

# Glossary

**1's Complement:** A binary number formed by inverting each bit of the original number. Used for subtraction of binary numbers where the 1's complement of the subtrahend (number being subtracted) is added to the minuend (the number the subtrahend is being subtracted from).

**2's Complement:** A binary number formed by inverting each bit of the original binary number and then adding one. Used for subtraction of binary number where the 2's complement of the subtrahend is added to the minuend.

## A

**Alternating Current:** A form of electrical current in which the direction of electron flow changes over time.

**AC:** Alternating Current; A form of electrical current in which the direction of electron flow changes over time

**Amperage:** The strength of the current of electricity

**Analog:** Also known as linear electronics, branch of electronics with infinitely varying quantities

**Analog-to-Digital:** Circuit that converts an analog input to the corresponding digital output.

**AND:** The Output of this circuit is High (1) only if all of its inputs are High.

**Associative:** A mathematical property for Addition and Multiplication.  $A + (B + C) = (A + B) + C$   $A(BC) = (AB)C$

**ASCII Code:** (American Standard Code for Information Interchange) Seven Bit Alphanumeric code used by most computer manufacturers.

**Astable:** Digital circuit that oscillates between two unstable output states.

**Asynchronous:** Operations in a digital circuit are not executed in time with a clock

**Asynchronous Counter :**Type of counter in which each flip flop output serves as the clock input signal for the following flip flop in the chain.

**Atom:** The smallest building block of matter

## B

**Batteries:** A voltage storage device that stores electricity chemically and provides a direct current.

**Baud Rate:** The number of bits per second transmitted or received.

**BCD:** Binary Coded Decimal; A digital code in which each of the decimal digits, 0 – 9, are represented by a group of four binary bits

**BCD Decoder:** A device that translates Binary Coded Decimal into another number system, usually decimal.

**Bi-directional Bus:** A bus that allow information to flow in both directions using Tri-state gates.

**Binary:** Numerical value represented in the Binary or Base-2 number system.

**Binary Counter:** A Group of flip-flops connected in a special arrangement in which the states of the flip-flops represent the binary number equivalent to the number of pulses that have occurred at the input of the counter

**Binary Coded Decimal:** Four-bit code used to portray each digit of a decimal number by its 4 bit binary equivalent.

**BCD:** Binary Coded Decimal; Four-bit code used to portray each digit of a decimal number by its 4 bit binary equivalent

**Binary Ladder:** A circuit constructed in such a way that resistor values successively increase by a factor of 2. This network will provide a proportional voltage to a binary number input.

**Bistable:** Having two stable states, often associated with flip-flops and latches

**Bit:** Digit in the binary system.

**Boolean algebra:** Algebraic process used in the design and analysis of digital systems. In Boolean algebra only two values are possible, 0 and 1

**Boolean Expression:** Terms written in Boolean algebra that express the output of a circuit in terms of the input.

**Breadboard:** A method of construction used to test and verify circuit operation.

**Buffer:** Circuit designed to have a larger output current and/or voltage capability than an ordinary logic circuit.

**Bus:** An arrangement of parallel wire that permits the simultaneous transmission of data.

**Byte:** Eight-Bit word.

## C

**Cadmium Sulfide Cell:** A light sensitive resistor; also known as a photocell

**Capacitor:** A component capable of storing an electrical charge

**Capacitor Code:** The code written on a capacitor that allows the user to determine its rating

**Capacitance:** Measurement of how much electrical charge a device can store

**Carry:** Digit or bit that is generated when two numbers are added and the outcome is greater than the base for the number system being used.

**Cascade:** Adjoining logic circuits in a serial fashion with the output of one circuit driving the input of the next and so on.

