# Paralleling Equipment
## PowerCommand
## Model 300

## Digital Master Control

## Description

The PowerCommand™ Digital MasterControl is a microprocessor-based paralleling system component, designed to directly interface with Cummins PowerCommand Paralleling generator sets. The Digital MasterControl is designed for use in low or medium voltage isolated bus (not utility paralleled) and infinite bus (utility paralleled) applications. The control system provides flexibility to meet specific application requirements, ease of operator use, advanced functionality and optimum system reliability and serviceability. The MasterControl may be either separately installed at a convenient location or integrated into the system power sections when required.

The PowerCommand™ GenSet 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.

Control power for PowerCommand and the Digital MasterControl is usually derived from the generator set starting batteries, and is backed up by an independent battery backup system.

## Features

The control offers a wide range of standard control and digital display features so custom control configurations can be achieved with minimum custom design work.

### *Major Control Features Include:*

- **Full Function Master Control for Infinite Bus Paralleling Systems.** System master control provides provisions for use of the on-site power system for both emergency/standby (isolated bus) operation, and operation in parallel with a utility (mains) service for applications ranging from short term soft power transfer to continuous paralleling situations.
- **High Resolution Color Touchscreen** with graphical information displays, comprehensive system and generator data, strip charting capability, integral manuals, and many other features.
- **Automatic Load Adding and Shedding** (Optional) System includes “smart” load sequencing to automatically add load and remove load as system capacity changes due to generator set availability and also changes in system load level.
- **PowerCommand Network**. Provides detailed operational data on all components in the system, and allows direct operator control of the system.
- **Warranty.** PowerCommand systems are supported by a worldwide network of independent distributors, who provide parts, service and warranty support.
- **Remote User Interface**. (Optional) The control system is configured to allow use of a remote PC-based operator panel, running the same software as the master control panel.

# Operator Panel

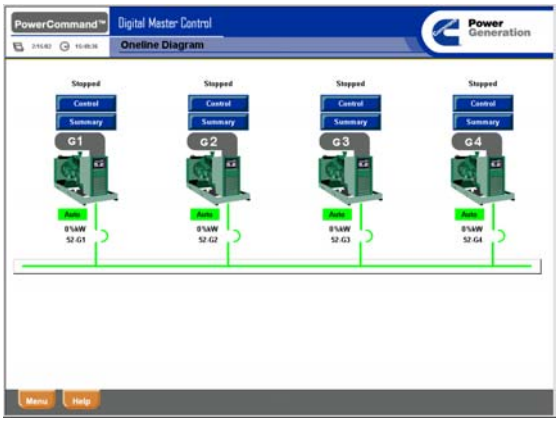
The operator panel provides the user with a complete package of easy to view and use information.

## *Touchscreen Operator Panel*

A full color high-resolution 15 inch (diagonal) touchscreen operator interface panel (HMI) is provided to allow the operator to monitor and control the on site power system.

All data is configurable for display in either US standard or metric indications. Screens are configured in a typical Windows™ format, with a pop-up menu in the lower left corner of the screen providing access to various screens. There is a context sensitive help button on each screen. Access to other system control and monitoring functions through a menu button with pop-up option display.

The HMI includes the following screens and/or functions:



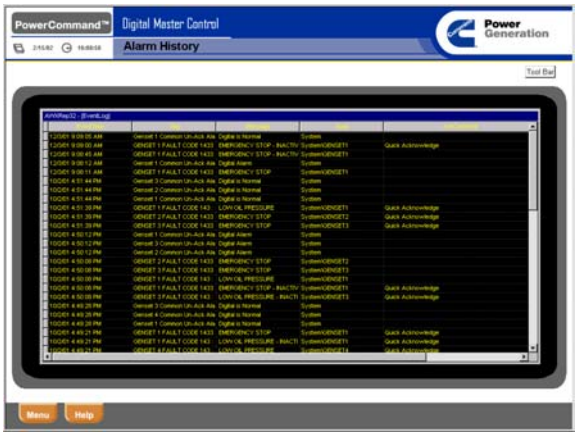

**One Line Diagram**.
The one-line diagram screen displays system status by a combination of animation, changing screen color, text messages, and pop-up indicators. Conditions visible on the screen include:

- **Generator set(s), and bus configuration**, with generator set, parallel breaker and bus energized/de-energized indication (red indicating energized, green indicating de-energized).
- **Generator set designation**. Control, data, and performance summary screens are accessible through hot keys (links) located on or adjacent to the genset icon.
- **Generator set mode** (run/off/auto)
- **Generator set status** (normal/warning/shutdown/load demand stop). A windows-like popup menu provides access to all system functions from the one-line diagram screen.
- **Paralleling breaker status.** (open/closed/tripped). (Status and condition of other breakers and devices is optional when supplied or required by the project.)
- **Bus condition** (energized or de-energized) Clicking on the bus icon provides access to a bus AC data screen.

