

SONY

An Introduction to Digital Wireless Microphone Technology



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Outline

Sony started in the wireless microphone business in 1974 with the introduction of the 40 MHz band VHF system. This was soon followed by the industry-first PLL Synthesised VHF system in 1983. Continually enhancing its line of wireless microphone systems, Sony introduced a groundbreaking 800 MHz band PLL Synthesised UHF Wireless Microphone system at the NAB event in 1991.

Throughout this period, Sony has been at the forefront of technology – offering the first UHF PLL Synthesised Wireless Microphone system with 282 selectable channels, introducing a space diversity RF reception system, realising 42 operational channels with a 36 MHz band and more.

These technologies have been adopted for the range of Sony wireless microphone systems available today. Providing superb audio performance, operational flexibility and reliability, these systems have been widely accepted in a broad range of professional audio applications from broadcasting, production and theatre to entertainment and conferences.

Sony has consistently developed these systems under the policy of:

- > Superb audio performance with wide dynamic range
- > Highly stable signal transmission
- > Flexible simultaneous multi-channel operation

While Sony wireless microphone systems have greatly innovated professional audio operations, the growth in popularity of High Definition (HD) content creation and digital audio recording/transmission has called for the development of large-scale, multi-channel wireless microphone systems with improved sound quality. In response to these urgent requirements, Sony has striven to develop a digital audio wireless transmission technology that can match the quality and performance of wired transmission technology and that can also facilitate increased simultaneous multi-channel operation.

Since the introduction of our first digital audio wireless transmission technology, Sony has continued to promote innovative technological developments that open up a new world of professional audio. Our goal is to make wireless connectivity an option for a wide range of audio systems.



04 Digital Audio Wireless Transmission System

OVERVIEW

A digital audio wireless transmission system refers to the methods used for handling audio signals after they have been converted from analogue to digital via an A/D converter.

In a conventional analogue wireless system, a compander (compressor/expander) system has been the key element in allowing wide dynamic range transmission. A compander system is composed of complicated analogue circuits that provide sound quality and response characteristics.

However, this analogue system requires an advanced technique to keep performance levels constant, because analogue circuits are, by nature, subject to the variable performance and adjustments of their parts.

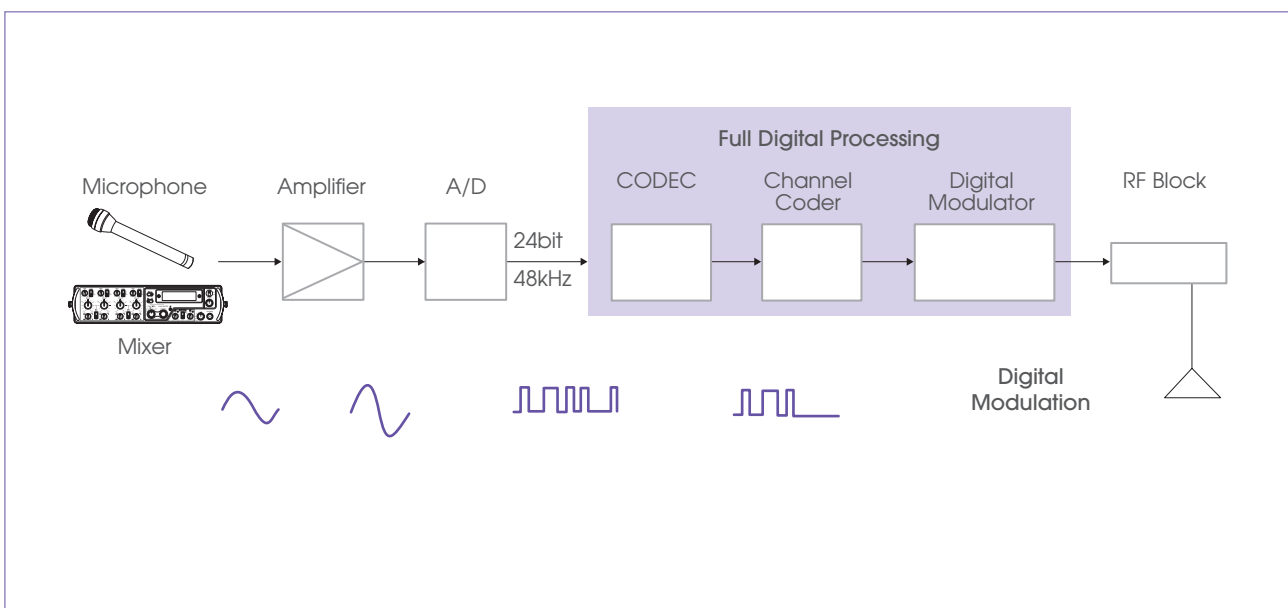
In contrast, the digital audio wireless transmission system is free from such fluctuations as it doesn't use a compander system. In short, digital audio wireless transmission is an optimum system to transmit high-quality audio signals without deterioration.

