

# Murata Controls Noises of HDMI-Compliant Devices

Several methods using common mode choke coils were evaluated to implement an effective noise suppression measure in A/V systems compliant with HDMI ver.1.3a.

The development of high-definition (HD) capable products is increasing in the field of digital home appliance, and full HD models have become conventional among TVs and DVD players. Recently, the development of digital camcorders and game machine products, which can reproduce high-resolution videos, has also been gaining ground.

Until now, analog D-terminal connectors and component terminals have been used as video terminals for HD-capable equipment. As products move toward higher resolution, a digital differential interface called High-Definition Multimedia Interface (HDMI) is being adopted, making digital equipment more suitable for high-speed transmission.

Aside from having features such as less signal attenuation and high external noise resistance, the HDMI has an advantage

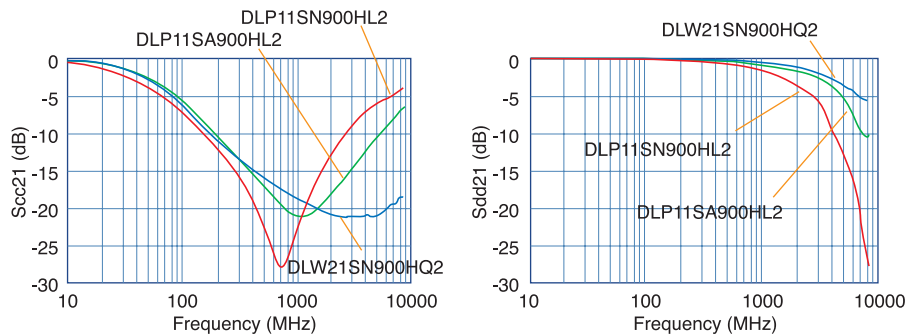


Fig. 2: Static characteristics of common mode choke coils used for the evaluation

of less radiation noise because the signal lines cancel out each other's magnetic field. In reality, however, the problem of radiation noise can sometimes occur because of the common mode noise induced by coupling in an IC and peripheral circuits, or by the mode conversion from a differential signal.

In such cases, employing noise suppression measure using a common mode choke coil becomes effective, because it has a little effect on signal waveforms and can eliminate common mode choke noise. It should be noted, however, that caution should be exercised because the common mode choke coil to be selected and its placement will be different depending on the signal frequency, peripheral circuits, and peripheral components.

High-Definition Multimedia Interface is an interface that can simultaneously transmit video and audio signals through three pairs of data lines and one pair of clock lines. Figure

1 shows an outline diagram of transition minimized differential signaling (TMDS) that is being used by HDMI. The maximum data transfer efficiency is 10.2Gbps and the data signal frequency for a pair of lines is 1GHz or higher. Initially, HDMI is capable of transmitting video with a resolution of up to 1080p or 8-bit True Color. Meanwhile, HDMI version 1.3, which was developed in 2006, can transmit video images with a resolution of 1080p or 12-bit Deep Color.

Murata Manufacturing Co., Ltd. studied a method of using the common mode choke coil effectively for HDMI version 1.3 in relation to radiation noise, signal quality, and time domain reflectometry (TDR).

## Radiation Noise Suppression Measures

In the process, the company connected two devices equipped with HDMI using a 3m-cable and measured the radiation noise in the frequency range of 1 to 5GHz. Table 1 shows the specifications of each of the common mode choke coils manufactured by Murata Manufacturing namely, the DLP11SN900HL2 and the DLP11SA900HL2, both having dimensions of 1.25 × 1.0mm, and the 2.0 × 1.2mm-size DLW21SN900HQ2. The company has installed the common mode

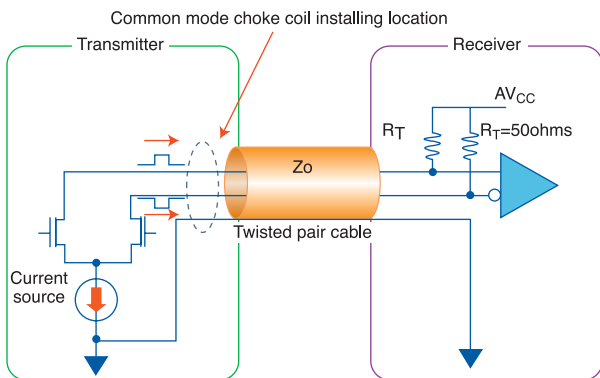


Fig. 1: Outline diagram of HDMI

Table 1: Specifications of common mode choke coils used for the evaluation

Part No.	Common code impedance ( $\Omega$ )	Rated current(mA)	Rated voltage(Vdc)	Size(mm)
DLP11SN900HL2	90 $\pm$ 20%	150	5	1.25 × 1.0
DLP11SA900HL2	90 $\pm$ 20%	150	5	1.25 × 1.0
DLW21SA900HQ2	90 $\pm$ 25%	280	20	2.0 × 1.2

