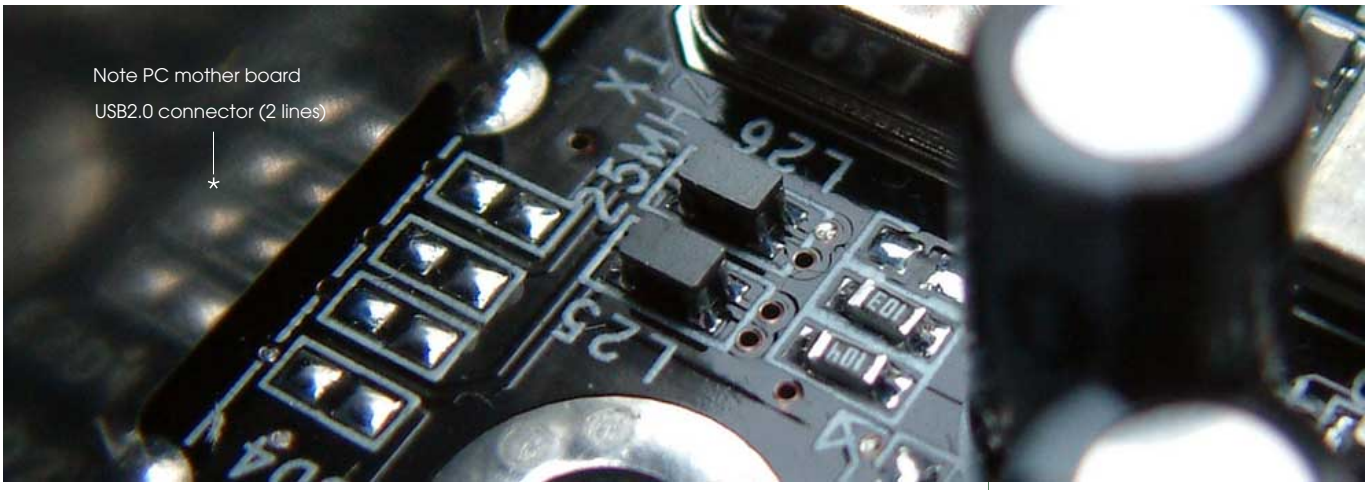


Ferrite Chip Common-mode Filters For High-speed Signal Lines, ACM2012 series

Conforming to RoHS Directive

Conformity to RoHS Directive: This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used, except for exempted applications.

We're offering four ideal specifications optimized for USB2.0 (480Mbps) and IEEE1394 (400Mbps/100Mbps)

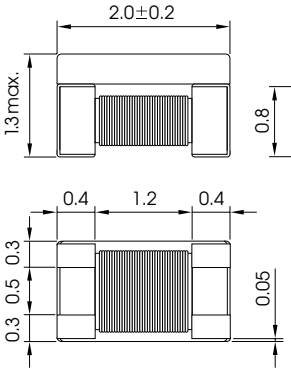
The high precision formation technology and the automatic coiling and terminal connection technologies of our micro core units achieve a coupling coefficient between coils of more than 0.99. While improving removal of common-mode elements accumulated on signal lines, the deterioration of signal waves by differential-mode impedance has been reduced to one of the lowest levels in the industry.

Of course, this also provides superb absorption/stabilizing protection from common-mode elements (skew fluctuation) created by differential signals' phase lags, voltage differences, and so forth.

The device optimized for USB2.0 complies with the

32bit interval signal (SYNC Field) standard, so demonstrating performance at the industry's highest level. The three products for IEEE1394 also have ideal impedance characteristics without distorting Speed Signal waveforms.

