

Sony Corporation Tektronix Real-Time Spectrum Analyzer (RTSA) Plays an Important Role in Monitoring Communication Conditions between IC Card and Reader/Writer for the “FeliCa” Contactless IC Card Technology



Solution Summary

Challenge	Signals from the contactless IC card were dynamic and weak compared to signals from the reader/writer, which made capture difficult.
Solution	RTSA enabled Sony to capture details of dynamic changes in spectrum, in addition to evaluation based on waveforms captured by oscilloscopes.
Benefits	The ability to capture small level communication signals resulted in higher reproducibility, ease of measurement, and reduced operator dependency.

Background: Measuring the Performance of the Contactless IC Card System

FeliCa is a contactless IC card technology developed by Sony Corporation. Applications that would have previously required multiple cards are now being incorporated into a single IC card. The first card equipped with FeliCa technology was introduced in Hong Kong in 1997. Since then this IC card technology has been adopted by many industries in Japan, by public transportation systems for passenger tickets, and used for “Edy”, a form of e-money applying FeliCa technology. As of March 2006, the total number of FeliCa IC chips shipped worldwide surpassed 120 million.

FeliCa communicates on a standard frequency of 13.56 MHz with a speed of 212 kbps. FeliCa adopts the Manchester bit-coding scheme, ASK modulation method. Time slots are used as the anti-collision method, with high-speed transactions between the IC card and reader/writer completed within 0.1 second.

Mr. Kenichi Okamura of Sony Corporation Core Component Business Unit is in charge of analyzing data obtained through ISO-compliant measurement methods and establishing FeliCa evaluation methods. To maintain compatibility, high-performance and quality, it is important to establish a specific measurement methodology and test solution for the FeliCa technology.

Challenges in Measurement: Extracting Dynamically-Changing Spectra and Requirements for High Dynamic Range

FeliCa is compliant with the ISO/IEC18092 standard (212kbps Passive mode). Measurement test methods for contactless IC card RF component evaluation are regulated by ISO 10373-6, where tests were conducted with oscilloscopes. However, some issues require not only time domain but also frequency domain analysis. In particular, frequency domain measurements were required for analyzing points where communication cannot be established between the IC card and reader/writer.

Until now, there have been two issues when conducting spectral measurements on contactless IC card systems. First, the spectrum changes dynamically within a short period of time between the IC card and reader/writer. Generally, a spectrum analyzer is used to conduct spectral measurements. However, conventional swept spectrum analyzers cannot



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measure spectra that change over time. Therefore, these conventional devices were not appropriate to monitor contactless IC card system communication where conditions change dynamically within a short period of time.

The second issue concerns the dynamic range of the signal. This contactless IC card system is not equipped with its own power supply and instead uses the electromagnetic field supplied from the reader/writer. To monitor the electrical behavior of the IC card, measurements must be taken while the card is activated and held against the reader/writer. It has been difficult to make these measurements with a broad-spectrum measuring device, such as a digital oscilloscope, since the response signal level from the IC card during communication is extremely small compared with the carrier signal from the reader.

Some attempts have been made to use FFTs to analyze parts of the waveform captured by a digital oscilloscope. However, there were many items such as real-time communication condition monitoring that could not be accomplished with a digital oscilloscope.

Reason for Selection of the RTSA: Communication Channel Analysis Enabled by Timeline Data and High Vertical Resolution

To analyze frequency domain behavior, it is necessary to have a device that can capture a dynamically-changing spectrum with high resolution. The Tektronix Real-time Spectrum Analyzer (RTSA) Series meets these requirements by providing data capture over a timeline with 14-bit vertical resolution and enabling successive FFT processes of specified waveform parts to analyze dynamically-changing spectrum. "The ability to capture waveform data over a timeline and high vertical resolution are the reasons why Sony chose the RTSA Series," said Mr. Okamura.

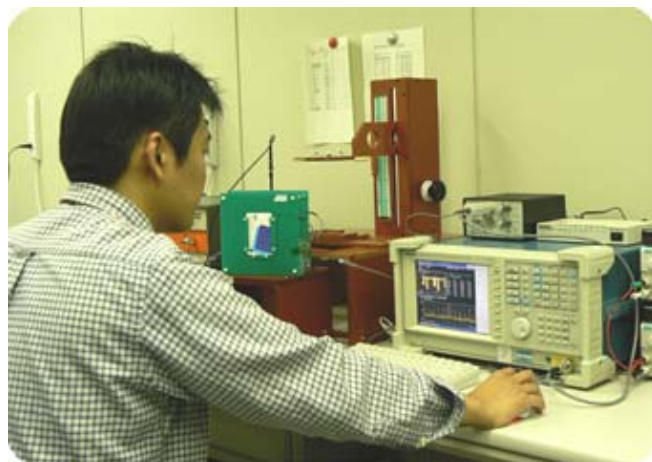
Summary: Ability to Capture Small Level Signals Over a Timeline Allows Real-Time Communication Evaluation

"The difference between oscilloscope-captured waveform data processed through FFT and data captured by RTSA is quite obvious," said Mr. Okamura. "Since the whole communication condition sequence is captured in memory as timeline waveform data, we are able to go back and

cut out any part of the waveform for re-analysis." Mr. Okamura praised the RTSA since it allows radio frequency characteristic analysis of IC cards such as even/odd harmonic component distribution and upper/lower side band symmetry.

For over two years, Mr. Okamura has extracted data using RTSA under various conditions to achieve reproducible evaluations of communication conditions. Sony has also reduced operator dependency by increasing the ease of making the necessary measurements. Tektronix has developed an exclusive software analyzer program for Sony to help them with meeting these goals. Deploying this program enabled higher accuracy and reproducibility in FeliCa evaluations.

"The next challenge is to develop the ability to identify transitional spectrum changes within a much shorter time span," said Mr. Okamura. As the FeliCa technology progresses, establishing an evaluation method for this advancing technology will also become increasingly essential.



Measurement Conducted by RTSA