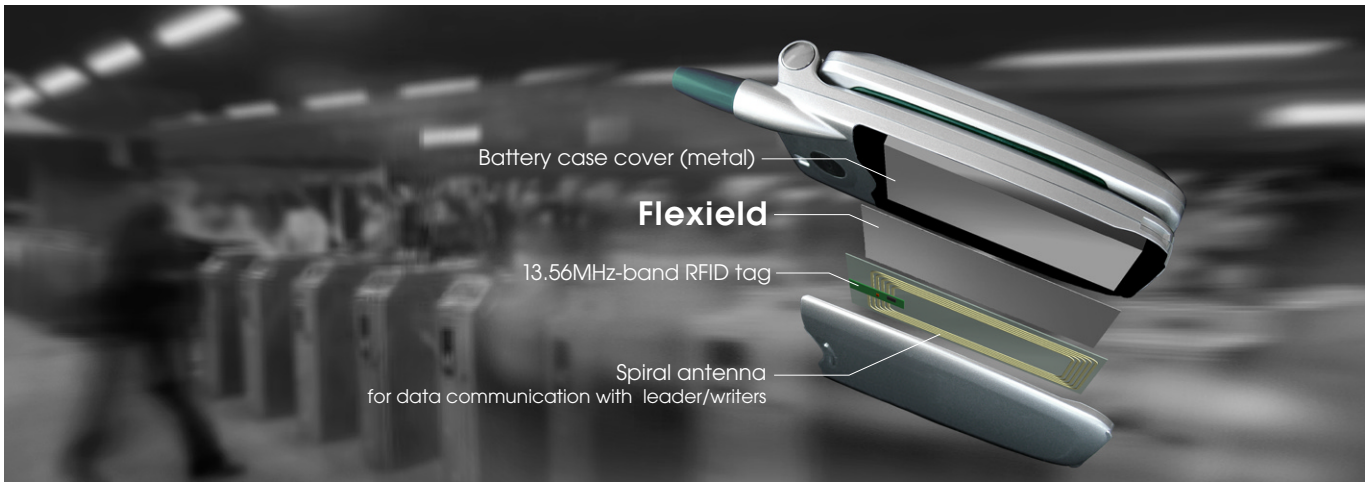


Flexible Composite-Type Electromagnetic Shield Material For The 13.56MHz-Band RFID System, TDK Flexield® IRL04 type

Pb Free The product is entirely lead-free. Moreover, it contains no mercury, cadmium, hexavalent chromium, PBB, or PBDE, all of which RoHS has been trying to eliminate.

13.56MHz-band/mobile phone RFID system —Forefront of the information utilization revolution. Flexield cutting-edge products support early realization of the system.

- Industry-leading high level/low-loss characteristics have been achieved as sheet-style electromagnetic sheet materials, reinforcing the carrier wave (magnetic field) focusing function essential for stable operation of 13.56MHz-band RFID tag integrated with mobile phones.
- Thinner sheets than the conventional high-μ products IRL02 and IRL03 allow matching of the impedance with RFID spiral antennas, increasing freedom of embedding design.
- Thickness variations of 0.05, 0.1, and 0.5mm are available as standard. Setting size and thickness appropriate for the RFID tag design specifications is possible.
- A high-precision management system for the product line which reduces fluctuations in the μ value, thickness, and size has been established, increasing the stability of impedance matching in mass-production of RFID tag-mounted devices.

Standard material characteristic/specification

Material name	IRL04			
Operating temperature range	−40～+85 degrees C			
Initial permeability* μ_i	35 typ.			
Heat conductivity	1.4W/mk			
Standard sheet size	300×200mm			
Standard sheet thickness (mm)	0.05	0.1	0.25	0.5
Standard sheet mass (g)	10	20	50	100
Surface resistivity (Ohm/□)	1M min.		10k min.	
Density	3.3g/cm^3			
Environmental friendly	lead & halogen-free			