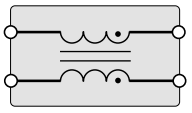
Shapes and dimensions



Weight : 7.5mg
Dimensions in mm

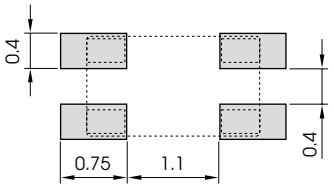
Equivalent circuit

Nondirectional

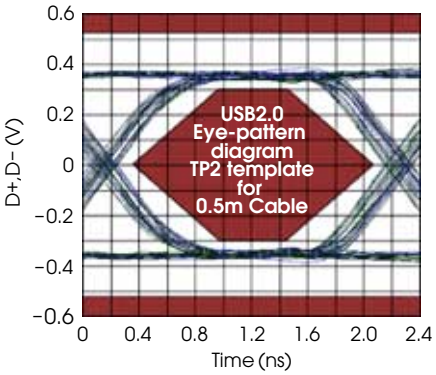


Recommende PC board pattern

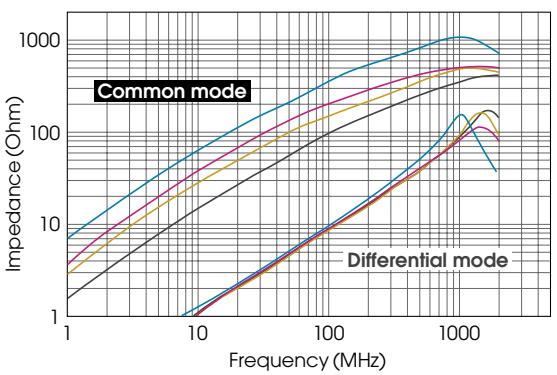
(Reflow process)



Providing ideal USB2.0 transmitting waveforms (ACM2012-900-2P)



Optimized impedance vs. frequency characteristics



Recommended product for USB2.0

ACM2012-900-2P

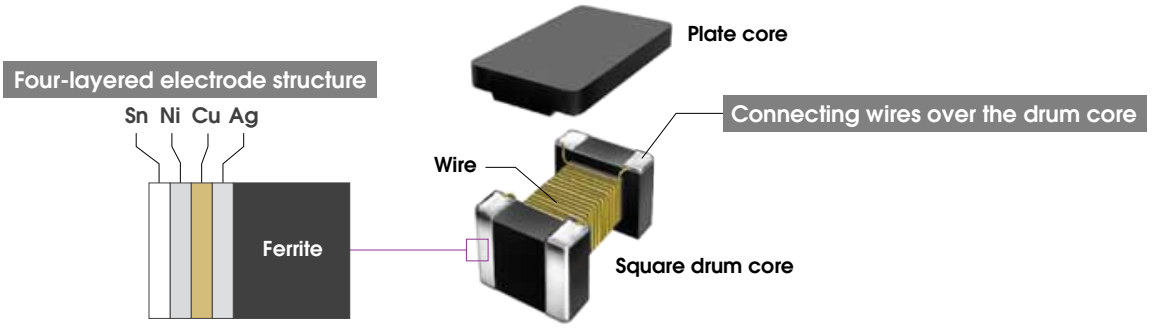
Recommended product for IEEE1394

ACM2012-121-2P
ACM2012-201-2P
ACM2012-361-2P

Original coil-connection structure offers excellent implementation reliability and fixing strength.

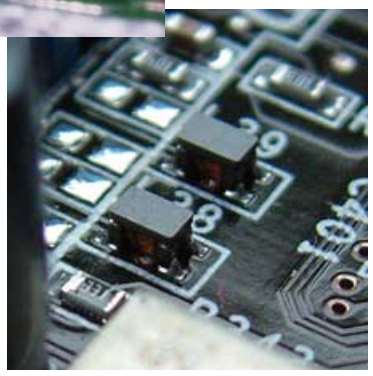
ACM2012 series

Original terminal electrode and coil-connection structure capable of maintaining land pattern smoothness and solder fillet were applied. Superb implementation reliability and fixing strength were achieved by improving the smoothness of the surfaces of terminal electrodes.



High-level reliability is, of course, also achieved.

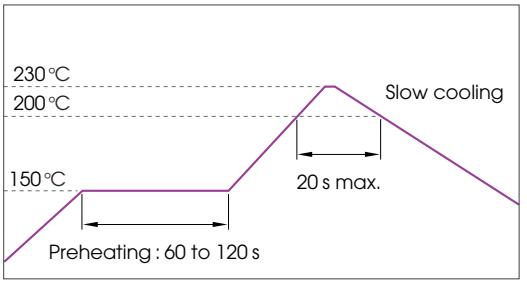
It easily passed TDK's reliability tests for solder ability, soldering heat tolerance, side-pressure strength, flexure strength, high-temperature load, moisture load, thermal shock, low-temperature properties, vibration, and so forth. As well as applicability to fast automatic attaching systems, it readily responds to high reliability demands for diverse applications with advanced designs.



