTE Main, LTE DRX, GNSS, Wi-Fi/BT
US	LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26
	3G Bands: B1, B2, B5, B8
Wireless	EMEA
	LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A
	3G Bands: B1, B2, B5, B8
	Wi-Fi: IEEE 802.11a/b/g/n
	Bluetooth: BT4.2 (BR/EDR+BLE)

Source: device datasheet

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Claim 6

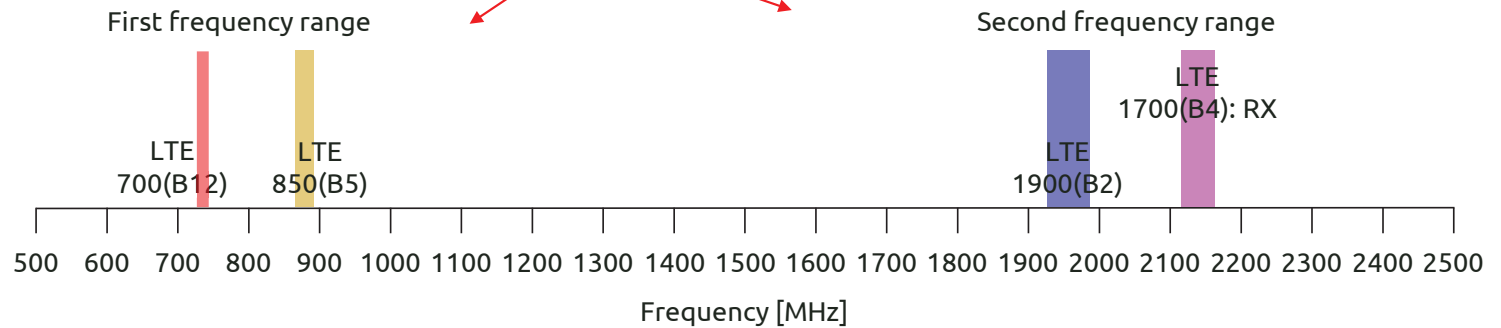
[6e] at least two of the at least four frequency bands are contained within a first frequency range and [6f] at least two of the at least four frequency bands are contained within a second frequency range (filled in blue) and [6f] at least two of the at least four frequency bands are contained within a second frequency range (filled in blue),
 [6g] the first frequency range being lower in frequency than the second frequency range,

[6e] At least two of the at least four frequency bands are contained within a first frequency range (filled in red) and [6f] at least two of the at least four frequency bands are contained within a second frequency range (filled in blue)

Communications	
Antenna	LTE Main, LTE DRX, GNSS, Wi-Fi/BT
US	LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26 3G Bands: B1, B2, B5, B6
EMEA	LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A 3G Bands: B1, B2, B5, B8
Wi-Fi	IEEE 802.11a/b/g/n
Bluetooth	BT4.2 (BR/EDR+BLE)

Source: device datasheet

[6g] The first frequency range being lower in frequency than the second frequency range

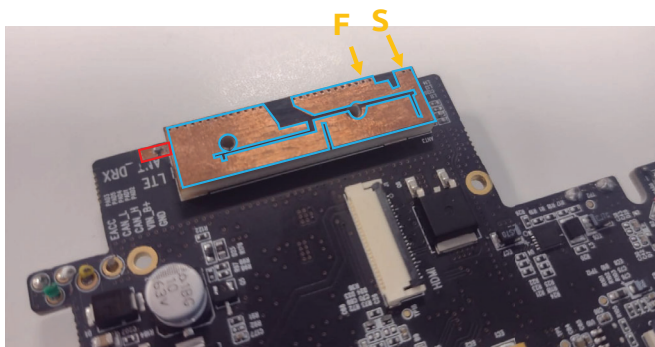


CONFIDENTIAL

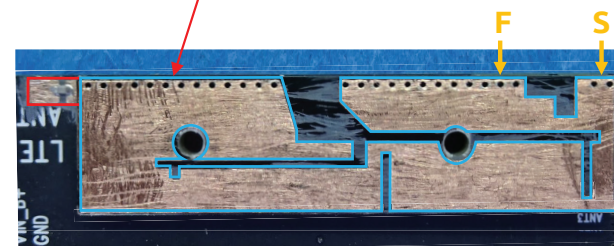
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Claim 6

[6h] the first antenna defining a first antenna contour comprising an entire perimeter of the first antenna, and



[6h] The first antenna defines a first antenna contour (indicated in blue and red) comprising an entire perimeter of the first antenna



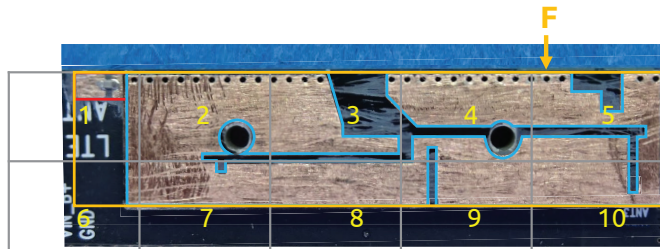
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Claim 6

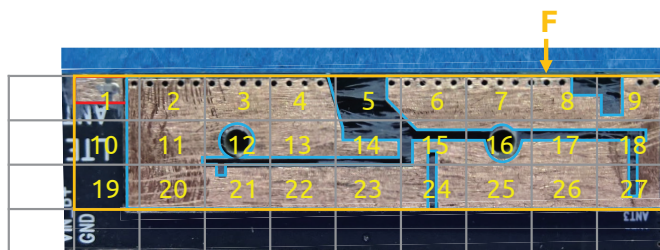
[6i] wherein the first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and

[6i] The first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20



$N_1 = 10 \text{ cells}$

$$F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log\left(\frac{1}{2}\right)} = \frac{\log(27/10)}{\log(2)} = 1.43 \geq 1.20$$



$N_2 = 27 \text{ cells}$

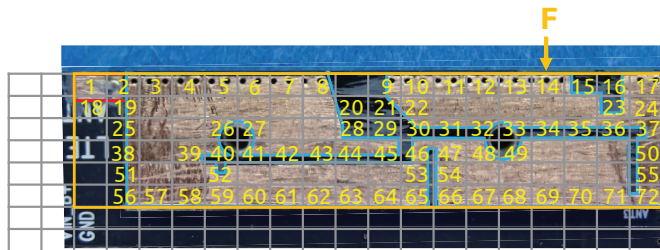
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Claim 6

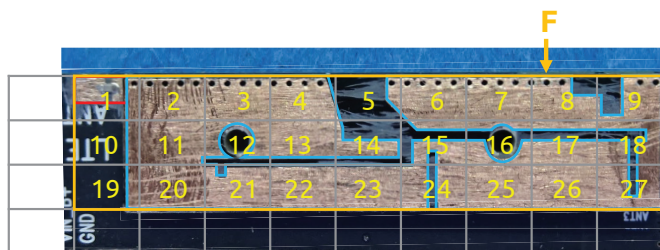
[6j] complexity factor F_{32} having a value of at least 1.35; and

