

NUMERIC

120V AC

The line to neutral voltage in a single-phase two wire AC, not including green safety ground, system as commonly found in the US.

240V AC

The line to line voltage in a single-phase three wire (not including green safety ground) AC system as commonly found in the US.

230V AC

The line to neutral voltage in a single-phase two wire (not including green safety ground) AC system as commonly found in Europe and many other parts of the world.

3 phase *see also Single Phase*

Refers to 3 phase power generation typically 480V AC and higher. The AC utility is a three-phase system. In its simplest form there are three conductors connected to three conductive coils, which pass through a magnetic field, thus, inducing the electrons in the wires to flow. As the polarity of the magnetic field changes from North to South, electrons are induced to flow first one way then the other. This produces AC current flow. The current that is induced in the three wires is 120° out of phase. The current flow in the first conductor starts 120° before the second and it starts 120° before the third. Three phase generators are only found on the largest boats.

3 stage charging

A technique of battery charging that uses three distinct stages to ensure a fast and complete charge and a safe maintenance voltage. As there are several manufacturers of multiple stage charging systems, there is a slight difference in terminology in the field. See each key word for a more complete definition.

- Stage 1: Charge or Bulk Mode
- Stage 2: Acceptance or Absorption
- Stage 3: Float

A

ABYC

American Boat and Yacht Council, a voluntary standards creating body for the marine industry responsible for Standards and Recommended Practices.

AC

see Alternating Current

AFD

see Alternator Field Disconnect

AGC Fuse

A 1-1/4 inch long x 1/4 inch diameter glass fuse with fast blow characteristics.

AIC Amperes Interrupt Capacity

see Interrupt Rating

ATO/ATC Fuse

The blade type fuse now commonly used in the automobile industry. It has fast blow characteristics like the AGC fuse.

AWG (American Wire Gauge)

see also SAE Wire Gauge

AWG (American Wire Gauge) is a U.S. standard set of non-ferrous (copper or aluminum) wire conductor sizes. The "gauge" refers to the diameter. Typical household wiring is AWG number 12 or 14. Telephone wire is usually 22, 24, or 26. The higher the gauge number, the smaller the diameter and the thinner the wire. Thicker wire can carry more current because it has less electrical resistance over a given length. Also larger wire is used when the voltage drop along its length must be minimized. For example: High output alternator wiring might be a 2 AWG while the starter cable for a modest engine a 1 or 0 AWG.

absorption *see 3 Stage Charging*

see also Float Charge, Bulk, Equalization

Absorption refers to the second phase of a multistage charging system, also called acceptance by some manufacturers. During the absorption cycle the battery is maintained at the maximum charging voltage. Typically about 2.4V per cell or 14.4V for a typical 12V system. (28.8V for a 24V system). This is the gassing voltage for a liquid battery. Gelled batteries are typically charged at slightly lower voltages. The gassing voltage is also temperature dependent. The battery cannot be maintained for long periods of time in the absorption phase.

acceptance

see absorption

alternating current

A periodic current (sine wave) with an average value over a cycle of zero. The current reverses at regular intervals of time and has alternately positive and negative values.

alternator

Commonly refers to the DC charging source on an engine. The alternator is a three-phase AC device that produces alternating current, which is then rectified by a diode bridge to create direct current. Three-phase AC devices are reliable and inexpensive to make compared to a DC generator of the same ampacity.

alternator field disconnect

The alternator field is created by a coil of wire surrounded by ferrous metals. When the coil is energized with electric current it becomes an electro-magnet. This electromagnet is rotated, inducing current flow in the three phase coils that surround it. By controlling the strength of the magnetic field, the output of the alternator may be controlled. If the output of the alternator is open circuited there is no place for the energy to go. The voltage rises to a dangerous level. By disconnecting the alternator field, the magnetic field is turned off, thus the voltage cannot soar. This is a safety feature on some battery switches.

ambient temperature

The temperature of the medium in which the heat of a device is dissipated. The ambient temperature is often specified in standards for device performance (such as the UL Standards) as the basis for determining the heat rise of the component.

ammeter

Ammeter measures current flow in a circuit. An ammeter is inserted in series in the circuit. We consider four types:

Analog

The classic analog ammeter uses the magnetic field associated with current flow through a moving coil of wire, to in turn move a needle over a meter face which displays amps. This type of meter can only measure very small current, micro-amps, before the moving coil becomes too large to be practical. To measure higher currents a shunt resistor is inserted into the circuit. (see Shunt). Most of the current flows through the shunt resistor but some passes through a meter movement as described to read amps when the movement is scaled appropriately.

Digital DC

The digital DC ammeter uses a shunt resistor to measure current flow. (see Shunt). The shunt is connected in series in the wiring of the circuit whose current is to be measured. The shunt sense leads are connected to the DC ammeter, which is really a millivolt meter. The millivolt input from the shunt is scaled to read amps per the resistance of the shunt. For example, a current flow of 10 amps through a 100A-100mV shunt would result in a voltage of 10mV across the sense leads. A millivolt meter would display 10, which we would interpret as 10 Amps.

Digital AC

The digital AC ammeter also uses a shunt resistor to measure a voltage drop, which is then scaled to read amps. The difference, however, is that the resistor is not normally connected directly in the AC wire of the circuit to be measured. A device called a current transformer (CT, see Current Transformer) is placed around the AC wire. A current is induced in the CT, which is then passed through a load resistor. The digital meter actually measures the voltage across this load resistor and internally scales it to read the appropriate number of amps.

Portable

Most portable meters today are digital and use the same techniques of measurement as described above. However, they are commonly limited to a few amps when connected in series to measure current. If high currents are to be measured, the portable meter must use some external sensing means. Commonly these consist of shunt resistors and clamp-on ammeter sensors that use Hall Effect sensors. (Operation of which are beyond the scope of this appendix. In short, they generate a voltage, which can be scaled to read amps just as the shunt resistor.)

ampacity

The current carrying capacity of a conductor or device.

ampere *see Coulomb*

Definition 1

The classic definition of an ampere is a unit of electric current flow equivalent to the motion of 1 coulomb of charge, or 6.25 X 10¹⁸ electrons, past any cross section in 1 second. This is an intuitive way to think about an ampere. It is the flow of a huge number of electrons through a conductor.

