Thin Film Common-mode Filter For High-speed Signal Lines, TCM2010 series

TDK's Thin Film Common-mode Filter TCM2010 series are all lead-free and ready for high-temperature lead-free solder processing. In addition to being lead-free, no mercury, cadmium, hexavalent chromium, PBB, or PBDE -- which the RoHS directive is trying to abolish -- are contained in the products.

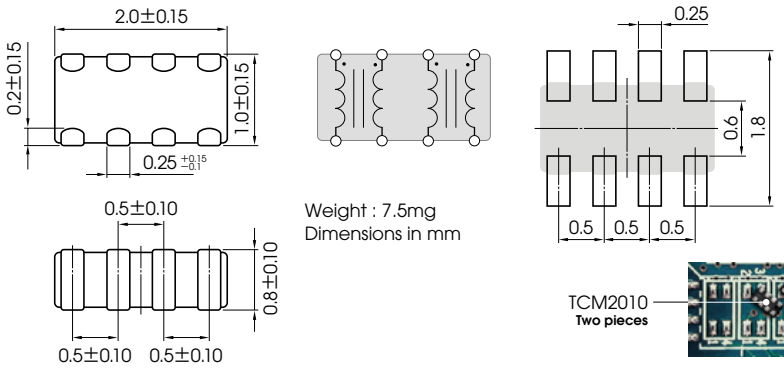
Pb Free

The state-of-the-art chip array offers an unprecedented level of circuit-condensation effect and superb high-frequency noise deterrence, as well as an EMI countermeasure for high-speed data transmission lines.

The world-leading thin-film magnetic head wafer formation technology and cutting-edge mass-production process are integrated in our original layered magnetic circuit design technology based on super tiny chip integration.
Two sets of common mode filters structured with two super tiny thin-film coils are condensed in the 0.8mm thick 2010 chip.
This chip array is enough for an IEEE1394 interface. Plus, the circuit board area occupied is as small as 2.0mm2. Also, as an EMI countermeasure on LVDS lines of laptop computers with four chip common node filters (single element) of 3216 size, the actual mounting area can be reduced by more than 80% by replacing it with TCM2010. Its specifications go beyond the conventional level, realizing a frequency characteristic of immense EMI deterrence in a wide range of frequencies, while significantly deleting transmission signal affectors.

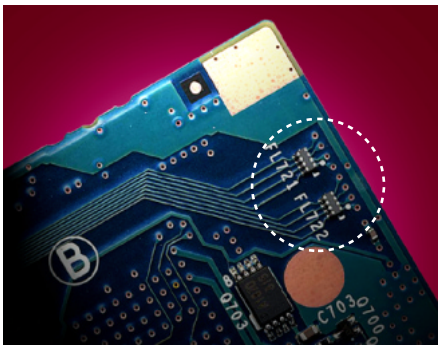
Shapes and dimensions

Recommende PC board pattern (Reflow process)



Weight : 7.5mg
Dimensions in mm

On LVDS lines of laptop computers

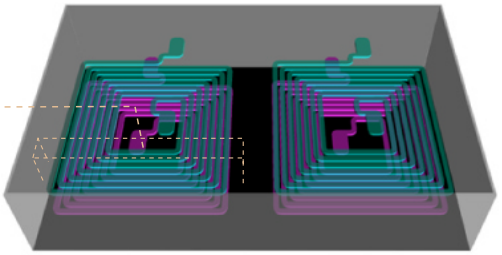


TCM2010
Two pieces

Chip common node filters (single element) of 3216 size
Four pieces

Offering the best-suited EMI filter function for high-speed interfaces.

Formation design of super tiny thin-film coils for which a large reduction of stray capacitance was obtained, and application of ferrite material for which high-frequency low-loss characteristics were reinforced, are the two most significant technological advantages of TCM2010. These advantages allow significant shifting of common mode resonance frequency to a high-frequency range, reducing differential mode impedance -- which affects signal wave pattern --to the lowest levels of the industry standard. This permits a superb high-speed differential transmission characteristic which has almost no effect on signals in a wide band range. It also provides superb absorption/ stabilizing effects on the common mode elements (skew fluctuation) brought about by phase and power voltage difference of differential signals.