*at 10MHz

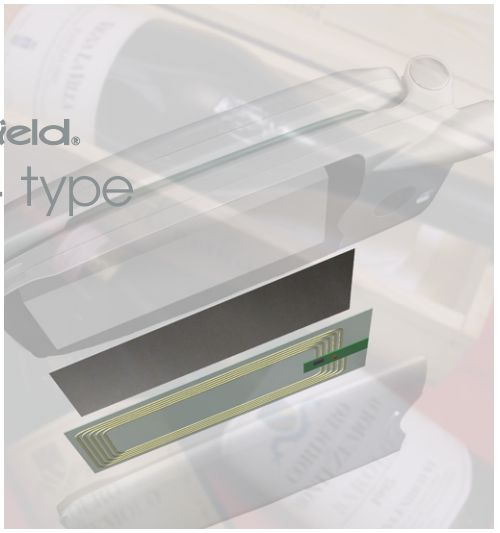
Increased Improvement Of Mobile RFID System

The 13.56MHz-band RFID (wireless communication via IC tag and IC cards) system has become common as it is widely used in JR East Suica cards and electronic money cards designed for convenience stores. In its next development, increased efforts will be spent in integrating the system in small mobile devices such as mobile phones and PDA devices.

With RFID reader/writers installed in mobile phones, storage transition/distribution history of wine, for example, can be verified at the store giving customers ease of mind in purchasing rather pricey vintage wines.

In particular, mounting wireless tags and readers/writers to mobile phones - their use has been significantly widespread globally - have been receiving high expectation from diverse fields as an "information collection/management" technology that could cultivate unprecedented information utilization culture. With demonstrative experiments using embedded terminals performed at many locations, wireless tag-mounted sets were released and accelerated efforts have been put in the development of ultra-small reader/writer-mounted terminals.

Technical Issues Of The 13.56MHz-Band RFID



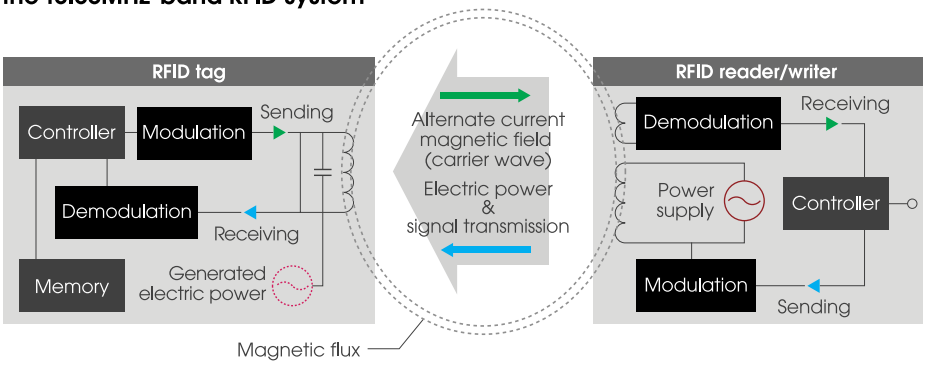
"Dwelling environment" of wireless tags which differs that of resin cards

Even the 13.56MHz-band RFID tags, which is easily integrated in slim resin cards, faces rather trouble some issues with mobile phones.
Inside mobile phones – a leading example of high-density implementation – the beta-earth sides are placed between piles of both-sided multilayered circuits. In order to keep high communication quality and to facilitate normal operation of each function, sensitive units such as image signal processing circuits as well as the RF circuit parts are surrounded by casing cells with metal shields. Also, with active use of the Bluetooth, digital camera features and tuner circuits, separation of each circuit and shielding by metal shields and vaporized films are implemented in a drastic manner unprecedented in the last generation models. This is where the wireless tags much differ in "dwelling environment" to the resin cards without metal shields.

The 13.56MHz-band RFID system communicates in magnetic field.

The RFID systems of UHF band which are in practical use in Europe and America and the 2.45GHz-band RFID systems of under 4mm-square ultra-small IC (μ-chip) tags are noncontact read/write system via radio waves (magnetic field). The 13.56MHz-band RFID system supplies electric power and communicate by the electromagnetic induction occurring between the spiral antennas(looped flat-coils) equipped on the reader/writer and wireless tags.