[6j] The first antenna contour has a level of complexity defined by complexity factor F_{32} having a value of at least 1.35



$N_3 = 72 \text{ cells}$

$$F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log\left(\frac{1}{2}\right)} = \frac{\log(72/27)}{\log(2)} = 1.42 \geq 1.35$$



$N_2 = 27 \text{ cells}$

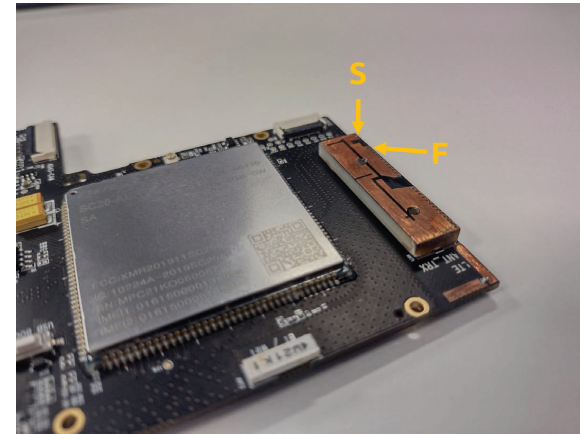
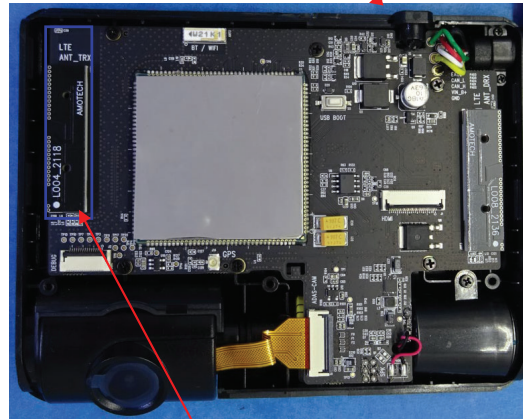
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Claim 6

[6k] a second antenna configured to operate in at least one frequency band being used by a 4G communication standard,

Antenna system



[6k] The antenna system comprises a second antenna (indicated in blue) configured to operate in at least LTE 700(B12)

Communications

Antenna	LTE Main, LTE DRX, GNSS, Wi-Fi/BT
US	LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26
	3G Bands: B1, B2, B5, B8
Wireless	EMEA
	LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A
	3G Bands: B1, B2, B5, B8
	Wi-Fi: IEEE 802.11a/b/g/n
	Bluetooth: BT4.2 (BR/EDR+BLE)

Source: device datasheet

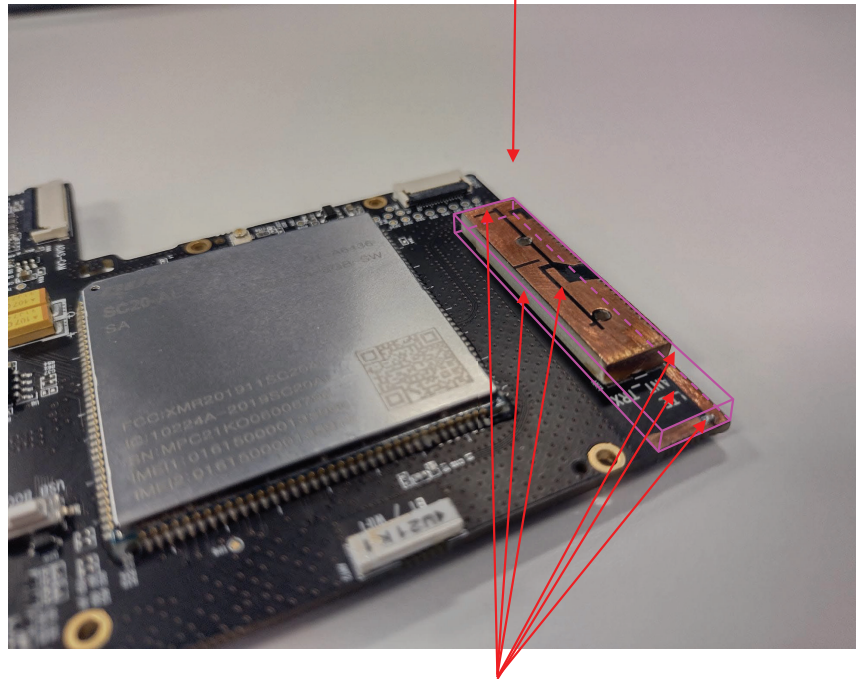
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Claim 6

[6l] the second antenna defining an antenna box that is a minimum-sized parallelepiped that completely encloses a volume of the second antenna and [6m] wherein each face of the minimum-sized parallelepiped is tangent to at least one point of the volume of the second antenna,

[6l] The second antenna defines an antenna box (outlined in pink) that is a minimum-sized parallelepiped that completely encloses a volume of the second antenna



[6m] Each face of the minimum-sized parallelepiped is tangent to at least one point of the volume of the second antenna

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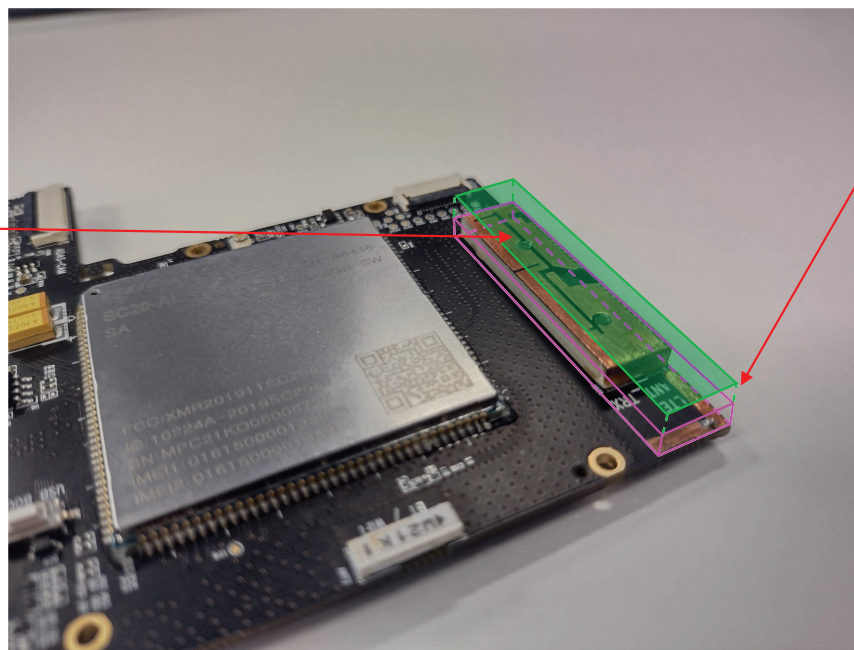
US 11,349,200 - SmartWitness AP1

