

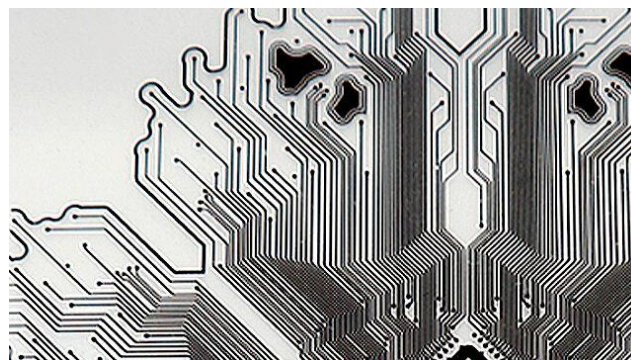
# TECHNICAL REPORT

Good news! For those who want to create electromagnetic wave shielding and implement electrostatic countermeasures inexpensively and effectively.

Replace various conductive materials with screen printing

## Conductive ink that allows free setting of resistance value

Thanks to adjustment technology of resistance value, effective electromagnetic wave shielding and electrostatic countermeasures are possible by screen printing. In addition, this adjustment technology expands the application possibilities such as quality improvement of sensor device and cost reduction of electronic circuits.

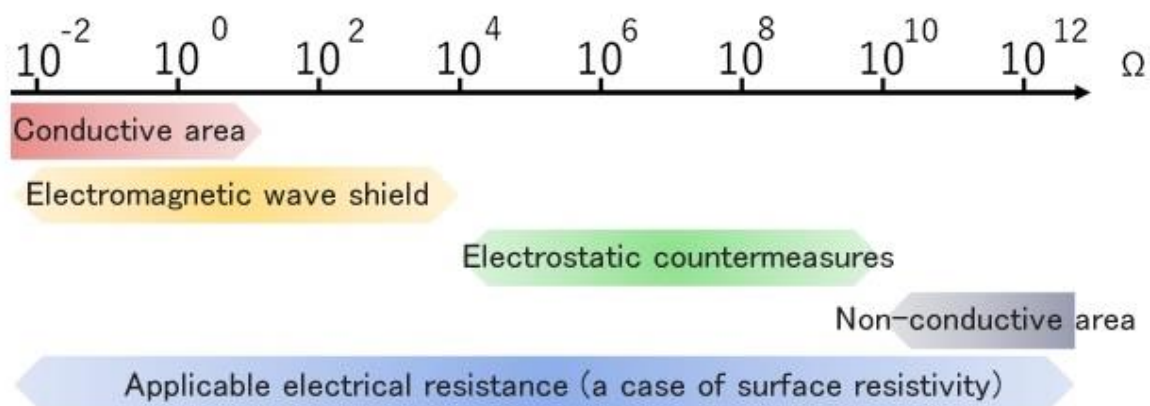


### 1. Conductive ink that enables you to set electrical resistance value freely

#### 1.1 Achieve both screen ink function and flexible electrical resistance value

Our conductive ink can be set in a wide range of electrical resistance value from  $1.0 \times 10^{-1} (\Omega)$  to  $1.0 \times 10^{10} (\Omega)$  or higher, from conductive to non-conductive. Owing to this ink, you can produce electromagnetic wave shielding and conduct electrostatic countermeasures, etc. with inexpensive and highly flexible screen printing.

In addition, by applying this conductive function to other inks, it is possible to improve sensor quality and reduce the cost for electronic circuits.



Application	Surface resistance value ( $\Omega$ )	Main effects
Electromagnetic wave shield	$1.0 \times 10^{-1}$ to $1.0 \times 10^4$	<ul style="list-style-type: none"> <li>Block the intrusion of electromagnetic waves and prevent malfunction of internal circuits</li> <li>Block the leakage of electromagnetic waves and prevent malfunctions of peripheral devices and health damages.</li> </ul>
Electrostatic countermeasures	$1.0 \times 10^4$ to $1.0 \times 10^{10}$	<ul style="list-style-type: none"> <li>Prevent electrification and avoid electric discharge and dust adhesion due to electrostatic.</li> <li>Prevent electric discharge from the outside by setting a high resistance value.</li> </ul>
Sensor quality improvement aid	Resistance value suitable for the application	<ul style="list-style-type: none"> <li>Prevent malfunction due to electromagnetic wave incidence to the sensor and electrostatic discharge</li> <li>Reduce dust adhesion due to electrostatic and improve sensor sensitivity.</li> </ul>
Assist cost reduction of electronic circuits	Resistance value suitable for the application	<ul style="list-style-type: none"> <li>Add functions such as electromagnetic wave shielding and electrostatic countermeasures to the circuit</li> <li>Replacement by printing electronic circuit elements (resistors, etc.) and insulators</li> </ul>

## 1.2 Achieve both screen ink function and flexible electrical resistance value

Standard conductive inks are as follows. Resistance values other than the following inks can also be set by adjusting ink and printing conditions. For example, the surface resistivity can be made lower than that of single-layer printing by using multi-layer printing.

