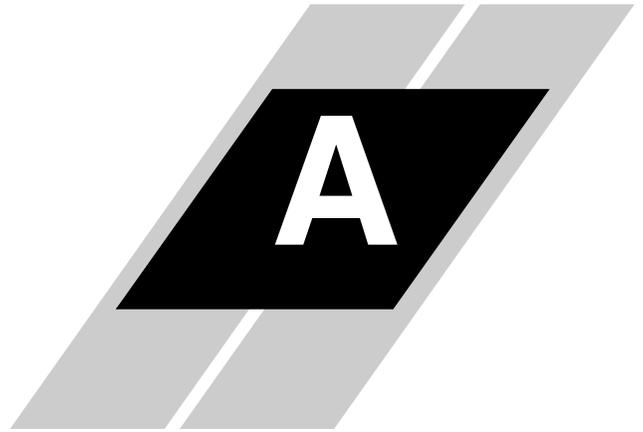


# Glossary and Bibliography



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## Glossary

- Ambient Temperature** The air temperature in the chamber containing a powered electronic unit. A unit's heat sinks rely on a lower ambient temperature in order to dissipate heat away from sensitive electronics.
- Arrival Frequency** The arrival frequency refers to the set output frequency of the inverter for the constant speed setting. The arrival frequency feature turns ON an output when the inverter reaches the set constant speed. The inverter has various arrival frequencies and pulsed or latched logic options.
- Auto-tuning** The ability of a controller to execute a procedure that interacts with a load to determine the proper coefficients to use in the control algorithm. Auto-tuning is a common feature of process controllers with PID loops. Hitachi inverters feature auto-tuning to determine motor parameters for optimal commutation. Auto-tuning is available as a special command from a digital operator panel. See also *digital operator panel*.
- Base Frequency** The power input frequency for which an AC induction motor is designed to operate. Most motors will specify a 50 to 60 Hz value. The Hitachi inverters have a programmable base frequency, so you must ensure that parameter matches the attached motor. The term *base frequency* helps differentiate it from the carrier frequency. See also *carrier frequency* and *frequency setting*.
- Braking Resistor** An energy-absorbing resistor that dissipates energy from a decelerating load. Load inertia causes the motor to act as a generator during deceleration. See also *four-quadrant operation* and *dynamic braking*.
- Break-away Torque** The torque a motor must produce to overcome the static friction of a load in order to start the load moving.
- Carrier Frequency** The frequency of the constant, periodic, switching waveform that the inverter modulates to generate the AC output to the motor. See also *PWM*.
- CE** A regulatory agency for governing the performance of electronic products in Europe. Drive installations designed to have CE approval must have particular filter(s) installed in the application.
- Choke** An inductor that is tuned to react at radio frequencies is called a "choke," since it attenuates (chokes) frequencies above a particular threshold. Tuning is often accomplished by using a movable magnetic core. In variable-frequency drive systems, a choke positioned around high-current wiring can help attenuate harmful harmonics and protect equipment. See also *harmonics*.
- DC Braking** The inverter DC braking feature stops the AC commutation to the motor, and sends a DC current through the motor windings in order to stop the motor. Also called "DC injection braking," it has little effect at high speed, and is used as the motor is nearing a stop.
- DC Link** The portion of the variable frequency drive between the input rectifiers and the output stages. It delivers smoothed DC power to the control and output stages of the drive.
- Deadband** In a control system, the range of input change for which there is no perceptible change in the output. In PID loops, the error term may have a deadband associated with it. Deadband may or may not be desirable; it depends on the needs of the application.
- Digital Operator Panel** For Hitachi inverters, "digital operator panel" (DOP) refers first to the operator keypad on the front panel of the inverter. It also includes hand-held remote keypads, which connect to the inverter via a cable. Finally, the DOP Professional is a PC-based software simulation of the keypad devices.