TRANSMITTER

The transmitter in the digital audio wireless transmission system digitises analogue audio signal inputs from microphones and mixers and then wirelessly transmits them as a digital signal. Let's now take a look at the processes that occur within the transmitter.

An analogue audio signal is first amplified in the amplifier and digitised in the A/D converter. In the DSP, three types of processing are performed: digital encoding in the CODEC, channel coding in the channel coder and modulated signal generation in the digital modulator. In the CODEC, the digital audio signal input from the A/D converter has data reduction applied and it is converted into a low transfer rate digital stream.

Subsequently, the channel coder adds the synchronisation and error-handling data necessary for the wireless transmission and then encrypts the data. After that, the digital modulator generates a PI/4 QPSK modulation signal for digital wireless transmission from the channel-coded digital stream. The modulation signal is then converted to analogue through the D/A converter and carried to the RF block. Finally, in the RF block, the modulated carrier wave is amplified to the adequate transmission power level and transmitted to the receiver.

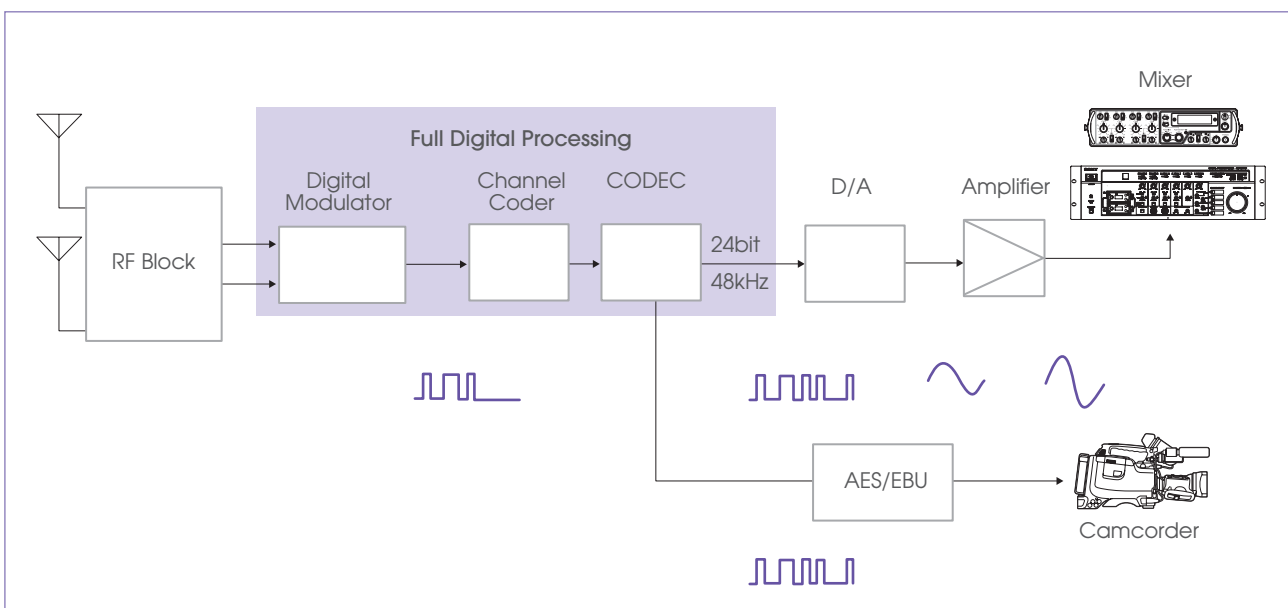


RECEIVER

Upon receiving the modulated carrier wave from the transmitter, the receiver reproduces the digital audio signal and outputs it as either an analogue or digital audio signal to audio equipment such as an audio mixer or a power amplifier. The major processes performed within the receiver are as follows:

In the RF block, the received signal is digitised through the A/D converter. Similar to the transmitter, three main processes are then performed in the DSP: digital demodulation in the digital demodulator, channel decoding in the channel decoder and digital decoding in the CODEC. After receiving the A/D-converted RF signal, the digital demodulator reproduces the digital stream that was channel coded at the transmitter. Then the channel decoder performs synchronisation, decryption and audio data abstraction processes.