**Ceramic Disk:** A capacitor named for the material that its dielectric is made from

**Circuit:** A complete path for the flow of electricity.

**Clear:** A Flip-Flop input used to make  $Q=0$ .

**Clock:** Digital signal in the form of a rectangular pulse train or a square wave.

**Closed Circuit:** A circuit for which there is a complete path for the electrons to flow

**Color Code:** Colored strips on a resistor used to determine its value in ohms.

**Combinational Logic:** Circuits made up of mixture of logic gates, with no feedback from outputs to inputs.

**Commutative:** A mathematical property for Addition and Multiplication.  $A + B = B + A$ ;  $AB = BA$

**Commutator:** Part of the armature to which the coils of the rotor are connected

**Comparator:** A device that examines two inputs and indicates if they are identical.

**CMOS:** Complementary Metal-Oxide Semiconductor; Integrated-circuit technology that uses MOS-FETs as the principal circuit component. This logic family belongs to the class of unipolar digital ICs

**Compile:** To translate from a high level language such as WinCupl to a low level language such as machine language

**Conductor:** Any material that allows the flow of electricity through it.

**Control:** A switch

**Conventional Current Flow:** The thought that electrons flow from positive to negative

**Count Down:** Numerical numbers decreasing in value

**Count Up:** Numerical numbers increasing in value

**Counter:** A device which adds or subtracts numbers for display without saving to memory.

**Current:** The total amount of electrons flowing through a circuit per unit time; measured in Amperes (one coulomb of electrons passing a single point per second).

## D

**Data Sheet:** An industrial standardized document which describes the properties, families and pin outs of modern integrated circuits

**Data Shifting:** The process of moving a bit from one flip-flop to the next.

**Debug:** A screen used in some programming languages

**Decimal:** Number system in base ten

**Decoder:** Digital circuit that converts an input binary code into a decimal number

**DeMorgan's Theorem:** Theorem stating that the complement of a sum (OR operation) equals the product (AND operation) of the complements, and theorem stating that the complement of a product (AND operation) equals the sum (OR operation) of the complements.

**Demultiplexer (DEMUX):** Logic circuit that depending on the value of its select inputs will channel its data input to one of several data outputs.

**Dielectric:** Insulating material in the center of a capacitor

**Digital:** Of or pertaining to the class of devices or circuits in which the output varies in discrete steps (i.e. pulses or on-off operation)

**Digital Multimeter:** An instrument used typically to measure voltage, current, and resistance. The data is sent to a digital display. See also Meter.

**Digital State:** The voltage condition existing anywhere in a digital circuit. Typically read as "high" or "low"; can be tested with a logic probe or a meter.

**Digital Waveform:** A waveform that changes between solely High and Low in a given time.

**Digital-To-Analog:** Circuit that converts a digital input to a corresponding analog output.

**DIP:** Dual In-line Package, a style of IC

**DC:** Direct Current; A form of electrical current in which the direction of electron flow does not change over time

**Direct Current:** A form of electrical current in which the direction of electron flow does not change over time.

**Distributive:** A mathematical property for Addition over Multiplication.  $A(B + C) = AB + AC$

**Divide By N:** A counter system that will count up to the number N and then reset by using a NAND gate.

**Dual Logic:** The application of DeMorgan's Theorems

**Duality:** See Dual Logic

**Duty Cycle:** The ratio of HIGH time to the total cycle time, expressed as a percent.

## E

**Edge-Triggered D Flip-Flop:** A flip-flop circuit in which the inputs are clocked and the outputs appear on the same clock edge.

**Electron:** A negatively charged particle in an atom

**Electron Flow:** The movement of electrons from a negative to a more positive point

**Electrolytic:** A special type of capacitor which has a dielectric in the form of a metal oxide deposited on the anode with an electrolyte present. Although sensitive to correct polarity it allows for far greater capacitance values.

**Enable:** To start or activate

**Encode:** To convert information into a coded form.

**Encoder:** A logic device that translates from decimal to another code such as binary

**Exclusive NOR:** A logic gate with two inputs that outputs a 1 (high) when both inputs are alike.

**Exclusive OR:** A logic gate with two inputs that outputs a 1 (high) when its inputs are opposite.

**Expanding Functions:** To add more gates in order to increase the number of inputs to a specific gate.

## F

**Fall Time:** The amount of time it takes a signal to go from high to low

**Falling Edge:** The part of a waveform where the signal is going from high to low

**Fan Out:** Maximum number of standard logic inputs that the output of a digital circuit can drive reliably.

**Farads:** Unit of measurement for a capacitor

**Fast Carry:** During subtraction operations a carry signal is generated concurrently with the rest of the subtraction operation, without having to ripple through the gates.

