Topics

Film-type Wideband Multiband Antenna for M2M Device

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With the advancement of Internet and mobile telephone technologies, the use of Machine to Machine (M2M)*1 services is on the rise both in Japan and around the world. Both moving objects such as vehicles and fixed objects such as production machinery are being monitoring with M2M devices. Also, although mobile telephone frequency bands used in many countries are mostly the same, the frequency bands used for M2M services are different in some countries. Hence, with vehicles such as trucks, monitoring with M2M devices might be done using different frequency bands across various countries.

Due to these circumstances, M2M wireless modules must support various wireless systems, and must be equipped with wideband, multiband antennas to handle multiple frequency bands. Furthermore, there are demands for antennas with better installability due to the limited positions and space in which antennas can be mounted in vehicles and on industrial equipment.

In addition, some M2M devices might be used in areas of insufficient radio signal level depending on the operating conditions of the vehicles or industrial equipment. For this reason, high gain antennas are required to enable stable communications in weak radio signal areas.

To meet these demands, NTT DOCOMO has developed a film-type wideband, multiband antenna for M2M devices that supports mobile telephone frequency bands and Wi-Fi®*2. This article outlines the configuration of the film-type wideband multiband antenna and examples of its potential uses.

1) Antenna Configuration

(1) Array antenna

The film antenna introduced in this article adopts an array antenna*3 structure to achieve high gain on multiple bands. **Figure 1** shows the elemental antennas. Fig. 1 (a) shows a low band (800 - 900 MHz)/high band (1,700 - 2,600 MHz, Wi-Fi) combination wideband-type achieved in one element, while Fig. 1 (b) shows a high band-type achieved with one high band element, with the low band element (800 - 900 MHz) omitted from the wideband-type. Both of these elements are designed based on the dipole antenna*4.

Base stations usually have plenty of space to install antennas, and so the low band and high band arrays are usually in different positions.

*1 M2M: Machine-to-Machine Communications between machines. Systems that enable machines to communicate with each other without any human mediation.
*2 Wi-Fi®: A registered trademark of the Wi-Fi Alliance.
*3 Array antenna: An antenna consisting of multiple elements.
*4 Dipole antenna: The simplest of all antenna configurations. The ends of the cable (feeding point) are connected to two straight conductors (antenna elements).

However, due to the space constraints common with M2M antennas, space is saved by positioning the low band and high band arrays in the same place (**Figure 2**). Generally, the distance between elements of array antennas is 0.5 to 0.9 wavelengths, although this depends on the number of elements. Also, directivity*5 gain is maximum with an element spacing of 0.8 to 0.9 wavelengths, however this falls rapidly if exceeded due to the effects of grating lobes*6. Considering this characteristic, configurations with different numbers of elements are used for the different frequencies, three-element arrays for high bands, and two-element arrays for low bands. This is because with a three-element low band array, the normalized wavelength spacing of the elements becomes small due to the long low-band wavelength, therefore the radiative pattern substantially deteriorates and the gain falls. Also, optimizing each elemental spacing in advance suppresses the effects of grating lobes and maximizes gain in all bands.

(2) Using PET (PolyEthylene Terephthalate) sheet

Designed to be attached to vehicle glass, this

*5 Directivity: An antenna radiation characteristic indicating the directional characteristics of radiation strength (or reception sensitivity) from the antenna.

*6 Grating lobe: The radiative pattern of a linear array of evenly spaced antenna elements is determined by the distance between the elements, the number of elements and the beam scanning amount. Certain combinations radiate and can be measured in visible regions of actual space, although some combinations create large lobes (beams) in visible regions separate from the main lobe radiating in the desired direction in invisible regions, which reduces gain in the desired direction. These unwanted lobes are called grating lobes.

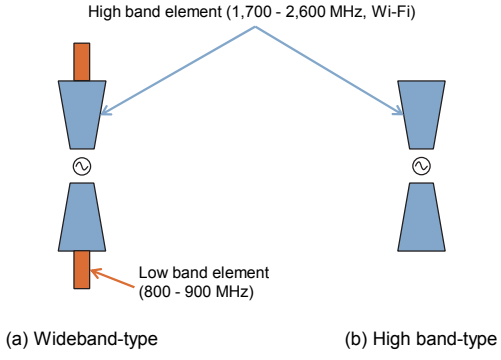

Figure 1 Elemental antennas (images)

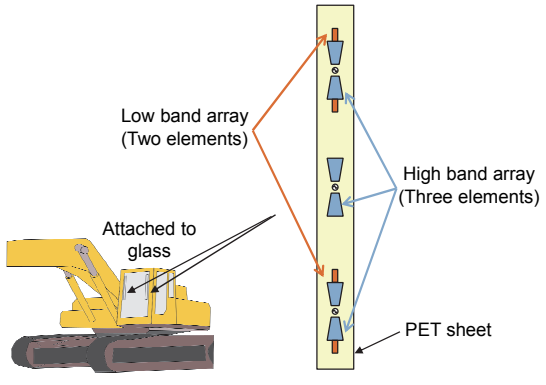

Figure 2 Film-type wideband multiband antenna

antenna uses a 0.1 mm PET sheet instead of the usual printed substrate. Also, the antenna elements are optimized in consideration of the dialectic constant of the glass.

(3) Power combiner

We developed a power combiner for the feed circuit of the antenna to provide two-way power combining functions for the lower-band array antenna and three-way power combining functions for the higher-band array antenna to suit the developed array antenna structure. This power combiner has three ports, with one port having a notch filter to suppress the higher-band frequency signal. This enables the power combiner to output the lower-band and higher-band frequency signals to two and three ports respectively, and hence effectively combine both signals. The output port of the power combiner is fed into the input port of M2M module. The power combiner for receiving signals can also operate as a power divider for transmitted signals.

2) Usage Cases

Making use of thinness and transparency of the film antenna, the following examples of practical application can be considered.

- Glass surfaces of automobiles etc.

  As infotainment*7 is gradually becoming more popular, presumably it will become more common to enjoy video content in passenger and rear seating in vehicles while on the move, which means attachment of this antenna to glass surfaces will preserve visibility in the limited space available in vehicles.

- Monitoring equipment

  As monitoring equipment installed on roadways is designed in consideration of the landscape, film could enable remote monitoring without compromising the landscape by devising ways to install it in certain locations.

- Others

  Depending on the way it's attached, film could also enable anti-theft measures. As well as that, the extensive use of glass in construction in recent years also holds prospects for advantageous applications of this technology.

This article has outlined a film-type wideband, multiband antenna developed to support mobile telephone frequency bands and Wi-Fi. The structure of this array antenna achieves never-before-seen high gain, and uses PET sheeting for excellent installability. As well as being attachable to glass, the technology aims to enable stable communications with M2M devices used all over the world. In the future, this technology has potential to play a role in the expansion of global use of M2M devices.

REFERENCE

[1] The Institute of Electronics, Information and Communication Engineers: "Antenna Engineering Handbook (2nd Edition)," Ohmsha, Ltd., pp.399-409, 2008 (In Japanese).

*7 Infotainment: Services that provide combined information and entertainment. For example, this could refer to combined services that enable on-board music and video appreciation as well as access to map and traffic congestion information.