SZÉCHENYI ISTVÁN EGYETEM
AUDI HUNGÁRI JÁRMŰMÉRNÖKI
KAR

CHARACTERIZATION OF AN METAL–OXIDE–SEMICONDUCTOR FIELD-EFFECT TRANSISTOR (MOSFET)

Measurement practice III.

FOR VEHICLE ENGINEER STUDENTS

Version: 1.1

Széchényi István University
Department of Power Electronics and Drives

1. Introduction

This measurement exercise examines the characterization of an N-type MOSFET transistor.

1.1 Objectives

1.2 Required instruments and components

- power supply (see Fig. 1.);
- resistor table (see Fig. 2.);
- semiconductor table (see Fig. 3.);
- digital multimeters;
- measuring cables (to the power supply and multimeter).

Fig.1. Power supply (TP-2303)

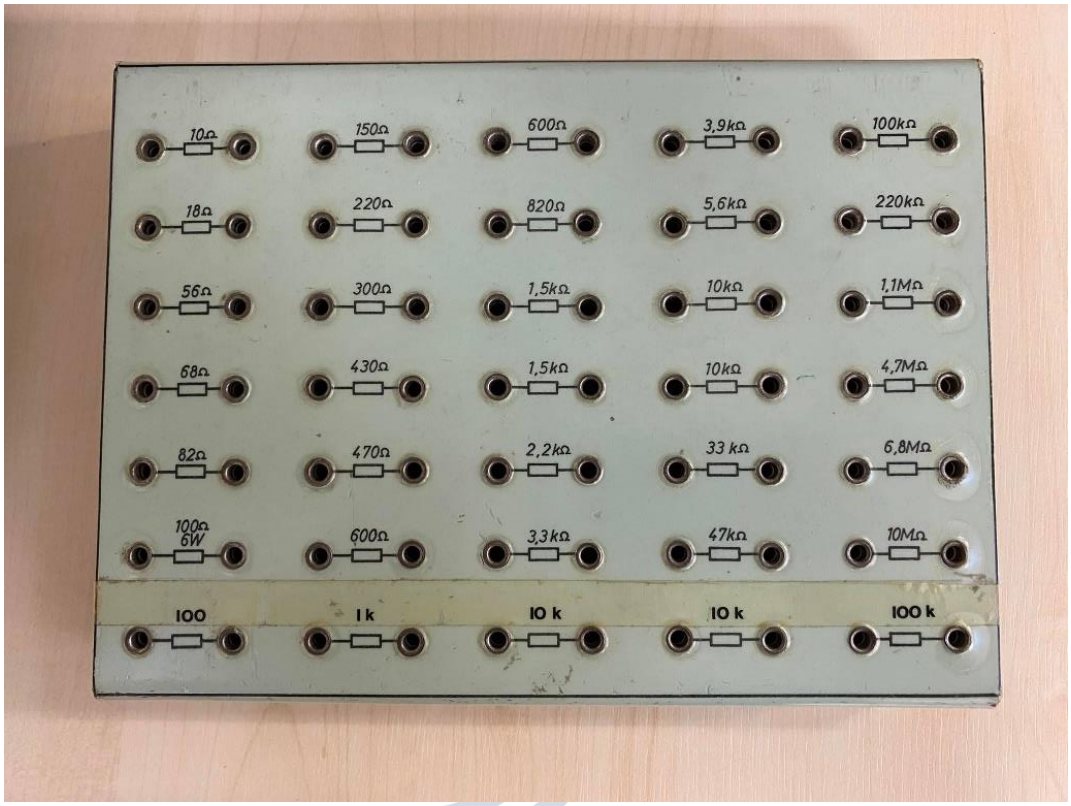

Fig.2. Resistor table