**Feedback:** Returning the signal from output back to the circuit input.

**Fixed Resistor:** A resistor whose value can not be modified

**Flip Flop:** Memory device capable of storing a logic level.

**Forbidden:** A state which is not allowed

**For/Next:** A programming command which creates a finite loop

**Frequency:** The number of cycles completed by as waveform each second; measured in Hertz (Hz).

**Full Adder:** Logic circuit with three inputs and two outputs. The inputs are a carry bit (C<sub>in</sub>) from a former stage, a bit from the augend, and a bit from the added, respectively. The outputs are the sum bit and carry out bit (C<sub>out</sub>) produced by the addition of the bit from the addend with the bit from the augend and C<sub>in</sub>.

**Full Decoder:** A decoder that has an output for each possible binary number output.

## G

**GAL:** Generic Array Logic, a type of programmable logic chip

**Gate:** The basic building block of digital electronics. The basic logic gate has one or more inputs and one output and is used to perform one of the following logic functions: AND, OR, NOR, NAND, INVERT, exclusive-OR, or exclusive-NOR.

**Gated Flip-Flop:** A Flip-Flop in which a Gate Enables the Flip-Flop

**Giga:** Mathematical abbreviation meaning times 1,000,000,000. E.g. 1GHz or 1GByte

**Glitch:** Momentary, compressed, spurious, and sharply defined change in voltage.

**Goto:** A programming command which sends the program to a specific, identified line of code

**Ground:** A return path to the earth or a common connection

## H

**Half Adder:** Logic circuit with two inputs and two outputs. The inputs are a bit from the augend and a bit from the addend, respectively. The outputs are the sum bit produced by the addition of the bit from the augend and the addend with the bit from the augend and the ensuing carry (Cout) bit, which will be added to the next stage.

**Hertz:** Abbreviated Hz. A unit of frequency measuring the number of cycles per second

**Hexadecimal:** Number system which has a base of 16; digits 0 through 9 plus letters A through F are used to express a hexadecimal number.

**High:** Logic level 1

## I

**IC Speed:** The time it takes for a change in the input to reach the output.

**Impedance:** The total resistance in an Alternating Current circuit due to resistive and reactive components; symbolized by Z.

**Inhibit:** To shut down or cause to cease functioning; typically a control signal which keeps data from passing through the gate.

**Input:** The signals entering a logic circuit

**Insulator:** Any material which doesn't allow the flow of electricity through it.

**Interface:** A device that joins or links two or more non-compatible devices together for data transfer.

**Interfacing:** Joining of dissimilar devices in such a way that they are able to function in a compatible and coordinated manner; connection of the output of a system to the inputs of a contrasted system with different electrical characteristics.

**Inverter:** Also referred to as the NOT gate: logic circuit that implements the NOT operation. An INVERTER has exclusively one input, and its output logic level is always the opposite of this input's logic level.

## J

**JEDEC:** Joint Electronic Device Engineering Council

**J-K Flip-Flop:** A flip-flop that can be turned on, turned off, toggled, or left the same according to control signals on the J and K inputs.

## K

**Karnaugh Mapping:** Two-dimensional, graphic form of a truth table used to simplify a sum of products expression.

**Kilo:** Mathematical abbreviation meaning times 1,000. E.g. 1kV or 1kHz

**Kirchhoff's Law:** The sum of the voltage drops in any closed path is equal to the sum of the battery voltage; the algebraic sum of the currents at a node is zero.

## L

**Ladder:** One possible structure of A to D and D to A converters.

**Large Scale Integration:** LSI; A level of IC complexity in which there are 100-9999 gates per chip

**Latch:** Type of Flip-Flop. A circuit that assumes an on state or an off state according to the input signal

**Leading Edge:** The part of a digital waveform that goes from low to high

**LSB:** Least Significant Bit; Right most bit (smallest weight) of a binary expressed quantity

**Least Significant Bit:** Right most bit (smallest weight) of a binary expressed quantity.

**LED:** Light Emitting Diode; A diode that emits light in a forward biased manner

**LCD:** Liquid Crystal Display; A method of displaying information that uses the selective reflection of light

**Light Emitting Diode:** A diode that emits light in a forward biased manner.

**Liquid Crystal Display:** A method of displaying information that uses the selective reflection of light

**Load:** That part of the circuit that produces work. Anything that uses electricity

**Logic:** In digital electronics, the decision-making capability of gate circuits, in that a HIGH represents a true condition and a LOW represents a false condition.