<b>Diode</b>	A semiconductor device that has a voltage-current characteristic that allows current to flow only in one direction, with negligible leakage current in the reverse direction. See also <i>rectifier</i> .
<b>Duty Cycle</b>	1. The percent of time a square wave of fixed frequency is ON (high) versus OFF (low). 2. The ratio of operating time of a motor, braking resistor, etc. to its resting time. This parameter usually is specified in association with the allowable thermal rise for the device.
<b>Dynamic Braking</b>	The inverter dynamic braking feature shunts the motor-generated EMF energy into a special braking resistor. The added dissipation (braking torque) is effective at higher speeds, having a reduced effect as the motor nears a stop.
<b>Error</b>	In process control, the error is the difference between the desired value or setpoint (SP) and the actual value of a the process variable (PV). See also <i>process variable</i> and <i>PID Loop</i> .
<b>EMI</b>	Electromagnetic Interference - In motor/drive systems, the switching of high currents and voltages creates the possibility of generating radiated electrical noise that may interfere with the operation of nearby sensitive electrical instruments or devices. Certain aspects of an installation, such as long motor lead wire lengths, tend to increase the chance of EMI. Hitachi provides accessory filter components you can install to decrease the level of EMI.
<b>Four-quadrant operation</b>	Referring to a graph of torque versus speed, a four-quadrant drive can turn the motor either forward or reverse, as well as decelerate in either direction (see also <i>reverse torque</i> ). A load that has a relatively high inertia and must move in both directions and change directions rapidly requires four-quadrant capability from its drive.
<b>Free-run Stop</b>	A method of stopping a motor, caused when the inverter simply turns OFF its motor output connections. This may allow the motor and load to coast to a stop, or a mechanical brake may intervene and shorten the deceleration time.
<b>Frequency Setting</b>	While frequency has a broad meaning in electronics, it typically refers to motor speed for variable-frequency drives (inverters). This is because the output frequency of the inverter is variable, and is proportional to the attained motor speed. For example, a motor with a base frequency of 60 Hz can be speed controlled with an inverter output varying from 0 to 60 Hz. See also <i>base frequency</i> , <i>carrier frequency</i> , and <i>slip</i> .
<b>Harmonics</b>	A <i>harmonic</i> is a whole number multiple of a base or fundamental frequency. The square waves used in inverters produce high-frequency harmonics, even though the main goal is to produce lower-frequency sine waves. These harmonics can be harmful to electronics (including motor windings) and cause radiated energy that interferes with nearby electronic devices. Chokes, line reactors, and filters are sometimes used to suppress the transmission of harmonics in an electrical system. See also <i>choke</i> .
<b>Horsepower</b>	A unit of physical measure to quantify the amount of work done per unit of time. You can directly convert between horsepower and Watts as measurements of power.
<b>IGBT</b>	<b>Insulated Gate Bipolar Transistor (IGBT)</b> - A semiconductor transistor capable of conducting very large currents when in saturation and capable of withstanding very high voltages when it is OFF. This high-power bipolar transistor is the type used in Hitachi inverters.
<b>Inertia</b>	The natural resistance of an object to being accelerated or decelerated by an external force. See also <i>momentum</i> .
<b>Intelligent Terminal</b>	A configurable input or output logic function on the Hitachi inverters. Each terminal may be assigned one of several functions.
<b>Inverter</b>	A device that electronically changes DC to AC current through a alternating process of switching the input to the output, inverted and non-inverted. A variable speed drive such as the Hitachi SJ300 is also called an inverter, since it contains three inverter circuits to generate 3-phase output to the motor.

