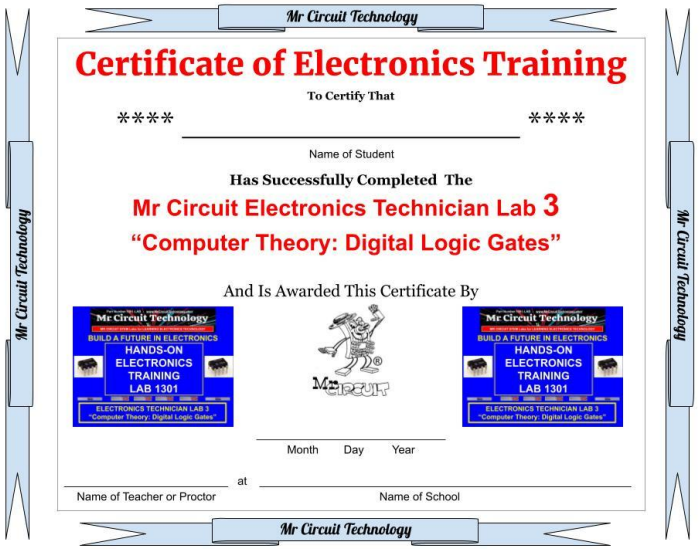
COVER

This is the *FOURTH* lesson in the

# MR CIRCUIT LAB 3.




**COMPLETE THIS LAB 3 AND EARN A CERTIFICATE OF ELECTRONICS TRAINING**

**LAB 3: Computer Theory: Digital Logic Gates**

04 00 COVER 1301-SL4



## Basic Electronics
## LAB 3
## Digital Logic Gates for future Engineers and Techs

# Lesson 4

# The 'NAND' Logic Gate


**There are 3 pages. Start with Page 1 at the center of this booklet.**

Booklet Number 1301-SL4



MR CIRCUIT ELECTRONICS TRAINING LAB

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# Introduction to Digital Logic Gates "The 'NAND' Logic Gate"



The **'NAND' Logic Gate** is really the **inversion** of the 'AND' Logic Gate. The 'NAND' is the **complement** of the "AND' logical operation. It is like putting a 'NOT' Gate on the output of an 'AND' Gate. It has two inputs and there are 4 possible combinations on these inputs as shown in the Truth Table below.

Here is the symbol for a 'NAND' Logic Gate

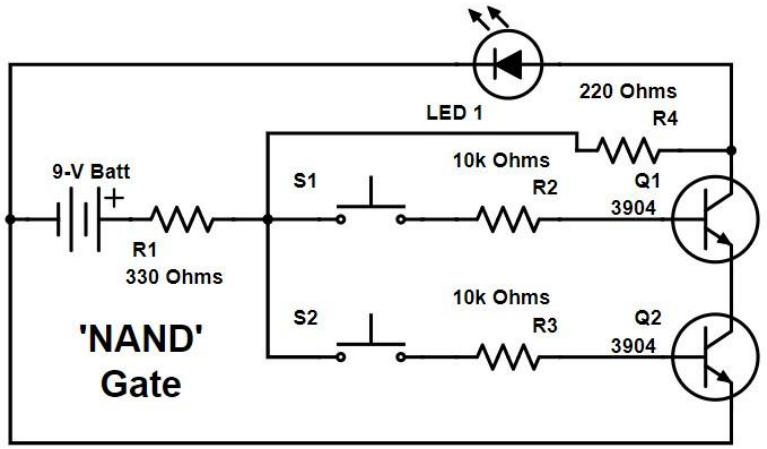

Here is the Truth Table for both the 'AND' and the 'NAND' Logic Gates so you can compare them.

| Truth Table for the 'AND' Gate | | |
|---|---|---|
| Input A | Input B | Output Q |
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

| Truth Table for the 'NAND' Gate | | |
|---|---|---|
| Input A | Input B | Output Q |
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |


**LAB 3: Computer Theory: Digital Logic Gates**

Here is a schematic of an electronic circuit that performs the function of a 'NAND' Logic Gate.




