Mobile Phones and EMC Design

TDK Corporation Magnetics Business Group
Masashi Orihara

1 Noise Countermeasures for Mobile Phones

Mobile phone functions have been expanding to point where the original telephone function seems just and extra feature. They have developed into mobile tools. Expanded features such as cameras and high-resolution screens mean that higher frequency signals are used, which creates harmonics causing higher levels of noise in the communication frequency band.

Several radio sending and receiving methods are frequencies used for mobile phones. Mobile phones are devices for sending and receiving radio waves, so noise from the phone itself can become interfering waves that can deteriorate performance. Devices themselves are compact, so the noise source and the antenna for sending and receiving are very close, within 10 cm. As a result, even a small level of noise causes the input power to the antenna to become large.

This problem is directly related to reception sensitivity, so it is not a serious problem in locations where there is a strong radio wave. However, it can be impossible to receive a signal in locations where the radio wave is weak.

To resolve this issue, noise suppression components can be added to signal lines on the baseplate where the harmonics flow, which cause noise. Figure 1 shows examples of countermeasure components.

Different signal transmission interfaces are used according to mobile phone performance and cost, so it is necessary to select components according to this. Generally, Common Mode Filters are used for high-speed differential transmission lines, which have balanced transmission, whereas chip beads and three-terminal filters are used for single-ended lines, which have unbalanced transmission. Recently, reception functions for FM radios, TVs, wireless LANs, and GPS (Global Positioning System) have been added to mobiles phones. Therefore, it has become necessary to implement noise countermeasures over a wide frequency band. TDK's MZA1608 chip bead array, which contains multiple lines integrated into one chip, and MEA1608 three-filter array, which contains four lines and is 1608 size (1.6 × 0.8 mm), have been developed as countermeasure components to be equally effective for multiple signal lines. In addition, the TCM1608 Series of Common Mode Filters, which are 1608 size and contain two pairs of filters, have also been developed.

It has become common to use a combination of these components as countermeasures for low to high frequencies and for common mode and differential mode.

Figure 1 Block Diagram of Mobiles Phones and Explanation of Countermeasure Components

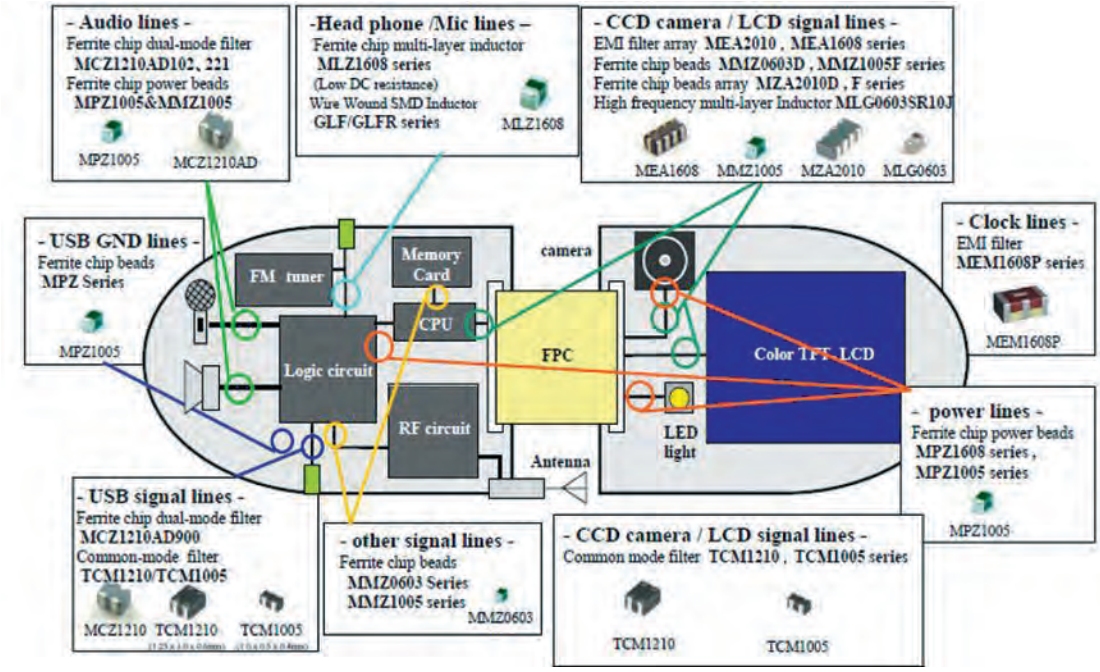
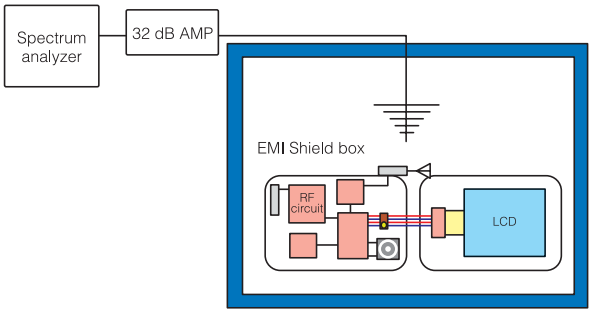


