Technology Focus

Murata Taps Capacitive-Coupled Method for Wireless Power Transfer

Murata Manufacturing Co., Ltd. is moving forward with the development of a field-coupled wireless power transmission system. In August 2011, Murata launched the mass production of LXWS Series module that is capable of 10W wireless power transmission.

This article outlines the technology of the field-coupled wireless power transmission system that Murata is developing, the trend of its practical applications, and its future prospects.

Technology Outline

Murata's field-coupled wireless power transmission system features the two pairs of asymmetric dipoles, consisting of the power-sending side active electrode and passive electrode and the power-receiving side active electrode and passive electrode that are positioned vertically. This system transmits electric power by means of an induction field that is produced by coupling these two pairs of asymmetric dipoles (See Fig. 1).

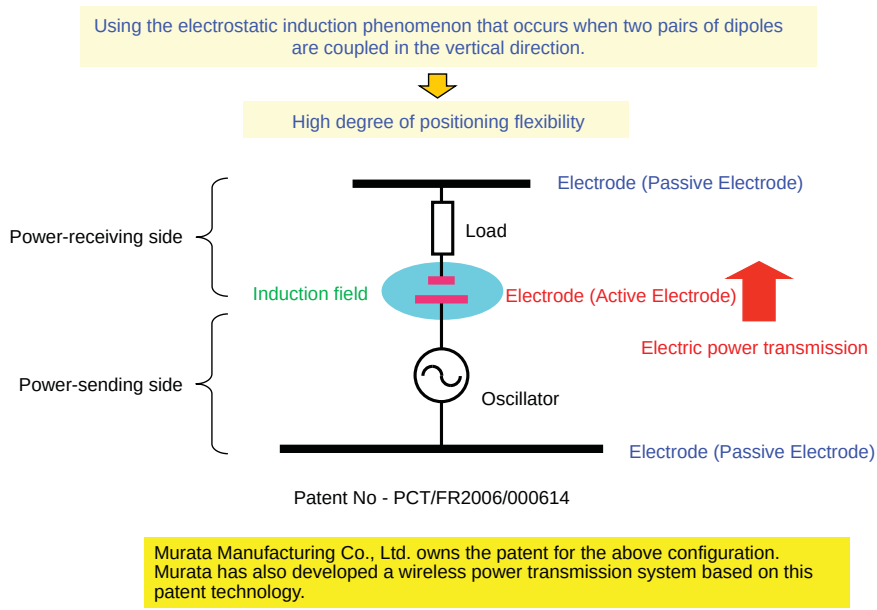


Fig. 1: Basic configuration of the field-coupled type power transmission system

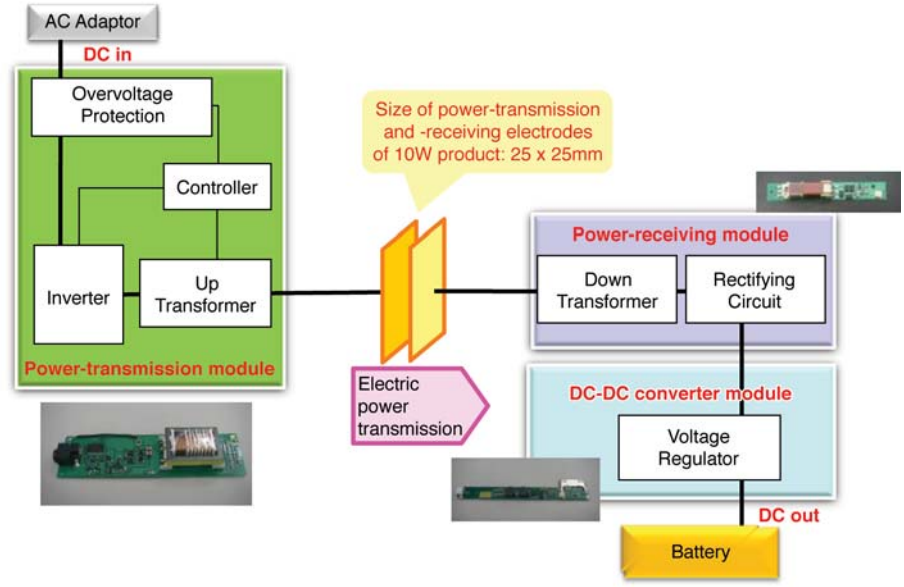


Fig. 2: Block diagram of the field-coupled wireless power transmission system

This configuration makes it possible to perform high-efficiency wireless power transmission with a high degree of positioning flexibility.

