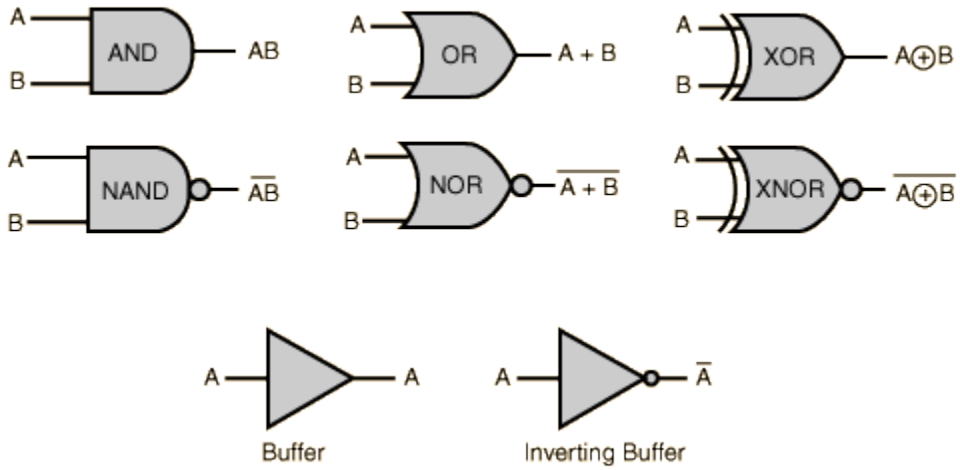
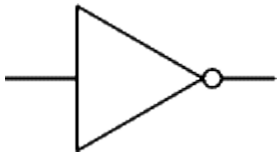
Digital Circuits

Logic Gates



NOT gate (Inverter)

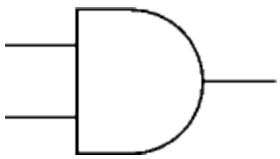
The output Q is true when the input A is NOT true, the output is the inverse of the input: **Q = NOT A**
A NOT gate can only have one input. A NOT gate is also called an inverter.



Input A	Output Q
0	1
1	0

AND gate

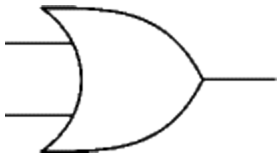
The output Q is true if input A AND input B are both true: **Q = A AND B**
An AND gate can have two or more inputs, its output is true if all inputs are true.



Input A	Input B	Output Q
0	0	0
0	1	0
1	0	0
1	1	1

OR gate

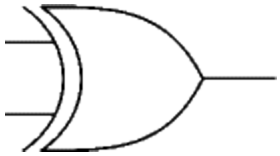
The output Q is true if input A OR input B is true (or both of them are true): **Q = A OR B**
An OR gate can have two or more inputs, its output is true if at least one input is true.



Input A	Input B	Output Q
0	0	0
0	1	1
1	0	1
1	1	1

EX-OR (EXclusive-OR) gate

The output Q is true if either input A is true OR input B is true, **but not when both of them are true**:
Q = (A AND NOT B) OR (B AND NOT A)
This is like an OR gate but excluding both inputs being true. The output is true if inputs A and B are **DIFFERENT**. EX-OR gates can only have 2 inputs.



Input A	Input B	Output Q
0	0	0
0	1	1
1	0	1
1	1	0

NAND/NOR/EX-NOR

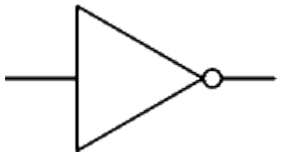
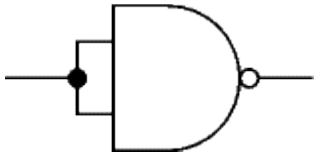
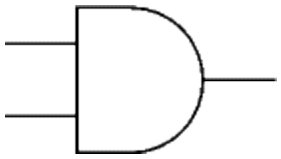
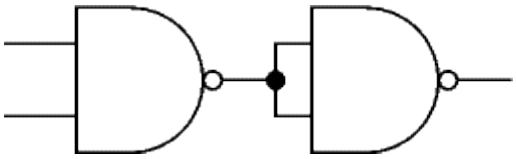
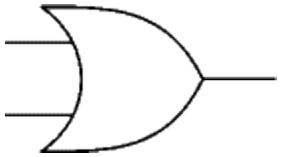
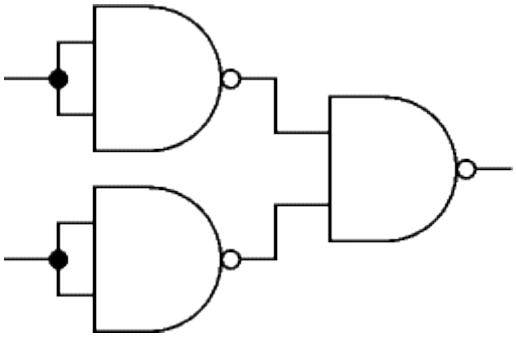
The outputs of these are just inverted form of the corresponding gate without the 'N' in the name.