Claim 6

[6n] an orthogonal projection of the antenna box along a normal to a face with a largest area of the second antenna defining
[6o] an antenna rectangle,

[6n] An orthogonal projection of the antenna box along a normal to a face* with a largest area of the second antenna

[6o] Antenna rectangle (filled in green)



*Normal to a face means perpendicular to the face

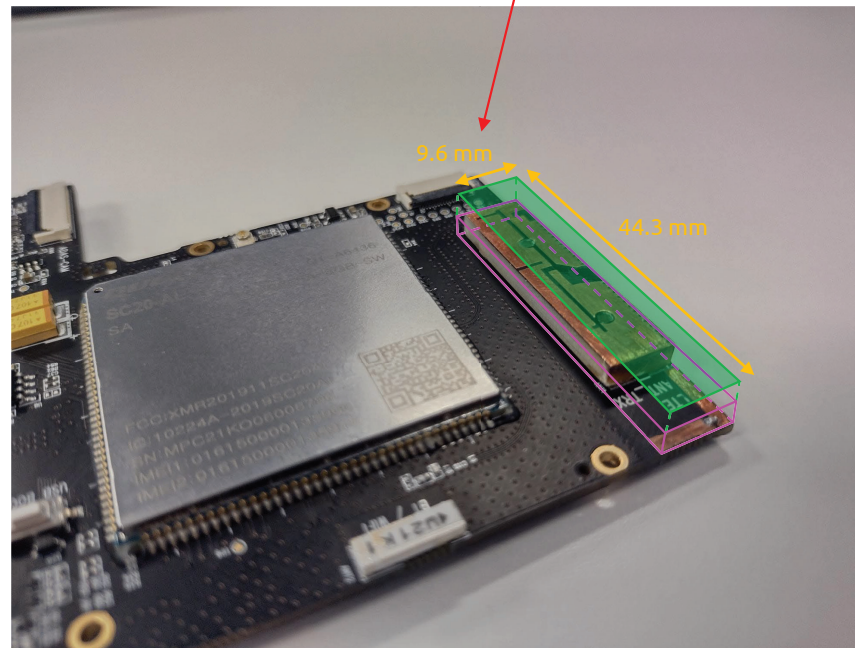
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Claim 6

[6p] 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, and

[6p] 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 $44.3/9.6 = 4.61 \geq 2$



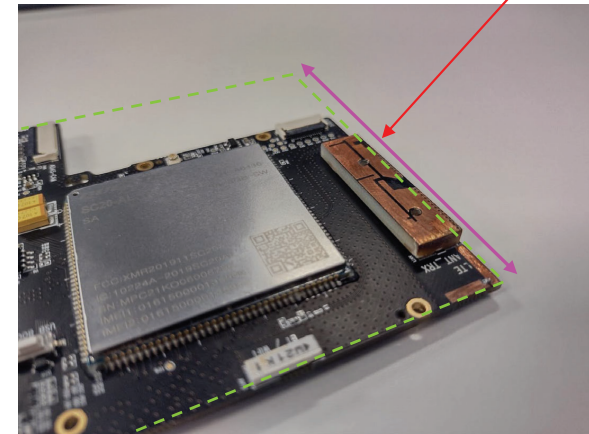
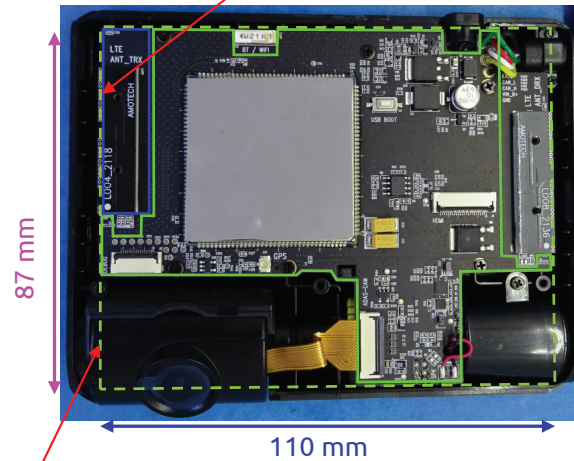
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Claim 6

[6q] wherein at least one of the first and second antennas is close to a first short side of a ground plane rectangle enclosing the ground plane.

[6q] At least the second antenna is close to a first short side of a ground plane rectangle (indicated with a dashed green line) enclosing the ground plane



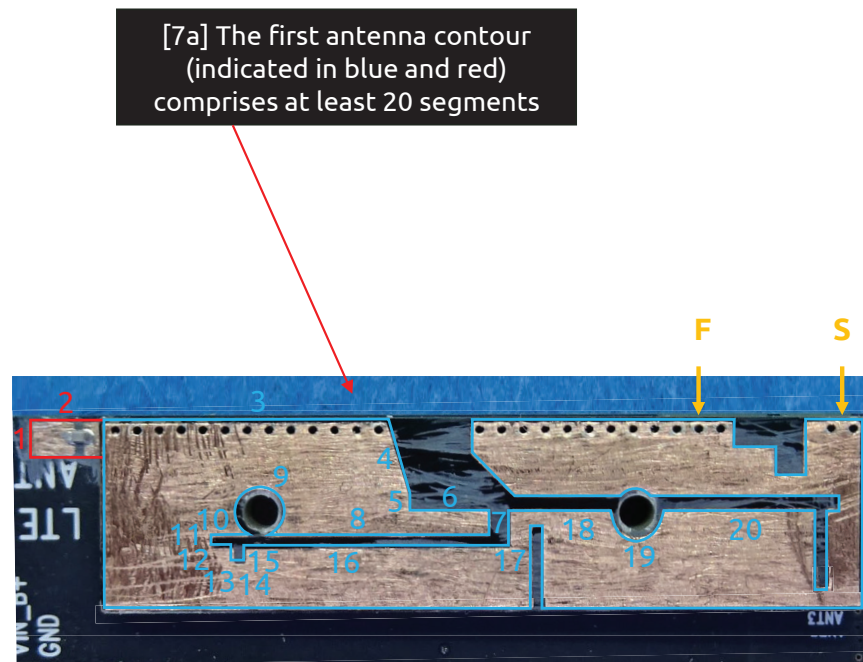
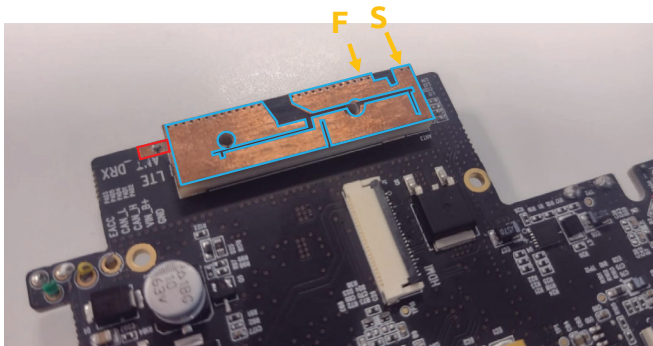
First short side (indicated in pink)

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Claim 7

[7a] The wireless device of claim 6, wherein the first antenna contour comprises at least 20 segments.

