

GenSet Controls

PowerCommand

Digital GenSet Control



Description

The PowerCommand™ Control (PCC 3100) is a microprocessor-based generator set monitoring, metering, and control system. The control provides an operator interface to the genset, digital voltage regulation, digital governing, and generator set protective functions. The integration of all the functions into a single control system provides enhanced reliability and performance compared to conventional control systems.

PowerCommand generator set controls are suitable for use on generator set ranging in size from approximately 20kW to 4000 kW. They will directly read AC voltages up to 600VAC, and can be configured for any frequency, voltage, and power connection configuration from 120 to 13,800 volts AC.

The PowerCommand control is designed for mounting on the generator set.

Control power for PowerCommand is usually derived from the generator set starting batteries. The control functions over a voltage range from 8VDC to 35VDC.

Features

The control offers a wide range of standard control and digital display features so custom control configurations are not needed to meet application requirements. System reliability is not compromised by use of untested special components.

Major Control Features Include:

- **Digital Governing and Voltage Regulation**, including digital overcurrent fault regulation.
- **AmpSentry™ Protection** for true alternator overcurrent protection.
- **Analog and Digital AC Output Metering.**
- **Battery Monitoring System** to sense and warn against a weak battery condition.
- **Digital Alarm and Status Message Display**
- **Generator set Monitoring:** Displays status of all critical engine and alternator generator set functions and includes sensor failure monitoring.
- **Smart Starting Control System:** Integrated fuel ramping to limit black smoke and frequency overshoot, in addition to optimized cold weather starting.
- **PowerCommand Digital Paralleling** (optional). Factory kits are available to upgrade standard controls to PowerCommand digital paralleling.
- **PowerCommand Network** (optional). Factory kits are available to add network capability to any generator set.
- **Warranty.** PowerCommand Controls are supported by a worldwide network of independent distributors who provide parts, service and warranty support.

Operator Panel

The operator panel provides the user with a complete package of easy to view and use information. Connections to the operator panel are sealed locking plug interfaces, for reliable, vibration-resistant interconnection to the generator set wiring harness.

Control Switches and Functions

Control arrows on the screen lead the operator to information. The system control switches provide the operator with a positive indication that the switch is operated. The switches are totally sealed and designed to provide reliable service for the life of the generator set control.

- **RUN/OFF/AUTO Mode Control Switch** - oil tight, three position switch starts and stops the generator set locally or enables start/stop control from a remote location. The NOT IN AUTO lamp will flash when the control is in the RUN or OFF mode. In the AUTO mode, the generator set can be started with a start signal from a remote device, such as automatic transfer switches. Switch is available in keyed configuration.
- **EMERGENCY STOP Control Switch.** A two-position safety “mushroom” head switch provides an easy and obvious means to immediately shut down the generator set in the event of an emergency condition.
- **PANEL LAMP Control Switch.** Turns the back-lit control illumination on and off, for easy reading of the entire control panel in dark lighting conditions. The panel lights automatically switch off after 8 minutes to save battery and lamp life.
- **MENU Switch.** Returns the operator to the main menu selections screen, regardless of the position in the menu logic.
- **RESET Switch.** Clears the digital display and status panel and allows the genset to start after a fault condition has been corrected.
- **SELF TEST Switch.** Prompts the control to perform a self-test of the system, and displays all fault messages.
- **PHASE SELECT Switch.** Controls the phase that is displayed on the analog AC instrumentation.
- **Operator Adjustments.** All operators and service level control system adjustments are made through digital raise/lower switches from the front of the control panel. The control includes provisions for many set up and adjustment functions via raise/lower push-button switches on the operator panel. Functions that can be adjusted by the operator include:
 - Time delay start (0-300 seconds)
 - Time delay stop (0-600 seconds)
 - Alternator voltage (plus or minus 5%)
 - Alternator frequency (plus or minus 3 hertz).
- **Service Adjustments.** Critical service level adjustments are possible only after entering an access code into the operator panel. Adjustments

include governor and AVR gain and stability, and other parameters. The adjustment level is displayed on the control panel. There are no rotary switches of pots in the control system.