Consequently, the CODEC decompresses the low transfer rate audio signal that has data reduced in the transmitter and regenerates the digital audio signal. Finally, the digital audio signal is output to the audio equipment, either as an analogue or digital audio signal. Should the audio equipment have a digital interface such as AES/EBU, the receiver can output the digital audio signal directly. Conversely, if the audio equipment is only equipped with an analogue interface, the digital audio signal is D/A converted, amplified and output by the audio equipment as an analogue audio signal.



The audio CODEC and digital modulator/demodulator are core DSP technologies used in the digital audio wireless transmission system. The following section provides a general explanation of these two key technologies.

AUDIO CODEC

OVERVIEW

In the wireless system, audio signals have to be transmitted within a limited wireless bandwidth. Transmitting the highest possible quality audio in this limited bandwidth is the major issue for wireless microphone development. In addition, low-latency audio transmission is another requirement of microphone applications.

Sony is committed to designing audio CODEC technology that provides outstanding sound quality. To transmit the best quality audio within limited bandwidth, we decided to develop a digital wireless transmission system that employs the Sony digital audio CODEC, which realises both outstanding sound quality and low latency.

The Sony digital audio CODEC has the following three main features:

- Outstanding sound quality in 24-bit/48-kHz sampling
- Low latency
- Secure transmission

The Sony digital audio CODEC achieves an optimum balance between sound quality, bit-rate and latency, while having the redundant bit assignment necessary for wireless transmission.

FEATURES

Outstanding Sound Quality

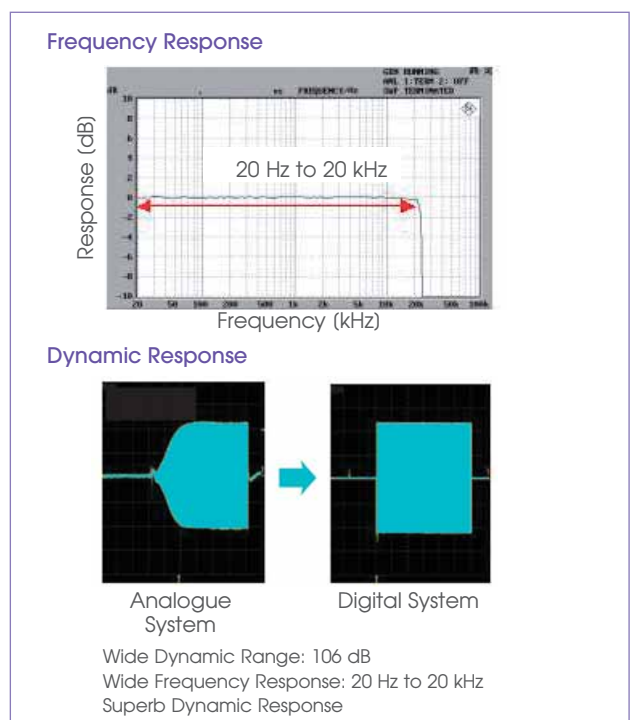
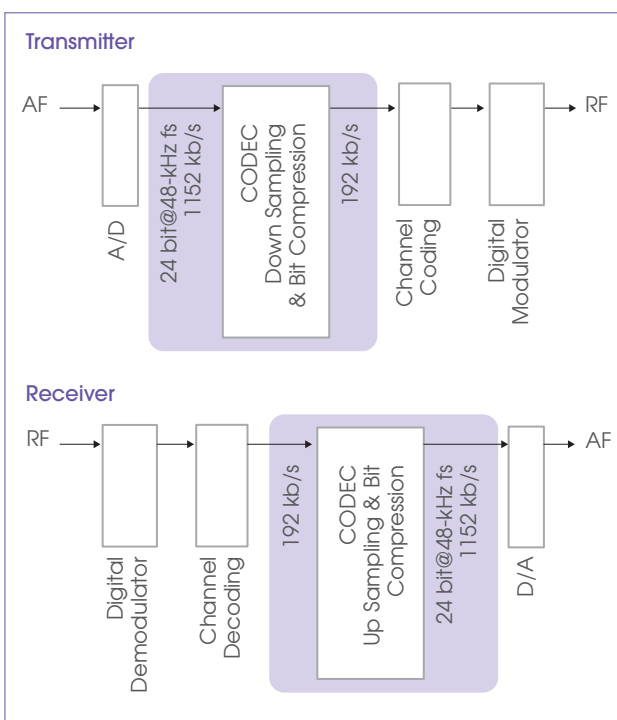
High sound quality is the most important aspect for the audio CODEC. High sound quality is achieved through a wide dynamic range, a wide frequency response and excellent transient response performance – factors that are indispensable for quality-critical broadcasting and sound reinforcement (SR) applications.

