A Development of Built-in Antenna for W-CDMA Visual Terminals

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1.Introdaction

There are two big subjects in the antenna for cellular phones; these are "increase of antenna gain in talk position" and "decrease of an SAR value". Conventionally, the planer inverted-F antenna (PIFA), the monopole antenna, and the helix antenna etc have been used as a typical antenna of a cellular phone. However, these three antennas are unbalanced power supply antennas, and since antenna current is distributed on a substrate, they tended to be influenced from the human body in talk position.

In " increase of antenna gain in talk position ", by considering as the balanced power supply antenna which used the "balun." decreasing the antenna current on a substrate and reducing the influence by the human body have been realized [1]. On the other hand, in "reduction of an SAR value", mainly, keeping away the peak point of antenna current from a human body, shifting adjustment of matching circuit, or lowering transmitted electric power have been carried out.

In this paper, compatible " increase of antenna gain in talk position " and "reduction of an SAR value", the 1l U-antenna with the balanced electric supply(U-dipole antenna), was developed as a built-in antenna for W-CDMA visual terminals, the various characteristics are reported.

2.Antenna structure.

The antenna structure of the 1l U-antenna with the balanced electric supply for the W-CDMA visual terminals examined is shown in Fig. 1.

The structure of the case is a fold-up formula, the extended outside size is 180*52*20mm. This antenna is arranged to the upper case, prepared the interval of 3mm upward and 4mm in the right-and-left direction between the antenna and the end of a substrate. And this antenna has structure that stuck the element of the shape of a tape with a width of 5mm on the case inner side.

The form of this element is U character form, breadth is fixed 50mm and length is two kinds, 33mm or 18mm. In addition, electric power is supplied to this antenna through a matching circuit and a unbalanced - balanced conversion curcuit.

3.Characteristics of antenna.

3-1 Current distribution.

The current distributions of PIFA and the U-dipole antenna are shown respectively in Fig. 2-(a) and Fig. 2-(b). Measurement frequency is 1920MHz and the current distributions have turned regularly at each maximum.

Since the PIFA shown in Fig. 2- (a) has unbalanced electric supply, antenna current is flowing to the whole substrate and ne ar the point supplying electric power serves as maximum of current. On the other hand, since the U-dipole antenna shown in Fig. 2- (b) has balanced electric supply, antenna current is hardly flowing on the substrate. Moreover, although the maximum of current distribution had become near the point of supplying electric power with the 1/2 l length U-dipole antenna, by having made element length into 1l, the maximum of current became near the center (this antenna near element bending) of an element on either side.

3-2 Impedance characteristic.

Fig. 3 is the impedance characteristic of the U-dipole antenna. In addition, bazooka

balun is used for measurement. 250MHz is required the band-wise for W-CDMA (transmitting band-width: 1920MHz - 1980MHz, a receiving band-width: 2110MHz - 2170MHz). As, in this antenna structure, the distance between antenna elements and substrate is near and becomes barrow band-wise, so that a matching circuit for extensive band-wise is needed.
The element length of a U-dipole antenna is 1l, and this impedance characteristic is near the point resonating [parallel] from Fig. 3. Then, for extensive bandwidth of this U-dipole antenna, it realized by using 2 resonance matching circuit [2] constituted from a balanced system. The impedance characteristic of the U-dipole antenna that was adapted in the balanced system 2 resonance matching circuit2), is shown in middle of Fig. 3.

3-1 Radiation characteristics.

3-2-1 The radiation characteristics in the case of free space and at talk position.

The two U-dipole antennas with the perpendicular length that is different are shown in Fig. 4. Although the electric length of two elements of each of Fig.4 (a) and (b) are the same, there is a difference in the mechanical length in the perpendicular length. Straight line-like antenna whose perpendicular length is 33mm in the direction is shown in Fig.4-(a) and meanda line-like antenna whose perpendicular length is 18mm is shown in Fig.4-(b).