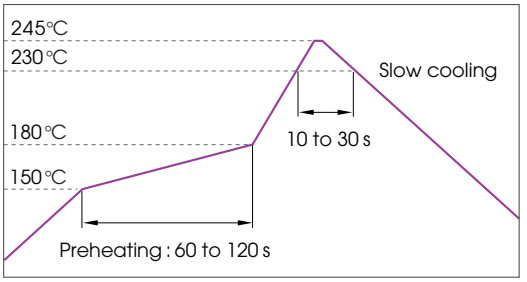
T1.3mm World smallest size

Recommended soldering conditions

Eutectic solder/Reflow process



Lead-free solder/High-temperature reflow process



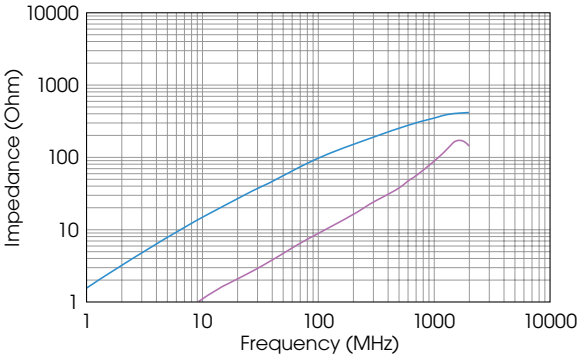
Frequency characteristics and Electrical Characteristics