In an analogue system, a compander system is integrated to provide the wide dynamic range. However, while compander systems have improved over time, they may not be the fundamental solution for transient response performance.

The Sony digital audio CODEC system has been developed to fundamentally improve the transient response performance and therefore further enhance sound quality. It employs 24-bit/48-kHz sampling digital audio and provides:

- Wide dynamic range of more than 106 dB
- Wide frequency response of 20 Hz to 20 kHz
- Superb transient response performance

By digitally processing audio signals, the Sony digital audio CODEC provides highly accurate transient response performance that can be a challenge to achieve in an analogue circuit.



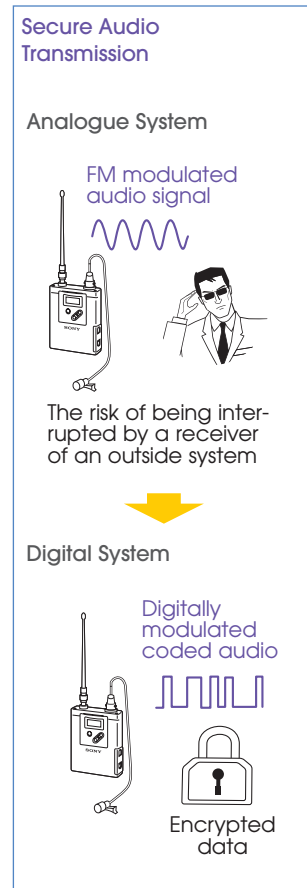
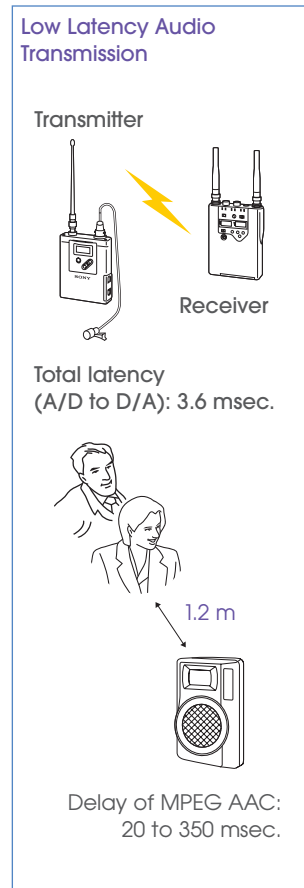
Low Latency Audio Transmission

The second key factor of the audio CODEC is its low latency. In a digital device, signal delays can often occur due to the sampling, synchronisation and calculation process. However, low latency is the mission-critical feature especially in vocal and speech wireless microphone applications.

In a commonly-used CODEC, for example MPEG AAC, more than 20 ms is required just for decoding. In contrast, the Sony digital audio CODEC realises an extremely low latency of 1.5 ms for both encoding and decoding by optimising the balance between the redundant data assignment that is necessary for wireless transmission, synchronisation processing and CODEC processing. As a result, an extremely low latency of 3.6 ms – from the A/D converter of the transmitter to the D/A converter of the receiver – is achieved. In terms of spatial distance, latency becomes only 1.2 m.

