# Flexible Composite-Type Electromagnetic Shield Materials For 13.56MHz RFID System

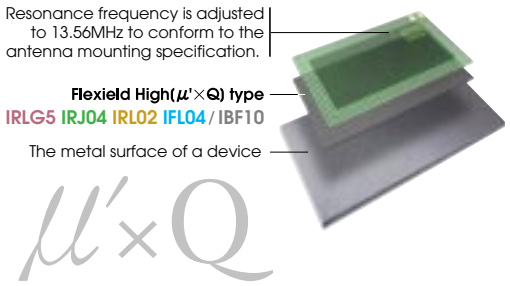
# Flexield

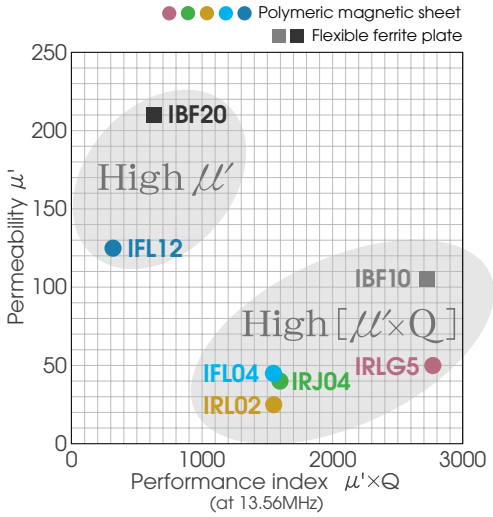
Series

## IRLG5, IRJ04, IRL02, IFL04, IFL12, IBF10, IBF20


Enriched lineup of characteristics responding to the advanced needs of RFID systems

### Improving built-in RFID antenna performance



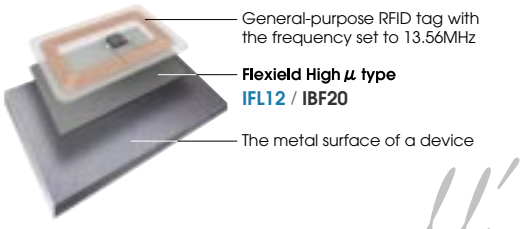




# Flexible Composite-Type Electromagnetic Shield Materials For 13.56MHz RFID System

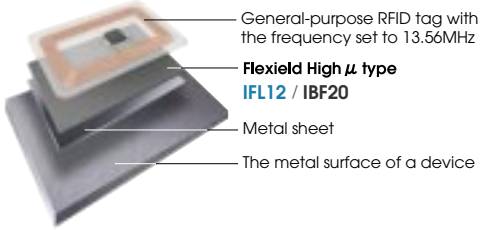
# Flexield Series

RFID:Radio Frequency Identification

### Adjusting resonance frequency when attaching general-purpose RFID tags




### Multi-purpose/built-in metal sheet type




### High-performance index type optimal for small terminal devices with built-in RFID antennas

Because the 13.56MHz RFID system uses a magnetic field as carrier wave, designed communication range may not be attained when loop antennas are close to a metal case, shielded case, ground surface of circuit board, or steel surfaces such as battery casing.

This attenuation of carrier wave occurs because the eddy current induced on the metal surface creates a magnetic field in the reverse direction to the carrier wave. Metal surface is unavoidable for small RFID terminal devices such as mobile phones. Measures must be taken to reduce eddy current and to enable the normal communication performance of loop antennas.

Realizing the best antenna performance without compromising circuit pattern design or structural design — To make this happen, TDK developed a high-performance index ($\mu'\times Q$) type, where high Q, which minimizes the carrier wave attenuation even if it's directly attached to the antenna, and the force of permeability ($\mu'$), which shield the carrier wave from the metal surface, are sought. Based on the characteristics of the industry's highest level, a wide range of materials are available to allow optimal communication performance according to the device's design conditions. These materials support diverse needs such as high $\mu'$, low $\mu''$, sheet thickness, and flame resistance.

#### Polymeric magnetic sheet

**IRLG5** New advanced product with the industry's highest level performance index ($\mu'\times Q$)2780 and a Q value exceeding 55.6

**IRJ04** Highly efficient product with 1600 performance index and superior flame resistance (UL94V-0 acquired)

**IRL02** Low-loss ($\mu''$:0.4), thick product (T:1, 2mm) with 1560 performance index

**IFL04** The thinnest (T:0.05, 0.1mm) product with a 1560 performance index, high-insulation PET film pressure bonding

#### Flexible ferrite plate

**IBF10** Supports increased communication performance design with a 105 $\mu'$ value, the highest among the high Q types, and 2760 performance index

### The high $\mu$ type supports active application of general-purpose RFID tags

In recent years, the need for low-cost solutions using the 13.56MHz general-purpose RFID tags without adjustment in terminals - such as mobile phones - where adjacency of metal surfaces is inevitable, has been growing.

But if a general-purpose RFID tag of 13.56MHz resonance frequency is attached to a metal surface, the L value of the antenna characteristics will decrease because of the offsetting magnetic field, and the preset resonance point will markedly shift to a higher frequency.

As a preventive measure to this communication inability, the high $\mu'$ type, which realized $\mu'$ over the 100 level, can be attached directly to the back of the tag. This will equivalently reinforce the L element of the antenna resonance circuit. By optimizing the thickness of Flexield and the attachment size/shape, the resonance point which shifted to a higher frequency can be returned to 13.56MHz.

#### Polymeric magnetic sheet

**IFL12** New advanced product as thin as 0.05mm with a 125 $\mu'$ value, facilitating the use of general-purpose tags in mobile terminals.

#### Flexible ferrite plate

**IBF20** New and advanced product with a 210 $\mu'$value, the industry's highest level, responding to the need for the use of general-purpose tags

All products comply with the RoHS directive*.

Efforts for halogen-free materials are underway.

* Conformity to RoHS Directive: This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used, except for exempted applications.

# Enriched material lineup to respond to the cutting-edge needs of RFID systems. The characteristics and thicknesses your devices need are here.

## Polymeric magnetic sheet

### IRLG5

This halogen-free polymeric magnetic sheet utilizes the latest development achievements of magnetic powder. Its medium thickness (surface resistivity: 10kΩ/□ min.) is best for improving electromagnetic environment where high insulation is not required, such as the metal case of readers/writers and the metal parts of RFID tag detection systems.

By controlling the shape and high density filling of superior characteristic magnetic powder optimized for 0.25mm and 0.5mm sheet thicknesses, it exceeds the high Q slim type **IFL04** in high Q/low loss (low $\mu$") properties. With the industry's highest grade performance index ($\mu' \times Q$) 2780 typ., it shows a remarkable magnetic flux convergence effect at 13.56MHz. Pressure bonding of high-insulation PET film (surface resistivity: 1GΩ/□ min.) is also available.

### IRJ04

Polymeric magnetic sheet using originally developed magnetic powder with superior flame resistance (UL94V-0) and surface resistivity (1G / min.). There's no risk of causing damage when directly attached to the back of a loop antenna because the loss element $\mu$" is 1 before the rise, while the $\mu$' value is 40 typ. at 13.56 MHz, promising efficient convergence of carrier magnetic field (signal, power).

### IRL02

Halogen-free polymeric magnetic sheet with a 1MΩ/□ min. high resistance, which achieved a low loss of 0.4 $\mu$" and a 63 typ. Q value using low-loss magnetic powder. 1mm and 2mm thick types, which are effective in reinforcing the send/receive performance of readers/writers and tag detection systems, are available. Through cutting or punching out processes, a large magnetic shield effect, which improves the electromagnetic environment inside the devices, can be attained. On request, we can also provide customized shapes through moulding.

### IFL04 IFL12

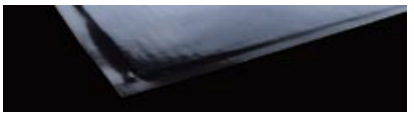
One of the thinnest halogen-free polymeric magnetic sheets using originally developed magnetic powder. Their thinnest standard thicknesses come in 0.05mm and 0.1mm. Previously difficult installation in small spaces is now easier. It offers much freedom in designing 13.56MHz RFID systems by reinforcing mobile RFID communication performance and placing general-purpose RFID tags on the metal surface.

**IFL04** offers reduced loss element $\mu$" at 13.56MHz to a 1.3 typ. insignificant level. By directly attaching it to the back of the loop antennas built in RFID mobile terminals, the magnetic flux convergence effect of 45 typ. $\mu$' can be fully utilized, ensuring good communication range and stability.

**IFL12**, with originally produced high $\mu$ magnetic powder, achieved a 125 typ. $\mu$' value (at 13.56MHz), one of the industry's highest $\mu$' values as a polymeric sheet. When general-purpose RFID antenna is attached to the metal surface, the resonance frequency set to 13.56MHz will make a large shift to a high frequency zone, which makes communication unable. But by attaching **IFL12** on the back of the antenna, the shifted resonance frequency can be corrected and a practical communication performance can be achieved.

## Flexible ferrite plate

### IBF10 IBF20



Super-thin sintered high $\mu$' ferrite plate sealed between PET film (surface resistivity: 1GΩ/□ min.) and adhesive tape layers. Two types of sheet thickness are available : 0.15mm and 0.26mm which include the PET film and cohesive tape layers.

Our original sealing structure allows flexibility which is close to that of a polymeric magnetic sheet, offering resistivity to bending during installation *.

* Shaping and holing the ferrite plate requires processes for hard materials, and it won't be as easy as processing polymeric materials. Please contact us for details.

**IBF10** offers a 105 typ. $\mu$' high value as well as the industry's highest level performance index ($\mu' \times Q$) 2760 typ., a similar level to that of **IRLG5**., realizing outstanding magnetic flux convergence effect at 13.56MHz. Its loss element $\mu$" is reduced to 4 typ. level and it achieved a 28 typ. Q value, which allows **IBF10** to enhance the performance of the RFID antennas used in readers/writers and small terminal devices.

