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CONTROL OF STOCK CURRENT IN FIELD-EFFECT TRANSISTORS BY GATE VOLTAGE

Suvonova Sohiba Ahmedjonovna*; Turaev Akmal Ataevich**

*Master,
Bukhara State University, UZBEKISTAN

**Associate Professor of Physics,
Bukhara State University,
UZBEKISTAN

ABSTRACT

This paper examines the preparation of a field-effect transistor and how the current is controlled by the gate voltage supplied by the source, which is determined by the value of the current resistance flowing through the channel in a bipolar circuit.

KEYWORDS: *Transistor, field-effect transistor, integral optics, p-n junction, epitaxial structure, gate, stock, bipolar circuit.*

INTRODUCTION

The creation of the transistor was one of the most important events of the twentieth century, leading to the rapid development of the field of semiconductor electronics, which began in 1833 with the experiment of the English scientist Michael Faraday with semiconductor material-silver sulfide.

Transistor (English: transfer-transfer and resistor-resistance) is a three-electrode semiconductor device designed to amplify, generate and convert electrical vibrations.

According to the structure, principle of operation and parameters of transistors divided into two: bipolar and field (unipolar) transistors. Bipolar transistors use semiconductors with both types of conductivity (p-type and n-type). A bipolar transistor operates at the expense of a p-n junction located close to each other and directs current through a base-emitter junction. Field-effect transistors are semiconductor devices that are controlled by a change in the electric field in the conduction channel to control the current value, and the input voltage acting on the output current in the transistors creates an electric field. Only one type in field-effect transistors (n-type or p-type) semiconductors are used.

Two types of primary and non-primary charge carriers play an important role in a bipolar transistor. In field-effect transistors, the current is generated using the main current carriers, and the charge of the non-main current carrier does not play an important role. This is why a field-effect transistor is also called a unipolar transistor. In a bipolar transistor, the output current is controlled by the input current of the base or emitter. The input resistance is small. A bipolar transistor can be used where the input resistance needs to be small. But some circuits require a large input resistance. Current control in field-effect transistors For AC-controlled alternating current and low-frequency alternating currents, the input resistance of the transistor is very large: 108-1015 Ohms, the field-effect transistor preparation technology is simpler than that of a bipolar transistor. In addition, field-effect transistors occupy a small surface area in chips and consume less current. It therefore allows the generation of several thousand to tens of thousands of transistors and resistors on a small scale. Field-effect transistors are designed to amplify egkdsh udulek signals and power.

In field-effect transistors, unlike bipolar transistors, only one type of charge carrier is involved in current formation: either electrons or cavities. Therefore, they are also called unipolar transistors.

Today, semiconductors play an important role in science and technology. Semiconductor electronic devices are used in various sectors of the economy. Year after year, the hitherto unknown properties of semiconductors are being identified and new devices are being developed from them.

Different types of field-effect transistors are required to increase the reliability of the operation of integrated optics. The issue of stabilizing the parameters of the illuminator (generator) is very important. These parameters are very sensitive to changes in the operating mode and require special electronic circuits. Special current limiters for semiconductor lasers and LEDs are needed, especially if a current source is needed to create accurate measuring devices. The use of field-effect transistors for these purposes simplifies the circuit, unlike bipolar transistors. In this paper, the operation of a current limiter based on a field-effect transistor controlled by a p-n junction is analyzed.

The field-effect transistor under study was prepared based on the epitaxial structure. An n-type conductivity layer has been planted on the bottom of the p-type silicon, which represents the gate area. The length of the channel is 25 µm, width 560 µm, stock and istok contacts width 12 µm. The gradient of the current carrier concentration increases in the channel width in the p-n junction direction.

