Matrix Memory Device

Mirfatma Javadova and Ilona Chernytska

Abstract The article considers a matrix memory element, which is a storage matrix built using diodes based on complex semiconductors. A decoder device using memory cells based on Cu_2Se diodes, which provides the necessary signal based on various combinations of input signals. MD (memory device) can find application in information processing systems when creating a storage device with the required capacity and capable of working in the interval from −60 °C to +125 °C. As a multi-functional device, the requirement for the electoral device is that it is advantageous in terms of energy saving and for the same reason, the decoders are built on the elements with the lowest energy consumption. Matrix memory element can be used built using diodes based on complex semiconductors and matrix memory device can be used in information distribution and processing networks, computer technology, automation systems and in other areas of technology. İn information processing systems when creating a memory device with the required capacity. Based on the abovementioned, the devices are modern, economical, highly technological for the development and applicable to modern automation devices and switching equipment.

Keywords Information transfer · Complex semiconductor · Reliability · Digital switches · Electricity

1 Introduction

The development of microelectronics has allowed the use of semiconductor elements (bipolar transistors and MOS structures) to build memory devices. The use of bipolar transistors and MOS structures can significantly increase the speed of MD reduce their mass, dimensions and increase reliability [1].

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Table 1 Characteristics of MD made on various electronic technological basis

RAM type	Applicabe elements	Characteristics			
		Production time, ns	Typical information capacity, byte	Density of information placement, byte	Energy consumption during storage of information
Semi conductor	Bipolyar Transistors	50 ÷ 300	103 ÷ 105	Up to 200	Yes
	MOS Structures	250 ÷ 100	103 ÷ 106	200 ÷ 300	Yes
Magnetic	Ferrite cores	350 ÷ 1200	106 ÷ 108	10 ÷ 20	No

The Table 1 shows the data characterizing the MD made on a different elemental – technological basis. The table shows that on bipolar transistors it is advisable to build a MD with an information capacity of less than 105 bits, but with high speed. The MD on MOS structures have a capacity of $10^3 \div 10^6$ bits at moderate speed.

2 Methods

The main disadvantage of MD on mentioned structures is the energy consumption during storage of information. In this regard, at present the development of memory is carried out in two directions. MD are developed on integrated circuits with the improvement of their capabilities, as well as on new elements which do not consume energy when storing information.

A special memory device can be built using diodes based on complex semiconductors. It‘s possible to consider the memory matrix built using diodes based on complex semiconductors. Matrix memory device can be used in information distribution and processing networks, computer technology, automation systems and in other areas of technology. Advantageously, MD can find application in information processing systems when creating a memory device with the required capacity.

XM-based diodes have a memory, moreover, information can be stored in them even in the absence of power, the duration of information storage by XM diodes is checked for 1.5 years. The ability of XM diodes to withstand high temperatures and radiation resistance suggests that memory cells developed on the basis of XM diodes can compete with modern memory elements currently used in memory devices [2].

A characteristic feature of the proposed memory device is that it is built on diodes based on complex semiconductors with two stable states, Fig. 1. With N capacitance, this storage device also provides reception, storage and delivery of N number n bit numbers. A disadvantage of the known matrix memory device is the inability to use the operating currents less than the full value supplied by the vertical and horizontal buses, which leads to disruption of the elements installed before and after the selected