Universal Gates

NAND and NOR gates possess a special property: they are universal. That is, given enough gates, either type of gate is able to mimic the operation of *any* other gate type. For example, it is possible to build a circuit exhibiting the OR function using three interconnected NAND gates. The ability for a single gate type to be able to mimic any other gate type is one enjoyed only by the NAND and the NOR. In fact, digital control systems have been designed around nothing but either NAND or NOR gates, all the necessary logic functions being derived from collections of interconnected NANDs or NORs.

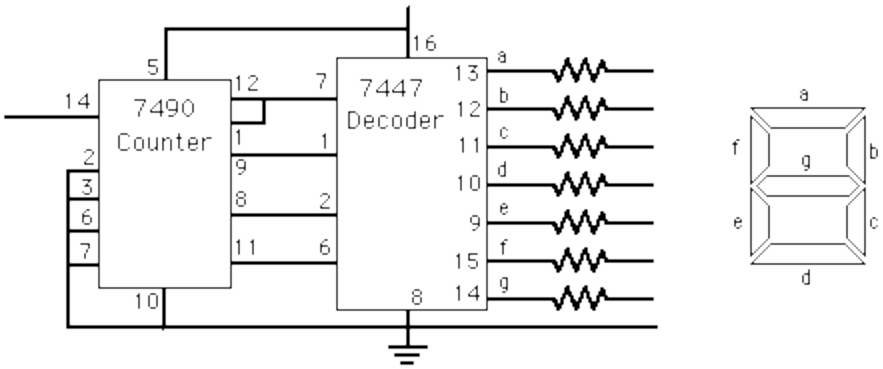
NAND gate equivalents

The table below shows how NOT, AND and OR gates are implemented using the **NAND** gate:

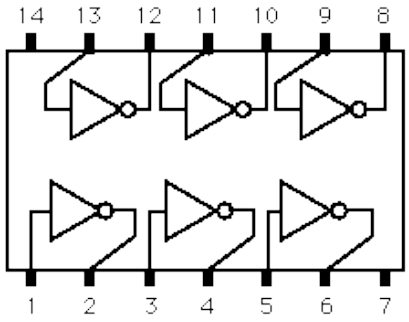
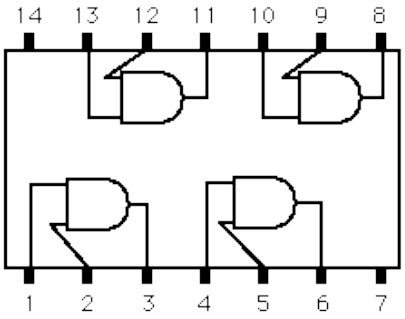
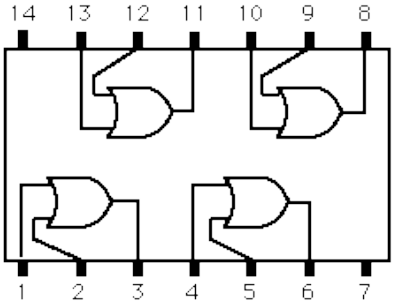
Gate		Equivalent in NAND gates
NOT		
AND		
OR		

Counter and Decoder

The 14-pin 7490 counter chip and the 16-pin decoder chip are often used together to drive 7-segment displays.



Pin Diagrams

NOT (7404)	**AND (7408)**	**OR (7432)**
		
XOR (7486)	**NAND (7400)**	**NOR (7402)**