



Joint Development LLC

Key Battery Terminology

Accumulator	A rechargeable battery or cell (see also Secondary battery).
Active Material	The material in the electrodes of a cell or battery that takes part in the electrochemical reactions of charge or discharge.
Ambient Temperature	The average temperature of the surroundings.
Ampere or Amp	An Ampere or an Amp is a unit of measurement for an electrical current. One amp is the amount of current produced by an electromotive force of one volt acting through the resistance of one ohm. Named for the French physicist Andre Marie Ampere. The abbreviation for Amp is A but its mathematical symbol is "I". Small currents are measured in milli-Amps or thousandths of an Amp.
Amp Hour or Ampere-Hour	A unit of measurement of a battery's electrical storage capacity. Current multiplied by time in hours equals ampere-hours. One amp hour is equal to a current of one ampere flowing for one hour. Also, 1 amp hour is equal to 1,000 mAh
Ampere-Hour Capacity	The number of ampere-hours which can be delivered by a battery on a single discharge.
Anode	During discharge, the negative electrode of the cell is the anode. During charge, that reverses and the positive electrode of the cell is the anode. The anode gives up electrons to the load circuit and dissolves into the electrolyte.
Aqueous Batteries	Batteries with water-based electrolytes. The electrolyte may not appear to be liquid since it can be absorbed by the battery's separator.
Actual Capacity or Available Capacity	The total battery capacity, usually expressed in ampere-hours or milliampere-hours, available to perform work. The actual capacity of a particular battery is determined by a number of factors, including the cut-off voltage, discharge rate, temperature, method of charge and the age and life history of the battery.
Battery	An electrochemical device used to store energy. The term is usually applied to a group of two or more electric cells connected together electrically. In common usage, the term "battery" is also applied to a single cell, such as a AA battery.
Battery Capacity	The electric output of a cell or battery on a service test delivered before the cell reaches a specified final electrical condition and may be expressed in ampere-hours, watt- hours, or similar units. The capacity in watt-hours is equal to the capacity in ampere-hours multiplied by the battery voltage.
Battery Charger	A device capable of supplying electrical energy to a battery.
Battery-Charge Rate	The current expressed in amperes (A) or milli amps (mA) at which a battery is charged.
Bobbin Cell	A cylindrical electrode (usually the positive) pressed from a mixture of the active material, a conductive material, such as carbon black, the electrolyte and/or binder

	with a centrally located conductive rod or other means for a current collector.
Boost Charge	Charging of batteries in storage to maintain their capacity and counter the effects of self-discharge.
Cutoff Voltage, final	The prescribed lower-limit voltage at which battery discharge is considered complete. The cutoff or final voltage is usually chosen so that the maximum useful capacity of the battery is realized. The cutoff voltage varies with the type of battery and the kind of service in which the battery is used. When testing the capacity of a NiMH or NiCD battery a cutoff voltage of 1.0 V is normally used. 0.9V is normally used as the cutoff voltage of an alkaline cell. A device that is designed with too high a cutoff voltage may stop operating while the battery still has significant capacity remaining.
C	Used to signify a charge or discharge rate equal to the capacity of a battery divided by 1 hour. Thus C for a 1600 mAh battery would be 1.6 A, C/5 for the same battery would be 320 mA and C/10 would be 160 mA. Because C is dependent on the capacity of a battery the C rate for batteries of different capacities must also be different.
Capacity	The capacity of a battery is a measure of the amount of energy that it can deliver in a single discharge. Battery capacity is normally listed as amp-hours (or milli amp-hours) or as watt-hours.
Cathode	Is an electrode that, in effect, oxidizes the anode or absorbs the electrons. During discharge, the positive electrode of a voltaic cell is the cathode. When charging, that reverses and the negative electrode of the cell is the cathode.
Cell	An electrochemical device, composed of positive and negative plates and electrolyte, which is capable of storing electrical energy. It is the basic “building block” of a battery.
Charge	The conversion of electric energy, provided in the form of a current, into chemical energy within the cell or battery.
Charge Rate	The amount of current applied to battery during the charging process. This rate is commonly expressed as a fraction of the capacity of the battery. For example, the C/2 or C/5.
Charging	The process of supplying electrical energy for conversion to stored chemical energy
Chemistry	Common chemistries include variations of lead, nickel and lithium. Each chemistry calls for its own charging algorithm; traditionally different battery chemistries are not interchangeable in the same charger. Each chemistry possesses its own shipping, handling and disposal regulation requirements.
Constant-Current Charge	A charging process in which the current applied to the battery is maintained at a constant value.
Constant-Voltage Charge	A charging process in which the voltage applied to a battery is held at a constant value.
Current	Measured in amps. This corresponds to the rate at which electrons can be removed from the battery. The current capability of a battery depends on the cell design and the chemistry.

