

# PowerCommand<sup>®</sup> 2100 digital generator set control



## Description

The PowerCommand 2100 control 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.

The PowerCommand control is designed for mounting on the generator set and is suitable for use on a wide range of generator sets in non-parallel applications. The PowerCommand control will directly read AC voltages up to 600 VAC and can be configured for any frequency, voltage and power connection configuration from 120 to 600 VAC.

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

Power for PowerCommand control is usually derived from the generator set starting batteries. It functions without degradation in performance over a voltage range from 8 VDC to 35 VDC.

## Features

**Digital engine speed governing controls** - Provide isochronous frequency regulation (optional on some genset models).

**Digital voltage regulation** - 3-phase sensing.

**AmpSentry<sup>™</sup> protective relay** - UL Listed, true alternator over current protection.

**Analog and digital AC output metering.**

**Battery monitoring system** - Senses and warns against a weak battery condition.

**Digital alarm and status message display.**

**Generator set monitoring** - Displays status of all critical engine and alternator functions.

**Smart starting control system** - Temperature dynamic integrated fuel ramping to limit black smoke and frequency overshoot, in addition to optimized cold weather starting.

**PCCNet interface** - A proprietary RS485 network interface to allow easy plug and play interface to remote annunciators, relay modules for extensible I/O and other devices.

**Advanced serviceability** - Interfaces to InPower<sup>™</sup>, a PC-based software service tool. A version of InPower is available for customer use.

**PowerCommand LonWorks<sup>®</sup> network (optional)** - Provides interfaces to external devices through a twisted pair wire and other media.

**Certifications** - Suitable for use on generator sets that are designed, manufactured, tested, and certified to relevant UL, NFPA, ISO, IEC, and CSA standards.

**Warranty and service** - Backed by a comprehensive warranty and worldwide distributor service network.

## 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 locking plug interfaces for reliable, vibration-resistant interconnection to the generator set wiring harness.

### Control switches and functions

**Off/manual/auto mode control switch** - The *not in auto* lamp will flash when the control is in the *manual* or *off* mode. In the *auto* mode, the generator set can be started with a start signal from a remote device, such as an automatic transfer switch.

**Manual run/stop control switch** - When the mode control switch is in the *manual* position and the *manual/run/stop* switch is pressed, the generator set will start, bypassing time delay start. The control is configurable to include an idle period on manual start. If the generator set is running in the *manual* mode, pressing the *run/stop* switch will cause the generator set to shut down after a cool down at idle period.

**Panel lamp/lamp test control switch** - Depressing the *panel lamp* switch will cause the panel illumination to operate for approximately 10 minutes. Pressing and holding the switch will sequentially illuminate all LED lamps on the panel to confirm proper operation of these components.

**Fault acknowledge/reset switch** - The control includes a *fault acknowledge* function to allow the operator to reset the fault condition. If the fault condition is not corrected, the fault will reappear, but will not be logged as a separate event. Multiple faults can be logged and displayed at one time.

**Emergency stop control switch** - Pressing the *emergency stop* switch will cause the generator set to immediately shut down. The generator set is prevented from running or cranking with the switch pressed in.

**Operator adjustments** - The control includes provisions for many set up and adjustment functions via raise/lower 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 ( $\pm 5\%$ )
- Alternator frequency ( $\pm 5\%$ )

### Indicating lamps



The operator panel includes a series of LED indicating lamps to allow the operator to view the general status of the generator set. Functions displayed include:

**Green lamps** to indicate generator set running (operating at rated voltage and frequency); remote start signal received.

**Red (flashing) lamp** to indicate not-in-auto mode and a red lamp to indicate common shutdown.

**Amber lamp** for common warning.

Lamps (5) are configurable for color and function. These lamps are configured with InPower for any condition monitored by the control. Default configuration for these lamps include the following functions:

- Low oil pressure warning
- High engine temperature warning
- Low oil pressure shutdown
- Over speed shutdown
- Fail to start

### Analog AC metering panel (optional)



The PowerCommand control can be equipped with an analog AC metering panel that simultaneously displays 3-phase Line-to-Line AC volts and current, kW, power factor, and frequency.

