White paper

OMRON

Issue date: March 2018

About High Frequency Relays for High-speed Differential Transmission Signal Switching

Overview

In recent years, various devices have been generating, transmitting, and processing a large amount of information data, including high image quality of cameras mounted on digital cameras and smart phones, high image quality distribution of television and Internet moving images, and the liking.

There are HDMI, USB, MIPI, DDR, Thunderbolt, PCI Express, SATA (Serial ATA), etc. as standards for signal transmission, and high speed signals exceeding the bandwidth of several Gbps are used even for general use. ***(Figure 1)***

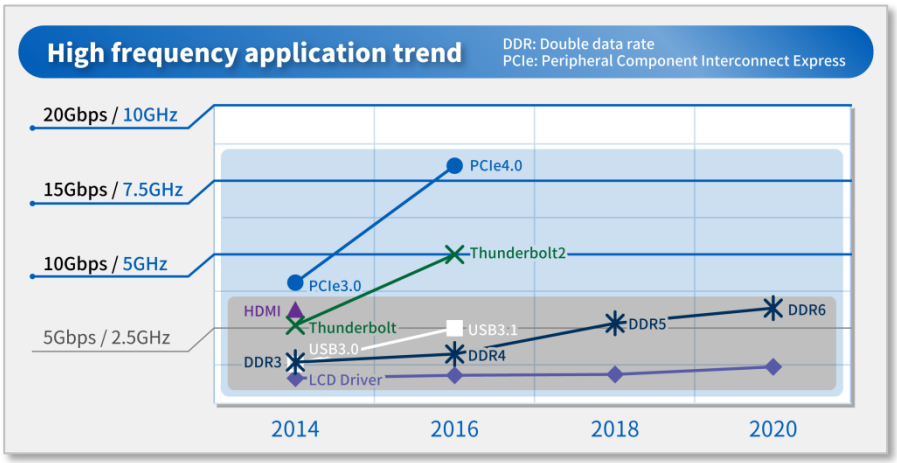
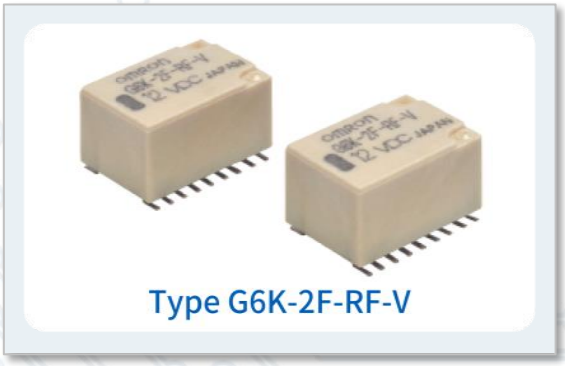


Figure 1

This high speed signal is widely used not only for communication between devices but also for processing equipment internal circuits, communication between built-in parts, production equipment and inspection equipment at the stage of manufacturing equipment and parts, and the like.

Mechanical relays are built in these equipment main bodies, production equipment and inspection equipment, and are used for switching the connection destination of signals, on / off control, and the like.

In the case of transmission and switching of high speed signals by means of mechanical relays, change and deterioration of the signal waveform due to the transmission characteristic (frequency characteristic) of the relay used affects the signal quality, so that a relay having better transmission characteristics



This product is a relay with excellent transmission quality developed for these high speed signals, especially for high speed differential transmission signals.

On high speed differential transmission system

First, we will explain the difference between differential transmission system used for high speed signal transmission and single end system used in conventional signal.

In the single-end system, a signal is transmitted with one line, and the magnitude of the signal is determined by the potential difference with the ground.

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On the other hand, in the differential transmission method, opposite phase signals are transmitted to the two lines, respectively, and the magnitude of the signal is determined by the potential difference between the two lines. ***(Figure 2)***

In the single-end method, since a single signal line transmits a signal, there is a merit that the number of signal lines is small, but it is susceptible to the influence of external noise and there is a limit in speeding up.

Therefore, in order to transmit a large amount of signals quickly, it is necessary to increase the number of signal lines and to perform parallel transmission and to consider synchronism between parallel signals, and it is rarely used for high-speed signal applications.

