THE TIME DIVISION MULTIPLEX MEASURING SYSTEM FOR SINGLE-TRANSIENT SIGNALS

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ABSTRACT

In order to reduce the measuring channels for the single-transient signals, the author propose the time division multiplex technique and intrduce the method of SAW delay line in this paper.
That used method of SAW tap-delay line in this system is different from previous methods conSists in making traditional method, which is one-path signal input different delayed multi- path signals output, alter new method , which is simultaneous multi-path signal inputs that are respectively delayed and one-path signal serial output.

INTRODUCTION

There are many single-transient signals needed to be measured in trials. Previous methods made signals on each path respectively transmit and record by individual measuring channel,most of which were coaxial cable transmission, oscillometer and sychronous photographing to record. Hence, one signal occupied one measuring channel so that the system was very bulk,high expensive and low availability. For these reasons, it is essential that using the time division muitiplex technique cut down the number of measuring channels so as to lower costs and save money.

For the single-transient signal,owing to the quick change of rising edge (or falling edge) of the signal ,it is not feasible to use usual time division method in general telemetry system. In general PCM,we perhaps come across the problem of selecting high-speed devices. For example, if we want to transmit five signals,supposing that rising edge time of each transient signal is 35 ns,then we must require that the total sampling rate reaches 150 MHZ above.If the code of data of each path is 8 bit,then bit

rate will be reached 1200 Mb/s above,which is not capable of realization at present. So we must find a new technical way to solove this problem.

We have perfectly solved above-mentioned problem by employing the time division multiplex technique.This technique is different from the time division technique in general telemetry system in that simultaneous single-transient signals are differently delayed to queue as serial analogue signals through delay component and then transmitted over a common channel.In the mode of transmission ,we throw away coaxial cable and use optical fiber. In the mode of recording and storing,we also discard traditional method which employed oscillometer and sychronous photographing. Now we employ the method of signal digitalization and make digitialized signals store in buffer register and memory permanently in disk.

THE COMPOSITION AND BLOCK-DIAGRAM OF MEASURING SYSTEM

1. The composition of the system

The time divition multiplex measuring system for single-transient signal is composed of signal delay queuing, optical fiber transmission,signal digitalization and storage as well as microcomputer system.

a. Signal delay queuing consists of selectors,modulator,isolator,delay components and amplifiers.

b. Optical fiber transmission consists of 100 MHZ analogue optical transmitter,optical fiber ,100 MHz analogue optical receiver and so on.

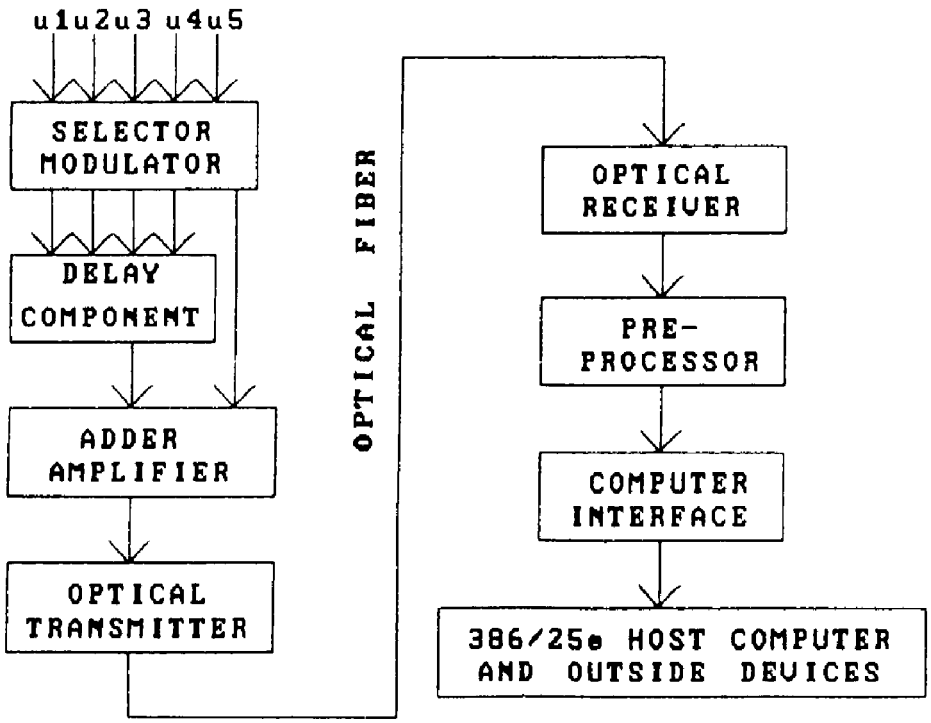
c. Signal digitalization and storage consists of pre-processor,A/D converter, RAM ,the interface of compuer and so on.

d. Microcomputer system includes 386/25e host computer,RS3240 printer,DXY-880A ploter, 1400 colour display and the software of data processing.