Alarm and Status Indication Lamps

The control panel provides dual-element LED indicating lamps for the following functions:

- **Non-Automatic (Red-Flashing).** Indicates that the control mode select switch is in the OFF or RUN position.
- **Warning (Amber).** Indicates a potentially damaging condition on the generator set and that the status screen is displaying a warning condition. The reset switch is used to clear the message after the warning condition is corrected.
- **Shutdown (Red).** Indicates that the generator set has shut down due to a failure in the genset or to protect the generator set. The status screen is displaying a shutdown condition. The reset switch and Mode Select switch are used to clear the message and re-start the genset after the shutdown condition is corrected.
- **Phase and Scale Indication (Green).** Indicates the phase that is displayed on the analog AC instrumentation.

Analog AC Metering Panel

The PowerCommand control is equipped with an analog AC metering panel that displays 3-phase output power conditions.

Analog metering on the control panel provides clear indication of generator set stability, including the magnitude of displacement and rate of change during lead transients, which cannot be viewed a clearly with digital metering equipment. These meters are also ideal for “walk-by” status checks by the operator. All meters are 2.5-inch (63.5mm), 90-degree scale. Meter faces UV protected against discoloration from exposure to sunlight. The kilowatt meter and ammeter are scaled in percent of AC output for easy recognition of generator set status and load level (0-90% of rating: green; 90-100% of rating: amber; >100% of rating: red).

- **Kilowatt Meter:** Indicates 3-phase AC power output as a percent of rated load. Provides a true indication of total kW load on the generator set, regardless of the load power factor. Scale is 0-125%. Accuracy is $\pm 5\%$.
- **Frequency Meter:** Indicates generator set output frequency in hertz. Calculated frequency is based on engine speed and alternator voltage zero-crossing and is not affected by voltage waveform distortion caused by non-linear loads. Scale is 45-65 Hz. Accuracy is ± 0.5 Hz.
- **AC Voltmeter:** Dual scale AC voltmeter indicates alternator output voltage. Accuracy: $\pm 2\%$. Scales:

0-300VAC, 0-600 VAC; 0-400 VAC, 0-750 VAC; 0-5260 VAC; or 0-15,000 VAC.

- **AC Ammeter:** Indicates current output in percent of maximum rated standby current. Accuracy: $\pm 2\%$. Scale: 0-125%.

Alarm and Status Display Panel

A two-line, 16 character-per-line, LED alphanumeric screen displays alarm and status messages and information regarding AC output, engine conditions, and adjustments via a menu-driven system. Provides detailed information on all critical generator set parameters. Detailed messages provide a clear indication of problems with reference to the operator's service manual for further direction. The operator can easily follow the logic path without the use of an operator's manual.

Display is configurable for multiple languages and for units of measurement. All data on the control can be viewed by scrolling through screens with the navigation keys.

On sensing a warning or shut down condition, the control displays the warning or shutdown message, lights the warning or shutdown indicator lamp on the front of the control, and provides a code number referenced to the generator set manuals. The manuals provide the operator with more information on the nature of the problem and how to get the generator set back into service. See *Protective Functions* for information on conditions that may be displayed by the control.

Data Displays in the control include:

Engine Data

- **Engine Starting Battery Voltage**
- **Engine Lube Oil Pressure** (PSI or kPA)
- **Engine Lube Oil Temperature** ($^{\circ}\text{F}$ or $^{\circ}\text{C}$)
- **Engine Coolant Temperature** ($^{\circ}\text{F}$ or $^{\circ}\text{C}$) Control displays data for left and right bank of "V" engines.
- **Engine Operating Hours**
- **Number of Starts**
- **Engine RPM**
- **Engine Exhaust Temperature** ($^{\circ}\text{F}$ or $^{\circ}\text{C}$) Control displays data for left and right bank of "V" engines. (optional)

Alternator Data

- **Generator Set Output Voltage** - all phases, line to line and line to neutral, accuracy 1% over the stated temperature range of the control. Displays data for all phases simultaneously to allow viewing of voltage balance.
- **Generator Set Output Current** - all phases, accuracy 1% over the stated temperature range of the control. Displays data for all phases simultaneously to allow viewing of load balance.
- **Generator Set Output Frequency**

- **Generator Set Power Output** - PowerCommand displays generator set kW and power factor with leading/lagging indication. Accuracy 5%.
- **Generator Set kWh Power Output** - Displays total kilowatt-hours produced by the generator set.
- **% Governing and % Voltage Regulation** - Control monitors the signals to the governor actuator and excitation system and indicates duty cycle for these signals. This information is valuable as a diagnostic tool for the genset.