On the other hand, in the differential transmission method, it is the greatest merit that it is resistant to noise in order to see the potential difference between the two signal lines. Normally, since external noise is similarly applied to two signal lines, noise is cancelled

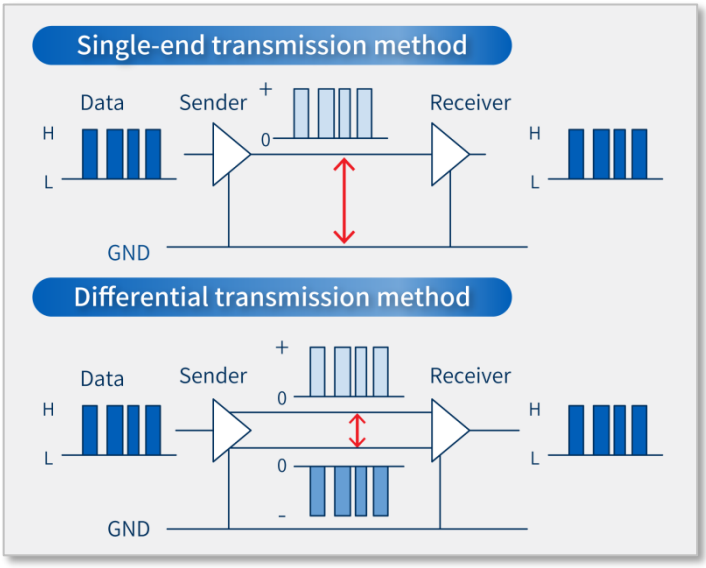

Figure 2

out when viewed by a potential difference at the time of reception. ***(Figure 3)***

Also, being resistant to noise means that the voltage amplitude of the signal can be kept low, so it is possible to shorten the rise / fall time of the signal and to increase the speed. ***(Figure 4)***

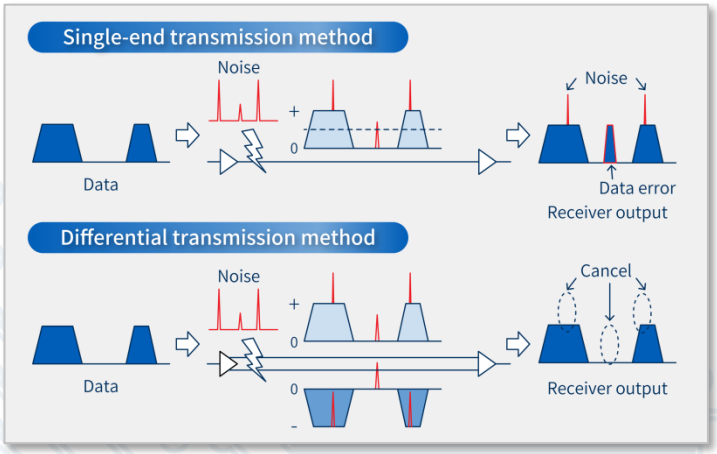

Figure 3

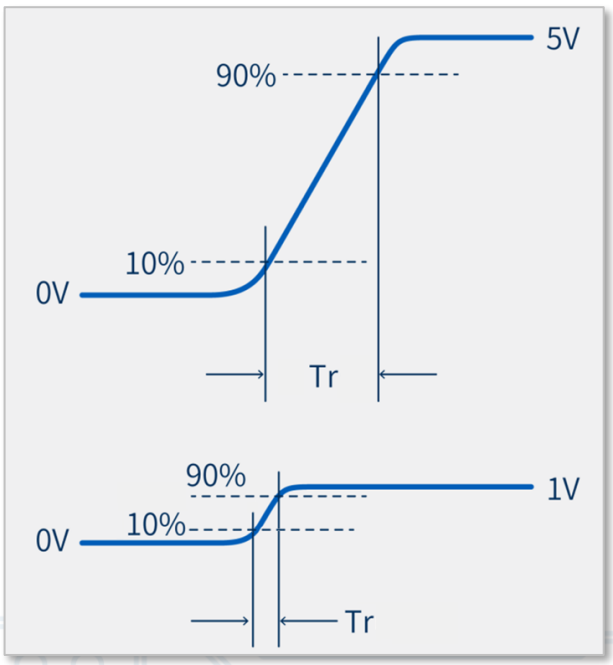

Figure 2

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In the high-speed differential transmission system, the specification required for the mechanical relay is a two-pole contact type for transmitting signals on two lines, a signal is transmitted by a potential difference between the two signal lines, so that a one-pole contact side And the transmission characteristics on the 2 pole contact side are equivalent. In circuit switching applications, it is also said that the transmission characteristics on the N.O contact side and the N.C contact side are equivalent.