Secure Audio Transmission

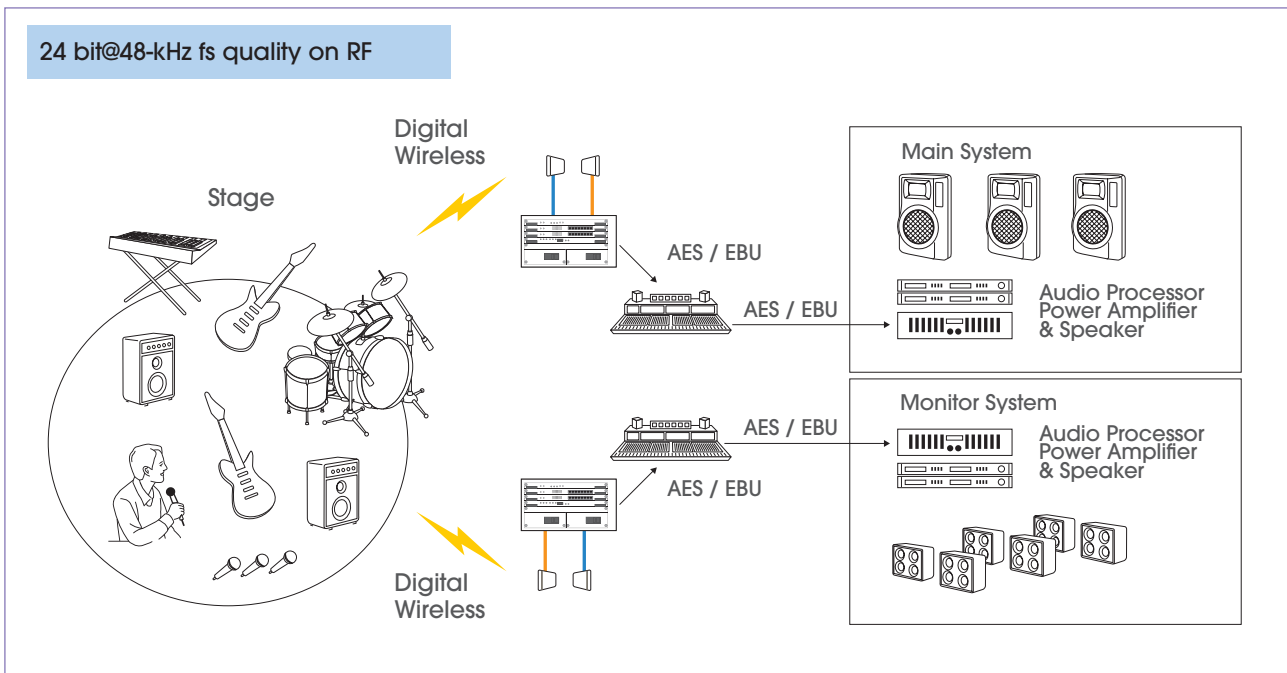
Secure audio transmission is another important issue for the audio CODEC. In an analogue wireless transmission system, the transmitted audio signal is at risk of being intercepted by a receiver of an outside system. FM-modulated audio signals can be demodulated by any receiver. However, the digital audio wireless transmission system transmits digitally modulated and encrypted data, which mitigates the risk of such interception and provides highly secure transmission for even the most critical applications.



APPLICATIONS

By combining the digital audio CODEC and digital wireless transmission technologies, digital audio signals used in a wide range of applications can be transmitted wirelessly. The digital audio wireless transmission system can be used in quality-critical applications where analogue systems have not been

used in the past. Sony digital audio wireless transmission technology expands the possibility of creating wireless connections to all sorts of audio devices, from microphones to audio processors to loudspeakers.



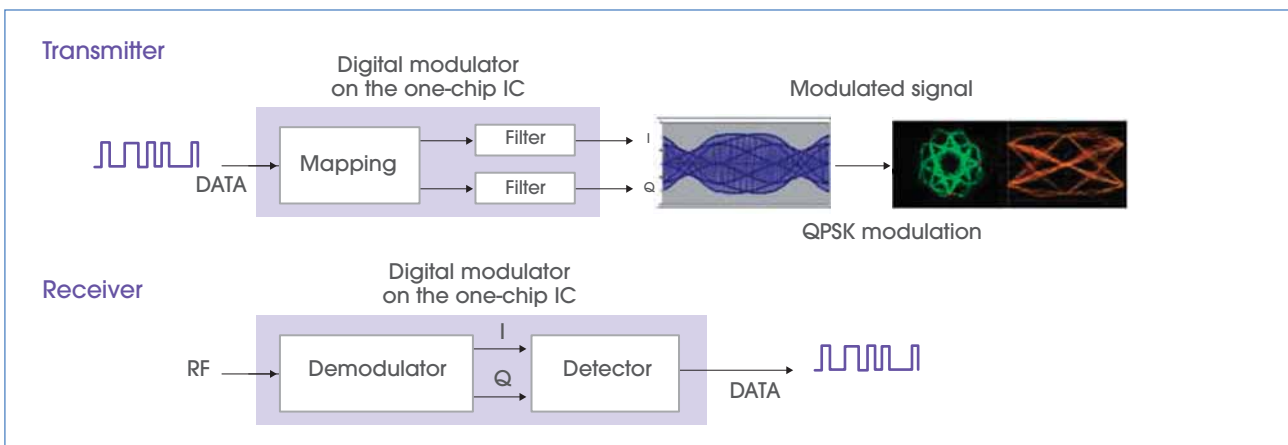
DIGITAL MODULATOR AND DEMODULATOR

OVERVIEW

Large-scale simultaneous multi-channel operation is an essential feature in wireless audio systems. Responding to this requirement, Sony has developed a one-chip digital modulator and demodulator that allows large-scale simultaneous multi-channel operations.