Communication conceptual model of the 13.56MHz-band RFID system



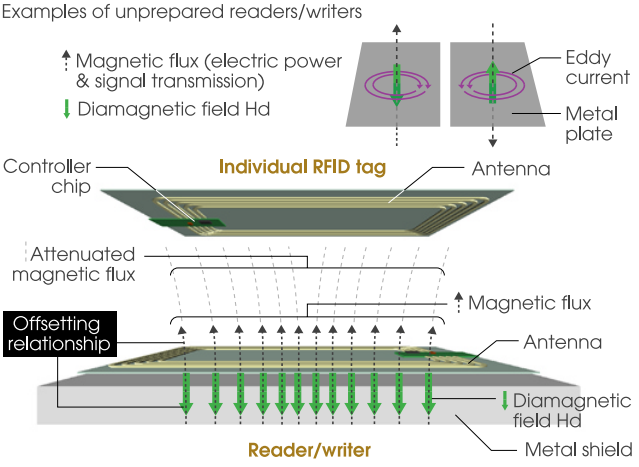
For the UHF-band and 2.45GHz-band RFID system, which use "radio waves" for communication, it takes a lot of courage to relocate to metal-surrounding "foreign country" from their comfortable environments such as resin and paper. To keep a practical communication range, it is necessary to prepare for the difficult issue of "communicational malfunction due to reflections" (Flexield best serves the purpose because of the superior electroabsorption characteristic in every frequency band).
However, these "dwelling environment" issues do concern the 13.56MHz-band RFID system that uses magnetic field for communication. The metal surfaces adjacent to the antenna is a great threat of hindering communication capability.

Communication disability due to diamagnetic field (case examples of reader/writer)

Not to mention the reader/writer modules, slim-sheet-processed tags experience sudden disconnection of data communication once it is placed above battery packs and etc surrounded by printed-circuit boards and metal cases. There are a several physical factors involved in this, but what's more critical is electromagnetic induction to antennas, or metal surfaces.
When magnetic flux occurring on the spiral antennas of reader/writer penetrates the metal surface, eddy current of the flux, according to Faraday's law, runs through the metal. But its rotation direction is opposite to the direction of electric current in the spiral antenna (the direction in which the magnetic field opposite to the magnetic pole direction of carrier magnetic field on the antenna is produced). This means that the carrier waves (alternate current magnetic field) supplying electric power to the tags and all modulated data over the waves are cancelled out by and greatly attenuated by the diamagnetic field Hd element induced on the metallic surfaces.
The tags have no power source on their own. If no sufficient carrier waves reach the tags, there will be no electro motive force and therefore the functions of the tags halt instantly and the communication abruptly fails (see the diagram below).

The occurrence principle of diamagnetic field and the attenuation model of magnetic flux(carrier wave)

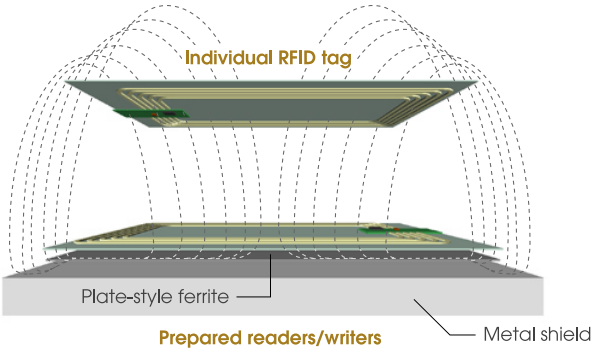
Examples of unprepared readers/writers



One "magnetic material" to support the operation of Suica system

To prevent these worst cases, magnetic materials with magnetic flux focusing force, or magnetic permeability, came into use.
The Suica system uses plate-style high magnetic permeability ferrite materials for the readers/writers and has achieved sufficient communication range and stable operation. The following diagram shows its effect:
By inserting high permeability ferrite plates between the reader and writer modules, the magnetic flux (modulated input data signals and output command signals are placed over the carrier wave) occurring on the spiral antenna will be drawn and focused on the plate placed underneath, and magnetic field loop penetrating the cards (RFID tag) placed on the sides and above the ferrite plate will be formed. Of course, if the spiral antenna is well separated from the metal surface this "plate" will be unnecessary, but magnetic flux converging necessary tools are still necessary for slim ticket gate devices.

