Application Of Parallel Digital Interface For The Interconnection Of Digital Audio Equipment.

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A parallel interface for digital audio applications is reported. Most of the conventional interfacesuse serial data transfer which tends to require complicated connections as the system level becomes higher. In order to solve such complications, a parallel interface has been employed for experiments at commercial recording studios with satisfactory results. This interface offers more simplified exchange of complicated data among several pieces of equipment.

1. Foreword

Over the past several years, AES among others has debated and experimented at length with musical signal data transmission between pieces of digital audio equipment (see reference document 1, etc.). Much of this debate and experimentation centered on 2-channel systems and had to do with 1-to-1 serial interfacing. Ho~~wever, in a~~ctual practice digital audio systems are for the most part composed of a number of pieces of equipment, as Fig. 1 (a) shows, and this in turn gives rise to changes in the paths of data transmission inside the system.

In order to accommodate changes in data transmission paths inside the system when using serial interfaces, it is necessary to gather together all the cables in a separately installed switchbox. Moreover, as the number of pieces of equipment comprising the system increases, the number of cables also increases, necessitating an even more complicated switchbox.

Therefore, a practical-use system that accommodates changes in the system and the data transmission paths and does not use a switchbox yet needs few cables is required. With this in mind, we have experimented with a bi-directional parallel interface like the one shown in Fig. 1 (b) and herein report on the results of this experimentation.

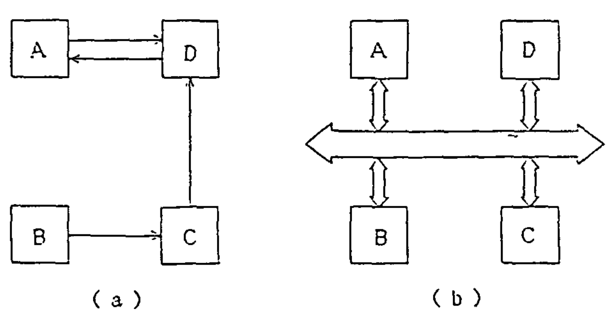

Fig.1 The interconnection of digital audio equipment

2. About the Bi-directional Parallel Interface

Experiments were carried out with the bi-directional parallel interface as shown in the timing chart of Fig. 2.

In the chart, the word SYNC is combined with the sampling frequency, with 1 sample interval being divided at the 32, 48, 64, etc., time slots designated by the transmission [clock. Data transmission/reception for each piece of equipment is established by receiving the time slot output from the transmitter.

Here, the number of slots within a given sample is limited by the transmission lag. The high frequency transmission speed v for all paths is

$$v \doteqdot 1/\sqrt{LC} = 1/Z_0C \qquad (1)$$

(where L and C are the inductance and capacitance per unit length, and Z_0 is the characteristic impedance)

Slot width ts for sampling frequency fs and channel number n is

$$ts = 1/fs \cdot n \qquad (2)$$

Therefore, the following relations must be satisfied for bidirectional transmission over a distance of 1 m.

$$2 \cdot \ell / v < ts \qquad (3)$$

At distances greater than those in (1) and (2) above, the number of slots is:

$$\ell < 1/2\, Z_0\, C\, fs \cdot n \qquad (4)$$

$$fs = 48\text{kHz},\ Z_0 = 75\Omega,\ C = 65\text{pF/m}$$

$$\ell < 2.14 \times 10^3 \times 1/n \qquad (5)$$

Fig.3 shows a graph of $\ell = 2.14 \times 10^3 \times 1/n$. The underside of this curve is the area in which slots can be realized.

In the interests of circuit simplification a distance of up to 30m was designated as a safe distance with a 32-slot configuration when data is picked up at the transmission clock rising position.