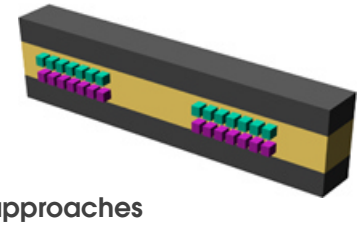


Typical application

It offers the best common node noise deterrence in radiation prevention for laptop computers' LVDS lines and DVI lines for high-resolution digital displays as well as IEEE1394 interfaces.

Thin-film conductor layout model of TCM2010 series

TCM2010 series thin-film cross-sectional form model



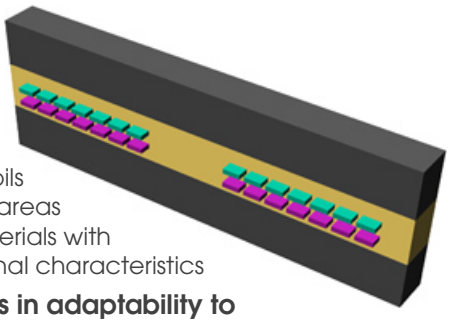
Our approaches

- Small thin-film coils (with reduced stray capacitance) based on high-resolution pattern design
- Applying high-saturation magnetic flux density/ high-frequency low-loss ferrite materials

Achieved characteristic superiority

- Shifted common mode resonance frequency to a high-frequency band range
- Great improvement of high-frequency differential transmission characteristics

Conventional thin-film type cross-sectional form model



Thin-film coils
with large areas
Ferrite materials with
conventional characteristics

Limitations in adaptability to the latest requirements

- Limitation in realizing high-speed differential transmission using stray capacitance between coils
- Difficulty in downsizing and thickness minimization because of the limit of ferrite physicality.

Typical Electrical Characteristics

Part No.	Common-mode impedance (ohm) (at 100MHz)	DC resistance (ohm) (1-line)	Rated current (A)	Rated voltage (V)
TCM2010-101-4P	100±20%	1.5 max.	0.1 max.	10 max.
TCM2010-201-4P	200±20%	2.0 max.	0.1 max.	10 max.

Operating temperature range : –30 to +85°C
Operating Humidity range : 0 to 90 %RH(Maximum wet-bulb temperature: 38°C/Non-condensing)

Frequency characteristics

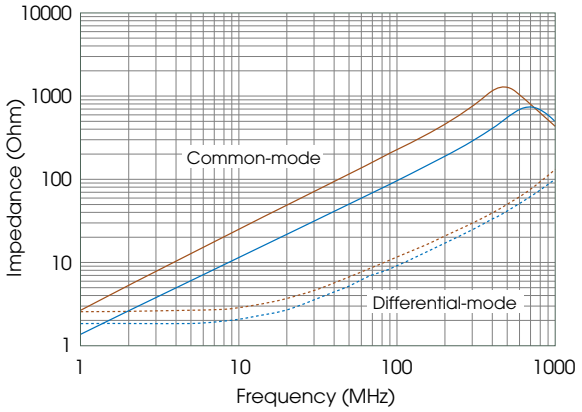
Reference data

TCM2010-101-4P TCM2010-201-4P

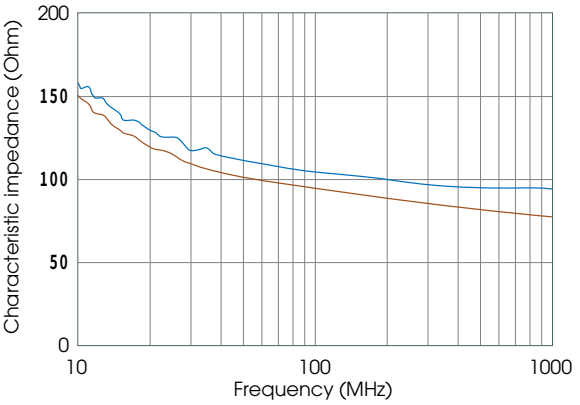
A measuring instrument / measurement conditions