Definition 2

In 1948 this alternative definition was adopted: A unit of electric current in the meter-kilogram-second system. It is the steady current that when flowing in straight parallel wires of infinite length and negligible cross section, separated by a distance of one meter in free space, produces a force between the wires of 2 x 10⁻⁷ newtons per meter of length.

ampere-hour

The electric charge transferred past a specified circuit point by a current of one ampere in one hour.

Amp-Hour Rating (AH)

This is a common rating for batteries. This is the total number of ampere-hours that a battery can deliver over 20 hours at a constant rate of discharge before the battery voltage falls below 10.5 volts.

analog

Refers to a signal or input that varies continuously over time. Voltages and currents are analog signals, as are temperature and pressure.

anode

The electrode of an electrochemical cell with the more negative potential. The less noble metal of an electrolytic cell that tends to corrode.

B

battery *see also Cell*

Two or more cells connected together. Thus a group of batteries connected together can also be referred to as a battery.

battery bank

When groups of batteries are wired in series or parallel or a combination to increase voltage or capacity the entire group is referred to as a battery bank. When batteries are connected in series the amp-hour rating is the same and the voltage is additive. When batteries are connected in parallel the voltage is the same and the amp-hour rating is additive.

battery state-of-charge

The term is used to describe and estimate of how much energy the battery is able to deliver. There have been many attempts to develop improved state-of-charge estimates. The most common methods include: specific gravity, at-rest open-circuit voltage, and amp-hour measurement.

battery switch rating

see *Continuous Switch Rating and Intermittent Switch Rating*

battery types

AGM (Absorbed Glass Mat)

A technique for sealed lead-acid batteries. The electrolyte is absorbed in a matrix of glass fibers, which holds the electrolyte next to the plate, and immobilizes it, preventing spills. AGM batteries tend to have good power characteristics, low internal resistance, and good behavior during charging.

Flooded

A design for lead-acid batteries. The electrolyte is an ordinary liquid solution of sulfuric acid. Flooded cells are prone to making gas while being charged. Flooded cells must be periodically checked for fluid level and water added as necessary. Flooded cells are also typically less expensive than AGM or gel cell type lead-acid batteries.

Gel cell

Gel or sealed lead acid batteries are basically the same chemistry as a wet (flooded cell) battery. The batteries' electrolyte is in a gelatin form and is absorbed into the plates and the battery is sealed with epoxies. The batteries are exceptionally leak resistant and may be used in any position. Battery uses include UPS, emergency lights, and camcorders. These batteries are 2 volts per cell, so the common batteries are 4, 6, and 12 volt.

blade

That portion of a fuse to which the fuse block connects.

bonding, cathodic

The electrical interconnection of metal objects in common contact with water, to the engine negative terminal, or its bus, and to the source of cathodic protection.

branch circuit see also *Main*

The portion of the wiring system after the main circuit protection device.

break (rating)

The amount of current that can be passing through a set of contacts, such as those in a solenoid, when they open, without damaging the contacts. This can be a rating for a single event or over some number of cycles, generally 1,000, 10,000 or 1,000,000.

bulk

That part of a multi-stage charge regime at which the maximum amount of current is flowing. This is normally limited by the size of the charging source. Lead acid batteries have the ability to accept, or absorb, large charging currents as long as they do not overheat or begin gassing. The bulk cycle allows the fastest possible charge.

bus, busbar

A bus is a group of common connections, often consisting of a strip of copper or brass with a number of screws or bolt studs for the connection of wires. It may be a negative or a positive bus.

C

CE (Conformité Européenné)

The CE marking is a conformity marking consisting of the letters "CE". The CE marking is applied to products regulated by certain European health, safety and environmental protection legislation. The CE marking is obligatory for products it applies to. The manufacturer affixes the marking certifying that the product conforms to applicable regulations, in order to be allowed to sell the product in the European market.

CFR (Code of Federal Regulations)

The written regulations of the United States Federal Government.

cathode

The electrode of an electrochemical cell with the more positive potential. The more noble metal of an electrolytic cell that tends not to corrode.

cell

An electrochemical system that converts chemical energy into electrical energy. Typically consisting of two conductive plates with different galvanic potential immersed in an electrolyte.

cell, primary

An electrochemical device, which is discharged only once and then, discarded.

cell, secondary

see also *Battery*
An electrochemical device, which may be discharged and recharged a number of times.

charge

Classically refers to an accumulation of electrons producing an electrostatic charge. In common use it often refers to restoring energy to a battery. Specifically, it would refer to the part of a multi-stage battery charging cycle when the voltage was held constant at or about the gassing voltage.

charge cycle

The stages through which a multi-stage charging source restores energy to a battery. A four-stage charge cycle includes:

bulk or charge cycle

Constant current for fast charging

acceptance or absorption cycle

Constant voltage for thorough charging

float cycle

For maintenance and long life

equalization cycle

Controlled overcharge for maximum capacity. see *key words above*

circuit

A closed path of electrically, or electro-magnetically connected, components or devices that is capable of current flow. Typically consisting of loads, sources, conductors, and circuit protection (circuit breakers and fuses). For example: A battery, fuse, and bilge pump connected together with wire are a circuit. The path must be continuous and closed.

circuit breaker

A device that, like a fuse, interrupts current in an electric circuit when the current becomes too high. Unlike a fuse, a circuit breaker can be reset after it has tripped. When high current passes through the circuit breaker, the heat it generates or the magnetic field it creates causes a trigger to rapidly separate the pair of contacts that normally conduct the current.

Circular mils

A method of specifying wire size mathematically. One Circular Mil is a unit of area equal to that of a circle .001" in diameter. The actual area of a Circular Mil is:

$$A = \pi r^2$$

$$A = 3.1428 \times (.0005)^2 \text{ inches}$$

$$A = .0000007857 \text{ square inches}$$

Class-T fuse

A very robust fuse with a 20,000 AIC. It also has very fast response to short circuit currents.

coil

see *inductor*

Cold Cranking Amperes (CCA)

see also *Marine Cranking Amperes*
CCA is the discharge load in amps which a battery can sustain for 30 seconds at 0° F. (-18° C) and not fall below 1.2 volts per cell (7.2V on 12V battery). This battery rating measures a burst of energy that an engine needs to start in a cold environment. This

rating is used mainly for rating batteries for engine starting capacity and does not apply to NiCad batteries, NiMH batteries or Alkaline batteries.

common

May have more than one meaning. Typically denotes a bus that is at ground potential most often. The negative bus is called "the common"; sometimes the neutral bus is also called "the common". May also mean a group of connections that are connected together "in common" even though they are at a different potential than ground.

conductivity

Conductance is the reciprocal of resistance, which depends on the resistivity constant of the material. Resistivity is the resistance of a conductor having unit cross section and unit length. Conductivity is the reciprocal of the resistivity. Its units are 1/ohm-cm or ohm/cm, or 1/ohm-circular mils/ft.

conductor

That part of an electrical circuit whose resistance relative to the balance of the circuit is zero. For example, in a circuit consisting of a light bulb and a battery, connected together with wire, the wire is referred to as the conductor.