**Explanation of the circuit:** When you connect power to this 'NAND' Logic circuit, the LED will light up by current flowing from the Negative of the battery through the LED, then through R4 and R1 to the Positive of the battery.

In order to shut off the LED, you have to forward-bias both transistors Q1 and Q2 at the same time to basically short the Anode of the LED to the negative side of the battery. That happens when your press S1 and S2 simultaneously.

As you can see, this circuit acts like an 'NAND' Logic Gate, that is, both inputs have to be True for the output to be False, which is the opposite of an 'AND' Logic Gate.

Now, use the QR Code to watch video Lesson 4. Then, using pages 2 and 3 in this booklet, build a 'NAND' Logic Gate circuit.

PAGE 1

# Step-by-Step Assembly Guide for "The 'NAND' Logic Gate"



**Step 1:** Follow these steps carefully to build the **'NAND'** Logic Gate.

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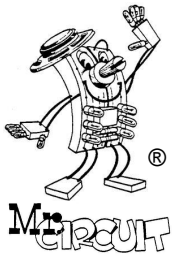
**Step 2:** Find the Experiment Parts Bags for the Mr Circuit Lab 3

**Step 3:** Take out the following parts needed to build the **'NAND'** Logic Gate:

- one Solderless Circuit Board
- one 9-Volt Battery Snap
- one LED (Light Emitting Diode)
- one 220 Ohm resistor (Red, Red,, Brown, Gold)
- one 330 Ohm resistor (Orange, Orange, Brown, Gold)
- two 10,000 (10k) Ohm resistors (Brown, Black, Orange, Gold)
- five Jumper Wires
- two NPN Transistors (3904)
- two Normally-Open Pushbutton Switches

**Step 4:** Now, using the Pix of the Assembled Circuit on Page 3, install all the parts on the Solderless Circuit Board in this order.

__ **Install** the NPN transistor Emitter in 7b, Base in 6b, Collector in 5b
__ **Install** the NPN transistor Emitter in 7g, Base in 6g, Collector in 5g
__ **Install** the LED, Cathode in 4a, Anode in 5a
__ **Install** a 220 Ohm resistor in 14e to 5d
__ **Install** a 330 Ohm resistor in 14a to Positive Buss
__ **Install** a 10,000 Ohm resistor in 10j to 6i
__ **Install** a 10,000 Ohm resistor in 10e to 6c
__ **Install** a Jumper Wire in 25d to 7j
__ **Install** a Jumper Wire in 14c to 12f
__ **Install** a Jumper Wire in 5h to 7d
__ **Install** a Jumper Wire in 4b to Negative Buss
__ **Install** a Jumper Wire in 14b to 12a
__ **Install** the Battery Snap, Red in Pos. Buss, Black in Neg. Buss
__ **Install** the two Normally-Open Pushbutton switches with 4 legs. Install the legs as shown here.




12d 14d
12b 14b

**Switch S1**

12i 14i
12g 14g

**Switch S2**

**Step 5:** Lightly touch the battery to the Battery Snap (Note: do not connect it, just touch it lightly.) The LED should light up. If it does not, then please check your wiring carefully and try again.

**Step 6:** With the battery connected, press Switch S1. Did the LED remain on? ____

**Step 7:** Press Switch S2, did the LED remain on? ____

**Step 8:** Now, press both switches at the same time forward-biasing both transistors. Did the LED turn off?_____ .

**Step 9:** Conclusion: You should have observed that this circuit works like an **inversion of an 'AND'** Logic Gate. When Switch S1 puts a HI on the Base of Q1, and Switch 2 puts a HI on the Base of Q2, the transistors are both forward-biased at the same time. This causes the LED to turn off indicating a _____ on the output of the 'NAND' Logic Gate.

You have now learned how an 'NAND' Logic Gate works and how to build one using electronic components. These are the same type of components used in today's digital circuits.

**Step 10:** Now, disassemble the circuit and put all the parts back into the plastic bag and go to the next lesson in this lab.

