

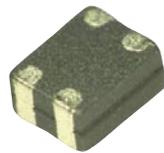
# Commercialization of Common Mode Filters for DisplayPort and Application Examples

TDK Shonai Corporation Satoru Saitoh

Dempa Shimbun High-Technology May 21, 2009 Edition

## 1. Commercialization background

Recently, digital devices are able to handle larger volumes of data due to market demands. In the past, signal transmissions were single ended, but now, differential signal transmissions are mainly used for transferring large volumes of data at high speeds.



1210 size common mode filter for DisplayPort TCM1210U series

Computers, which are used here as an example of a digital device, often handle video and high-resolution images, and computers are requiring faster transmission speeds. As a result, multiple interfaces exist. Here, the commercialization background of common mode filter noise suppression components for high-speed signals such as DisplayPort, which is a type of computer external interface, and examples of noise suppression will be explained according to the following.

- DisplayPort
- High-speed common mode filters
- Noise suppression examples
- Conclusion

## 2. DisplayPort

DisplayPort is a high-speed digital interface for displays, and was formed by VESA to standardize video interfaces for computer related devices. The current trend is to replace LVDS with DisplayPort for connection lines between computers and LCDs, and in the future to replace signal transmissions with laptop LCDs. Circuits using DisplayPort can be simpler than circuits using LVDS. Connectivity with consumer devices is also ensured, so it will become more common in the future.

## 3. Higher-speed common mode filters

Higher resolution transmission signals such as HDMI, which is used for LCD TVs, are becoming more common and are replacing the conventional LVDS and DVI. This trend is required for computer peripheral devices, and as a result, the new standard DisplayPort was established.

When selecting the best noise suppression components for high-speed differential transmission interfaces, the cutoff frequency (frequency with an attenuation of -3dB), which is one of the filter characteristics, is an important index to consider. The basic frequency for DisplayPort is in the GHz band as shown in Table 1. Therefore, existing types of common mode filters designed for the MHz

**Table 1 Computer digital interface**

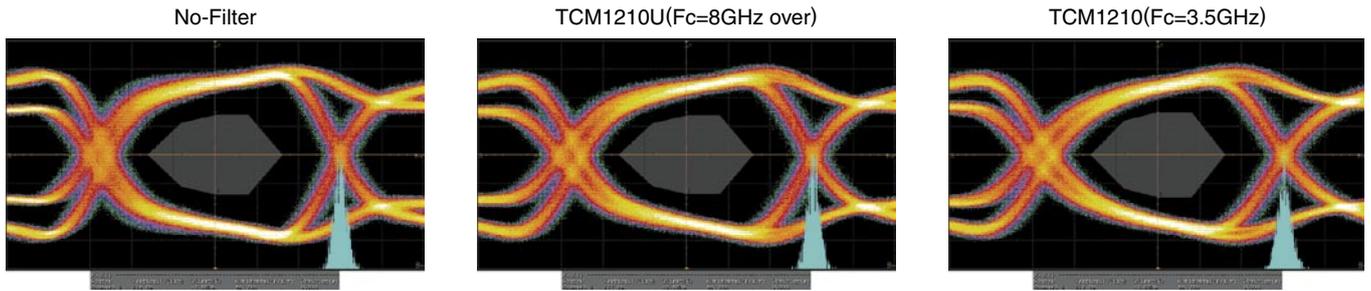
Applied interface	DisplayPort	LVDS	DVI	HDMI	USB2.0 HS	USB3.0 SS
Bit rate (Frequency)	2.7Gbps (1.35GHz)	(1.0GHz and lower)	1.65Gbps (825MHz)	3.4Gbps (1.7GHz)	480Mbps (240MHz)	5.0Gbps (2.5GHz)
Differential pair	4-pair	14-pair	4-pair	4-pair	1-pair	3-pair include HS
AC-coupling	Yes	None	None	None	None	Yes
Audio support	Yes	None	None	Yes	None	None

( ) shows basic frequency

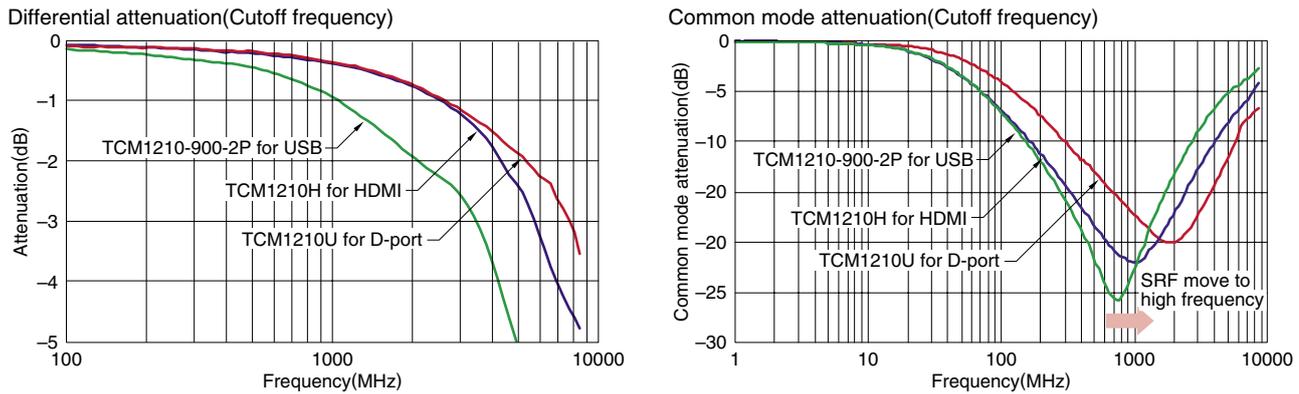
**Table 2 TDK common mode filter**

Type	Differential insertion loss (Cutoff frequency)	Comon mode impedance [100MHz]	Characteristics impedance	Recommended interface
TCM1210	3.5GHz	90Ω	100Ω	USB2.0 HS
TCM1210H	6.0GHz	90Ω	100Ω	HDMI, DVI
TCM1210U	8.0GHz	50Ω	100Ω	DisplayPort etc.

