

# MOSFET LOGIC CIRCUITS

## I. OBJECTIVES

- Finding out the logic function of some circuits with MOSFET,
- Lightning a 7-segment display.

## II. COMPONENTS AND INSTRUMENTATION

You will use a breadboard, n-channel IRFZ24N MOSFETs, 5161AS 7-Segment Display and resistors. Because you will apply and measure dc voltages you will need a dc regulated voltage supply and a digital multimeter.

## III. PREPARATION

### 1.P. Logic inverter with MOSFET

The following logic convention is used: the high level of the voltage – “1” logic, the low level of the voltage – “0” logic.

For the n-channel IRFZ24N MOSFET, what is the value of the threshold voltage,  $V_{Th}$ , and of  $\beta$ , according with the datasheet?

#### 1.1.P Logic function

- Find the logic function of the circuit from Fig. 1.

### 2.P. NAND logic circuit

- What is the electrical operating table for the circuit in Fig. 2?  $v_A, v_B \in \{0V, 5V\}$ . What are the states (off or extreme conduction) of transistors  $T_A$  and  $T_B$  for all possible combinations of values of  $v_A$  and  $v_B$ ?
- What is the truth table for the circuit in Fig. 2?

### 3.P. NOR logic circuit

- What is the electrical operating table for the circuit in Fig. 3?  $v_A, v_B \in \{0V, 5V\}$ . What are the states (off or extreme conduction) of transistors  $T_A$  and  $T_B$  for all possible combinations of values of  $v_A$  and  $v_B$ ?
- What is the truth table for the circuit in Fig. 3?

### 4.P. 7-Segment display

- For 5161AS 7-Segment Display identify the pinout diagram from the datasheet or from Fig. 4. Is the 7-Segment Display with common anode or common cathode?
- Fill in the table with 0/1 values and draw the schematics for displaying digits **1** and **8**.

Table 1

	A	B	C	D	E	F	G	DP
Digit <b>1</b>								
Digit <b>8</b>								

- Propose a new schematic, with a MOSFET n type transistor, to control the frequency of the digit.
- Compute a suitable value for resistors to obtain maximum 20 mA forward current per segment.

## IV. EXPLORATION AND RESULTS

### 1. Logic inverter with MOSFET

#### 1.1. Logic function

##### Exploration

Build the circuit in Fig. 1.

- Apply  $v_A \in \{0V; 5V\}$ , obtained from the dc power supply.
- Measure  $v_Y$  with the dc voltmeter for all possible combinations of the input voltage.

##### Results

- The truth table in which A and Y are the input and output logic variables.
- What is the logic function of the circuit?

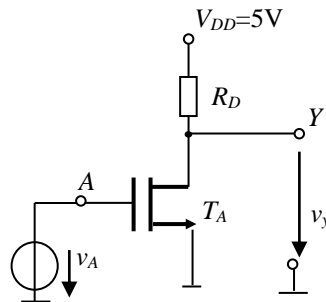


Fig. 1. Logic inverter with MOSFET

### 2. NAND logic circuit

#### Exploration

Build the circuit in Fig. 2.

- $v_A, v_B \in \{0V; 5V\}$  in all possible combinations
- Measure  $v_Y$  with the dc voltmeter for all possible combinations of the two input voltages.

#### Results

- Electrical operating table containing  $v_A, v_B, v_Y$ , the off or exc states of  $T_A$  and  $T_B$  for the 4 possible combinations of  $v_A$  and  $v_B$  values from  $\{0V; 5V\}$
- Truth table with A, B logic inputs and Y logic output
- Is the logic function the same as the one determined at 2.P.?

