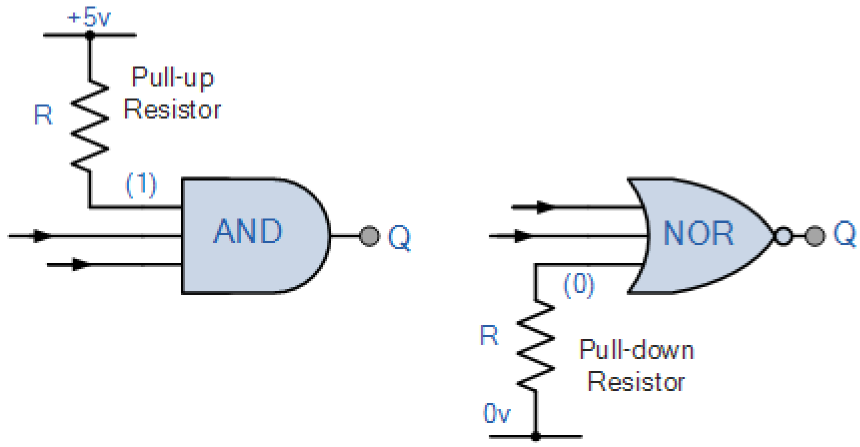


Digital Logic Gates Summary

There are three basic types of digital logic gates, the AND Gate, the OR Gate and the NOT Gate

We have also seen that each gate has an opposite or complementary form of itself in the form of the NAND Gate, the NOR Gate and the Buffer respectively, and that any of these individual gates can be connected together to form more complex **Combinational Logic** circuits.

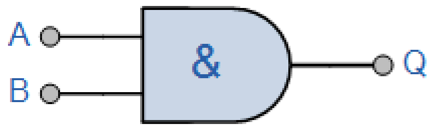
We have also seen, that in digital electronics both the NAND gate and the NOR gate can both be classed as "**Universal**" gates as they can be used to construct any other gate type. In fact, any combinational circuit can be constructed using only two or three input NAND or NOR gates. We also saw that NOT gates and Buffers are single input devices that can also have a **Tri-state** High-impedance output which can be used to control the flow of data onto a common data bus wire.

Digital Logic Gates can be made from discrete components such as Resistors, Transistors and Diodes to form **RTL** (resistor-transistor logic) or **DTL** (diode-transistor logic) circuits, but today's modern digital 74xxx series integrated circuits are manufactured using **TTL** (transistor-transistor logic) based on NPN bipolar transistor technology or the much faster and low power CMOS based MOSFET transistor logic used in the 74Cxxx, 74HCxxx, 74ACxxx and the 4000 series logic chips.

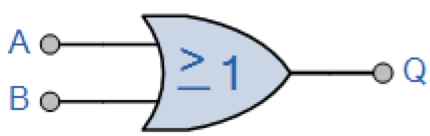
The eight most "standard" individual **Digital Logic Gates** are summarised below along with their corresponding truth tables.

Standard Logic Gates

The Logic AND Gate

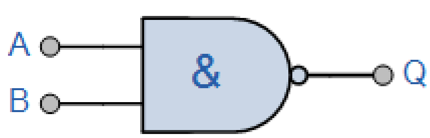
<table>
<tr><th>Symbol</th><th colspan="3">Truth Table</th></tr>
<tr><td rowspan="5">
2-input AND Digital Logic Gate</td><td>B</td><td>A</td><td>Q</td></tr>
<tr><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>0</td></tr>
<tr><td>1</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Boolean Expression Q = A.B</td><td colspan="3">Read as A AND B gives Q</td></tr>
</table>

The Logic OR Gate

<table>
<tr><th>Symbol</th><th colspan="3">Truth Table</th></tr>
<tr><td rowspan="5"></td><td>B</td><td>A</td><td>Q</td></tr>
<tr><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Boolean Expression Q = A + B</td><td colspan="3">Read as A OR B gives Q</td></tr>
</table>