**Logic Analyzer:** A piece of test equipment used for monitoring one or more digital waveforms.

**Logic Families:** Categories of Integrated Circuits

**Logic Gates:** The basic building block of digital electronics. The basic logic gate has one or more inputs and one output and is used to perform one of the following logic functions: AND, OR, NOR, NAND, INVERT, exclusive-OR, or exclusive-NOR.

**Logic Probe:** Digital troubleshooting tool which senses and indicates the logic level at a particular point in a circuit.

**Logic Symbols:** The schematic symbol for gates.

**Look Ahead Carry:** A carry signal is developed at the same time the other outputs are being generated. Carry does not have to ripple through other stages.

**Loop:** Complete path or sub-path in a circuit OR a programming language term

**Low:** Logic level 0 or False state

**LSI:** Large Scale Integration; A level of IC complexity in which there are 100-9999 gates per chip

## **M**

**Machine Language:** A series of bits written for instruction of computers, the first level of computer language

**Master Slave Flip-Flop:** A type of flip flop in which the input data are entered into the device on the leading edge of the clock pulse and appear at the output on the trailing edge.

**Maxterm Boolean Expression:** The form of a Boolean expression that is in the form of a Product of sums

**Medium Scale Integration:** A level of IC complexity in which there are 12-99 gates per chip

**Mega:** A mathematical abbreviation which means times 1,000,000

**Memory:** Ability of a circuit's output to remain at one state even after the input condition that caused that state is removed.

**Micro:** A mathematical abbreviation which means times .000001

**Micro-micro:** A mathematical abbreviation which means times 10 to the negative 12<sup>th</sup> power

**Milli:** A mathematical abbreviation which means times .001

**Minterm:** The form of a Boolean expression that is in the form of a sum of products

**MOD:** Abbreviation for Modulus; The number of counting states in a number system

**Modulus:** The number of counting states in a number system.

**Monostable:** Circuit that belongs to the flip-flop family, but which has only one stable state (Normally Q=0).

**Most Significant Bit:** Leftmost binary bit (Largest weight) of a binary expressed quantity.

**MSB:** Most Significant Bit; Leftmost binary bit (Largest weight) of a binary expressed quantity.

**MSI:** A level of IC complexity in which there are 12-99 gates per chip

**Multimeter:** A device used to measure voltages, resistance and continuity in a circuit

**Multiplexer:** Logic circuit that, depending on the status of its selected inputs, will channel one of several data inputs to its output.

**Multivibrator:** A class of digital circuits in which the output is connected back to the input to produce one stable state, two stable states or no stable states

## N

**NAND:** Logic circuit which operates like an AND gate followed by an INVERTER. The output of a NAND gate is LOW (logic level 0) only if all inputs are HIGH (logic level 1).

**Nano:** Mathematical abbreviation meaning times 0.000000001. E.g. 1ns

**Negative Edge:** Falling edge of a waveform, when logic level goes from high to low

**Nibble:** One half a byte, a four bit binary word

**Noise:** Unwanted voltages induced in connecting wires or PC board traces that might affect the input levels in the circuit thus affecting the output

**Non-Overlapping Clock:** Delayed clock or a dual clock system. The two rectangular waves are offset so that only one is HIGH at a time.

**NOR:** Logic circuit which operates like an OR gate followed by an INVERTER. The output of a NOR gate is LOW (logic level 0) when any or all inputs are HIGH (logic level 1).

**NOT:** Output logic level is always the opposite of the input's logic level. See Inverter

**Notch or Dot:** A mark on an IC chip which helps identify the pin numbers

**Neutron:** An electrically neutral particle without a net charge with about the same mass as a proton found in the Nucleus of an atom

**Nucleus:** Composed mostly of Protons and Neutrons, the nucleus is the center of the atom

## O

**Octal:** Number system which has a base 8; digits from 0 to 7 are used to express an octal number.

**Ohmmeter:** An instrument used for measuring resistance

**Ohm:** A unit of measure for resistance

**Ohm's Law:** The relationship of voltage, current and resistance in a circuit  $I=V/R$ ,  $V=IR$ ,  $R=V/I$

**One:** Logic level in Digital used to represent High

**One-Shot:** Circuit that belongs to the flip-flop family, but which has only one stable state (Normally  $Q=0$ ).

**Open Collector:** Type of output structure of some TTL circuits in which only one transistor with a floating collector is used.