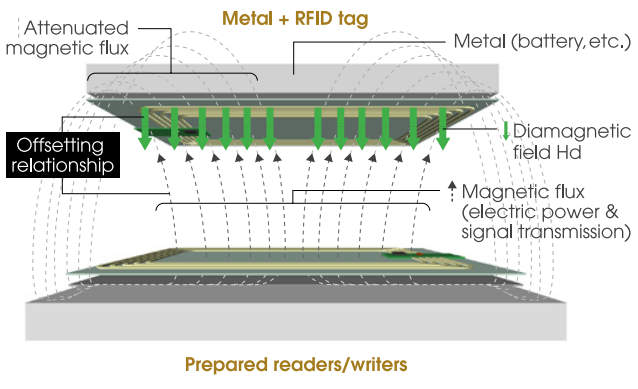
Magnetic flux distribution model of prepared readers/writers

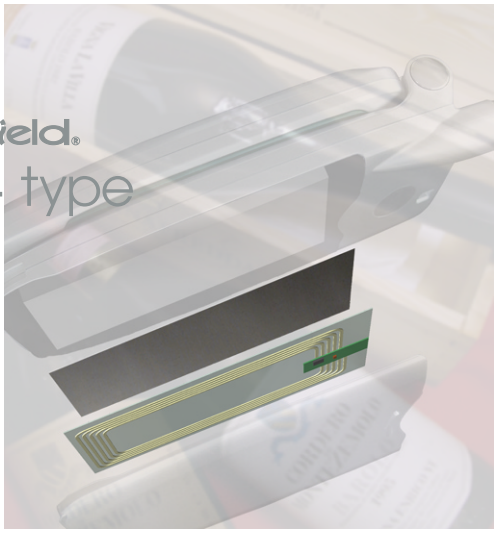


Communication inability due to diamagnetic field (case examples of wireless tags)

However, the communication inability due to the occurrence of diamagnetic field Hd is not a matter which only concerns readers/writers. This can also occur when wireless tags are placed directly or close to metal surfaces. Even when it's held over the reader/writer with sufficient magnetic filed, the strength of the magnetic flux penetrating the inner circumference of the wireless tag antenna (electric power and carrier wave of the data) is drastically faded by the offsetting effect of the diamagnetic field Hd, resulting in communication inability (see the diagram below).

Attenuation model of unprepared wireless tag's magnetic flux (carrier wave)





But it is considered extremely difficult to apply the ferrite plates integrated into the readers/writers to mobile phone because of their thickness and physical strength. Even with resin ferrite, which is superior in shock resistance, there will be no installation space. Therefore, in order to install the 13.56MHz-band RFID tags on mobile phones and in order for them to perform in an operable distance, an eddy-current reduction tool with magnetic flux convergence effect similar to that of high-permeability ferrite plates of the Suica system readers/writers is required. High-permeability sheet materials that are similar to or even thinner and stronger than the current wireless tags would be the best, but it is not easy to realize that.

Development Concept Of The IRL04 Type

Even the industry-leading high-μ sheet faces thickness limitation

TDK Flexield, used as an EMI countermeasure electromagnetic shield material in diverse fields, has been improved in its physicality and magnetic characteristics in order to respond flexibly to diverse requirements of the devices and circuits that require countermeasures. In particular, the IRL02 and IRL03 series, with high magnetic loss (μ") between 100MHz and 10GHz, are the pioneering high-É products quickly responding to the needs of digital devices of ever-accelerated processing speed.
With an addition of the 0.05mm slim type, numerous achievements have been made in reducing mutual interference of the internal circuits of PDA devices, game machines, digital cameras, and mobile phones, as well as reducing radiant noises, improving antenna sensitivity and SAR.
It has received high regard as a powerful reinforcement to cope with noise factors that conventional EMI countermeasure components and circuit pattern design knowledge could not deal with, such as high-frequency radiation from the flexible cables of handy devices such as digital cameras, in particular, with high-density 3D implementation or radiation issues of high-frequency electric current over the rear shield of small LCD panels.

However, even the IRL02 and IRL03, which are better in high-μ characteristic in 13.56MHz band than other materials, were not good enough to operate RFID tags of mobile phones in the practical communication range. In order to realize magnetic flux focusing effect to prevent diamagnetic field Hd with a thickness that's as slim as or slimmer than the tag sheet integrated into the spiral antenna, the permeability rate in 13.56MHz band must be much higher than that of the conventional IRL series.