Figure 2 Measurement Connection

Noise from the terminal was measured when a video was played at full-screen display



2 Countermeasures

Many portions in mobiles phones use digital signals including the data from display units such as LCDs and camera modules. Therefore, high-order harmonics at these locations are radiated as noise from lines on the baseplate or from cables that connect baseplates. It is necessary to remove unnecessary harmonics that are originally supposed to be the data signal by reflecting them using inductor components that are inserted on the signal line by using heat transformation due to resistance components, and by using bypass to the GND via capacitor components between the GND.

Three-terminal filters with inductors and capacitors, chip beads with magnetic materials, and Common Mode Filters with magnetic coupling can be used. Chip beads and Common Mode Filters can be used in combination with chip capacitors.

3 Examples of Noise Countermeasures

Digital Signal Line

Figure 3 shows the noise mainly from the FPC (Flexible Printed Circuits) received by the 1seg antenna of an actual mobile phone. It was found that the noise level greatly increased in the 470 to 770 MHz range, which is used for digital TV. Therefore, a three-terminal filter was used on the signal line (image signals to the LCD) before it reached the FPC.

As shown in Figure 3, it was confirmed that noise could be greatly reduced by using the MEA1608PE three-terminal filter array.

This shows that the main cause of the noise was the FPC.

Figure 3 Emission Noise from a Mobile Phone

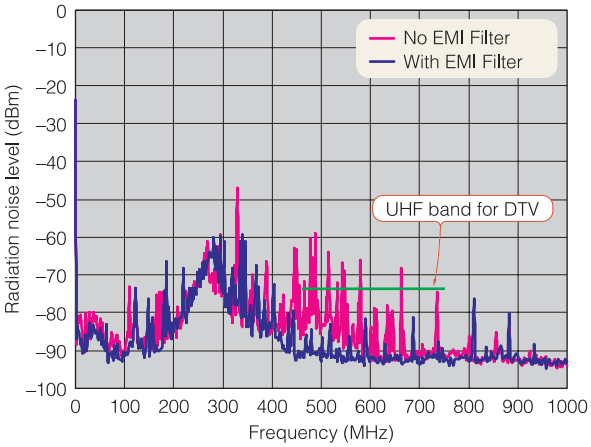
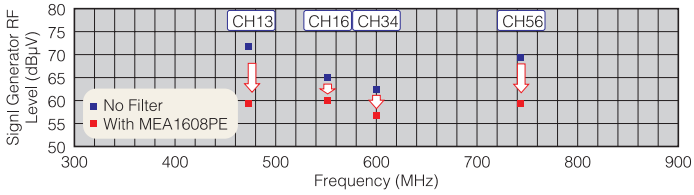


Figure 4 shows the evaluation results for improving reception sensitivity for 1seg broadcast using a filter. It was found that the noise that interrupted the broadcast wave could be reduced, and the original reception sensitivity could be restored.

Figure 4 Improved 1seg Reception Sensitivity when a Filter is Used

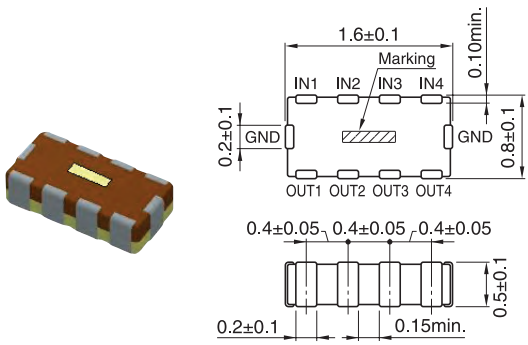


Channel	Channel Frequency	Sensitivity Improvement
13	473 MHz	13 dBμV
16	551 MHz	5 dBμV
34	599 MHz	6 dBμV
56	743 MHz	10 dBμV

Figure 5 shows the size and characteristics of the MEA1608PE220 component that was used for the test. By comparing this with MEA1608LC (Figure 6), which is a conventional product for mobile phones, it is possible to acquire a large amount of attenuation at 500 MHz maximum, which is the low frequency for the digital TV broadcast frequency band. This was realized using the same 1608 size as the conventional product by reviewing the filter circuit and the design for the built-in multilayer coil and capacitor.