Zc (Common-mode Impedance) : Impedance Analyzer E4991A
Zd (Differential-mode Impedance) :Calculation using the S parameter values (standard impedance: 100 Ohm)

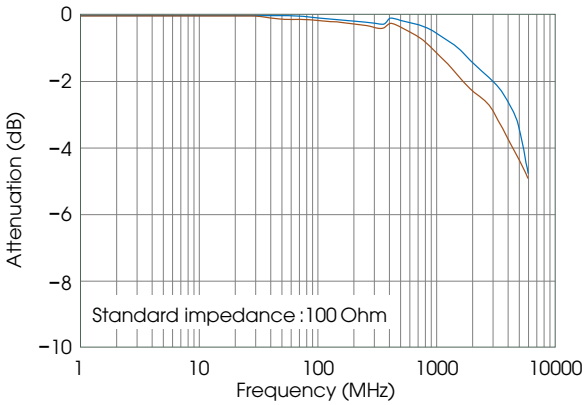
Impedance vs. frequency characteristics



Characteristic impedance vs. frequency characteristics

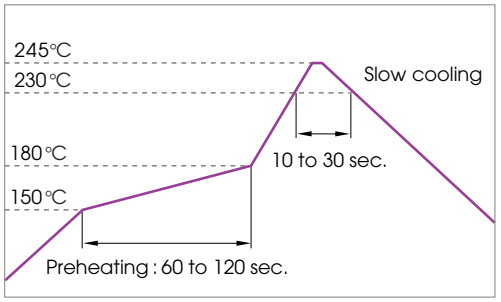


Differential mode transmission characteristics



Recommended soldering conditions

Lead-free solder/High-temperature

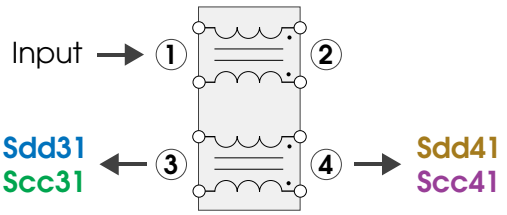


Exquisite integration of the magnetic circuit reduces crosstalk between the two built-in elements.

The crosstalk between the two common mode filters with thin-film form based on our original magnetic path design is very small and has almost no effect on transmission signals.
Of course, it is readily compatible with the IEEE1394 standard which requires 1MHz - 500MHz/-26dB or less in the differential mode.

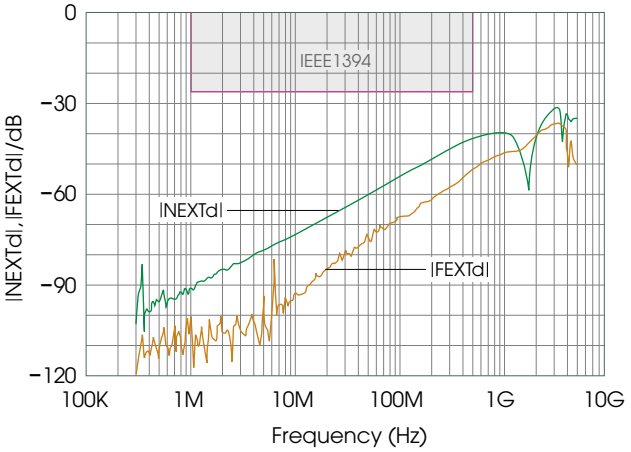
Crosstalk vs. frequency characteristic

Measurement board : The 0.4mm thick glass epoxy FR4/Dielectric constant : 4.6 (at 1GHz)
Beaten-copper on the whole backside area