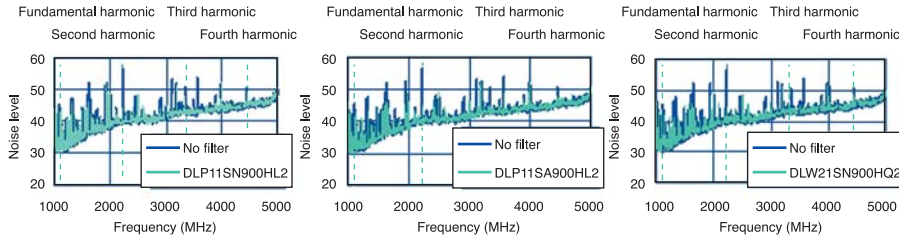


Fig. 3: Radiation noise evaluation of HDMI (horizontally polarized waves)

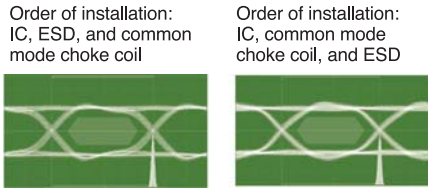


Fig. 4: HDMI waveform evaluation results

choke coils in signal lines and clock lines and confirmed the radiation noise reduction effect. The resolution of the data transmitted in this evaluation was 1080p or 12-bit Deep Color with maximum signal frequency of 1.11GHz. Figure 2 shows the common mode transmission characteristics, specifically Scc21, where the noise elimination effect increases in proportion to the value of Scc21, and the differential mode transmission characteristics, Sdd21, where the effect on signal waveforms decreases in proportion to the Sdd21, of the common mode choke coils used for the evaluation.

Figure 3, on the other hand, shows the result of the radiation noise measurement when these common mode choke coils are used. The figure shows that the common mode choke coils can be used to suppress radiation noise at 1GHz or higher. In particular, a large noise suppression effect in the harmonic components of signals was observed. In all cases where common mode choke coils were used, the noise at 2.22GHz is at-

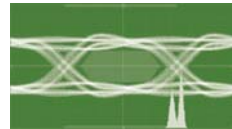


Fig. 5: Waveform evaluation results of using 1GHz cut-off frequency common mode choke coil

tenuated by approximately 10dB. The attenuation volume for noise at 3.33GHz and 4.44GHz varies depending on the common mode choke coils used. The noise suppression effect of the DLP11SN900HL2 was less than the other common mode choke coils because the Scc21 value of DLP11SN900HL2 is lower in bands higher than 3GHz as shown by the data in Fig. 2. Based on Fig. 2 and Fig. 3, it is assumed that HDMI requires a common mode choke coil that has an attenuation volume of 10dB or higher in bands higher than 3GHz.

**Maintains Waveform Quality**

Murata Manufacturing has evaluated the waveforms based on the compliance test standards of HDMI version 1.3. A video signal generator was used as a signal source while the 12-bit Deep Color signals were used as the output. The company has evaluated the waveforms in case where common mode choke coils are used together with a com-

monly used electrostatic-shielding device (ESD). Fig. 4 shows the waveforms that were transmitted when the installing locations are changed. The DLP11SN900HL2 was used for this evaluation, with a cut-off frequency of 3.5GHz as the common mode choke coil and a 1.0pF-capacitance device as the ESD. However, engineers are advised to exercise caution as the effect on transmitted waveforms of an electrostatic-shielding device varies depending on its capacity and the location for installation.

Figure 5 presents the signal waveform generated when the common mode choke coil with a cut-off frequency of approximately 1GHz was used. The waveform distortion was large and the waveforms did not comply with the standards. After investigating the relationship between transmitted waveforms and cut-off frequencies of common mode choke coils, it has become clear that a common mode choke coil with a cut-off frequency of 3.5GHz or higher is required in order to assure sufficient mask margin for transmitting 12-bit Deep Color signals.

