

Glossary

Ambient temperature

The temperature of the environment surrounding a power supply.

Bandwidth

Based on the assumption that a power supply can be modeled as an amplifier, the bandwidth is that frequency at which the voltage gain has fallen off by 3 dB. Bandwidth is an important determinant of transient response and output impedance.

Bleed resistor

A resistor usually connected across a filter circuit to discharge capacitors when the unit is turned off.

Breakdown voltage

See: *Isolation*.

Bridge

- (1) Rectifier circuit incorporating four diodes (full-bridge) or two diodes (half-bridge).
- (2) Converter or chopper section of switching power supplies incorporating four transistors (full-bridge) or two transistors (half-bridge).

Brownout

Condition during peak usage periods when electric utilities reduce their nominal line voltage by 10% to 15%.

Brownout protection

The ability of a power supply to continue operating within specification through the duration of a brownout.

Burn in

The period directly following the very first turn-on of a given power supply. It is characterized by a relatively high and declining failure rate.

Bus

- (1) The system of conductors (wire, cable, copper bars, etc.) used to transport power from the power supply to the load.
- (2) A communications structure used to control various instruments and subsystems (e.g., IEEE-488 bus).

CB-report

Document necessary for the mutual recognition of approvals between different national test normes.

CEE (International Commission on Rules for the Approval of Electrical Equipment)

A regional, European safety agency in which the United States participates only as an observer.

Chopper

See: *Inverter*.

Common-mode noise

That component of noise common to the input and return or output and return lines with respect to an electrically fixed point, usually chassis ground.

Constant current

A power supply that regulates current level regardless of changes in load resistance.

Constant current limiting circuit

Current-limiting circuit that holds output current at some maximum value whenever an overload of any magnitude is experienced.

Constant voltage

A power supply that regulates voltage level regardless of changes in load resistance.

Convection

The transfer of thermal energy in a gas or liquid by currents resulting from unequal temperatures.

Converter

- (1) A device that delivers DC power when energized by a DC source.
- (2) Sections of a switching power supply that perform the actual power conversion and final rectification.

Cooling

Removal of heat, which, in a power supply, is generated by transformation, rectification, regulation, and filtering. It can be accomplished using radiation, convection, forced air, or liquid means.

Cross regulation

In a multiple-output power supply, the load variation of one output can cause a voltage change in other outputs. This voltage change divided by its nominal value is the cross regulation.

Crowbar

A type of overvoltage protection in which an SCR is placed directly across the output terminals of a power supply.

CSA (Canadian Standards Association)

An independent Canadian organization testing for public safety, similar to the function of Underwriters' Laboratories in the United States.

Current limiting circuit

A circuit designed to prevent overload of a constant-voltage power supply. It can take the form of constant, foldback or cycle-by-cycle current limiting.

Cycle-by-cycle current limiting circuit

Current-limiting circuit that immediately reduces output current to some minimum level whenever an overload of any magnitude is experienced.

Derating

A reduction of some operating parameter to compensate for a change in one or more other parameters. In power supplies, the output power rating is generally reduced at elevated temperatures.

Dielectric withstand voltage

See: *Isolation*.

Differential mode noise

That component of noise measured with respect to output or input to its return; it does not include common-mode noise.

Drift

See: *Stability*.

Dynamic load

A load that rapidly changes from one level to another. To be properly specified, both the total change and the rate of change must be stated.

Efficiency

The ratio of output power to input power. It is generally measured at full-load and nominal line conditions. In multiple-output switching power supplies, efficiency can be a function of total output power and its division among the outputs.

Electric strength test voltage

Ability of a power supply to withstand a high voltage potential placed either from the input terminals to ground, from any of the output terminals to ground, or between any pair of input and output terminals. This specification is important for safety reasons and is partially dependent on the mechanical design of the power supply.

EMC (electromagnetic compatibility)

Any electromagnetic effect: Emissions from elements within apparatus (motors, converters, choppers), disturbance of elements and measures for improving the functionality.

