SEARCH METHOD OF R-DAT FOR LSI 2671 (F-5)

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SEARCH METHOD OF R-DAT FOR LSI

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Abstract

A high-speed music search is one of the most important features of the R-DAT (Rotary-head Digital Audio Tape Recorder). This paper describes some methods for the "high speed music search", and especially describes the drum servo control system controlled by a pilot signal recorded in the ATF (Automatic Track Following) area. This technology realizes high performance in that the error of the relative velocity between the rotary head and the tape is less than 5% under a tape speed of 1~200 times as fast as the normal tape speed. Additionally we developed a one-chip Digital Servo LSI which performs the above-mentioned functions for each rotation of the drum, capstan and reels.

1. Introduction

The DAT conference was inaugurated in 1983 and technical specifications for the R-DAT standard (Rotary Head Digital Audio Tape Recorder) were established in July of 1986. The R-DAT system makes possible the recording and playback of superb sound quality not obtainable with conventional tape recorders. Furthermore, it offers a variety of operating features including time display and a search function for locating any position on tape. Up to 4 hours of recording time is possible on a cassette which is approximately 1/2 the size of a compact cassette.
Among these features, this paper considers various methods for the high speed search function.

2. R-DAT Information

As shown in Fig.1, there are many signals recorded on tape in the R-DAT system besides the music signal (PCM area). Information called the sub code is recorded in areas SUB-1 and SUB-2. The sub codes contain information regarding tape position such as:

- S-ID which indicates the starting position for each music selection.
- P-NO which indicates the music number.
- A-TIME which indicates the time from the beginning of the tape.
- P-TIME which indicates the time from the beginning of each music selection.

If the above information is read while the tape is in mode of FF or REW, any desired position on the tape can be located quickly and accurately.

3. Constant Relative Velocity Control

The R-DAT system uses a rotary head to increase the relative velocity between the tape and head to perform high density recording and playback. The head is rotated by a drum motor.
When the drum motor is rotated during FF or REW at the same speed as normal recording or playback, the transfer rate of the playback signal changes because the relative velocity changes in proportion to tape speed. To play back the informations under this condition, it is necessary to change the playback signal equalizer characteristics according to the transfer rate and to change the clock sampling PLL characteristics. Thus, a method is employed which changes the rotating speed of the drum motor according to tape speed and plays back the information at a constant relative velocity.
Fig.2 shows the relationship, at a constant relative velocity, between the tape speed and drum motor rotating speed and the number of envelopes within half a drum rotation.

4. High Speed Search System

The methods below maintain the relative velocity at a constant.

a) Providing a tape speed sensor on the mechanism (Fig.3).
Although the relative velocity can be kept constant regardless of the presence or absence of a playback signal, there is a chance that detection errors may occur due to slipping of the sensor.

b) Feeding back the phase error voltage of the clock sampling PLL to the drum motor (Fig.4).
Although circuit design is relatively simple, it must be used together with another method since the feedback loop may open when the relative velocity deviates due to the narrow lock range of the PLL.

c) Controlling the rotating speed of the drum so that the number of envelopes is constant (Fig.5).
When the stability of the tape transport system during FF or REW is poor, it may not be possible to accurately detect the number of envelopes. Furthermore, there is a chance that the relative velocity detection error may become large since the number of envelopes is small during FF as shown in Fig.2.

d) Controlling the drum motor by calculating the tape speed from the rotating speed of the reels (Fig.6).
Although the relative velocity can be adjusted regardless of the presence or absence of a playback signal, it is necessary to know in advance the tape length and tape thickness.

e) Controlling the drum motor so that the frequency of the playback signal is constant (Fig.7).
Although the detection range is wide, relative velocity offset occurs if the servo gain is small.

Besides these methods, methods a) through e) can be combined, or the tape speed can be controlled instead of the drum motor.

5. Use of an LSI Chip for the High Speed Search System

In implementing an LSI chip for the high speed search system, method e) mentioned above was employed due to the following reasons:

- Wide detection range of relative speed error
- Small load on the microcomputer
- Easy implementation of digital techniques

The ATF pilot signal (130 kHz), because it is low in frequency and always found within the playback signal, is detected so that its frequency could be kept constant.
Fig.7 shows the block diagram and Fig.8 shows the timing chart for the digital servo section. The rotating speed of the drum motor is controlled by extracting the ATF pilot portion from the playback signal and sequentially updating the TP value according to the period of the ATF pilot. Updating of the TP value is stopped during blank portions of the tape, thus maintaining the rotating speed of the drum motor. A method for direct F-V conversion of the ATF pilot was also employed to improve the starting characteristics of FF and REW.
The solid lines in Fig.9 represent the characteristics during FF. Characteristics with a relative velocity error within 5% were obtained. The dotted lines in Fig.9 represent the characteristics during REW. At the point where the relative velocity error approaches 5%, it appears that time was required for the rotating speed to drop due to the large moment of inertia of the drum.