Ink name	Ink layer thickness (single layer)	Surface resistance value	Applicable substrates
MRX-HF Conductive Ink Brown	14 $\mu$ m	$\leq 1\Omega$	PET, PC, etc
MRX-HF Conductive Ink Gray	14 $\mu$ m	$\leq 200\Omega$	Same as above
MRX-HF Conductive Ink Black	10 $\mu$ m	$\leq 10,000\Omega$	Same as above
GLS-HF Conductive Ink Black	8 $\mu$ m	$\leq 2,000\Omega$	Glass, polyamide

### 1.3 Common excellent features of conductive ink

Conventionally, electromagnetic wave shields and electrostatic countermeasures have been dealt with by methods such as using metal foil and conductive materials. However, printing conductive ink is a less expensive and more flexible method than the conventional method.

Excellent features	Details
High moisture resistance, lightweight and thin	<ul style="list-style-type: none"> <li>Compared with metal foil and metal vapor deposition, it is more resistant to humidity and has less deterioration in performance over time.</li> <li>Achieve the same performance in light weight and thinness compared with other construction methods</li> </ul>
Inexpensive and flexible screen printing	<ul style="list-style-type: none"> <li>Compared with pasting metal foil and painting conductive materials, printing is a simple and inexpensive method.</li> <li>It is possible to adjust resistance value, parts and patterns where conductivity is added which is difficult with other methods.</li> </ul>
Achieve both decoration and other functions	<ul style="list-style-type: none"> <li>It is possible to get both conductivity and decoration by adding conductivity to decorative ink and overprinting.</li> <li>It is possible to get both other ink's functions such as sensor compatible (IR transmission) and conductivity.</li> </ul>

## 2. Electromagnetic wave shielding ink

### 2.1 What is electromagnetic wave shielding ink ?

Electromagnetic wave shielding ink blocks electromagnetic wave from intruding or leaking into the printed ink layer. Thanks to this ink, it is possible to apply an electromagnetic wave shielding function by inexpensive screen printing.

The following is an example of the printed material using electromagnetic wave shielding ink that blocks shields electromagnetic waves (in this case, radiated electric field) radiated from the computer screen. You can see the value of radiated electric field has been dropped from normal value of 128 (V/m) in the left photo to unmeasurable of 0 (V/m) in the right photo.



## 2.2 Printing example of electromagnetic wave shielding ink

This is a printing example of black, gray and brown of MRX-HF Conductive ink (substrate: PC) Achieving both an electromagnetic wave shielding function and decoration, it is possible to apply it to process reduction.



## 3. Anti-static measure ink

### 3.1 What is anti-static measure ink ?

Anti-static measure ink can add functions such as prevention of static charge, Electro-Static Discharge countermeasures by inexpensive screen printing.

For anti-static measure, it is necessary to appropriately adjust the electrical resistance value of the area where ink is printed according to the preconditions (usage environment, cause of electrostatic, etc.) and the problem to be solved (electrification, electric discharge, etc.). Therefore, anti-static measure ink, which allows you to freely set the resistance value and printed area, is one of the most ideal solution for them.

### 3.2 Electrical properties and surface resistivity used for anti-static measures

The following table shows the classification of electrical properties used for anti-static measures and advantages(○) and disadvantages(×) of each countermeasure.

(Refer to: IEC 61340-5-1,5-2 Standard)

Classification of electrical properties and surface resistance value used $\rho_s(\Omega)$	Characteristics and application to anti-static measures
Electrostatic conductivity $1.0 \times 10^2 \leq \rho_s < 1.0 \times 10^5$	It is hard to be electrified but electrical charge moves faster  ○ It unlikely becomes a source of electrostatic as it hardly electrifies. × There is a risk of electric discharge when a charged object comes into contact with it.