Impedance vs. frequency characteristics

Common-mode Differential-mode

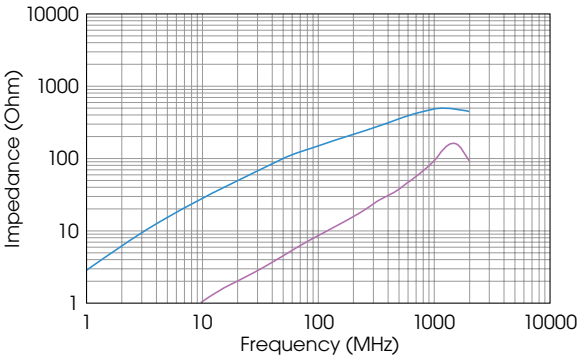
Recommended product for USB2.0

ACM2012-900-2P



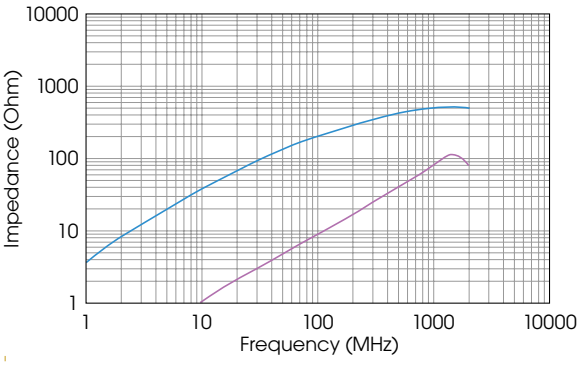
Recommended product for IEEE1394

ACM2012-121-2P



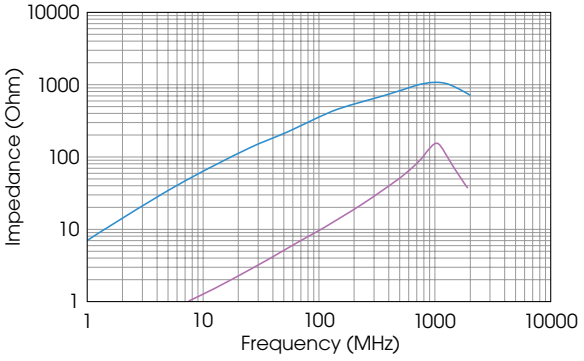
Recommended product for IEEE1394

ACM2012-201-2P



Recommended product for IEEE1394

ACM2012-361-2P



Electrical Characteristics

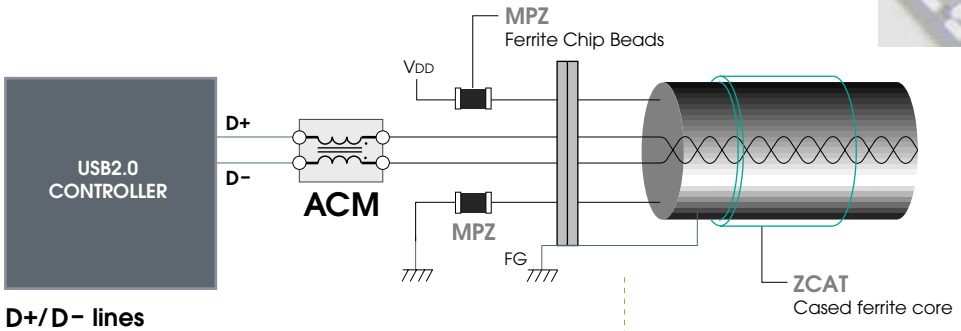
Recommended product lineup

Part No.	Impedance (Ohm) (at 100MHz)		DC resistance (Ohm)max. (1-line)	Rated current (mA) max.	Rated voltage (V) max.	Recommended applications Transmission speed (bps)			
	Common mode (typ.)	Differential mode (ref.)				USB1.1 12M	USB2.0 480M	IEEE1394 100M	IEEE1394 400M
ACM2012-900-2P	90	7	0.19	400	20	◎	◎		○
ACM2012-121-2P	120	8	0.22	370	20	○	○		◎
ACM2012-201-2P	200	8	0.25	350	20			○	◎
ACM2012-361-2P	360	10	0.5	220	20			◎	

Operating temperature range : −25 to +85°C

USB2.0 Interface

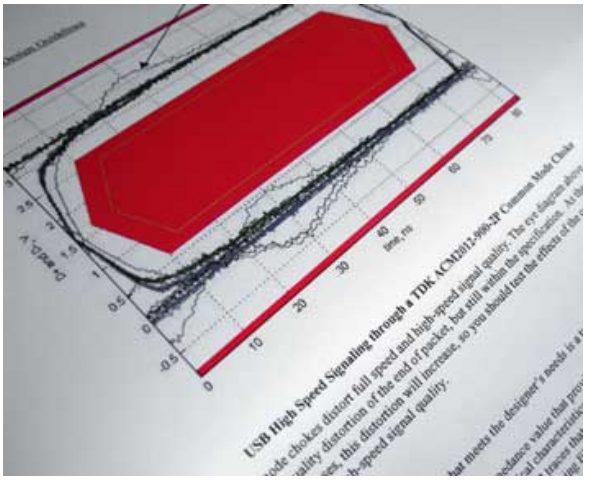
ACM2012 series



D+/D− lines

480Mbps

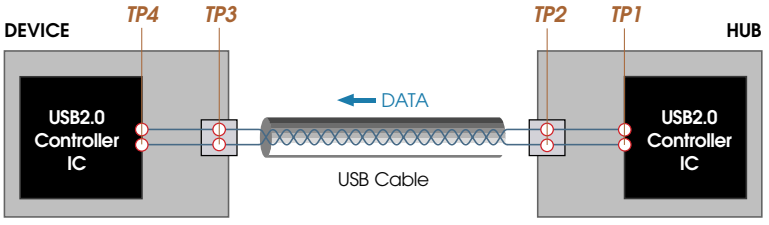
ACM2012-900-2P



Requirements for USB2.0 differential signal waveforms

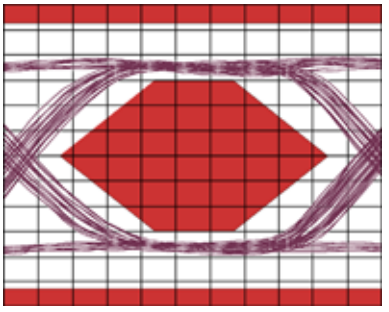
USB2.0 has standards for prevention of performance errors. In coping with EMC, more attention should be directed to the Eye pattern wave forms standard – which specifies the acceptable range of transmitted differential signal wave forms – and the requirement specifying the lower limit of the first bit voltage in a 32bit interval signal (SYNC Field) transmitted at the beginning of every data transmission.