**System Control**


The system control screen provides the operator with the ability to enable or disable load demand operation, view timer values and view the load demand sequence; initiate test (with or without load); control the shutdown sequence for the generator sets in the load demand mode; set the load demand time delays; set the load demand operation set points; and display and modify the automatic load add and shed sequence.

**System Data Logging.**




The master control touchscreen records the date, time, and nature of all alarm and shutdown conditions reported on the system. This log includes all alarms reported on the generator set and all master control and network-connected functions.

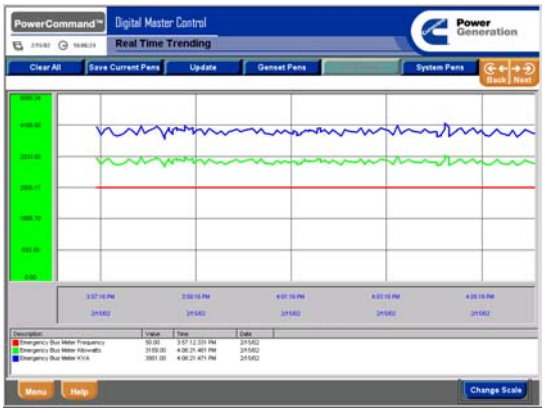
**Genset Status Summary**.


The genset status summary provides an analog and graphical display of critical generator set operating parameters. The screen includes generator set state display (stopped, time delay start, idle speed state, rated volts/hz, synchronizing, load share, or load govern); analog AC metering for generator set, including 3-phase AC volts and current, frequency, kW, and power factor; and 3-phase AC bus voltage and frequency. The screen provides a complete display of all engine and alternator data present in the generator set control. The screen also shows status of the bus and generator set breaker. Hot buttons are provided for quick access to similar data on all machines.

**Load Control**.


The load control screen provides an analog display of system load as a percent of available capacity of the generator sets that is operating in parallel on the bus. The screen provides an alphanumeric display of this data. It also displays the name, status and priority of each load block (whether on or off), and the total load of that block. The screen allows the operator to manually add and shed loads in any sequence desired.

**Trending.**




The Touchscreen provides real time trend charts for any monitored value in the system, with up to 8 monitored points at any time. Historical trend charts using a data log function in the control may also be provided (optional). The Historical charts are configurable for functions displayed, and for the time frame displayed, and allow comparison of historical data from multiple time periods simultaneously.

**Alarms.** Any alarm on any generator set or in the system will cause an alarm bar and warning condition display to appear on the touchscreen. A click on the bar will cause a pop-up screen display that describes the equipment where the fault has occurred, and the name of the fault. The screen allows the operator to attempt to reset the fault from the HMI.

**Service Manuals.** The HMI includes the ability to display the entire content of all operating and service manuals for the entire system, including generator sets (engine, alternator and control system), paralleling controls, master controls, and transfer control equipment.

**Service Information**. The service information pop-up screen includes the name, address, and phone number for the local service point for the equipment.

**AC Metering Screens**


The touchscreen is configurable to AC data in analog "needle type" meter displays**.**

**Transfer Controls** (Optional). A transfer control screen is provided for each transfer breaker pair in the system. The transfer control screens provide status information on the condition of the normal service and generator service at each device (service available), which source is connected to the load, as well as transfer control status. Information provided includes:

- Virtual indication "lamps" for common alarm, not in auto, test/exercise mode, load shed, transfer inhibit, retransfer inhibit, fail to close, fail to disconnect
- AC data for the two sources feeding the transfer pair, including line to line and line to neutral AC Volts for all phases of both sources, frequency of both sources, load current, power factor, kW, and kVA for the load.
- Test "pushbutton" and fault reset "pushbutton".
- The screen also displays status of all active time delays and all active faults.