The meter panel is composed of a series of LEDs configured in bar graphs for each function. The LEDs are color coded, with green indicating normal range values, amber for warning levels and red for shutdown conditions. Scales for each function are in % of nominal rated values. Resolution is 1% for values close to nominal and increases at values far from nominal.

### Alphanumeric display panel



The PowerCommand control is provided with an alphanumeric display capable of displaying 2 lines of data with approximately 20 characters per line. The display is accompanied by a set of six tactile-feel membrane switches that are used by the operator to navigate through control menus and to make control adjustments. (There are no rotary potentiometers in the control. All adjustments are made via the display panel or InPower). Display is configurable for multiple languages. It is configurable for units of measurement.

All data on the control can be viewed by scrolling through screens with the navigation keys.

The control displays all active fault conditions with the latest displayed first. Active and inactive faults are displayed.

The display panel includes a screen-saver timer that will turn off the display after 30 minutes of inactivity. Touching any key will turn the screen back on.

**Generator set hardware data** - Generator set rating in kVA, complete generator set model number and provisions for generator set serial number, engine model and serial number, and alternator model and serial number. The control stores the part number of the control and the software version present in the control. This information is read using InPower.

**Data logs** - Number of start attempts and number of start attempts since reset. Number of times generator set has run and duration of generator set running time. Generator set kWh produced. The control also stores number of start attempts, operating hours and kW hours since each has been reset. This data is read with InPower.

**Adjustment history** - Provides a record of adjustment and setting changes made on the control and identifies whether adjustment was made via the operator panel or with a service tool. If a service tool is used, the control provides a record of the serial number of the tool used. This information is read with InPower.

**Fault history** - Provides a record of the most recent fault conditions with time stamp, along with the number of times each fault has occurred. Up to 20 events are stored in the control non-volatile memory.



**Load profile data** - Control logs data indicating the operating hours at percent of rated kW load in 10% increments. The data is presented on the operator panel based on total operating hours on the generator set based on number of hours under 30% load and number of hours at more than 90% of rated. InPower can be used to read data in detail (10% increments).

**Generator set output voltage** - All phases, Line-to-Line and Line-to-Neutral, accuracy 1%. Data for all phases is displayed simultaneously to allow viewing of voltage balance.

**Generator set output current** - All phases, accuracy 1%. Data for all phases is displayed simultaneously to allow viewing of load balance.

**Generator set output frequency.**

**Generator set power output** - PowerCommand displays generator set kW and kVA output (average and individual phase and direction of flow), and power factor with leading/lagging indication. Accuracy 5%.

**Generator set kWh power output** - Displays total kilowatt-hours produced by the generator set and total produced since last reset, with time stamp of time of last reset.

**Generator set control temperature.**

**Engine starting battery voltage.**

**Engine lube oil pressure.**

**Engine coolant temperature.**

**Engine lube oil temperature (option on some genset models).**

**System data display** - The generator set will exchange data with Cummins transfer switches utilizing PowerCommand transfer controls and other generator sets using the PowerCommand 2100 control that are located on the same site and interconnected using a PowerCommand network. Information displayed from each transfer switch in the system includes: transfer switch name (assigned by customer at site), kW load (when fitted with load monitoring equipment), sources available, source connected and if any alarm conditions are present on the switch. Genset data includes genset name, kW load, status and name of any alarm conditions that are present.

**Service adjustments** - The operator panel includes provisions for adjustment and set up of all control functions in the generator set. The operator panel includes an access code that is used to protect the control from unauthorized service level adjustments.

## Internal control functions

### Engine control

**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.

PowerCommand includes a smart starting system that is designed to quickly start the engine, minimize black smoke, 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.

The control can incorporate a time delay start and a warmup period at idle speed. See *Engine governing* for details.