EMI (electromagnetic interference)

Also called radio-frequency interference (RFI), EMI is unwanted high-frequency energy caused by the switching transistors, output rectifiers, and zener diodes in switching power supplies. EMI can be conducted through the input or output lines or radiated through space.

ESR (equivalent series resistor)

The amount of resistance in series with an ideal (lossless) capacitor, which reduces the performance of a real capacitor. In general, the lower the ESR, the higher the quality of the capacitor and the more effective it is as a filtering device. ESR is a prime determinant of ripple in switching power supplies.

Faraday shield

An electrostatic shield wound on a transformer, designed to reduce interwinding capacitance. The result is less common-mode noise at the output of the power supply.

FCC (Federal Communications Commission)

United States federal regulating body whose new EMI limits affect the design and production of digital electronics systems and their related subassemblies, such as power supplies.

Ferroresonance

A principle used in a simple open-loop (non-feedback) voltage stabilizing power supply.

Filter

A frequency-sensitive network that attenuates unwanted noise and ripple components of a rectified output.

Flyback converter

Switching power supply configuration using a single transistor and a flyback diode.

Foldback current limiting circuit

Current-limiting circuit that gradually decreases the output current under overload conditions until some minimum current level is reached under a direct short circuit.

Forward converter

Switching power supply configuration using a transistor.

Frequency changer

Power-conversion equipment that transforms AC electric power from one frequency to another without affecting its other characteristics.

Full-bridge converter

Four-transistor switching power supply configuration used to handle high power levels.

Full-wave rectifier

Rectifier circuit that rectifies both halves of an AC wave.

Ground loop

A feedback problem caused by two or more circuits sharing a common electrical line, usually a common ground line. Voltage gradients in this line caused by one circuit may be capacitively, inductively, or resistively coupled into the other circuits via the common line. With power supplies, this problem can be reduced using single-point grounding.

Half-bridge converters

Two-transistor switching power supply configuration used in medium-power applications.

Half-wave rectifier

Single-diode rectifier circuit that rectifies only one-half the input AC wave.

Harmonic distortion

AC current outputs with multiple harmonic frequencies to AC line frequency provoked by the switching devices in a power supply.

Head room

In a linear regulator, the head room is the difference between the secondary voltage supplied by the power transformer at nominal input voltage and the regulated output voltage. Head room is necessary to ensure proper regulation under full load and low input voltage operation.

Heat sink

Device used to conduct away and disperse the heat generated by electronic components.

Hi-pot (high potential voltage)

See: *Isolation test voltage*.

Holdup time

The total time any output will remain within its regulation band after the input line voltage has been turned off. Typically measured at full load and nominal line conditions.

Hybrid supplies

A power supply that combines two or more different regulation techniques, such as ferroresonant and linears or switching and linear.

IEC (International Electrotechnical Commission)

An international safety agency. Its headquarters are in Geneva, Switzerland.

Inhibit

The ability to electrically turn off the output of a power supply from a remote location.

Input surge current

See: *Inrush current*.

Input voltage range

The range of source voltages for which the power supply meets its specifications.

Inrush current

A high surge of input current that occurs in switchers and occasionally in linears upon initial turn on, caused by charging of the input capacitors.

Instantaneous current limiting circuit

See: *Cycle-by-cycle current limiting circuit*.

Insulation

Material used to isolate a device by preventing or reducing the transmission of electricity.

Interaction

Total static regulation of a power supply when line and load changes occur simultaneously.

Inverter

- (1) A device that delivers AC power when energized from a source of DC power. Inverters may be frequency, amplitude, or pulse-width modulated to vary output-voltage.
- (2) The chopper section of a switching power supply.

Isolation

The degree of electrical separation between two points. It can be expressed in terms of voltage (breakdown), current (galvanic), or resistance and/or capacitance (impedance). In power supplies it is important to maximize the input to output isolation.