Cycle	One sequence of charge and discharge.
Deep Cycle	A cycle in which the discharge is continued until the battery reaches its cut-off voltage, usually 80% of discharge.
Shallow Cycling	Charge and discharge cycles which do not allow the battery to approach its cutoff voltage. Shallow cycling of NiCd cells lead to "memory effect". Shallow cycling is not detrimental to NiMH cells and it is the most beneficial for lead acid batteries.
Cycle Life	For rechargeable batteries, the total number of charge/discharge cycles the cell can sustain before its capacity is significantly reduced. End of life is usually considered to be reached when the cell or battery delivers only 80% of rated ampere-hour capacity. NiMH batteries typically have a cycle life of 500 cycles, NiCd batteries can have a cycle life of over 1,000 cycles. The cycle of a battery is greatly influenced by the type depth of the cycle (deep or shallow) and the method of recharging. Improper charge cycle cutoff can greatly reduce the cycle life of a battery.
CCV	Closed circuit voltage, where the battery or cell is under a load from an external source
C-Rate	The discharge or charge current expressed as a multiple of the rated capacity in ampere-hours. Standard example: A battery rated at 1000 mAh provides 1000 mA for one hour if discharged at 1C.
Direct Current (DC)	The type of electrical current that a battery can supply. One terminal is always positive and another is always negative.
Discharge	The conversion of the chemical energy of the battery into electric energy.
Depth of Discharge	The amount of energy that has been removed from a battery (or battery pack). Usually expressed as a percentage of the total capacity of the battery. For example, 50% depth of discharge means that half of the energy in the battery has been used. 80% DOD means that eighty percent of the energy has been discharged, so the battery now holds only 20% of its full charge.
Discharge, deep	Withdrawal of all electrical energy to the end-point voltage before the cell or battery is recharged.
Discharge, high-rate	Withdrawal of large currents for short intervals of time, usually at a rate that would completely discharge a cell or battery in less than one hour.
Discharge, low-rate	Withdrawal of small currents for long periods of time, usually longer than one hour.
Drain	Withdrawal of current from a cell.
Dry Cell	A primary cell in which the electrolyte is absorbed in a porous medium, or is otherwise restrained from flowing. Common practice limits the term "dry cell" to the Leclanché cell, which is the common commercial type.
Duty Cycle	The operating regime of a cell or battery including factors such as charge and discharge rate, depth of discharge, cycle length, and length of time in the standby mode.
Electrochemical Couple	The system of active materials within a cell that provides electrical energy storage

	through an electrochemical reaction.
Electrode	An electrical conductor through which an electric current enters or leaves a conducting medium, whether it be an electrolytic solution, solid, molten mass, gas, or vacuum. For electrolytic solutions, many solids, and molten masses, an electrode is an electrical conductor at the surface of which a change occurs from conduction by electrons to conduction by ions. For gases and vacuum, the electrodes merely serve to conduct electricity to and from the medium.
Electrolyte	A chemical compound which, when fused or dissolved in certain solvents, usually water, will conduct an electric current. All electrolytes in the fused state or in solution give rise to ions which conduct the electric current.
Electropositivity	The degree to which an element in a galvanic cell will function as the positive element of the cell. An element with a large electropositivity will oxidize faster than an element with a smaller electropositivity.
End-of-Discharge Voltage	The voltage of the battery at termination of a discharge.
Energy	Measured in watt-hours. This is the product of the potential and the capacity.
Energy - Output Capability	expressed as capacity times voltage, or watt-hours.
Energy Density	Ratio of cell energy to weight or volume (watt-hours per pound, or watt-hours per cubic inch).
Final Voltage	(see Cutoff voltage)
Float Charging	Method of recharging in which a secondary cell is continuously connected to a constant-voltage supply that maintains the cell in fully charged condition. Typically applied to lead acid batteries.
Galvanic Cell	A combination of electrodes, separated by electrolyte, that is capable of producing electrical energy by electrochemical action.
Gassing	The evolution of gas from one or both of the electrodes in a cell. Gassing commonly results from self-discharge or from the electrolysis of water in the electrolyte during charging.
Gravimetric Energy Density	(Wh/kg) Energy a battery is capable of providing per given weight; higher Gravimetric Energy Density allows for a lighter weight battery.
Internal Resistance	The resistance to the flow of an electric current within the cell or battery.
Load	A term used to define the current drain on a battery. Internal battery resistance and depleting state-of-charge cause the voltage to drop.
Memory Effect	A phenomenon in which a cell, operated in successive cycles to less than full, depth of discharge, temporarily loses the remainder of its capacity at normal voltage levels (usually applies only to Ni-Cd cells). Note, memory effect can be induced in NiCd cells even if the level of discharge is not the same during each cycle. Memory effect is reversable.