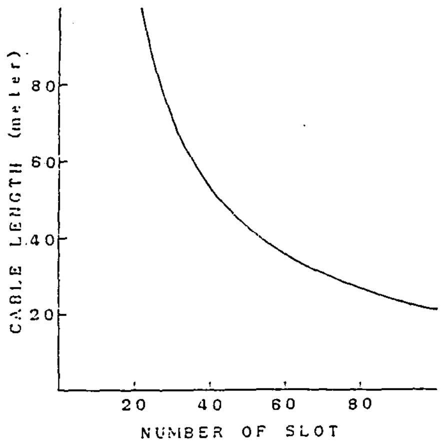

Fig.3 The number of slot within 1 sampling period versus cable length

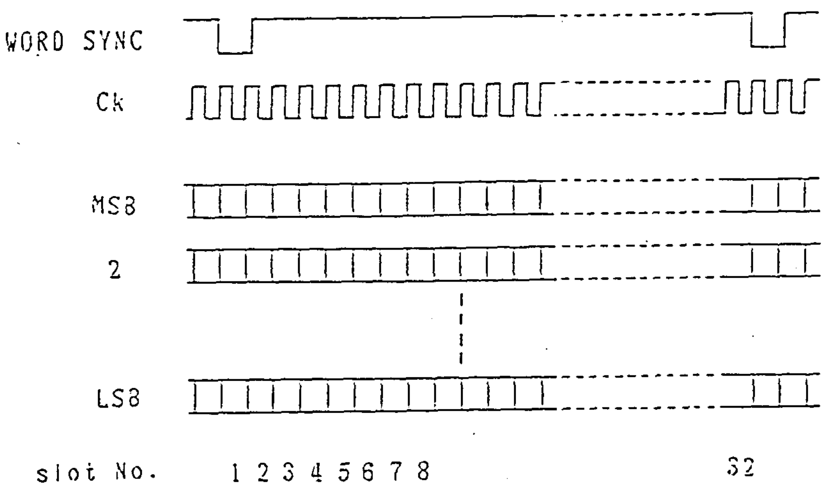

Fig.2 Timing chart

The I/O slots of the various pieces of equipment within the system are set by the switches inside the equipment or by the system controller. In the former case, there is a possibility that a missetting may trigger a driver output collision; however, this can be avoided by the method shown in Fig. 4, where a slot high impedance is detected and, after determining its availability, a circuit opens the output onto the specified slot.

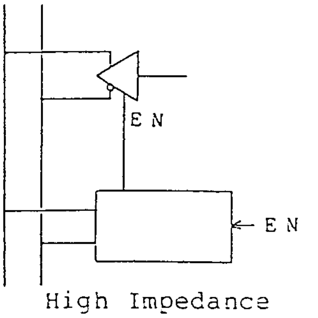

Fig.4 Protection circuit for double booking

3. Application Example

(1) Regular Parallel Interface

As shown in Fig. 5, the transmission line employs a RS422 balance line suitable for the noise margin, transmission distance, and transmission rate. All equipment is provided with two 50-pin connectors that connect all pins in parallel. The bus is connected by a paired, twisted multi-cable.

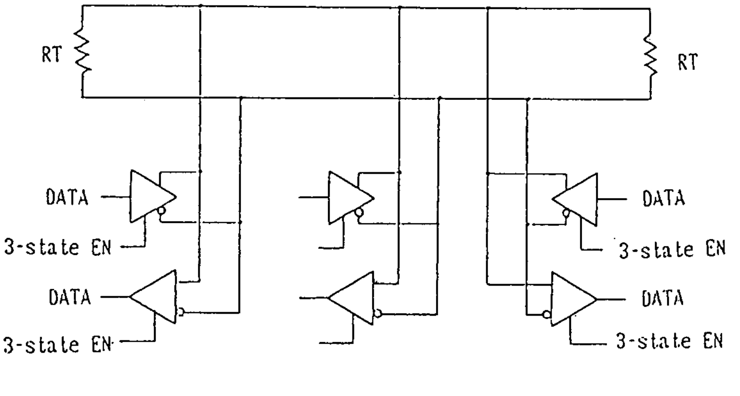

Fig.5 RS-422

Party Line configuration

(2) Introduction into Digital Mastering Console and Peripheral Equipment

Fig. 6 shows a block digram of the DENON DN050MD digital mastering console. The area inside the solid lines is the digital mastering console system and the transmission line is composed of 32 slots.

