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***Journal of Scientific and Engineering Research*, 2017, 4(2):76-77**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Features of the Current Regulation in Double-Transistor Circuit

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Abstract It is shown that in the double-transistor circuit on field-effect transistors current regulation factor is increased by order of magnitude compared with the known circuits.

Keywords current regulation, field-effect transistors, pinch-off voltage, dynamic load.

Introduction

In order to ensure efficient operation of semiconductor sensors in low-power electronic circuit stable voltage or current sources are required. In this aspect, the field -effect transistors are more versatile. In particular, they can be used to design stabilizing devices with controlled current [1, 2]. For this purpose, we have used silicon field-effect transistors with a maximum drain current in the range *1÷5 mA* and pinch-off voltage *– 0.6÷4 V*.

It is known that by varying the gate voltage the output characteristics of the field-effect transistors can be controlled. Accordingly, with zero bias at the gate when the source is short-circuited directly to the gate (fig. 1a), field-effect transistors allow for regulation of the current with a maximum value. By adding the resistance between the source and the gate is possible to control the regulation current, which also contributes to slight improvement in stabilization of the current, fig. 1b. This paper shows that the replacement of this resistance to field-effect transistor will significantly improve the current regulation factor, fig. 1c.

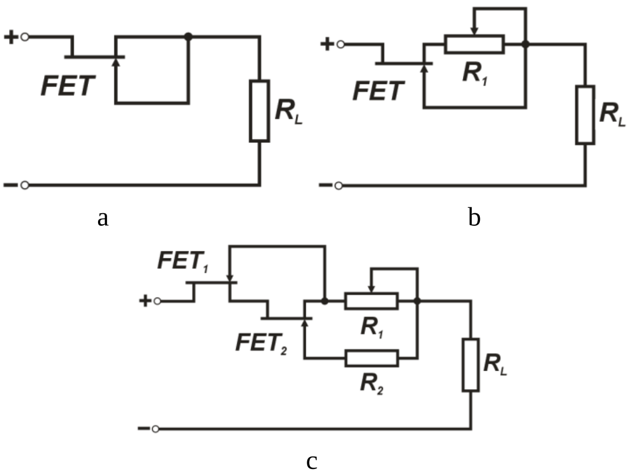
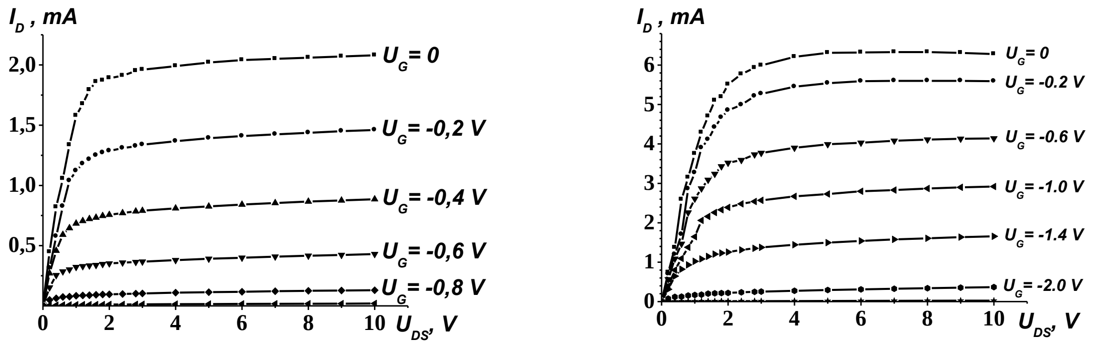


Figure 1: Current regulators on field-effect transistors

The saturation region with the highest dynamic resistance allows in the range from the saturation voltage to pre-breakdown voltages to obtain a high current regulation factor

$$K = \frac{1}{I_{reg}} \frac{I_{\max} - I_{\min}}{U_{\max} - U_{\min}}. \quad (1)$$

With reference to field-effect transistors shown in fig. 2, at their inclusion to the circuit according to fig. 1a and at current *1.5 mA*, current regulation factor is, respectively, *1.27 %/V* and *2.48 %/V*.



a **b**

Figure 2: Drain current-voltage characteristics of filed-effect transistors with different pinch-off voltage

In double-transistor circuit (fig. 1c) current variations on the voltage across the saturation region is significantly reduced, i.e. the current stability is improved, fig. 3. In this scheme by resistance R_2 operating current can be chosen. The pinch-off voltage of the gate transistor (FET_2) should be less than pinch-off voltage of the drain transistor (FET_2), fig. 1c and fig. 2.

With reference to field-effect transistors shown in fig. 2, at their inclusion to the circuit according to double-transistor circuit (fig. 1c) and at current *1.5 mA*, current regulation factor is *0.2 %/V,* which is higher by order of magnitude compared with the other circuits.

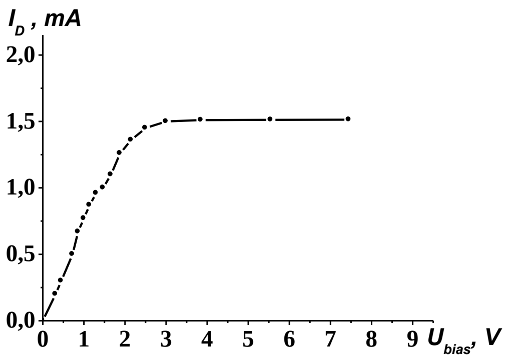


Figure 3: Dependence of drain current of double-transistor circuit from bias voltage

On the basis of this circuit is possible to design devices for the precise investigations of the current-voltage characteristics of Zener diodes, transient voltage suppressors and structures with non-linear current-voltage characteristics, as well as to develop a power sources with a constant current for the temperature sensors, LEDs, the strain gauges.

References

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