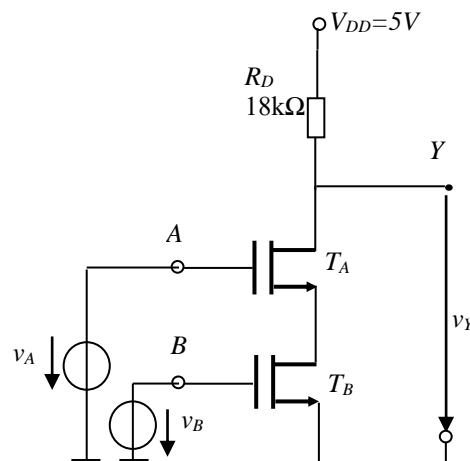


Fig. 2. NAND logic circuit

### 3. NOR logic circuit

#### Exploration

Build the circuit in Fig. 3.

- $v_A, v_B \in \{0V;5V\}$  in all possible combinations
- Measure  $v_Y$  with the dc voltmeter for all possible combinations of the two input voltages.

#### Results

- Electrical operating table containing  $v_A, v_B, v_Y$ , the off or exc states of  $T_A$  and  $T_B$  for the 4 possible combinations of  $v_A$  and  $v_B$  values from  $\{0V;5V\}$
- Truth table with A, B logic inputs and Y logic output
- Is the logic function the same as the one determined at 3.P.?

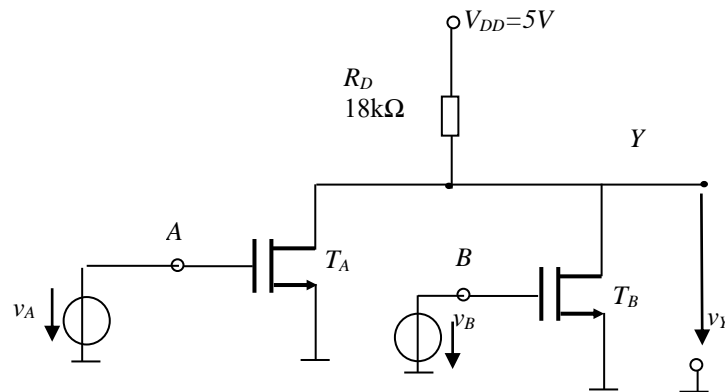


Fig. 3. NOR logic circuit

### 4. 7-Segment display

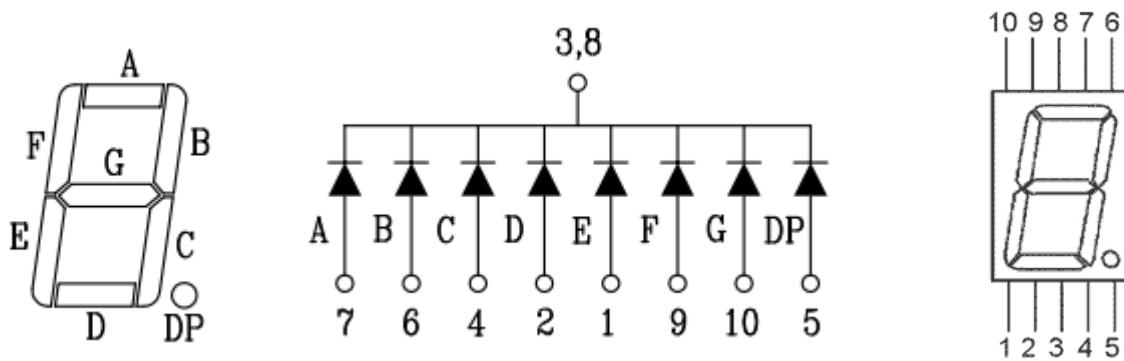


Fig. 4. The 7-Segment display [4]

#### Exploration

- Build the circuit proposed at 4.P to display the digit 1.
- Display all digits from 0 to 9, and DP.
- Using the MOSFET n type transistor, modify the circuit to control the frequency of the displayed digit, from 1 Hz to 100 Hz.

**Results**

- Table containing 0/1 values for displaying digit **0**. What are the electric values corresponding to **0** and **1**?
  - What is the maximum frequency to detect the flicker of the digits?

**REFERENCES**

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