# Internal Components

## *System PLC*

Paralleling control functions (synchronizing, load sharing, etc.) are provided by the PowerCommand Generator set paralleling controls. System control logic such as load add and shed sequence is performed by a programmable logic controller (PLC). The PLC is a DIN-rail mounted device to allow easy servicing of components. Other features of the PLC include:

- **On-Line Changes.** The PLC may be interconnected to a personal computer and control sequences may be modified without shutting down the system.
- **EEPROM Program Storage.** The PLC program is stored in non-volatile EEPROM memory, with additional battery backup of the PLC RAM for storing system configuration settings.
- **LED Status Indicators.** The PLC and Input/Output (I/O)blocks include LED status indicators for use in viewing system status and diagnosis of failures.

- **I/O Block Surge Suppressors.** Inputs and outputs to the PLC are connected via integral surge suppressors to provide protection against over voltage damage to the system and provide greater reliability.

## *Protective Functions*

Protective functions in the Digital MasterControl are provided by the PowerCommand generator set controls. These functions include over and under bus voltage, under frequency, over load, and phase sequence protection. Since these functions are resident in the genset controls, they are effectively redundant, so that whenever a generator set is closed to the bus the protective functions are available. The use of InPower software allows fast, consistent settings for all system protective functions; and they can also be adjusted through the system operator panels.

On a warning condition the control system indicates a fault by displaying the fault name and code. The nature of the fault and time of occurrence is logged in the genset control (based on engine operating hours) and in the master control based on a system real time clock. The service manual and InPower service tool provide service keys and procedures based on the service codes provided.

### *Control Power System*

Control power for the system is derived from the generator set 24VDC starting batteries. A solid state no break "best battery" selector system is provided so that control voltage is available as long as any battery bank in the system is available. All battery banks are isolated to prevent the failure of one battery from disabling the entire system. A station battery and charger back up the generator set control power systems so that the master control has multiple redundant control power.

The PowerCommand control (on each generator set in the system) continually monitors the battery charging system for low and high DC voltage, and runs a battery load test every time the engine is started. Functions and messages on the generator paralleling control include:

- Low DC voltage (battery voltage less than 24VDC, except during engine cranking)
- High DC voltage (battery voltage greater than 32VDC).
- Weak Battery (battery voltage less than 14.4 VDC for more than 2 seconds during engine cranking).

The master control station battery also includes battery and charger failure testing and indication.

## **Sequence of Operation** (typical)

### *Loss Of Normal Power:*

System is given signal to start by receipt of start signal from the power transfer control(s) (Master PC or PLC) or other remote device. On receipt of this signal, all generator sets automatically and independently start, accelerate to rated frequency and build up to rated voltage. The first start system monitors this process, and on finding a generator set at 90% of rated voltage and frequency, automatically disables all other units from closing to the bus, and closes the ready unit to the bus. At this time the utility main breakers are opened, non-essential loads are shed, and the generator main bus breakers connect generator sets to the system bus.

After the first unit is closed to the bus, the control of the remaining units is switched to the synchronizer in each generator paralleling control, which causes the generator set to synchronize with the system bus, and then close to it at the proper time. As each unit closes to the bus, the unit assumes it's proportional share of the total load on the bus, and the control system automatically adds loads to the generator bus by closing feeder breakers.

The load control system monitors the total capacity of the bus and the load demand for each load step, and automatically manages load adding and shedding based on priority and genset capacity available to serve the load.

### *Failure Of A Unit To Start Or Synchronize:*

If a genset fails to start, after the fail to start time delay (in the generator set control) has expired, the unit will be shut down, and an alarm will sound. The priority control system manages loads in the system to maintain service in priority order to loads based on available generator set capacity. The priority override controls on the HMI may be used by an operator to manually add low priority loads to the bus, if he determines that generator capacity is available to serve the loads. Bus overload monitoring protects the first priority loads in the event that the bus is inadvertently overloaded due to operator error.

If a unit fails to synchronize, after a preset time delay, an alarm will sound, but the unit will continue to attempt to synchronize until signaled to stop by manual operation of the control switches on the generator set.

### *Bus Overload:*

If a bus overload occurs for any reason, a load shed signal will be generated to initiate load shedding in the system. If the bus does not return to proper frequency within a predetermined period of time (adjustable via the HMI), additional load shed signals will be generated until the generator set bus returns to normal frequency.

Loads that are shed due to overload require manual reset via the HMI.

### *Load Demand Mode:*

When the system is running in the emergency mode with the "load demand" switch on the HMI in the "on" position, controls shall continuously monitor the total load on the bus. If the total load on the bus falls below preset limits for a period of 15 minutes, the controller will automatically shut down generator sets in an operator predetermined order, until the minimum number of generators required to operate the load remain on the bus. The purpose of this function is to allow the generator sets to operate closer to their rated capacity, thereby decreasing fuel consumption, and reducing wear on the system.

