Development of Interface components (Electronic wire/Antenna/Carriage)

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Fujikura is working on the development of value-added products of internal and external interface components (cable assembly, antenna, carriage, etc.) for electronic devices with reductions in size and weight, high-speed transmission and ecology as the keywords. This report describes Fujikura's development of micro coaxial assembly, film antenna and high-speed transmission cable.

1. Preface

The development of an electronic appliance such as a computer brings much contribution to society. We have been producing interface components (cable assembly, antenna, coil, etc.) to support the advancement of electronic appliances since 1970's.

The history of electronic appliance is the history of reductions in size and weight and continuous cost cutting. Technologies for high-speed transmission, environmental conservation and radio transmission are also advancing at present. This trend is also reflected to the interface components we produce. In spite of the fact that small quantities of a variety of products are produced, they have a short life span and must be produced in a short time. While we improve our technologies of cable manufacturing, assembling, film laminating, high speed transmission, precise measuring, high frequency measuring to satisfy these requests, we develop value-added products and improve productivity (human resources reduction).

We have been wrestling with environmental issues from early on. We developed products and production methods to meet RoHS, and the needs for halogen free and energy saving. We also manufacture carriages, a part of the read and write head of an HDD, as a derivative of the coil business. We work toward achieving technologies to ensure precise resonance control and cleanliness needed for a carriage with an increase in writing density. In addition, we are improving our production technologies to supply high-performance, high-reliability products by high throughput.

1 Electronic Component R&D center

2. Micro coax assembly

2.1 Development of micro coax assembly (Fig.1)

Since the introduction of a micro coax assembly to a mobile phone, we have mass produced micro coaxial assemblies.

A typical micro coaxial cable consists of an AWG # 42 (25 μm7 stranded) center conductor and an outer conductor of spiral shield. It is said that an average diameter of Japanese people's hair is from 80 μm to 120 μm. The conductor is much finer than the hair. An outer diameter of the cable is 0.29 mm. It is thinner than a core diameter of a mechanical pencil. Because this assembly has excellent noise immunity and good transmission characteristics in the band of GHz, and good flexibility, the applications are expanding as a wiring material for opening, closing, and rotating portion of small electronic devices.

We are working toward developing new products and precision assembly technologies, including auto production machines.

Fig. 1. Micro Coaxial core and Assemblies.

Abbreviations, Acronyms, and Terms.

Active equalizer
Signal arrangement device with an amplifier element
Assembly
Cable attached to connector and/or other parts
RF—Radio Frequency
The frequency available in wireless communication
Impedance matching
Matching the input impedance with the output impedance in electric transmission channel
AWG—American wiring Gage
A conductor size standard
Feeding Point
The point of a signal going in and out of an antenna
Harmonics
Multiple frequency of a certain frequency
Non-halogen materials
Materials free of halogen (fluorine, chlorine, bromine, iodine) Halides are restricted because it is hazardous to humans
HDD—Hard Disk Drive
A storage device to record and write information onto the disk to which a magnetic substance is applied
Pair cable
A cable of two twisted electric wires
Membrane
A sheet to which printed circuit technology is applied
Helical winding shielding method
A cable shielding method
RoHS—Restriction of Hazardous Substances
Banned substances directive
UL—Underwriters Laboratories
Safety certification organization of America
USB-IF—USB Implementers Forum, Inc.
The organization which standardizes USB and carries out the management

2.2 Development of flat micro coaxial cable assembly

This is a flat (ribbon) cable consisting of 3 to 5 micro coaxes coated with a resin with excellent abrasion resistance (Fig.2, Table1). Sheet-like wiring circuits have been conventionally used in opening and closing portions of sliding appliances need to be a height of 2 to 3 mm. On the other hand, this flat micro coaxial cable assembly (Fig. 3) is reduced to 1 to 1.5 mm in height with the wiring vertically arranged. This cable with a long bending radius can withstand bending of over 200,000 times. This flat micro coaxial cable assembly is well suited for thinner appliances in the future.

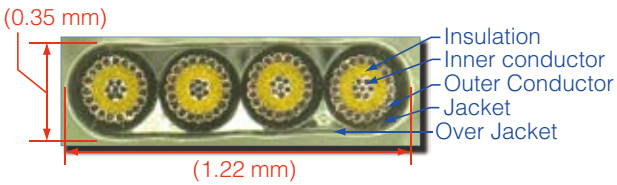

Fig. 2. Flat (Ribbon) Micro Coaxial Cable (AWG42X4 Cores).

Fig. 3. Flat Micro Coaxial Assembly.

Table 1. Flat (Ribbon) Micro Coaxial Cable Specification.

