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Short Communication

Computer-based voltage-division multiplexing (VDM) in telecommunication

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Abstract

In telecommunication engineering, different types of multiplexing, such as FDM, TDM and QM exist. A new multiplexing technique, VDM, is reported in the paper. It can be implemented using an analog chip as well as a computer program to be run on a digital computer. VDM has capacity to bear huge traffic through single channel and also provides for secrecy of information. Moreover, VDM can be used in communication of even number of computers without using any sophisticated software.

Key words: Multiplexing, single-channel communication VDM, secrecy.

1. Introduction

As the field of communication is rapidly getting congested, we need, for efficient communication, a system which is capable of carrying huge traffic, and simultaneously maintains high reliability, speed and is error-free in operation.

To transit a number of signals through a single-communication path, different types of multiplexing techniques have been developed. They are: FDM where use is made of frequency filters, TDM where time filter performs the main role and quadrature multiplexing (not yet put into practice) where the phase of the oscillator controls the technique[1–3]. A new multiplexing technique, VDM, is reported in this paper. TDM and VDM can be combined to realise a matrix multiplexing of signals to facilitate the handling of a huge traffice.

2. Basic scheme

There are various types of voltage comparators[4,5] with different characteristics (fig. 1). The voltage comparators having characteristics shown in fig. 1a and b may, respectively, be

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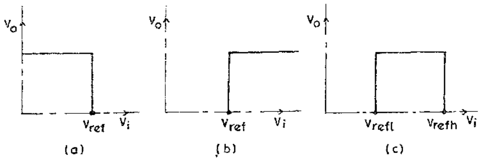

FIG. 1. Typical characteristics of different types of voltage comparators.

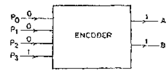

FIG 2. Block diagram to encode A_i and B_i for a particular P_i.

termed as LVF (low-voltage filter) and HVF (high-voltage filter). The window comparator, bearing characteristic of fig. 1c, may accordingly be used as BPVF (band-pass-voltage filter) or BSVF (band-stop-voltage filter).

A new multiplexing technique can be developed using these voltage filters, and the technique may be termed as 'voltage division multiplexing' (VDM). To illustrate the technique, two signals, A and B, are assumed to be voltage division multiplexed, each being binary-digitally coded in a nibble. Also, the voltage levels of binary digits in the representation of the signals are different (Table I). Different combinations of binary digits occur in the representation of A and B at any instant at any bit position in a nibble (Table II).

Depending on the voltage level (*i.e.* using voltage filter), any P_i ($i = 0$ to 3) of Table II can be enabled (set) to generate difference code of A and B for any bit position. An illustration (fig. 2) for P_3 set condition clarifies the picture. This idea can be used to realise VDM in a communication system as depicted in fig. 3. In the receiver, the reference voltages of comparator may be typically chosen as shown in fig. 3b assuming that peak-to-peak voltage of noise is limited to ($\pm$ V/2) volts.

For the three signals, A, B and C to be VDMed, it is required that:

For A, digit 1 = 1 volt

For B, digit 1 = 2 volts   digit 0 = 0 volt in all the cases.

For C, digit 1 = 4 volts.

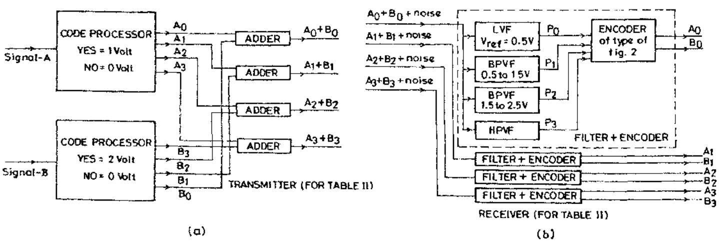

FIG. 3. VDMed transmitter/receiver.

Table I

Signal	Digit-1	Digit-0
A	1 V	0
B	2 V	0

Table II

I_0	I_1	I_2	I_3		
					I_i = ith bit of nibble
0	1	0	1	A	
0	0	1	1	B	
0	1 V	2 V	3 V	$A + B$	
					P_i = ith addition of two ith bits of A and Bs nibble
P_0	P_1	P_2	P_3		

Table III

I_0	I_1	I_2	I_3	I_0	I_1	I_2	I_3		
0	0	0	0	1	1	1	1	C	
0	0	1	1	0	0	1	1	B	
0	1	0	1	0	1	0	1	A	
0	1 V	2 V	3 V	4 V	5 V	6 V	7 V		$A + B + C$
P_0	P_1	P_2	P_3	P_4	P_5	P_6	P_7		

Its coding scheme is shown in Table III. It may be noted that voltage level for digit 1 should be so chosen that the sum of such two levels in any two signals should not equal the level of the remaining signal.

VDM can be utilised in digital transmission of the data in PCM technique. Figure 4 illustrates the method of using VDM to transmit $(n \times m)$ number of signals in matrix multiplexing scheme, where each of the $2(=n)$ channels of PCM-TDM uses $2(=m)$ signals in VDM mode. Thus any PCM-TDM path of m channels can utilise VDM to increase the signals for transmission/reception.

It may be noted here that VDM can also be realised on a digital computer by a computer program and need not depend on any voltage filter simulation. What is needed is the execution of algorithm I which is developed for Table II system. For this purpose, a typical 8085 microcomputer system shown in fig. 5 will serve the purpose, on the execution of a typical data-logging program.