2. The block-diagram of the system

The block-diagram of the time division multiplex measuring system for single-transient signal is shown in Figure 1.

Figure 1 shows that five transient signals u_1,u_2,u_3,u_4 and $u_5$occur simultaneously. After the signals except the first signal have been selected,modulated and isolated , they are differently delayed by delay components and transmitted to amplifier.As a consequence, the output signals of amplifier are analogue group signals, which queue as serial. Group signals are fed to optical transmitter to be modulated and then transmitted over optical fiber and finally demodulated to recover orginal group signals by optical receiver. These group signals are converted to digital signals after pre-processing(detecting, amplifying , band-limiting), stored in RAM(preserved not less than 7 days in the state of power off) , transmitted to computer via interface circuit and memoried permanently in disk to provide later data processing.



FIGURl. BLOCK-DIAGRAM OF MEASURING SYSTEM

THE DELAY METHOD OF MULTIPATH SIGNAL

There are many approches to signal delay. This system employs the method of the surf ace acoustic wave(SAW) delay line.

1. The principle of SAW delay component

To describe the principle of SAW delay component,we introduce firstly the principle of interdigital transducer and the surface acoustic wave.

a. Interdigital transducer and the surf ace acoustic wave

If a piece of piezoelectric material's surface is plated interdigital aluminium sheet, it forms interdigital transducer,shown in Figure 2. The same fingers of interdigital transducer link up to form two poles.

When the two poles of IDT are added alternative voltage , due to piezoelectric effect , the pulling-putting-pulling stress and tiny deformation are alternatively produced among interdigital fingers on the surface of piezoelectric material. In the meanwhile, this stress and deformation periodicially varies with the alternative change of voltage.Hence it produces the mechanical wave propagating towards two directions on the surface of piezoelectric substrate, that is surface acoustic wave. Thus IDT accomplishes the conversion of electricity to sound.

IDT can not only performs the conversion of electricity to sound but also performs the conversion of sound to electricity . Shown in Figure 3, in order to realize the

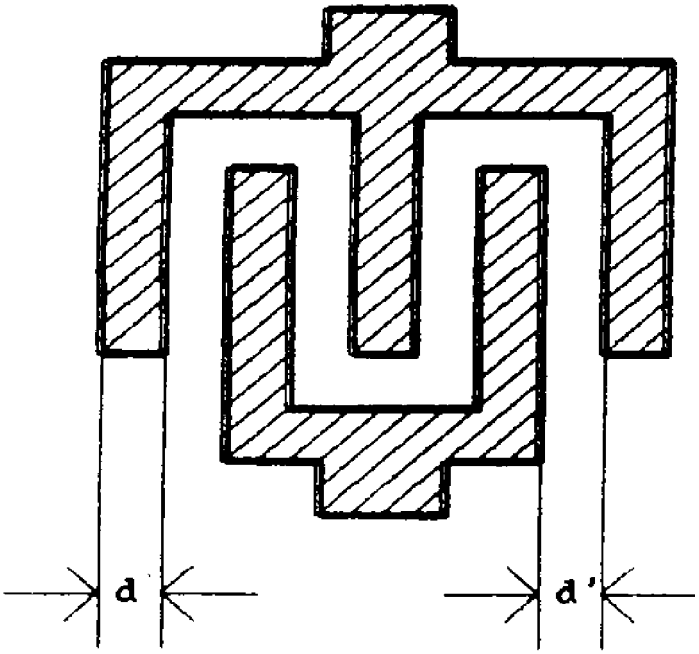


FIGURE 2. CONFIGURATION OF INTERDIGITAL TRANSDUCER

interconversion of electricity-sound,we can plate a group of interdigital transducers at each of two ends of a small piece of piezoelectric material's surface,one of a group of interdigital transducers which two poles are added alternative voltage is simulated the surface acoustic wave.