**Sleep mode** - PowerCommand can be configured to include a sleep mode. When enabled, and when the mode select switch is in the off position, the control will revert to a low power consumption mode until a control switch on the operator panel is operated (reset, panel lamp, manual run or emergency stop).

**Data logging** - The control maintains a record of manual control operations, warning and shutdown conditions, and other events. The control also stores critical engine and alternator data before and after a fault occurs, for use by InPower and the technician in evaluating the root causes for the fault condition.

**Fault simulation mode** - PowerCommand, in conjunction with InPower software, will accept commands to allow a technician to verify the proper operation of all protective functions of the control by simulating failure modes or by forcing the control to operate outside of its normal operating ranges.

**Engine starting** - The control system automatically controls the engine starter and provides proper engine fueling and alternator control to provide fast and efficient starting.

**Cycle cranking** - Configurable for number of starting cycles (1 to 7) 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 (cool down)** - 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 shutdown after signal to stop in normal operation modes. Default for both time delay periods is 0 seconds.

### Engine governing

The PowerCommand control includes integrated digital governing capability to directly drive an engine fuel control valve. Features of the governing system (when enabled) include:

**Isochronous governing** - Controls engine speed within  $\pm 0.25\%$  for any steady state load from no load to full load. Frequency drift will not exceed  $\pm 0.5\%$  for a  $33^\circ\text{C}$  ( $60^\circ\text{F}$ ) change in ambient temperature over an 8 hour period.

**Temperature dynamics** - Modifies the engine fuel system (governing) 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.



## Engine governing (continued)

**Smart idle mode** - Engine governing can be regulated at an idle speed for a programmed period on automatic stop of the engine or in manual mode. In an automatic mode, the control will bypass the idle period if the engine is at a low load level for sufficient duration for cool down. During idle mode engine protective functions are adjusted for the lower engine speed, and alternator function and protections are disabled.

Idle speed can be initiated by the operator when the generator set is running in the manual mode.

**Glow plug control (optional)** - Modifies the engine start cycle to include a programmed time period for operation of glow plugs. This feature is available on generator sets that require glow plug control only.

## Alternator control

PowerCommand includes an integrated 3-phase Line-to-Neutral sensing voltage regulation system that is compatible with either shunt or PMG type excitation systems (some generator set models are always PMG). The voltage regulation system is full wave rectified and has a PWM output for good motor starting capability and stability when powering non-linear loads. Major system features include:

**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  $\pm 0.5\%$  for a 33 °C (60 °F) 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 V/Hz overload control** - The voltage roll-off set point and rate of decay (i.e. the slope of the V/Hz 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. The regulation system will drive a Permanent Magnet Generator (PMG) to provide 3 times rated current on all phases for motor starting and short circuit coordination purposes.

## Protective functions

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. 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, initiate shutdown 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 controller run time and engine operating hours data. Adjustments to most set points are made using the InPower service tool.

The control system includes a “*fault bypass*” mode that may be enabled by a service technician. The fault bypass mode forces the system to function regardless of the status of protective functions. (Each function must be individually bypassed.) In this mode the only protective functions that are operational are over speed, loss of speed sensor, moving the control switch to the off position or pressing the emergency stop switch.

The control maintains a record of the time that the mode is enabled, and all warning or shutdown conditions that have occurred while in the “*fault bypass*” mode.

The control system automatically captures the generator set logged parameters on a fault condition.

Many protective functions within the control system are configurable for warning, shutdown or both (2 levels). Exceptions to this include functions such as over speed conditions and loss of speed sensing. In addition, some functions can incorporate control functions as a consequence of a fault.

## System protective functions

**Ground fault warning (optional)** - 600 VAC class generator sets with solid ground. 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 (configurable contact closed to ground or open) to indicate customer-specified conditions. The control is programmable for warning, shutdown or status indication, and for labeling the input. Eight additional faults can be input to the control via the network.