See also: *Electric strength test voltage*

Leakage current

Current flowing between the output buses and chassis ground due to imperfections in electronic components and designs. It must be tightly controlled to satisfy safety regulations such as UL and VDE.

LGA (Landesgewerbeanstalt Bayern, Bavarian Trade Institute)

A private German organisation testing for public safety and EMC, is a notified body to the EU, similar to VDE.

Line frequency regulation

The variation of an output voltage caused by a change in line input frequency, with all other factors held constant. This effect is negligible in switching and linear power supplies, but it is a critical specification of ferroresonant power supplies.

Line regulation

The variation of an output voltage due to a change in the input voltage, with all other factors held constant. Line regulation is expressed as the maximum percentage change in output voltage as the input voltage is varied over its specified range.

Linear regulator

A common voltage stabilization technique in which the control device (usually a transistor) is placed in series or parallel with the power source to regulate the voltage across the load. The term "linear" is used because the voltage drop across the control device is varied continuously to dissipate unused power.

Load

For voltage regulated power supplies, the load is the output current.

Load regulation

Variation of the output voltage due to a change in the output's load within a specified range with all other factors held constant. It is expressed as a percentage of the nominal DC output voltage.

Logic enable

The ability to turn a power supply on and off with a TTL signal. A logic low generally turns the supply off; a logic high turns it on.

See also: *Logic inhibit* .

Logic high

A TTL voltage of higher than 2.3 V with a maximum of up to 50 V. Also known as "logic 1".

Logic inhibit

The ability to turn a power supply off and on with TTL signals. A logic low generally allows the power supply to operate. A logic high turns off the power supply.

See also: *Logic enable* and *Logic low*.

Logic low

A TTL voltage lower than 0.8 V. Also known as a "logic 0".

Margining

The ability to adjust (generally with a switch) the output manually, usually to within +5% of nominal. This capability is used in system testing.

Master

The unit in a master-slave system of interconnection that exercises control over the outputs of one or more slave units. Such a system is a common technique used to ensure load sharing of parallel operating power supplies. Redundancy is not achieved in this configurations.

Modular

A physically descriptive term used to describe a power supply made up of a number of separate subsections, such as an input module, power module, or filter module. Modular construction tends to lower the MTBF.

MTBF (mean time between failures)

A measure of reliability. The reliability interval calculated in accordance with the procedures of MIL-HDBK 217.

MTTR (mean time to repair)

The average time required to repair a power supply. It is a result of both electrical and mechanical design factors.

Multiple output supply

A power supply that delivers two or more different output voltages.

Noise

Noise is the aperiodic, random component of undesired deviations in output voltage. Usually specified in combination with ripple.

See: *PARD* and also: *Ripple* .

Nominal output voltage

The intended, ideal voltage of any given output.

Off-line switcher

A circuit configuration commonly used in PWM switchers in which the input rectifier and filter section sit directly across the AC input line.

Open-frame construction

A construction technique common to OEM power supplies where the supply is not provided with an enclosure. It can be either a simple printed circuit board or a circuit board mounted on a metal chassis without a cover.

Operating temperature

The range of temperatures within which a power supply will perform within specified limits.

Opto-isolator

Device that provides electrical isolation and a signal path by making an electrical to optical to electrical signal transformation from its input to output terminals. This is accomplished with a light-emitting diode in close proximity to a phototransistor. Opto-isolators are used in the feedback loop to maintain electrical isolation between the input and output of the power supply. Ageing may distort the demanded feed-back response.

Output impedance

The value of a fictional resistor in series with an ideal voltage source that would give the same magnitude of AC voltage across the supply terminals as observed for a particular magnitude and frequency of alternating current.

Overcurrent protection

See: *Current limiting circuit*.

Overshoot

The amount by which an output exceeds its final value in response to a rapid change in load or input voltage, measured as a percentage of the nominal. It is an important value at turn-on and following a step change in load or line voltage.