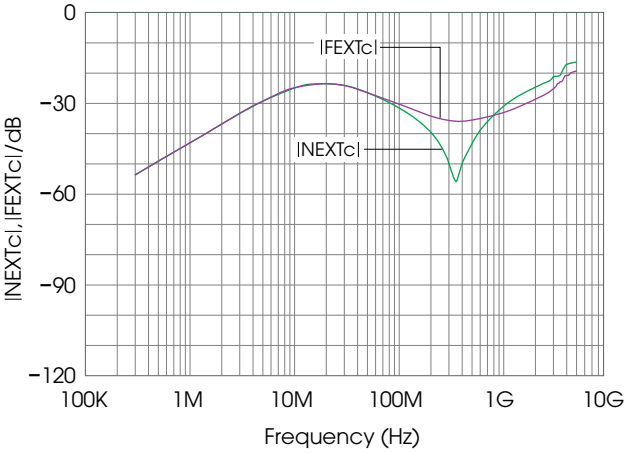
Differential-mode

Sdd31= Differential-mode Near-end crosstalk(NEXTd)
Sdd41= Differential-mode Far-end crosstalk(FEXTd)

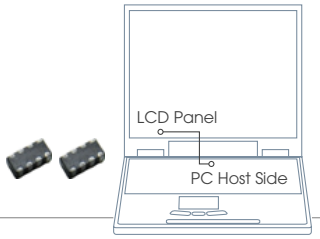


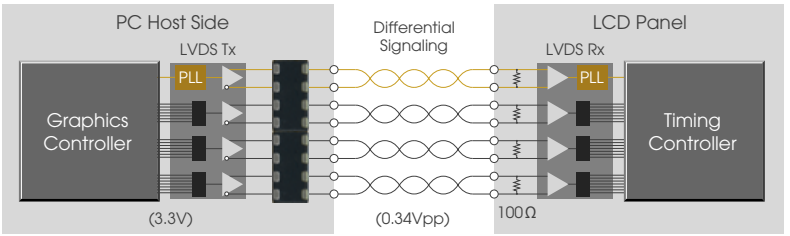
Common-mode

Scc31= Common-mode Near-end crosstalk(NEXTc)
Scc41= Common-mode Far-end crosstalk(FEXTc)



EMI countermeasure example
Laptop computer/LVDS lines

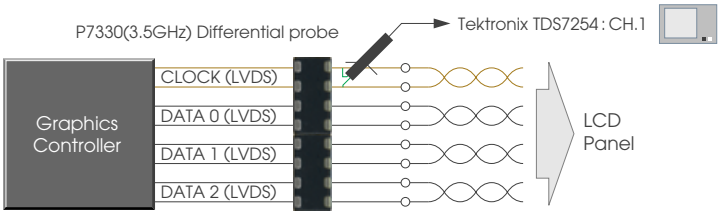




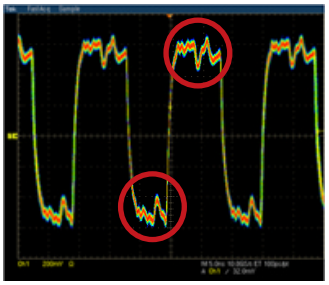
1

Clock waveform

Comparison of before/after countermeasures
(XGA : 65MHz)

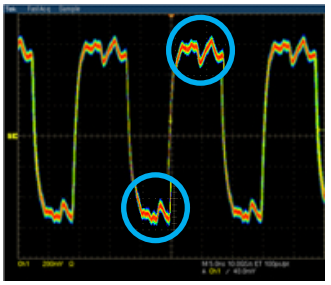


Initial condition (Through)



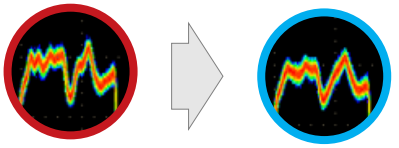
200mV/div 5ns/div

When TCM2010-201-4P are used



200mV/div 5ns/div

Sharp ringing elements are repressed.