External equipment such as digital tape recorders and digital sound effect equipment are connected via the 32-slot data bus in the same way as internal equipment is connected. The I/O slots of the various pieces of equipment inside the system are controlled by the system controller, and you can configurate data paths using the switches on the operations panel. Also, the system has a check function for inspection of data in any given slot by means of the DA or display processor. In this example, the system employs empty lines and transmits an emphasis flag and DSP overflow flag.

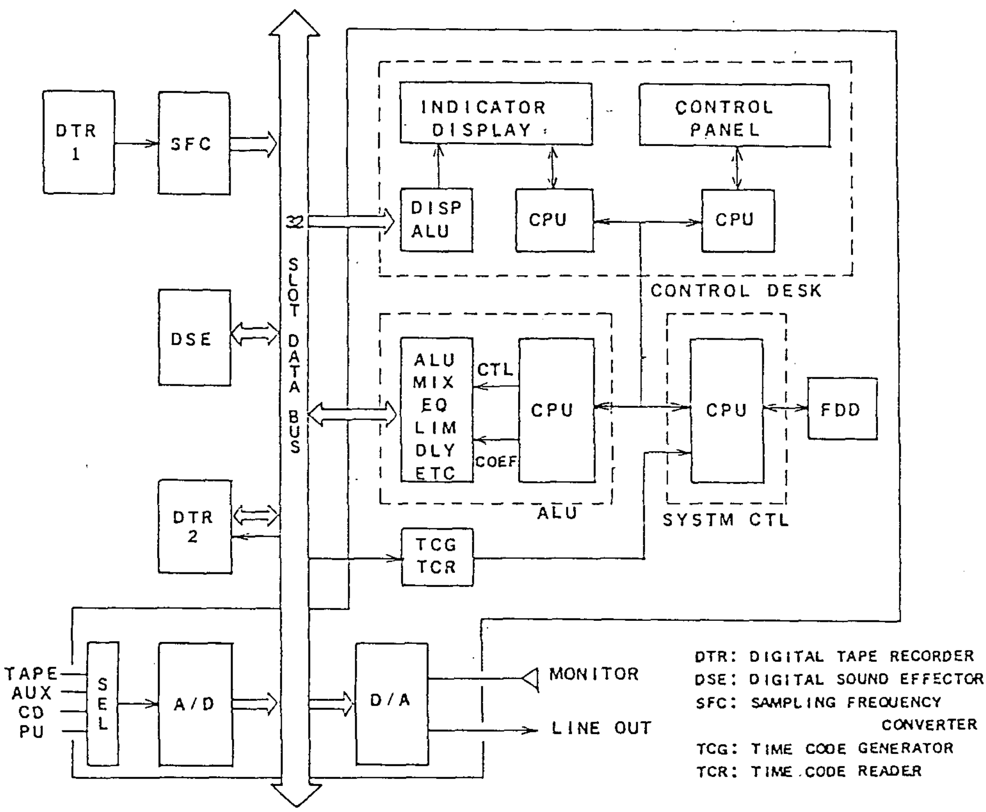

Fig.6 Block diagram of digital mastering console system

(3) Applications for a Multi-channel System

As stated previously, the parallel interface is also suitable for multi-channel system data transmission in the same way as for systems with few channels. However, the single bus line will be inadequate for use with recorders and consoles having more than 32 channels.

The MITSUBISHI X-800 32-channel PCM recorder comes equipped with separate bus lines for input and output.
With data transmission between studios, transmission distances over 50m require use of one-way transmission.

4. In Conclusion

Experimentation with parallel interfacing has been conducted as described above, with the following advantages:

(1) Data paths can be changed without changing the connections.
(2) Misconnection unlikely because all equipment is tied together via the multi-cable bus connection.
(3) The interface circuits used are comparatively small-scale when there are many channels or many pieces of equipment comprise the system.

Therefore, future digital audio systems whose functions are expected to be upgraded even further by parallel interfacing comprise a reliable and effective means of data transmission while remaining extremely simple in configuration. Hereafter, we would like to direct our research efforts toward ways to use redundant bits and system-internal equipment control metnods.

Reference Document: 1) DRAFT AES3-1985