OVP (overvoltage protection)

A protection mechanism for the load circuitry that does not allow the output voltage to exceed a preset level. In most cases, the output voltage is reduced to a low value, and the input power must be recycled to restore the power supply output. Often protection is provided by a suppressor diode across the output, engaging overcurrent limiting.

Parallel operation

The ability of power supplies to be connected so that the current from corresponding outputs can be combined into a single load.

PARD

Acronym for "periodic and random deviation" and used as the specification term for ripple and noise. Ripple is the unwanted portion of the output harmonically (periodically) related in frequency to the input line and to any internally generated switching frequency. Noise is the unwanted, aperiodic output deviation.

Pass element

The active circuit element, typically a transistor, that forms the output power stage of a linear power supply.

Peak charging

A rise in voltage across a capacitor caused by the charging of the capacitor to the peak rather than rms value of the input voltage. This generally occurs when a capacitor has a high discharge resistance across it and large ripple and noise or spikes on its input line. In a switcher, this parameter affects minimum load conditions (discharge resistance) on each output required to maintain regulation.

Peak transient output current

The maximum peak current that can be delivered to a load during transient load conditions, such as electric motor starts.

Phase controlled modulation

A circuit used in switching regulators where the operating frequency is held constant (typically 50 or 60 Hz line frequency) and the phase angle at which the control elements are turned on is varied, controlling both line and load changes with minimal dissipation.

Pin fins

Type of heat sink that uses pins in place of conventional extruded fins.

Post regulator

Usually a linear regulator used on the output of a switching or ferro power supply to improve overall (load) regulation.

Power factor

The ratio of actual power used in a circuit to the apparent power. Power factor is the measure of the fraction of current in phase with the voltage and contributing to average power.

Power fail detect

A circuit that senses the DC voltage across the input capacitors of a switching power supply. Should the AC input line fail, it senses an abnormally low DC level across the capacitors and provides an isolated TTL output signal warning of imminent loss of output power.

Power supply

The common term for electronic devices that provide DC output voltages when powered by an AC primary source.

Pre-regulator

A regulator circuit that provides a line-regulated output, which is then processed by a second regulator, the post-regulator, which provides load regulation.

Programming

The capability of controlling the voltage of each output.

Push-pull converter

Used in switching power supplies where the main switching circuit uses two transistors operating in push-pull. The main advantage is simplicity of design.

PWM (Pulse width modulation)

A circuit used in switching regulated power supplies where the switching frequency is held constant and the width of the power pulse is varied, controlling both line and load changes with minimal dissipation.

Rated pulse power

The maximum power that may be delivered by the power supply on a pulse basis. The rated pulse power usually averages out to the maximum continuous output power.

Recovery time

The time required by a transient overshoot or undershoot in a stabilized output quantity to decay to within specified limits.

Redundance

The ability to connect power supplies in parallel so that if one fails the other will provide continuous power to the load. This mode is used in systems when power supply failure cannot be tolerated.

Reference

A known stable voltage to which the output voltage is compared for the purpose of stabilizing the output voltage.

Regulator

The part of a power supply that controls the output voltage. In most cases, the regulator acts to stabilize the output voltage at a preset value.

Remote on-off

See: *Inhibit*.

Remote sensing

A method of moving the point of regulation from the output terminals to the load. Compensates voltage drops in the power distribution bus, but negative impact on dynamic load behavior must be tolerated.

Response time

The amount of time (ms) it takes for an output to react to a dynamic load change and to settle to within some tolerance band following a load change.

Return

An arbitrary name for the common terminal for all the outputs. It carries the return current of all the outputs.

Reverse voltage protection

The ability of a power supply to withstand reverse voltage at the input terminals when hooked up in the reverse polarity.

RFI (Radio frequency interference)

See: *EMI*.

Ripple

The periodic AC noise component of the power supply output voltage.

See: *PARD*.