Conformité Européenné

see *CE*

continuous current

The current flow, which a device or a conductor can carry, consume, or supply with no time limit. The continuous current rating is normally dependent on the temperature, since resistance increases with temperature. For battery switches the continuous current rating is established by testing for one hour at the rating. This is reasonable since thermal equilibrium would be reached within one hour.

continuous switch rating (UL 1107)

The two ratings in the UL marine battery switch standard are Intermittent and Continuous. Intermittent is a 5 minute rating and is based on temperature rise of various sections of the switch as the rated current is applied over a 5 minute period. The Continuous rating is the same, but the time period is 1 hour.

converter

An electrical device that converts one type of electrical energy into another. Battery chargers convert AC power to DC to charge the battery. Inverters convert DC power into AC, both are converters. Often used in RV industry to mean a power supply that runs the domestic DC loads when shore power is available.

coulomb see also *Ampere*

The measurement unit of electric charge, which is determined by the number of electrons in excess (or less than) the number of protons. Classically a charge of 1 coulomb = 6.25 X 10¹⁸ electrons. The meter-kilogram-second unit of electrical charge equal to the quantity of charge transferred in one second by a steady current of one ampere.

counterpoise

That portion of an antenna system composed of wires or other types of conductor arranged in a circular pattern at the base of the antenna at a certain distance above ground. Insulated from the ground, it forms the lower system of antenna conductors.

cranking (starting)

Normally associated with "cranking current" which is the current required by the starter circuit prior to engine starting. The cranking current varies significantly during the starting cycle. Initially, there is a large surge of current required to overcome the inertia and compression of the engine. This surge can be two to four times the average cranking current. Once the engine is turning there are peaks and valleys as the pistons go through the compression and exhaust cycles. The cranking current rating is used for sizing batteries, cables, and battery switches.

current *see also Amperage*

Current is a flow of electrical charge carriers, usually electrons or electron-deficient atoms. The common symbol for current is the uppercase letter I. The standard unit is the ampere, symbolized by A. Physicists consider current to flow from relatively positive points to relatively negative points; this is called conventional current or Franklin current. Electrons, the most common charge carriers, are negatively charged. They flow from relatively negative points to relatively positive points.

Electric current can be either direct or alternating. Direct current (DC) flows in the same direction at all points in time, although the instantaneous magnitude of the current might vary. In an alternating current (AC), the flow of charge carriers reverses direction periodically. The number of complete AC cycles per second is the frequency, which is measured in Hertz. An example of pure DC is the current produced by an electrochemical cell. The output of a power-supply rectifier, prior to filtering, is an example of pulsating DC. The output of common utility outlets is AC.

current rating

The maximum current in amperes that a device will carry continuously under defined conditions without exceeding specified performance limits.

current transformer *see also Ammeter*

The "CT", as current transformers are commonly referred to, is used by AC ammeters to "sense" current flow in a wire in an AC circuit. It is a toroidal coil of wire through which a wire whose current we wish to measure is passed. It is normally encapsulated and looks like a "doughnut", which is how electricians commonly refer to it. The doughnut has two wires coming out of it, which are connected to the AC ammeter. As current flows in the AC wire we wish to measure, it induces a current flow in the current transformer. The magnitude of the current varies directly with the current flowing in the AC wire. Current transformers are rated by the number of maximum amps that can flow in the measured wire and the current generated, by the CT, at that current flow. For example: A 50:5 CT is rated for 50 amps flowing in the measured wire, and it generates 5 amps of current as a consequence.

cycle

A cycle of a battery is a discharge plus a charge. For example, if a fully charged battery has a load applied, is then discharged and recharged, that is one cycle. Cycle life is the total number of cycles a battery yields.

D

DC *see Direct Current*

deep-cycle batteries

Batteries with thick plates to allow for reserve energy to be stored within the battery plate and released during slow discharge for prolonged periods. The high-density active material remains within the batteries' plate/grid structure longer, resisting the normal degradation found in cycling conditions. Deep cycle batteries are typically used where the battery is discharged to a great extent and then recharged.

delay

A difference in time between the initiation of an event and its occurrence, or between an event's observation and enunciation of it. This is usually used to refer to the time between the application of current through to a fuse or circuit breaker and the time when the device opens.

derating

A decrease in a device's rating, usually amperage, due to its application in ambient conditions different from those in which it was tested or for which it was designed originally.

dielectric strength

The maximum voltage that a material can withstand without allowing the two voltage potentials to short together.

Specifications subject to change. See www.blueseas.com for current information.

digital

A digital signal is one which has only two valid values denoted as 1 or 0. Commonly these are equated to distinctly different voltage. For example: A voltage of +5V would equal a 1 and a voltage of 0V would equal a 0.

A digital meter is one that displays values as numerical values rather than as the position of a meter on a relative scale.

Direct Current (DC)

An electric current that always flows in the same direction. The magnitude may vary but the current direction is always the same. Commonly referred to as DC. Examples of direct current sources are batteries, fuel cells, and photovoltaic cells. DC sources such as battery chargers and alternators actually use rectified AC current as the source.

discharge

Refers to the consumption of energy from a battery, or to the electrostatic discharge associated with a lightning bolt, capacitor, etc.

double insulation system

An insulation system comprised of basic insulation and supplementary insulation, with the two insulations physically separated and arranged so they are not simultaneously subjected to the same deteriorating influences to the same degree.

double pole

Indicates a switch, relay, or circuit breaker with two separate conductive paths, which are opened or closed simultaneously when the device is operated.