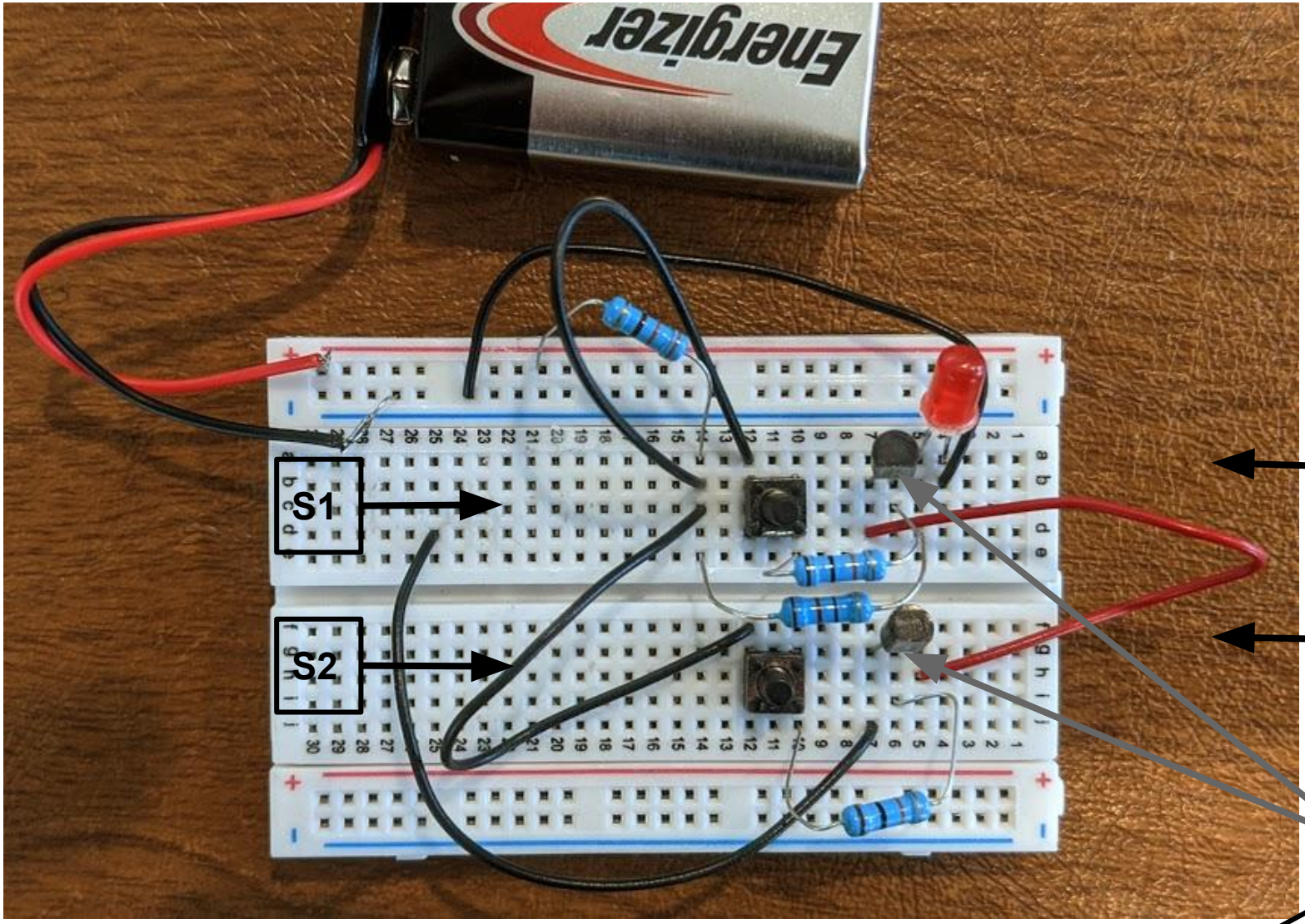
**LAB 3: Computer Theory: Digital Logic Gates**



PAGE 2

# Assembly Pix for Lesson 3 “The ‘NAND’ Logic Gate”






PAGE 3

**Lesson 3 - The ‘NAND’ Gate**