Item		unit	AWG42			AWG46		
			3cores	4cores	5cores	3cores	4cores	5cores
Inner conductor	Material	–	Ag coated Cu Alloy			Ag coated Cu Alloy		
	Structre	pc/mm	7/0.025			3/0.025		
	Outer Dia.	mm	0.075			0.054		
Insulation	Material	–	Fluoric resin			Fluoric resin		
	Outer Dia.	mm	0.165			0.125		
Outer conductor	Material	–	Sn coated Cu Alloy			Sn coated Cu Alloy		
	Outer Dia.	mm	0.225			0.175		
Jacket	Material	–	Fluoric resin			Fluoric resin		
	Outer Dia.	mm	0.29			0.24		
Over Jacket	Material	–	Fluoric resin			Fluoric resin		
	Outer Dia.	mm	0.35 × 0.93	0.35 × 1.22	0.35 × 1.51	0.30 × 0.78	0.30 × 1.02	0.30 × 1.26

3. Film antenna

3.1 Development of film antenna

Conventionally, the antenna element (wireless LAN, Bluetooth, etc) for small electronic, uses sheet metal and FPC (Flexible Printed Circuit). We have manufactured FPC antennas by etching and membrane one by printing. We have developed a low-cost, small, thin film antenna as a new line-up [1]. The film antenna can reduce the initial costs and contribute to shorter lead times. The antenna element can be easily bent along a curved surface and located in devices.

We can take charge of every phase of a project from an element design through product design, trial manufacturing, evaluations, actual tuning, and mass production. In the trial production period, we can make samples within short period (3days). Then we evaluate and offer the customized sample to our customer. Its materials are in compliance with UL, RoHS and non-halogen requirements.

3.2 Development of high value-added film antenna

We work on the development of high value-added film antennas to respond to diversified uses. We have a strong lineup of the elements of our own design. We also commercialized film antenna elements for WWAN, WiMAX, WLAN, Bluetooth, GPS, UWB, digital television, multiband antenna with many resonance frequencies (Fig.4, 5) and a multi port antenna with mutual interference robustness [2].

In addition, we have established various connection methods, for example, RF coaxial cable connecting (Fig. 6), the metal pad forming (Fig. 7), and plating of the feeding point (Fig.8) according to each customer's feeding method. We commercialized a three-dimensional antenna which is glued to a resin molded part as the first step (Fig.9). Furthermore, we attempt to make a three-dimensional antenna element.

4. High-speed transmission cable

4.1 Development of High-speed transmission cable

The need for interface components enabling high-speed transmission becomes higher due to the proliferation of cloud computing and the need for high-resolution data processing.

Fig. 4. Multi-Band Antenna.

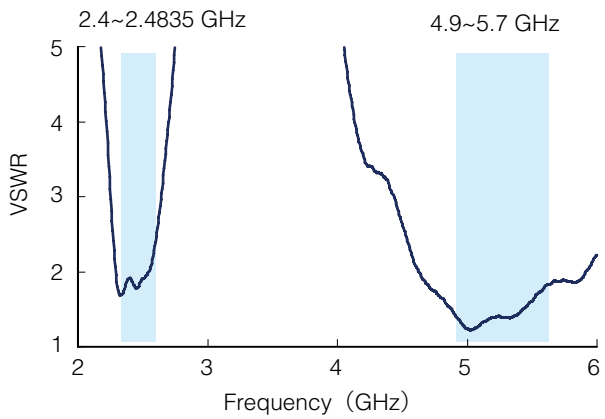

Fig. 5. VSWR of Multi-Band Antenna.

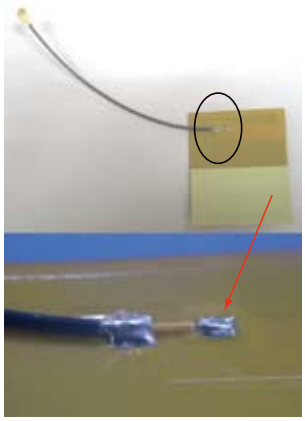

Fig. 6. RF Coax Cable connecting.

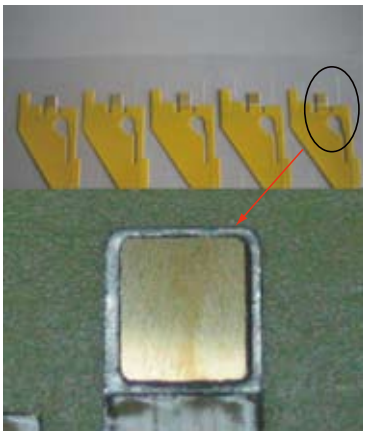

Fig. 7. Metal Pad forming.

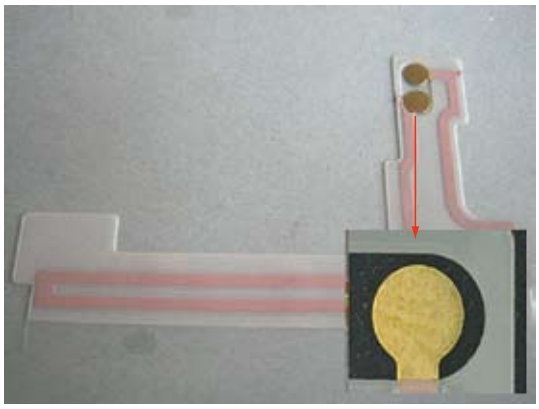

Fig. 8. Plating of feeding point.

Fig. 9. 3D type glued to a resign molded part.