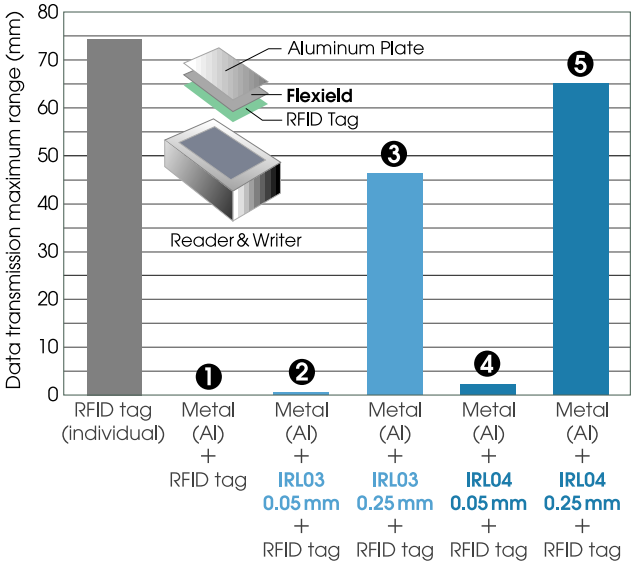
Materials accelerating the improvement of the 13.56MHz-band RFID mobile phones

The IRL04 type which has achieved the permeability 1.5 times better than that of the conventional IRL series is the most recent achievement of the effort. The effect of the difference in these permeability rates was clearly demonstrated in the measurement result using a pseudo mobile phone model with an aluminum plate.

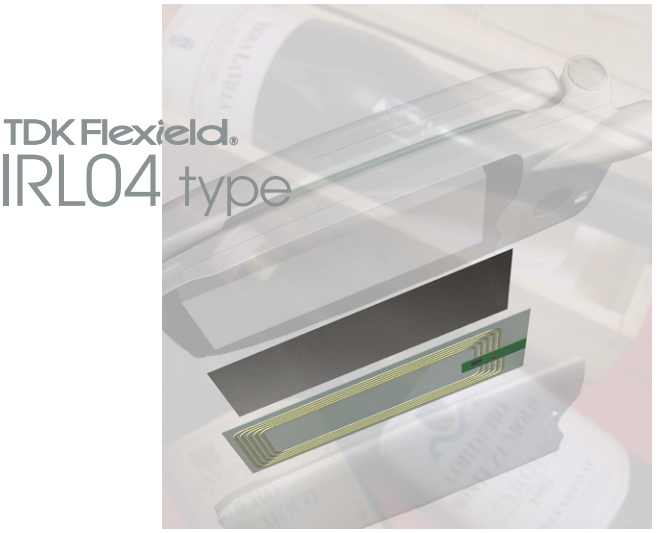
Comparison of maximum data communication range

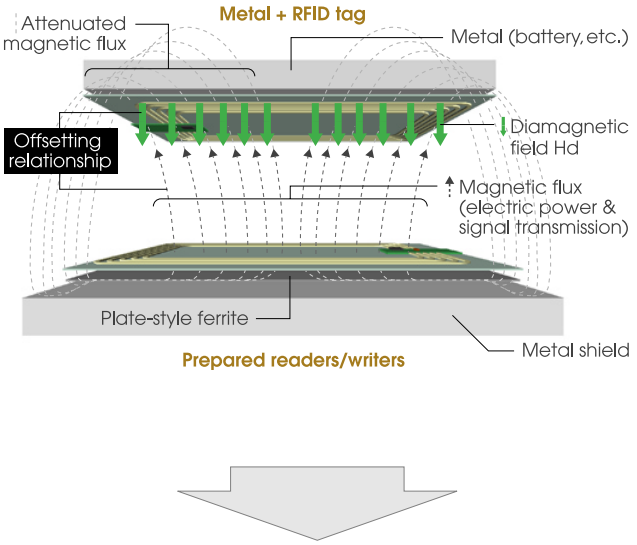
Individual RFID tag's data transmission maximum range: 74mm

Data communication maximum range was measured (error occurrence rate: 0%) between RFID tags and readers/writers in the following five mounting variations with an aluminum plate with the same size as a RFID card attached to the surface of the battery case cover of a folding-type mobile phone.

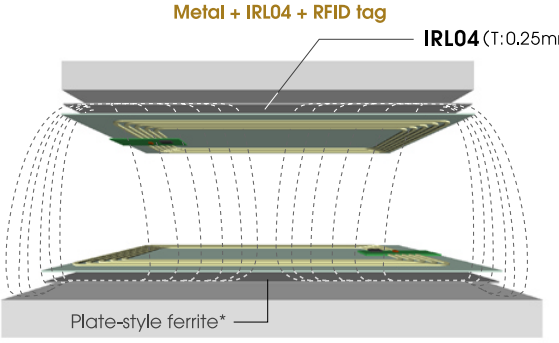


Better communication range by as long as 20mm than that of conventional IRL series has been achieved. Of course, with reinforced μ" in GHz band, greater effect and further low-profiling can be expected for various EMI countermeasures. Since the original aim of the project was "early realization of RFID mobile phones", the μ-frequency characteristic is optimized for the 13.56MHz-band RFID system wireless tags.
Also, a high-precision management system of the production lines to prevent inconsistency of permeability and thickness has been established. Matching stability in mass-production of RFID tag mobile phones has also been improved.