**Open Circuit:** A circuit that is disconnected in some way, there is not a continuous path for electrons to flow

**OR:** Digital circuit that implements the OR operation. The output of this circuit is HIGH (logic level 1) if any or all of its inputs are HIGH.

**Orbit:** Path of an electron as it travels around the Nucleus

**Oscilloscope:** An instrument used to view and measure waveforms

**Output:** The signal leaving a logic gate

**Overflow:** When in the process of adding signed binary numbers a carry of 1 is generated from the MSB position of the number into the sign bit position.

## **P**

**PAL:** Programmable Array Logic, a type of programmable device

**Parallel Data Transfer:** Operation where several bits of data are transferred simultaneously into a counter of a register.

**Partial Decoder:** A logic circuit which will give an active signal on one output line for a binary number input to the circuit. The circuit does not have a solitary output line for each possible binary number input to it as a full decoder has.

**Period:** The length of time it takes a periodic waveform to repeat

**Phase:** The relative position of one signal relative to another signal.

**Phototransistor:** A component that produces an output when light falls on it

**Pico:** A mathematical abbreviation which means times 10 to the negative 12<sup>th</sup> power

**Pin:** A metal connection on an IC chip

**Pin-Out:** The pin numbers on an IC which correspond to the gate or device location.

**Pin Numbers:** The numbering system used to identify pins on a chip. They go from the upper left corner of the chip, counter-clock wise, beginning with the number 1

**PLD:** Programmable Logic Device, a type of chip which can be programmed, used, erased and then reprogrammed

**Polarity:** The negative and positive side of devices

**Positive Edge:** The edge of a signal moving from low to high

**Potentiometer:** A variable resistor, a resistor whose value can be adjusted

**Preset:** An input used to set  $Q = 1$

**Product of sums:** Logic expression consisting of two or more OR terms (sums) that are ANDed together.

**Prohibited:** A set of inputs that are not supposed to be used

**Propagation Delay:** Delay from the time a signal is applied to the time when the output makes its change.

**Proton:** A positively charged particle in an atom

**Pulse:** A sudden change from one logic level to another, followed after a time by a sudden change back to the original level.

**Pulse Amplitude:** The height of the wave above zero

**Pulse Width:** The total width of the pulse for a periodic wave form

**Pulse Width Modulation:** Technique to control the ratio of time that a signal spends on vs. how long it spends off

**PWM:** Pulse Width Modulation; Technique to control the ratio of time that a signal spends on vs. how long it spends off

## Q

**Q,  $\bar{Q}$ :** The complementary outputs of a flip-flop.

**Quantum:** Atoms absorb or emit energy in a series of steps rather than continuously. A quantum is the amount of energy needed to move the outer electrons up a level.

## R

**RC Circuit:** An analog circuit whose output provides a filtering or charge storage function.

**Reset:** Term synonymous with "CLEAR" (Q = 0 Logic level)

**Resistor:** A component used for introducing resistance into a circuit

**Resistance:** The opposition to current flow

**Ripple Counter:** Type of counter in which each flip-flop output serves as the clock input signal for the next flip-flop in the chain.

**Rising Edge:** The edge of a signal that goes from low to high

**Rise Time:** The amount of time it takes a signal to transition from a low to a high

**Rotor:** Part that spins around in an electric motor

**R-S Flip-Flop:** A flip-flop that can be turned on with the set input and turned off with the reset.

## S

**Schematics:** A wiring diagram or blueprint of a circuit

**Schottky:** A logic type in the TTL family

**Sequential Logic:** Logic that is based on the output of a previous state.

**Serial Data Transfer:** Transfer of data from one place to another one bit at a time.

**Series:** A connection of components so that the same current flows through each one

**Set:** To preset or turn on a flip-flop and cause the output, Q, of a flip flop to assume a 1 level.

**Seven Segment Display:** An alphanumeric display made up of seven segments.

**Shift Counter:** A counter in which data is shifted through to another flip-flop or shifted back to the input of the first flip-flop.