We have high technology and the experience of manufacturing the world top-class high-speed transmission cable (Fig. 10) for high-end servers.

By using next-generation metal cable manufacturing technique, we are challenging the limit of a metal cable.

We developed this high-speed transmission technology and assembly technology and commercialized the cable assembly that meets the consumer standards such as USB3.0 and the HDMI as well as the world's smallest diameter cable excellent in portability.

We work on the development of an active cable with an active equalizer and the composition cable consisting of an optical fiber and a metal cable that can be used for high-transmission.

Fig. 10. High-speed transmission Cable.

Fig. 11. USB3.0 Cable Assembly.

4.2 The world's first USB3.0-certified assembly (Fig.11)

We developed a cable assembly [3)4)] in conformity with the USB 3.0, a next-generation transmission standard for a device of a transmission rate of 5 Gbps, which is 10 times as fast as USB 2.0 and received the certification from USB-IF in 2011. Furthermore, we developed a cable of world's smallest 3.6 mm diameter (Table 2) to improve the portability of the cable (while a cable outer diameter, generally, is 5 − 6 mm).

We achieved this small cable without deteriorating signal quality by using an original insulation material and a signal shield and cabling technologies.

We use a low-loss shield differential pair cable in broad band despite its small diameter.

Besides, to achieve a low-loss plug, we tune them by a transmission analysis technology and impedance matching assembling technology.

Shield pair cable showed losses of 3 dB/m in 2.5 GHz(5 Gbps) and 6.25 dB/m in 7.5 GHz of the third harmonics, using a silver-plated soft copper conductor for the signal line, polyolefin for the dielectric, and metal foil for the shield.

Table 2. USB3.0 Cable Assembly Specification.

No.	Item		Long Type	Small Dia. Type
1	Suepr Speed Pair (5.0Gbps)	Conductor	AWG30 Ag coated anealed Cu	AWG34 coated anealed Cu
		Insulation	Low loss polyolehin	Low loss polyolehin
		Shield	Metal foil single shield	Metal foil single shield
		Drain	AWG 32	AWG 34
		Structure	Shield pair	Shield pair
		Diff. Impedance	100 Ω	100 Ω
2	USB 2.0 Pair	Conductor	AWG 28 Sn coated anealed Cu	AWG 30 Sn coated anealed Cu
		Insulation	Polypropylene	Polypropylene
		Structure	Twisted pair	Twisted pair
		Diff. Impedance	90 Ω	90 Ω
3	Power GND	Conductor	AWG 24	AWG 28
4	Spacer	—	(Option)	(Option)
5	Outer shield	Shield	Metal foil + Braid double shield	Metal foil + Braid double shield
6	Jacket	Material	PVC or Non-halogen Resin(Option)	PVC or Non-halogen Resin(Option)
		Outer Dia. (nominal)	5.0mm	3.6mm
7	Max. cable length		2.0 m	1.0 m
8	Plug	A end(Host)	Standard A	Standard A
9		B end	Standard B	Standard B
10				Micro B

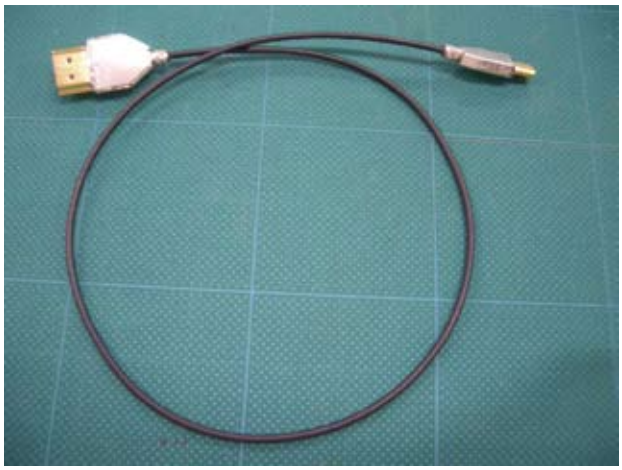

Fig. 12. Small Dia. Cable Assembly (HDMI A-C type).

The lineup offers long-type cables (up to 2 m) and small-diameter-type (up to 1 m) cables of 3.6 mm outer diameter.

The assemblies of standard A plug, standard B plug and micro B plug are available for both type products.

4.3 Development of interface cable assembly of the world smallest diameter

We developed an interface cable assembly of the world smallest diameter (2.1 mm) [5].

We improved the portability of the interface cables for mobile appliances (such as Mobile PC, Smart phone, Tablet PC) connected to video devices and external data storage devices.

We developed a pocket size assembly of 20 — 50 cm in length, a minimum length.

It supports the products corresponding to each standard connector such as HDMI (Fig.12), Display port and USB3.0 and a customized product.

5. Conclusion

This report has focused on a micro coaxial cable assembly, film antenna, and high-transmission speed cable among our interface components (cable, assembly, antenna, coil etc) in the development stage.

We continue to develop the interface components of the high value-added product with reductions in size and weight, high-speed transmission and ecology as the keywords

We want to contribute to the development of the interface components of the electronic equipment in future.

References

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