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Electronics D (Digital)

Introduction

Digital electronics, opposed to analog electronics uses discrete signals instead of continuous signals. In principle, there are only two values for the signal: “Low” (logic 0) and “high” (logic 1), which represent the boolian constants “false” and “true”.

Digital circuits are based on logic elements that connect the digital signals and produce a different digital signal as a result. The logic elements consist of elementary logic gates which form the basis of any logic operation.

Logic gates

Logic gates carry out boolian operations. The various logic gates are: AND, OR, NAND, NOR, XOR, XNOR und NOT.
NAND or NOR gates can be used to construct any logic gate and function, which is why they are highly important. Using logic gates and linking them in the correct fashion leads to the realization of e.g. Flipflops and counters. More complex implentations are processors.

Logic gates and truth tables

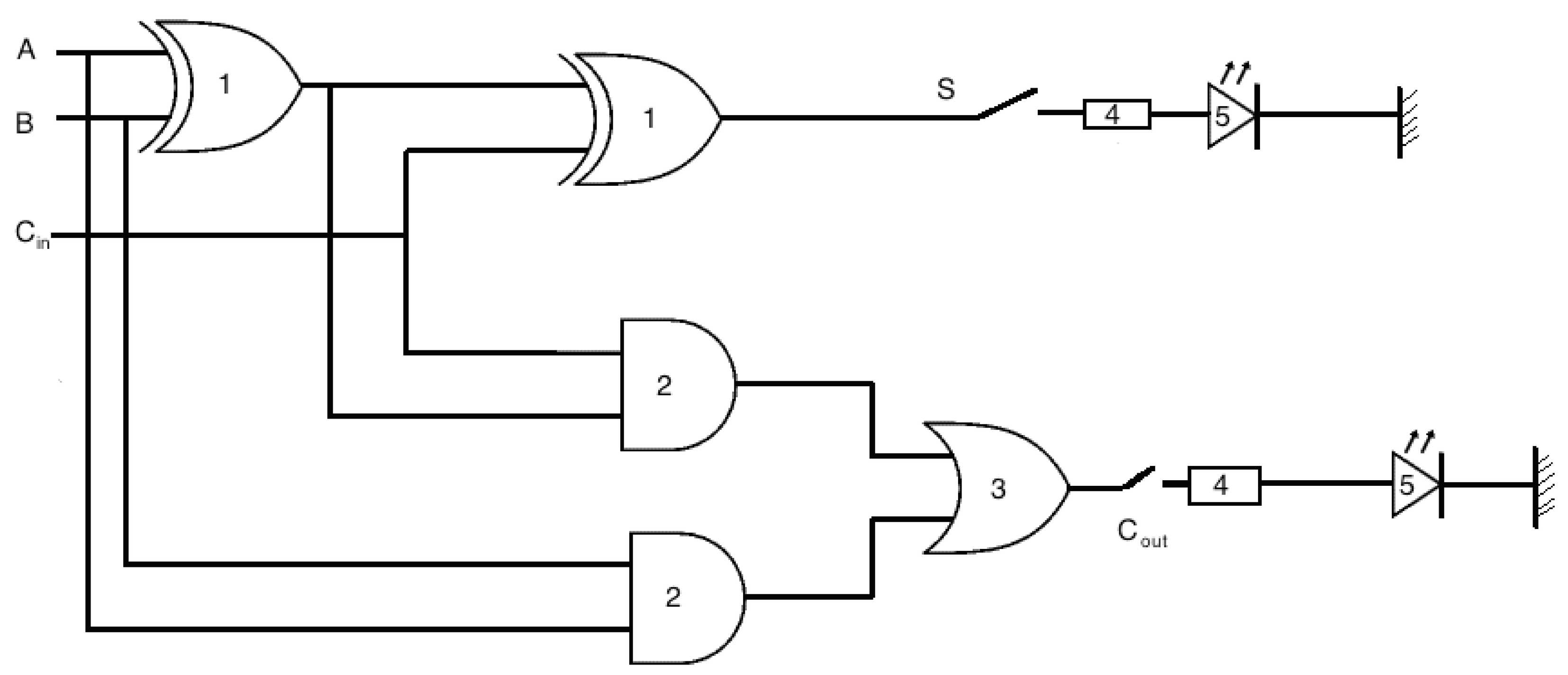
Type	Distinctive shape	Rectangular shape	Boolean algebra between A & B	Truth table
AND		&	$A \cdot B$	INPUT: A B / OUTPUT: A AND B 0 0 0 0 1 0 1 0 0 1 1 1
OR		≥1	$A + B$	INPUT: A B / OUTPUT: A OR B 0 0 0 0 1 1 1 0 1 1 1 1
NOT		1	$\overline{A}$	INPUT: A / OUTPUT: NOT A 0 1 1 0
NAND		&	$\overline{A \cdot B}$	INPUT: A B / OUTPUT: A NAND B 0 0 1 0 1 1 1 0 1 1 1 0
NOR		≥1	$\overline{A + B}$	INPUT: A B / OUTPUT: A NOR B 0 0 1 0 1 0 1 0 0 1 1 0
XOR		=1	$A \oplus B$	INPUT: A B / OUTPUT: A XOR B 0 0 0 0 1 1 1 0 1 1 1 0
XNOR		=1	$\overline{A \oplus B}$ or $A \odot B$	INPUT: A B / OUTPUT: A XNOR B 0 0 1 0 1 0 1 0 0 1 1 1

Example - Electronic adder

The electronic adder is a digital circuit that performs addition of numbers. It is an integral part of modern chip technology. In many computers and other kinds of processors, adders are used not only in the arithmetic logic unit(s), but also in other parts of the processor, where they are used to calculate addresses, table indices, and similar.

