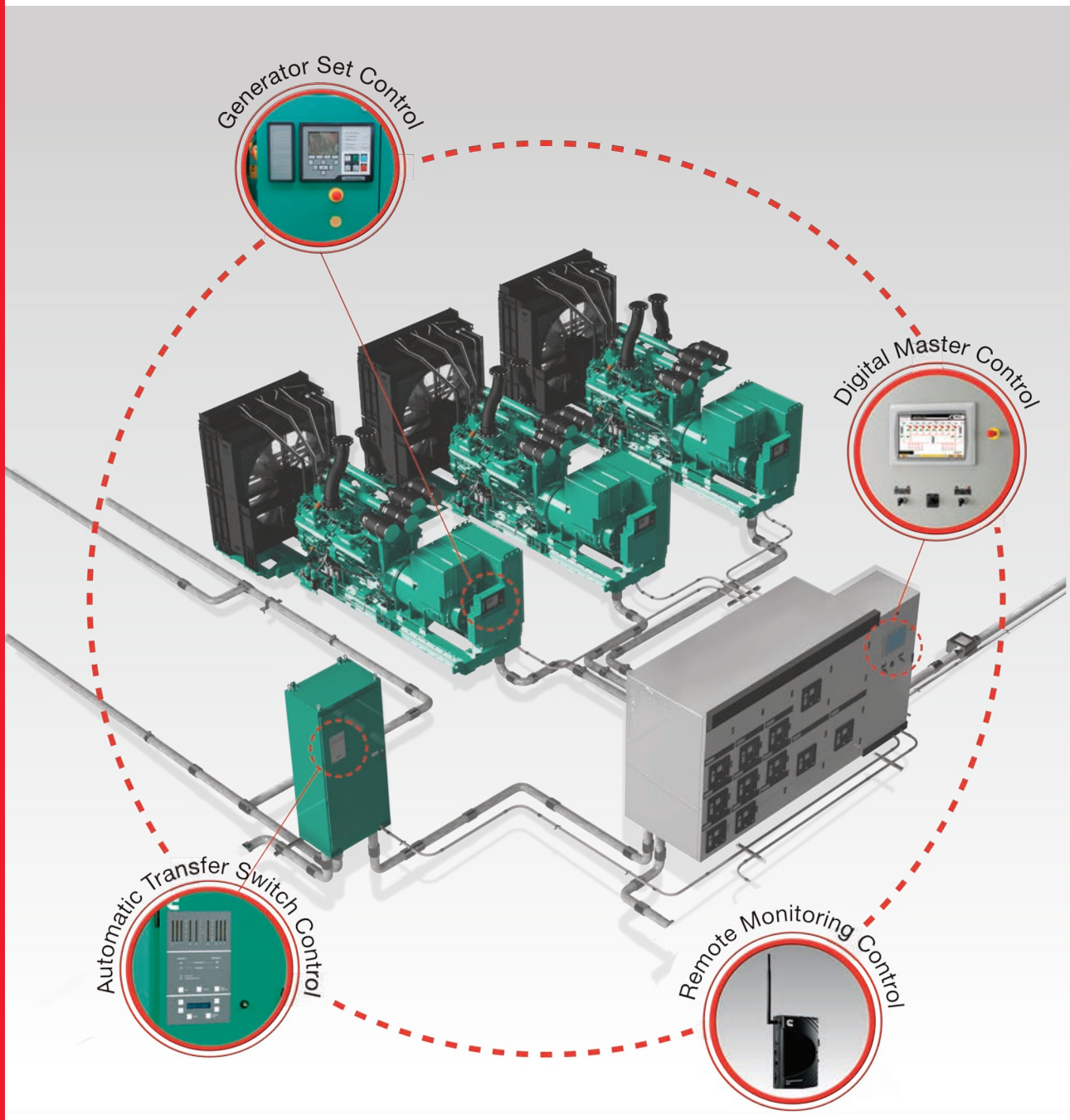
Digital Controls Technology



Our energy working for you.™

Not All Controls Are The Same

Integrated Controls vs Supervisory Controls

In 1995, Cummins introduced the first fully integrated PowerCommand® digital controls across its entire range of commercial generator sets. These microprocessor-based controls are the industry's only total integrated platform which is capable of integrating engine, alternator control and protection functionality into a common system.

Unlike other manufacturers, Cummins products are designed as a single system, not individual components of a larger system. This single integrated control system can control prime mover and generator and provide other control functions that enhance reliability and performance.