Mid-Point Voltage	The voltage of a battery midway in the discharge between the fully charged state and the end voltage.
Negative Electrode	The electrode acting as an anode when a cell or battery is discharging.
Negative Terminal	The terminal of a battery from which electrons flow in the external circuit when the cell discharges. See Positive Terminal.
Nonaqueous Batteries	Cells that do not contain water, such as those with molten salts or organic electrolytes.
Ohm's Law	<p>The formula that describes the amount of current flowing through a circuit. Ohm's Law - In a given electrical circuit, the amount of current in amperes (I) is equal to the pressure in volts (V) divided by the resistance, in ohms (R). Ohm's law can be shown by three different formulas:</p> <ul style="list-style-type: none"> • To find Current $I = V/R$ • To find Voltage $V = I \times R$ • To find Resistance $R = V/I$
Open Circuit	Condition of a battery which is neither on charge nor on discharge (i.e., disconnected from a circuit).
Open-Circuit Voltage	The difference in potential between the terminals of a cell when the circuit is open (i.e., a no-load condition).
Operating Temperature	The temperature at which a battery operates. The battery will operate effectively within a specified temperature range which varies based on the battery's function and application purposes. If the battery is used outside of this range, the application may fail prematurely.
Overdischarge	Discharge past the point where the full capacity of the battery has been obtained.
Oxidation	A chemical reaction that results in the release of electrons by an electrode's active material.
Parallel Connection	The arrangement of cells in a battery made by connecting all positive terminals together and all negative terminals together. The voltage of the group remains the same as the voltage of the individual cell. The capacity is increased in proportion to the number of cells.
Parallel Pack Configuration	Cells of similar voltage and capacity are connected in parallel to increase the capacity of the battery pack. The positive terminals of all cells are connected together, or to a common conductor, while all negative terminals are connected in the same fashion. The parallel battery pack capacity is the sum of all cell capacities combined, while the battery pack voltage remains as is.
Passivation	Formation of a protective layer on a substrate that prevents reaction with the substrate by another chemical species. In the case of liquid cathode lithium cells, a passivation layer of lithium salts form on the lithium anode as the active electrolyte is introduced into the cell. This layer prevents further reaction between the lithium and the electrolyte, and provides the benefit of long shelf life..
Polarity	Refers to the charges residing at the terminals of a battery.

Positive Electrode	The electrode acting as a cathode when a cell or battery is discharging.
Positive Terminal	The terminal of a battery toward which electrons flow through the external circuit when the cell discharges. See Negative Terminal.
Power Density	The ratio of the power available from a battery to its volume (W/L).
Primary Battery	A battery made up of primary cells. See Primary Cell.
Primary Cell	A cell designed to produce electric current through an electrochemical reaction that is not efficiently reversible. The cell, when discharged, cannot be efficiently recharged by an electric current. Alkaline, lithium, and zinc air are common types of primary cells.
Protection Circuit	Built into a battery pack to ensure safety under all operational/environmental circumstances; preventing abuses such as excessive current, high heat, overcharge and overdischarge.
Rated Capacity	The number of ampere-hours a cell can deliver under specific conditions (rate of discharge, end voltage, temperature); usually the manufacturer's rating.
Rechargeable	Capable of being recharged; refers to secondary cells or batteries.
Recombination	State in which the gases normally formed within the battery cell during its operation, are recombined to form water.
Reduction	A chemical process that results in the acceptance of electrons by an electrode's active material.
Seal	The structural part of a galvanic cell that restricts the escape of solvent or electrolyte from the cell and limits the ingress of air into the cell (the air may dry out the electrolyte or interfere with the chemical reactions).
Secondary Battery	A battery made up of secondary cells. See Storage Battery; Storage Cell.
Self Discharge	Discharge that takes place while the battery is in an open-circuit condition.
Self-Discharge Rate	Internal chemical reactions cause capacity loss resulting in shelf life limitations for a specific chemistry.
Separator	The permeable membrane that allows the passage of ions, but prevents electrical contact between the anode and the cathode.
Series Pack Configuration	Cells of similar voltage and capacity are connected in series to increase the voltage of the battery pack. The positive terminal of the first cell in the series is connected to the negative terminal of the second cell in the series and so on. The series battery pack voltage is the sum of all cell voltages combined, while the battery pack capacity remains as is.
Series Connection	The arrangement of cells in a battery configured by connecting the positive terminal of each successive cell to the negative terminal of the next adjacent cell so that their voltages are cumulative. See Parallel Connection.
Shelf Life	For a dry cell, the period of time (measured from date of manufacture), at a storage temperature of 21 degrees C (69 degrees F), after which the cell retains a specified percentage (usually 90%) of its original energy content.