**Figure 1 DisplayPort eye pattern diagram**



**Figure 2 Comparison TCM series characteristics**



band cannot be used. This is because there is an eye pattern diagram test for evaluating signal transmission quality as shown in Figure 1, and the cutoff frequency of TDK's TCM1210 common mode filters used for USB 2.0 is 3.5GHz, which does not contain the range for the eye pattern. On the other hand, the TCM1210U common mode filters that were developed for DisplayPort show the waveform almost the same as when no filter is used. This is because the TCM1210U cutoff frequency is 8.0GHz, so influence on the signal can be minimized. TDK's common mode filters for high-speed signals can remove only common mode noise without affecting the interface waveform.

Table 2 shows a TDK thin film common mode filter for interfaces.

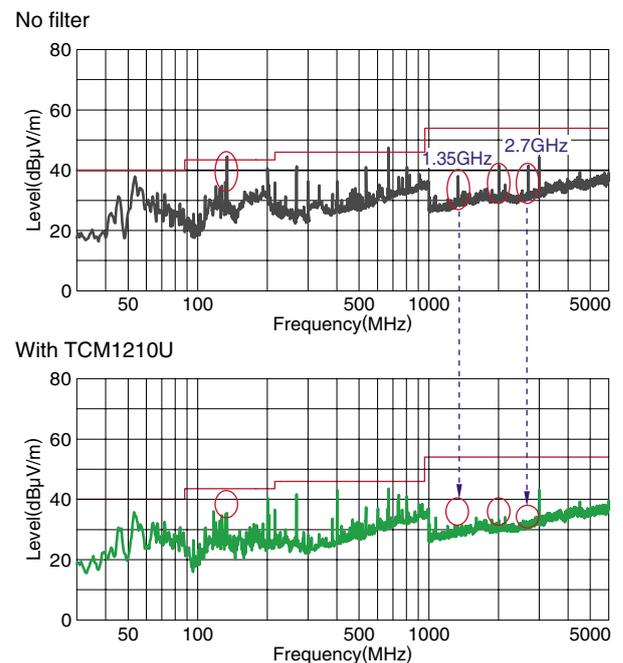
The TCM1210H series of products with a cutoff frequency of 6.0GHz for HDMI are an existing thin-type high-speed common mode filter by TDK. We also have the ACM2012H wound type product available.

The TCM1210U is a commercialized filter for DisplayPort based on TDK's improved thin film technology used to manufacture magnetic heads for HDDs. This optimal design allows for our new commercial common mode filters to have a high cutoff frequency. We are now studying in order to achieve smaller, higher speed products while improving the accuracy of our thin film technology.

## 4. DisplayPort noise suppression examples

As mentioned previously, TDK's common mode filters are used to remove only common mode noise efficiently without affecting differential transmission signals in harmony with market demands. The following shows the noise level when connecting a desktop computer to an LCD monitor using a DisplayPort cable.

**Figure 3 DisplayPort noise suppression example**



## 5. Conclusion

As explained previously, when using DisplayPort, data signal transmission speeds are expected to increase. It is assumed that devices compatible with SuperSpeed USB3.0 (5.0Gbps) will begin to enter the market during 2010. Devices are designed to not have noise, but there is some noise that occurs because of the higher speeds. Therefore, based on TDK's original technologies such as thin film processing and materials, we will continue to develop and commercialize smaller noise suppression components with higher functionality and complexity as key parts for noise management.

The top graph shows the noise level without using a filter, and the bottom graph shows the noise level using a TCM1210U series common mode filter for DisplayPort. The basic frequency for DisplayPort is 1.35GHz, and the noise attenuation efficiency by the common mode filter at the harmonics frequency is about 5dB. This is very effective when the noise emitted by DisplayPort lines or cables is over the noise standard such as by the FCC. It was also found that common mode filters are effective for each peak noise and base noise emitted by desktop computers in addition to harmonics from the DisplayPort. This is because the noise from other circuits was transferred as common mode noise to the DisplayPort signal line.

Generally, common mode filters are used for suppressing noise when the noise level is high. Current computers (especially laptop computers) have communication functions such as 2.4GHz WLANs, and 900MHz GSM/WCDMA band communication modules. Therefore, common mode filters are used to suppress noise (to prevent self-jamming). For example, noise radiated by interface cables can be transferred to the transmitting/receiving antenna inside of a computer causing the communication sensitivity, which is important for wireless communications, to degrade. Therefore, common mode filters are used to improve communication sensitivity on the LVDS lines of LCDs. Similar problems are expected with computer LCD interfaces using DisplayPort. Therefore, TCM1210U will be effective for suppressing such noise.

**Table 3 List of products**

### ELECTRICAL CHARACTERISTICS

Part No.	Common mode impedance ( $\Omega$ )[100MHz]	Cutoff frequency (GHz)	DC resistance ( $\Omega$ ) max.[1line]	Rated current DC(mA)max.	Rated voltage DC(V)max.	Insulation resistance (M $\Omega$ )min.
TCM1210U-120-2P	12	8.5typ.	0.70	100	10	10
TCM1210U-300-2P	30	8.5typ.	0.75	100	10	10
TCM1210U-500-2P	50	8.0typ.	1.40	100	10	10

• Operating temperature range: -25 to +85°C

• Please note that the articles from the May 21, 2009 Edition of the Dempa Shimbun contained in this chapter have been edited by our company.