Mobile Phone
EMC Design for Differential Interference

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1 Background

Mobile phones have become multifunction devices with many different functions contained in a small body including digital cameras, 1seg TVs, music players, and electric money (as known as e-money). Some mobile phones are equipped with full keyboards and they can be used like computers. In addition, displays have become larger and have higher resolution requiring faster signal transmission. As a result, differential transmission has begun to be used in addition to single-ended transmission. Therefore, conventional noise countermeasures for single-ended transmission are no longer enough. This section will explain examples of noise countermeasures for mobile phone differential transmission lines.

2 Mobile Phone Differential Transmission Lines and their Countermeasures

Basic System Configuration and Signal Flow

Differential signals are used for the following three systems, as shown in Figure 1.

1. From the CPU to the LCD line
2. From the CPU to the camera line
3. From the CPU to the USB2.0 line

These lines are connected using an FPC or thin coaxial cable. However, because they are long, they can act as antennas and radiate noise, which becomes a factor that negatively affects peripheral circuits, especially the RF circuit. Generally, the differential transmission method has less noise, but in reality, self-poisoning occurs when there is skew between signals or noise from other circuits enters the signal line.

Noise Countermeasures

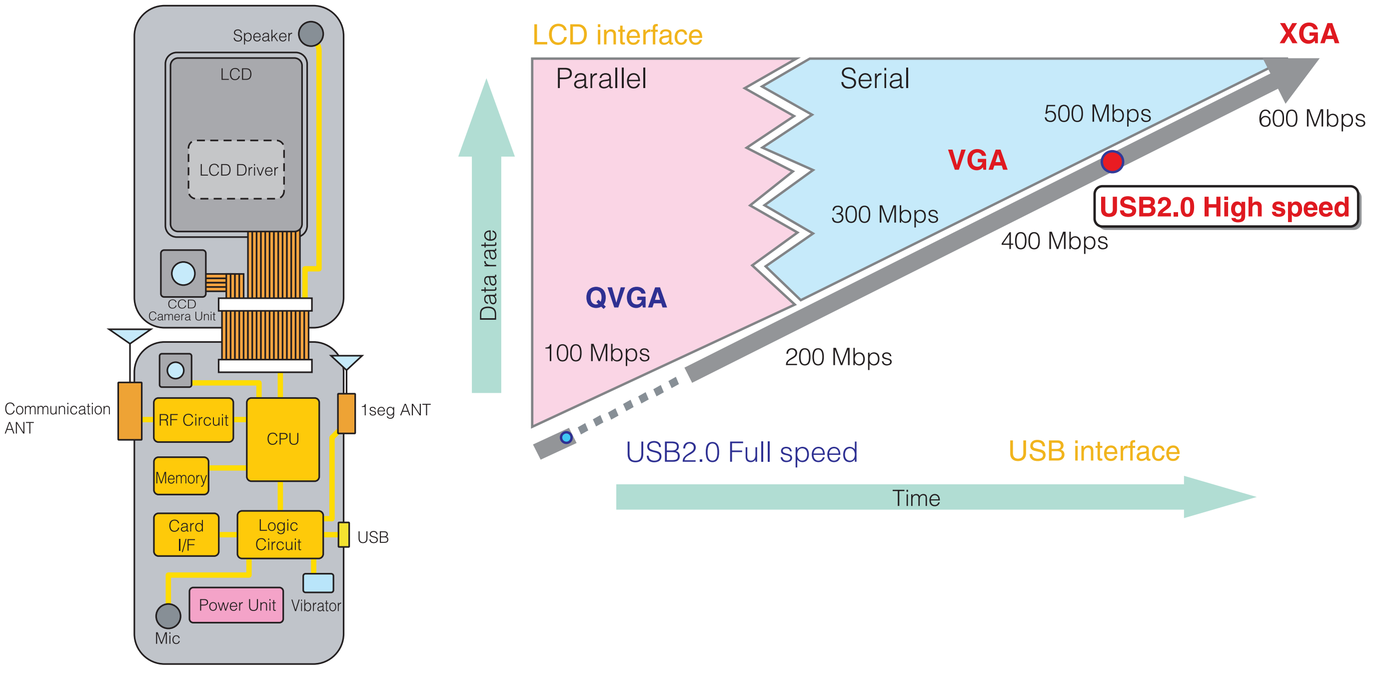
In order to prevent self-poisoning, it is necessary to suppress unnecessary noise from cables that can act as antennas.

1. Cable (transmission line) impedance matching → Reflection noise
2. Pattern design to prevent skew → Common mode noise due to skew
3. Component and cable layouts that prevent noise

There are usually restrictions for implementing item 3 because of the device design. Therefore, items 1 and 2 are important.

When items 1 and 2 are not sufficient for reducing noise, it is necessary to use filters that are compatible with differential signals.

Figure 1 Signal Waveform Quality



Method for Suppressing Differential Signal Noise

As is important with suppression of all signal line noise, it should be possible to acquire the maximum noise suppression while minimizing the effect on the signal. From this viewpoint, Common Mode Filters are the only components that can reduce common mode noise without affecting the signal.

