New Products

# Small and Low-Profile Multiband Antennas for Mobile Phones

## 1. INTRODUCTION

Many improvements are being made in mobile phone equipment to respond to user requirements for multi-functionality, multiband capability to support 3rd generation communication protocols, thinner handsets, and so on. Increasingly antennas are being built in, so that user requirements in terms of communication performance must be met under the stringent conditions inside the handset.

To respond to these requirements, we describe here antennas that we have marketed that incorporate proprietary structures and materials, are thin (only 2.5 mm) and small, and have multiband capability.

## 2. FEATURES

### 2.1 General description

To achieve antennas that are smaller and thinner, yet deliver the required characteristics, we have introduced technologies of basic circuit patterning, materials and structure that differ from those of existing products. Figure 1 shows typical antennas designed to suit various handset configurations. These antennas comprise a 3-layer dielectric, with radiation elements connected to both sides of the dielectric that constitutes the middle layer. The features of these antennas are summarized as follows.

**Figure 1 Typical antennas.**

### 2.2 Parallel 2-Wire Circuitry

The increasing trend to handsets with multiband capability has resulted in a need for antennas that cover an extremely broad range of frequencies. However since antennas are built-in they are smaller and connected to ground, making it more difficult to cover an expanded band. Accordingly we have modified the radiation element with respect to a planar inverted-F antenna (PIFA), thereby reducing the size, and, by disposing in parallel a conductor of substantially the same configuration as the radiation element, have expanded the bandwidth. Simulation data demonstrating this effect are shown in Figure 2.

### 2.3 High Dielectric Loading

By loading a material with a high dielectric constant as the radiation element of the antenna, it is possible to reduce antenna size. However our proprietary conductor structure as described above (a conductor of substantially the same configuration aligned in parallel) presents two problems: 1) if a material of high dielectric constant is loaded between conductors, the bandwidth becomes extremely narrow; and 2) normally materials that have a high dielectric constant also have a high dielectric loss tangent, with a consequent tendency for radiation resistance to decrease.

For this reason we have developed a resin for injection molding which can be applied as a coating to the outside of the conductor only, and which also has a high dielectric constant (approximately 18) while the rise in dielectric loss tangent is held to about 0.002 (the "new material" referred to in Figure 3). By means of this material it has

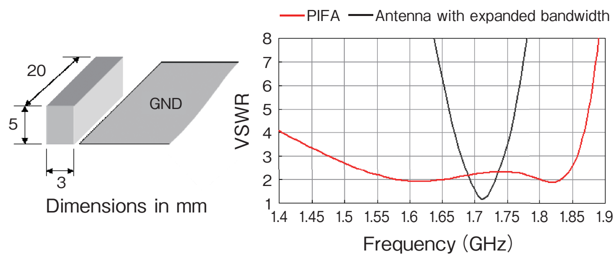


**Figure 2 Example of bandwidth expansion.**

been possible to achieve both reduced size and expanded bandwidth.

### 2.4 Manufacturing Process

To realize the features described above, we have developed a manufacturing process, similar to that for PCBs, in which a middle layer material (low-dielectric material) is fabricated with double-sided interconnect patterning, and is inserted into an injection-molding die for molding, so that the high-dielectric material is coated onto the outside. Further, with this structure and manufacturing process we have achieved antennas of 2.5-mm thickness.

A variety of mounting configurations are in demand for the built-in antennas, depending on the individual handset. As an example, Figure 4 shows a mounting configuration using a PCB that supports coaxial cable power supply. The antenna is disposed in the narrow space under the battery. A wide variety of other mounting configurations are also possible in accordance with handset requirements, such as power supply by spring and direct soldering of power supply terminal to the PCB.