Short-Circuit	A condition that occurs when a short electrical path is unintentionally created. Batteries can supply hundreds of amps if short-circuited, potentially melting the terminals and creating sparks.
Short-Circuit Current	That current delivered when a cell is short-circuited (i.e., the positive and negative terminals are directly connected with a low-resistance conductor).
Smart Battery	These batteries are designed to communicate critical data to their device and charger. For example, the smart battery can cue the device to illuminate if its capacity falls below a specified threshold. There are two main protocols for this: Single-Wire Bus (all communications via one wire) or SMBus (use of two wires to transmit more sophisticated data.)
Spirally Wound Cell	A cylindrical cell which uses an electrode structure made by winding the electrodes and separators into a cylindrical “jelly roll” construction.
Starting-Lighting-Ignition (SLI) Battery	A battery designed to start internal combustion engines and to power the electrical systems in automobiles when the engine is not running. SLI batteries can be used in emergency lighting situations.
Stationary Battery	A secondary battery designed for use in a fixed location.
State of Charge (SOC)	The available capacity in a battery expressed as a percentage of rated capacity.
Storage Battery	An assembly of identical cells in which the electrochemical action is reversible so that the battery may be recharged by passing a current through the cells in the opposite direction to that of discharge. While many non-storage batteries have a reversible process, only those that are economically rechargeable are classified as storage batteries. Synonym: Accumulator; Secondary Battery. See Secondary Cell.
Storage Cell	An electrolytic cell for the generation of electric energy in which the cell after being discharged may be restored to a charged condition by an electric current flowing in a direction opposite the flow of current when the cell discharges. Synonym: Secondary Cell. See Storage Battery.
Sulfation	Process occurring in lead batteries that have been stored and allowed to self discharge for extended periods of time. Large crystals of lead sulfate grow that interfere with the function of the active materials.
Taper Charge	A charge regime delivering moderately high-rate charging current when the battery is at a low state of charge and tapering the current to lower rates as the battery becomes more fully charged.
Temperature Effects	Battery life dramatically shortens when operated at extreme high or low temperatures. High temperatures cause the electrolyte to evaporate which reduces capacity. Low temperatures can increase internal resistance which produces heat that causes the electrolyte to evaporate which reduces capacity. Example of Temperature Effect with NiMH: 20 °C Optimal life cycle 30 °C Cycle life reduced by 20% 40 °C Cycle life reduced by 40% 45 °C Cycle life reduced by 50%
Terminals	The parts of a battery to which the external electric circuit is connected.
Thermal Runaway	A condition whereby a cell on charge or discharge will destroy itself through

	internal heat generation caused by high overcharge or high rate of discharge or other abusive conditions.
Trickle Charging	A method of recharging in which a secondary cell is either continuously or intermittently connected to a constant-current supply that maintains the cell in fully charged condition.
Vent	A normally sealed mechanism that allows for the controlled escape of gases from within a cell.
Volt	The unit of measurement of electromotive force, or difference of potential, which will cause a current of one ampere to flow through a resistance of one ohm. Named for Italian physicist Alessandro Volta (1745-1827).
Voltage Delay	Time delay for a battery to deliver the required operating voltage after it is placed under load.
Voltage Depression	An abnormal low voltage, below the expected value, during the discharge of a battery.
Voltage (potential)	Measured in volts. The open circuit voltage is defined by the chemistry (i.e. active materials.) This is independent of the size of the battery.
Volumetric Energy Density	(Wh/L) Energy a battery is capable of providing per given size; higher Volumetric Energy Density allows for a smaller battery.
Voltage, cutoff	Voltage at the end of useful discharge. (See Voltage, end-point.)
Voltage, end-point	Cell voltage below which the connected equipment will not operate or below which operation is not recommended.
Voltage, nominal	Voltage of a fully charged cell when delivering rated current.
Watt	A measurement of total power. It is amperes multiplied by volts. 120 volt @ 1 amp = 120 watts @ 10 amps.
Wet Cell	A cell, the electrolyte of which is in liquid form and free to flow and move.
Working Voltage	The typical voltage or range of voltages of a battery during discharge.