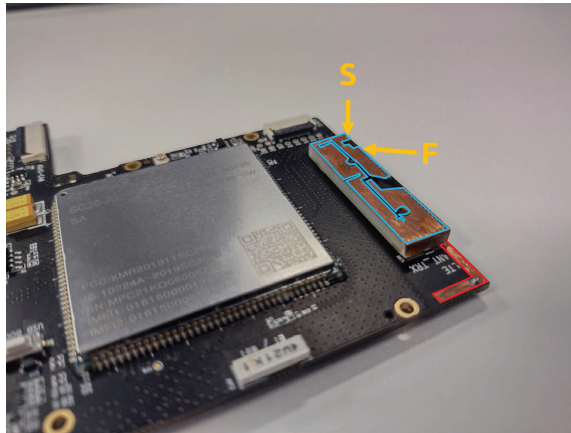


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Claim 9

[9a] The wireless device of claim 6, wherein the second antenna defines a second antenna contour comprising an entire perimeter of the second antenna,



[9a] The second antenna defines a second antenna contour (indicated in blue and red) comprising an entire perimeter of the second antenna

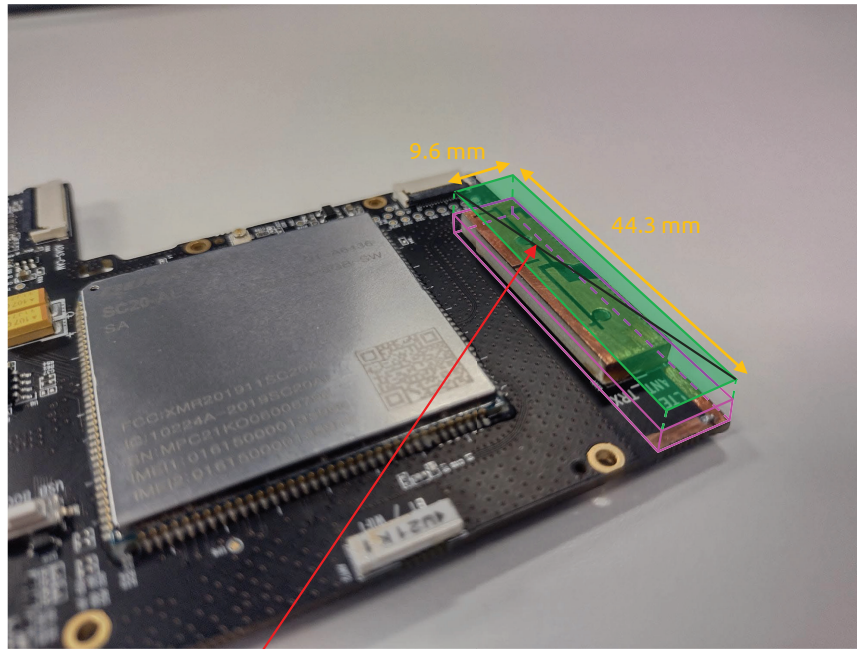


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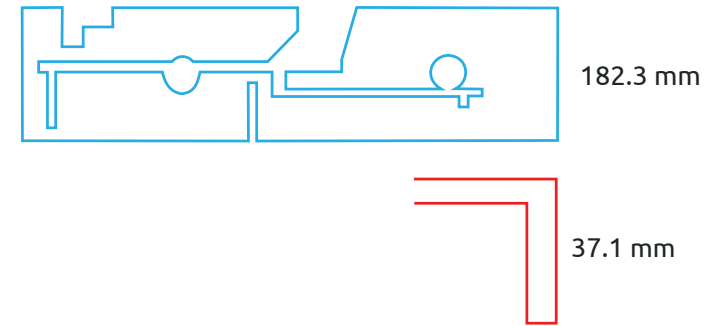
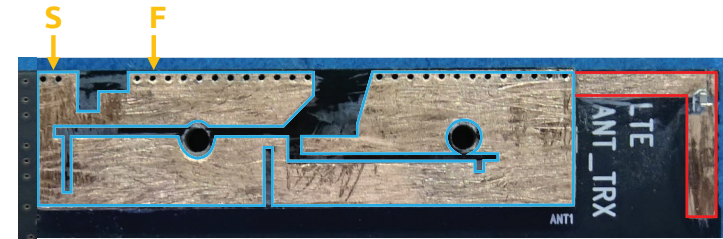
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Claim 9

[9b] wherein a length of the second antenna contour is greater than four times a diagonal of the antenna rectangle.



Diagonal of the antenna rectangle = 45.33 mm



Length of the second antenna contour = $(182.3 + 37.1) = 219.4$ mm

[9b] The length of the second antenna contour (219.4 mm) > 4*Diagonal of the antenna rectangle (4*45.33 = 181.32 mm)

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Claim 10

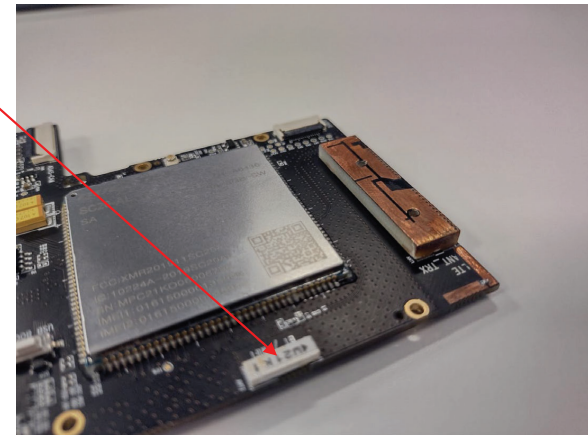
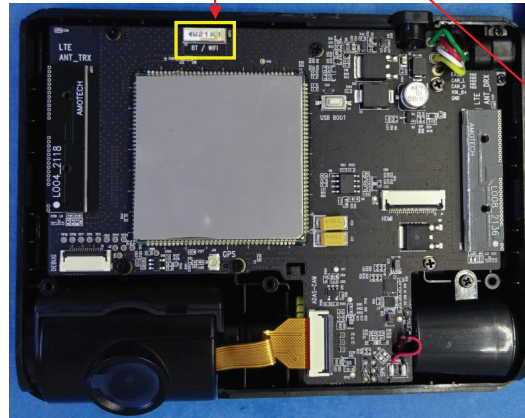
[10a] The wireless device of claim 6, wherein the antenna system comprises a third antenna configured to provide operation in a wireless communication standard.