E

Earth

The third planet from the sun in Astronomy, but in electrical terms it refers to a connection, which is made to a conductor that is connected to the planet Earth. In grounded electrical systems there is a connection, which is a copper rod or some other highly electrically conductive connection, to the actual Earth. This is to ensure a safe conductive path for a short circuit, which in turn helps prevent electrocution.

electrode

A conductive material, in an electrolyte, through which electrical current enters or leaves.

electrolysis

Chemical changes in a solution, or electrolyte, due to the passage of electric current.

electrolyte

A liquid in which ions are capable of migrating and, therefore capable of conducting current. Solutions of acids, bases, and salts in water are electrolytes.

electron *see also Coulomb*

An electron is a negatively charged subatomic particle. It can be either free (not attached to any atom), or bound to the nucleus of an atom. In electrical conductors, current flow results from the movement of free electrons from atom to atom individually, and from negative to positive electric poles in general.

The charge on a single electron is considered as the unit electrical charge. It is assigned negative polarity. Electrical charge quantity is not usually measured in terms of the charge on a single electron, because this is an extremely small charge. Instead, the standard unit of electrical charge quantity is the coulomb, symbolized by C, representing about 6.25×10^{18} electrons.

Electromotive Force (EMF)

Commonly referred to as voltage, electromotive force is the energy per unit of charge that is supplied by a source of electrical energy such as a battery, charger or alternator.

Electromagnetic Interference (EMI)

Noise generated by a load (typically by electrical switching action). Usually specified as meeting agency limits for conducted EMI (noise conducted back onto the power bus) or radiated EMI (noise emitted into the area surrounding a device).

energy *see also Power*

The classically simple definition is, the capacity to do work. Energy may be manifested as, mechanical motion, thermal heat, or electrical power, which is consumed, radiated, dissipated, or stored over a period of time. The energy in a direct-current circuit is equal to the product of the voltage in volts, the current in amperes, and the time in seconds. The units for energy are Watt-hours. In alternating current (AC) circuits, the expression for energy is more complex.

engine negative terminal

The point at which the engine negative, generally the engine block, is connected to the negative of the battery.

equalization *see Charge Cycle*

Equalization is a controlled overcharge, which removes lead-sulfate that is not converted during normal charging. Equalization is best accomplished by using a constant current of 2-7% of battery capacity while allowing the battery voltage to rise to its highest "natural voltage". For a 12V battery this can be as high as 16.2V. The equalization cycle is continued until the specific gravity of all cells cease to continue to rise and are approximately equal. The equalization cycle should only be used on liquid electrolyte batteries and only while the operator is on the premises.

equalizer

A device wired across the same potential poles of a multiple bank battery bank consisting of serially wired batteries, i.e., two 12 volt batteries in series to produce 24 volts. An equalizer maintains half its input voltage at its output terminals. When loads are taken off one of the batteries in the bank at that batteries voltage, which is half of the bank voltage, the equalizer senses that battery's voltage is no longer the one half the voltage of the entire bank and the equalizer "recharges" the lower voltage battery from the higher voltage battery.

F

fast, fast acting *see also Delay*

Refers to the amount of time that a fuse can endure an over-current before blowing. Fast fuses are used to protect sensitive equipment.

fault

A defect in the normal circuit configuration, usually due to unintentional grounding. Commonly referred to as a short circuit.

field

Typically refers to a magnetic field. Specifically used when discussing the rotating electro-magnetic field associated with an alternator. By varying the field current, thus its strength, the output of the alternator may be controlled.

float charge

see also Bulk, Acceptance, Equalization

A constant voltage, well below the gassing point, that is applied to a battery to maintain its capacity. The voltage is such that neither charging nor discharging is occurring.

frequency *see also Hertz*

For an oscillating or varying current, frequency is the number of complete cycles per second in alternating current direction. The standard unit of frequency is the hertz, abbreviated Hz. If a current completes one cycle per second, then the frequency is 1 Hz; 60 cycles per second equals 60 Hz (the standard alternating-current utility frequency).

fuse

A fuse is a safety device, consisting of a strip of low-melting-point alloy, which is inserted in an electric circuit to prevent excess current from flowing. If the current becomes too high the alloy strip melts, opening the circuit.

fusible link

A type of fuse with a replaceable conductive alloy link that may be replaced if it “blows” due to over-current.

G

galvanic corrosion

The corrosion that occurs at the anode(s) of a galvanic cell.

galvanic isolator

A device installed in series with the (AC) grounding (green) conductor of the shore-power cable to effectively block low voltage DC galvanic current flow, but permit the passage of alternating current (AC) normally associated with the (AC) grounding (green) conductor. This is typically two diodes wired in parallel facing opposite directions, sized to meet full fault current.

galvanic compatibility chart

A list of metals and alloys arranged in order of their potentials as measured in relation to a reference electrode when immersed in seawater. The table of potentials is arranged with the anodic or least noble metals at one end, and the cathodic or most noble metals at the other.

generator

A rotating machine capable of generating electrical power. In the narrow definition generator refers to a DC machine and alternator refers to an AC machine. However, in common use the term generator is used to refer to AC machines as well.

green wire

The green wire is the non-current carrying safety grounding wire in an AC system in the United States. It is connected to an exposed metal part in the electrical system to provide a path for fault current in the case of a short circuit.

ground fault

GFI (Ground Fault Interrupter)

GFI is a generic term referring to both GFCI and GFP

GFCI (Ground Fault Circuit Interrupter) see GFI

A device intended for the protection of personnel that functions to de-energize a circuit, or portion thereof, within an established period of time when a current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

GFP (Ground Fault Protector) see GFI

A device intended to protect equipment by interrupting the electric current to the load when a fault current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protection device of that supply circuit.

ground, ground conductor

A point in a circuit which is at zero potential with respect to the Earth, or which is at the lowest potential in the system, (as with a floating ground).

grounded

The AC current carrying conductor that is intentionally maintained at ground potential, also called neutral.

grounding, grounding conductor

The AC conductor, not normally carrying current, used to connect the metallic non-current carrying parts of electrical equipment to the AC system and engine negative terminal, or its bus, and to the shore AC grounding conductor through the shore power cable. This term can also refer to the normally non-current carrying conductor used to connect metallic non-current carrying parts of direct current devices to the engine negative terminal, or its bus, to minimize stray current corrosion.

ground plate

A conductive plate, commonly sintered copper, that is placed in contact with seawater to provide a connection to earth for a boat’s ground systems.