Representative circuit example of relay

Main applications of relays used in semiconductor inspection apparatuses include signal switching between the main body of the inspection apparatus and the inspection object, switching of input / output channels of the apparatus, and the like. Specific circuit examples are shown below.

- Input and switch different signals to the inspection object.
- Switch inputs and outputs of signals to a plurality of inspection objects and inspection device channels.
- Switching between signal from inspection equipment and loopback test

Evaluation of high-speed differential transmission signal

In digital signals, "1" and "0" change complicatedly, so it is not possible to evaluate the quality of the waveform from a single frequency signal.

For that reason, what is commonly referred to as "eye pattern (eye diagram)" obtained by sampling a signal waveform in a relatively long time or displaying a prescribed pattern signal (such as a random signal) in superimposition is generally used. It is called an eye pattern because the image on which the waveform is superimposed looks like an eye. ***(Figure 5)***

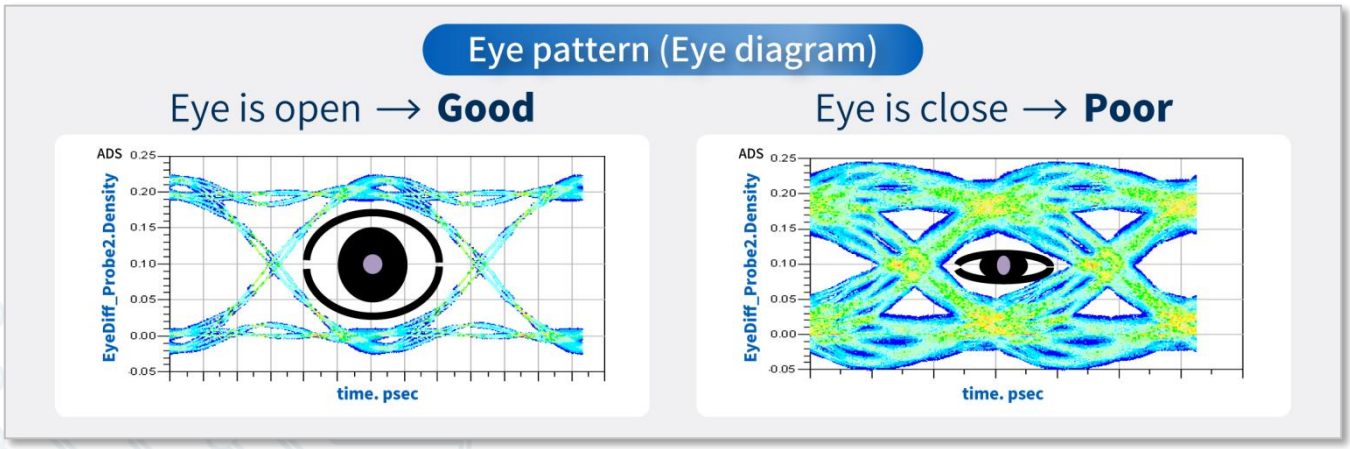

Figure 5

The vertical axis of the eye pattern image is voltage amplitude and the horizontal axis is time.

When the voltage amplitude varies, the upper and lower lines are displayed thickly, and in the case of attenuation, the upper and lower widths become narrow.

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When there is variation in the time axis direction, the width of the line that transits from the top to the bottom or from the bottom to the top increases.

When the opening (the part where the eye is open) is wide, it can be said that the signal quality is good because the signal can be read correctly. If it is narrow, the signal can not be read correctly or an error occurs and the signal quality deteriorates.

Eye pattern characteristics are important for relays used for differential transmission signals, but the specifications required for relays are generally different depending on the application.