Fig. 2 shows the block diagram of the entire system configuration. The power-sending side consists of a power-transmission module and power-transmission electrode and the power-receiving side consists of a power-receiving electrode, a power-receiving module, and a DC/DC converter. The power-transmission module is assembled with power supply circuits that fully utilize Murata's power supply circuit designing technologies, and control circuits for assuring safety. The electric power converted into alternating current by the power-transmission module is transmitted to the power-receiving side via a capacitor configured using a power-transmission electrode and a power-receiving electrode. The power-receiving side is assembled with a rectifying circuit and voltage converter circuit and it supplies stable direct current power to a battery or other device.

Advantages of Field-Coupled Method

Murata is pouring its efforts into developing the field-coupled method because it offers unique advantages that

cannot be provided by other methods. Among the advantages of the field-coupled method, are 1) high degree of flexibility in positioning the coupling devices; 2) high degree of flexibility in designing the electrode shape and dimensions, and 3) electrode with less heat generation.

Fig. 3 shows the power transmission efficiency graph in relation to displacement between the coupling devices (between electrodes in the case of the field-coupled method and between coils in the case of an electromagnetic induction method). When displacement (dz/D) between electrodes is one, the electrodes (in the case of the field-coupled method) or coils (in the case of an electromagnetic induction method) of power-sending and power-receiving sides hardly overlap with each other and they are considerably displaced (electrodes are displaced by a length of one diameter). Even in this condition, the drop in power transmission efficiency of the field-coupled method is about 20 percent. When displacement of the electrodes is small, the drop in the power transmission efficiency of the field-coupled method stays at about 10 percent. In this way, the field-coupled method offers a high degree of flexibility in positioning coupling devices in a horizontal direction, and makes it possible to construct an electric power charging system that is easy to use by the consumers, for example, charging a mobile phone even if it is placed slightly dislodged on the charger.

As a way of improving the degree of flexibility in positioning coupling devices, multiple electrodes can be switched to transmit electric power. This method can charge the power-receiving equipment highly efficiently regardless of its location on a charger because it operates only the electrode at the placement location of the power-receiving equipment. Furthermore, this method is noise free and enables developing a system that has an extremely low effect on the user's body or on the device to be charged.

The second advantage of this method is that it provides a high degree of flexibility in designing the electrode shape and dimensions. As long as the desired capacity of electric power to be transmitted is obtained between the power-transmission and power-receiving electrodes, there is no restriction regarding the shapes and dimensions of the electrodes. The electrode does not have to be rectangular and any shape can be adopted, such as a triangle or circle. Moreover, in the case of the field-coupled method, the electric current that flows to the electrodes is extremely small (several milliamperes). Consequently, there is almost no restriction on the materials to be used to construct the electrode and its thickness. The thickness of electrodes that can be used is less than several micrometers (see Fig. 4). Therefore, Murata can respond to wide-ranging customer needs with regard to electrode shape, dimensions, and materials.

The third advantage of this method is that there is almost no heat generation in the electrode. As mentioned above, the electric current that flows to the electrode of the field-coupled method is less than several milliamperes and there is almost no Joule heat, which is produced by the electric current and resistance. As a result, this method can be used to realize a safe system that does not cause damage to a battery even if the electrode is placed near it.

Equipment Applications, Trends

Murata has used this power transmission system for tablet terminals, e-book terminals, and smartphones, and has