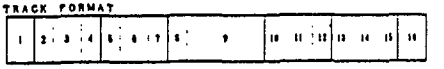
6. Conclusion

In this paper, various high speed search systems were considered. The method in which the frequency of the ATF pilot signal is kept constant was implemented as a function on the digital servo LSI chip.
Because the high speed search assumes that information regarding the tape position is already recorded, it is desirable to provide a means to record this information automatically during recording. Furthermore, a function which arranges and re-records information when it is random, greatly affects the performance of the high speed search.
In addition to the digital servo LSI chip, three signal processing LSI chips, one servo analog IC chip and one playback signal equalizer IC chip for a total of six chips were developed for the R-DAT system. These LSI chips enabled the R-DAT system to be designed with simple circuits.
The authors would like to thank Mr. Suzuki for permission in preparing this paper and to the many others for their cooperation.

References

DAT CONFERENCE "RECOMMENDED DESIGN STANDARD <R-DAT>"

TRACK FORMAT



		NUMBER OF BLOCKS	PERIOD (μS)
1	MARGIN	11	420.9
2	PLL (SUB)	2	76.5
3	SUB-1	8	306.1
4	POST AMBLE	1	38.3
5	IBG	3	114.8
6	ATP	5	191.3
7	IBG	3	114.8
8	PLL (PCM)	2	76.5
9	PCM	128	4898.0
10	IBG	3	114.8
11	ATP	5	191.3
12	IBG	3	114.8
13	PLL (SUB)	2	76.5
14	SUB-2	8	306.1
15	POST AMBLE	1	38.3
16	MARGIN	11	420.9
	TOTAL	196	7500

* CALCULATED UNDER THE CONDITION THAT 30 ϕ -90° WRAP ANGLE.2000 RPM CYLINDER IS USED.

FIG.1 Track format

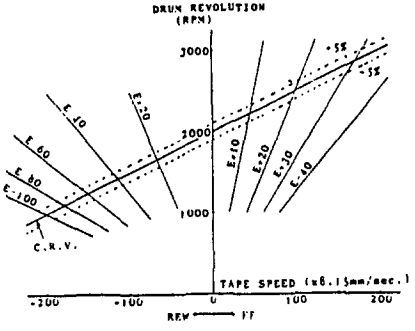


FIG.2 Constant relative velocity (C.R.V.) and number of envelopes (N)

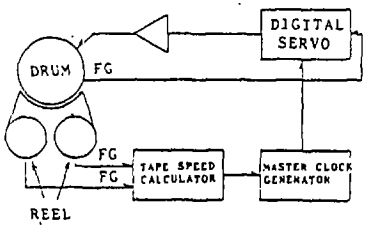


FIG.3 Search method (a)

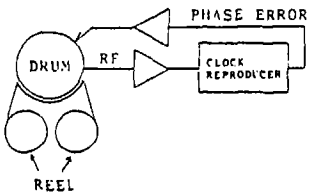


FIG.4 Search method (b)

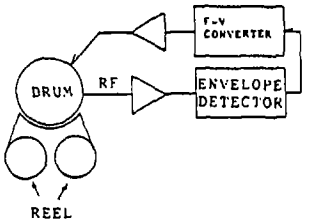


FIG.5 Search method (c)

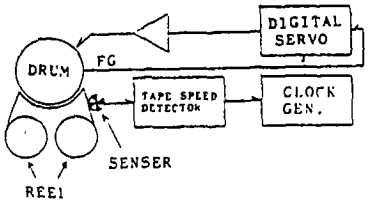


FIG.6 Search method (d)

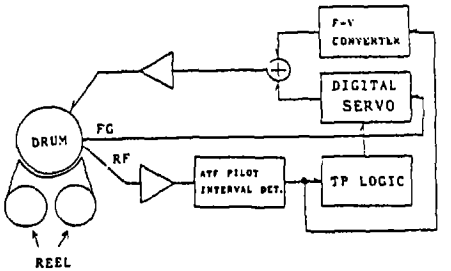


FIG.7 Search method (e)

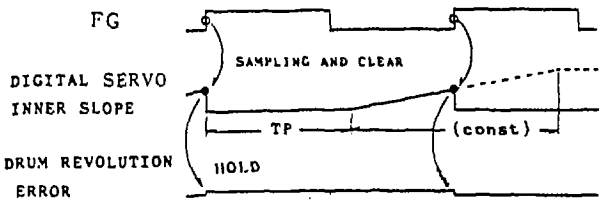


FIG.8 Timing chart of digital servo section

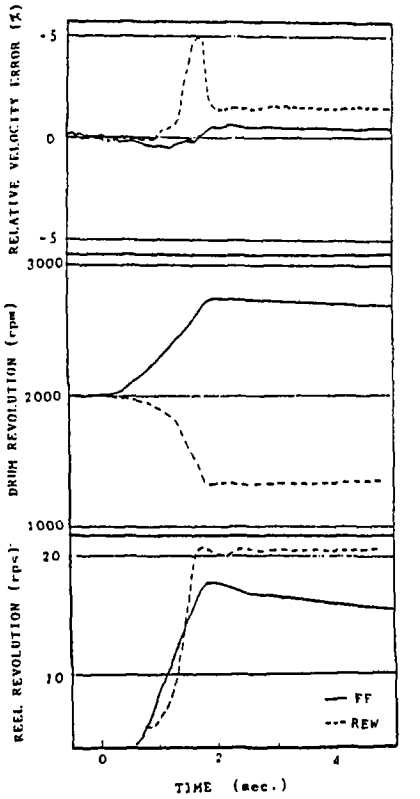


FIG.9 Characteristic of FF/REW search