In addition to the long experience of RF technology in the analogue wireless transmission system, the digital audio wireless transmission system incorporates a digital modulation system that is less vulnerable to

wave interference. These technologies allow highly stable wireless transmission even for a large number of simultaneous multi-channel operations. The newly-developed Sony one-chip digital modulator and demodulator enables up to 16 channels of simultaneous multi-channel operation in a bandwidth of just 8 MHz. Using a unique algorithm optimised for wireless microphone applications, this one-chip IC device is small enough to be integrated into a relatively small-sized general DSP for portable devices.

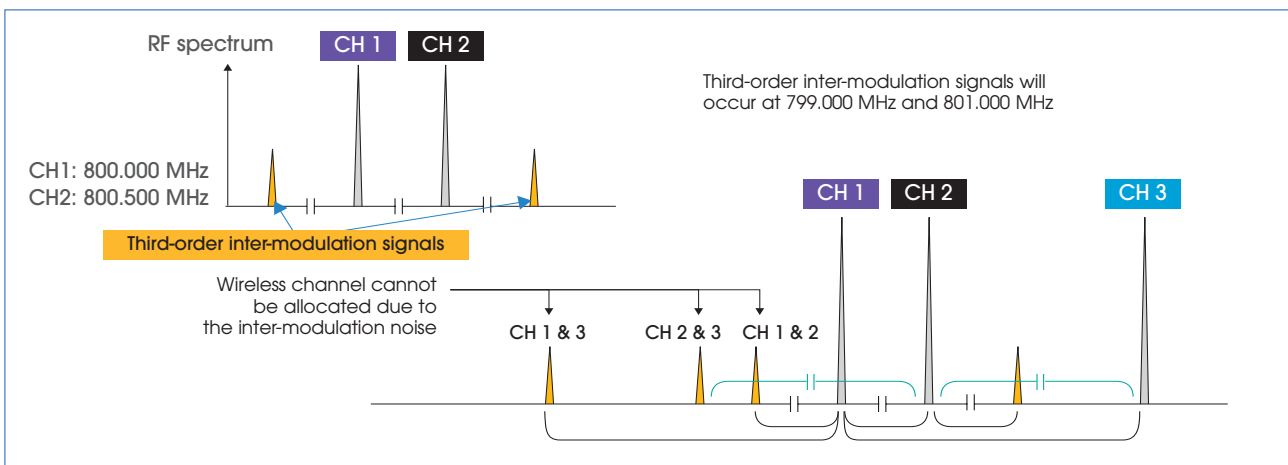


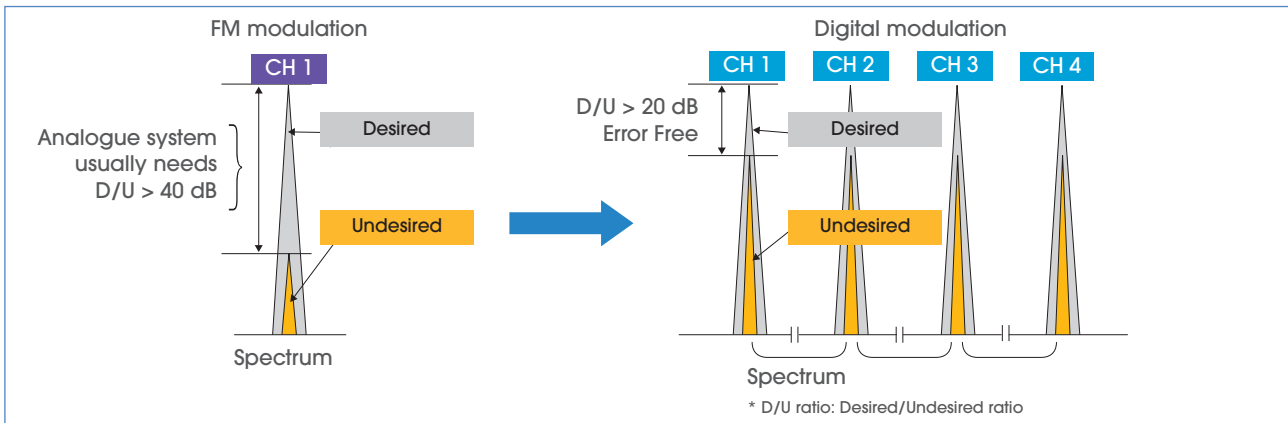
FEATURES

More Simultaneous Multi-channel Operations

The RF design is an important technique to realise multi-channel operations. In wireless systems with multiple channels, the inter-modulation that is generated in the RF amplifier of the transmitter/receiver often causes interference between the wireless channels. The RF block of the analogue

wireless system is designed with careful considerations to eliminate such inter-modulation. However, the inter-modulation cannot be constrained either in the analogue or digital system if the RF part is composed of analogue circuits.