The reason is as follows. In consideration of whether clearance of system evaluation of customer's application (transmission / reception unit, characteristics of the whole transmission path such as cable, connector, device) and interface standard (USB, HDMI, MIPI, etc.) It is because it is common that the specifications of relays are determined for the motor.

Product structure outline (Characteristic of structure principle)

The existing G6K-RF series was the basic structure shielding the outer circumference of the signal relay with good frequency characteristics with a metal case.

By shielding with a metal case and grounding, high frequency characteristics were improved by configuring a microstrip line structure in which a space between a metal case, a resin case and a signal terminal is used for a high frequency transmission line.

However, in this structure, there are restrictions such as the thickness of the resin case inside the signal relay, the spacing between the signal terminals and the metal case, and there is a limit to making ideal transmission path characteristics.

In the new product of this time, by making the shape and dimensions of the metal case aiming at the optimum characteristic impedance for each part of the signal terminal of the built-in relay, it was possible to improve to the more excellent frequency characteristic. ***(Figure 6)***

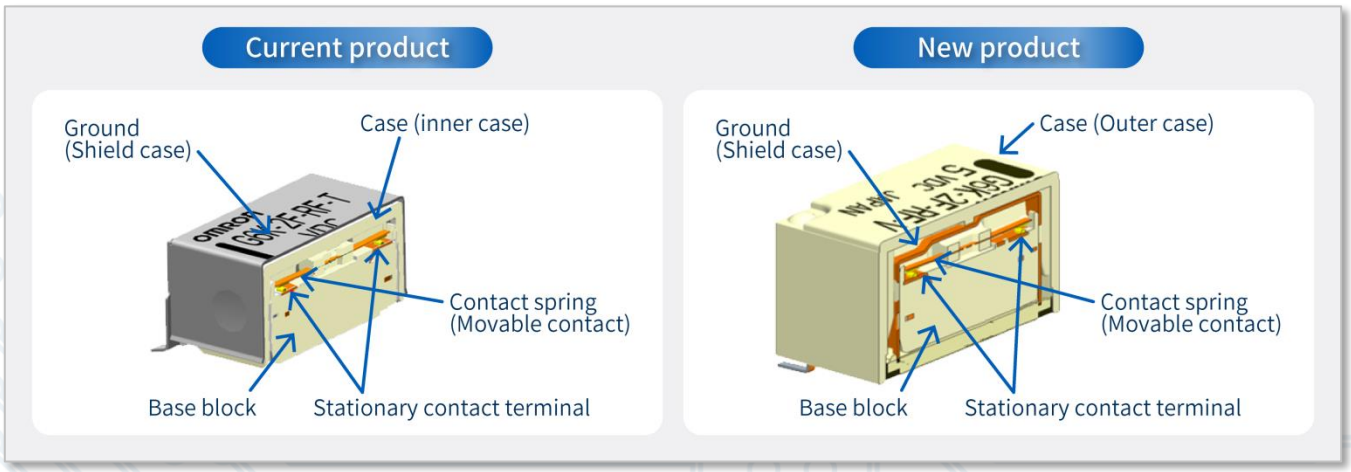

Figure 6

About High Frequency Relays for High-speed Differential Transmission Signal Switching

Feature 1: high-speed transmission signal related characteristics

It realized a stable linearity high insertion loss characteristic at 3 dB or less from DC to 8 GHz. ***(Figure 7)***

This enables stable signal transmission in a wide frequency band.

It also supports DC signals, so it can also be used to switch between conduction check and DC inspection signal.