Figure 5 MEA1608PE220 Three-Terminal Filter Array

Appearance, Size, and Frequency Characteristics



Dimensions in mm

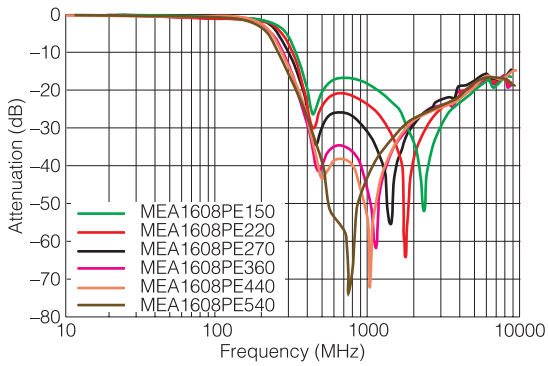
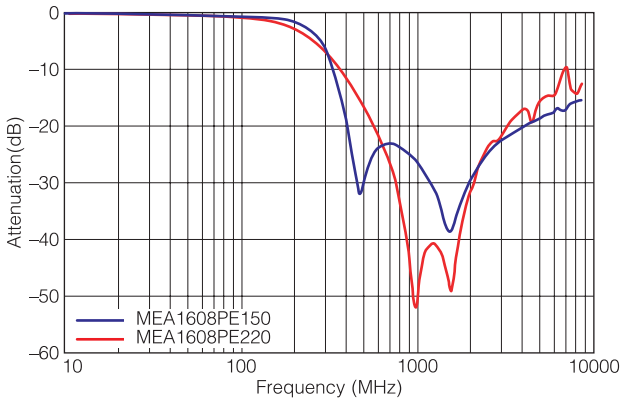


Figure 6 Comparison of Frequency Characteristics for MEA1608LC and MEA1608PE



Compared to the conventional MEA1608LC (Figure 9), the MEA1608PH Series (Figure 7), which has a high-frequency cutoff (–3 dB), can be used for higher signal frequencies. TDK's product lineup contains filters according to the frequency where noise needs to be reduced. However, it is also necessary to consider the influence on the signal waveform. It is also important to consider the capacitance in addition to the bandpass characteristics of the filter.

Figure 7 Filter for Higher Passband Frequencies for Handling High-Speed Signals

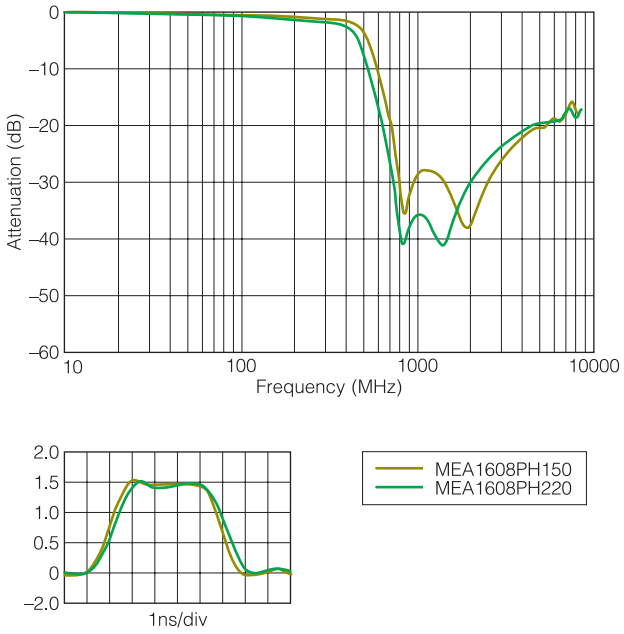


Figure 8 shows a comparison of the signal waveform and attenuation after passing the filter. Compared to the capacitance of 22 pF (MEA1608LC220), 4 pF (MEA1608LC040) had a shorter signal rise time and improved response characteristics.

It is necessary to select components with a lower capacitor capacitance when high-speed signal rise is needed.