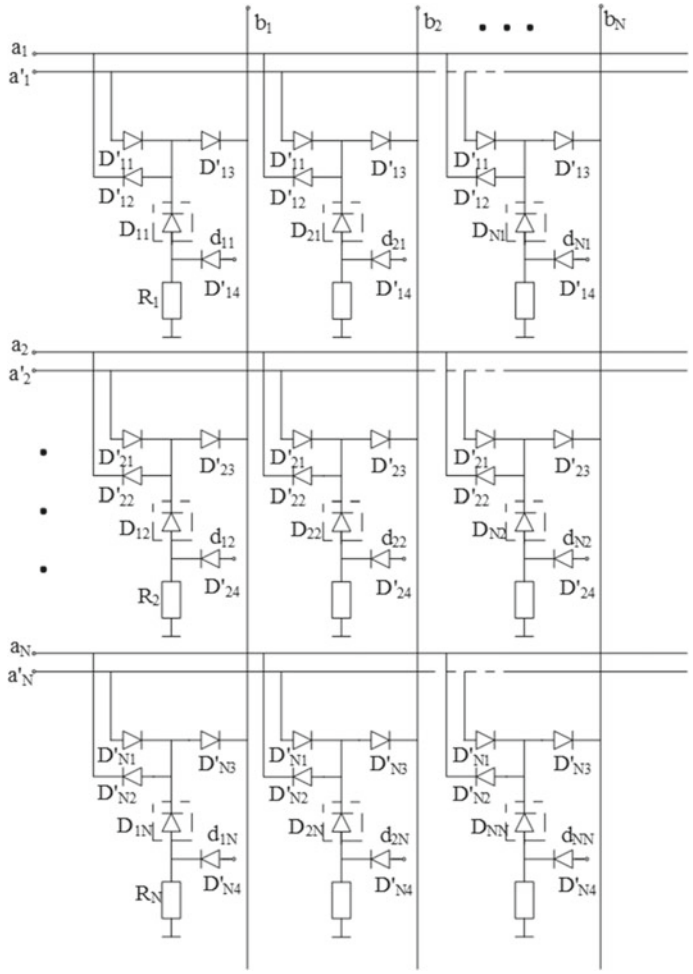

Fig. 1 Matrix memory device

elements. Therefore, in such storage devices of a matrix type, at the outputs of each storage element, additional elements are used to record information.

The matrix storage device contains b_1,b_2, …b_N vertical bus; D_{11}, D_{12}, …D_{1N}; D_{21}, D_{22}, …D_{2N}; D_{N1}, D_{N2}, …D_{NN} diodes based on complex semiconductors; D'_{11}, D'_{12}, D'_{13}, D'_{14}; D'_{21}, D'_{22}, D'_{23}, D'_{24};... D'_{N1}, D'_{N2}, D'_{N3}, D'_{N4} decoupling diodes in one column d_{11}, d_{12}, …d_{1N}; d_{21}, d_{22},... d_{2N};... d_{2N},... d_{N1}, d_{N2},.., d_{NN} output pins of diodes based on complex semiconductors for each column. Matrix memory device operates as follows. The memory device simultaneously records all the digits of the same number.

Voltage across one vertical bus and n horizontal buses (n is the number of bits of one number) is supplied simultaneously. A voltage with a value is supplied via

the vertical bus, where U is the total voltage value $\frac{2}{3}U$ for switching the memory element. The voltage with the value $-\frac{1}{3}U$ is supplied via the horizontal bus a, the voltage with the value $+\frac{1}{3}U$ is supplied through the horizontal bus a1. To record n bits of a single number in the memory device, one of the vertical buses b1, b2, … bn is supplied with voltage with magnitude $\frac{2}{3}U$, while voltage for each horizontal bus is either with magnitude $+\frac{1}{3}U$ or magnitude $-\frac{1}{3}U$. When recording '1' in the memory device, voltage is applied simultaneously to the voltage of the vertical bus $\frac{2}{3}U$ via the corresponding horizontal bus $+\frac{1}{3}U$. If it is necessary to record '0' in the storage device, then a voltage with magnitude is supplied via the corresponding horizontal bus $+\frac{1}{3}U$. Thus, when recording '1', the storage element—a diode based on complex semiconductors is powered by a voltage with a value

$$\frac{2}{3}U + \frac{1}{3}U = U \tag{1}$$

The value $\frac{1}{3}U$ is so small that the diode based on complex semiconductors does not respond to this and remains in the same zero '0' state. When reading the recorded information in the storage device via the corresponding vertical bus, a voltage signal with a value $-\frac{2}{3}U$ is provided, and at the same time, horizontal signals of a voltage signal each with a value $-\frac{1}{3}U$. The reliability of the memory cells in the mode of reading, storing and overwriting information is determined by the stability of the voltage and switching current of the memory element. Researches have shown that the switching voltage and switching current of these elements is practically not depends of the ambient temperature in the range of $-60 \div +125$ °C. The distribution curves of the value of the turn-off voltage obtained at a frequency of 100 kHz and for a pulse duration of a logical "0" 0.5 μs are shown in Fig. 2. Figure 3 shows the distribution curve of switching current. As follows from Fig. 2, the most likely value of the turn-off voltage is 6.3 V, which allows the use of memory cells in conjunction with standard TTL ICs with a voltage of 5 V.