As part of PowerCommand power systems, digital controls combine generator, transfer and controls technologies into the only pre-integrated system designed by one manufacturer-Cummins, to provide a single source of accountability for peace of mind to our customers.

Integrated Controls

- Greater efficiency of facility design by reduction in physical space requirements provides lower total cost of ownership.
- Provides higher reliability by reduction in the number of components to minimize points of failure in the system
- Developed with the generator set to work with alternator and engine to provide better reliability and integrated built-in protection capability.

Supervisory Controls

- A supervisory control system tends to have a higher total cost of ownership due to the number of individual components used.
- In supervisory control systems, a higher number of points of failure resulting in lower reliability are to be expected.
- Supervisory controls lack integration thereby providing points of failure for protection and reliability.

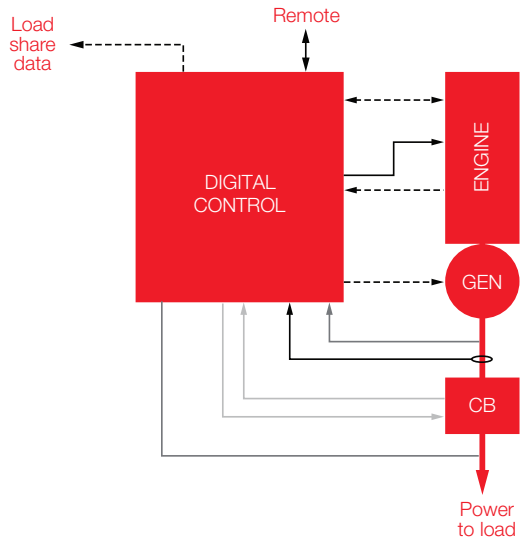


Figure 1 *– In a digital environment, all engine, generator and load control functions are combined in a small digital central control unit. Reliability is enhanced because interconnections have been reduced.*

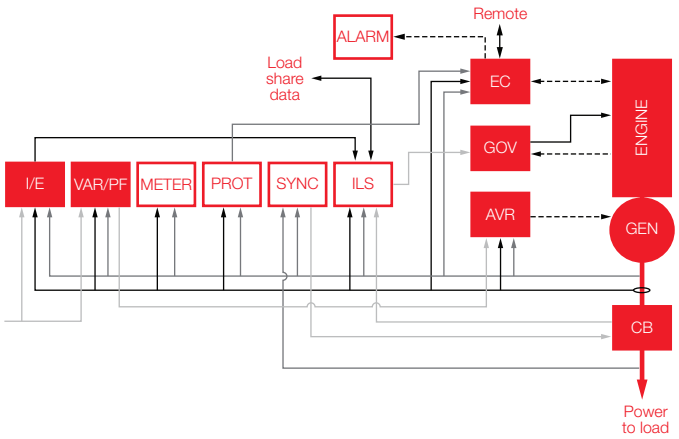


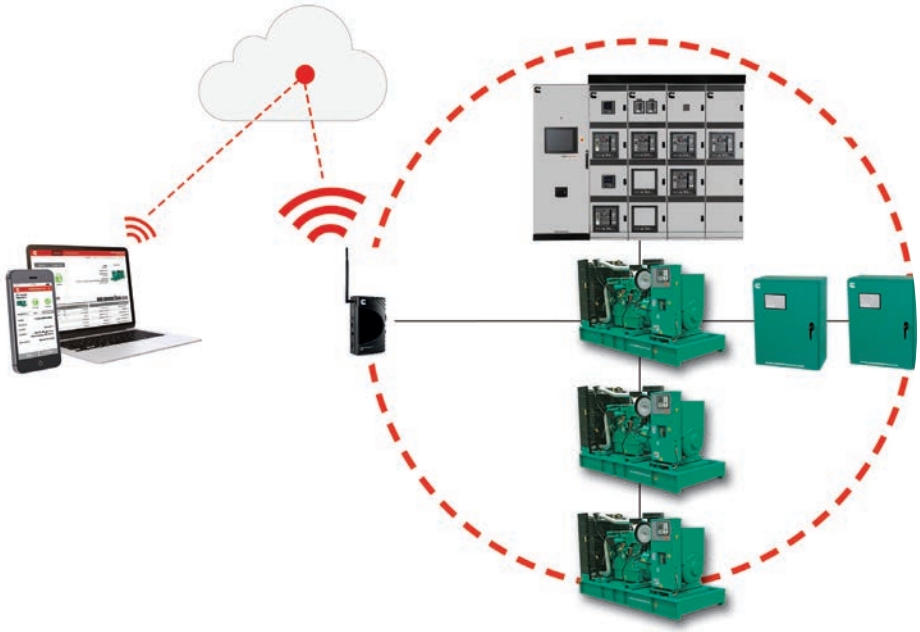
Figure 2 *– This illustrates the various analog components required in a utility paralleling application. Note the number of separate components, wires and connections—all which detract from reliability.*