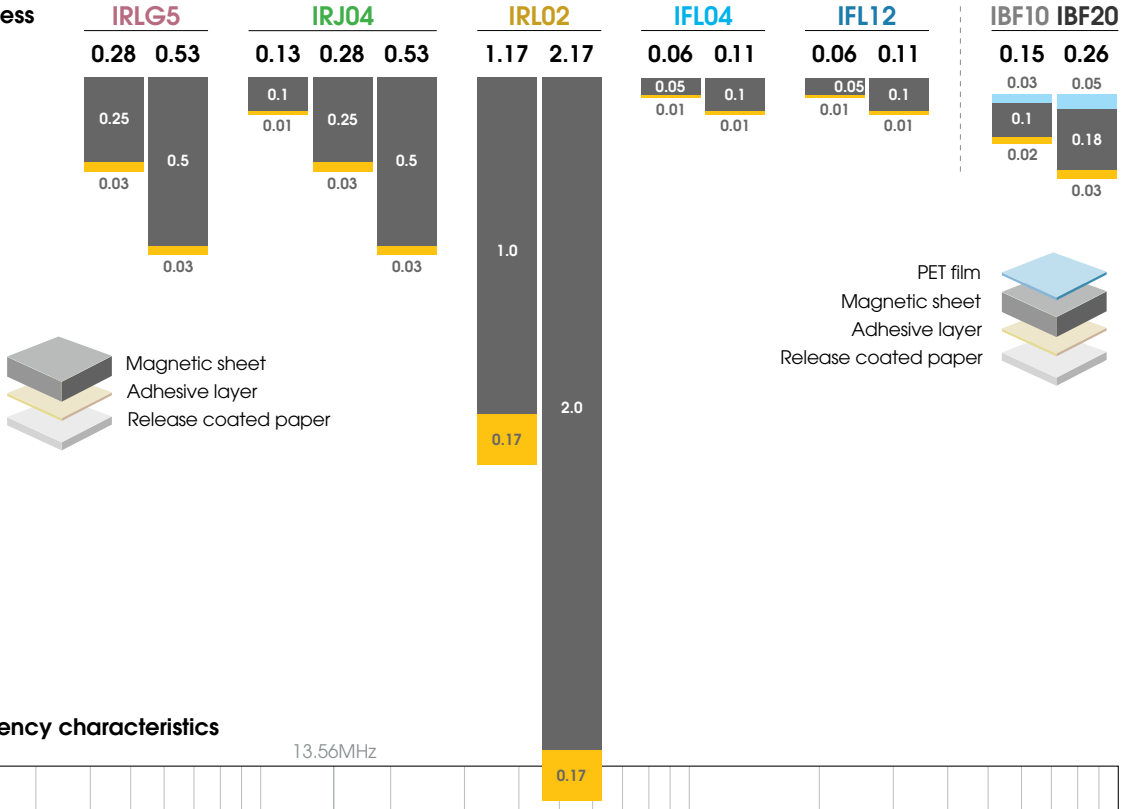
Flexible ferrite plate **IBF20** provides a 210 typ. $\mu$' value at 13.56MHz – the industry's highest level as a magnetic sheet – making it best suited for countermeasures for battery packs (magnetic shield) , which affect the communication performance of mobile RFID systems. Similar to **IFL12**, it is effective to prevent the resonance frequency's shift to a high frequency zone when a general-purpose RFID antenna adjusted to 13.56MHz is attached to the metal surface.

# Flexield Series

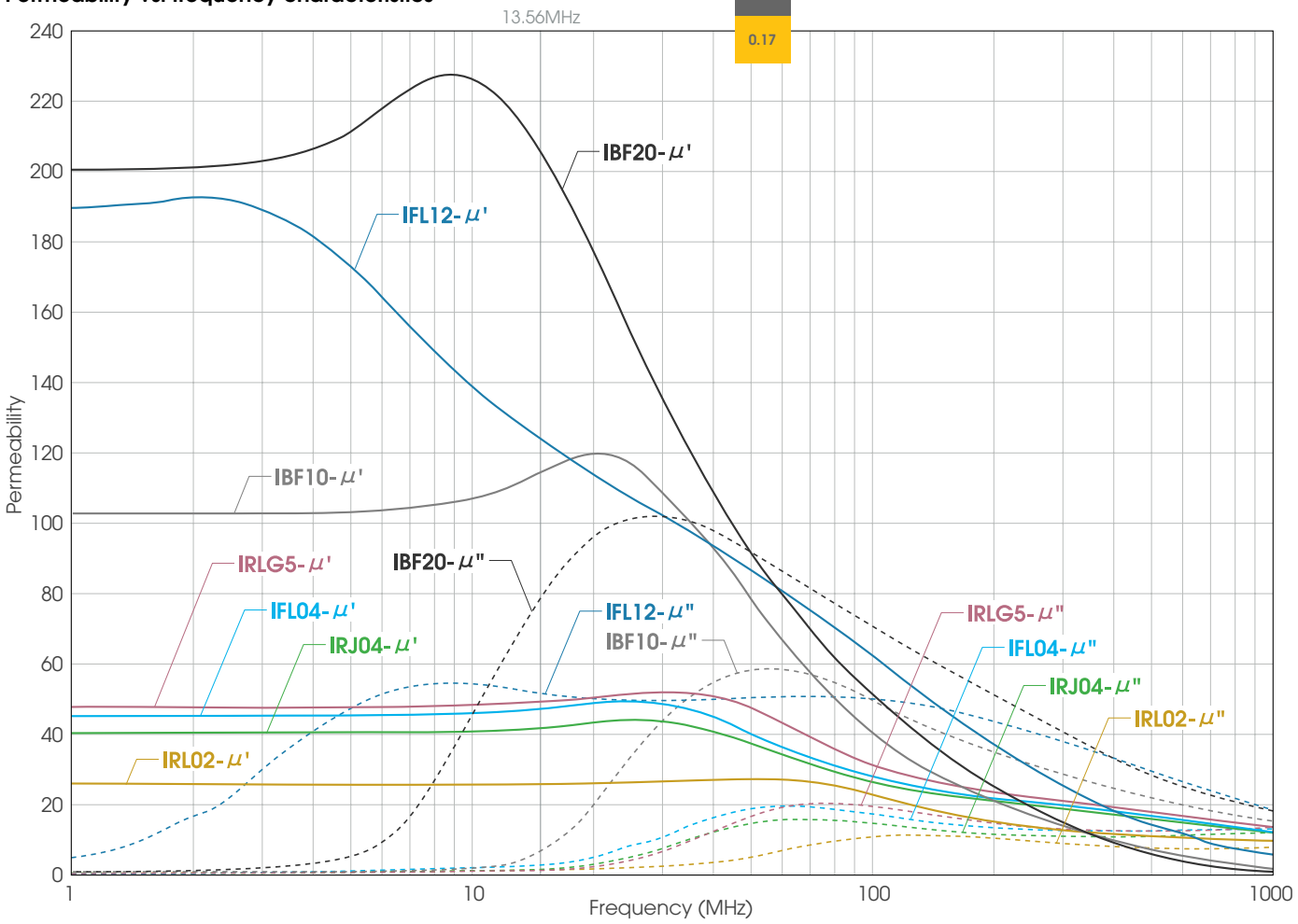
## Standard sheet thickness
## Permeability vs. frequency characteristics

### Standard sheet thickness

Dimensions in mm

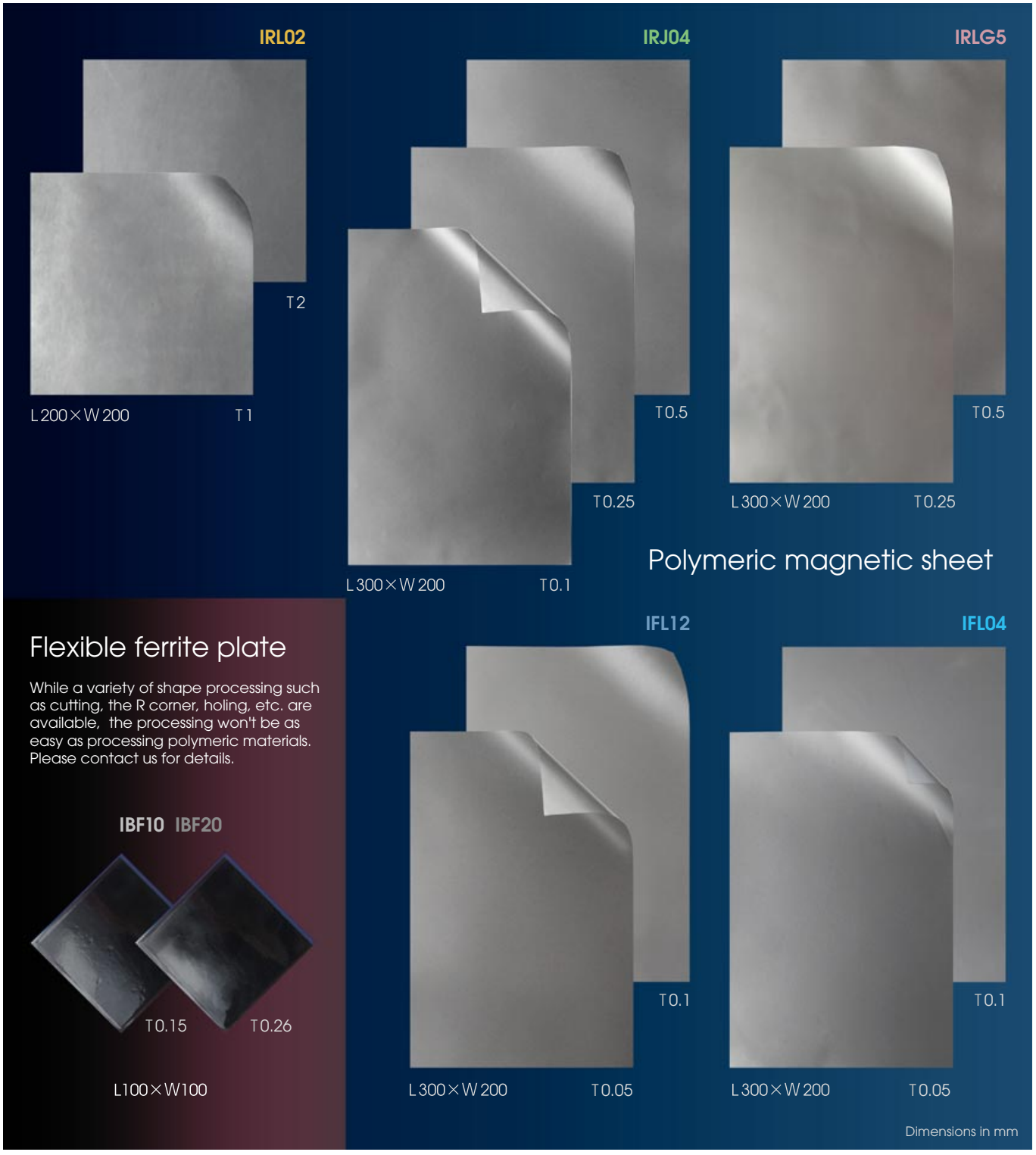



### Permeability vs. frequency characteristics



## We respond to requests for diverse sheet shapes and processing such as half-cut processed adhesive sheet, adhesive tape processed long rolls in a flexible, quick manner.