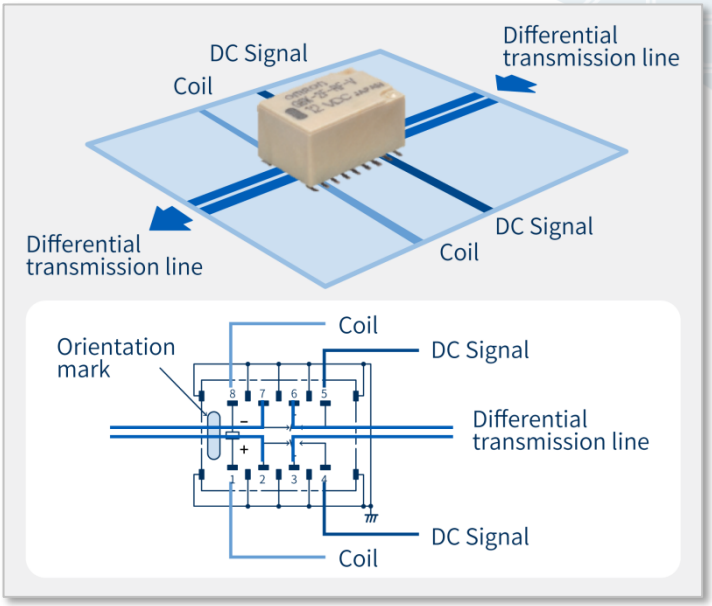

Figure 7

Feature 2: Others

- Restriction of pattern wiring on the bottom side of relay.

In existing high frequency relays, there are some connectors connected to the board with the bottom of the relay as GND, and some patterns can not be provided on the bottom side of the relay because they interfere with the signal line inside the relay.

In order to avoid this, it was necessary to wire complicated wirings using multilayer boards and sacrificing differential transmission characteristics in circuit design. In this product, since it can be wired also to the bottom side of the relay, it can contribute to a simple circuit design with good characteristics. ***(Figure 8)***

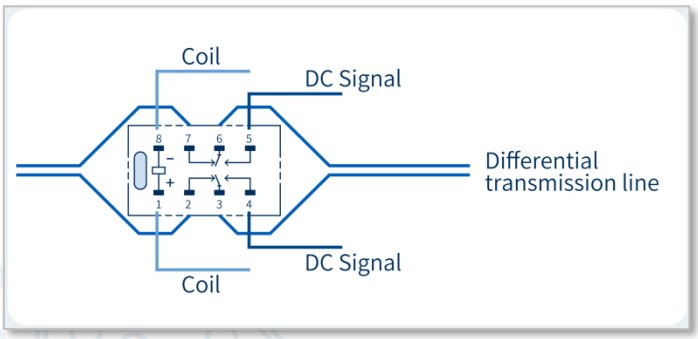

Figure 8

- Adopted resin exterior case

In existing high-frequency relays, many cases are used for the outer case, but in this product a resin case is adopted.

In the metal case, there is a problem that the probe pins short-circuit through the metal case at the time of inspecting the relay mounting board and damage the board and parts, but this product can prevent this.

- Outer L type surface mount terminal shape

By making the terminal shape an outer L shape and the same dimensions, we have achieved excellent solderability and improved visibility of the soldered state at the appearance inspection.

About High Frequency Relays for High-speed Differential Transmission Signal Switching

- Main ratings, characteristics, specifications

Item	Value	Note
Contact resistance	100mΩMax. (Initial)	10mA at 1VDC with voltage drop method
Operate voltage	80%Max.	
Release voltage	10%Min.	
Operate time	3msMax.	
Release time	3msMax.	
Coil power consumption	Approx. 100mw	
Dielectric strength	350VAC, 50/60Hz 1min	Between coil and contacts, Between contacts of different polarity, Between contacts of the same polarity, Between ground and coil/contacts
Insulation resistance	500MΩMin.	
Rated load (resistance)	10mA / 10VDC 1A / 30VDC 0.3A / 125VAC 1W at 8GHz	
Max. switching voltage	125VAC, 60VDC	
Max. switching current	1A	
Max. carry power	1W	at 8GHz, Impedance50Ω, V.SWR 1.2Max at load.
Max. switching power	1W	at 8GHz, Impedance50Ω, V.SWR 1.2Max at load.
Mechanical endurance	50,000,000ops. Min.	
Electrical endurance	1,000,000ops. Min.	Load condition 10mA/DC10V
	100,000ops. Min.	Other rated load condition
Ambient temperature	-40℃～+70℃	with no icing or condensation

Afterword

Applications of high-speed transmission signals are expected to further increase speed and signal transmission quality requirements as digital devices of appliances and household appliances are digitized, the amount of signal information is increased, and applications and fields such as IoT are expanded.

We believe that this relay can be widely deployed in semiconductor inspection equipment, manufacturing equipment and related equipment used in these devices.

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