H

Hertz *see Frequency*

Hertz is a unit of frequency of one cycle per second. It replaces the earlier term of “cycle per second (cps).” The abbreviation for Hertz is Hz.

hot

Hot usually refers to the ungrounded current carrying conductors in an AC system. These would typically have a voltage of 120V or 240V in the United States. The term Hot is also used to describe a circuit that is energized, and has a potential greater than ground.

I

IACS

see International Annealed Copper Standard

Impressed current

Direct current supplied by a device employing a power source external to the electrode system of a cathodic protection installation. The impressed current is used to counteract the undesired galvanic current.

inductance

An effect in electrical systems in which electrical currents store energy temporarily in magnetic fields before that energy is returned to the circuit.

inductor *see Coil*

A length of wire that is wound around a core that is used as a storage element for a magnetic field in an electric circuit.

inrush

The momentary steep wave front of very high current exhibited by a load on initial application of power.

Intermittent switch rating (UL 1107)

The two ratings in the UL marine battery switch standard are Intermittent and Continuous. Intermittent is a 5 minute rating and is based on temperature rise of various sections of the switch as the rated current is applied over a 5 minute period. The Continuous rating is the same, but the time period is 1 hour.

International Annealed Copper Standard

Abbreviated as IACS, this is a measurement of relative electrical conductivity that uses copper as the standard of 100%. The expression “Brass 28 IACS” would mean that the brass under discussion had 28% of the electrical conductivity of an identically sized piece of copper.

interrupt rating (AIC)

The fault current that a device, normally a fuse or circuit breaker, is capable of breaking without damage to the circuit.

inverter

An inverter converts DC power stored in a battery to AC power which is used by most household appliances.

Ignition protection (IP)

Devices, which operate in a potentially explosive environment, must be ignition protected. This would include engine rooms with gasoline engines. There is a very specific set of tests which a device must pass to claim ignition protection. They include operating safely in an explosive mixture of propane and air.

isolation transformer

A transformer that is inserted in series with the incoming AC power to provide a magnetic coupling for power between the ship’s systems and the AC grid. By magnetically coupling the power there is no direct connection by wires, which isolates the ships AC system from the AC grid.

isolator

Refers to two or more diodes wired in parallel and then inserted in series with the output of an alternator. This allows for the alternator to charge multiple batteries. The voltage drop across the diodes can cause incomplete charging. Isolators should not be used with alternators that use internal voltage sensing for regulation. To be properly installed the voltage sense lead must come from the house battery.

J, K

kilo

A prefix in the metric system equal to 1000 times, as in kilohertz, 1000 cycles per second.

L

line *see also Load*

The conductors that are at the supply of energy to a circuit. Line normally refers to the current carrying non-grounded conductors in an AC system.

line loss *see Voltage Drop*

The power loss that occurs due to amperage flowing through the resistance of conductors over their length.

listed (UL Listed)

Indicates that a device or component has met certain specifications as set forth by Underwriters Laboratory. Further, it means that the device or component has been tested for conformance and ‘listed’ with UL so it can use the UL logo and claim conformance to the specification.

load *see also Line*

A device that consumes power and does work.

load group

A collection of loads, which normally have similar characteristics. For example the lighting circuits might be considered a load group. Also implies that the loads are supplied by a common bus.

lockouts (AC)

A device allowing the selection of only one source from multiple AC sources, preventing the connection of more than one source of AC power to a bus at the same time.

M

magnetic

Displaying the characteristics of a magnet, including being able to induce current flow in a conductor when relative motion exists between them and being able to attract ferrous materials.

main *see also Branch Circuit*

Refers to the main circuit breaker or bus in a power distribution system. This is the input power source for the system.

make (rating)

The current that a breaker, switch, or relay can connect into without damaging the device.

make before break

Describes a switch action that connects the new circuit before disconnecting the old. This type of switch action is required for battery selector switches in order to avoid an open circuit for the engine alternator, which can cause extreme voltages that can damage the alternator and accessory electronics.

Marine Cranking Amperes (MCA)

MCA is the discharge load in amps, which a battery can sustain for 30 seconds at 32°F (0° C), and not fall below 1.2 volts per cell (7.2V on 12V battery). This battery rating measures a burst of energy that an engine needs to start in a cold environment.

modified sine wave

A marketing term to describe an AC waveform, created by an inverter that is a pulse width controlled square wave. While an improvement on the classic square wave inverter, it is not actually a sine wave or a close approximation.

motor circuit protection

Motors require circuit breakers or fuses that are specifically designed for their current requirements. This is because motors require a high initial surge of current to get them started.

N

NEC see *National Electrical Code*

NEMA

National Electrical Manufacturers Association

N-type (alternator)

An N-type alternator has a set of diodes, called the diode trio, which supply the positive DC potential required for the rotating field current. The actual regulator switches the negative to achieve the proper field strength to create the desired correct alternator output.

National Electrical Code NEC

The NEC is developed and maintained by the National Fire Protection Association which describes how residential, commercial, and RV electrical systems must be installed. The NEC is adopted, sometimes with revision, by states that also adopt the Uniform Building Code. Electrical inspections required by most building permits follow the NEC. While not required aboard boats, the NEC is a valuable guide to safe electrical systems. The goal of the NEC is personal safety and fire prevention.

neutral see also *Single Phase*

The neutral is the grounded current carrying conductor in a single phase, four wire, 120/240V AC system.

neutral-to-ground bonding

Connecting the ground and the neutral together via an electrical conductor.

neutral-to-ground switching

In the US, inverter/charger installations that are used in marine applications must have neutral-to-ground switching. This guarantees that the neutral and the green wire are common after the green wire connection to neutral that is achieved through the shore power cord no longer exists after the cord is disconnected and shore AC is no longer serving as the boat's AC source. There must also be only a single ground point in the AC system. This prevents a voltage differential from developing between the boat's AC neutral and the shore or genset AC neutral, which may cause an electric shock or nuisance tripping of GFI's.

non-inverter loads

Non-inverter loads are heavy loads that are not appropriate to run from an inverter because the load on the batteries would be excessive or illogical. They include hot water heater, electric space heat, air conditioning, heavy pumping loads, etc. A battery charger that supplies the same battery as is being used by the inverter would also be a non-inverter load.

nuisance trip

A circuit breaker or fuse, which trips or blows without the circuit actually being overloaded. This may be due to weak breaker or a surge current which requires a slow tripping breaker or a slow blow fuse.

O

ohm

The unit for resistance equals $V/I = \text{volts/amps}$. The unit of resistance is the ohm, symbol Ω , the Greek letter Omega.