[10a] The antenna system comprises a third antenna (indicated in yellow) configured to provide operation in at least a wireless communication standard: WiFi

Communications

Antenna	LTE Main, LTE DRX, GNSS, WiFi/BT
	US LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26 3G Bands: B1, B2, B5, B8
	EMEA LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A 3G Bands: B1, B2, B5, B8
Wireless	Wi-Fi: IEEE 802.11a/b/g/n
	Bluetooth: BT4.2 (BR/EDR+BLE)

Source: device datasheet

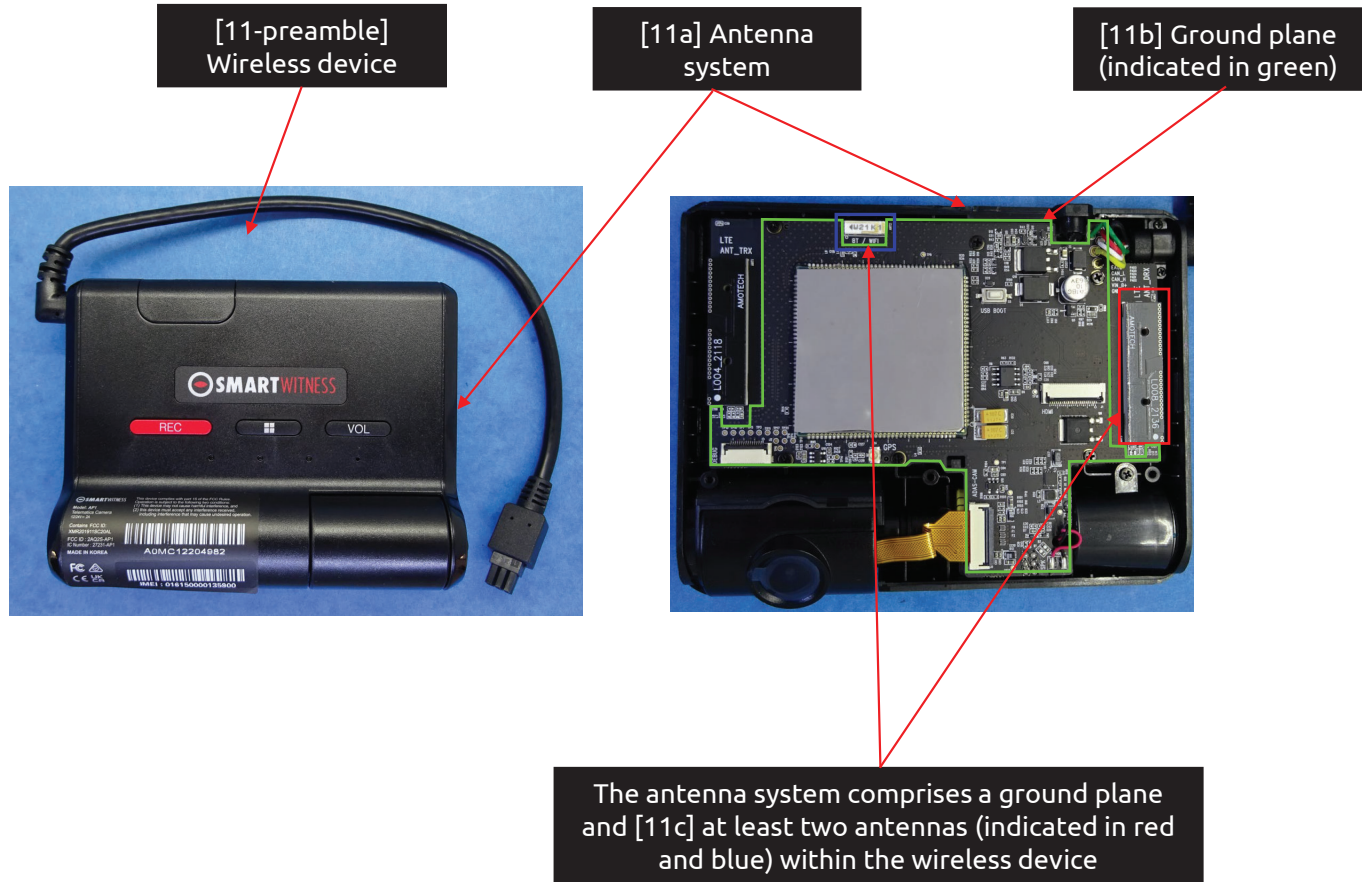


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Claim 11

[11-preamble] A wireless device comprising:
[11a] an antenna system comprising
[11b] a ground plane and
[11c] at least two antennas within the wireless device, the antenna system comprising:



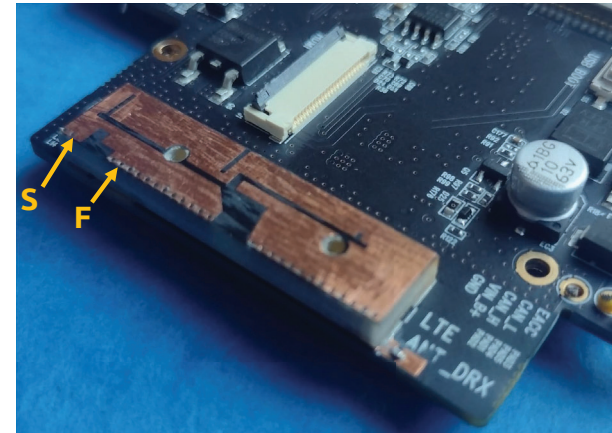
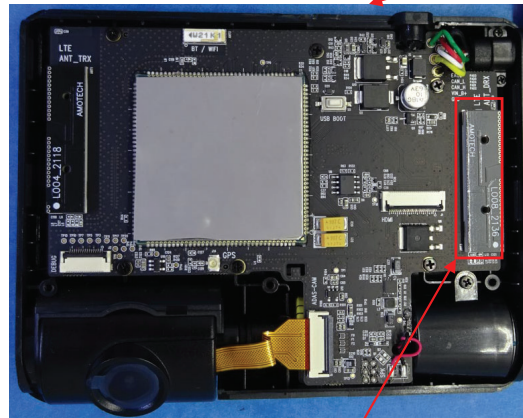
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Claim 11

[11d] a first antenna configured to provide operation in at least three frequency bands being used by 4G communication standards,

Antenna system



[11d] The antenna system comprises a first antenna (indicated in red) configured to provide operation in at least LTE 700(B12)/2100(B4)/1900(B2)

Communications

Antenna	LTE Main, LTE DRX, GNSS, Wi-Fi/BT
US	LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26 3G Bands: B1, B2, B5, B8
	LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A 3G Bands: B1, B2, B5, B8
Wireless	Wi-Fi: IEEE 802.11a/b/g/n
	Bluetooth: BT4.2 (BR/EDR+BLE)