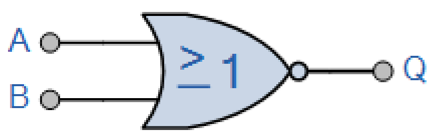
Inverting Logic Gates

The Logic NAND Gate

<table>
<tr><th>Symbol</th><th colspan="3">Truth Table</th></tr>
<tr><td rowspan="2"></td><td>B</td><td>A</td><td>Q</td></tr>
<tr><td>0</td><td>0</td><td>1</td></tr>
</table>

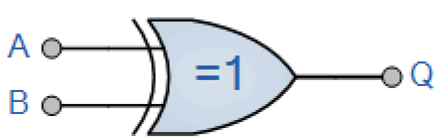
	0	1	1
	1	0	1
	1	1	0
Boolean Expression $Q = \overline{A . B}$	Read as A **AND** B gives **NOT** Q		

The Logic NOR Gate

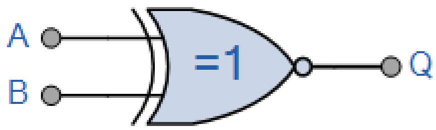
Symbol	Truth Table		
	B	A	Q
	0	0	1
	0	1	0
	1	0	0
	1	1	0
Boolean Expression $Q = \overline{A + B}$	Read as A **OR** B gives **NOT** Q		

Exclusive Logic Gates

The Logic Exclusive-OR Gate (Ex-OR)

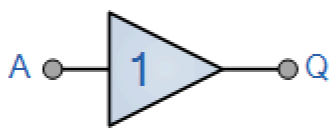
Symbol	Truth Table		
	B	A	Q
	0	0	0
	0	1	1
	1	0	1
	1	1	0
Boolean Expression $Q = A \oplus B$	Read as A **OR** B but not **BOTH** gives Q (odd)		

The Logic Exclusive-NOR Gate (Ex-NOR)

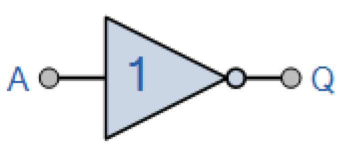
Symbol	Truth Table		
	B	A	Q
	0	0	1
	0	1	0
	1	0	0
	1	1	1
Boolean Expression Q = $\overline{A \oplus B}$	Read if A **AND** B the **SAME** gives Q (even)		

Single Input Logic Gates

The Hex Buffer

Symbol	Truth Table	
	A	Q
	0	0
	1	1
Boolean Expression Q = A	Read as **A** gives **Q**	

The NOT gate (Inverter)

Symbol	Truth Table	
	A	Q
	0	1
	1	0
Boolean Expression Q = not A or $\overline{A}$	Read as inverse of **A** gives Q	

The operation of the above **Digital Logic Gates** and their Boolean expressions can be summarised into a single truth table as shown below. This truth table shows the relationship between each output of the main digital logic gates for each possible input combination.

Digital Logic Gate Truth Table Summary

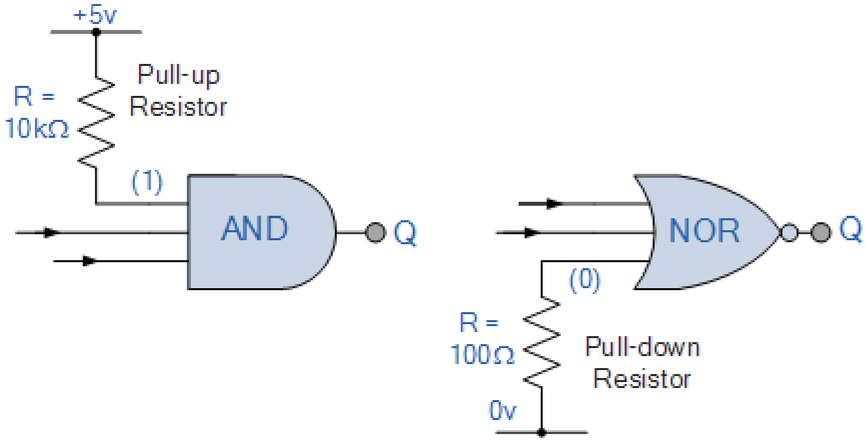
The following logic gates truth table compares the logical functions of the 2-input logic gates detailed above.

