

HDCAM-SR VTR

1. INTRODUCTION

Since we introduced the HDCAM VTR as high-definition (HD) 1/2-inch cassette tape format in 1997, we sold 14,000 units including camcorder in more than 40 countries worldwide as of the end of August, 2004. The HDCAM has become the most popular format for HDTV production in Japan. CineAlta 24P model has also been used for cinema, drama and CM production mainly in Japan and Hollywood, and it made a remarkable contribution to offer new application for HD VTR.

However, not a few customers of high end contents creators requested for more headroom in picture quality than HDCAM. Broadcast stations who had a plan to start 5.1ch audio broadcasting also requested more digital audio channels. Responding to such growing requests, we introduced another state-of-the-art format, HDCAM-SR. It provides high-quality picture image, high data-transfer rates, 12ch of audio tracks and additional new feature; RGB4:4:4 recording. We expect that HDCAM-SR will become a mastering format for high end contents creation.

The SRW-5000, flagship model of HDCAM-SR studio recorder, was sold 500 units at the end of August 2004 since its release in December, 2003 for its good reputation from major broadcast stations in Japan, or major networks, motion picture companies and post production houses in USA. In addition to these customers "Star Wars Episode III" which will be released next year has been shot on all RGB4:4:4 digital camera and SRW-5000 has been used for capturing RGB4:4:4 images.

1. HDCAM-SR Format Overview

The HDCAM-SR format adopts the latest image compression technology MPEG-4 Studio Profile (SP). The MPEG-4 SP has scalability to realize both YPbPr4:2:2 and RGB4:4:4 sampling with 10bit quantization and offers higher picture quality and mild compression recording in 440Mbps high video data transfer rate.

The HDCAM-SR allows choosing most appropriate recording format for required application, because both interlaced and progressive scan format in various field/frame frequencies are available. There are 12 channels of discrete audio tracks with 24bit quantization and they can be used for 5.1ch surround audio or multilingual audio recording.

Since the HDCAM-SR has a capability to store 3-line of non-compressed data, multiple ancillary data packets such as closed caption can be stored on the tape. Format overview of HDCAM-SR is shown below.

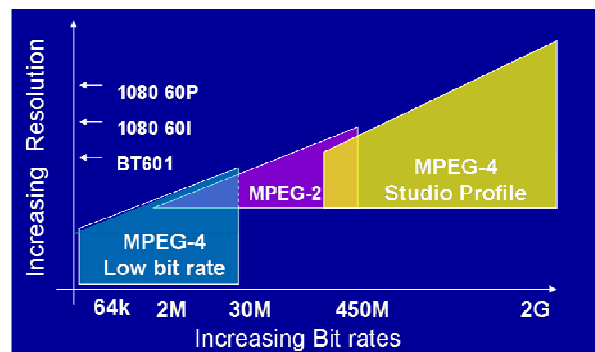
| | |
|-------------------------------------|---|
| Compression format | MPEG-4 Studio Profile |
| Image format | 1920(H) x 1080(V) or 1280(H) x 720(V) |
| Video sampling format /Quantization | YPbPr 4:2:2/ 10bit or RGB 4:4:4 / 10bit |
| Audio sampling rate /Quantization | 48kHz / 24bit (12 channel audio tracks) |
| Compression Ratio | 1/2.7 (4:2:2) or 1/4 (4:4:4) |
| Video data rate | Video 440Mbps, Total 594Mbps |
| Error correction coding | Reed Solomon |
| Channel Coding | Scrambled NRZ |
| Minimum recorded wavelength | 0.294 μ m |
| Track Pitch | 13.2 μ m |
| Drum Diameter | 81.4 mm |
| Tape Speed | 117.62 mm/s |
| Field / frame frequency | 1920 x 1080: 23.98, 24, 25, 29.97, 30PsF 1920 x 1080: 50, 59.94, 60i 1280 x 720 : 59.94P (4:2:2 only) |
| Maximum recording time | L size cassette: 155min(24P), 149min(50i), 124min(60i) S size cassette: 50min(24P), 48min(50i), 40min(60i) |

HDCAM-SR Format Overview

3. HDCAM-SR Five Core Technologies

3.1 MPEG-4 Studio Profile (SP)

The MPEG-4 SP is high scalable technical standard because it comprises various resolutions such as SDTV, HDTV, and Film-resolution (2K and more). It defines not only YPbPr4:2:2 but also RGB4:4:4.

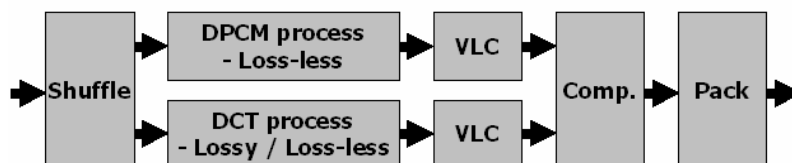


MPEG-4 SP Scalability

To gain maximum benefit from this compression scheme, the HDCAM-SR format uses intra-frame compression for progressive image capturing and intra-field compression for interlaced images. Image compression process uses two parallel processes,

Differential Pulse Code Modulation (DPCM) and Discrete Cosine Transform (DCT). Outstanding multi-generation performance of the HDCAM-SR with mild compression can be realized by simultaneous use of DPCM, which realizes loss-less compression system and DCT, which is improved approximately 13% to existing MPEG-2 for its efficiency.