<b>Isolation Transformer</b>	A transformer with 1:1 voltage ratio that provides electrical isolation between its primary and secondary windings. These are typically used on the power input side of the device to be protected. An isolation transformer can protect equipment from a ground fault or other malfunction of nearby equipment, as well as attenuate harmful harmonics and transients on the input power.
<b>Jogging Operation</b>	Usually done manually, a jog command from an operator's panel requests the motor/drive system to run indefinitely in a particular direction, until the machine operator ends the jog operation.
<b>Jump Frequency</b>	A jump frequency is a point on the inverter output frequency range that you want the inverter to skip around. This feature may be used to avoid a resonant frequency, and you can program up to three jump frequencies in the inverter.
<b>Line Reactor</b>	A three-phase inductor generally installed in the AC input circuit of an inverter to minimize harmonics and to limit short-circuit current.
<b>Momentum</b>	The physical property of a body in motion that causes it to continue to remain in motion. In the case of motors, the rotor and attached load are rotating and possess angular momentum.
<b>Multi-speed Operation</b>	The ability of a motor drive to store preset discrete speed levels for the motor, and control motor speed according to the currently selected speed preset. The Hitachi inverters have 16 preset speeds.
<b>Motor Load</b>	In motor terminology, motor load consists of the inertia of the physical mass that is moved by the motor and the related friction from guiding mechanisms. See also <i>inertia</i> .
<b>NEC</b>	The National Electric Code is a regulatory document that governs electrical power and device wiring and installation in the United States.
<b>NEMA</b>	The National Electric Manufacturer's Association. NEMA Codes are a published series of device ratings standards. Industry uses these to evaluate or compare the performance of devices made by various manufacturers to a known standard.
<b>Open-collector Outputs</b>	A common logic-type discrete output that uses an NPN transistor that acts as a switch to a power supply common, usually ground. The transistor's <i>collector</i> is <i>open</i> for external connection (not connected internally). Thus, the output <i>sinks</i> external load current to ground.
<b>Orientation</b>	When using the expansion card SJ-FB with encoder feedback, the orientation feature is available. Also called <i>home search</i> in motion terminology, you can specify a search direction and a stop position. Typically the orientation procedure is necessary after each inverter powerup.
<b>Power Factor</b>	A ratio that expresses a phase difference (timing offset) between current and voltage supplied by a power source to a load. A perfect power factor = 1.0 (no phase offset). Power factors less than one cause some energy loss in power transmission wiring (source to load).
<b>PID Loop</b>	Proportional-Integral-Derivative – a mathematical model used for process control. A process controller maintains a process variable (PV) at a setpoint (SP) by using its PID algorithm to compensate for dynamic conditions and varies its output to drive the PV toward the desired value. See also <i>error</i> .
<b>Process Variable</b>	A physical property of a process that is of interest because it affects the quality of the primary task accomplished by the process. For an industrial oven, temperature is the process variable. See also <i>PID Loop</i> and <i>error</i> .
<b>PWM</b>	Pulse-width modulation: A type of AC adjustable frequency drive that accomplishes frequency and voltage control at the output section (inverter) of the drive. The drive output voltage waveform is at a constant amplitude, and by "chopping" the waveform (pulse-width-modulating), the average voltage is controlled. The chopping frequency is sometimes called the <i>carrier frequency</i> .