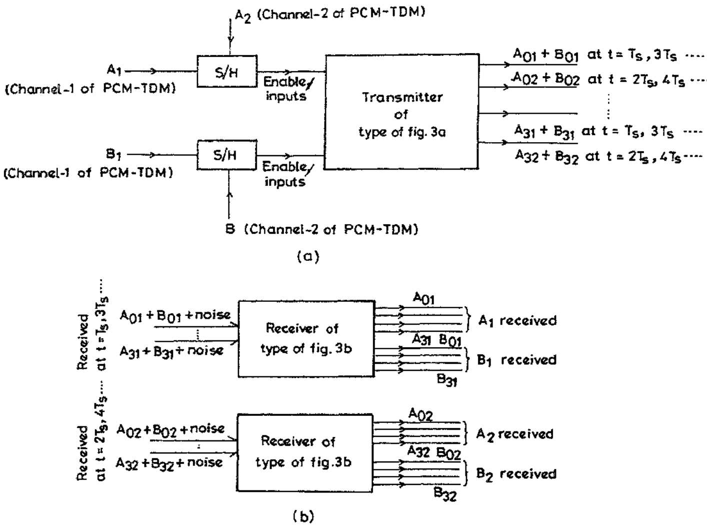

FIG. 4. Matrix multiplexing technique in transmission/reception.

3. Conclusion

Computer-based VDM on matrix multiplexing operation with PCM-TDM can fulfill the first criterion of any efficient communication system *i.e.* the capability to carry huge traffic which is indispensable, in general, in this information era and specifically for defence and information needs. As there is no device, at present, which is speedier and more accurate than a computer, the above illustrated marriage of computer with VDMed operation automatically satisfies the second criterion.

Another important feature of the VDM is the secrecy of information which is essential in some typical communication systems such as defence system, VIP links, etc. While TDM-PCM code meets this requirement, in matrix multiplexing, VDM provides for far greater secrecy over that of TDM-PCM. This is because the signal under VDM operation can not be separated as long as the bit levels (YES and NO states) of signals under VDM operation are not known. VDM is inherently a secrecy-maintained technique. Computer-based VDMed operation, when mixed with PCM-TDM linked in matrix system, provides for a highly advanced communication system.

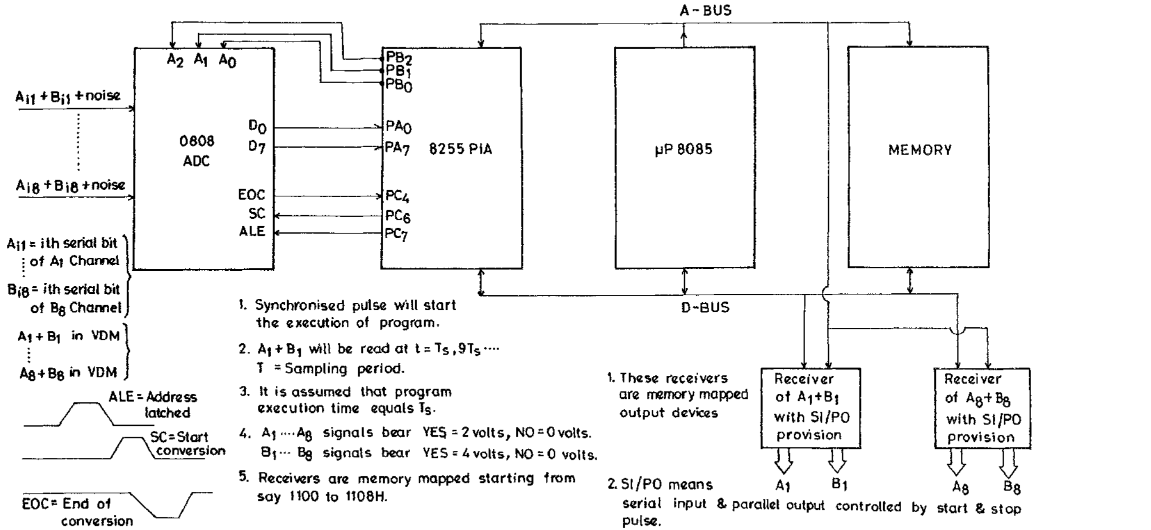

FIG. 5. Typical computer-based VDMed telecom system.

Algorithm I

1. READ RECEIVED VOLTAGE (VR) AT FIRST SAMPLING INSTANT INITIATED BY SYNCHRONISED PLUS RECEIVED FROM OPPOSITE END.
2. IF VR IS LESS THAN 0.5 VOLTS, GO TO STEP 6.
3. IF VR IS LESS THAN 1.5 VOLTS, GO TO STEP 8.
4. IF VR IS LESS THAN 2.5 VOLTS, GO TO STEP 10.
5. I_3 OF $A_0 = 1$ AND I_3 OF $B = 4$, GO TO STEP 12.
6. I_0 OF $A = 0$ AND I_0 OF $B = 0$.
7. GO TO STEP 12.
8. I_1 OF $A = 1$ AND I_1 OF $B = 0$.
9. GO TO STEP 12.
10. I_2 OF $A = 0$ AND I_2 OF $B = 1$.
11. GO TO STEP 12.
12. NEXT SAMPLING INSTANT HAS BEEN REACHED? IF YES GO TO STEP 13. IF NO GO TO STEP 14.
13. READ VR GO TO STEP 2.
14. GO TO STEP 12.

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