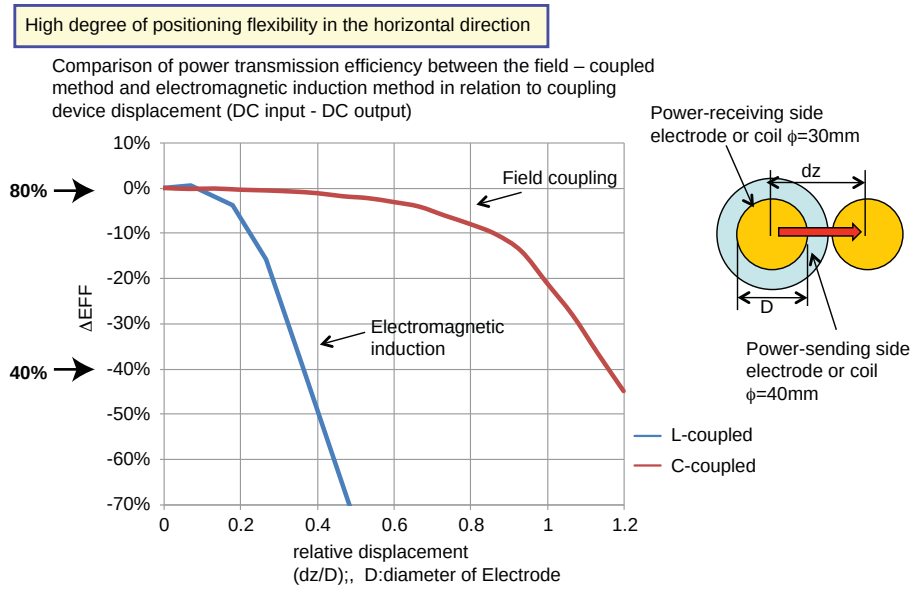


Fig. 3: Free positioning

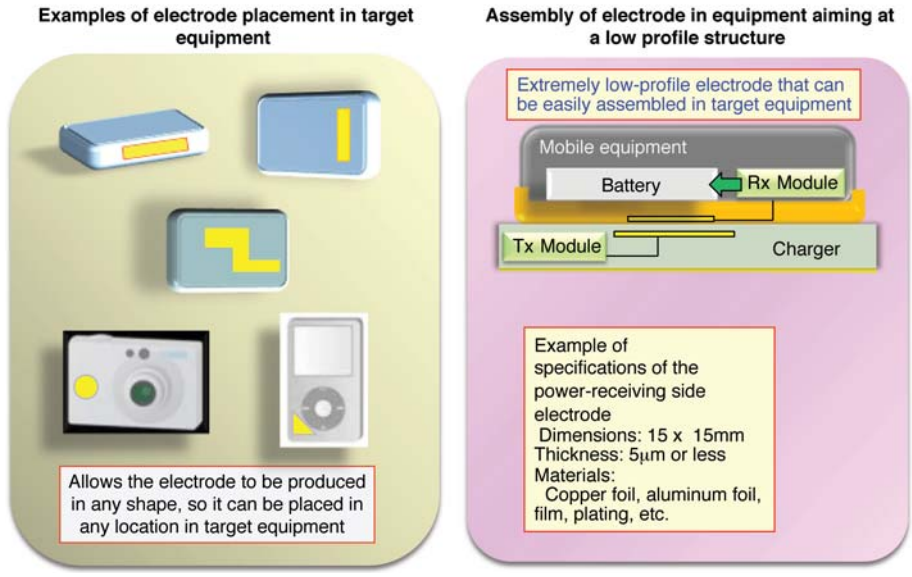
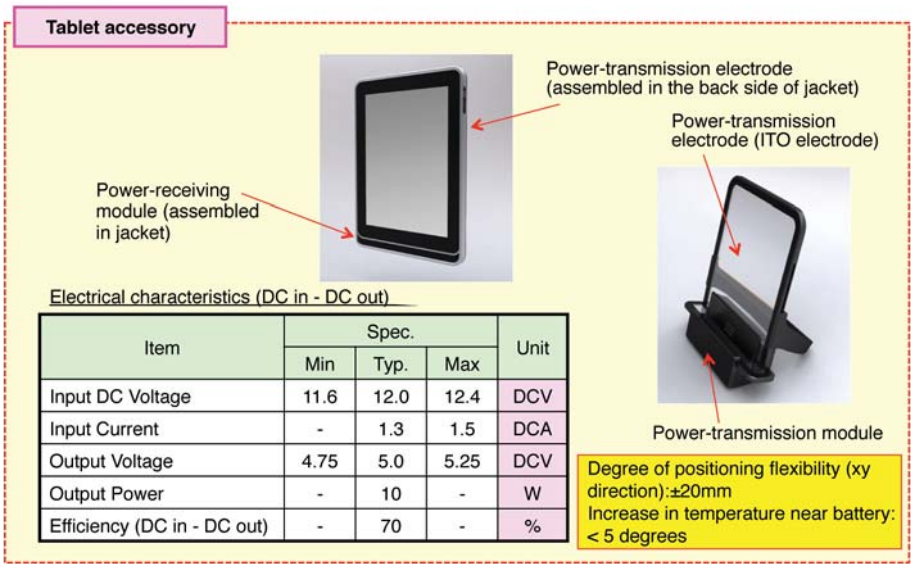