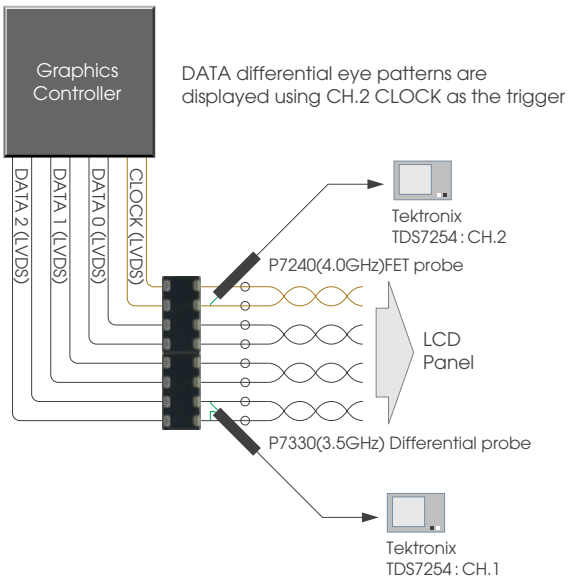
Before countermeasures

After countermeasures

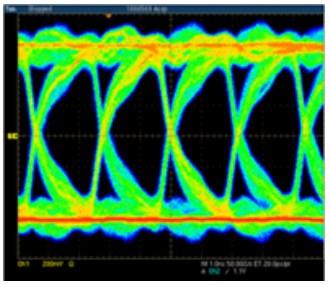
2

Eye patterns of data signals

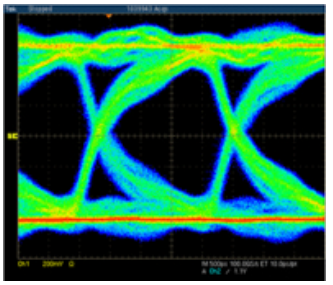
Comparison of before/after countermeasures
(227.5MHz)



Initial condition (Through)



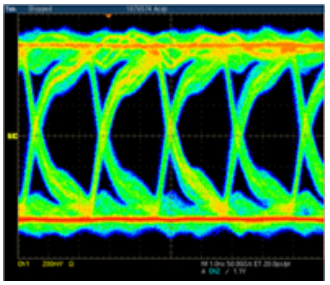
200mV/div 1ns/div



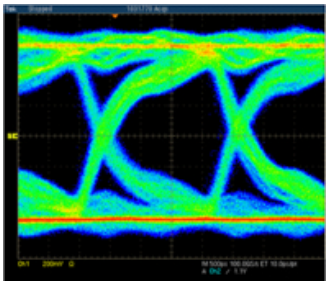
200mV/div 500ps/div

No deformation or deterioration of eye patterns is observed.