**Emergency stop** - Annunciated whenever the local or remote emergency stop signal is received. Alarm panel distinguishes between local or remote operation.

## Engine protection

**Over speed 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.

**Low lube oil pressure warning** - Level is preset to match the capabilities of each engine. Control includes time delays to prevent nuisance shutdown signals.



**High coolant temperature shutdown** - Level is preset to match the capabilities of each engine. Control includes time delays to prevent nuisance shutdown signals.

**High coolant temperature warning** - Level is preset to match the capabilities of each engine. Control includes time delays to prevent nuisance shutdown signals.

**High oil temperature warning (optional)** - Level is preset to match the capabilities of each engine. Control includes time delays to prevent nuisance shutdown signals.

**Low coolant level warning/shutdown** - Optional on some genset models.

**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.

### Engine protection (continued)

**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.

**Dead battery shutdown** - Indicates that generator set failed to start due to failed starting battery.

**Fail to start (overcrank) shutdown.**

**Fail to crank shutdown** - Control has signaled starter to crank engine but engine does not rotate.

**Redundant starter disconnect.**

**Cranking lockout** - The control will not allow the starter to attempt to engage or to crank the engine when the engine is rotating.

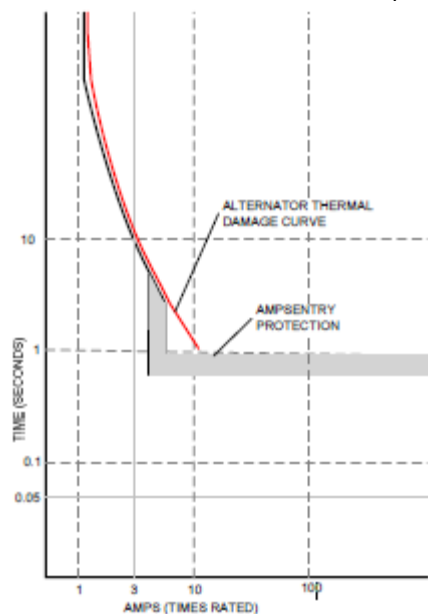
**Sensor failure indication** - All analog sensors are provided with sensor failure logic to indicate if the sensor or interconnecting wiring has failed. Separate indication is provided for fail high or low.

### AmpSentry protective relay

AmpSentry protective relay is a UL Listed comprehensive monitoring and control system integral to the PowerCommand control system 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. See document R1053 below for a full size time over current curve.

**Over current warning** - Output current on any phase at more than 110% of rating for more than 60 seconds or more than 400% for more than 1 second.

**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.



**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. Values adjustable from 105-125% of nominal voltage with time delay adjustable from 0.25-10 seconds. Default value is 110% for 10 seconds.

**Low AC voltage shutdown (27)** - Voltage on any phase has dropped below a preset value. Adjustable over a range of 50-95% of reference voltage, time delay 2-10 seconds. Default value is 85% for 10 seconds. Function tracks reference voltage.

**Under frequency shutdown (81u)** - Generator set output frequency cannot be maintained. Settings are adjustable from 0-10 Hz below nominal governor set point for a 0-20 second time delay. Default: 6 Hz, 10 seconds.

**Over frequency shutdown/warning (81o)** - Adjustable for operation in a range of 0-10 Hz above nominal frequency, with a time delay of 0-20 seconds. Defaults: disabled.

**Over load (kW) warning** - Provides a warning indication when engine is operating at a load level over a set point or due to under frequency. Adjustment range: 50-140% of rated kW, 0-120 second delay. Defaults: 105%, 60 seconds.

**Reverse power shutdown (32)** - Adjustment range: 5-20% of standby kW rating, delay 1-15 seconds. Defaults: 10%, 3 seconds.

**Reverse Var shutdown** - Shutdown level is adjustable: threshold 0.15-0.50 per unit, delay 10-60 seconds. Defaults: 0.20, 10 seconds.