■ Please refer to the product files in Product Update File for standard sheet images of the EMI prevention products.



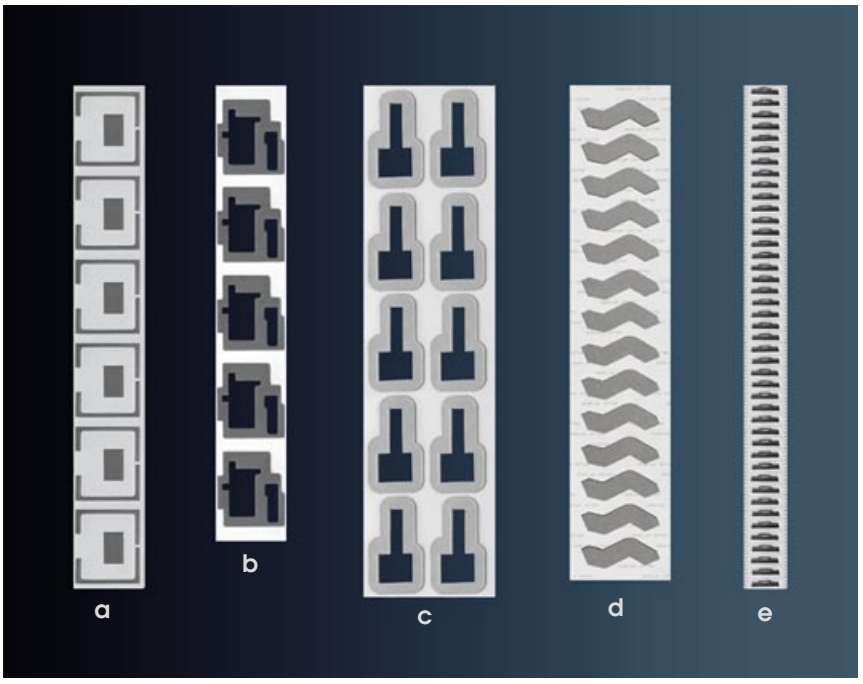

Our integrated processing network through close collaboration with specialized factories allow accurate manufacturing and the shortest delivery periods to respond to diverse requests from making sheet processing samples to mass production. Device development and evaluation process can be shortened with a reduced cost. As well as half-cut processing, punching-out sheet processing, high-insulation PET film processing, long roll adhesive tape processing, we support diverse shapes and processing methods such as punching-out processing of large sheets.

Flexible Composite-Type Electromagnetic Shield Materials
For 13.56MHz RFID System

Standard size, thickness
Examples of diverse processing

# Flexield
Series

We have established a high-precision management system to reduce the inconsistency in $\mu$ value, thickness, and size. This allows the smallest size tolerance for small devices where multiple boards and circuit units are crammed such as mobile phones and digital cameras. This can also make drastic improvement in the stability of resonance frequency matching in the mass production of terminals with RFID loop antennas.




## Examples of half-cut adhesive sheet processing

For directly attaching to RFID mobile terminal loop antennas **a, b**
For directly attaching to RFID general-purpose tags **c**
For prevention of radiation from flexible I/O cable (connection between circuit boards of digital cameras) **d**

## Example of molding

Mobile phone SAR level reduction chip (taping type) **e**

## Long roll adhesive tape processing

Supported products

**For 13.56MHz RFID systems**

**IFL04**

| 0.06 | 0.11 |
|---|---|
| 0.05 | 0.1 |
| 0.01 | 0.01 |

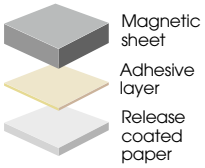
**IFL12**

| 0.06 | 0.11 |
|---|---|
| 0.05 | 0.1 |
| 0.01 | 0.01 |

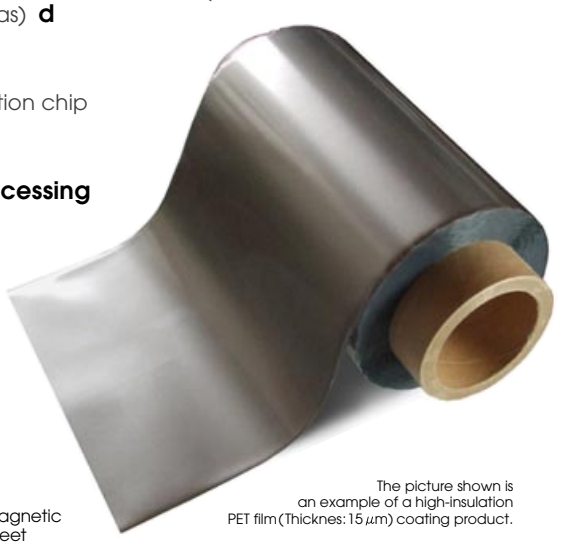
**For EMI Prevention**

**IFL10M**

| 0.06 | 0.11 |
|---|---|
| 0.05 | 0.1 |
| 0.01 | 0.01 |




Dimensions in mm



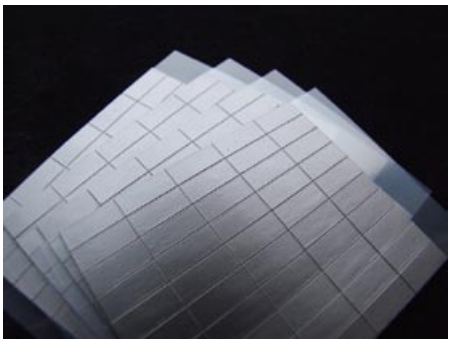
The picture shown is an example of a high-insulation PET film (Thicknes: 15 $\mu$m) coating product.

## TDK standard roll specifications

W 200 mm × L 100 m
Core material length : 300 mm
Core material inner diameter : 76.2 mm (3 inches)

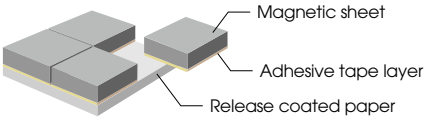
The thicknesses of adhesive layer come in 0.03mm and 0.17mm as well as 0.01mm.

## What is half-cut processing?

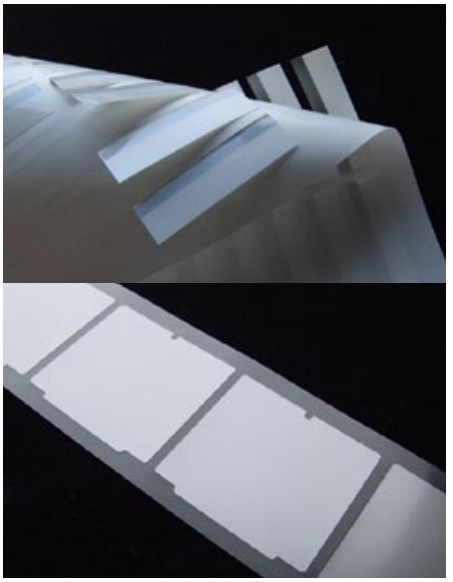


Punched-out shape: 12×5 mm×50 pieces (60×50 mm)

The half-cut processing is a method used when punching out standard Flexield with adhesive tape. This method leaves the release coated paper on the bottom layer without being punched out.




If the punched-out shape is rectangular (or a continuously arranged repeated shape), we will deliver as half-cut processed sheets (see picture above).
If the punched-out shape leaves unused spaces, we will deliver as sticker-type sheets without the unused spaces (see picture below).

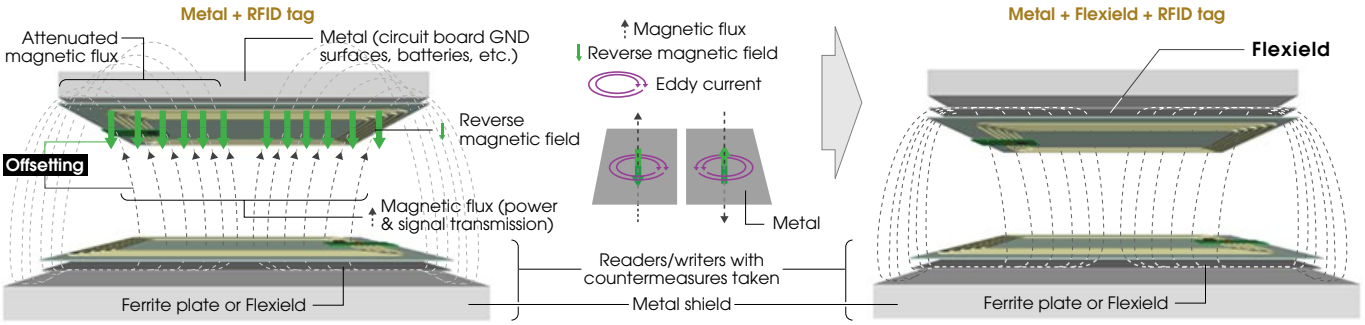


For improvement of RFID mobile terminal send/receive characteristics

# Flexield optimized for the 13.56MHz band RFID systems. The superb carrier wave convergent effect increases system performance.

## The send/receive performance of the 13.56MHz RFID system can be reinforced through magnetic flux convergent effect with $\mu'$ permeability

**Data communication (magnetic flux distribution) models of the mobile phone RFID system optimized with Flexield**




When the 13.56MHz carrier wave (magnetic field energy) penetrates the ground of a circuit board or metallized shield surface, eddy current will be induced on the metal surface, generating an unnecessary magnetic field that offsets the carrier wave.