Cummins PowerCommand®
Digital Controls Technology

As a world leader in pre-integrated power systems, Cummins designs and builds all the key components of the power system including generator sets, transfer switches, digital master controls complete with switchgear and remote monitoring solutions into one fully integrated value package. The single accountability for the entire system is clearly with Cummins. With the Power of One™, we not only supply the whole system, we design and manufacture the entire control system.

The Power of One

Using common communications protocols, these components utilize fully integrated PowerCommand microprocessor-based controls for all system control and protection functions. The inherent control capabilities of the system components allow for the design of more intelligent power systems, resulting in major gains in the areas where designers and users need them the most.



Enhanced System Reliability

- PowerCommand generator set controls, automatic transfer switch controls and digital master controls utilize distributed logic. In the event of a loss of a single component, the controls are designed to operate independently, which in turn provides a reduced system and not a total system failure.
- The integration of PowerCommand components allows the elimination of many components in a typical system to minimize single points of failure and improve system reliability.
- PowerCommand controls have been carefully analyzed and subjected to a detailed failure mode effect analysis (FMEA) and have a mean time between failures (MTBF) of up to 300,000 hours to achieve optimum hardware and logical reliability.
- Seamless integration of functional components of the power system allows status of all components and values in a complex power system to be viewed and controlled from a central or remote display unit as well as a computer.

As a single-source manufacturer of complete power systems, we provide the highest degree of design and performance control to ensure each element works in harmony and seamlessly, based on decades of field proven reliability.

Generator Set Control
Enhanced Efficiency and Performance

PowerCommand® is a microprocessor-based generator set monitoring, metering and control system designed to meet the demands of today's engine driven generator sets. This single integrated control system can directly operate the engine fuel system in conjunction with an engine control unit where appropriate, directly control the alternator excitation system and provide other control functions that enhance reliability and performance.

PowerCommand controls are **interchangeable** (can be easily upgraded so future expansion is less costly), **interoperable** (can be easily interfaced with other equipment to share data) and **internet-able** (can be linked to the internet for easier and more reliable remote monitoring and operating).

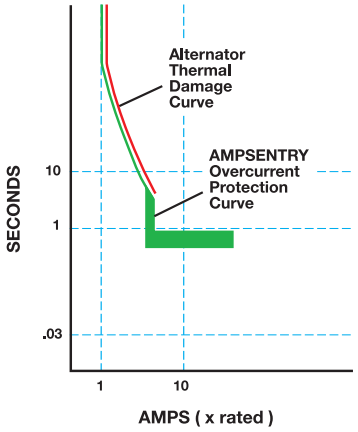
Alternator Protection

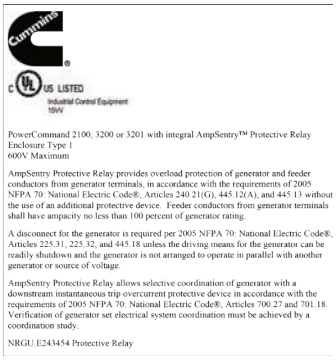
Conventional generator set protective systems often do not adequately protect the generator set and can malfunction, resulting in nuisance system failures.

Ampsentry™ protection is designed to eliminate nuisance generator set failures that occur with molded-case breaker protection to provide a higher standard of protection for the alternator. It guards the electrical integrity of the alternator against thermal damage.

Diagram 1 *- Digital sensing and protection is matched to the damage curve. PowerCommand digital control uses a trip characteristic that approximates the damage curve to prevent excessive heat build-up to provide alternator protection.*

Diagram 1




US LISTED
Industrial Control Equipment
19W

PowerCommand 2100, 3200 or 3201 with integral AmpSentry™ Protective Relay
Enclosure Type 1
600V Maximum

AmpSentry Protective Relay provides overload protection of generator and feeder conductors from generator terminals, in accordance with the requirements of 2005 NFPA 70: National Electric Code®, Articles 240.21(G), 445.12(A), and 445.13 without the use of an additional protective device. Feeder conductors from generator terminals shall have ampacity no less than 100 percent of generator rating.