Figure 8 Changes to the Signal Waveform by the EMI Filter

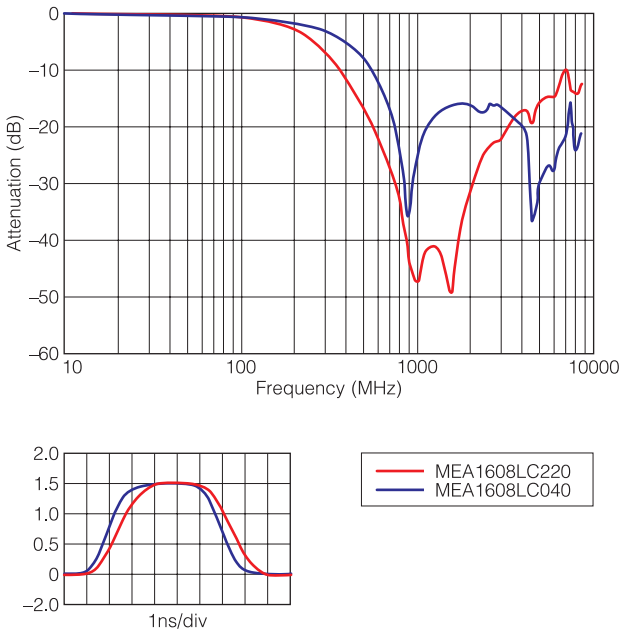
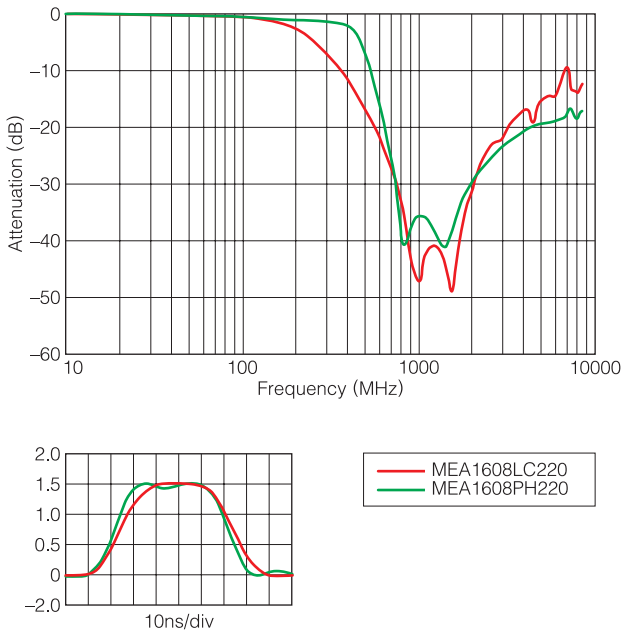


Figure 9 Comparison of Frequency Characteristics for MEA1608LC and MEA1608PH

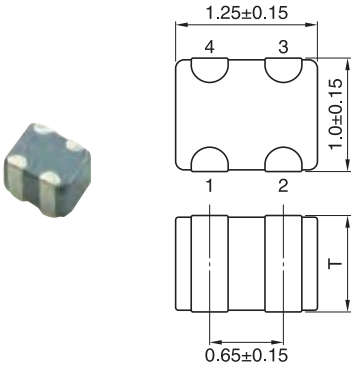


Audio Signal Lines

Burst noise can occur on audio systems due to the transmission waves of mobile phones. As a countermeasure, chip beads and common mode chip beads can be used on the audio line of microphones and speakers. Figure 10 shows examples of characteristics and internal circuits for the MCZ1210 Series of common mode chip beads.

Figure 10 MCZ1210 Common Mode Chip Beads

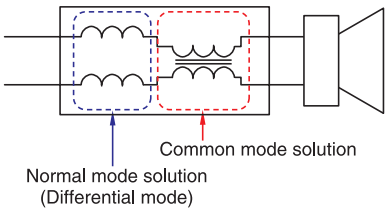
Appearance, Size, and Frequency Characteristics



Dimensions in mm

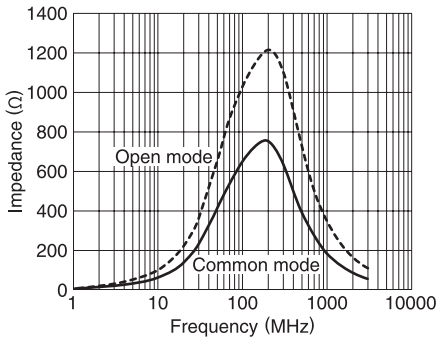
T	Weight
0.5±0.10mm	3 mg
0.85±0.15mm	4 mg

MCZ1210AD102
for Audio signal line



Impedance Frequency Characteristics

MCZ1210AD102



MCZ1210AD221