A fundamental solution to this problem, which significantly degrades the send/receive performance of mobile terminals, would be to avoid placing metal objects such as shields around communication tags (loop antenna). But the shields between circuit units, which ensure individual circuit function, and the case shields, which prevent unnecessary radiation, are essential for mobile terminals where RF circuit blocks, oscillators, image/sound processing high-speed LSIs, and high-speed communication interfaces are implemented in a high-density and three-dimensional fashion. Each board in the terminals has a low-impedance ground layer over the entire surface. This design consideration is also true for the latest readers/writers — it would be quite a task to try to find a space, where no influence of metal surface is expected, for an RFID tag inside the 13.56MHz RFID system devices for which smallness and thinness are sought.

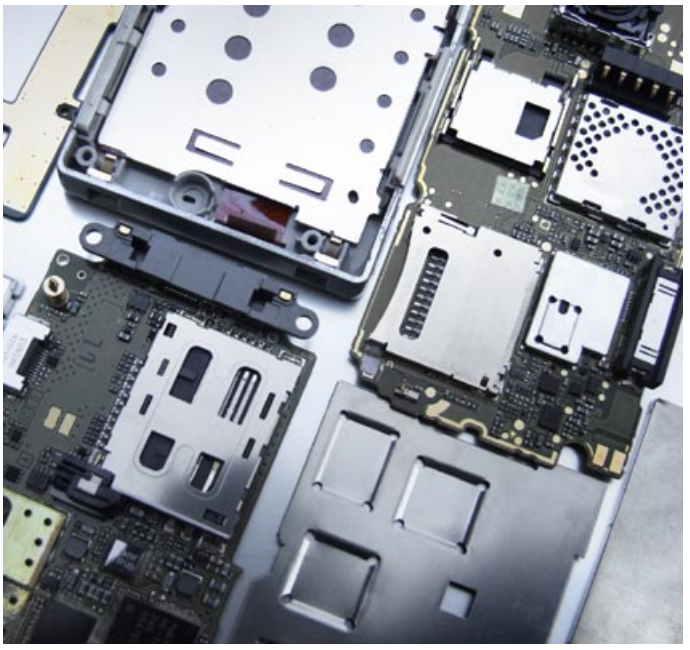
This is why the $\mu'$ effect (magnetic flux convergent effect) of Flexield, which is superior in preventing inter-circuit electromagnetic coupling issues, and the reflection and interference of radiant waves, received high expectations.

## Roles of the 13.56MHz RFID systems and magnetic sheets

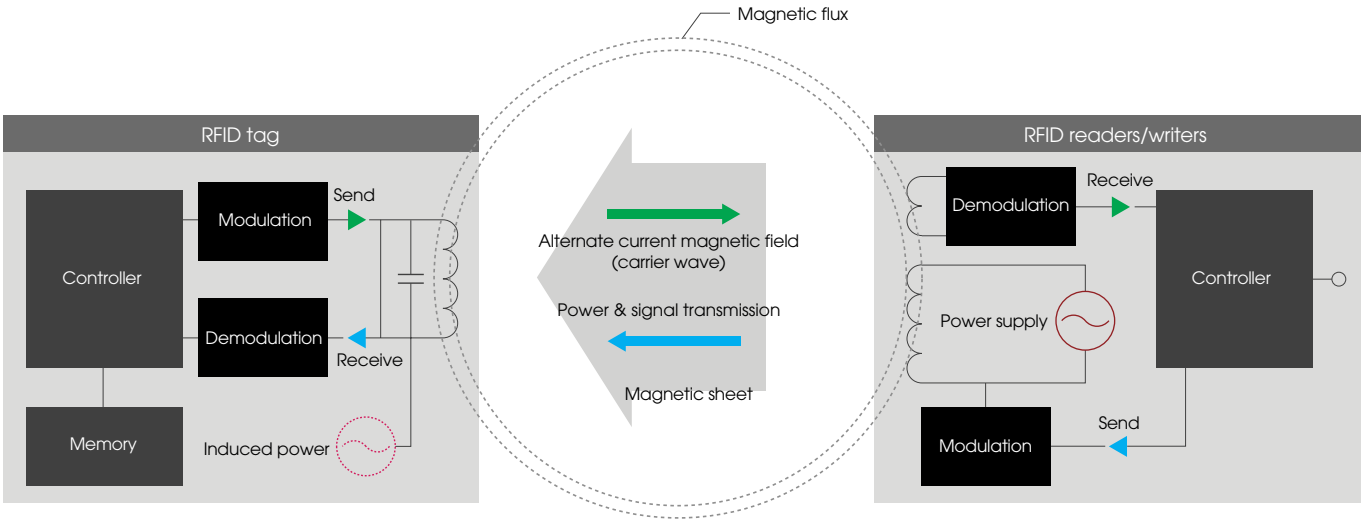
**The "living environment" of wireless tags, which differs from that of resin cards.**

Even the 13.56MHz RFID tags, which is easily integrated in slim resin cards, faces rather troublesome issues with mobile phones.

The inside of mobile phones – the most advanced field of high-density implementation – houses ground surfaces on both sides and multi-layered circuit boards. To ensure appropriate operation of every function and quality voice communication, sensitive units such as RF circuits, image signal processing units are encompassed by casing cells with metallized shields. Mobile phones today actively feature Blue-tooth, digital camera, tuner circuits, etc., and each circuit is separated and shielded with metal shields, and vapor-deposited coating in a very strict fashion incomparable to those of the previous generation models. As a wireless tag, this makes their "living environment" quite different from that of resin cards without metal shields.



**Conceptual model of the communication of the 13.56MHz RFID systems**




## The 13.56MHz RFID system operates in magnetic fields

The UHF band RFID systems, which are in practical use in Europe and the United States, and 2.45GHz RFID systems using super-small IC (μ-chip) with a side under 4mm long are contact-free read/write systems using electric wave (electric field). But the 13.56MHz RFID systems use electromagnetic induction between the spiral antennas (looping flat coils) of readers/writers and wireless tags to supply electric power and perform communication.

Migrating the UHF band and 2.45GHz RFID systems, which use "electric waves" to communicate, from a familiar environment of resin, paper, etc. to an environment of "foreign country surrounded by metal" takes certain measures. In order to secure practical communication range, countermeasures to a tough issue of "communication failure due to reflection" must be prepared (Flexield is best suited for this because it provides good electroabsorption characteristics in each frequency band).

But these issues caused by the difference in "living environment" also affect the 13.56MHz RFID systems which use magnetic field when they communicate. The existence of metal surface close to the antenna can be a big threat of losing communication capability.

## Communication failure due to metal surfaces (examples of reader/writer)

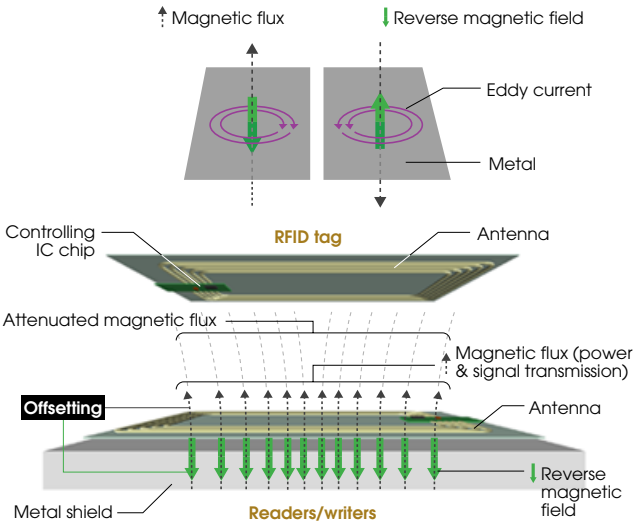
If the thin sheet tags, not to mention the reader/writer modules, are placed on the battery packs surrounded by printed-circuit boards or a metal case, data communication will suddenly be disconnected. Although there are a several physical factors for the disconnection, the most critical factor is the electromagnetic induction to the metal side behind the antenna.

When the magnetic flux occurring in the spiral antenna of reader/writer passes the metal surface, eddy current centering on magnetic flux according to the Faraday's law occurs.

The rotation direction is the opposite to the current running in the spiral antenna (i.e. the direction which causes a magnetic field in the reverse direction of the magnetic direction of carrier magnetic field occurred in the antenna). In short, the carrier wave (alternate current magnetic field), which supplies power to the tags, and the overlaid modulated data signals are all cancelled out by the reverse direction magnetic field elements induced on the metal surface, causing significant attenuation.

If the carrier wave transmitted to the tags without power supply is not enough, there will be no electromotive force. The tag functions will halt immediately and communication will be lost abruptly (see diagram below).

**The principle of occurrence of reversed magnetic field and the attenuation model of magnetic flux (carrier wave)**
Examples of reader/writer without countermeasures



# Roles of the 13.56MHz RFID systems and magnetic sheets

## One "magnetic sheet" supports the operation of the Suica system

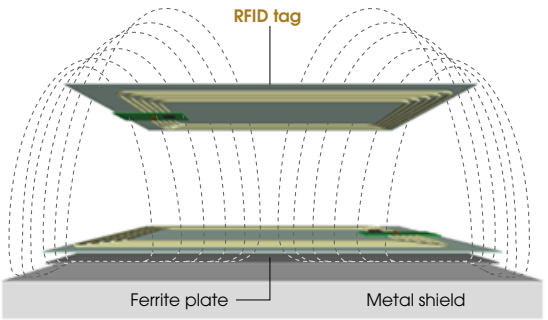
To prevent these worst situations, a magnetic material with permeability – the force to focus magnetic flux – was chosen. A plate-shaped high-permeability ferrite material is used in the readers/writers of the Suica system, providing sufficient communication range and proving stability in operation.


The diagram below shows how it works.

By inserting a high-permeability ferrite plate between the metal surface and the reader/writer module, the magnetic flux (carrier wave = carrying modulated read data signals and readout command signals) occurring in the spiral antenna will be focused on the ferrite plate laid directly under it as if it is sucked to it. This draws magnetic loops which starts from the sides or surface of the ferrite plates and penetrates the card (RFID tag) held over it.

Of course, this "plate" is not necessary if the spiral antenna is placed far from the metal surface. But the plate is an essential magnetic flux convergence tool for the slim ticket gates already in practical use.