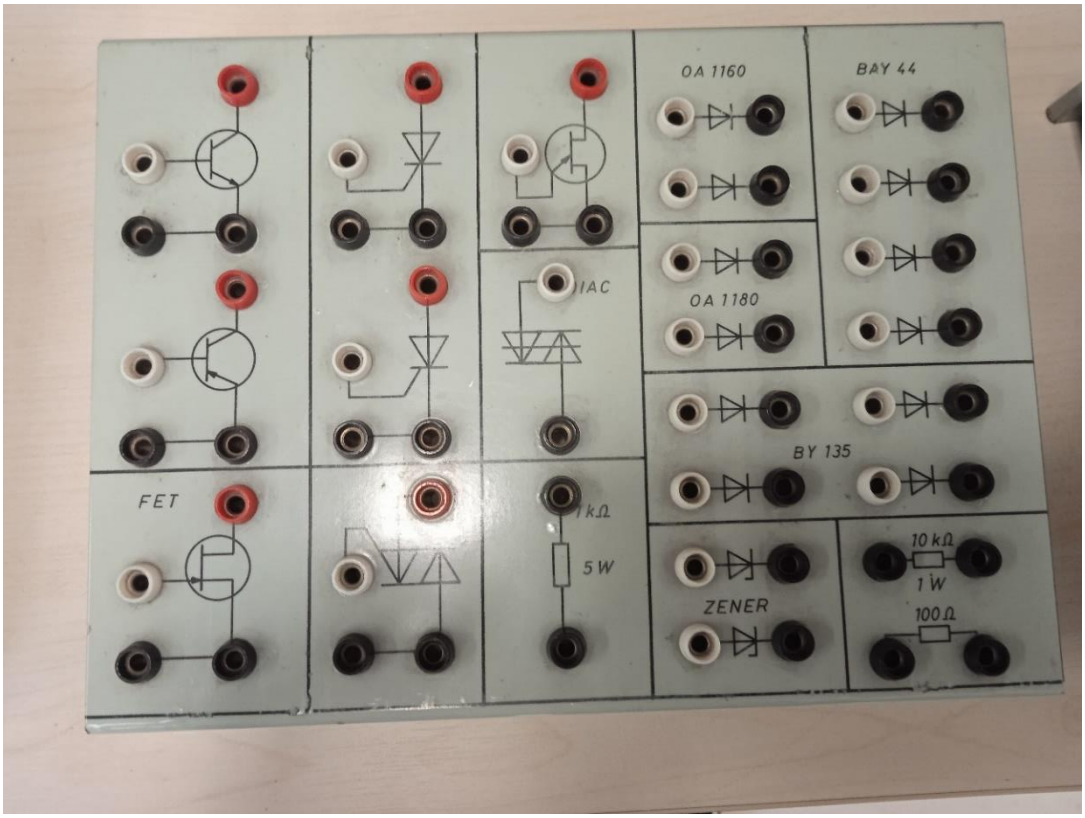

Fig.3. Semiconductor table

3. Measurement exercises, wiring diagrams

The circuit diagram of measurement is shown in Fig. 4. The visual connection of the power supply and the measuring instrument is shown in Fig. 5 and 6. As shown in Fig. 6, the right output of the power supply provides the drain (output) voltage and the left output provides the gate-source voltage.

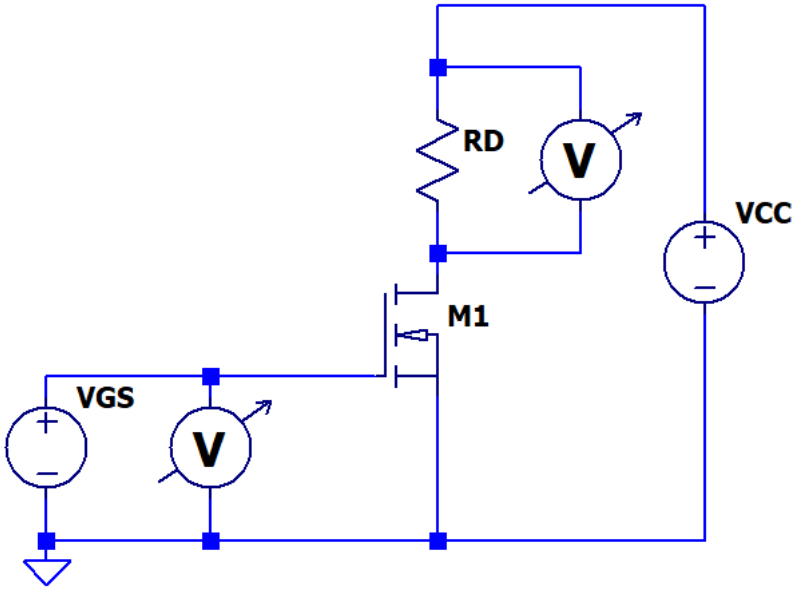

Fig.4. Circuit diagram

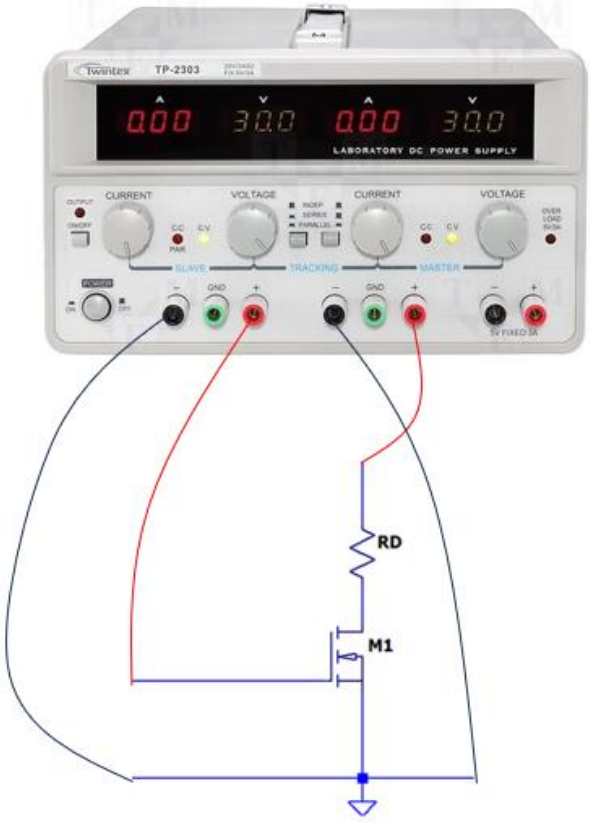

Fig.5. Connecting power supply

During the measurement exercise, the voltage of the gate-source (V_{GS}) and the drain resistance (RD) are measured by a digital multimeter (see Fig. 6.)

