

Performance of GS913(Guided Scrambling nine to thirteen) Modulation code for High Density Rewritable Optical Disc

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1. Introduction

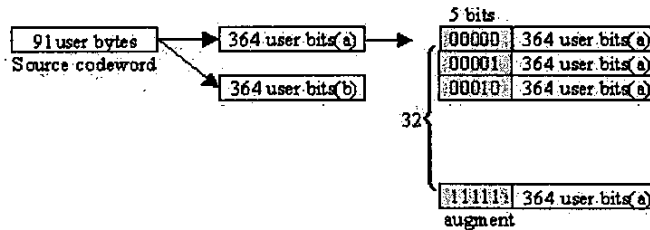
Recently, as a HD Video Recorder, a high density rewritable disc system using a blue laser diode has been strongly recommended. At last ODS and ISOM, we have proposed extremely efficient DC-free RLL codes for a high density rewritable optical system^{1,2}. And we have shown the newly developed GS913(Guided Scrambling 9 to 13), d=1 code can achieve a 4.5% higher overall rate compared with the (1,7)PP code. In this paper, we report the performance of this GS913 code for a high density rewritable disc system using a blue laser diode(405nm), NA0.85 and 0.1mm thickness cover layer.

2. Guided Scrambling 9 to 13(GS913) Modulation Coding Algorithm

In this section, we describe the GS913, d=1 modulation coding algorithm for high density rewritable optical disc system. In the GS format, the p redundant bits are used to generate a selection set of size $L=2^p$. In this paper, we select p=5, so that 32 different codewords are produced in the selection set of our implementation. The penalty values (such as DSV) are calculated for the 32 candidate codewords, and subsequently the codeword with the minimum penalty value is selected. GS913 encoding algorithm is summarized as followed.

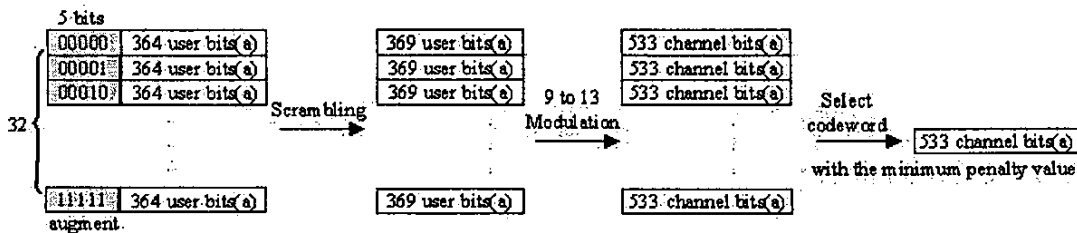
Step1. The 91 user bytes source code is divided into two 364 user bits

Step2. The augment 5bits(p=5) are added to each 364 user bits. In this step, 32 different codewords are produced for each 364 user bits.



Step3. The 32 different codewords are scrambled by the polynomial $x^5 + x^2 + x$.

Step4. Each scrambled 32 different codewords is modulated by 9 to 13 modulator with d=1, 5states, 9 to 13 modulation table.



Step5. The penalty values of each 32 modulated codewords are calculated to select the codeword with the minimum penalty value among the 32 candidate codewords. In this paper, we use the following penalty function for calculating penalty value.

$$\text{Penalty} = \sum |\text{DSV}| + 10,000(\text{RLk} - 10)$$

where, RLk is Run Length k and (Run Length k-10) is used to achieve k constraint (k=11).

Step6. The modulated codeword with the minimum penalty value among the 32 alternative candidate codewords is selected by using the MTO (or MTOi) criterion³ to record on the optical disc.

Figure 1 shows the detailed GS913 encoder description. Figure 2 shows the simulation result of the low frequency (lf) suppression characteristic of the GS913 code and 17PP code. In this simulation result, the lf suppression performance of the GS913 code is 2dB better than that of 17PP at the 10⁻⁴ frequency.