The radiation characteristics in each free space are shown in Fig. 5. These U-dipole antenna as shone Fig.5- (a) and Fig.5- (b) radiate both polarization (horizontal polarization and vertical polarization). Moreover, when the ratio of vertical polarization and horizontal polarization radiated (Hereafter, it considers as an V/H ratio.) is considered, although the electric length is the same element length, the difference in the perpendicular length shows that the main polarization differs. When the perpendicular length is 33mm, a V/H ratio is set to 10.1dB, the main polarization of an antenna is radiate as vertical polarization, and when the perpendicular length is 18mm, unlike the time of 33mm, a V/H ratio is set to -5.0dB, and the main polarization of an antenna is radiate as horizontal polarization.

Next, the radiation characteristics at talk position are shown in Fig. 6-(a) of and Fig. 6-(b). The weighting of -6dB is carried out on a horizontal polarization.

When the perpendicular length is 33mm, an antenna gain at talk position is set to -2.2dBi, and when the perpendicular length is 18mm, antenna gain at talk position is set to –1.70dBi. As compared with the perpendicular length of an element being 33mm from Fig. 5, when the perpendicular length is 18mm, main polarization of antenna is horizontal polarization in free space. In order that the polarization of an antenna might also incline if a cellular phone is leaned when using a cellular phone, it became clear that the antenna whose length of the perpendicular length is 18mm and main polarization in free space is horizontal polarization is higher 0.5dB at the talk position from Fig. 6.

We performed examination that there is correlation between the vertical and horizontal radiation polarization ingredients radiated to the ratio of the vertical ingredient of an element and a horizontal ingredient, and there is correlation also in a gain at the talk position[3]. In this time, it became clear that the same result is obtained with two U -dipole antennas that equivalent electric length is same but element structure differs.

3-2-2 The elevation characteristic of the gain on a griddle.

Since the video terminal has opened the case on the table and transmitting video is also assumed, unlike the conventional voice terminals, and the data terminal which connects with PC and uses, the elevation characteristic of the gain in the level surface was examined supposing the case where it is put on the desk on a griddle. The elevation characteristic of the average gain in the level surface is shown in Fig. 7. In addition, the reference antenna chose the helix antenna that still is using.
When the average antenna gain is compared, the antenna gain that the perpendicular length is 33mm is larger than the antenna gain that the perpendicular length is 18mm in Fig. 7. Because the main polarization of the antenna that the perpendicular length is 33mm is vertical polarization and the main polarization of the antenna that the perpendicular length is 18mm is horizontal polarization from Fig. 5. Moreover,

although it is common to either of the elements, if elevation of an antenna becomes 20 degrees or less, the antenna gain will decrease rapidly. If it compares with the spiral antenna, when the element whose length of the perpendicular length is 33mm and the antenna elevation was 20 degrees or more, it became clear to become the gain of at the helix antenna and an equivalent gain.

3-3 SAR characteristics.

The SAR characteristic of the U-dipole antenna was examined. An SAR distribution of two dipole antennas with which element length differs is shown in Fig. 8. Fig. 8- (a) is an SAR distribution of 1/2 l length of U-dipole antenna, moreover, Fig. 82- (b) is an SAR distribution of 1l length U-dipole antenna.

The peak point of an SAR distribution of 1/2 l length U-dipole antenna is near the point supplying electric power, and the SAR value became 8.5 mW/g from Fig. 8 -(a). On the other hand, the SAR value of 1l length U-dipole antenna became 2.14 mW/g, and the SAR value became below the half. This is because there are two peak points of an SAR distribution of 1l length U-dipole antenna like the peak point of a current distribution of Fig .2 as shown in Fig. 8 -(b), and because two peak points are separated from the human body as compared with the peak point at the time of 1/2 l.