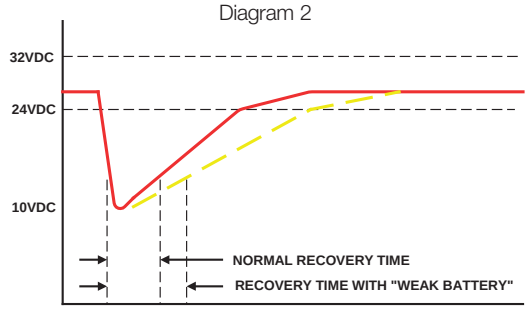
A disconnect for the generator is required per 2005 NFPA 70: National Electric Code®, Articles 225.31, 225.32, and 445.18 unless the driving means for the generator can be readily shutdown and the generator is not arranged to operate in parallel with another generator or source of voltage.

AmpSentry Protective Relay allows selective coordination of generator with a downstream instantaneous trip overcurrent protective device in accordance with the requirements of 2005 NFPA 70: National Electric Code®, Articles 700.27 and 701.18. Verification of generator set electrical system coordination must be achieved by a coordination study.

NRGU.E243454 Protective Relay

Ampsentry protective relay is UL certified.

Diagram 2



Starter Battery Protection

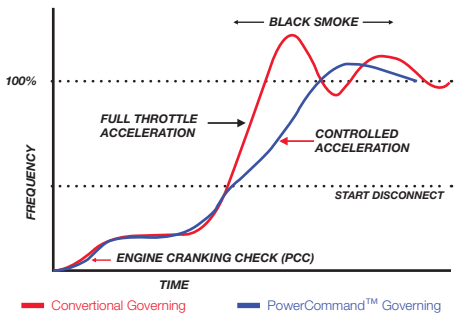
The leading cause of a generator set failing-to-start is due to flat starting batteries. Cummins provides general start protection with our low and high battery voltage warning indicator to continuously monitor battery voltage. The control system will monitor the battery to detect a failure in the charging system, and a 'weak battery' alarm sounds when the battery voltage drops too far and recovery is extended (refer to Diagram 2). This ensures improved generator set reliability and repeated stability.

Smart Starting Control System

When the engine is in a starting mode, the smart starting control system checks for engine rotation and provides enough fuel to accelerate the engine gradually to reach rated speed, reducing black smoke upon starting. The digital control system can also adjust the governor settings based on temperature of the engine to make it more stable on starting and more responsive as it warms up.

Diagram 3 *– In most conventional generator sets, the engine speed control system does not 'know' that the generator set is in a starting mode. Consequently, the control tends to over-fuel the engine during startup, resulting in a cloud of black smoke from the exhaust.*

Diagram 3



First Start Sensor

Cummins pioneered the use of First Start Sensor interlock technology to prevent simultaneous closure of unsynchronized generator sets to a dead system bus. A backup dead-bus sensor system in each control allows the system to properly start after a power failure.

Diagram 4

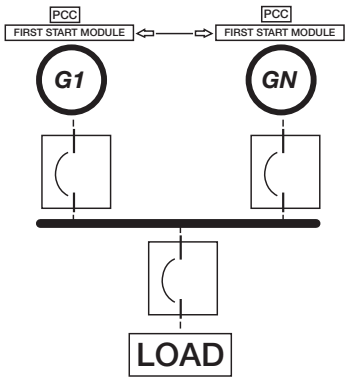


***Diagram 4** – The PowerCommand® First Start Module uses inter-generator set arbitration to permit only one unit to close to the bus first. All others are inhibited from closing to the bus, until arbitration has determined which generator set shall be the selected first-to-close unit.*

Breaker Failure Protection

Breaker failure protection controls and monitors breaker closure signals and provides a warning or shutdown if the breaker fails to close or open upon command to prevent system malfunction or generator damage.

Emissions Control

The ability of digital systems to integrate diverse functions is especially important in modern emissions-controlled diesel engines. Integrating engine control functions (fuel rate and injection timing) with fluctuation in generator load is critical for minimizing exhaust emissions from diesel engines. In fully integrated digital systems, these functions are integrated in PowerCommand generator set controls. This results in better engine performance under varying loads, reduced exhaust emissions and more stable output frequency and voltage.