Ohm's law

States that the ratio of the EMF (Electromotive Force) applied to a closed circuit to the current in the circuit is a constant. That constant is the resistance of the circuit. It may be stated as $V = IR$ (or $E = IR$, using E as the abbreviation of EMF whose units are volts). The unit of resistance is the ohm.

open

Indicates a condition in an electric circuit in which there is a break in the conductive path. The break may be intentional such as an open switch or relay or it may be unintentional such as a broken wire or a blown fuse. In any case, the continuous conductive path required for an electric circuit is not available.

open circuit voltage

Generally, the voltage of a source when it is not connected to a load through an electrical circuit. Specifically, the voltage of a battery when it is not delivering or receiving power. A typical value for a liquid lead acid battery is 12.8V for a fully charged battery which has not been charged or used for 24 hours. Open circuit voltage is sometimes used as an indicator of the state-of-charge of a battery.

The table below gives typical open circuit voltages for both liquid and gelled electrolyte lead-acid batteries at various states-of-charge. These voltages should be considered approximations and may vary according to manufacturer and the specific gravity of the electrolyte the battery is initially filled with.

Typical Open Circuit Voltage After 24 Hours for Liquid and Gelled Electrolyte Batteries

Percent Charge	Liquid Electrolyte per cell voltage	Liquid Electrolyte Nominal 12V Battery	Gelled Electrolyte per cell voltage	Gelled Electrolyte Nominal 12V Battery
100%	2.10	12.60	2.175	13.05
80%	2.09	12.54	2.13	12.78
60%	2.07	12.42	2.08	12.48
40%	2.04	12.24	2.05	12.30
20%	1.98	11.80	2.02	12.12
0%	1.95	11.70	1.98	11.88

overcurrent

When the current in a circuit exceeds the rating of the devices or conductors in it. Fuses and circuit breakers protect from overcurrent by opening the circuit if such a condition exists and/or persists.

P

PE

see *Protective Earth*

P-type (alternator)

A P-type alternator is one which one end of the coil which supplies the rotating magnetic field is connected to the negative and the regulator controls the positive side of the coil to regulate the alternator output.

panelboard

A collection of circuit breakers, switches, and instrumentation installed into a panel which provides the central point for power distribution and monitoring for the electrical system. May also refer to a smaller panel which is located remotely from the main panel which is used to supply loads in the adjacent area. In the marine industry they are usually called "panels", or "circuit breaker panels", or "distribution panels".

parallel circuit

An electrical circuit in which the positive connections are all in common and the negative connections are all in common. The voltage of the system appears across each branch of the circuit. The current varies as required by each load or source.

parallel device

A switch, solenoid, relay, or solid state device which is used to connect multiple batteries or busses together.

paralleling switch

Typically refers to a battery switch that allows multiple batteries to be connected together for engine starting. Often used to connect the battery serving the domestic system to the engine starting circuit for emergencies.

percent of charge

An estimate of the remaining charge in a battery. Percent of charge is very difficult to determine accurately without sophisticated microprocessor based calculations.

Peukert's equation

A formula that shows how the available capacity of a lead-acid battery changes according to the rate of discharge. The capacity of a battery is expressed in Amp-Hours, but the simple formula of current times hours does not accurately represent the situation. Peukert found that the equation: $C = I^n T$ fits the observed behavior of batteries. "C" is the theoretical capacity of the battery, "I" is the current, "T" is time, and "n" is the Peukert number, a constant for the given battery. The equation captures the fact that at higher discharge current, there is less available energy in the battery.

pigtail

Wires which protrude from a device to connect it to the circuit. Often used in encapsulated products. Sometimes refers to a method of hooking up circuits in which a group of conductors are connected together and then one wire is connected to the circuit. This is done in order to simplify wiring.

plate (battery)

Flat, typically rectangular components that contain the active material, lead or lead compound, and a mechanical support structure called a grid, which also has an electrical function, carrying electrons to and from the active material. Plates are either positive or negative, depending on the active material they hold.

polarity

Refers to the electrical charge, which may be positive or negative. It also refers to the positive and negative terminals of a battery or load in a DC system. In AC systems it refers to the connections made to the hot and neutral. There is often a reverse polarity light that indicates if the neutral and hot are reversed.

polarized system

An electrical system in which the positive and negative or the hot and neutral must be connected in a particular way and cannot be switched. Sometimes there are mechanical preventions to insure the correct polarity. For example, in an AC plug the physical configuration of the plug and receptacle force a polarized connection.

pole

Indicates a conductive path in a switch or relay. Switches that are single pole have one conductive path, switches that are two pole have two conductive paths. Also refers to the magnetic poles on an electromagnet or a permanent magnet.

potential

The voltage across a circuit element. Implies the potential to do work.

power

Electrical power is the rate at which electrical energy is converted to another form, such as motion, heat, or an electromagnetic field. The common symbol for power is the uppercase letter P. The standard unit is the watt, symbolized by W. In utility circuits, the kilowatt (kW) is often specified instead; 1 kW = 1000W.

Power in a direct current (DC) circuit is equal to the product of the voltage in volts and the current in amperes. This rule also holds for low-frequency

alternating current (AC) circuits in which energy is neither stored nor released. At high AC frequencies, in which energy is stored and released (as well as dissipated or converted), the expression for power is more complex.

In a DC circuit, a source of V volts, delivering I amperes, produces P watts according to the formula: $P = VI$

When a current of I amperes passes through a resistance of R ohms, then the power in watts dissipated or converted by that component is given by: $P = I^2R$

When a potential difference of V volts appears across a component having a resistance of R ohms, then the power in watts dissipated or converted by that component is given by: $P = V^2/R$

power factor

In an AC, circuit loads other than resistance shift the phase angle between the voltage and the current. This shift is the result of energy being stored and released in inductors and capacitors. Since this storage does not represent a consumption of power, a power measurement must take the relative phase of voltage and current into account. The ratio of actual power to the simple product of measured voltage and measured current is called the power factor. Modern electronic devices such as microwave ovens, battery chargers, and computers do not draw current in the same sinusoidal wave shape as the incoming voltage. These distorted wave shapes are also less effective at delivering power and give rise to a power factor less than unity because of the additional frequencies present in the current waveform.

propagation

The transmission of an electrical or electromagnetic signal through a medium such as air or a conductor.