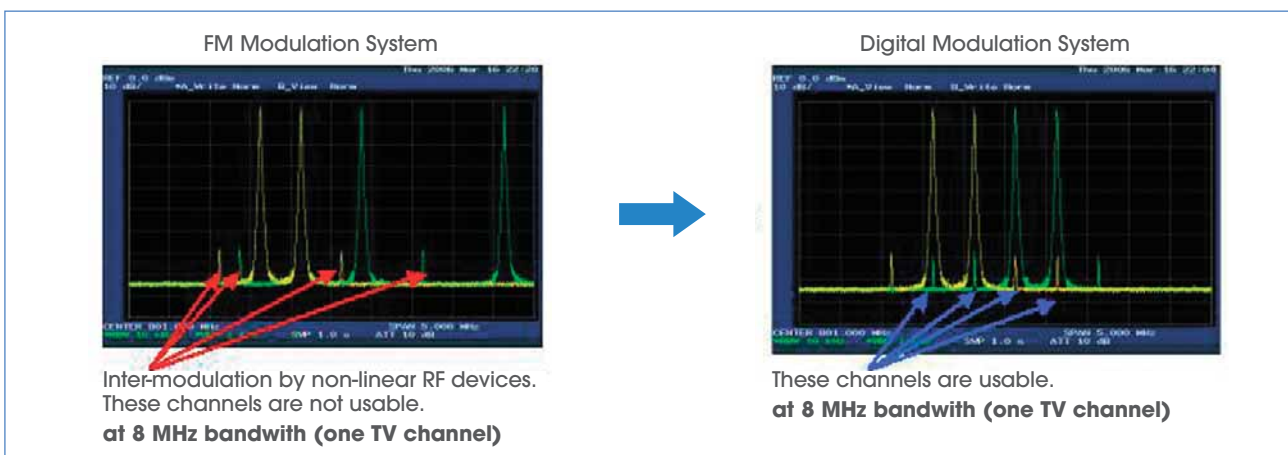




Then why are digital systems advantageous to simultaneous multi-channel operation? As shown in the chart above, the D/U (Desired/Undesired) signal ratio will be the S/N ratio of demodulated audio signal in the analogue system. The higher the undesired signal level, the higher the noise will be in the modulated signal. Typically, the analogue system requires a 40-dB D/U signal ratio.

In the Sony digital wireless system, an error does not occur when it provides a D/U signal ratio of more than 20 dB. More specifically in the digital system, no audio signal degradation occurs as long as the D/U signal ratio reaches 20 dB, even if the undesired signal level is strong. For this reason, the digital system is far more tolerant to the undesired signal of the analogue transmission system (more than 40 dB) and thus has an advantage compared with the potential risk of inter-modulation interference.

The advantage of undesired signal tolerability brings about a great improvement in simultaneous multi-channel operation. The figure below (left) shows channel allocations in a conventional analogue system. Here, it is necessary to assign channels by skipping unusable channels where inter-modulation occurs. In contrast, the below figure (right) shows the channel allocation in a digital modulation system. The effect of undesired signal is reduced to approximately less than 20 dB compared to the analogue system. By combining the digital modulation system with an excellent RF circuit, even the inter-modulated channels can be allocated as usable channels. In other words, an equally spaced channel allocation is realised, without having to worry about inter-modulation. In Europe, for example, this allows 1.6 times more channels to be simultaneously operated compared to an analogue system.