When TCM2010-201-4P are used



200mV/div 1ns/div

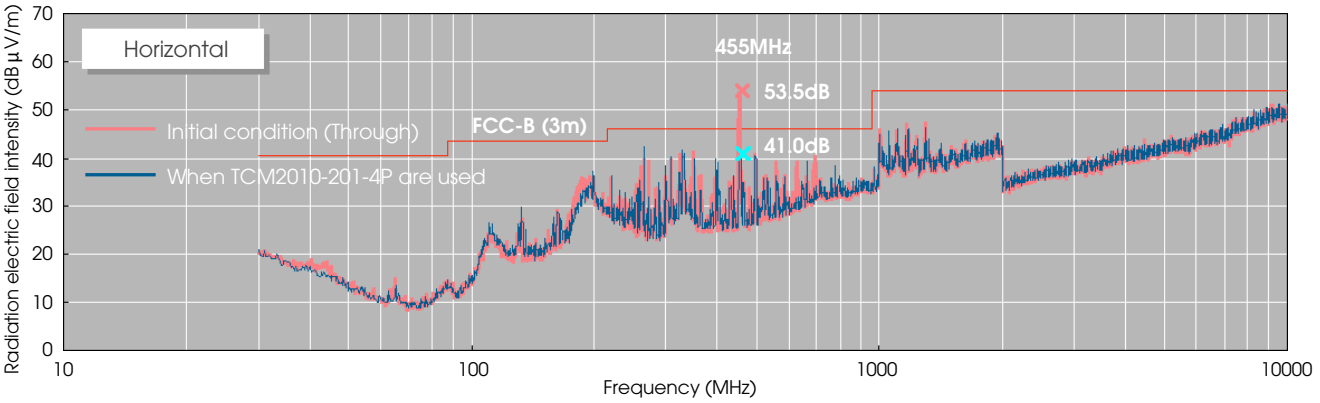


200mV/div 500ps/div

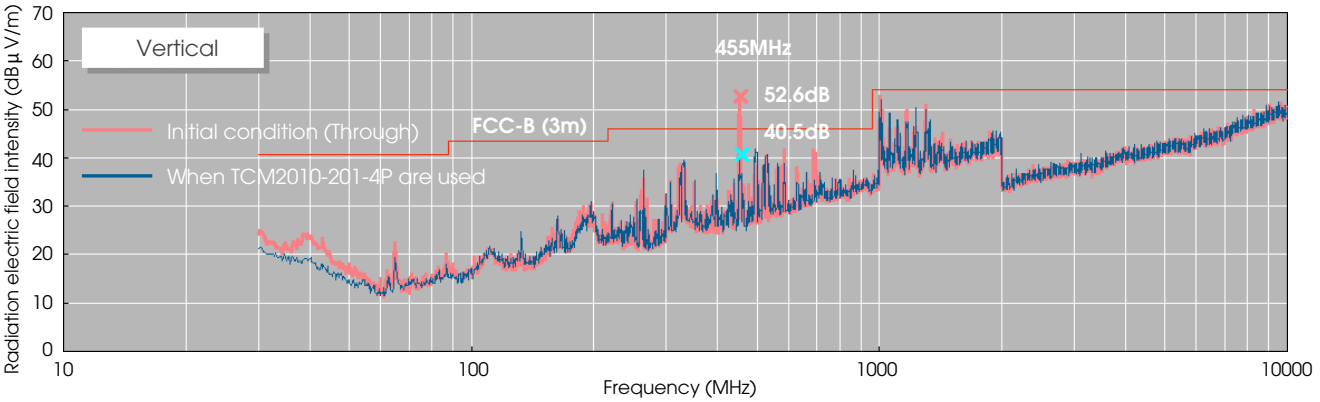
3

Radiation electric field intensity

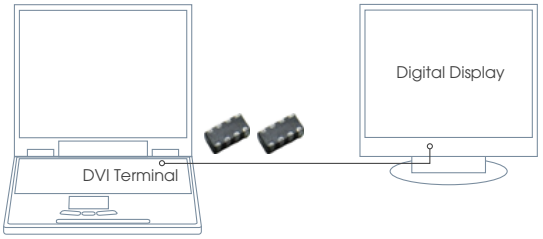
Comparison of before/after countermeasures

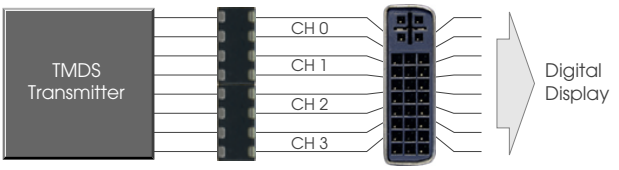


In the double higher harmonic element (455MHz) of the LVDS signals,
a repression effect of more than 12dB wave was achieved both horizontally and vertically.