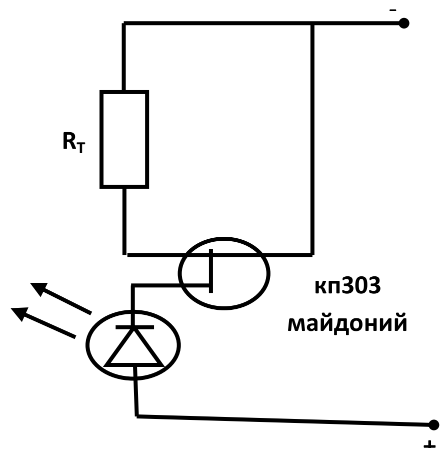

Figure 1. Connection of a field-effect transistor to a circuit in current-limiting mode.

The maximum current of the stock is 6.31 mA, the voltage across the duct is 2.4 V. The current in the form of a bipolar pole is generated by connecting the outputs of the gate with an external resistor. As a result, the automatic shift mode is set (Figure 1).

Such a mode differs from the voltage regimes determined by the common demand connection mode or voltage divider according to the saturation mechanism of the stock current. In this case, the channel modulation process is effective. The dynamic resistance of the channel increases sharply. In automatic displacement, the channel is compressed by the transverse and longitudinal components of the electric field. As can be seen from the circuit diagram of the limiter, the current flowing through the “channel-to-resistor” circuit is determined from the relationship (voltage corresponding to the resistance). At a given voltage, the saturation mode on the volt-ampere line of the stock current corresponds to the value of the external resistance. In addition to the stabilization current, such a stabilizer is characterized by a slope characteristic, saturation voltage, and breakdown voltage in the stabilization field.

In a field-effect transistor, the stock current is controlled by the gate voltage supplied by the source. Also in the two-pole circuit under consideration, the current flowing through the channel is controlled by the value of the resistance. an increase in the value of the resistance leads to a decrease in the stock current (Fig. 2).

The maximum value of the stabilization current is equal to the maximum current of the field-effect transistor at zero displacement. Indeed, from the measurement results, the stabilization current at zero resistance is equal to the maximum current of the field-effect transistor (Table 1).

TABLE 1 THE DEPENDENCE OF THE STABILIZATION CURRENT ON THE EXTERNAL RESISTANCE

R_T ,Ом	S_{st} ,мА	R_T ,Ом	S_{st} ,мА
0	6,31	1000	1,27
100	4,40	1500	0,96
200	3,45	2000	0,80
400	2,45	3000	0,53
700	1,70	4000	0,44

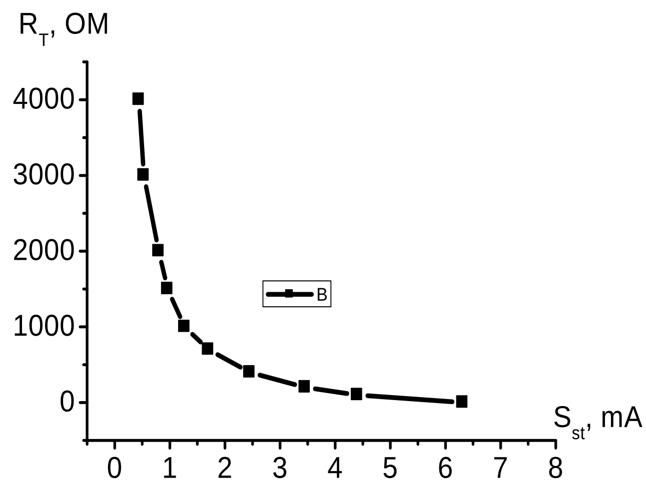

Figure 2. -dependence of stabilization current on external resistance

As the external resistance increases, the stabilization current decreases. For example, at a resistance of 200 Ohms, the stabilization current is 3.45, which is generated at a closing voltage of 0.8V. At a resistance of 400 Ohms, the current corresponds to a voltage of 0.1V.

The dependence of the stabilizing current on the resistance can be explained as follows: the external resistance of the controller, together with the channel of the field-effect transistor, resembles a voltage divider that closes the channel. As a result, the voltage drops proportional to the value of the resistance, and the current remains controlled according to the value of the resistance. The correspondence of the volt-ampere characteristic lines can be explained by the fact that in both modes the same voltage is present in the circuit.

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