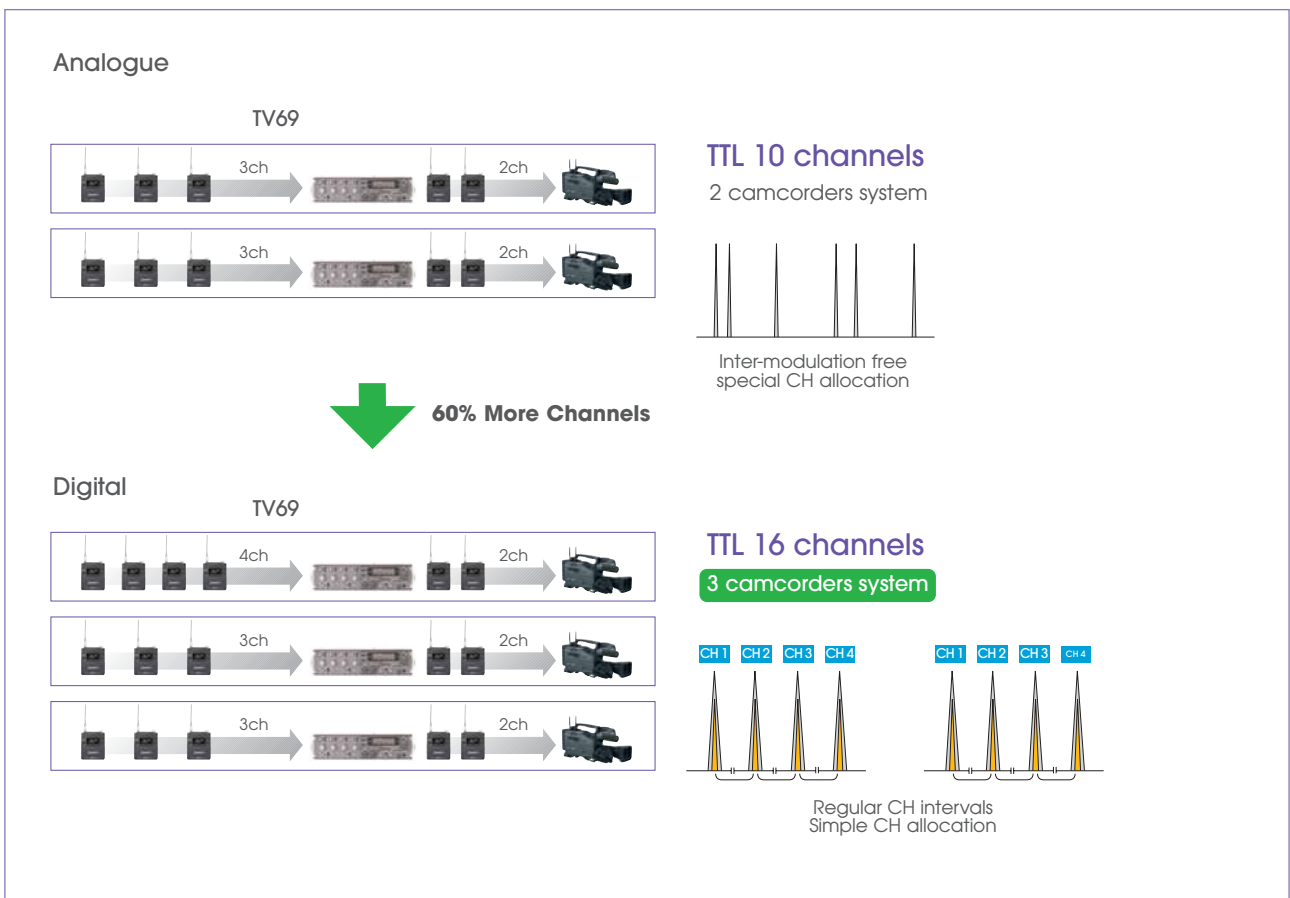


DIGITAL MODULATOR AND DEMODULATOR / CONTINUED

APPLICATIONS

The following example shows a multi-channel operation system used in the production of a reality TV show in the UK. In the analogue system, 10-channel simultaneous operation is possible in one TV bandwidth. Therefore, when one TV channel is available, a 16-channel system can be configured.

On the other hand, the digital system allows for simultaneous operation of up to 16 channels in one TV bandwidth, enabling the configuration of larger systems across the available TV channels.



Future of Digital Audio Wireless Transmission System

As described over the previous pages, the technology used in the Sony digital audio wireless transmission system delivers outstanding sound quality and large-scale, multi-channel operation. This technological innovation can be applied not only to wireless microphone applications, but also to wireless audio transmission between a broad range of professional audio equipment.

This technology also has the potential to leverage any future improvements in DSP processing power or reductions in component size and power consumption – thereby enhancing system performance. What's more, its audio and data multiplexing capability allows for the wireless transmission of not only audio signal, but various other types of useful information too, offering further operational convenience.

By incorporating these advanced technologies, Sony will continue to enhance the digital audio wireless transmission system, thereby opening up a whole new world of audio applications.

The Digital Wireless Microphone System brochure is now available.

Contact your local Sony office to request a copy or download a PDF version from www.sonybiz.net/go-digital



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