Adjustments

- Allows operator to adjust voltage, frequency, time delay start, and time delay stop.

Version/History

- **Generator Set Hardware Data** - Generator set rating in kW (standby or prime), Generator set model number. The control also displays the software version present in the control.
- **Fault History** - Provides a record of the most recent fault conditions with time stamp, along with the number of times each fault has occurred. At least 20 events are stored in the control memory.

Set Up

- Allows a service condition to adjust and set up the control system after entering an access code. Functions available include all governing and voltage regulation adjustments, control calibration, and custom fault set up.

Internal Control Functions

General Functions

Remote Start Mode - PowerCommand accepts a ground signal from remote devices or a network signal to automatically start the generator set and immediately accelerate to rated speed and voltage.

Idle Mode - The control is configured to accept a ground signal to cause the engine to operate at idle speed rather than its nominal operating speed. In the idle state the excitation system is prevented from operating. Idle speed operation function is available only in RUN mode.

Sleep Mode - PowerCommand can be programmed to automatically switch off the operator panel displays to reduce battery voltage drain when the control is not being used and the generator set is not running. Depressing any button on the operator panel, new fault conditions or receipt of a remote signal at the control will "wake up" the control.

Smart Starting - designed to quickly start the engine, minimize black smoke, and minimize voltage and frequency overshoot and oscillations on starting. The control system does this by careful control of the engine fuel system and alternator excitation system. As the start signal is initiated, the control checks the magnetic pick-up monitoring the engine speed to verify that the

engine is rotating. If the engine is not rotating, the control switches off the starter and then makes another attempt. If the attempt fails, a shutdown message is signaled on the digital display screen and the generator set cannot be started until the fault is cleared. This process helps prevent starter or ring gear damage.

The system also directly controls the fuel rail actuator, and provides only enough fuel for engine starting. Once the engine reaches start disconnect speed, it will ramp to operating speed at a controlled rate.

Engine Control

- **Engine Starting**
- **Cycle Cranking** - Configurable for number of starting cycles (1 to 6) and duration of crank and rest periods. Control includes starter protection algorithms to prevent the operator from specifying a starting sequence that might be damaging.
- **Time Delay Start And Stop (cooldown)** - Configurable for time delay of 0-300 seconds prior to starting after receiving a remote start signal, and for time delay of 0-600 seconds prior to ramp to idle or shut down after signal to stop in normal operation modes. The generator set control will monitor the load during operation of the generator set, and if the total load on the set is less than 10% of rated, it will reduce the operation time for the time delay stop to prevent extended operation of the engine at very light load levels. Default for both time delay periods is 0 seconds.
- **Smart Starting** –designed to quickly start the engine, minimize black smoke, and minimize voltage and frequency overshoot and oscillations on starting. The control system does this by careful control of the engine fuel system and alternator excitation system. As the start signal is initiated, the control checks the magnetic pick-up monitoring the engine speed to verify that the engine is rotating. If the engine is not rotating, the control switches off the starter and then makes another attempt. If the attempt fails, a shutdown message is signaled on the digital display screen and the generator set cannot be started until the fault is cleared. This process helps prevent starter or ring gear damage

Engine Governing

- **Isochronous Governing** - Controls engine speed within plus or minus 0.25% for any steady state load from no load to full load. Frequency drift will not exceed plus or minus 0.5% for a 60F (33C) change in ambient temperature over an 8 hour period.
- **Drop Governing** - Control can be adjusted to droop from 0 to 10% from no load to full load, using InPower.
- **Temperature Dynamics** - Modifies the engine fuel system control parameters as a function of engine temperature. Allows engine to be more responsive when warm, and more stable when operating at lower temperature levels.

- **Idle Mode** – The control system accepts a signal to control engine speed to a preset, adjustable idle speed when operating in the RUN mode.

Alternator Control

The excitation control system provided in PowerCommand controls is 3-phase sensing, provides pulse-width modulated output to the exciter, and operates with a permanent magnet generator (PMG) on the alternator. It is specifically designed for use in non-linear load applications.