The following are examples of this suppression method.

Examples of Countermeasures for LCD Differential Interface

CPU → LCD Controller

The following are examples of countermeasures using actual devices.

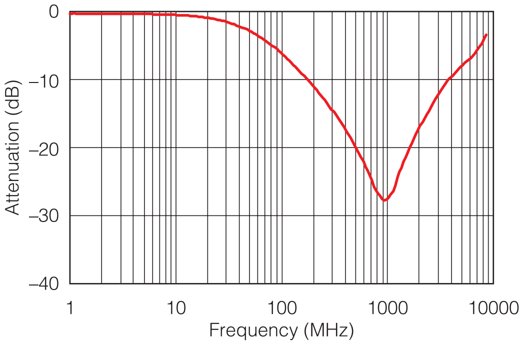
First, the Common Mode Filters that were used had the following characteristics.

1. Common Mode Attenuation (Scc21) Figure 2

   This is an index for measuring the removal of common mode noise from differential signals.

   The greater the amount of attenuation, the greater the common mode noise is attenuated.

Figure 2 Scc21

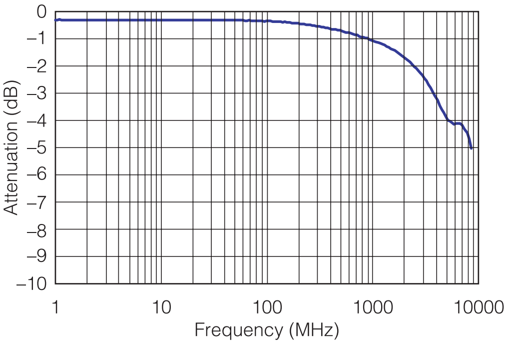


2. Differential Attenuation (Sdd21) Figure 3

   This is an index for measuring the influence (weakness) on the differential signal.

   The smaller the attenuation, the smaller the effect on the signal waveform. Generally, this is referred to as the cutoff frequency.

Figure 3 Sdd21



Next, Figure 4 shows the signal waveform when a Common Mode Filter is installed.

When a filter is used, signals can be transmitted on the clock and data lines without affecting the waveform.

