

# THAM 12.3

## A DEMODULATION LSI FOR LASER DISCS WITH AC-3 AUDIO

Manabu Honda and Kenji Mito

Pioneer Electronic Corporation, Saitama, Japan

### Abstract

We have developed a demodulation LSI for Laser Discs with AC-3 audio (digital multi-channel audio with surround). The LSI has functions to demodulate QPSK signals, to detect and correct errors and to output AC-3 data.

### 1. Introduction

The number of movies with high quality multi-channel audio for theater usage is recently increasing, and in order to enjoy the same sound effect at a home, a system of Laser Discs with digital multi-channel audio was developed. And this time, we have developed a LSI for compact and low-price playback system corresponding to these Laser Discs. The outline of the system, some of the features and performances of the LSI are introduced in this paper.

### 2. Outline of the system

We relate recording format of developed system at first. The system adopts AC-3 audio as a digital multi-channel audio with surround. AC-3 is a flexible digital audio compression technology, which supports a surround format formed of six discrete channels (left, center, right, left surround, right surround and subwoofer), each channel except for the subwoofer channel possessing 20kHz bandwidth. In the case of a Laser Disc system, AC-3 data rate is fixed at 384kbps. Being added check bytes, that are generated by doubly-

encoded Reed-Solomon code, and synchronous words and so on, the recording data rate becomes 576kbps.

They are modulated in Differential-QPSK format with a carrier frequency of 2.88MHz, recorded in place of the analog FM audio R-channel of conventional Laser Disc format. (see Fig.1)

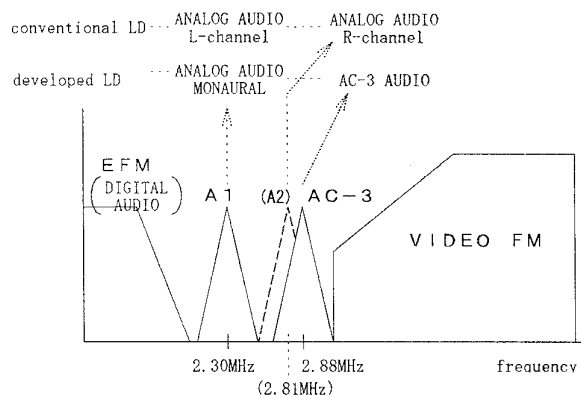


Fig. 1 Recording signal spectrum

### 3. Functions and features of the LSI

Fig.2 illustrates the playback system. The LSI is a key part of the demodulation block. The demodulation block also needs a band pass filter and a 32kword SRAM (see Fig.3).

The LSI has functions to demodulate QPSK signals, to detect and correct errors and to output AC-3 data. Using the digital signal processing technology contributes to the high performance of the stability and

the cheap cost of the LSI.

Features of the LSI are as follows.

- The detection adopts a differential detection method.
- In order to make the circuit simple, the detection block of the LSI treats the modulated signal as one-bit wide data.
- Phase resolution is 4-bit precision, because clock frequency to detect a phase is sixteen times as many as a carrier frequency.
- When 9bit/word memory is used as memory of error correction, ability of correction increases by erasure correction.
- The LSI outputs AC-3 data stream on digital audio interface.

We measured the number of byte errors, when a

Laser Disc with AC-3 audio was played back and signals from the Laser Disc were processed by the LSI on evaluation board. The byte error rate before the error correction is normally  $1\sim 2 \times 10^{-5}$ . In the worst case of time base error that results from wow and flutter of Laser Disc Player, byte error rate is  $1\sim 3 \times 10^{-4}$ . The estimated worst value of time base error is  $45\mu s$ . We have confirmed that results are little enough to correct errors.

#### 4. Conclusion

We have developed a demodulation LSI for Laser Discs with AC-3 audio. The LSI is useful for constructing compact, easy and economical demodulation block.

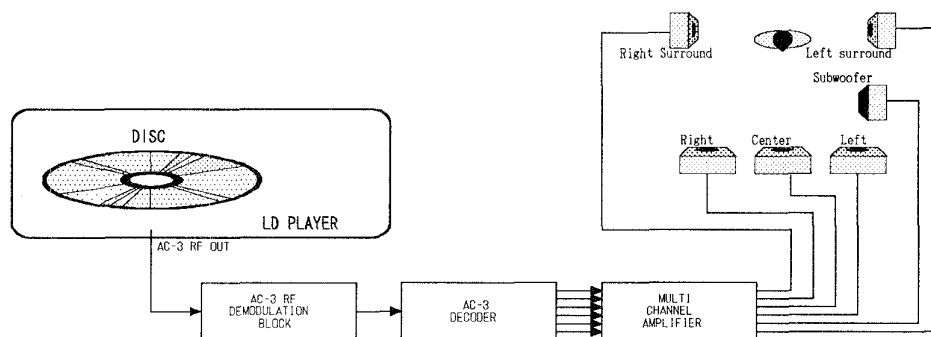


Fig. 2 AC-3 playback system

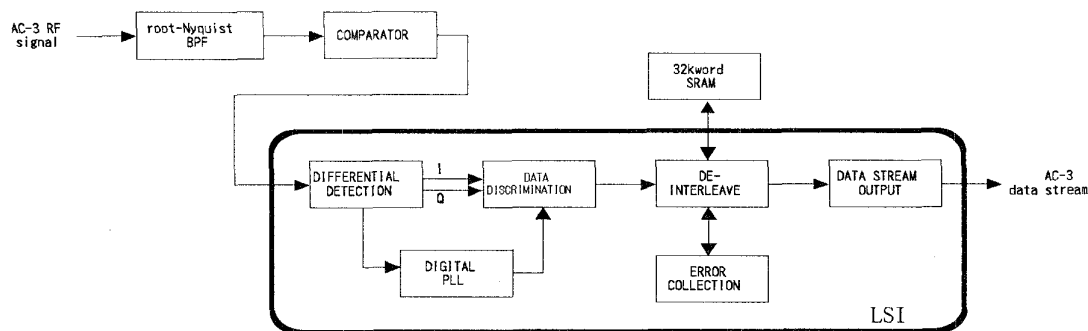


Fig. 3 Demodulation block diagram