**Excitation fault** - Shutdown of generator set will occur on loss of voltage sensing inputs to control.



### Environment

The control is designed for proper operation without recalibration in ambient temperatures from -40 °C to +70 °C (-40 °F to +158 °F), and for storage from 55 °C to +80 °C (-67 °F to +176 °F). Control will operate with humidity up to 95%, non-condensing. Control operation is not restricted by altitude.

The control system is housed in a NEMA 3R/IP53 enclosure. The operator control panel has a single membrane surface which is impervious to the effects of dust, moisture, oil and exhaust fumes. The panel uses sealed membrane or oil-tight switches to provide long reliable service life in harsh environments.

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.

## Control interface

### Input signals to the PowerCommand control include:

**Remote start signal** - May be connected via either discrete signal or Lon™ Network, or both.

**Remote emergency stop.**

**Remote alarm reset.**

**Configurable customer inputs** - Control includes (4) input signals from customer discrete devices that are configurable for warning, shutdown or status indication, as well as message displayed.

### Output signals from the control include four configurable relay drivers. Defaults for these are:

**Generator set common warning signal** - Operates when unit set is running under alarm conditions.

**Generator set common shutdown signal.**

**Not in auto** - Indicates that the mode control switch is not in the auto position or that the genset is shutdown under a fault condition.

**Ready to load (generator set running) signal** -

Operates when the generator set has reached 90% of rated speed and voltage and latches until generator set is switched to *off* or *idle* mode.

Control power for auxiliary devices is available from the controller.

### Network connections include:

**PCCNet interface** - A proprietary dedicated RS485 network for use in operating remote annunciator panels and remote I/O modules.

**Serial interface** - This communication port is to allow the control to communicate with a personal computer running InPower software.

**Echelon® LonWorks interface (optional).**

## Software

**InPower** - A PC-based software service tool that is designed to directly communicate to PowerCommand generator sets and transfer switches to facilitate service and monitoring of these products.

**PowerCommand for Windows®** - A software tool that is used primarily by operators to remotely monitor and control generator sets, transfer switches and other on-site power system devices.

## Warranty

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

Extended warranty options are available for coverage up to 10 years.

**For more information contact your local Cummins distributor or visit [power.cummins.com](http://power.cummins.com)**

## Certifications

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

**NFPA110:** For Level 1 systems

**UL508:** Recognized or listed and suitable for use on UL 2200 listed generator sets

**CSA C282-M1999:** Compliance

**CSA 22.2:** No. 14 M91 industrial controls

**ISO 8528-4:** 1993 compliance, controls and switchgear

**NFPA99:** Standard for health care facilities

**CE Mark:** Control system suitable for use on generator sets to be CE-marked

**EN 50081-2:** Industrial emissions

**EN 50082-2:** Industrial susceptibility

**ISO 7637, pulses #2b, 4:** DC supply surge voltage test

**Mil Std 202C, Method 101:** Salt fog test

**ANSI C62.41:** Surge withstand

**IEC 801.2, 3, 4, 5:** For susceptibility, conducted and radiated electromagnetic emissions

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

## Options and accessories

- Analog AC metering display - Provides a bar graph display of 3-phase AC volts and amps, kW, power factor and frequency.
- Key-type mode select switch - Replaces off/manual/auto switch with a key-type switch.
- Ground fault alarm module - Installs a separate ground fault indication relay and harness into a control customer input.
- Exhaust temperature monitoring.
- Digital remote annunciator.
- Digital output relay module - Provides (3) relays, each with 2 normally open and 2 normally closed contacts rated 10 A at 600 VAC, 5 A at 24 VDC. Functions of the relays are configurable.
- Engine oil temperature indication - Some genset models incorporate this feature as standard. On all models, the control may be configured to include an oil temperature warning or shutdown when oil temperature sensing is provided.
- CAN engine interface (optional on some models). Allows the genset control to directly monitor an engine control module.
- LON interface.
- Input/output expansion module - Provides up to 16 configurable Form-C relays, 12 configurable discrete inputs and 8 analog inputs.



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