**Impedance Matching**

The evaluation result of the image impedance of a common mode choke coil using the TDR measurement instrument is presented in Figure 6, where the image impedance of a component is an index equal to the characteristic impedance of transmission lines. Impedance matching is necessary to transmit a signal without reflecting it. The figure also shows

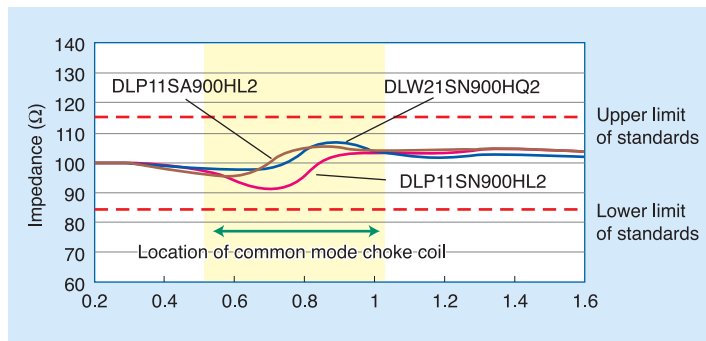


Fig. 6: Image impedance of common mode choke coil

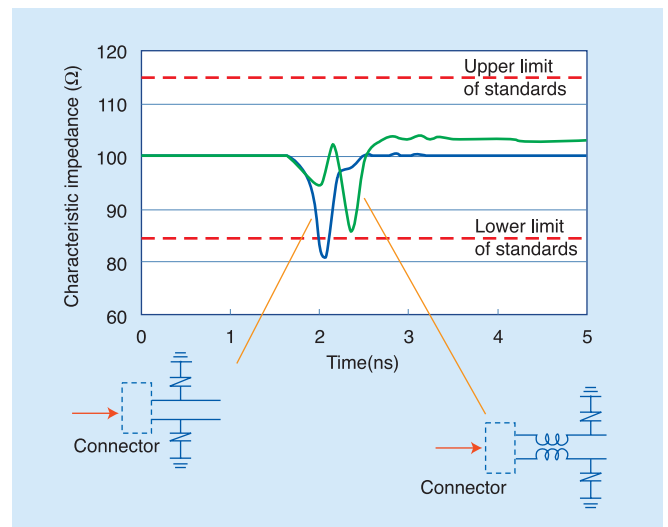


Fig. 7: TDR evaluation using an ESD together with a common mode choke coil

## Anti-Noise Technologies and Products

that the common mode choke coil used for this evaluation comply with the  $100 \pm 15\Omega$  level as required in HDMI standards.

In the case of using an ESD, sometimes the value of the image impedance cannot comply with the required standards due to the capacitance components used in an ESD. In such a case, the impedance can be matched by using the ESD together with a common mode choke coil. Figure 7 presents the image impedance of a standalone ESD that has a capacitance of 1.0pF, and the image impedance when the DLP11SN900HL2 common mode choke coil is used between a connector and an ESD. As shown in Fig. 7, the impedance standards can be satisfied when a common mode choke coil is used.

### Conclusion

Following the evaluations made, Murata Manufacturing identified the effective noise suppression measures of common mode choke coils used in HDMI version 1.3 or 12-bit Deep Color and the methods to implement them. First, the Scc21 value of a common mode choke coil must be high in order to suppress noises in the gigahertz-band. When the frequency band is 3GHz or higher, the Scc21 value must be 10dB or more. Second, the cut-off frequency of a common mode choke coil must be 3.5GHz or higher to assure sufficient eye pattern margin. Lastly, in order to provide antistatic measures, the connector must be installed first, followed by the ESD then the common mode choke coil. However, matching the impedance will become difficult and there-

fore caution is required.

The evaluation made by Murata Manufacturing studied the method of using common mode choke coils in HDMI, taking into consideration interface standards, signal frequency, and peripheral circuits, resulting to the establishment of effective noise suppression measures.

The company aims to continue offering optimal noise suppression methods amid the expected standardization of new video system interfaces in the future.

### About This Article:

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Please note the specification tables are to be corrected as follows.

Table 1: Specifications of common mode choke coils used for the evaluation

Part Number	
Error	Correction
DLW21SA900HQ2	DLW21SN900HQ2