<b>Reactance</b>	The impedance of inductors and capacitors has two components. The resistive part is constant, while the reactive part changes with applied frequency. These devices have a complex impedance (complex number), where the resistance is the real part and the reactance is the imaginary part.
<b>Rectifier</b>	An electronic device made of one or more diodes that converts AC power into DC power. Rectifiers are usually used in combination with capacitors to filter (smooth) the rectified waveform to closely approximate a pure DC voltage source.
<b>Regenerative Braking</b>	A particular method of generating reverse torque to a motor, an inverter will switch internally to allow the motor to become a generator and will either store the energy internally, deliver the braking energy back to the main power input, or dissipate it with a resistor.
<b>Regulation</b>	The quality of control applied to maintain a parameter of interest at a desired value. Usually expressed as a percent (+/-) from the nominal, motor regulation usually refers to its shaft speed.
<b>Reverse Torque</b>	The torque applied in the direction opposite to motor shaft rotation. As such, reverse torque is a decelerating force on the motor and its external load.
<b>Rotor</b>	The windings of a motor that rotate, being physically coupled to the motor shaft. See also <i>stator</i> .
<b>Saturation Voltage</b>	For a transistor semiconductor device, it is in saturation when an increase in input current no longer results in an increase in the output current. The saturation voltage is the voltage drop across the device. The ideal saturation voltage is zero.
<b>Sensorless Vector Control</b>	A technique used in variable-frequency drives to rotate the force vector in the motor without the use of a shaft position sensor (angular). Benefits include an increase in torque at the lowest speed and the cost savings from the lack of a shaft position sensor.
<b>Setpoint (SP)</b>	The setpoint is the desired value of a process variable of interest. See also <i>Process Variable (PV)</i> and <i>PID Loop</i> .
<b>Single-phase Power</b>	An AC power source consisting of Hot and Neutral wires. An Earth Ground connection usually accompanies them. In theory, the voltage potential on Neutral stays at or near Earth Ground, while Hot varies sinusoidally above and below Neutral. This power source is named Single Phase to differentiate it from three-phase power sources. Some Hitachi inverters can accept single phase input power, but they all output three-phase power to the motor. See also <i>three-phase</i> .
<b>Slip</b>	The difference between the theoretical (synchronous) speed of a motor at no load (determined by its inverter output waveforms) and the actual speed. Some slip is essential in order to develop torque to the load, but too much will cause excessive heat in the motor windings and/or cause the motor to stall.
<b>Squirrel Cage</b>	A “nick-name” for the appearance of the rotor frame assembly for an AC induction motor.
<b>Stator</b>	The windings in a motor that are stationary and coupled to the power input of the motor. See also <i>rotor</i> .
<b>Start Frequency</b>	The output frequency that the inverter first produces as the frequency command setting increases from zero. The start frequency is programmable, and is important to set properly for the load, etc.
<b>Tachometer</b>	1. A signal generator usually attached to the motor shaft for the purpose of providing feedback to the speed controlling device of the motor. 2. A speed-monitoring test meter that may optically sense shaft rotation speed and display it on a readout.

- Thermal Switch** An electromechanical safety device that opens to stop current flow when the temperature at the device reaches a specific temperature threshold. Thermal switches are sometimes installed in the motor in order to protect the windings from heat damage. The inverter can use thermal switch signals to trip (shut down) if the motor overheats. See also *trip*.
- Thermistor** A type of temperature sensor that changes its resistance according to its temperature. The sensing range of thermistors and their ruggedness make them ideal for motor overheating detection. Hitachi inverters have built-in thermistor input circuits, which can detect an overheated motor and shut OFF (trip) the inverter output.
- Three-phase Power** An AC power source with three Hot connections that have phase offsets of 120 degrees is a 3-phase power source. Usually, Neutral and Earth Ground wires accompany the three Hot connections. Loads may be configured in a delta or Y configuration. A Y-connected load such as an AC induction motor will be a balanced load; the currents in all the Hot connections are the same. Therefore, the Neutral connection is theoretically zero. This is why inverters that generate 3-phase power for motors do not generally have a Neutral connection to the motor. However, the Earth Ground connection is important for safety reasons, and is provided.
- Torque** A measure of rotational force. The units of measurement are the product of the distance (radius from shaft center axis) and force (weight) applied at that distance. Units are usually given as pound-feet, ounce-inches, or Newton-meters.
- Transistor** A solid state, three-terminal device that provides amplification of signals and can be used for switching and control. While transistors have a linear operating range, inverters use them as high-powered switches. Recent developments in power semiconductors have produced transistors capable of handling high voltages and currents, all with high reliability. The saturation voltage has been decreasing, resulting in less heat dissipation. Hitachi inverters use state-of-the-art semiconductors to provide high performance and reliability in a compact package. See also *IGBT* and *saturation voltage*.
- Trip** An event that causes the inverter to stop operation is called a “trip” event (as in *tripping* a circuit breaker). The inverter keeps a history log of trip events. They also require an action to clear.
- Watt Loss** A measure of the internal power loss of a component, the difference between the power it consumes and what its output delivers. An inverter’s watt loss is the input power minus the power delivered to the motor. The watt loss is typically highest when an inverter is delivering its maximum output. Therefore, watt loss is usually specified for a particular output level. Inverter watt loss specifications are important when designing enclosures.

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