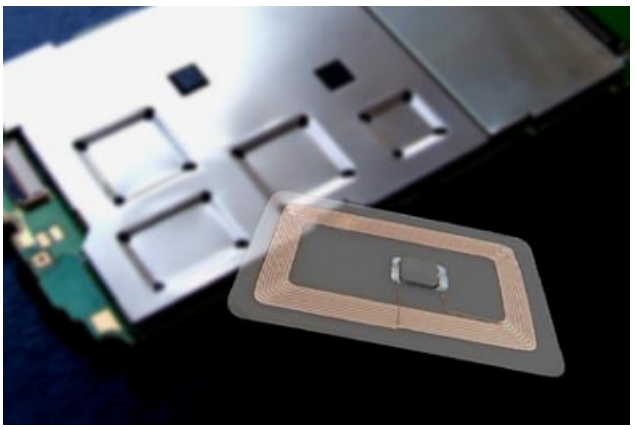
### Magnetic flux distribution model of the readers/writers with countermeasures taken




Readers/writers with countermeasures taken

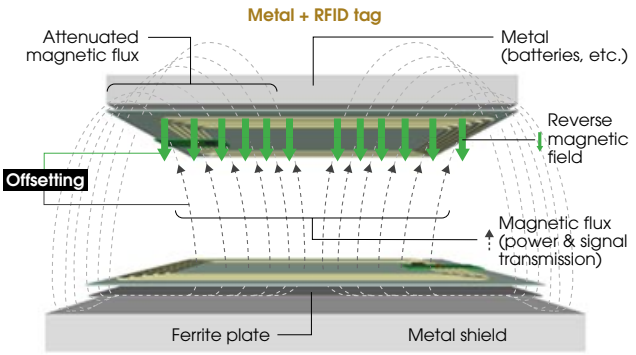
## Communication failure due to metal surfaces (examples of wireless tag)

But the issue of the communication failure due to the occurrence of reverse magnetic field concerns not just the readers/writers.



A similar problem also happens when a wireless tag is attached or closely positioned to the metal surface. In other words, the strength of the magnetic flux (the carrier wave of power and data) penetrating the inner periphery of the wireless tag antenna drastically attenuates due to the offsetting effect of the reverse magnetic field even when the card is held over the readers/writers with a sufficient magnetic field, causing a communication failure (as shown in the model diagram below).

### Magnetic flux (carrier wave) attenuation model of a wireless tag without countermeasures

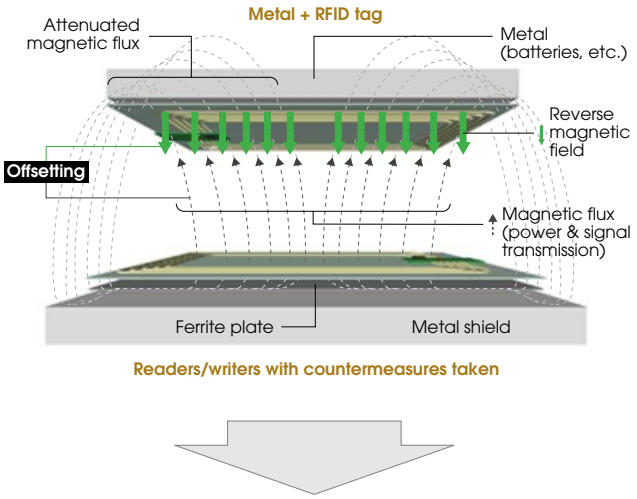



Readers/writers with countermeasures taken

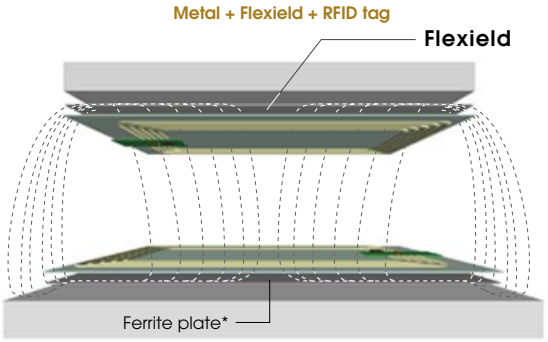
Using the ferrite plates applied in the readers/writers in mobile phones is difficult because of the thickness and physical strength. There's no space even for a shock-resistant resin ferrite. To install the 13.56MHz band RFID tags in mobile phones and to make them operate in a sufficient communication range, an eddy current reduction tool with magnetic flux convergence performance similar to that of the high-permeability ferrite plate in the Suica system readers/writers is required.

# Flexield
Series

A sheet high-permeability material that's as thin and tough as the current wireless tags or even thinner and tougher — Developing such dedicated magnetic sheets and improving characteristics are essential for the further promotion and evolvement of the 13.56MHz RFID system.




**Data communication (magnetic flux distribution) model of the mobile phone RFID system optimized with Flexield**




* Flexield can also be used in mobile handy readers/writers.

## Accelerate use of mobile RFID systems

The 13.56MHz RFID system (wireless communication using IC tags and IC cards) has been used in diverse fields such as transportation tickets and electronic money — FeliCa card(Suica, PASMO, ICOCA, PiTaPa, etc.), electronic money Edy, electronic money cards for convenience stores, etc. — as well as substitution cards for credit cards, ID cards, reward point cards, identification, entering/leaving management, electronic tickets, etc.

In particular, the widespread use of the wireless tags and readers/writers in mobile phones has been remarkable throughout the world, receiving great expectations from every field as an "information gathering/management" technology to create the culture of information usage previously unseen in any area, field, or style.

The development of application programs and downloading environment has been well arranged for the widely used mobile terminals with Mobile FeliCa (Mobile Wallet "Osaifu Keitai"). This made the efforts of developing super-small terminals with readers/writers progress faster.



FeliCa is a registered trademark of Sony Corporation.
Mobile Wallet "Osaifu Keitai" is a registered trademark of NTT DoCoMo, Inc.

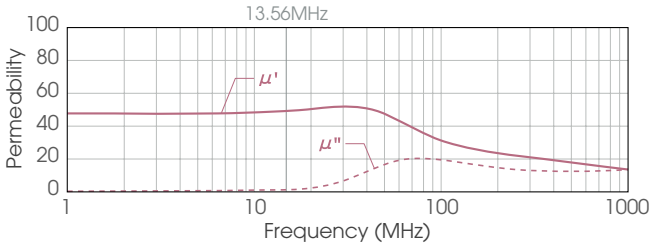
## TDK's efforts

### Seeking the industry's top specifications to quickly support the latest requirements

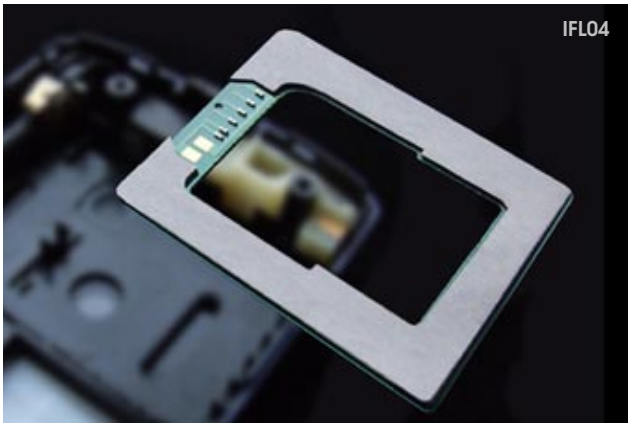
TDK's Flexield is utilized in diverse fields as a communication-performance reinforcing magnetic sheet for the 13.56 MHz RFID system. Improvements of its existing models and launching new models with advantages in material, magnetic characteristics, thickness, safety standard, environment friendliness, have been underway to provide appropriate support for the diverse needs of RFID equipment/devices which require countermeasures.

**IRLG5**, which seeks the maximum high Q/low loss by using newly developed magnetic powder, has achieved the industry's highest level performance index ($\mu'\times Q$) 2780 typ., a similar level to the flexible ferrite plate **IBF10** which has 105 $\mu'$ value. Medium thicknesses of 0.25mm and 0.5mm are available, providing efficient improvement for the metal parts of the readers/writers and tag detection systems. It can also be attached directly to built-in loop antennas.

**IRLG5 Permeability vs. frequency characteristics**



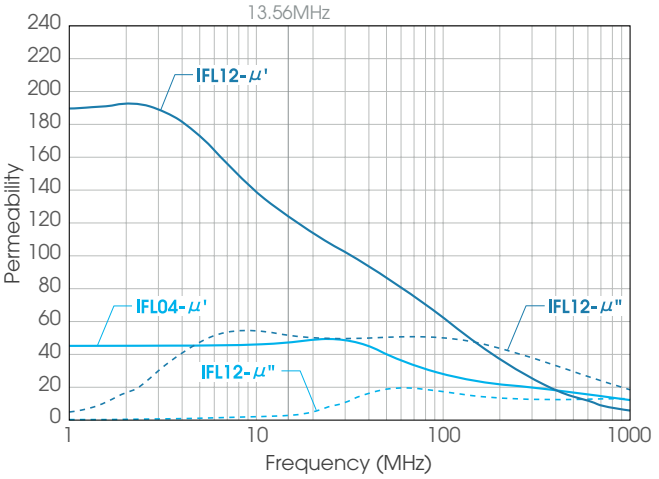

**IFL04** receives high regards as a low-loss/high Q type and can be attached directly to the built-in antennas of the 13.56MHz RFID systems. In addition to the **IFL04**'s thinnest specifications of 0.05mm and 0.1mm thick, a new material **IFL12**, which has the characteristics to deal with new demands, was developed.



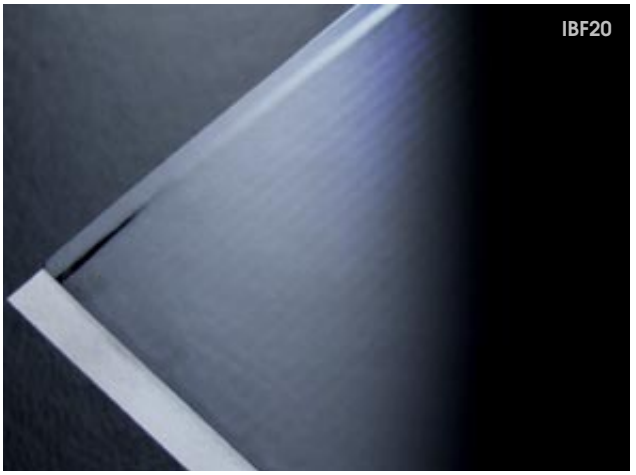

When a cheap 13.56MHz general-purpose RFID tag is used in terminals that are easily affected by the metal surfaces of devices such as mobile phones, a preset resonance frequency can be shifted to a higher frequency. Countermeasures to this problem must be taken.