Diagram 5

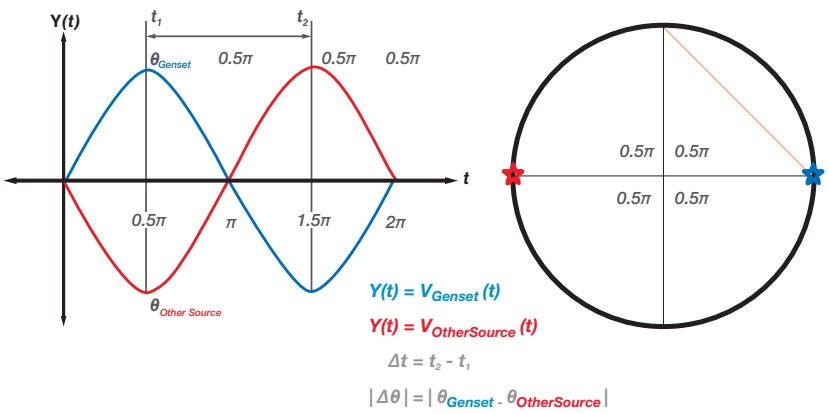


***Diagram 5** - PowerCommand synchronization is achieved by governing control, which enables waveforms of two different sources to become indistinguishable. Hence, Δt and $|\Delta\Theta|$ both tend towards zero, or similarly that the two stars on the unit circle exist at the same angular point.*

Digital Synchronizing

PowerCommand generator set controls operate over a very broad bus voltage and frequency operating range, and over very broad ambient conditions. The generator set governing controls are temperature dynamic, automatically adjusting governing characteristics to account for changes in engine operating temperature. PowerCommand generator set controls can synchronize even in the event of instability on the bus or abnormal frequency conditions.

Reduced Space Requirements

Digital controls allow many control systems to be located with the generator set instead of being isolated in a separate dust-and-vibration-free room. This occupies less floor space and requires less environmental protection to simplify installation, commissioning and reduce maintenance and repair.

Diagram 6

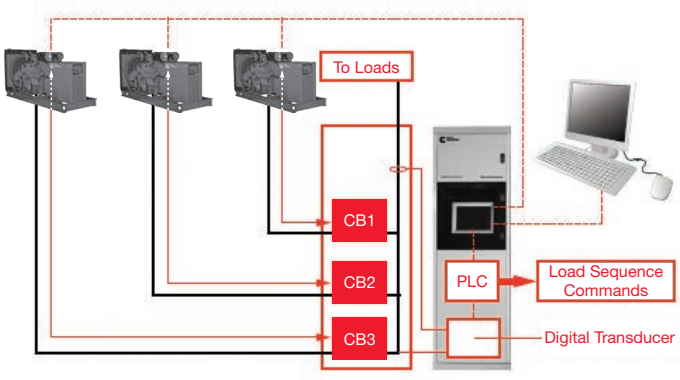


***Diagram 6** - Digital paralleling control systems only require one digital master controller, regardless of the number of paralleled generator sets. This reduces the 'footprint' of the control modules in addition to centralizing information and control into one input/output device.*

Generator Set Control

PowerCommand® 3.3
with Masterless Load Demand (MLD) Control Technology

The PowerCommand 3.3 MLD is a fully featured genset control with built-in Masterless Load Demand (MLD) technology. The integration of all control functions including voltage regulation, governing and paralleling into a single control system provides enhanced reliability and performance compared to conventional generator set control systems.

Masterless Load Demand-capable generators are equipped with an additional s-CAN network connection that allows sharing of information amongst paralleled generator sets. The generator set controls use this information to start/stop generator sets automatically based on load demand.

Reduced Fleet Operation Costs: Improves fuel efficiency of multi-gen systems by running the minimum number of gensets to match actual load requirements

Supports Large Fleet Operation: Up to 16 generator sets running in parallel

Easy Setup/Commissioning: Change MLD system settings from any one display and broadcast to all generator sets

Built-in Logic: Hassle-free installation with no additional equipment needed

Predictive Load Input: Intelligently anticipates large loads and adds capacity to provide reliable operation

Single Point Remote Start: Brings system online quickly for a fast start up operation

System Monitoring: View information about the entire system from any one display

Fast Response Time: Via s-CAN communication network

Run-Hour Equalization: Run-hour equalization feature extends engine life to reduce onsite support

Digital Master Control

Ease of Operation and Adaptability

PowerCommand digital master control (DMC) utilizes an integrated distributed logic control system design that ensures each major component in the system operates autonomously in the event of failure of other system components to improve system reliability.