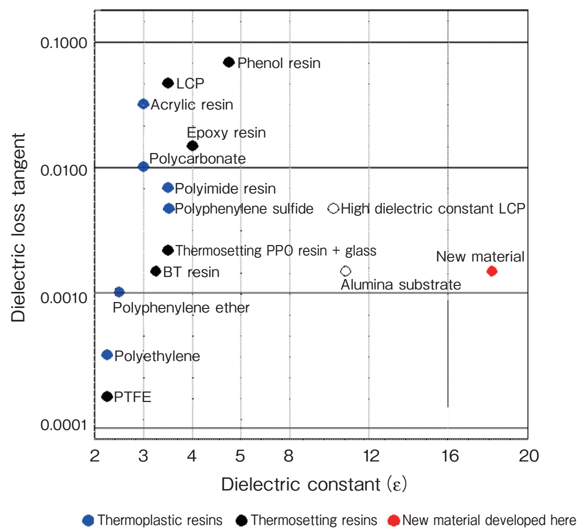


**Figure 3** **Dielectric constant vs. dielectric loss tangent for selected resins.**

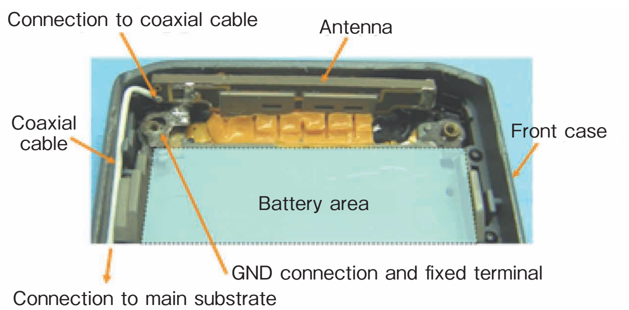


**Figure 4** **Example of antenna mounting.**

## 3. CHARACTERISTICS

Since antenna characteristics are affected by the configuration of the ground connection used, characteristics were evaluated by standard boards (GND) simulating mobile phone size. The frequency characteristics of VSWR are shown in Figure 5 and those for antenna radiation efficiency in Figure 6. In the standard GSM bandwidth (880~960 MHz), VSWR was substantially below 3 and radiation efficiency was substantially above 40 %, and at DCS/PMS/UMTS (1710~2170 MHz), VSWR was below 4 and radiation efficiency was above 40 %, achieving extended bandwidth and high efficiency.

## 4. CONCLUSION

As described above, we believe that these small and thin multiband-capable antennas based on our proprietary structure and materials can contribute to securing communications performance for various types of handsets. We also believe that mobile phones will become even smaller and have even greater functionality, and we remain committed to pushing further with the development of materials and to optimizing antenna design to secure antenna performance, even in this environment.

For more information, please contact:
Antenna Solution Team, Electronics Components Dept., Electronics and Automotive Systems Co., Furukawa Electric
TEL: +81-3-3286-3295 FAX: +81-3-3286-3960

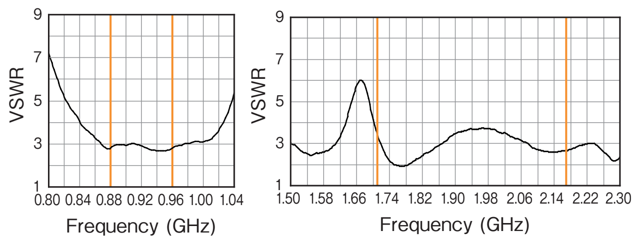


**Figure 5** **VSWR characteristics.**

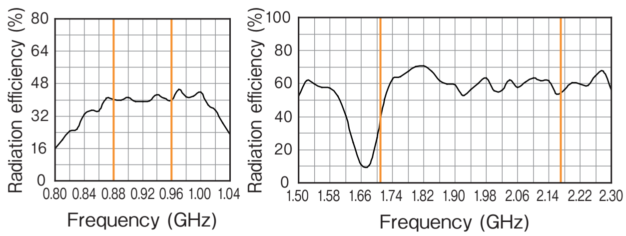


**Figure 6** **Antenna radiation efficiency characteristics.**