EMI countermeasure example
Laptop computer/DVI(UXGA) line





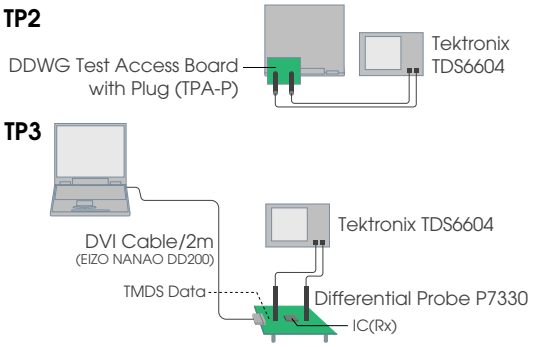
TMDS (Transition Minimized Differential Signaling)

1

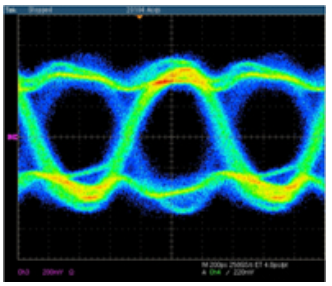
Eye patterns of data signals

Comparison of before/after countermeasures (810MHz)

Configuration of the eye pattern measuring system

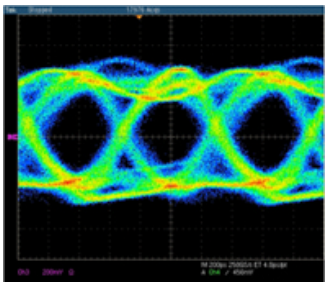


TP2 Initial condition (Through)



200mV/div 200ps/div

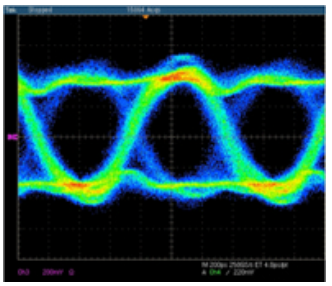
TP3 Initial condition (Through)



200mV/div 200ps/div

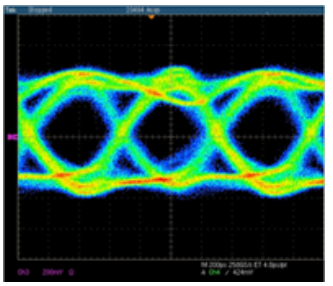
No deformation or deterioration of eye patterns is observed.