Q, R

RCBO or RCCB

Residual Current Circuit Breaker is a circuit breaker that includes an overcurrent trip mechanism like a conventional breaker and includes a leakage current trip that responds to current returning through a ground path instead of the neutral conductor or the other wires of a circuit with multiple live lines. The principle is the same as a Ground Fault Circuit Interrupter but RCCB's typically have a ground fault limit of 30mA or 100mA instead of 6mA of a GFCI used for personnel protection. GFCI's are generally useful for protecting a single load or a single branch circuit but are too sensitive for use as main circuit breakers. RCCB's are used for main circuit protection in Europe for boats, houses and commercial power distribution. Without this additional protection, as much as 40 Amps can flow in the ground wire, or into the water without tripping a conventional main circuit breaker.

RCD see also Residual Current Device

Recreational Craft Directive - European Directive 94/25-EC relating to recreational craft.

Following are special definitions related to the RCD:

CD

Committee Draft – the first draft circulated for comment by ISO Small Craft Technical Committee Working Group developing the standard.

CEN

The European Committee for Standardization.

DIS

Draft International Standard – an advanced draft where comments on the CD have been taken into account. Minor comments accepted by the Working Group will be incorporated in the FDIS, major changes will result in a second circulation as a DIS.

EN

European Standard (Norme).

FDIS

Final Draft International Standard – the last voting stage where standard bodies can only vote “yes” or “no” and the only changes will be editorial.

ICOMIA

The International Council of Marine Industry Associations – the International Marine Industry Trade Association, which represents 24 national marine industry associations. That includes virtually all countries with an active marine industry in Europe, North America, Asia and Australia. Its officers and members represent its members' views at the EU Commission, ISO, and CEN and its members' representatives are actively involved in all the RSG Standards Working Groups.

ISO

International Standards Organization

PREN

The abbreviation used by CEN to identify a draft standard at any stage.

WG

Working Group – the committee whose members have been nominated by their national standards body to develop any new standard required by the ISO Small Craft Tec. Committee (TC188) one of whom is chosen to act as the Convenor (Chairman/Secretary) by the TC188 members.

LIST OF EUROPEAN UNION (EU) & EUROPEAN ECONOMIC AREA (EEA) NATIONAL STANDARDS BODIES

Austria	ON	Italy	UNI
Belgium	IBN	Luxembourg	ITM
Denmark	DS	Netherlands	NNI
Finland	SFS	Norway*	NSF
France	AFNOR	Portugal	IPQ
Germany	DIN	Spain	AENOR
Greece	ELOT	Sweden	SIS
Iceland*	STRI	Switzerland	SNV
Ireland	NSIA	UK	BSI

* EEA countries – whose national standards bodies are participants in CEN debates, but have a non-voting status.

recognized (UL recognized)

A device that is UL Recognized differs from a device that is UL Listed. A Recognized device is expected to be installed within a larger assembly by a manufacturer, not in the field, and this larger assembly is then expected to be tested by UL. The UL Recognition then allows UL to skip testing of the specific embedded Recognized component. UL Recognition has little value for end users installing devices in the field.

rectifier

A device that allows current to flow in only one direction, such as a diode. Used to convert, or rectify AC current into DC.

regulator (voltage regulator)

A device, which uses a feedback loop to control the output of an alternator or other source. By measuring the output voltage and controlling the alternator field current, for example, the regulator is able to continuously adjust the alternator output to the desired voltage.

reserve capacity (battery)

RC is the number of minutes a new, fully charged battery at 80°F will sustain a discharge load of 25 amps to a cut-off voltage of 1.75 volts per cell (10.5V on 12V battery). This battery rating measures more of a continuous load on the battery.

residual current device

An RCD is an electrical safety device specially designed to immediately switch the electricity off when electricity is “leaking” to earth is detected at a level harmful to electrical equipment. In most countries using 50Hz power, an RCD is considered to provide personnel protection.

An RCD offers a high level of personal protection from electric shock when installed on a boat because the additional grounding through hull fittings is sufficient to trip and RCD during a fault. RCD's offer a backup level of safety if the green ground wire of a shore cable or a galvanic isolator has failed. Fuses or overcurrent circuit breakers do not offer the same level of personal protection against faults involving current flow to earth. RCDs are designed to operate within 10 to 50 milliseconds and to disconnect the electricity supply when they sense harmful leakage, typically 30 milliamps. See also GFI or GFCI devices which are similar in nature, but trip at 5mA for personnel protection. GFCI devices are required by ABYC standards for AC outlets in galleys, on deck and in machinery spaces. These cannot usually be used for the entire system because normal stray currents can cause nuisance tripping.

resistance

The opposition to the flow of current in an electric circuit as defined by Ohm's law. The unit of resistance is the ohm, symbol Ω , the Greek letter Omega.

reverse polarity

Describes a situation where the neutral and hot wires of an AC system are reversed. Most AC panels have an indicator to announce this condition, as it can be very dangerous.

RMS (Root-mean-square)

Root-mean-square (RMS) refers to the most common mathematical method of defining the effective voltage or current of an AC sine wave.

To determine RMS value, three mathematical operations are carried out on the function representing the AC waveform:

- (1) The square of the waveform function (usually a sine wave) is determined.
- (2) The function resulting from step (1) is averaged over time.
- (3) The square root of the function resulting from step (2) is found.

In a circuit whose impedance consists of a pure resistance, the RMS value of an AC wave is often called the effective value or DC-equivalent value. For example, if an AC source of 100 volts RMS is connected across a resistor, and the resulting current causes 50 watts of heat to be dissipated by the resistor, then 50 watts of heat will also be dissipated if a 100-volt DC source is connected to the resistor.

For a sine wave, the RMS value is 0.707 times the peak value, or 0.354 times the peak-to-peak value. Household utility voltages are expressed in RMS terms. A so-called “117-volt” AC circuit has a voltage of about 165 volts peak (pk), or 330 volts peak-to-peak (pk-pk).

S

SAE (Society of Automotive Engineers)

An organization which sets standards for various equipment used in the automotive industry. Since much of the basic equipment used in the marine industry originates in the automotive industry it can be a relevant specifications body for the marine industry as well.

