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A double-transistor cell on the basis of field-effect transistors

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Abstract: An alternating signal amplifier is proposed based on a double-transistor cell on field-effect transistors, wherein the simultaneous modulation of two series-connected channels lead to an increase in the gain. The gain is independent from value of the input signal, and is determined by inclusion circuitry.

Keywords: *field-effect transistors, voltage amplifier, dynamic load.*

The famous cascades with dynamic load on the field effect transistor have a low gain. This is caused by that primary transistor is connected in this circuits as a common source, and an additional transistor (dynamic load) as a current regulator. This results in a source follower, with his usual low gain [1].In order to increase the gain of the cascade with dynamic load, to eliminate the distortions of the desired signal and to extend functional capabilities a double-transistor cell is invited (fig. 1) [2], wherein, unlike the circuit with dynamic load [3], gate terminal of the additional transistor is disconnected from the source terminal and the source terminal is connected to the gate terminal of the primary transistor. As a result, by the input signal the two series-connected channels are simultaneously modulated, that has allowed increasing the gain.

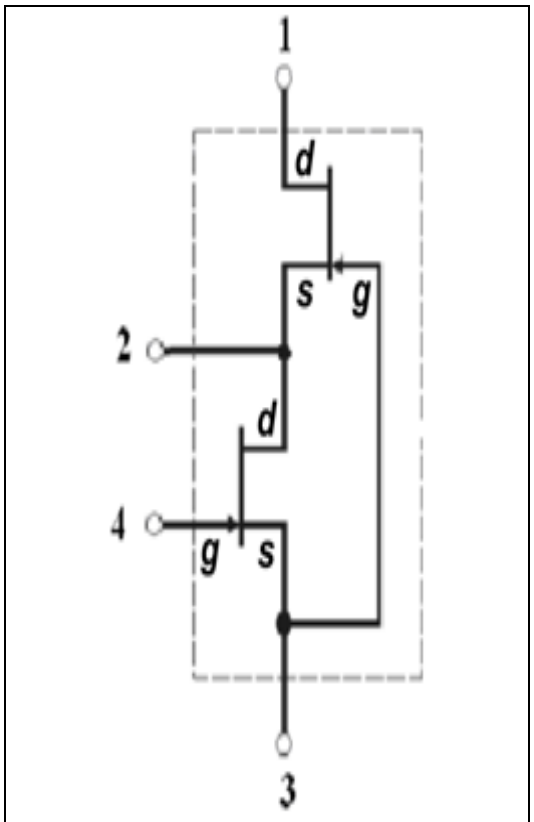
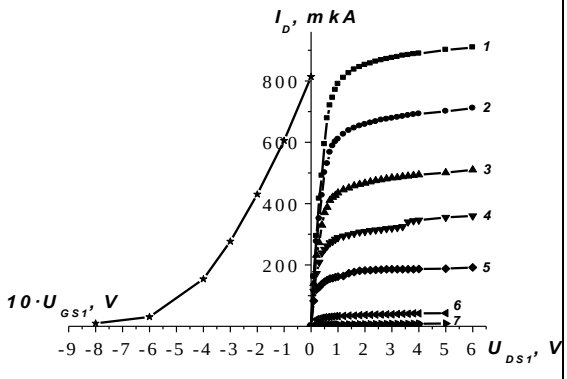


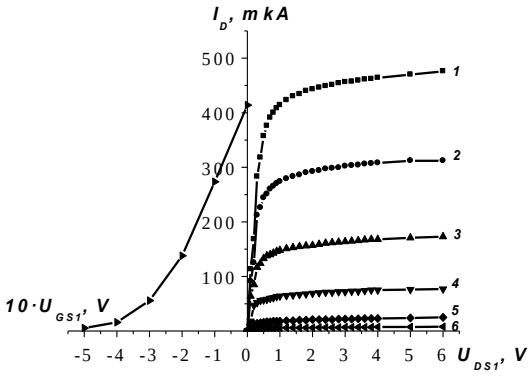
Fig. 1. Double-transistor cell

Creating a common contact to the source and gate regions of the primary transistor reduces the series resistance of the source and gate regions, excluding the input signal loss. This opens the possibility of its use as a stabilized current generator. Pinch-off voltage of the primary field-effect transistor is 0.8 V with a negative temperature coefficient and in additional field-effect transistor is 0.5 V - with a positive coefficient that provides a thermally stable mode, fig. 2.



a) in various gate voltages:

1-0; 2-(-0.1)V; 3-(-0.2)V; 4-(-0.3)V; 5-(-0.4)V; 6-(-0.6)V; 7-(-0.8)V



b) in various gate voltages:

1-0; 2-(-0.1)V; 3-(-0.2)V; 4-(-0.3)V; 5-(-0.4)V; 6-(-0.5)V

Fig. 2. Transfer and drain characteristics of silicon field-effect transistors

Circuit with common drain, fig. 3, as an alternating signal amplifier, operates as follows.