Schottky diode

A device that exhibits a low forward voltage drop (e.g. 0.6 V) and a fast recovery time. This type of diode is especially useful at high current, low voltage (typically 5 V DC), where low losses and high switching speed are important.

Secondary breakdown

Most common failure in the power transistors of switchers; it is caused by the coincidence of high voltage and current levels when the transistors are turned off. Its effects are irreversible, almost instantaneous, and fatal. It can be controlled through proper circuit design.

Semi-regulated output

A secondary output on a multiple-output power supply that receives line regulation only.

Sense Lines

S+ and S- lines, complementary to the Vo+ and Vo- lines, allowing the compensation of voltage drops due to line resistance.

Sequencing

Controlling the time delay and order of output voltage appearance and drop-out upon power supply turn on and turn off.

Series regulator

A linear regulator in which the active control element (transistor) is connected in series with the load.

Short-circuit protection

See: *Current limiting circuit*.

Shunt regulator

A linear power supply in which the active control element (transistor) is in parallel with the load.

Slave

The unit in a master-slave paralleling scheme that is controlled by the master unit.

See: *Master*.

Snubber

A network containing a resistor, capacitor, and sometimes diode used in switching power supplies to trap high-energy transients and to protect sensitive components.

Soft start

Input surge-current limiting in a switching power supply where the switching drive is slowly ramped up.

Stability

The change in output voltage that occurs at constant load, AC input, and temperature after a given period of time following warm-up. This effect is related, in part, to internal temperature and ageing effects.

Standby current

The input current drawn by any power supply under minimum load conditions.

Static load

A load that remains constant over a given time period. It is usually specified as a percentage of full load.

Stefan-Boltzmann law

A law of thermodynamics that describes the rate of emission of radiant energy from the surface of a body.

Step change

An abrupt and sustained change in one of the influence or control quantities (e.g. load current).

Stress-ageing

The process of subjecting a completed power supply to a variety of stresses to force the occurrence of all burn-in failures.

Switching frequency

The rate at which the source voltage is switched in a switching regulator or chopped in a DC to DC converter.

Switching regulator

A high-efficiency non-isolated DC to DC converter consisting of inductors and capacitors to store energy and switching elements (typically transistors or SCRs), which open and close as necessary to regulate voltage across a load. The switching duty cycle is generally controlled by a feedback loop to stabilize the output voltage.

Temperature coefficient

The average percentage of change in output voltage per degree change in temperature with load and input voltage held constant.

Thermal protection

Protection via a thermally actuated switch that interrupts the operation of a power supply if the internal temperature exceeds a predetermined value.

Thermal regulation

See: *Temperature coefficient*.

Thermistor

A device with relatively high electrical resistance when cold and almost no resistance when at operating temperature. Thermistors are sometimes used to limit inrush current in off-line switchers.

Transformer

A magnetic device that converts AC voltages to AC voltages at any level. An ideal transformer is a lossless device in which no energy is stored and that requires no magnetic current.

Transient

A temporary and brief change in a given parameter. Typically associated with input voltage or output loading parameters.

Transient response time

The amount of time taken for an output to settle to within some tolerance band, normally following a stated change in load.

UL (Underwriters' Laboratories)

An independent, non-profit organization testing for public safety in the United States. UL recognition is required for equipment used in some applications.

Undershoot

The amount by which an output falls below its final value in response to a rapid load change.

UPS (Uninterruptible power supply)

A device designed to supply power in the event of temporary or permanent loss of AC line power. Often these supplies will operate with either an AC line input or DC (battery) back-up input.

VDE (Verband Deutscher Elektrotechniker)

A German organization testing for public safety; similar to UL in the United States.

Warm up drift

The change in output voltage that occurs during warm-up from turn on of a cold supply until about 30 minutes after turn on. Warm-up drift is measured at constant load, input line, and ambient temperature and is primarily due to internal components reaching thermal equilibrium.

Warm up time

The time needed, after turn on, for the power supply to reach thermal equilibrium with a constant load. Usually estimated to be about 30 minutes.