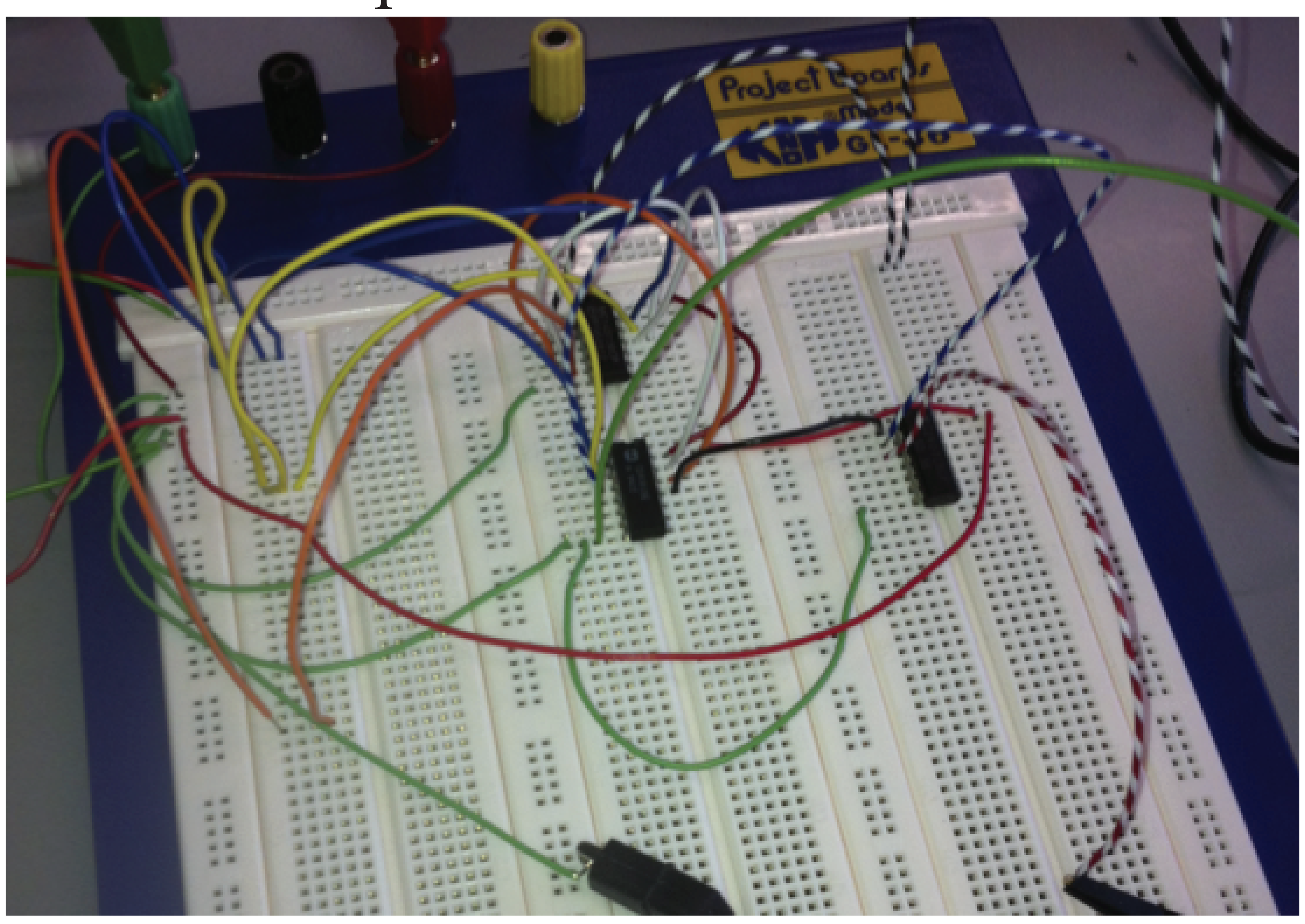
Full adder circuits add binary numbers and account for values carried in as well as out. A one-bit full adder adds three one-bit numbers, often written as A, B, and Cin; A and B are the operands, and Cin is a bit carried in from the next less significant stage. The full-adder is usually a component in a cascade of adders, which add 8, 16, 32, etc. binary numbers. The circuit produces a two-bit output sum typically represented by the signals Cout and S, where sum = 2x Cout + S.

Full adder logic diagram & truth table



A	B	C_{in}	S	C_{out}	Binary representation
0	0	0	0	0	00
1	0	0	1	0	01
0	1	0	1	0	01
1	1	0	0	1	10
0	0	1	1	0	01
1	0	1	0	1	10
0	1	1	0	1	10
1	1	1	1	1	11

Experimental realization



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