# MOSFET LOGIC CIRCUITS

## I. OBJECTIVES

a) Finding out the logic function of some circuits with MOSFET

## II. COMPONENTS AND INSTRUMENTATION

You will use the experimental assembly built with n-channel IRFZ24N MOSFETs and resistors. Because you will apply and measure both dc and ac voltages you will need a dc regulated voltage supply, a signal generator, a digital multimeter and a dual channel oscilloscope

## 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.

**1.2.P VTC**

- Plot the VTC $v_Y(v_A)$ for the circuit in 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. AND 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. NOR logic circuit

- What is the electrical operating table for the circuit in Fig. 4? $v_A$, $v_B \in \{0V, 5V\}$. 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. 4?

### 5.P. OR logic circuit

- What is the electrical operating table for the circuit in Fig. 5? $v_A$,$v_B \in \{0V, 5V\}$. 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. 5?

# IV. EXPLORATION AND RESULTS

## 1. Logic inverter with MOSFET

### 1.1. Logic function

**Exploration**

Build the circuit in Fig. 1.

- At input A, apply a TTL signal with 1kHz frequency obtained from the signal generator.
- Using the calibrated oscilloscope in the Y-t mode you will visualise $v_A(t)$ and $v_Y(t)$.

**Results**

- $v_A(t)$, $v_Y(t)$.
- The truth table in which A and Y are the input and output logic variables.
- What is the logic function of the circuit?

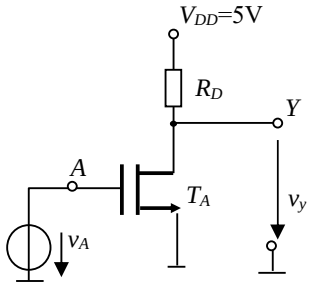


Fig. 1. Logic inverter with MOSFET

### 1.2. VTC

**Exploration**

Use the circuit in Fig. 1.

- $v_A(t)=5\sin(2\pi\ 1000t)$ [V] [Hz]
- Using the oscilloscope in the Y-X mode you will visualise the VTC $v_Y(v_A)$

**Results**

- VTC $v_Y(v_A)$. What is the value of the threshold voltage, based on the VTC from the oscilloscope?

## 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.?

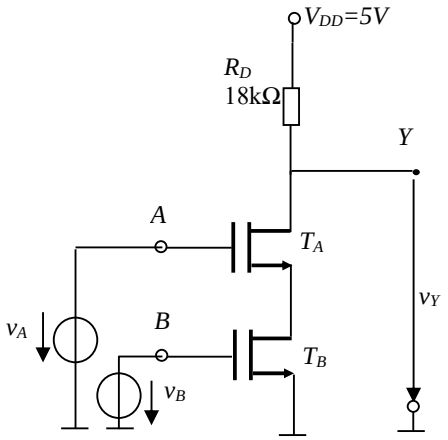

Fig. 2. NAND logic circuit

## 3. AND 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 $T_A$, $T_B$, $T_C$ 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.?

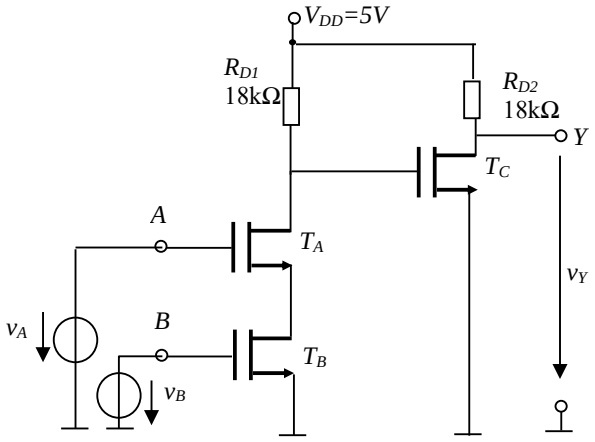

Fig. 3. AND logic circuit

## 4. NOR logic circuit

**Exploration**

Build the circuit in Fig. 4.

- $v_A$, $v_B \in \{0V;5V\}$ 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 4.P.?

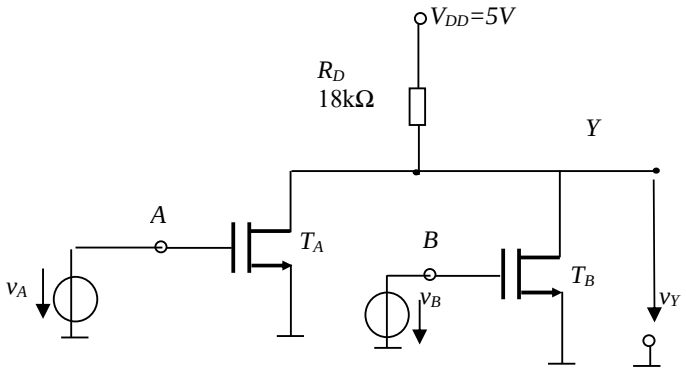


Fig. 4. NOR logic circuit

## 5. OR logic circuit

### Exploration

Build the circuit in Fig. 5.

- $v_A$, $v_B \in \{0V;5V\}$ 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 $T_A$, $T_B$, $T_C$ 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 5.P.?

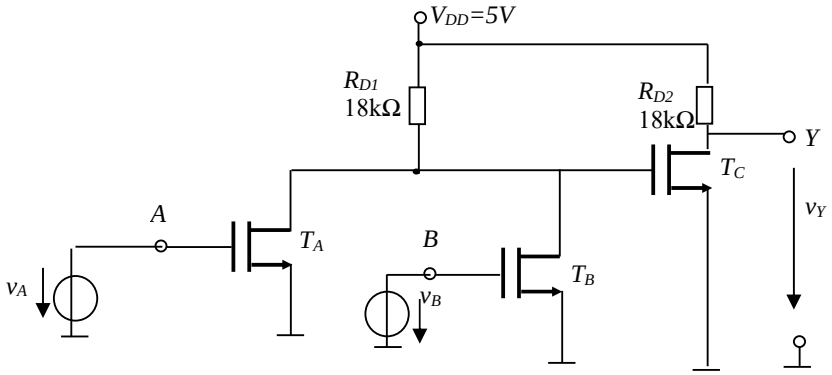


Fig. 5. OR logic circuit


**REFERENCES**

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