Next, the result, which examined the distance characteristic of the SAR value of 1l length U-dipole antenna, is shown in Fig. 9. It became clear from Fig. 9 to obtain, w hen an SAR value detached the distance between human body and the antenna, the SAR value decreased by detaching the distance between human body-antennas, and when the distance between an antenna-human body separated from 10mm to 13mm, it became half. Furthermore, it became clear by detaching the distance between antenna-human bodies to 17mm; the SAR value is obtained about 20% of margin to a standard value.

4. Conclusion.

The various antenna characteristics at the time of being adapted for visual terminals in the balanced electric supply 1l length U-dipole antenna were examined.

Consequently,

1. By having used the balanced electric supply using the non-balanced [balanced] conversion circuits, it made it possible to decrease the current on a substrate.
2. Extensive bandwidth adjustment with which a desired bandwidth is filled was realized by having made the element length of a U-dipole antenna into 1l length, and having loaded the balanced type 2 resonance matching circuit.
3. By optimizing element structure (the length of horizontal / vertical part), having horizontal / vertical polarization ingredient, the profit enabled high antenna structure at talk position
4. It was shown clearly by using 1l length U-dipole antenna structure that an SAR value is small made by making the peak point of an SAR distribution into two places, and separating from a human body.

Reference

1)K.Egawa, IEICE General Conf B-1-78,Mar.2000

2)K.Ogawa, Matsushita Technical Journal,Vol.44,No.6,Dec.1998

3)K.Egawa, IEICE General Conf B-1-123,Mar.2000

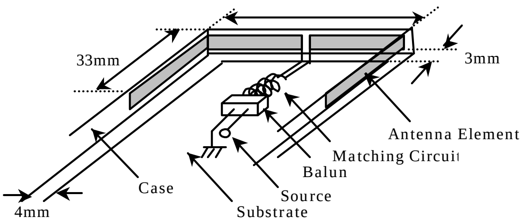
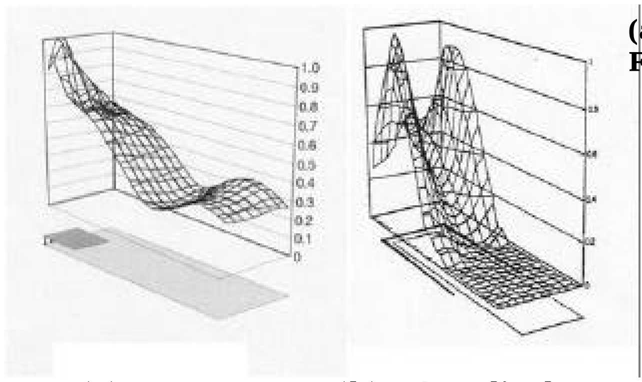