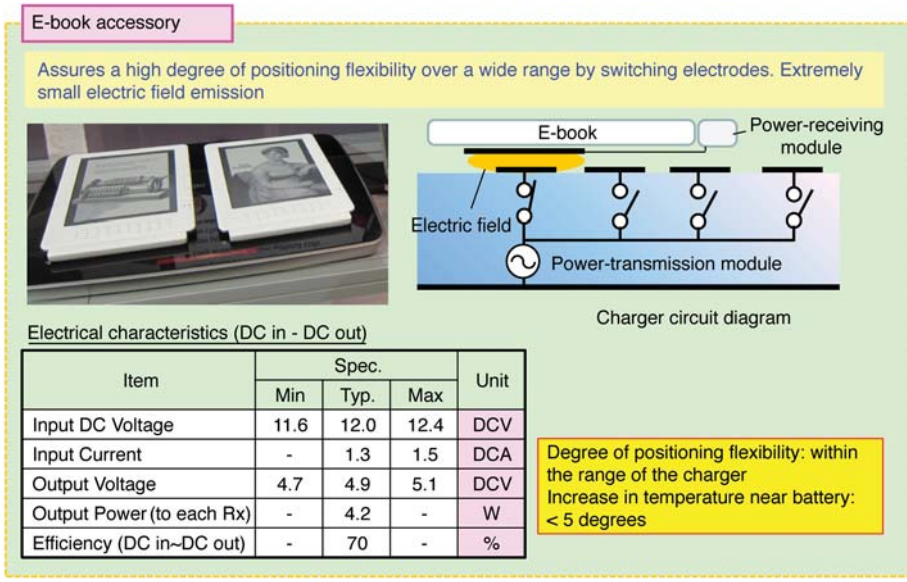
Fig. 4: Electrode with highly flexible shapes and low-profile structure



Electrical characteristics (DC in - DC out)

Item	Spec.			Unit
	Min	Typ.	Max	
Input DC Voltage	11.6	12.0	12.4	DCV
Input Current	-	1.3	1.5	DCA
Output Voltage	4.75	5.0	5.25	DCV
Output Power	-	10	-	W
Efficiency (DC in - DC out)	-	70	-	%

Fig. 5: Example of 10W system



Electrical characteristics (DC in - DC out)

Item	Spec.			Unit
	Min	Typ.	Max	
Input DC Voltage	11.6	12.0	12.4	DCV
Input Current	-	1.3	1.5	DCA
Output Voltage	4.7	4.9	5.1	DCV
Output Power (to each Rx)	-	4.2	-	W
Efficiency (DC in~DC out)	-	70	-	%

Fig. 6: Prototype for e-book (4W × 2)

been developing prototype chargers and jackets. The maximum power transmission of 10W has been achieved for tablet terminal application. Fig. 5 shows the specifications of the 10W power-transmission and power-receiving modules and an example of the prototype 10W power transmission system. This system has a high power transmission efficiency of 70 percent and its charging time is equal to that of a charger connected using a cable. Today, mobile devices use higher-capacity batteries and tablet terminals use a battery of 5Ah or higher. Therefore, these devices require a power transmission capacity of about 10W for charging and this module can meet the demand. The charger (shown in Fig. 5) uses a transparent material (indium tin oxide or ITO) for electrodes in order to provide a high designing flexibility that cannot be achieved by other methods.

The e-book terminal wireless charging system (shown in Fig. 6) uses a mechanism for switching the multiple electrodes (as mentioned in the previous section) in order to expand the charging area. This charging system can charge two e-book terminals placed in any location on this system. An entire desk at the users' office or an entire table at their home can be turned into a charger by further evolving this mechanism. Murata can develop a highly convenient charging system for consumers that would make it possible to charge a terminal by placing it anywhere on an office desk or a table.

Future Efforts

Murata intends to make a concerted effort to resolve the issues on 1) size reduction of the module; 2) expansion of the power transmission range (5W to 50W), and 3) standardization.

Size reduction of the modules (power-receiving module, in particular) is absolutely necessary in order to install them in compact devices such as smartphones and digital cameras. Therefore, Murata is working towards miniaturizing a key component of the modules, namely, the voltage conversion transformer. As one of the methods for miniaturizing the transformer, Murata is providing more insight for the development of devices that can operate at a higher power transmission frequency.

Regarding the issue of expanding the power transmission range, Murata is carrying out the development for expansion to 50W by focusing on charging notebook computers. Radio law-related issues apply after 50W power transmission is achieved. Murata has set up a plan that looks ahead to the development of power transmission technologies for achieving up to the 100W level.

Furthermore, to expand the wireless system, mutual connectivity must be assured by standardization. Murata has already started activities for standardizing the field-coupled method and has been pushing forward with the planning of technology standards and the creation of a business platform. The important point in the technological aspect is to develop a charging system that can charge many different types of devices. In addition to standardization of the system, Murata is aiming to develop a system that can charge devices that operate on different electric power voltages and come in different sizes by taking advantage of the field-coupled method.

About this Article:

The author, Shinji Goma, is part of the Technology & Business Integrated Products Department, Planning Section at Murata Manufacturing Co., Ltd.