Four observational points for the Eye pattern wave forms standard



USB2.0 transmits data in a differential 400m Vp-p signal. The Eye pattern wave forms standard defines templates* of distortion limits of waveforms at four observational points in a common example where the sending side (HUB) and receiving side (DEVICE) are connected by a USB cable.

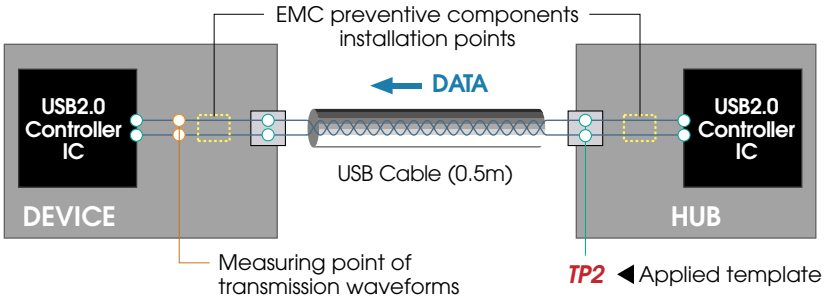
The template TP1 at the output of the USB2.0 trans-receiver on the sending side has the severest condition. TP2, TP3, and TP4: the higher the number, the further it is from the output end, and the less severe the conditions. Also, the longer the cable is, the more resistance it has, and so the smaller the pulse voltage range (D+, D- values) of differential signals becomes.



*Transmitted waveforms should not enter the red zone (Eye pattern) in any template.

USB2.0 Interface

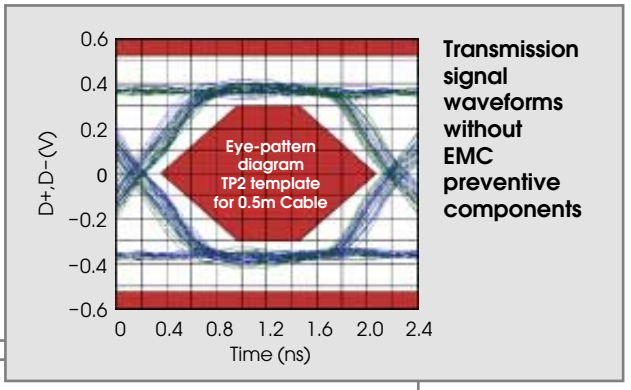
ACM2012 series



To simulate actual use conditions, this operations test is conducted using the same EMC preventive components on both the receiving and sending ends. The results below are for the use of a 0.5m cable with measurements at a location close to TP3. To prove the superiority of ACM, the TP2 template, where conditions are severer than TP3, was used.

Actual measurement example of the differential signal waveform of USB2.0

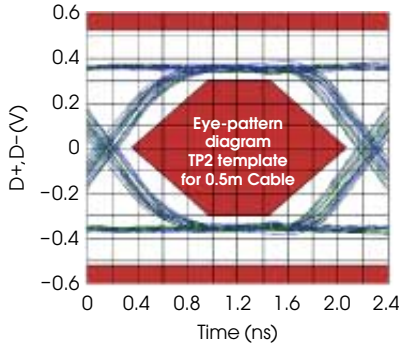
At USB2.0's data transmission speed (High speed) of 480Mbps, the repeat pulse frequency reaches 240MHz. Careful consideration has to be given to possible influence on the signal waveforms when choosing EMC preventive components to reduce radiant noise from the cables.
An example of how the characteristics of EMC preventive components effect the waveforms is shown below.



Transmission signal waveforms without EMC preventive components

Waveform when ACM2012-900-2P is applied

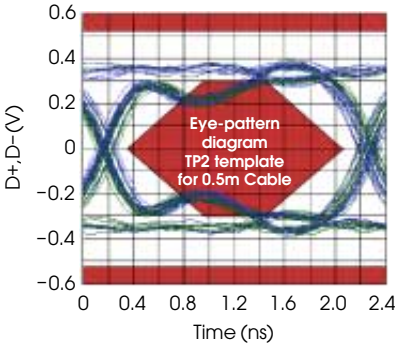
Common-mode Z:90Ω/100MHz
Differential-mode Z:18Ω/240MHz



Favorable transmission waveforms are achieved with appropriate CMF characteristic impedance* and low differential-mode impedance.