Data communication status (magnetic flux distribution) model of the mobile phone RFID system optimized with the IRL04



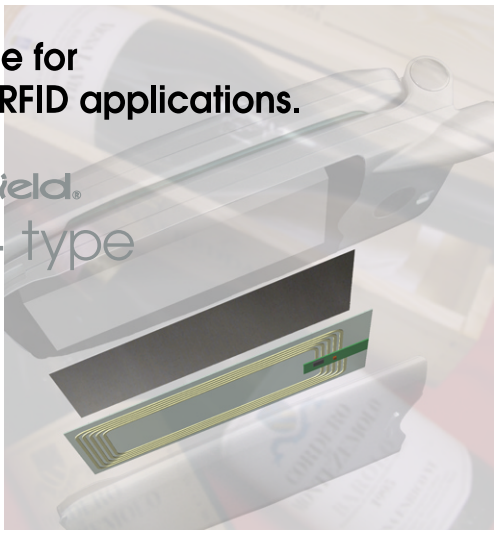
* Flexield is utilized for small handy readers/writers.

Seven materials and diverse thickness are available for the best electromagnetic characteristic of diverse RFID applications.

Complete lead-free quality has been achieved for all materials while maintaining superior electromagnetic characteristics.

Efforts are being made for halogen-free which some materials have not been realized yet.

Diverse processing and delivering styles such as half-cut adhesive sheets and special-shaped die-cut taping can be flexibly provided, offering selection of material characteristics and supply specification optimized for diverse devices, circuits, and production processes.



Method of naming the products

IRL03 A H 300×200×2

- Thickness(mm)
- Width(mm)
- Length(mm)
- When H is specified: Half-cut product
- When A or AB is specified: Processed with double coated tape
- Material name

RFID material lineup

Standard material characteristic/specification

Material name	IRL02		IRL03		IRL04			
Operating temperature range	−40～+85		−40～+85		−40～+85			
Initial permeability* μ_i	25 typ.		25 typ.		35 typ.			
Heat conductivity	1.4		1.4		1.4			
Standard sheet size	200×200	300×200	300×200		300×200			
Standard sheet thickness (mm)	1	2	0.05	0.25		0.05	0.1	0.25	0.5
Standard sheet mass (g)	100	250	10	50	0.5	10	20	50	100
Surface resistivity (Ohm/□)	1M min.		1M min.	1M min.		1M min.		10k min.	
Density	3.2		2.5	3.4		3.3			
Features	Standard type			Standard type		High permeability type			
Fire-resistant standard	——			——		**			
Environmental friendly	Lead & halogen-free			Lead-free		Lead & halogen-free			

* at 10MHz ** UL94 standard acquisition product is also prepared.

Material name	IRJ01	IRB02	IVM06
Operating temperature range	−40～+125	−40～+70	−40～+85
Initial permeability* μ_i	20 typ.	7 typ.	13 typ.
Heat conductivity	1.0	1.2	1.3
Standard sheet size	250×250	300×300	300×200
Standard sheet thickness (mm)	0.5	1 / 2 / 3 / 6	0.4
Standard sheet mass (g)	85	300 / 600 / 900 / 1800	80
Surface resistivity (Ohm/□)	1M min.	1M min.	1G min.
Density	2.5	3.3	3.3
Features	Heat resistance	Ready for Thick type	High resistivity
Fire-resistant standard	Acquired UL94V-1	——	Acquired UL94V-0
Environmental friendly	Lead & halogen-free	Lead & halogen-free	Lead-free

* at 10MHz

Our future approach and request for trial

We are committed to further improve the characteristics of new IRL series to support early prevalence and sophistication of the features of the 13.56MHz-band RFID mobile phones.

Please try out Flexield and, to make our effort more practical, tell us what you think and your requiests.

We have detailed documentation and trial kit available for you. Please feel free to contact our sales representatives.