- **Digital Output Voltage Regulation** - PowerCommand will regulate output voltage to within 0.5% for any loads between no load and full load. Voltage drift will not exceed plus or minus 0.5% for a 60F (33C) change in temperature in an 8 hour period. On engine starting, or sudden load acceptance, voltage is controlled to a maximum of 5% overshoot over nominal level.
- **Torque-Matched Volts/Hz Overload Control** - The voltage roll-off set point and rate of decay (i.e., the slope of the volts/hertz curve) is adjustable in the control.
- **Fault Current Regulation** - PowerCommand will regulate the output current on any phase to a maximum of 3 times rated current under fault conditions for both single phase and three phase faults. In conjunction with a permanent magnet generator, it will provide regulated 3 times rated current on all phases for motor starting and short circuit coordination purposes. It also regulates single phase faults to a maximum of 3 times rated current on any phase.

Protective Functions

PowerCommand provides a full complement of protective functions, specifically designed to prevent damage to the generator set and minimize the potential for nuisance failure conditions.

On a warning condition the control will indicate a fault by lighting the warning LED on the control panel, and displaying the fault name and code on the operator display panel. The nature of the fault and time of occurrence are logged in the control (based on engine operating hours). The service manual and InPower service tool provide service keys and procedures based on the service codes provided.

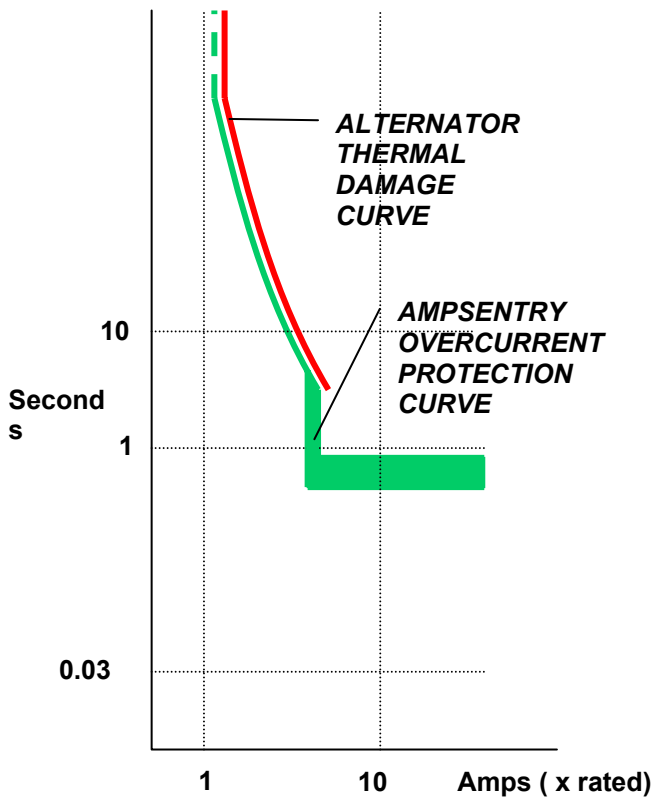
On a shutdown condition, the control will light the shutdown LED on the control panel, display the fault name and code, and initiate shut down and lock out the generator set.

The control maintains a data log of all fault conditions as they occur, and time stamps them with the engine operating hours data. The latest 20 events are maintained in non-volatile control memory.

PowerCommand provides the following system protective functions:

- **Ground Fault Warning (option- 600VAC class generator sets)** - Ground fault sensing is adjustable over a range of 100-1200 amps, with time delays of 0-1 second. May be configured for shutdown rather than alarm.
- **Configurable Alarm And Status Inputs** - PowerCommand will accept up to four alarm or status inputs (contact closed to ground) to indicate customer-specified conditions. The control is programmable for warning or shutdown indication, and for labeling the input.
- **Emergency Stop** - Annunciated whenever the local or remote emergency stop signal is received. Alarm panel distinguishes between local or remote operation.