On sensing that the available bus capacity is being approached, the standby units will automatically be restarted (in the reverse order of which they were shut down) and paralleled with the bus to assume their proportional share of system load. As each load parallels to the bus, load ramps to load share level.

The system automatically compensates for generator sets of different sizes.

### *Return of Normal Power*

When all of the system start signals are removed from the generator sets, the system will begin a retransfer process in either an open or closed transition mode, as selected by the operator.

If running in the closed transition mode, the system shall synchronize the generator bus to the first utility

source, close the utility breaker, ramp down load on the generator breaker to a minimum value, then open the generator bus breaker. This process shall be repeated sequentially across each breaker transfer pair.

If running in the open transition mode, the system shall sequentially transfer back to the utility by opening each generator bus breaker, then closing it's associated utility breaker at an operator-programmed time period later. This process shall be repeated sequentially across each breaker transfer pair.

When all loads have been transferred back to the utility, the generator set paralleling breakers shall all open, and the generator sets shall operate at no load for a cooldown period. When the cooldown period has been completed, the generator sets shall shut down.

If a system start signal is received during the cooldown period, one generator set will immediately close to the system bus and all other units will synchronize to it, as described in "Loss of Normal Power" above.

### *Exercise (Test) With Load Mode:*

The system will allow the generator sets to be tested by transfer of the system loads to the generator sets. Sequence of operation in this mode shall be similar to that described for a power failure condition.

### *Exercise (Test) Without Load Mode*

The system will allow testing of the generator sets at no load. In this operation mode the generator sets will start, build up to rated speed and voltage, synchronize and close to the generator bus, but system loads will not automatically transfer to the generator system. If a power failure occurs during a test period, loads will immediately close into the system on a priority basis.

When the system is operating in the closed transition mode, it shall always transfer between "good" sources without a power interruption to the load.

## Control Interface

All control interconnections in the MasterControl is provided on standardized terminal block assemblies. Interconnections to external equipment include:

- **Load Add and Load Shed Relays (Optional).** Each relay includes "form C" contacts (a normally open and a normally closed contact with common return) rated 10A @ 600VAC.
- **Paralleling Breaker Control Relays (Optional).** Relays is directly driven by the PowerCommand generator set control, and mounted in the master control for interconnection convenience.
- **Bus Voltage Connection.** Control includes fused 3-phase 4-wire connections up to 600VAC. It provides a bus voltage reference signal to the PowerCommand generator set control if desired.
- **System Remote Start Command.** Provided to allow for remote (with load) system test.

## Construction

The control system is housed in a rigid, freestanding, NEMA1/IP40 metal enclosed structure designed to require front access only. Framework is constructed of minimum 2.5-mm (12 gauge) steel sheet metal. The framework and all other sheet metal components of the system is primed with a rust-inhibiting primer and finished with satin finish ANSI 61 gray enamel.

Control components are totally isolated from power-carrying components by metal or insulating barriers. All components and surfaces operating at more than 50 volts is shielded to prevent inadvertent contact.

All control wiring is 105 degree C, 600 volt rated, and sized as required for safe, reliable operation. Each wire, device and functional component is identified by silk-screen or similar permanent identification.

Fuses are installed in DIN-rail mounted safety-type fuse holders, with integral "fuse blown" indicating lamps.

Terminal blocks are provided for all field connections on DIN-rail mounted devices.

## 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 is 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 0C to +46C, and for storage from –20C to +70C. Control will

operate with humidity up to 95%, non-condensing, and at altitudes up to 10,000 feet (5000 meters).

## Network

The MasterControl includes network communications over a Cummins PowerCommand Network. The network utilizes the widely used Echelon™ Lonworks™ technology as a basis. The network is suitable for local or (optional) remote control and monitoring functions.

## Options and Accessories

- ❑ **Load Add Relays (4 levels)**.
- ❑ **Load Add Relays (8 levels).**
- ❑ **Load Shed Relays (4 levels).**
- ❑ **Load Shed Relays (8 levels).**
- ❑ **Breaker Control Relays**

## Warranty

PowerCommand systems are a part of a complete power system 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. Contact your Cummins distributor for more information.

## See your distributor for more information

**Cummins Power Generation**
**1400 73rd Avenue N.E.**
**Minneapolis, MN 55432**
**763.574.5000**
**Fax: 763.574.5298**



**Warning:** 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.