**IFL12** realized a 125 high $\mu'$ value, which is the industry's highest level as a polymeric type, in the thinnest sheet style same as **IFL04**. By directly attaching **IFL04** with an optimized thickness and shape to a general-purpose tag, the tag can be installed in the terminals with metal surfaces such as mobile phones, allowing a practical communication range.

**IFL04 IFL12 Permeability vs. frequency characteristics**



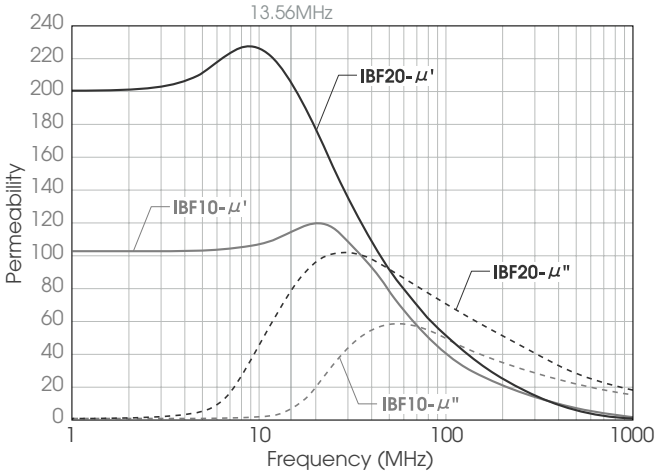

As a new material that helps utilize general-purpose tags, **IBF20**, the latest flexible ferrite plate material, achieved a 210 high $\mu'$ value, which drastically exceeds the existing standard as a magnetic sheet.




Two types of flexible ferrite plates, 0.15mm and 0.26mm thick, which have the flexibility of polymeric magnetic sheet by sealing super-thin 0.1mm, 0.18mm sintered ferrite plates with a high-resistance PET film and adhesive tape layer, are available. Just like **IFL12**, the flexible ferrite plate **IBF20**, for which the $\mu'$ value was increased to 210 typ. at 13.56MHz, also shows superb improvement effect against the fluctuation of resonance frequencies when attaching a general-purpose RFID antenna which is preset at 13.56 MHz to a metal surface.

Also, the intense magnetic convergence effect (shield effect) caused by the industry's highest level high $\mu'$ is the best countermeasure for battery packs which may affect the communication performance of mobile RFID systems.

**IBF10 IBF20 Permeability vs. frequency characteristics**




**IBF10** has been used widely with its industry's highest level performance index ($\mu'\times Q$)2760typ., and can utilize the magnetic flux effect of a 105typ. high $\mu'$ value with a small loss ($\mu"$: 3typ.), an advantage no other material can offer. It also allows the installation to a narrow space by directly attaching the one with 0.15mm thick to the built-in loop antenna of a small RFID terminal device, which has been not feasible with the existing thick and hard ferrite plates, offering a chance to improve the communication performance to a previously unseen level.

# Frequency characteristics/Basic specifications/Standard sheet shapes
# Permeability vs. frequency characteristics
## IRLG5 IRL02

**IRLG5**: High Q, low loss/midium-thick material/surface resistivity 10kΩ/□min. (suitable for adjusting resonance frequency when attaching general-purpose RFID antennas to metal surfaces).

**IRL02**: High Q, low loss/high resistivity 1MΩ/□min./thick material (Best suited for improving and reinforcing the communication performance and the electromagnetic environments of the readers/writers and tag detection systems).

### Frequency characteristics/Basic specifications/Standard sheet shapes

| Part No. | | IRLG5 | IRL02 |
|---|---|---|---|
| Materialsn | | Magnetic powder + Polymeric resin | Magnetic powder + Polymeric resin |
| at 13.56MHz | μ' typ. | 50 | 25 |
| | μ" typ. | 0.9 | 0.4 |
| Basic specifications | | | |
| Surface resistivity (Ω/□) | | 10k min. | 1M min. |
| Operating temperature rang (℃) | | −40 to +85 | −40 to +85 |
| Heat conductivity (W/m·k) | | 1.5 | 1.4 |
| Flame-resistance standard | | — | — |
| Environment friendliness | | RoHS*1/Halogen free | RoHS*1/Halogen free |
| Standard sheet shape/weight/density (shown in the typ. value) | | | |
| L×W×T*2 (mm)/(g)/(g/cm³) | | 300×200×0.25/56/3.7 | 200×200×1/130/3.2 |
| | | 300×200×0.5/111/3.7 | 200×200×2/260/3.2 |
| Standard thickness of adhesive layer*3 (mm) | | 0.03 | 0.17 |

*1. Conformity to RoHS Directive: This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used, except for exempted applications.

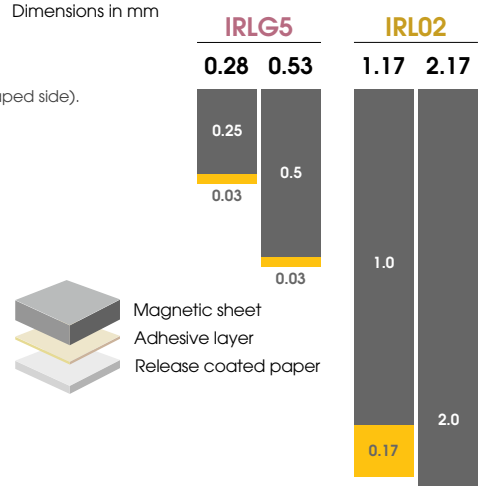
*2. Standard sheet specification: adhesive tape is attached on the back of the magnetic sheet. The thickness T does not include the thickness of the adhesive tape (adhesive layer ■).

*3. The thickness of each product's adhesive layer can be chosen from 0.01mm, 0.03mm, and 0.17mm.

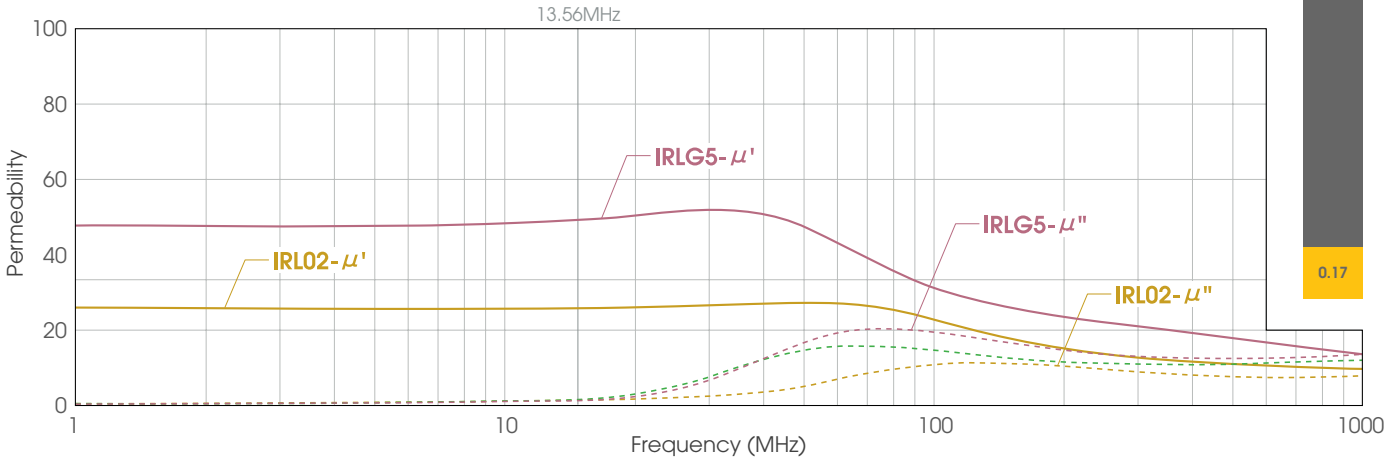
We also provide the pressure bonding of high-insulation PET films to the Flexield surface (the opposite side to the taped side). Two types of thicknesses of PET film are available: 15μm(0.015mm) and 25μm(0.025mm).

### Standard sheet thickness

Dimensions in mm




### Permeability vs. frequency characteristics



# Flexield
Series

## IRJ04

**IRJ04**: High Q, low loss, high resistivity 1MΩ/□min./flame resisting standard UL94V-0 acquired /thin, medium-thick material (best suited for improving the performance of built-in RFID antennas)

### Frequency characteristics/Basic specifications/Standard sheet shapes

| Part No. | | IRJ04 |
|---|---|---|
| Materialsn | | Magnetic powder + Polymeric resin |
| at 13.56MHz | $\mu$' typ. | 40 |
| | $\mu$" typ. | 1 |
| Basic specifications | | |
| Surface resistivity (Ω/□) | | 1M min. |
| Operating temperature rang (℃) | | −40 to +85 |
| Heat conductivity (W/m・k) | | 1.5 |
| Flame-resistance standard | | UL94V-0 |
| Environment friendliness | | RoHS*1 |
| Standard sheet shape/weight/density (shown in the typ. value) | | |
| L×W×T*2 (mm)/(g)/(g/cm³) | | 300×200×0.1/22/3.7 |
| | | 300×200×0.25/56/3.7 |
| | | 300×200×0.5/111/3.7 |
| Standard thickness of adhesive layer*3 (mm) | | Product of T: 0.1mm → 0.01 |
| | | Product of T: 0.25, 0.5mm → 0.03 |

*1. Conformity to RoHS Directive: This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used, except for exempted applications.

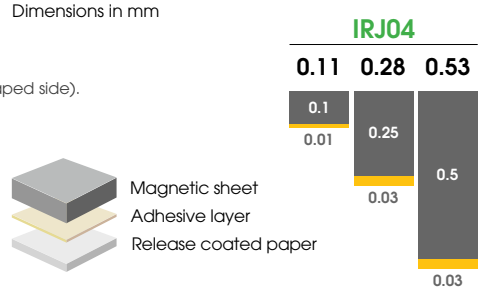
*2. Standard sheet specification: adhesive tape is attached on the back of the magnetic sheet. The thickness T does not include the thickness of the adhesive tape (adhesive layer ■).

*3. The adhesive layer thickness of 0.03mm and 0.17mm, as well as 0.01mm, are available.