Waveform when other common-mode filters are applied

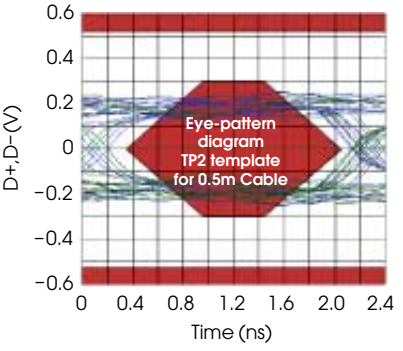
Common-mode Z:600Ω/100MHz
Differential-mode Z:40Ω/240MHz



You can expect reduced EMI. But signal waveforms will be greatly distorted because of mismatched CMF characteristic impedance, and therefore are not applicable.

Waveform when high-loss chip beads are applied

Z:120Ω/100MHz



Transmission signals will be greatly attenuated because of the high impedance of high-loss chip beads, and are therefore not applicable.

* CMF characteristic impedance: With the USB2.0 standard, the required characteristic impedance of a common-mode filter(CMF) is 90 ohms.

USB2.0 Interface

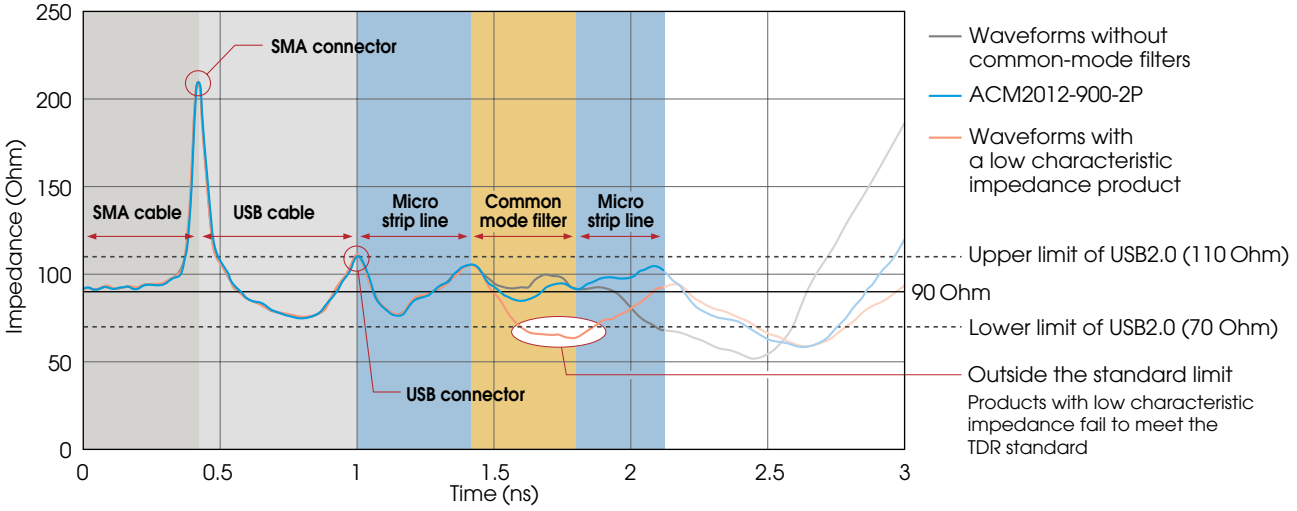
ACM2012 series

USB2.0's compliance with the TDR standard

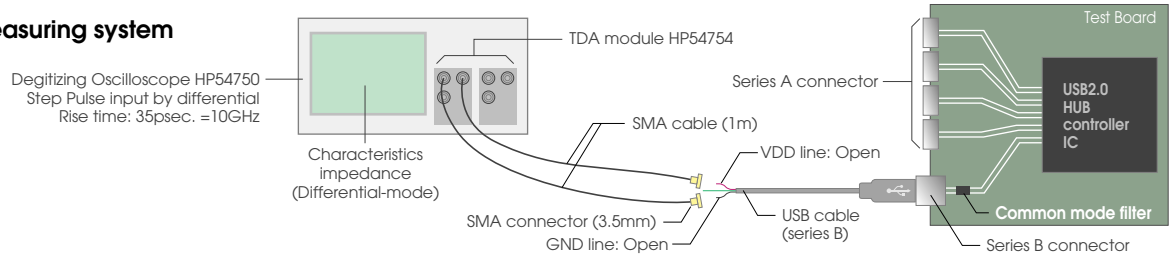
TDA : Time Domein Reflectometer

All interface standards have predefined characteristic impedances; 90 ohms for USB2.0; 110 ohms for IEEE1394; and 100 ohms for TMDS. When selecting common-mode filters for interfaces it is important to know whether or not the choice is optimized for the interface. The characteristic impedances of TDK's recommended products are adjusted to