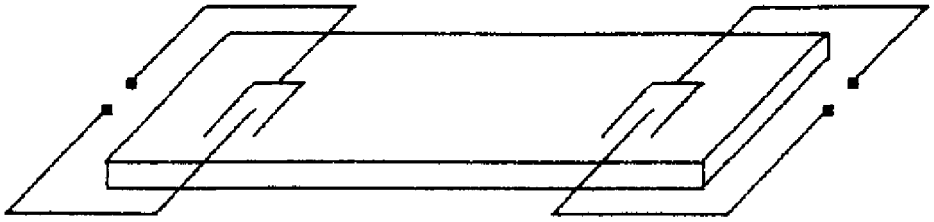


Figure 3. Block-digram of Measuring System

Beause the wave propagates on the surface of substrate,while propagating to another group, two poles of which produce alternatve voltage, whose frequency is the same as frequency of input terminal, due to positive piezoelectric effect.Thus the first group IDT performs the conversion of electricity to sound ,and the second group IdT performs the conversion of sound to electricity.

b. SAW delay line

Interdigital transducer is a kind of reversible transducer.It can not only produce SAW but also receive SAW.Therefore it can be easily made many kinds of SAW components. SAW delay line which is one kind of SAW components is widely used at present.

The basic form of SAW delay line is shown in Figure 4.

Each of two ends of the surface of piezoelectric material substrate is plated a group of IDT, which forms SAW delay line .Subdtrate is usually made of different piezoelectric materials, for example,piezoid,lithium niobate,tantalum niobate and so forth or same piezoelectric material(which is heterpolar in all directions), which cutting directions of magetic lines are different thereby its propagating speed of SAW on the material is different.

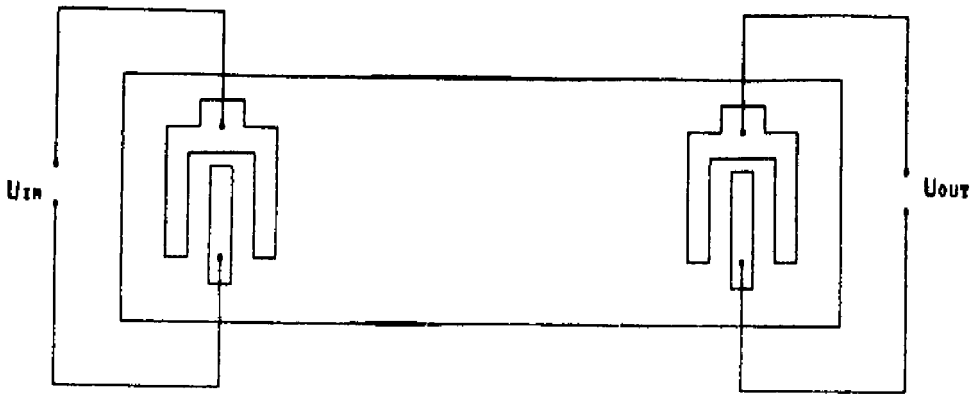


FIGURE 4. BASIC FORM OF SAW DELAY LINE

The principle of this kind of SAW delay line is : when the input terminal is added alternative voltage,simulated SAW passes through L delay and is converted to electric signals at the output terminal.

Where L is the center distance between two groups of IDT, d is the width of sheet, which depends on frequency choosed.

When we make IDT,we usually let d equal to the distance between fingers (d').

2.SAW tap-delay line

SAW delay in practice is generally multi-tapped,its block diagram is shown in Figure 5.

a.Using method of the tap-delay line

In general,the using method of tap-delay line is that the first couple of tap on the left is used as input transducer and the second ,the third, the fourth, and the fifth couple of tap on the right as output transducer. When alternative electrical signals added to input transducerand are transmitted over different paths, we obtain different delayed electrical signals at the second,the third ,the fourth and the fifth output transducers.However,the using method of the system is different from previous method ,in that the first ,the second, the third,the fourth couple of taps is used as input transducer simi and added alternative signals u_2,u_3 ,u_4 and u_5, the fifth couple of taps as output transducer.If the delay time of neighboured taps is 6 μ s,then the delays time of signals u_2,u_3,u_4 and u_5 are respectively 6 μ s, 12 μ s,18 μ s,24 μ s.Another signal u_1 is not delayed.

b. The requirements for tap-delay line

If the rising edge time of signal to be detected is 35 ns and its bandwidth is B_o=1/0.35 = 60 MHZ,then the bandwidth of high-frequency B= 20 MHZ.