Figure 4 Signal Waveform Quality

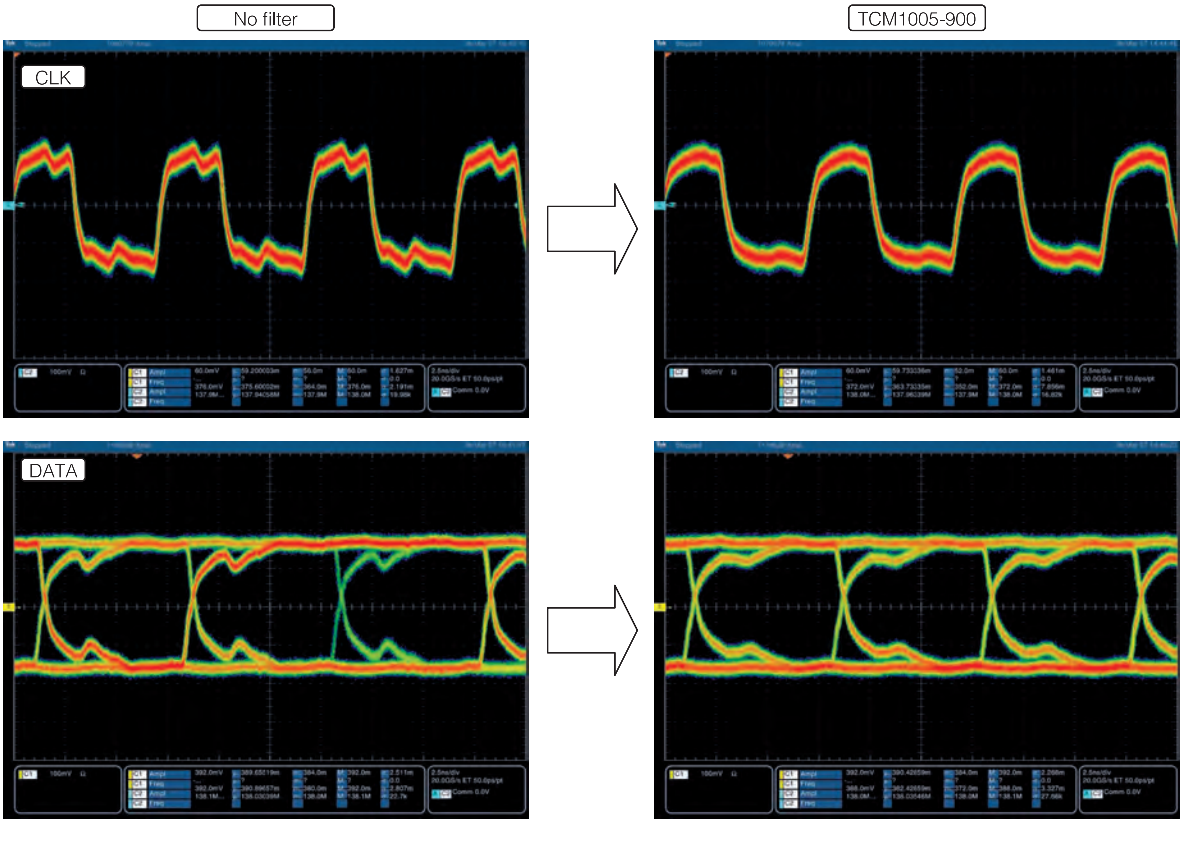
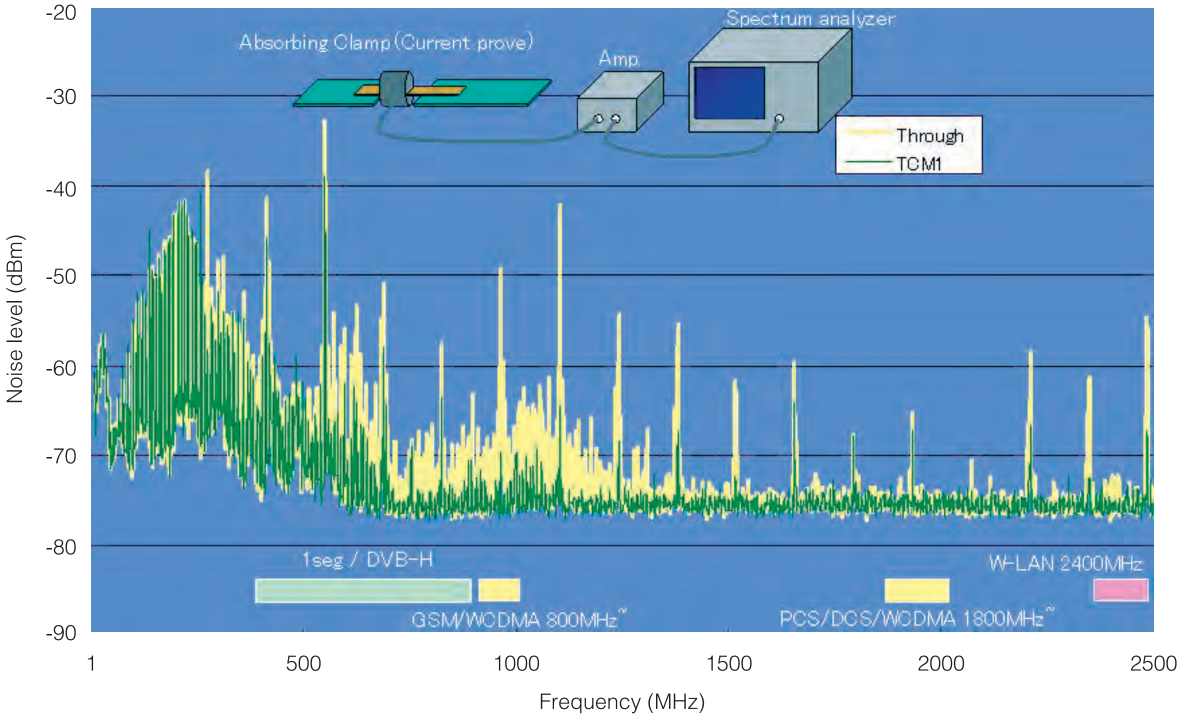


Figure 5 shows the effectiveness of the noise countermeasure. This data shows how much noise is generated from the LCD differential interface of a mobile phone.

Figure 5　Signal Waveform Quality

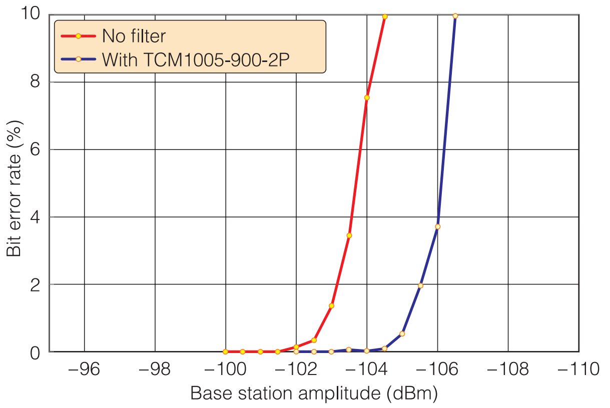


It was found that the harmonic noise of the differential signal occurred in the 1seg band and communication frequency band of the mobile phone. Noise was greatly attenuated when a Common Mode Filter was installed.

The following shows the effectiveness for improving reception sensitivity of mobile phones by reducing the noise of the differential interface.

In Figure 4, noise at the GSM band was suppressed when a Common Mode Filter was used, and the amount of noise passing the communication antenna decreased. It was also found that reception sensitivity was improved by several dB.

Figure 6　Mobile Phone Reception Sensitivity (GSM900 Band)



3 Conclusion

In the future, LCD resolutions will continue to increase and built-in cameras will have more pixels, so it is expected that differential interfaces will become even more widely used. Therefore, it will be more important to optimize the designs for signals, GNDs, and shielding.

If more countermeasures are needed even when these are optimized, please consider using Common Mode Filters, which are effective for differential signals.