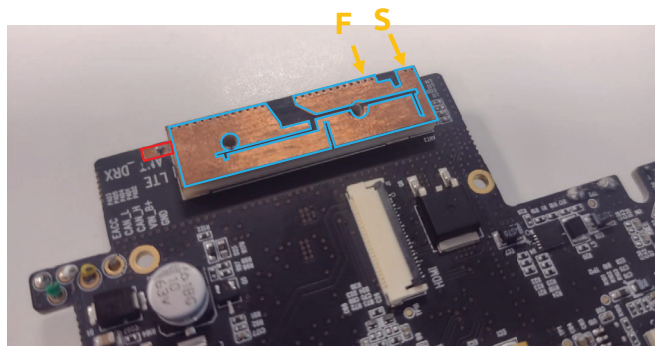
Source: device datasheet

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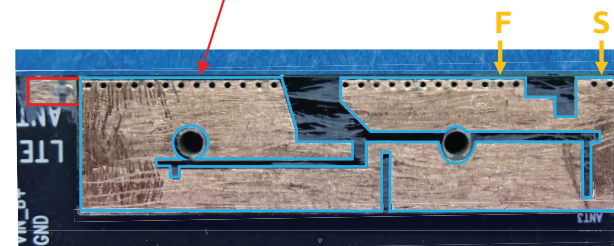
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Claim 11

[11e] the first antenna defining an antenna contour comprising an entire perimeter of the first antenna,



[11e] The first antenna defines a first antenna contour (indicated in blue and red) comprising an entire perimeter of the first antenna

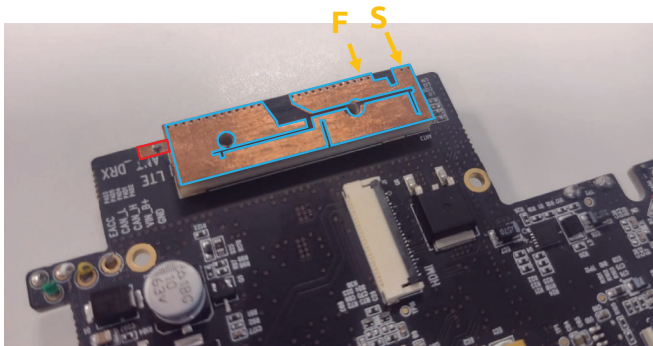


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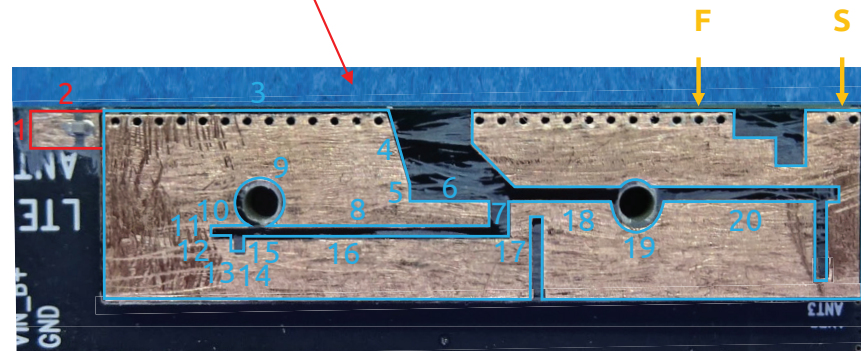
US 11,349,200 - SmartWitness AP1

Claim 11

[11f] the antenna contour comprising at least twenty segments,



[11f] The first antenna contour (indicated in blue and red) comprises at least 20 segments



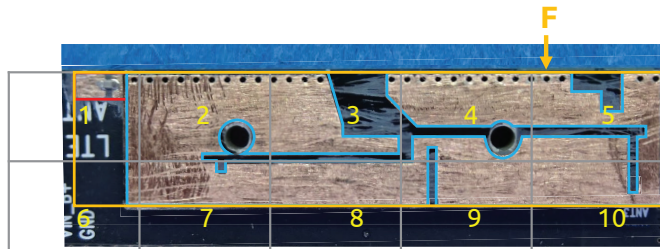
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Claim 11

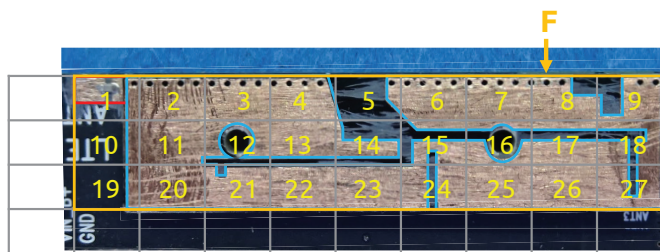
[11g] wherein the antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and

[11g] The first antenna contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20



$N_1 = 10 \text{ cells}$

$$F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log\left(\frac{1}{2}\right)} = \frac{\log(27/10)}{\log(2)} = 1.43 \geq 1.20$$



$N_2 = 27 \text{ cells}$

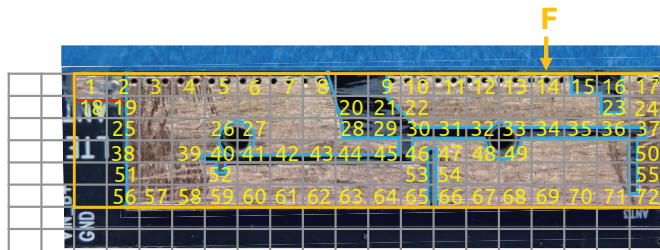
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Claim 11

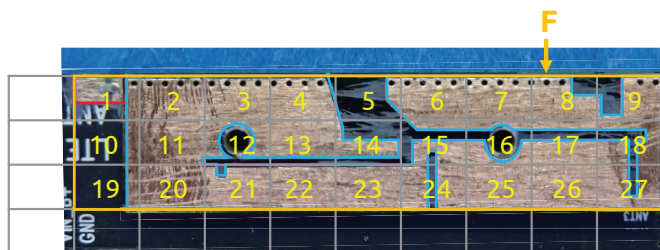
[11h] complexity factor F_{32} having a value of at least 1.35, and

[11h] The first antenna contour has a level of complexity defined by complexity factor F_{32} having a value of at least 1.35



$N_3 = 72 \text{ cells}$

$$F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log\left(\frac{1}{2}\right)} = \frac{\log(72/27)}{\log(2)} = 1.42 \geq 1.35$$