AmpSentry™



AmpSentry is a comprehensive monitoring and control system inherent to the PowerCommand control that guards the electrical integrity of the alternator and power system by providing protection against a wide array of fault conditions in the generator set or in the load. It also provides single and 3-phase fault current regulation, so that downstream protective devices have the maximum current available to quickly clear fault conditions, without subjecting the alternator to potentially catastrophic failure conditions. On any shutdown condition the excitation system of the alternator is immediately switched off. If a warning condition results in loss of voltage, and the condition

subsequently is cleared, the control will ramp in a controlled fashion to rated conditions, eliminating potentially damaging overvoltage conditions. Functions included in AmpSentry protection:

- **Over Current Warning** - Output current on any phase at more than 110% of rating for more than 60 seconds.
- **Over Current Shutdown (51)** - Output current on any phase is more than 110%, less than 175% of rating, and approaching thermal damage point of alternator. Control includes algorithms to protect alternator from repeated over current conditions over a short period of time. A time overcurrent characteristic curve is available by ordering document R-1053.
- **Short Circuit Shutdown** - Output current on any phase is more than 110%, more than 175% of rating, and approaching thermal damage point of alternator. Control includes algorithms to protect alternator from repeated over current conditions over a short period of time.
- **High AC Voltage Shutdown (59)** - Output voltage on any phase exceeds preset values. Time to trip is inversely proportional to amount above threshold. Setting is more than 110% for 10 seconds, or instantaneous at more than 130% of nominal voltage.
- **Low AC Voltage Shutdown (27)** - Voltage on any phase has dropped below a preset value. Setting is 85% for 10 seconds.
- **Under Frequency Shutdown (81u)** - Generator set output frequency cannot be maintained. Settings are 10% below nominal governor set point, with a 20 second time delay.
- **Over Load (kW) Warning** - Provides a warning indication when engine is operating at a load level over 100% for more than 5 seconds. A dedicated output relay is provided for use by the customer for load shedding.
- **Reverse Power Shutdown (32)** - Set point is negative 25% of genset rating for more than 3 seconds.
- **High Alternator Temperature (Option)**

Engine Protection

- **Overspeed (Shutdown)** - Default setting is 115% of nominal.
- **Low Lube Oil Pressure (Shutdown)** - Level is preset to match the capabilities of each engine. Control includes time delays to prevent nuisance shutdown signals. Control automatically adjusts set points for rated and idle speed operation.
- **Low Lube Oil Pressure (Warning)** - Level is preset to match the capabilities of each engine. Control includes time delays to prevent nuisance shutdown signals.
- **Oil Pressure Sender Failure (Warning)**
- **High Coolant Temperature (Shutdown)**
- **High Coolant Temperature (Warning)**
- **Coolant Temperature Sender Failure (Warning)**

- **Low Coolant Level (configurable for Warning or Shutdown)**
- **Low Coolant Temperature (Warning).** Indicates that engine temperature may not be high enough for a 10-second start or proper load pickup.
- **Low and High Battery Voltage (Warning) -** Indicates battery charging system failure by continuously monitoring battery voltage. Voltage less than 25VDC except when engine is starting, or more than 32VDC.
- **Weak battery (Warning) -** The control system will test the battery bank each time the generator set is signaled to start, and indicate a warning if the generator set battery indicates impending failure.
- **Fail to Start (Shutdown) –** Indicates that engine did not start after all cranking cycles have been completed. (Previously known as “Overcrank”.)
- **Fail to Crank (Shutdown) -** Control has signaled starter to crank engine but engine does not rotate.
- **Redundant Starter Disconnect**
- **Low Fuel-Day Tank (Warning)**
- **Cranking Lockout.** The control will not allow the starter to attempt to engage or to crank the engine when the engine is rotating.
- **NFPA110 Alarm Relays –** One form A contact for each condition, each rated 2A @ 30VDC/180VAC.

Control power for auxiliary devices is available from the controller. A 10A/24VDC fused source is available when the genset is running, and a 20A/24VDC fused source is available at all times.

Network connections include:

- **Serial Interface.** This communication port is to allow the control to communicate with a personal computer running PowerCommand for Windows software.
- **Echelon LonWorks Interface (Option).** PowerCommand generator sets incorporating this option are LonMark™ compliant.