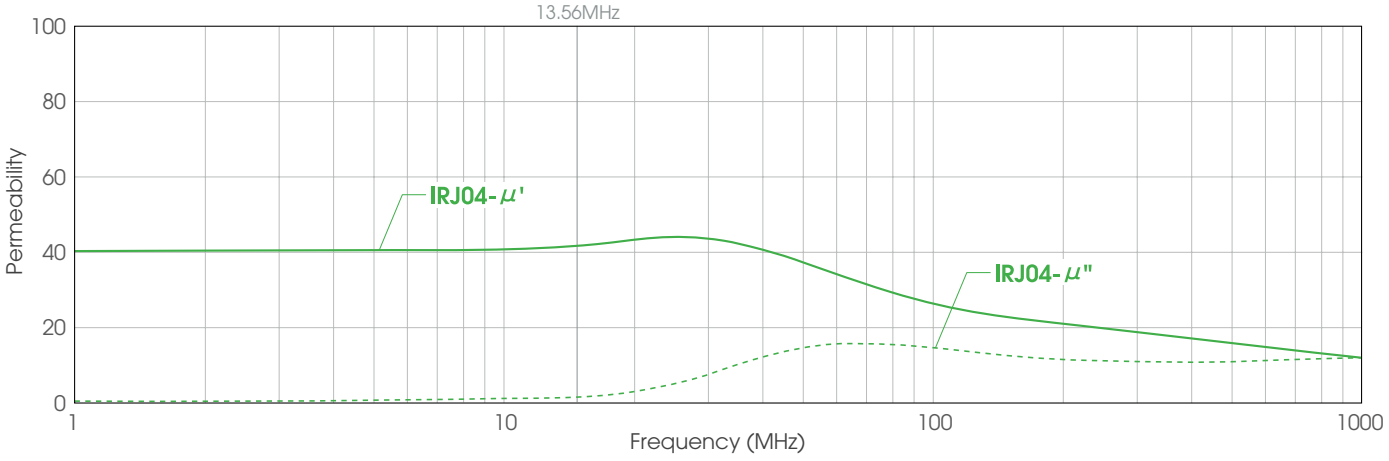
We also provide the pressure bonding of high-insulation PET films to the Flexield surface (the opposite side to the taped side). Two types of thicknesses of PET film are available: 15μm(0.015mm) and 25μm(0.025mm).

### Standard sheet thickness

Dimensions in mm




### Permeability vs. frequency characteristics



# Frequency characteristics/Basic specifications/Standard sheet shapes
# Permeability vs. frequency characteristics
# IFL04 IFL12

**IFL04**: High Q, low loss/the thinnest material (best suited for reinforcing the communication performance of small-space built-in RFID antennas such as the ones for mobile phones )

**IFL12**: High $\mu$/the thinnest material (suitable for adjusting resonance frequency when attaching general-purpose RFID antennas to metal surfaces )

### Frequency characteristics/Basic specifications/Standard sheet shapes

| Part No. | | IFL04 | IFL12 |
|---|---|---|---|
| Materialsn | | Magnetic powder + Polymeric resin | Magnetic powder + Polymeric resin |
| at 13.56MHz | $\mu$' typ. | 45 | 125 |
| | $\mu$" typ. | 1.3 | 50 |
| Basic specifications | | | |
| Surface resistivity (Ω/□) | | 10K min. | 100K min. |
| Operating temperature rang (℃) | | −40 to +85 | −40 to +85 |
| Heat conductivity (W/m·k) | | 1.5 | 1.5 |
| Flame-resistance standard | | — | — |
| Environment friendliness | | RoHS*1/Halogen free | RoHS*1/Halogen free |
| Standard sheet shape/weight/density (shown in the typ. value) | | | |
| L×W×T*2 (mm)/(g)/(g/cm³) | | 300×200×0.05/9/3.1 | 300×200×0.05/9/3.1 |
| | | 300×200×0.1/19/3.1 | 300×200×0.1/19/3.1 |
| Standard thickness of adhesive layer *3 (mm) | | 0.01 | 0.01 |
| Support for roll shapes | | TDK standard roll specification*4 | TDK standard roll specification*4 |

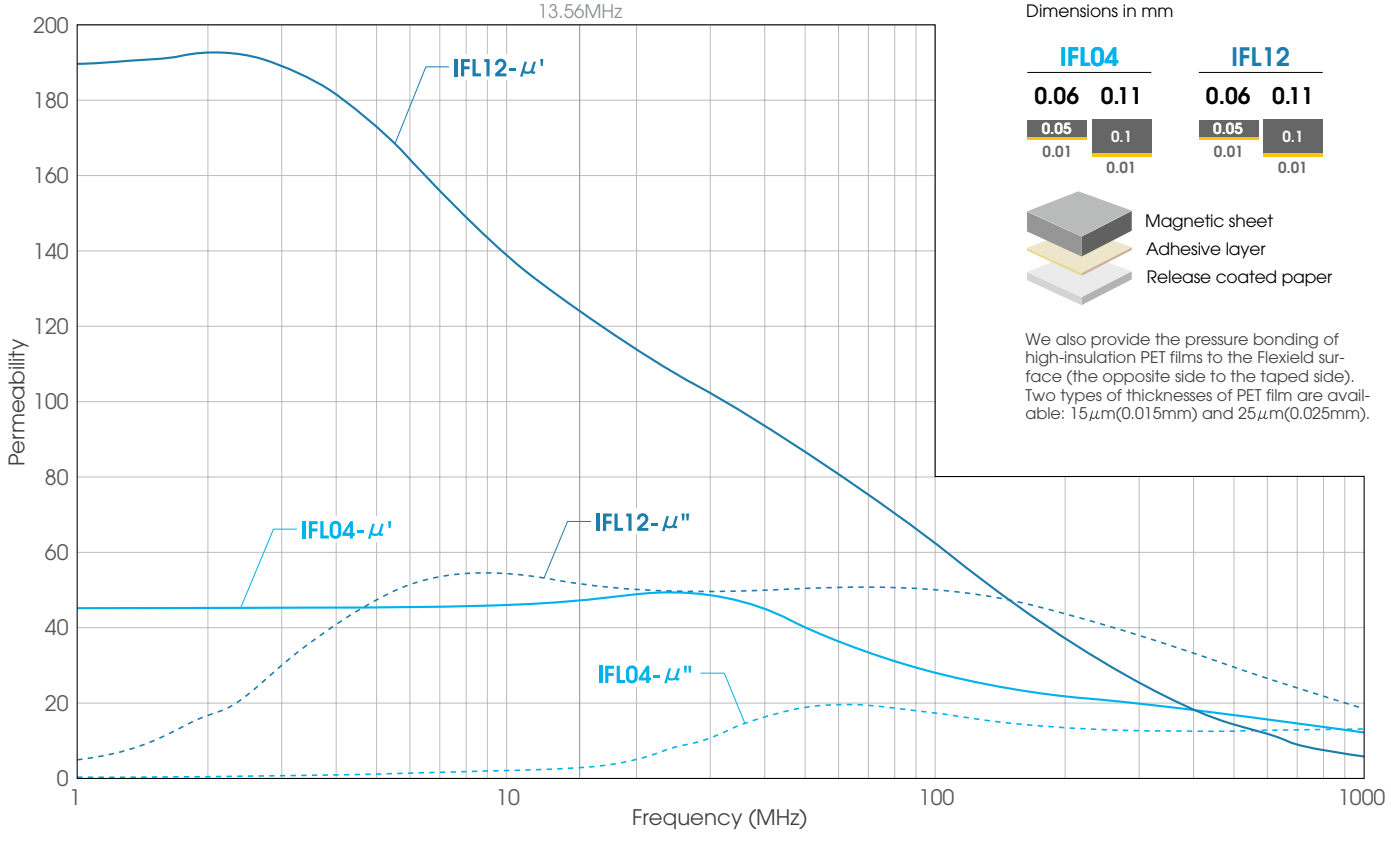
*1. Conformity to RoHS Directive: This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used, except for exempted applications.

*2. Standard sheet specification: adhesive tape is attached on the back of the magnetic sheet. The thickness T does not include the thickness of the adhesive tape (adhesive layer ■).

*3. The thickness of each product's adhesive layer can be chosen from 0.01mm, 0.03mm, and 0.17mm.

*4. Product of T: 0.05mm → W:200mm × L:100m (3.3kg) / Product of T: 0.1mm → W:200mm × L:100m (6.6kg)

### Permeability vs. frequency characteristics




### Standard sheet thickness

Dimensions in mm







We also provide the pressure bonding of high-insulation PET films to the Flexield surface (the opposite side to the taped side). Two types of thicknesses of PET film are available: 15μm(0.015mm) and 25μm(0.025mm).

# Flexield Series

## IBF10 IBF20

**IBF10**: High $\mu$, low-loss, high-insulation PET film processing flexible ferrite sheet (best suited for improving the performance of built-in RFID antennas)

**IBF20**: Top-level high $\mu$, high-insulation PET film processing flexible ferrite sheet (suitable for adjusting resonance frequency when attaching general-purpose RFID antennas to metal surfaces )