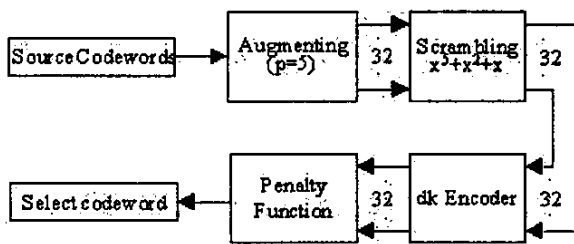


Figure 1 The detailed encoder description

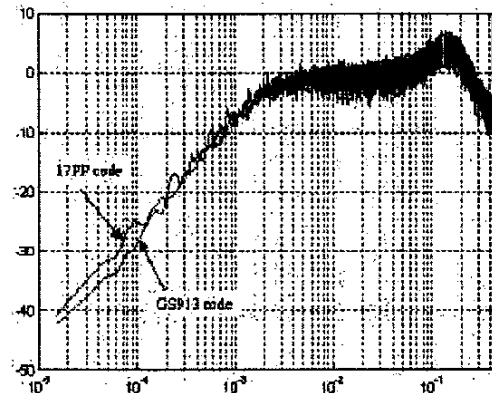


Figure 2 The low frequency suppression characteristic of GS913 and 17PP

3. Experimental Results

The basic parameters of our experimental system are shown in Table1. For achieving 24.5Gbytes user capacity, we use 405nm wavelength and NA of 0.85 and 0.1mm thickness of cover layer such as DVR-blue system⁴. The track pitch is 0.32μm and the channel bit length is 0.080μm under the linear velocity to 2.73m/s. Figure 3 shows the eye pattern and recovered clock of 17PP code and those of GS913 code. With this experimental result, the 17PP and GS913 code have nearly same jitter value under the same channel bit length. Figure 4 shows the radial tilt margin of GS913 code. The tangential tilt margin and the defocus margin are shown in Fig. 5 and 6, respectively. Through this experiment, we have accomplished 24.5GB recording capacity using a blue laser diode with the objective lens of NA0.85 and the cover layer of 0.1mm thickness and the GS913 modulation code.

Table 1 Major parameters of our experimental disc system

Parameter	Spec.
Wavelength (nm)	405
NA of objective lens	0.85
Thickness of cover layer	0.1 mm
User Capacity	24.5GB/side
Track Pitch	0.32 μm
Channel Bit Length	0.080 μm
Minimum Mark Length (2T)	0.16 μm
Channel data transfer Rate	34.1Mbps

4. Conclusions

In this paper, we have presented the results of GS913 modulation code under DVR-blue condition except the channel data transfer rate and reference linear velocity. We have achieved 24.5Gbytes user data capacity which is about 4.5% better than that of prior art 17PP code and nearly same jitter value and tilt margin, as well. We also report the low frequency suppression characteristics of 17PP and GS913

code. The lf suppression characteristic of GS913 code is about 2dB better than that of 17PP code. Our new modulation code, GS913, increases the recording capacity and the lf suppression performance. So that, this GS913 code can be one of the candidate modulation code for the high density rewritable optical system.

References

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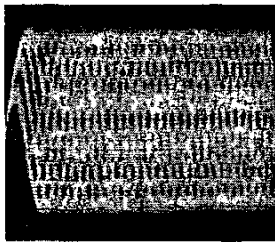


Figure 3 Eye pattern of 17PP Code(100DOW)

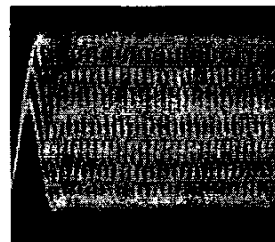


Figure 4 Eye pattern of GS913 code (100DOW)

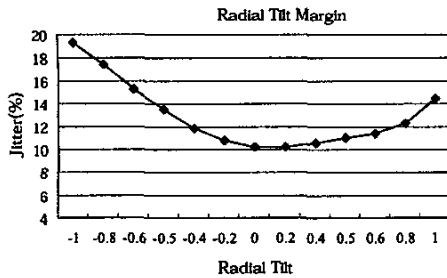


Figure 5 Tangential jitter margin of GS913 code

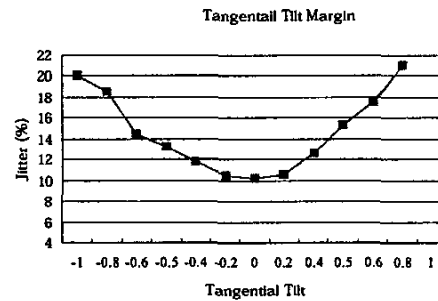


Figure 6 Tangential tilt margin of GS913 code

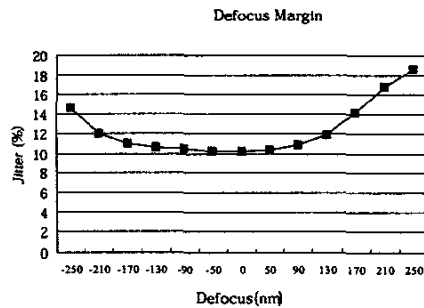


Figure 7 Defocus margin of GS913 code