**Shift Register:** Digital circuit that accepts binary data from some input source and then shifts these data through a chain of flip-flops one bit at a time to a higher order or lower order.

**Short Circuit:** An undesired pathway, usually low resistance, in a circuit

**Signal Generator:** A device used to create different wave forms.

**Signed Bit:** Leftmost bit of a binary number which designates whether the number is positive (0) or negative (1)

**Sine Wave:** A waveform of a single constant frequency and amplitude that continues for infinitely.

**Small Scale Integration:** A level of IC Complexity in which there are less than 12 gates per chip

**Source:** The origin of a digital input.

**Square Wave:** A waveform which consists of pulses defined as high and low.

**SSI:** Small Scale Integration; A level of IC complexity in which there are less than 12 gates per chip

**Stator:** Field winding in an electric motor

**Stepper Motor:** Motor which has permanent magnet for rotor which moves as the stator winding steps around

**Steering Logic:** The selection of one out of a number of inputs to be chosen through multiplexing

**Subtractor:** A circuit that subtracts two binary numbers.

**Subtrahend:** A number which is to be subtracted from another

**Successive Approximation:** The process of refining an A-D measurement using a sequence of steps.

**Sum of Products:** Logic expression consisting of two or more AND terms (products) that are ORed together

**Switch:** A component that opens or closes a circuit path

**Synchronous:** To occur or happen at the same time

**Synchronous Counter:** Counter in which all the flip-flops are clocked at the same time.

## T

**Tera:** Mathematical abbreviation meaning times 1,000,000,000,000. E.g. 1THz

**Thermistor:** Temperature sensitive resistor

**Timing Diagram:** A visual depiction of logic levels in relation to time.

**Toggle:** When a digital device changes state, it is said to toggle.

**Totem Pole:** A digital term used to illustrate the way two transistors are arranged at the output of most logic circuits.

**Trailing Edge:** The edge of a waveform which is transitioning from high to low

**Transistor:** An active semiconductor component used as an amplifier, detector or switch.

**Transistor-Transistor Logic:** Integrated circuits that use the bipolar transistor as the principle component

**TTL:** Transistor to Transistor Logic; Integrated circuits that use the bipolar transistor as the principle component.

**Transparent D Flip-Flop:** Flip-flop whose output will respond to the D input during the active level of the clock.

**Trigger:** Input signal to a flop-flop or one-shot causing the output to change states depending on the conditions of the control signal

**Tri-State:** Type of output configuration which allows three types of output states. The three types of output states being high impedance, LOW, and high.

**Troubleshoot:** A systematic procedure for finding a fault in a circuit.

**True or False:** A logic level in Digital used to talk about Low or High

**Truth Table:** Logic table that depicts a circuits output response to the various combinations of the logic levels at its inputs.

## U

**Unchanged:** Not changed, or the memory state of a flip-flop.

**Up/Down Counter:** A counter which can be made to count up or down depending upon the input condition.

## V

**Variable:** A letter or word that represents a number or expression

**Variable Capacitor:** A capacitor whose value can be adjusted.

**Variable Resistor:** A resistor whose value can be adjusted. Also known as a potentiometer

**Vcc:** Generally represents supply voltage for chips (typically 5 volts)

**Voltage:** The electromotive force in a circuit.

**Voltage Divider:** A tapped resistor, series resistors, or potentiometer across a source voltage to produce multiple output voltages.

**Voltage/Time Graph:** A graph which depicts the voltage of a circuit over an chosen period of time.

## W

**Waveform:** Representation of an electronic signal on an oscilloscope.

**Word:** Group of bits that represent a certain unit of information.

**Wiring Diagram:** A schematic, the visual representation of the connections in a circuit

## X

**XNOR:** Exclusive NOR gate, the output is high when both inputs are high or both inputs are low

**XOR:** Exclusive OR gate, the output is high when only one of the inputs is high

## Z

**Zero:** A logic level used to represent a low

The AMMQC program is an Equal Opportunity program.

Adaptive equipment is available upon request for individuals with disabilities.

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