$N_2 = 27 \text{ cells}$

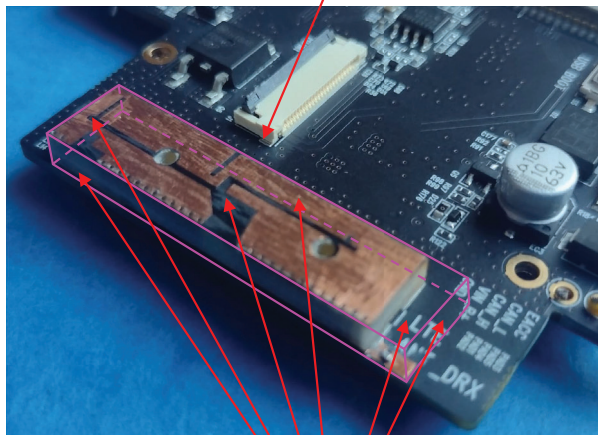
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Claim 11

[11i] wherein the first antenna defines an antenna box that is a minimum-sized parallelepiped that completely encloses a volume of the first antenna and
[11j] wherein each face of the minimum-sized parallelepiped is tangent to at least one point of the volume of the first antenna,

[11i] The first antenna defines an antenna box (outlined in pink) that is a minimum-sized parallelepiped that completely encloses a volume of the first antenna



[11j] Each face of the minimum-sized parallelepiped is tangent to at least one point of the volume of the first antenna

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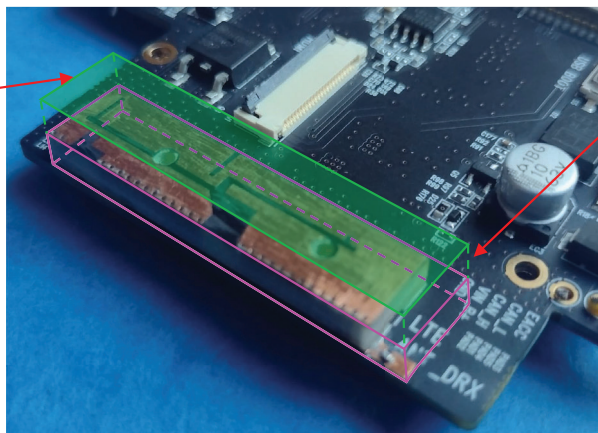
US 11,349,200 - SmartWitness AP1

Claim 11

[11k] an orthogonal projection of the antenna box along a normal to a face with a largest area of the first antenna defining [11l] an antenna rectangle,

[11l] Antenna rectangle (filled in green)

[11k] An orthogonal projection of the antenna box along a normal to a face* with a largest area of the first antenna



*Normal to a face means perpendicular to the face

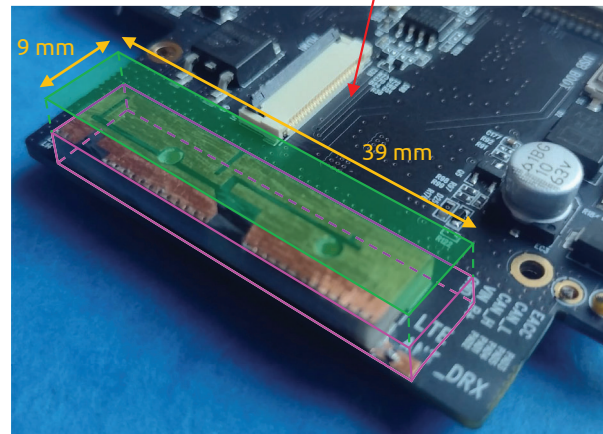
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Claim 11

[11m] an aspect ratio of the antenna rectangle being defined as a ratio between a width and a height of the antenna rectangle, wherein the aspect ratio has a value of at least 2; and

[11m] 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 $39/9 = 4.33 \geq 2$



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Claim 11

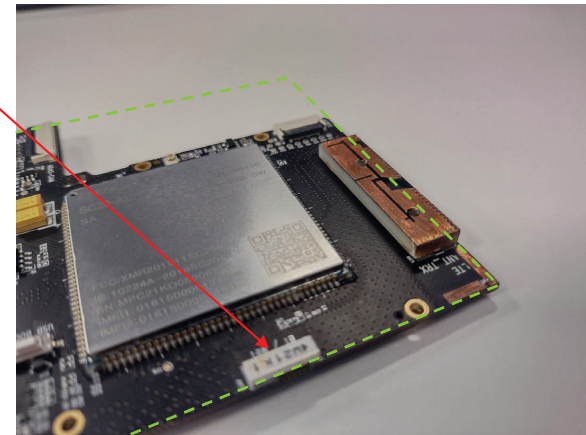
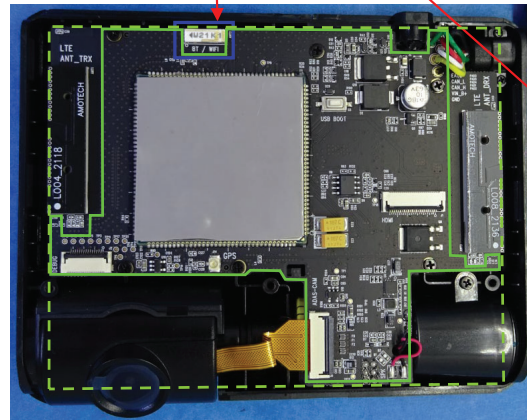
[11n] a second antenna configured to provide operation in a first wireless service, [11o] the second antenna being proximate to a side of a ground plane rectangle enclosing the ground plane.

[11n] The antenna system comprises a second antenna (indicated in blue) configured to provide operation in at least a first wireless service: WiFi 2.4GHz, and [11o] is proximate to a side of a ground plane rectangle (indicated with a dashed green line) enclosing the ground plane

Communications

Antenna	LTE Main, LTE DRX, GNSS, WiFi/BT
US	LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26
	3G Bands: B1, B2, B5, B8
EMEA	LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A
	3G Bands: B1, B2, B5, B8
Wireless	Wi-Fi: IEEE 802.11a/b/g/n
	Bluetooth: BT4.2 (BR/EDR+BLE)

Source: device datasheet

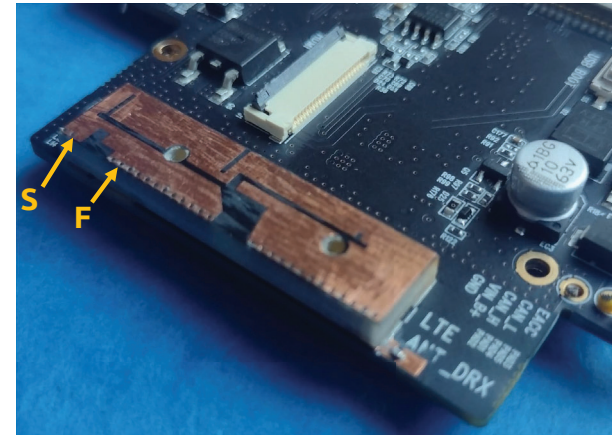
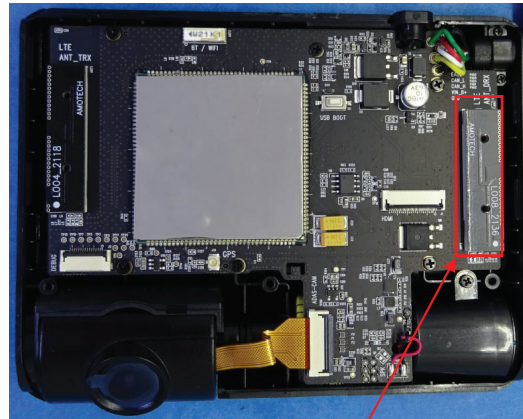


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Claim 12

[12a] The wireless device of claim 11, wherein the first antenna is configured to support at least four frequency bands.