<p>Electrostatic diffusivity  <math>1.0 \times 10^5 \leq \rho_s &lt; 1.0 \times 10^{11}</math></p>	<p>It is hard to be charged and electrical charge diffuses slowly (the area used for antistatic).</p> <ul style="list-style-type: none"> <li>○ It is not easily charged by nature and even if it is electrified, it discharges relatively slowly.</li> <li>○ Intense discharge does not occur even if a discharged substance comes to contact with it.</li> <li>× It is necessary to adjust resistance value according to the solution (charging conditions, desired charge decay, etc.)</li> </ul>
<p>Insulation  <math>1.0 \times 10^{11} \leq \rho_s</math></p>	<p>It is easily charged and the charge is easily stored but the speed of transfer and diffusion is small.</p> <ul style="list-style-type: none"> <li>○ Discharge does not occur as it does not energize even if a charged substance comes to contact with it.</li> <li>○ It is a solution to reduce the risk of discharge under limited conditions.</li> <li>× It causes static electricity as it is easily charged by friction.</li> </ul>

### 3.3 Printing example of anti-static measure ink

The photo below shows the printed material of GLS-HF Conductive ink Black and Gray (substrate: glass) Static charge can be prevented by setting the optimum resistance value in the electrostatic diffusivity region, which can solve problems such as discharge and dust adhesion, etc.



## 4. Application to quality improvement of sensor equipment

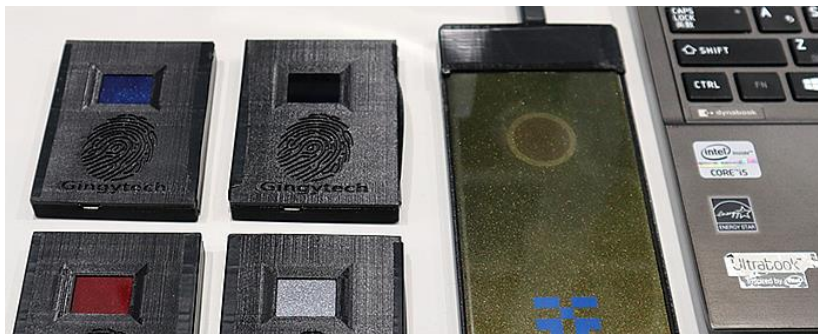
### 4.1 What is application to quality improvement of sensor equipment ?

The application to quality improvement of sensor equipment means that quality improvement can be realized by using conductive functions to solve deterioration of sensor sensitivity due to dust adhesion and sensor malfunction due to incident of electromagnetic waves. As these methods can be used with decoration process, compared with other methods, they can be implemented more easily than other methods.

Application to sensor equipment	Beneficial effects
Anti-static measure	<ul style="list-style-type: none"> <li>Apply antistatic treatment to housing and light receiving port to prevent dust adhesion and to improve sensing sensitivity.</li> <li>Take countermeasure against discharge due to static electricity to prevent malfunction</li> </ul>
Electromagnetic wave shield	<ul style="list-style-type: none"> <li>Apply electromagnetic wave shield to housing to prevent malfunction.</li> </ul>

## 4.2 Application example to quality improvement of sensor equipment

Applying anti-static measures to sensor ink for sensor light receiving port and ink for decorating housing, which prevents dust adhesion due to static electricity to the light receiving port and contributes to sensor sensitivity improvement.



## 5. Application to cost reduction of electronic circuits (Please contact us for details)

### 5.1 What is the application to cost reduction of electronic circuits ?

The application to cost reduction of electronic circuits means that replaces the elements and necessary functions used in electronic circuits by printing inexpensive and highly flexible conductive ink. This alternative method has a good compatibility with flexible circuits because its material is screen ink.

Note: As there is a case where printing is impossible depending on the content of alternation or problem to be solved, please feel free to get in touch with us for the specific issues and whether or not they can be solved by printing.



How to apply to electronic circuit boards	Features
Replacement of resistor	(Please feel free to get in touch with us for feasible resistance values, printing performance values, etc.) <ul style="list-style-type: none"> <li>· Achieve the optimum resistance value by adjusting the resistance value, printing pattern, and layer thickness.</li> <li>· Drastically reduce number of parts and mounting processes as it can be done only by printing</li> </ul>
Replacement of other electron elements	<ul style="list-style-type: none"> <li>· Realize insulation by screen printing that can prevent circuit shortcuts, etc.</li> </ul>
Countermeasures against electromagnetic waves and static electricity	<ul style="list-style-type: none"> <li>· Realize leakage prevention of electromagnetic waves by printing</li> <li>· Realize damage prevention of electronic circuits due to static electricity discharge by printing</li> </ul>

## 5.2 Substitution by printing of electronic circuit elements (the photo is just an image.)

The following is an image photo of electronic circuit substituted by screen printing elements. As for applying both conductivity and fine lines, limit values will vary depending on the conditions. If you are considering alternative electronic circuit elements (resistive elements, etc.) by printing, please feel free to contact us to discuss the possibility of solving your issue.