Inputs		Truth Table Outputs For Each Gate					
B	A	AND	NAND	OR	NOR	EX-OR	EX-NOR
0	0	0	**1**	0	**1**	0	**1**
0	1	0	**1**	**1**	0	**1**	0
1	0	0	**1**	**1**	0	**1**	0
1	1	**1**	0	**1**	0	0	**1**

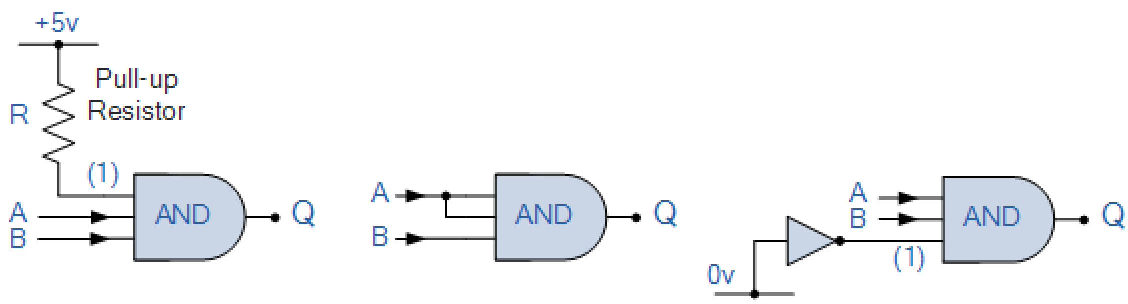
Truth Table Output for Single-input Gates		
A	NOT	Buffer
0	**1**	0
1	0	**1**

Pull-up and Pull-down Resistors

One final point to remember, when connecting together digital logic gates to produce logic circuits, any "unused" inputs to the gates must be connected directly to either a logic level "1" or a logic level "0" by means of a suitable "Pull-up" or "Pull-down" resistor (for example 1kΩ resistor) to produce a fixed logic signal. This will prevent the unused input to the gate from "floating" about and producing false switching of the gate and circuit.



As well as using pull-up or pull-down resistors to prevent unused logic gates from floating about, spare inputs to gates and latches can also be connected together or connected to left-over or spare gates within a single IC package as shown.



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P Poonam singh

Why the truth-table for digital logic is just opposite to the truth-table of symbolic logic?

Posted on October 12th 2018 | 8:55 am

Reply

W Wondimu

Helpful and interesting .

Posted on October 08th 2018 | 7:13 am

Reply

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k kisaka

nice tutorial it has been helpful.

Posted on September 27th 2018 | 10:23 am

Reply

A

Ammu

It is very useful but some more in depth is required

Posted on September 20th 2018 | 4:16 pm

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D

Dawood Bakhshi

It was very help for me.

Posted on September 18th 2018 | 8:04 am

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T

Titus

We need the real concepts of understanding this logic gates

Posted on March 23rd 2018 | 7:12 am

Reply

P

Prashant thakur

Are u preparing for up lt teacher computer teacher,if u doing this,please contact on 9675660968

Posted on April 05th 2018 | 11:52 am

Reply

V

Vaishnavi

Its clear but we need more information in depth about gates.

Posted on February 09th 2018 | 3:18 pm

Reply

S

Shravan Kumar

Very valuable material.

Posted on November 29th 2017 | 2:36 am

Reply

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h

hla myint.

Very helpful compilation of logic gates. thanks v. much.

Posted on August 17th 2017 | 11:49 pm

Reply

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h

handsen mulenga

Great, I need more and mre

Posted on April 16th 2017 | 6:27 am

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