Our dedicated ASIC chip for MPEG-4 SP which includes 800 million gates, it allows miniaturization and low power consumptions to be required for portable VTR.



Block diagram of the video compression processing

3.2 High density recording with new tape

We developed new HDCAM-SR dedicated tape with the latest high density recording technology. This tape can record more than triple amount of data of HDCAM, 440Mbps in a same size cassette tape as HDCAM. We achieved 6dB output improvement over HDCAM tape at the shortest recorded wavelength of 0.294um. Also our original binder design realizes high durability, and its special processing minimizes aging of the tape. Therefore HDCAM-SR tape is robust, high reliability and is able to store over the long term.

3.3 DRUM

The HDCAM-SR drum employs “twin-trace method” by using “4 tip - 8 gap embedded thin film DT head” for normal playback as well as variable speed or jog playback to trace 13.2um narrow tracks stably. Even though the HDCAM-SR has a reduced track pitch, the tracking performance is same as HDCAM for its this unique method covers overall width the equivalent of HDCAM track pitch.



HDCAM-SR Cassette Tape



SRW-5000 drum

3.4 ECC (Error Correction Coding)

The ECC for the HDCAM-SR has 36 tables per 1 field of Reed-Solomon Codes with 16 symbols for the inner, and 12 symbols for the outer(for video) while audio uses the

same number of bits as the data. The outer ECC for video is interleaved to the 12 tracks. Therefore if one track at the edit point is lost while doing insert editing, the ECC is sufficient to correct the whole lost track.

3.5 Advanced Equalizer

We have developed an Advanced Equalizer to maintain optimum output. There are following three cutting edge technologies used in this equalizer. Over sampling, used in the audio world, is applied to the playback RF signal. Auto-EQ circuit uses an innovative method, Least Mean Square (LMS), to maintain optimum equalization. PR4ML+ method is a combination of PR4ML and NRZ to change characteristics of PR4ML to give better response at both low and high frequencies. This method achieved much improvement in error rate.

4. HDCAM-SR VTR Product Introduction

4.1 Studio Recorder SRW-5000

The SRW-5000 is HD digital video cassette recorder, which employs the HDCAM-SR format. It's a high-end mastering VTR as CineAlta model for high-end contents creation such as cinema, drama, CM production and ON-AIR application for HD digital broadcasting. Major features of SRW-5000 are as follows;

- 1) High picture quality and multi format
- 2) Equivalent recording time and operability as HDCAM VTR
- 3) Discrete 12 channels of 24-bit audio tracks
- 4) Playback compatibility of Digital BETACAM (Option) and HDCAM
- 5) RGB4:4:4 Recording and Playback (Option)
- 6) Versatile internal format converter
 - 2-3 pulldown conversion
 - Down conversion
(1080 → 525 or 625, 1080 → 720P, 720P → 525)
 - Up conversion
(525 or 625 Digital BETACAM → 1080, 720P → 1080, 525 Digital BETACAM → 720P)
 - RGB4:4:4 ↔ YPbPr4:2:2 bi-directional conversions



SRW-5000



SRW-1 and SRPC-1

4.2 Portable Recorder SRW-1, SRPC-1

The SRW-1 HD portable VTR and the SRPC-1 HD video processor form the first Sony full-band width RGB4:4:4 portable VTR system, adopting the HDCAM-SR format. Major features of SRW-1/SRPC-1 are as follows;

1) RGB4:4:4 Recording and Playback as standard feature

The SRW-1 can be configured with RGB4:4:4 camera to record full-bandwidth RGB4:4:4 image.

2) Compact body

It is small, light-weight and suitable for field shooting. The SRW-1 and SRPC-1 work together as one piece.

3) Double speed recording

The SRW-1/SRPC-1 is equipped with a unique double-speed recording capability, which doubles the drum rotation and tape speed and thus achieves video data transfer rate of 880 Mbps. This feature provides three selectable recording modes.

The high quality mode is used to record highest-quality RGB4:4:4 HD images. In this mode compression ratio is 1/2. 1080/60P recording mode is used to achieve a slow-motion effect when playing back in 1080/30P mode. Dual stream recording mode allows the SRW-1/SRPC-1 to record images of two cameras simultaneously and makes it possible to shoot two different scenes or achieve 3D stereo shooting.

4) Internal format converter

- 2-3 pulldown conversion
- 1080 → 525 or 625 down conversion
- RGB4:4:4 → YPbPr color-space conversion

5. CONCLUSION

The HDCAM-SR is achieved with integrating lots of advanced technologies at high-level. It provides superb picture quality and high reliability with retaining

operationality of existing Sony 1/2-inch cassette tape format. We think it is suitable for coming HD digital broadcasting for its high picture quality as well as 12 channels of audio tracks which allows multi channel audio recording including 5.1ch surround audio.

Moreover, the HDCAM-SR has epoch-making feature, RGB4:4:4 recording capability. It's a big advantage for high-end contents creation application. It will be powerful weapon especially for cinema and CM production application which requires multiple compositions because RGB4:4:4 has a high affinity with CG processing and allows high working efficiency and high-quality result.

The HDCAM-SR is required for not only broadcasting application but also motion pictures production application by utilizing its potential. Especially it may much improve workflow of motion pictures production such as digital shooting, post-production, digital intermediate, distribution. And it will be absolutely fundamental equipment for high-end contents creation in the near future.