those of the recommended interfaces. They comply not only with the TDR standard's upper and lower limits, but also with the Eye pattern waveforms standard with ideal transmission waveforms as shown in the measurement results below.

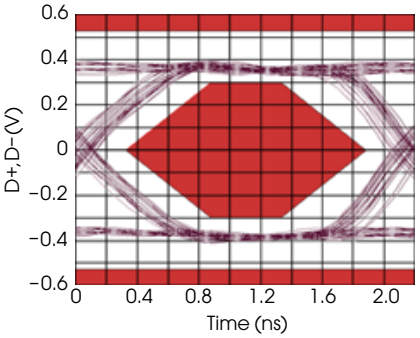
Example comparing with a common-mode filter with different characteristic impedance



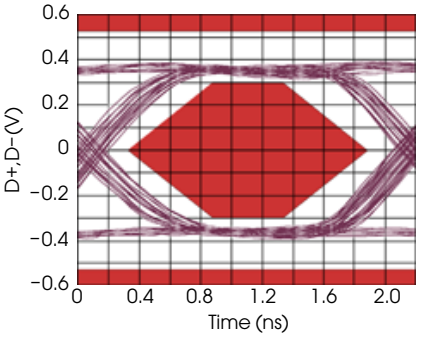
Measuring system



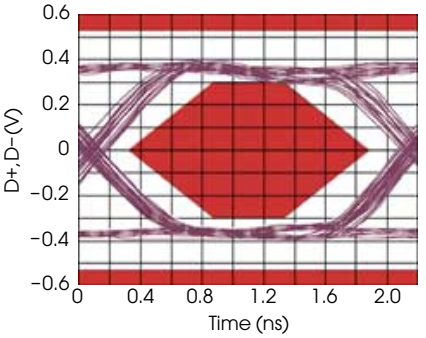
Waveforms without common-mode filters



Waveform when ACM2012-900-2P is applied



Waveform when low characteristic impedance products are applied



USB2.0 Interface

ACM2012 series

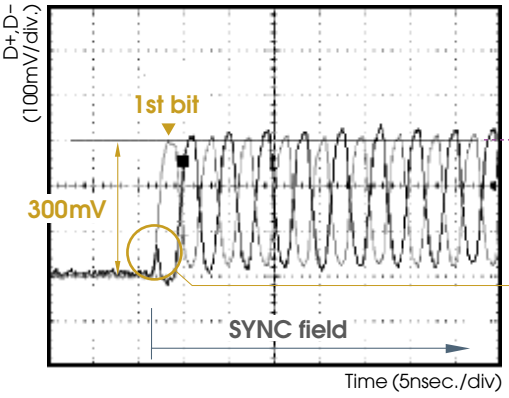
SYNC Field response waveforms of USB2.0

USB2.0 transmits data over a differential signal of 400mVp-p.
When it completes a session of data transmission, it sends
a 32bit interval signal before the next data transmission.

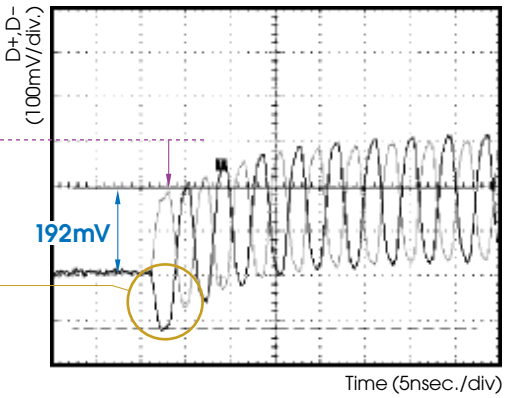
With a common-mode filter applied as an EMC preventative, the initial signal of the 32bit signal field (SYNC Field) is shifted to the negative, so the voltage peak value decreases far below the initial level when no countermeasure is taken.