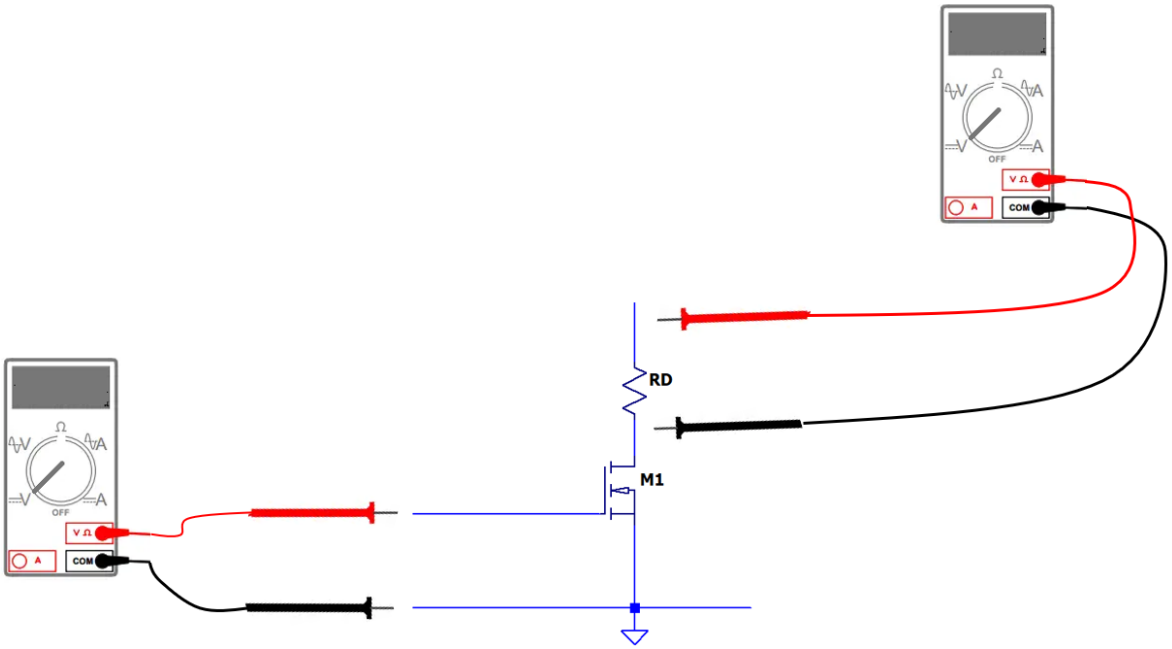

Fig.6. Connecting power supply

The steps of measurement:

1. Build the circuit depicted in Fig. 4. using the N-type MOSFET (Fig. 6. help!). Choose a value of 100Ω for the RD resistance!
2. Adjust the CH2 of the power supply to 2,8V (it is the gate - source voltage (V_{GS})). Adjust the current limit to 0.5A!
3. Adjust the CH1 of the power supply to 0V. Adjust the current limit to 0.5A!
4. Check the gate-source voltage (V_{GS}) with a digital multimeter. Record VGS before the Table 1. (once during the measurement)
5. Use a digital multimeter to measure the voltage at resistor R_D. From this, you can later calculate the drain (I_D) current and drain - source (V_{DS}) voltage and the other data!
6. Record V_{RD} in Table 1.
7. Repeat steps 5. – 6. above, with different supply voltage. Use the values given in Table 1!

5. Measurement results

Table 1. shows the measurement results and calculated values. Of the values in Table 1, Vcc is a set value, V_{RD} is a measured value, and the others are calculated values. After the calculations, determine the operating mode of MOSFET!

Type of the measured MOSFET is: IRL630. You can see below this part of the datasheet:

$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	2	3	4	V

Use 2,5V as the gate threshold voltage in your calculations! The applied gate - source voltage (as before) is equal to 2,8V.

Table 1. Results of the measurement

Vcc [V]	V_{RD} [V]	I_D [mA]	V_{DS} [V]	Operation mode
0	0	0	0	cut - off
0.5				
1				
1.5				
2				
3				
4				
5				
6				
7				
8				
9				
10				

5.1 Necessary equations

$$V_{CC} = V_{RD} + V_{DS} \quad (1)$$

$$I_D = \frac{V_{RD}}{R_D} \quad (2)$$

The semiconductor is active region, if:

$$0 < V_{GS} - V_{GS(threshold)} < V_{DS} \quad (3)$$

The semiconductor is cut-off region, if:

$$V_{GS} - V_{GS(threshold)} < 0 \quad (4)$$

The semiconductor is in saturation (ohmic) region if:

$$0 < V_{DS} < V_{GS} - V_{GS(threshold)} \quad (5)$$

Plot the output characteristics of the MOSFET ($I_D - V_{DS}$)!

6. Conclusions