TP2 When TCM2010-201-4P are used



200mV/div 200ps/div

TP3 When TCM2010-201-4P are used



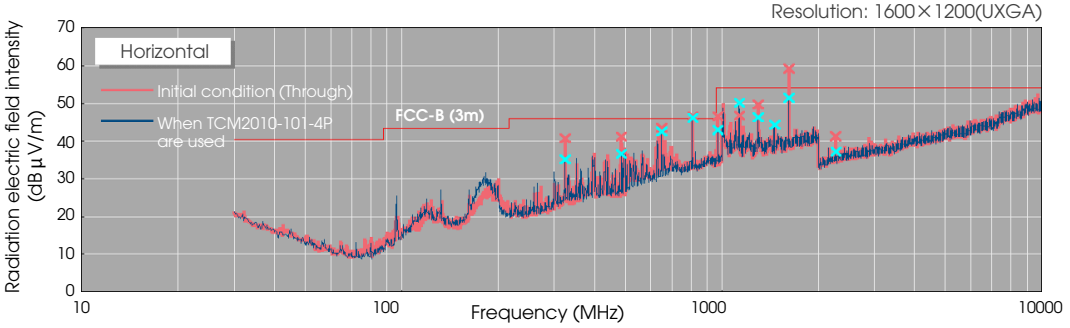
200mV/div 200ps/div

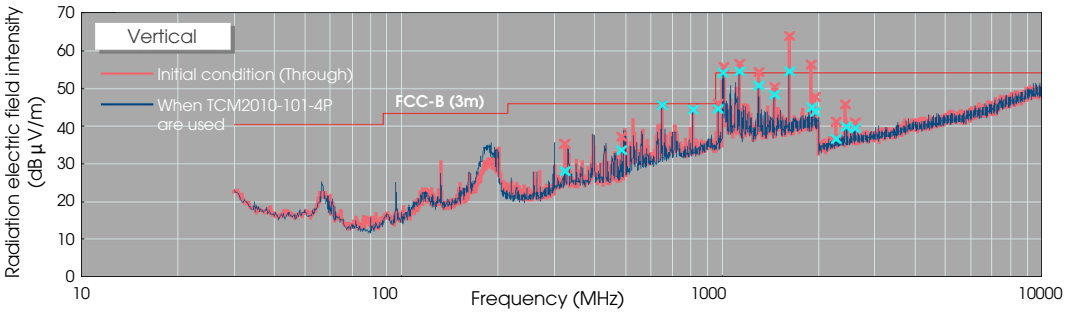
2

Radiation electric field intensity

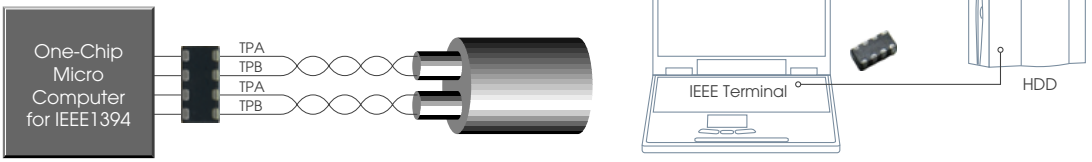
Comparison of before/after countermeasures

Resolution: 1600×1200(UXGA)



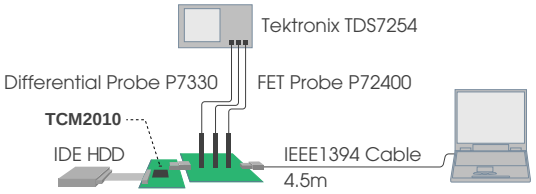


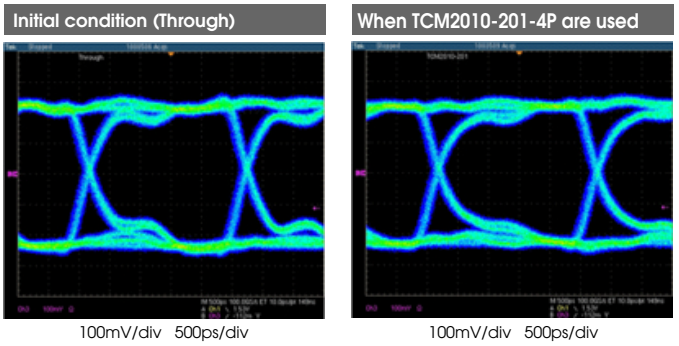
EMI countermeasure example IEEE1394(S400) interface



1 Eye patterns of data signals

Comparison of before/after countermeasures (400bps)

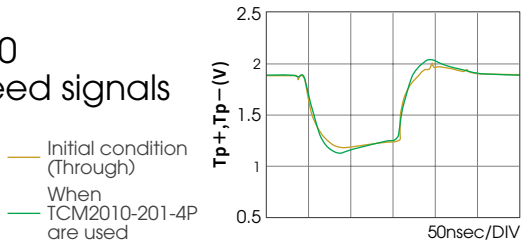




No deformation or deterioration of eye patterns is observed.

2 S400 Speed signals

(TPB)



Aside from eye pattern wave forms, the degree of effect on Speed Signal wave forms is another essential consideration in selecting a common mode filter for the IEEE1394 interface line.
This signal is transmitted to measure data transmission speed (100, 200, 400Mbps). But because it is sent in the common mode, configuration of the common-mode impedance value which doesn't massively distort the wave form will be the key control factor.
As shown in the measurement data on the left, the TCM series has achieved superior characteristics in this regard.

3 Radiation electric field intensity

Comparison of before/after countermeasures

A great repression effect is achieved in the fundamental wave and higher harmonic elements of IEEE1394 (S400) signal (200MHz).

Resolution: 1600×1200(UXGA)