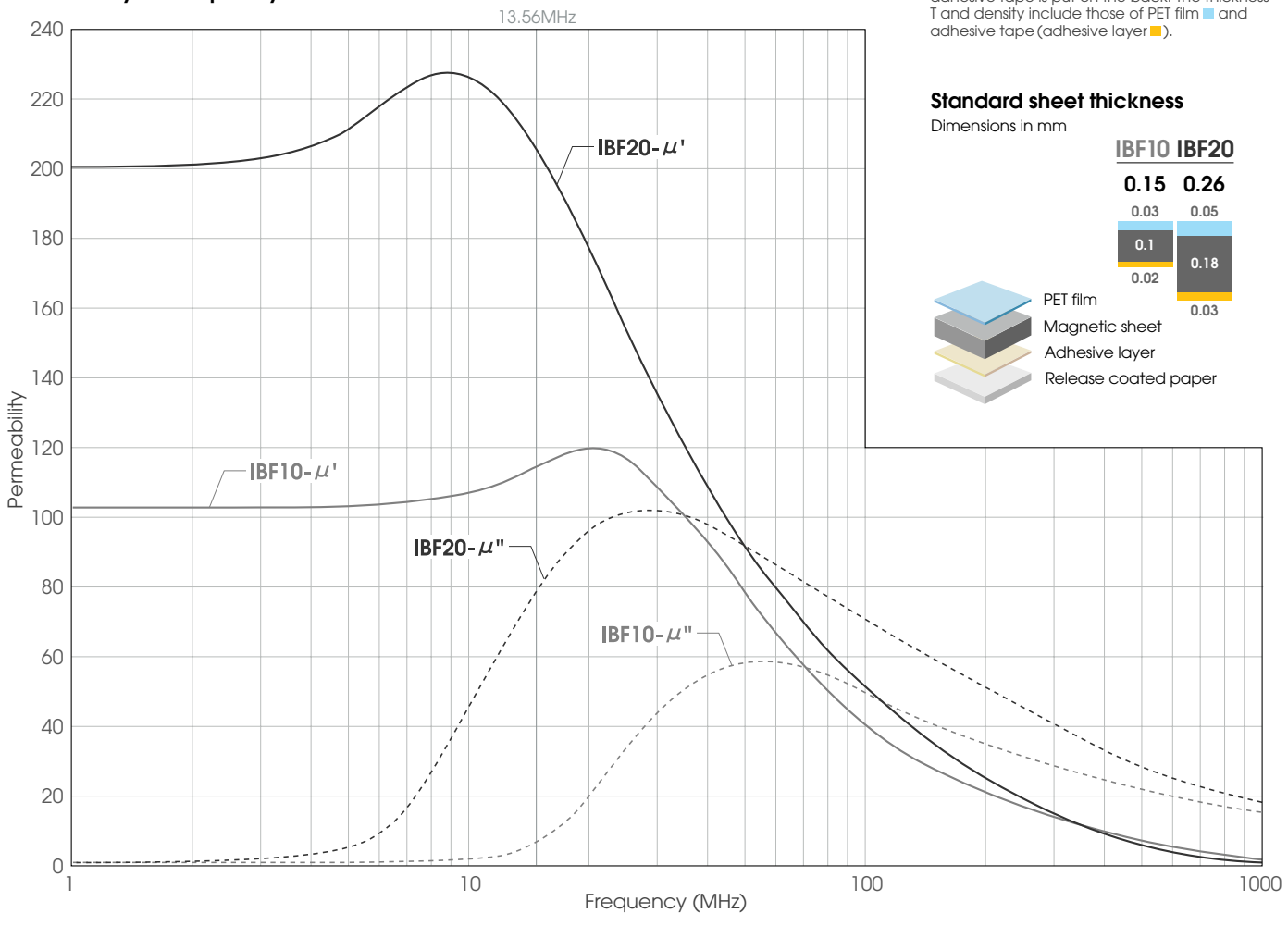
### Frequency characteristics/Basic specifications/Standard sheet shapes

| Part No. | | IBF10 | IBF20 |
|---|---|---|---|
| Materialsn | | Super-thin sintered ferrite platen | Super-thin sintered ferrite platen |
| at 13.56MHz | $\mu$' typ. | 105 | 210 |
| | $\mu$" typ. | 4 | 70 |
| Basic specifications | | | |
| Surface resistivity (Ω/□) | | 1G min. *1 | 1G min. *1 |
| Operating temperature rang (℃) | | −40 to +85 | −40 to +85 |
| Heat conductivity (W/m·k) | | 1.5 | 1.5 |
| Flame-resistance standard | | — | — |
| Environment friendliness | | RoHS*2/Halogen free | RoHS*2/Halogen free |
| Standard sheet shape*3/weight/density *3 (shown in the typ. value) | | | |
| L×W×T*3 (mm)/(g)/(g/cm3) | | 100×100×0.15/6/3.7 | 100×100×0.15/6/3.7 |
| | | 100×100×0.26/10/3.7 | 100×100×0.26/10/3.7 |

*1. Surface resistivity: The value of the PET film which coats the surface. *2. Conformity to RoHS Directive: This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used, except for exempted applications.

*3. Standard specific product : PET film is put on the surface of the flexible ferrite plate, and adhesive tape is put on the back. The thickness T and density include those of PET film ■ and adhesive tape (adhesive layer ■).

### Permeability vs. frequency characteristics




### Standard sheet thickness

Dimensions in mm

Product lineup/List of characteristics and specifications

## For the 13.56MHz RFID systems

### Frequency characteristics/Basic specifications/Standard sheet shapes

| Part No. | IRLG5 | IRJ04 | IRL02 | IFL04 | IFL12 | IBF10 | IBF20 |
|---|---|---|---|---|---|---|---|
| Type | Polymeric | Polymeric | Polymeric | Polymeric | Polymeric | Ferrite | Ferrite |
| $\mu'$ typ. (at 13.56MHz) | 50 | 40 | 25 | 45 | 125 | 105 | 210 |
| $\mu''$ typ. (at 13.56MHz) | 0.9 | 1 | 0.4 | 1.3 | 50 | 4 | 70 |
| Surface resistivity (Ω/□) | 10k min. | 1M min. | 1M min. | 10K min. | 100K min. | 1G min. *1 | 1G min. *1 |
| Heat conductivity (W/m·k) | 1.5 | 1.5 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 |
| Flame-resistance standard | — | UL94V-0 | — | — | — | — | — |
| Environment friendliness | Halogen free | — | Halogen free | Halogen free | Halogen free | Halogen free | Halogen free |
| Standard sheetshape (mm) | 300×200 | 300×200 | 200×200 | 300×200 *2 | 300×200 *2 | 100×100 | 100×100 |
| Standard sheet thickness (mm) | 0.25, 0.5 | 0.1, 0.25, 0.5 | 1, 2 | 0.05, 0.1 | 0.05, 0.1 | 0.15, 0.26 *3 | 0.15, 0.26 *3 |
| density (g/cm³) | 3.7 | 3.7 | 3.2 | 3.1 | 3.1 | 3.7 *3 | 3.7 *3 |

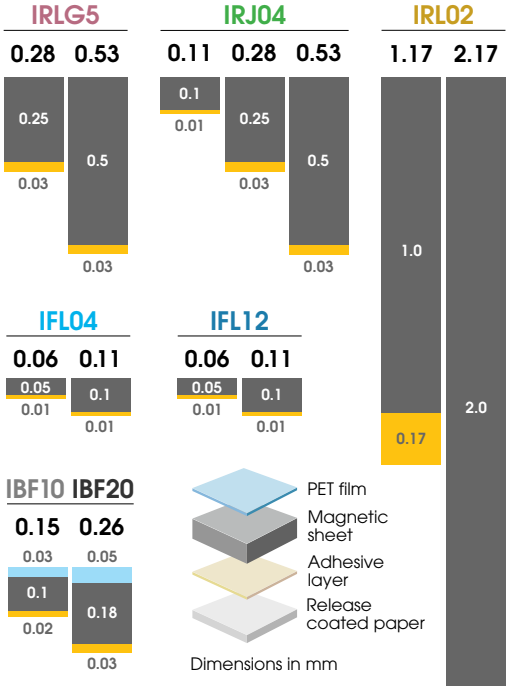
All products comply with the RoHS directive.
Conformity to RoHS Directive : This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used, except for exempted applications.

Operating temperature rang : −40 to +85℃

*1. The surface resistivity(1Gmin.) of IBF10 and IBF20 are that of PET film which coats the surface.

*2. Supports roll shapes: TDK standard (W200mm × L100m)

*3. The thickness and density values of IBF10 and IBF20T include thoseof PET film and adhesive tape (adhesive layer).




### Permeability vs. frequency characteristics

Flexible Composite-Type Electromagnetic Shield Materials
For 13.56MHz RFID System

# Flexield
Series

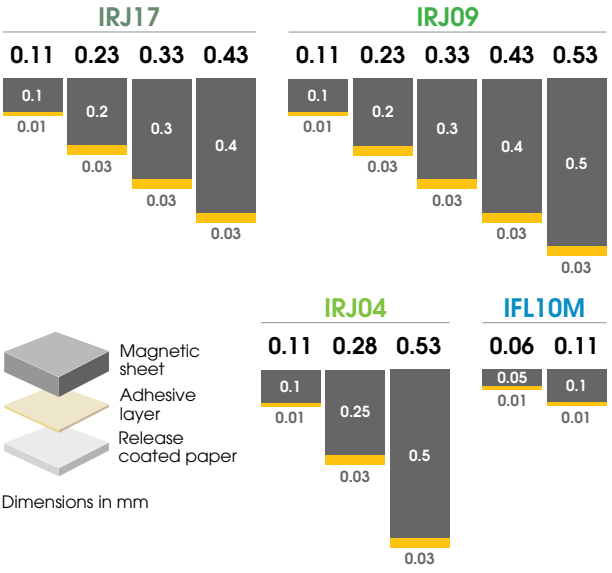
## For EMI prevention

■ For more details, please refer to the Product Update File of the EMI prevention products.

### Frequency characteristics/Basic specifications/Standard sheet shapes

| Part No. | IRJ17 | IRJ09 | IRJ04 | IFL10M |
|---|---|---|---|---|
| Type | Polymeric | Polymeric | Polymeric | Polymeric |
| Applied frequency band | 5MHz to 3GHz | 10MHz to 3GHz | 50MHz to 10GHz | 10MHz to 3GHz |
| $\mu'$(at 1MHz) | 180 typ. | 100 typ. | 40 typ. | 120 typ. |
| Surface resistivity (Ω/□) | 1M min. | 1M min. | 1M min. | 1M min. |
| Heat conductivity (W/m·k) | 1.7 | 1.7 | 1.5 | 1.5 |
| Flame-resistance standard | UL94V-0 | UL94V-0 | UL94V-0 | — |
| Environment friendliness | — | — | — | Halogen free |
| Standard sheetshape (mm) | 300×200 | 300×200 | 300×200 | 300×200 *1 |
| Standard sheet thickness (mm) | 0.1, 0.2, 0.3, 0.4 | 0.1, 0.2, 0.3, 0.4, 0.5 | 0.1, 0.25, 0.5 | 0.05, 0.1 |
| density (g/cm³) | 3.5 | 3.5 | 3.7 | 3.2 |

All products comply with the RoHS directive.
Conformity to RoHS Directive : This means that, in conformity with EU Directive 2002/95/EC, lead, cadmium, mercury, hexavalent chromium, and specific bromine-based flame retardants, PBB and PBDE, have not been used, except for exempted applications.
Operating temperature rang : −40 to +85℃
*1. Supports roll shapes: TDK standard (W200mm×L100m)




### Permeability vs. frequency characteristics