To prevent transmission errors caused by this feature, it is vital to maintain a voltage over 150mV starting from the initial bit of the SYNC Field. It is very important to consider this when choosing the correct common-mode filter, as well as the Eye pattern wave forms standard.

Response waveforms without EMI preventive components

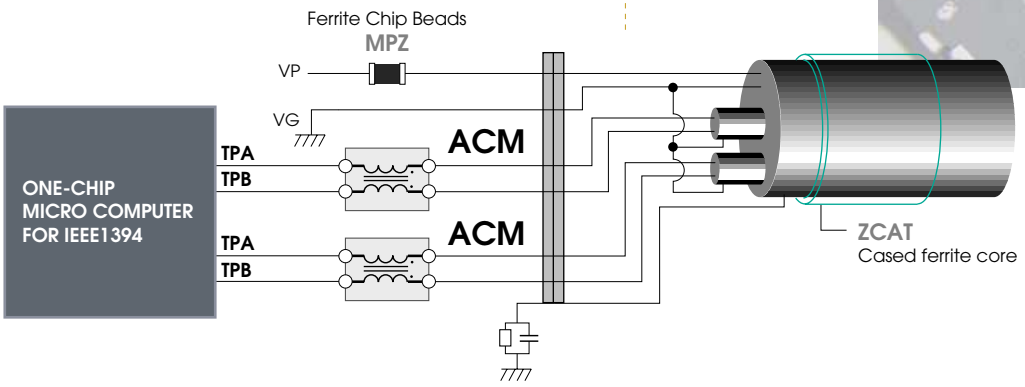


Response waveforms with ACM2012-900-2P



IEEE1394 Interface

ACM2012 series



TPA / TPB lines

for 100Mbps

ACM2012-361-2P

for 400Mbps

ACM2012-121-2P

ACM2012-201-2P

EMC countermeasures for IEEE1394 interfaces

Development of IEEE1394 has been accelerated as a rapid interface for the home network environment where digital home electronic appliances can be interconnected without computers. IEEE1394 also uses the differential transmission method. The correct differential impedance frequency characteristics must therefore be considered just as in the case of USB2.0. Distortion or disturbance of waveforms are a concern in high-speed transmission particularly, and so intense evaluation through operational tests are required.

The two recommended products of the ACM2012 series are ideal for that case. Both have their differential impedance reduced to the lowest level to provide good EMI prevention properties without the degradation of signal quality.

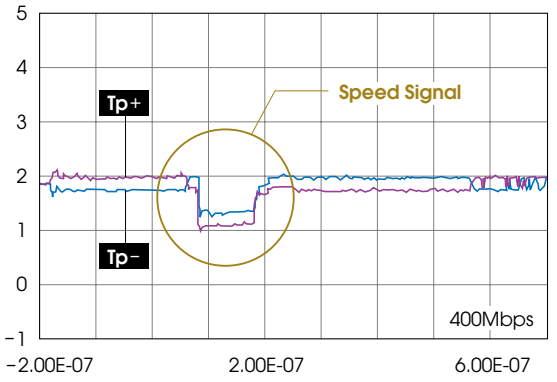
Speed Signal transmission waveforms of IEEE1394

Another important consideration in common-mode filter selection for IEEE1394 interface lines is the possible impact on Speed Signal waveforms.

This signal is used to detect data transmission speed (100, 200, and 400Mbps) and sent in common mode just like the USB2.0's "SYNC Field" described earlier. A common-mode impedance value of the common-mode filter must be chosen within a boundary which doesn't significantly distort the waveforms.

The three recommended products have common-mode impedances of 120, 200, and 360 ohms (at 100Mhz). It has been confirmed through transmission tests that there is no waveform distortion which could lead to errors.

Example of Speed Signal transmission waveform



Sample example

Effect of common-mode impedance on the Speed Signal waveforms