Certifications

PowerCommand meets or exceeds the requirements of the following codes and standards:

- **CSA C282-M1999** Compliance
- **CSA 22.2 No. 14 M91** Industrial Controls.
- **IEC 801.2:** Electrostatic Discharge Test
- **IEC 801.3:** Radiated Susceptibility
- **IEC 801.4:** Electrically Fast Transient
- **IEC 801.5:** Radiated Emissions
- **IEEE 587:** Surge Immunity
- **ISO 8528-4: 1993 Compliance,** Control Systems for Reciprocating Engine-driven Generator Sets
- **Mil Std 461:** Electromagnetic Emission and Susceptibility Requirements
- **NFPA 70:** US National Electrical Code. PowerCommand controls are suitable for use in Emergency, Critical, and Standby applications, as defined in articles 700,701, and 702.
- **NFPA99:** Standard for Health Care Facilities
- **NFPA110** for level 1 systems.
- **UL508** Listed, Category NIWT7 for US and Canada.

PowerCommand control systems and generator sets are designed and manufactured in ISO9001 certified facilities.

Environment

The control is designed for proper operation without recalibration in ambient temperatures from –40C to +70C, and for storage from –40C to +80C. Control will operate with humidity up to 95%, non-condensing, and at altitudes up to 10,000 feet (5000 meters).

The control system is designed and installed on the genset to withstand the affects of adverse environments. The control panel face is a single membrane panel which is impervious to water spray, dust, and oil/exhaust residue. The control door is gasketed to provide protection to internal components from moisture and RFI/EMI.

Control Interface

All customer connections to the PowerCommand Control are made in an enclosure that is separate and isolated from the control equipment. Easy connection is possible with large, clearly labeled terminal blocks and terminals that do not require lugs for customer connections. Input signals to the PowerCommand control include:

- **Remote Start signal.** May be connected via either discrete signal or Lon network, or both for premium reliability.
- **Remote Emergency Stop.**
- **Configurable Customer Inputs.** Control includes provisions for (4) input signals from customer discrete devices.
- **Low Fuel Level warning.**
- **Remote Alarm Reset**

Output signals from the control include:

- **Auxiliary “Run” Relays.** (Up to 3 optional) Each relay provides three sets of Form C contacts rated 2A @ 30VDC.
- **Generator Set Common Shutdown signal.** Form C relay contact (1 normally open and 1 normally closed contact with common) rated 2A @ 30VDC/180VAC.
- **Load Shed signal.** Form A relay contact, rated 2A @ 30VDC/180VAC. Operation is configurable for under frequency or over kW load, or both.
- **Ready to Load signal.** Form A relay contact, rated 2A @ 30VDC/180VAC. Operates when the generators sets has reached 90% of rated speed and voltage and latches until generator set is switched to off or idle mode.

The control system is specifically designed and tested for resistance to RFI/EMI, and to resist the effects of vibration to provide a long reliable life when mounted on a generator set. The control includes transient voltage surge suppression to provide compliance to referenced standards.

Software

PowerCommand for Windows

PowerCommand for Windows is a software tool that is used to remotely monitor and control generator sets, transfer switches, and other on-site power system devices.

Options and Accessories

- Key-type Mode Select Switch.**
- Ground Fault Alarm Module.**

- Full Function Paralleling.** Provides all paralleling functions, including automatic and manual operation, protection, and other features described in this document.
- Exhaust Temperature Monitoring**
- Alternator Temperature Monitoring**
- Digital Remote Annunciator**
- Digital Output Relay Module**

Warranty

PowerCommand control systems are a part of complete power systems provided by Cummins Onan, and are covered by a one-year limited warranty as a standard feature.

Extended warranty options are available for coverage up to 10 years. Contact your Cummins Onan distributor for more information.

See your distributor for more information



Cummins Power Generation
1400 73rd Avenue N.E.
Minneapolis, MN 55432
612.574.5000
Fax: 612.574.5298

Cummins Power Generation is a subsidiary of Cummins Inc.
PowerCommand is a registered trademark of Cummins Inc.
AmpSentry is a trademark of Cummins Inc.
Windows is a registered trademark of Microsoft.
LONWORKS AND LONMARK are registered trademarks of Echelon

Important: Backfeed to a utility system can cause electrocution and/or property damage. Do not connect to any building's electrical system except through an approved device or after building main switch is open.