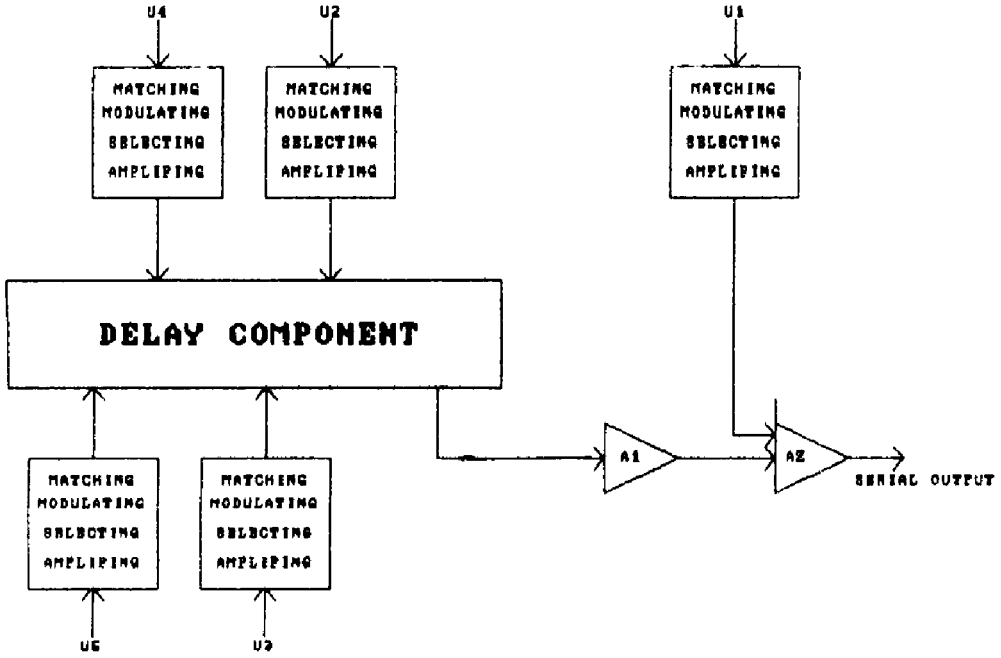


FIGURE5. BLOCK-DIAGRAM OF SAW MULTI-TAPPED DELAY LINE

To restain the disturbance od the body wave,the relative bandwidth of B must be satisfied:

$B/f_o < 40\ \%$,thus center frequency f_o must be satisfied following requirement:

$f_o > B/0.4 = 50$ MHZ

In order to reduce relative bandwidth and lower the requirment for tap of delay line.The center frequency f_o is taken to be 60 MHZ.Thereby the component of the highest frequency does not exceed 70 MHZ to ensure that the requirement of frequency for optical transmitter and optical receiver is satisfied (< 100 MHz).

c. The determination of the number of tap of delay line

For the purpose of enhance economic benefit,the more the number of multiplex,the better. However,because choosed piezoelectric material of SAW delay line is lithium niobate (LINBO). Currently,the substrate LINBO is restricted owing to the size and the processing of the crystal,it is difficult to exceed 100 mmm,moreover , the propagation speed of sound in LINBO is 3.488 mm/ μ s,apart from the surplus of two ends , total delay to be provided is beween 25~ 28 μ s.If the bandwidth of signal is 5.5 μ s,bandwidth before zero is 0.3 μ s and the interval beween paths is 0.2 μ s,then the number of delaying paths permit to be 4 paths and total number of paths is 5 paths

OPTICAL FIBER TRANSMISSION SYSTEM

1. The advantages of optical fiber transmission

There are many incomparable advantages of optical fiber transmission compared with coaxial cable transmission for high-frequency information.

First, optical fiber channel is capable of transmitting at much higher tranmission rate,

now the transmission rate has exceeded 1000Gb/s.
Second,optical communication can avoid the disturbance of electromagnetic wave.error-code tate is usually below 10^{-9}.
Third, optical fiber is low loss and suitable to long distance of commmunication.
2. The composition of system
Optical transmission system is mainly composed of analogue transmitter T193- 1, optical fiber with 8 core multimod aluminium as well as analogue receiver T195-1.
3. optical source device
At present there are two kinds of optical source device to be choosed in domestic contry : one is LDdevice(Laser device), another is LED device (light-emitting diode).
The system choose LED device beacuse it has the advantages of the high strengh of lighting,fine reliablity,low cost as well as uneasiness to the influence of temperature at the militry range of -55° c~ 125° c. we choose common domestically used PIN in receiving and detecting devices.
4.The properties of optical fiber transmission
a.The distance of communication > 1.2 km
b.The wave length of communication is 1.3 μ m
c.The distortion degree of the system < 2 %
d.Choosing LED as transmitter,PIN as receiver.

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