Fig.1 Antenna Structure



(a) PIFA (b) 1λ U-dipole

Fig.2 Current distribution

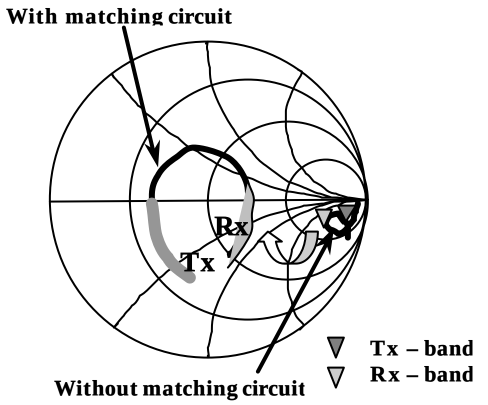


Fig.3 Impedance characteristic of antenna without matching circuit

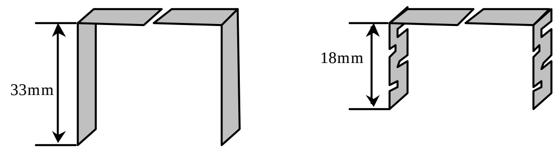


Fig.4 Antenna composition with different length to the perpendicular length

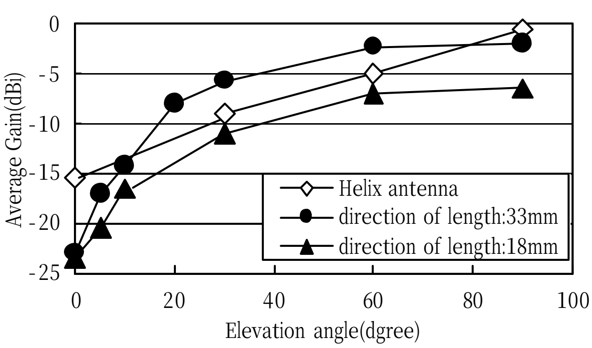
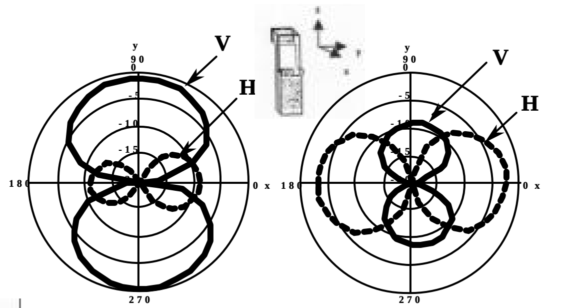
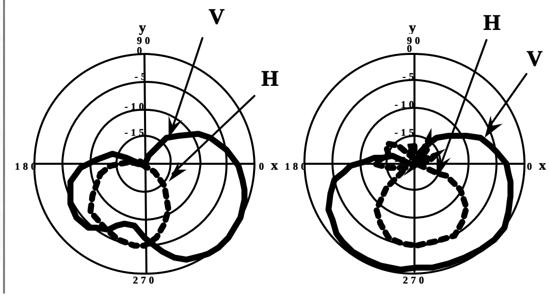


Fig.7 Elevation characteristics



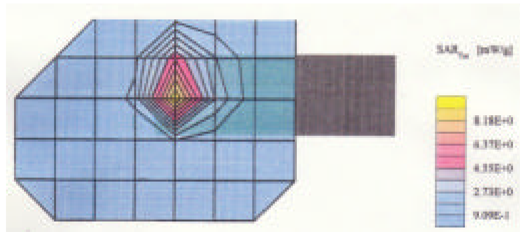
(a) 33mm(V/H:10.1dB) (b) 18mm(V/H:-5.0dB)

Fig.5 Radiation characteristics in free space

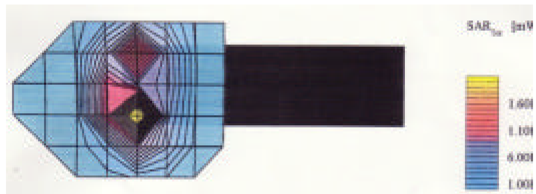


(a) 33mm(-2.2dBi) (b) 18mm(-1.7dBi)

Fig.6 Radiation characteristics in talk position



(a) 1/2 lambda dipole(SAR:8.5mW/g)



(b) 1 lambda dipole(SAR:2.14mW/g)

Fig.8 SAR distribution

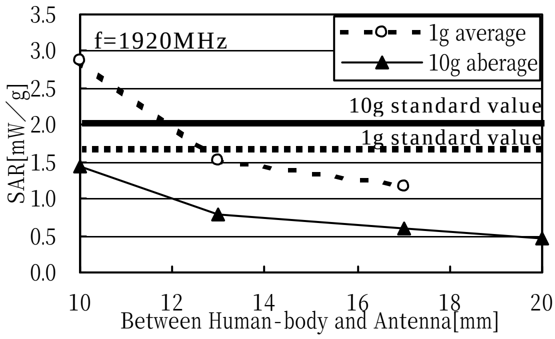


Fig.9 Distance characteristics of SAR value