SAE wire gauge

Wire sizes as specified by the SAE, specifically for stranded wire, similar to the AWG, see also AWG. The same gauge in SAE wire has a smaller conductor than in AWG wire.

sacrificial anode

A less noble metal intentionally connected to form a galvanic cell with a more noble metal for the purpose of protecting the more noble metal from corrosion. Most commonly zinc.

safety green (ground) wire

The non-current carrying conductor in a three wire 120V or four wire 240V AC circuit, it provides a safe path for fault current. See also green ground wire.

sealed lead-acid

see *Gel Cell self-limiting*

A device whose ability to limit output power regardless of input power is intrinsic to its design.

sheath

A material used as a continuous protective covering around one or more insulated conductors. The ABYC uses this term when discussing the allowable length of a conductor before it must have over current protection. The distance is extended if it is in a sheath.

shore power

AC utility power that is available when plugged into an outlet that is supplied from the main utility system.

short circuit

A conductive path of zero resistance. Typically refers to an unintentional connection between two conductors of opposite polarity. If a voltage is applied to a short circuit the current becomes very large and can start a fire, thus the need for short circuit, or overcurrent, protection in the form of fuses or circuit breakers.

shunt

A shunt resistor is a precise, low Ohm resistor that is temperature stable. It is used as a current "sensor" by using a millivolt meter to measure the voltage drop across it. Large current shunts are commonly made of one or more strips of manganin, a copper alloy capable of carrying high currents, that are soldered between machined blocks of brass with connecting bolts.

Shunts are rated according to the number of Amps they are capable of carrying and the voltage which is generated across the shunt when the rated current is being passed through it. Common shunt ratings include 100A 100mV or 500A 50mV. The resistance can be calculated by using Ohms Law, $V=IR$, $50mV=500A(R)$, therefore $R=0.1m\Omega$, or 0.0001Ω . This is a very small value of resistance; it must be in order to minimize the power loss when large currents are flowing.

The shunt normally has two separate screws with which the sense leads are attached. It is important to realize that the integrity of these connections are critical to accurate measurement and should not be used as current carrying connections.

sine wave

A waveform that can be expressed as the graph of the equation $y = \sin x$. The utility AC power is a sine wave.

single phase

The typical 120/240V AC system in the United States is a single phase system, meaning that the current flow in the two conductors is in phase or that they both cross zero at the same time.

skin effect

Skin effect refers to the phenomena of conductors' propagating AC current more efficiently on the conductors' surface than in its interior.

slow, slow blow see also *Delay*

A fuse that is a slow blow has a longer delay when subjected to over-current, before it fails. Slow blow fuses are required for loads that have high starting surges, like motors.

solenoid (relay)

An electromechanical device that is used to switch large currents. It consists of a coil of wire and a moving contact that makes an electrical connection when the coil of wire is energized.

source isolation (AC)

The arrangement of multiple AC power sources in such a manner that two AC sources cannot be connected to the same circuit simultaneously.

source selector

A switch or breaker configuration, which allows the user to pick which source to have connected to the bus. Typically used in AC systems with multiple sources such as shore power and one or more generators.

speed see *Delay*

Indicates how fast circuit protection devices react, specifically with respect to over circuit breakers and fuses.

square wave

An electrical waveform in which the current quickly goes from zero to its peak value in a step fashion. This is typical of inexpensive inverters.

starting bank

An arrangement of batteries that is designated for the function of engine starting.

storage battery

An electrochemical device capable of storing energy and releasing it and then able to be re-charged and repeat the process.

stray current

Unwanted current flows which occur due to a partial short circuit.

stray current corrosion

Corrosion that results when current from a battery or other external electrical (DC) source causes a metal in contact with an electrolyte to become anodic with respect to another metal in contact with the same electrolyte.

sulfation

Sulfation is the formation or deposit of lead sulfate on the surface and in the pores of the active material of the batteries' lead plates. If the sulfation becomes excessive and forms large crystals on the plates, the battery will not operate efficiently and may not work at all. Common causes of battery sulfation are standing a long time in a discharged condition, operating at excessive temperatures, and prolonged under or over charging.

surge

A large amount of current during the initial starting phase of a motor for example.

surge capacity

The measurement of the ability to withstand surge currents without damage.

surge current see also *Continuous Current*

The pulse of current that is associated with the initial large current required to start an electric motor, large resistive loads, and engine cranking.

switch

An electro-mechanical device that is intended to open an electrical circuit and thus turn a load or source on or off.

switchboard

see *Panelboard*

T

terminal

A connection point or device for an electrical circuit. A terminal strip is a series of screws which may or may not be connected to which wires are connected. Also refers to the connecting device which may be crimped on the end of a wire to enable it to be connected to the circuit with a screw, such as a ring terminal.

terminal studs

A threaded bolt onto which ring terminals may be placed and then fastened with a nut. Normally used for high current connections.

thermal

In a marine context thermal most commonly refers to a thermal circuit breaker, which uses the thermal effect of excess current flow to create differential expansion in a bi-metallic blade to open a circuit.

time-current curve see also *Delay*

A curve which depicts the relationship between the amount of current a fuse or breaker can hold with respect to time before opening the circuit.

tin plating

A plating of the element tin, which prevents corrosion. Commonly used to plate copper components such as a power bus.

toggle see also *Pole*

A switch which has a handle type actuator that can be placed in, at the most, three positions.

transfer switch, AC

see *source selector, Source Isolation*

An electrical relay or manual switch which selects an AC source alternative, such as a generator, shore power, or inverter.

transformer

see *Isolation Transformer*

trip free

A circuit breaker designed to trip when subjected to a fault current, even if the reset lever is held in the ON position.

U, V

ungrounded conductor

Any conductor that is not connected to the Earth ground system

volt (voltage)

The unit of electric potential and electromotive force, equal to the difference of electric potential between two points on a conducting wire carrying a constant current of one ampere when the power dissipated between the points is one watt.

volt-amps

The product of volts and amps, which is watts in a DC system and the apparent power in an AC system.

voltage drop

see *line loss*

W

watt

The unit of power which for a DC circuit is equal to volts times amps.

weatherproof

Constructed or protected so that exposure to the weather will not interfere with successful operation in rain, spray, and splash.

wire amperage rating

The current a conductor can carry under a set of specified conditions such as open air, in an enclosure, and at a specified temperature.

wire sizing

The process of selecting the appropriate sized conductor for the amount of current to be carried while considering the length of the circuit.

withstand voltage

The maximum voltage level that can be applied between circuits or components without causing insulation breakdown.

X, Y, Z

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2512	111	3176	80, 81	3488	80, 81	4015	117	5030	57	5211	59
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