However, the value of the turn-off voltage is characterized by a certain spread both from one switching cycle to another and for a separate memory element, which leads to the need to use statistical analysis methods to establish guaranteed acceptable signal values that ensure non-destructive reading of information. Assuming that the experimentally obtained distributions of the turn-off voltage values obey the normal

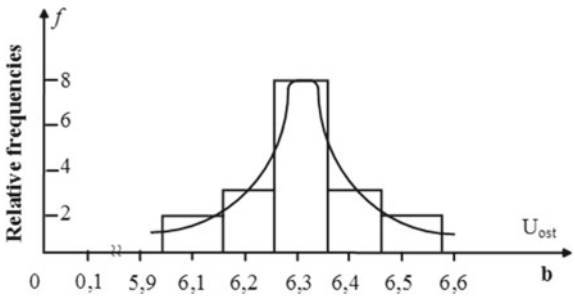

Fig. 2 Turn-off voltage distribution curve

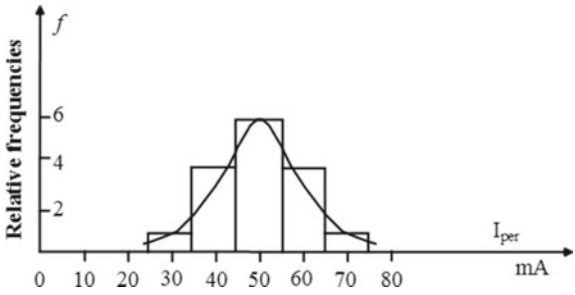

Fig. 3 Distribution curve of the switching current

law, numerical methods can be used to obtain statistical estimates of the mathematical expectation of the variance and the standard deviation of given value.

It is proved that the expansion of relations between the processes carried out in many areas of the national economy, as well as the implementation of the reception and transmission of information at numerous points, leads to the development of a two-way amount of information between various objects. At the modern stage of development of switching technology, the main means of providing two-way transmission of information between different objects is a digital switch [3].

The developed device of the decoder using memory cells based on Cu2Se diodes provides the output of a specific signal based on various combinations of input signals. Such devices are used in converters, control and selective circuits. The decoder, as a selective device, performs the function of selecting a device connected to its output. As a multifunctional device, it is beneficial from the point of view of energy saving and for the same reason, the decoders are built on the elements with the lowest energy consumption. As known, these elements, even at rest mode, do not consume electricity, while at the same time saving the information recorded in it.

3 Conclusions

A decoder device using memory cells based on Cu2Se diodes, which provides the necessary signal based on various combinations of input signals. Switching devices and memory elements called as a memory cell are capable of operating in the temperature range from −60 °C to +125 °C [4, 5]. Decoder devices developed using memory cells based on Cu2Se diodes, which provides the necessary signal based on various combinations of input signals. ("Patent" No. İ 2006 0041, 2006). Based on the above-mentioned, it can be confirmed that that the devices are economical and highly technological and suitable for the development and use of modern automation devices and switching equipment.

References

1. Abbasov G, Ibragimov M, Radjabov M (2002) On the construction of a switch using diodes based on complex semiconductors (in English). Physics number 3. ELM Publishing House
2. Abbasov H, Ibrahimov M, Rajabov M (2002) Symmetrical switching device. AzACU. Scientific works
3. Mehdiyeva S, Abbasov H, Cavadova M (2003) About the implementation of processes in determined three-stage switching systems. Az ACU. Scientific works. 1
4. Ermakov O (2004) Applied Optoelectronics. Technosphere
5. Cherniha R, Serov M (2003) Nonlinear systems of the burgers-type equations: lie and Q-conditional symmetries, ansätze and solutions. J Math Anal Appl 282(1):305–328. https://doi.org/10.1016/S0022-247X(03)00155-0