[12a] The first antenna (indicated in red) is configured to support at least LTE 700(B12)/850(B5)/2100(B4)/1900(B2)

Communications	
Antenna	LTE Main, LTE DRX, GNSS, Wi-Fi/BT
US	LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26
	3G Bands: B1, B2, B5, B8
Wireless	EMEA
	LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A
	3G Bands: B1, B2, B5, B8
	Wi-Fi: IEEE 802.11a/b/g/n
	Bluetooth: BT4.2 (BR/EDR+BLE)

Source: device datasheet

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Claim 13

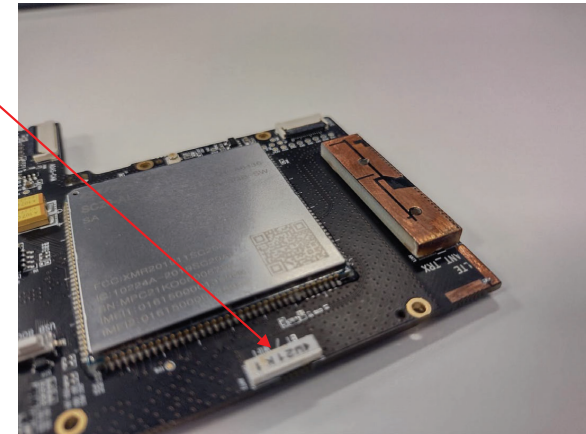
[13a] The wireless device of claim 11, wherein the first wireless service is a WiFi communication standard.

[13a] The first wireless service is a WiFi communication standard

Communications

Antenna	LTE Main, LTE DRX, GNSS, WiFi/BT	
Wireless	US	LTE CAT4: B2, B4, B5, B7, B12, B13, B25, B26 3G Bands: B1, B2, B5, B8
	EMEA	LTE CAT4: B1, B2, B3, B5, B7, B8, B20, B28A 3G Bands: B1, B2, B5, B8
		Wi-Fi: IEEE 802.11a/b/g/n Bluetooth: BT4.2 (BR/EDR+BLE)

Source: device datasheet

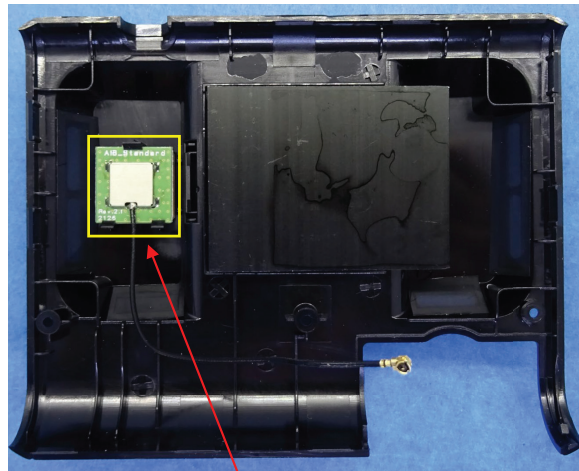


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Claim 15

[15a] The wireless device of claim 11, wherein the antenna system comprises a third antenna.



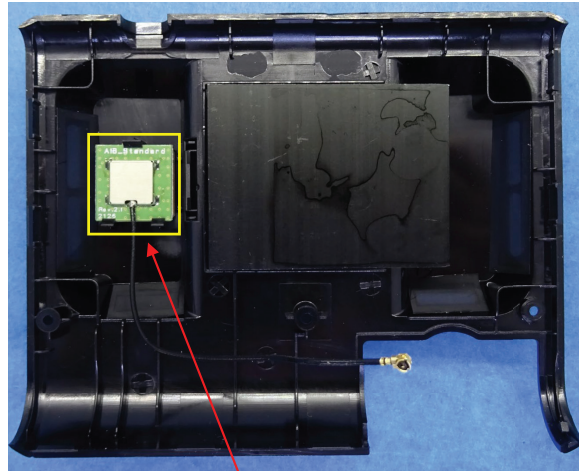
[15a] The antenna system comprises a third antenna (indicated in yellow)

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Claim 17

[17a] The wireless device of claim 15, wherein the third antenna is configured to provide operation in a second wireless service.



[17a] The third antenna (indicated in yellow) configured to provide operation in at least a second wireless service: GPS

Positioning	
GNSS	GPS, GLONASS, BeiDou
G-Sensor	Digital, Tri-Axial Acceleration Sensor

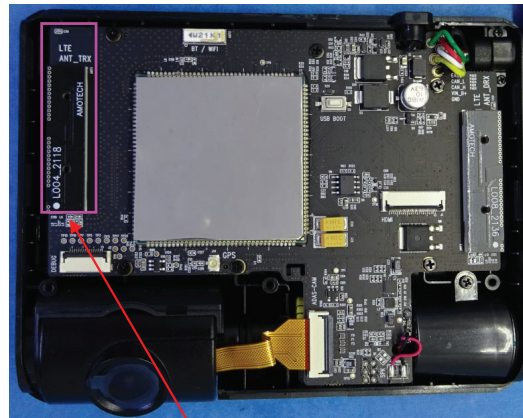
Source: device datasheet

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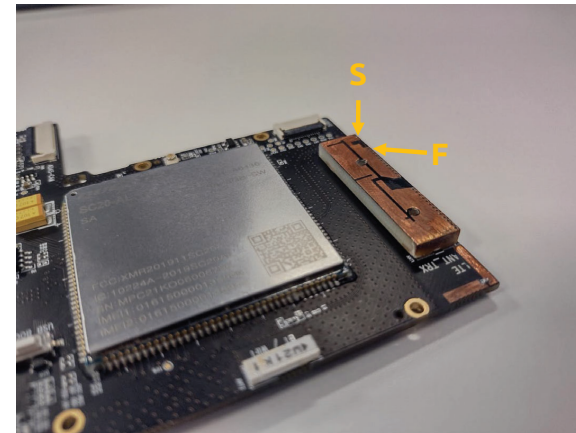
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Claim 19

[19a] The wireless device of claim 15, wherein the antenna system comprises a fourth antenna.



[19a] The antenna system comprises a fourth antenna (indicated in pink)



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