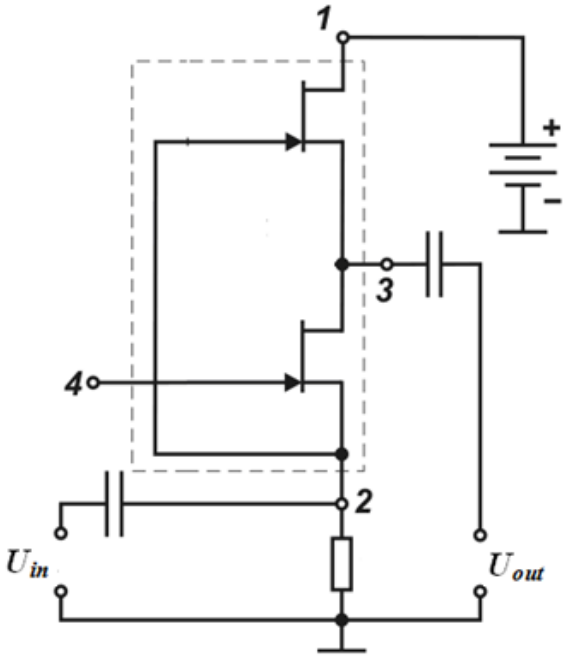


Fig. 3. An alternating signal amplifier with common drain

To drain terminal of the primary transistor positive bias voltage is applied, and to source terminal of the additional transistor negative bias voltage is applied through a resistor, for example, 9 V. To the input of the circuit, through the capacitor to the source terminal, AC voltage of input signal is fed and from the output terminal of the circuit the transformed signal is taken through the capacitor. As compared with the amplifier with dynamic load the double-transistor cell has a higher gain.An alternating signal amplifier with high gain on circuit with common source, fig. 4, operates as follows.

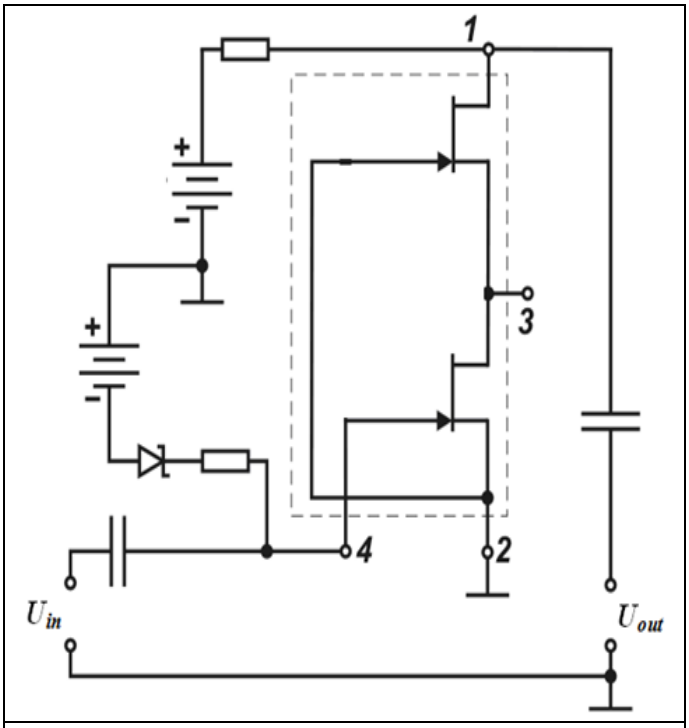


Fig. 4. An alternating signal amplifier with common source

To the drain of the primary transistor positive bias voltage is applied through the load resistor, and to the source of the additional transistor negative bias voltage is applied, for example, 9 V. On the one hand to the gate of the additional transistor blocking voltage equal to half of the pinch-off voltage of the additional transistor is applied through a resistor and Zener diode. On the other hand to the gate terminal alternating input signals is fed through the capacitor. The amplified output signal is taken through the capacitor from the drain load resistor of the primary transistor. As compared with the known circuit proposed cascade with a dynamic load in this inclusion mode has two orders of magnitude higher gain due to the simultaneous modulation of two series-connected channels, as shown in Table 1.

Table 1Data on input and output signals and gain of the alternating signal amplifier

An alternating signal amplifier with common drain (fig. 3)						
U_{IN}, mV	1	5	10	50	100	200
U_{OUT}, mV	4	20	40	200	400	800
K_G	4	4	4	4	4	4
An alternating signal amplifier with common source (fig. 4)						
U_{IN}, mV	1	2	4	6	8	10
U_{OUT}, mV	100	200	400	600	800	1000
K_G	100	100	100	100	100	100

Extension of the functional capabilities a double-transistor cell is invited (fig. 1) [2], wherein, unlike the circuit with dynamic load [3], gate terminal of the additional transistor is disconnected from the source terminal and the source terminal is connected to the gate terminal of the primary transistor. Enhancing the functionality of the amplifier based on cascade with a dynamic load in contrast to known analogs [1, 3] is achieved through the disconnection of gate terminal of additional transistor from the source terminal and connect the gate terminal of primary transistor to the source terminal of the additional transistor. As a result, by the input signal the two series-connected channels are simultaneously modulated, and the amplifying properties are improving. Moreover, this double-transistor cell representing a cascade with a dynamic load at the appropriate modernization can also be used to convert the input signal of low and medium power without distortions or losses.

CONCLUSIONS

A double-transistor cell is developed based on an automatic displacement mode, wherein the simultaneous modulation of two series-connected channels lead to an increase in the gain. The gain is independent from value of the input signal, and is determined by inclusion circuitry.

REFERENCES

[1] *Patent of Russian Federation* №2024111.
[2] *Patent of Republic of Uzbekistan* IAP№05322.
[3] A.G. Milehin. *Radio-technical circuits on field-effect transistors* (Energy, 1976).