The use of a dedicated-purpose DMC allows the provision of fully tested control hardware for load adding/shedding, load demand, utility paralleling and power transfer control functions as well as a range of HMI options for operator control and status.

At Cummins, we understand that facilities grow, change and expand over time. We have built the DMC product line for ease of scalability. Adding generators and loads to the control system can be configured without further programming, and future facility needs can be accommodated into any design as required.

DMC 8000 PowerCommand Paralleling System

One-line diagram with 8 gensets

Load Control

Remote Monitoring

Minimize Downtime and Maximize Power System Performance

PowerCommand remote monitoring equipment provides a convenient means of remotely monitoring and controlling generator sets, transfer switches and sensors. Designed for minimal service and support, the PowerCommand remote monitoring system provides an authorised user visibility of their power system from anywhere or at anytime - whether the user is onsite or offsite.

- Provides seamless integration with Cummins controls (generator set, transfer switch and expansion I/O modules) to reduce configuration and installation time
- Employs a straightforward graphical interface to monitor data and display overall system and device status (generator set, transfer switch, sensors and output controls)
- Ability to store system and device events, including faults and warnings triggered on a generator set, transfer switch and PowerCommand
- Easy setup of menu displays with graphical icons to control generator set and transfer switch set functions for efficient navigation and configuration
- Provides system and device event data logs containing detailed status of analog and discrete inputs – data log time intervals are configurable for each device type

Diagram 7 *– PowerCommand Cloud™ Remote Monitoring System*

InPower™

InPower is a PC-based software tool for direct service of PowerCommand products. Available in two editions, InPower uses a graphical interface compatible with Microsoft Windows® to provide direct connection capability.

InPower Pro: Allows users to modify and configure a range of settings within the control for advanced application-specific customization and monitoring of generator set operation and performance parameters.

InPower Lite: Enables users to check parameter settings for diagnostics and trouble-shooting purposes.

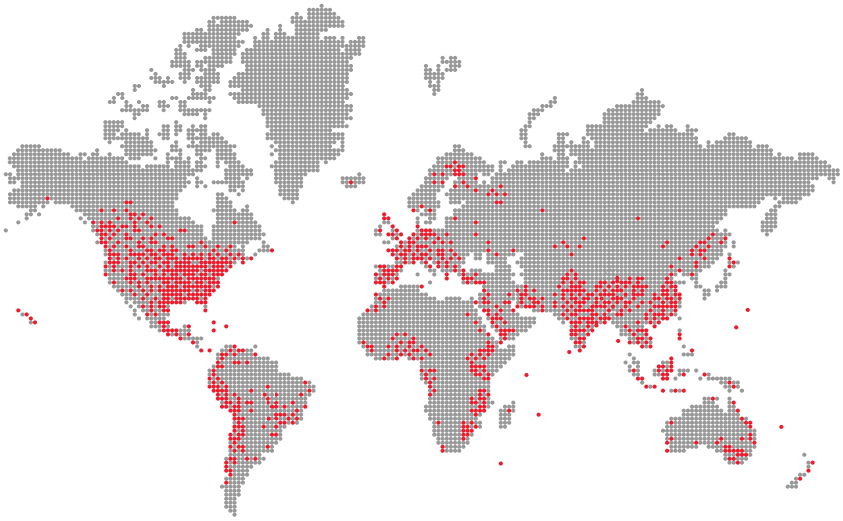
Advanced Serviceability

Calibrations and Adjustments: Users are able to calibrate a new piece of hardware to its appropriate setting and adjust different variables to improve and meet specific performance characteristics.

Fault Information System (FIS): InPower has a built in Fault Information System (FIS) that lists a number of faults and relevant troubleshooting methodologies for them.

Strip Chart and Monitor: The strip chart and monitor feature enables users to graphically display and monitor relevant equipment performance data in real time.

Calibration Capture Files: InPower allows users to take a snapshot of the settings loaded to a device which can be used to backup and restore current settings.



Our global operations:

52,600 employees in 190 countries
88 manufacturing facilities
7,200 sales & service centers
600 distributor locations

Asia Pacific
10 Toh Guan Road #07-01
Singapore 608838

Phone 65 6417 2388
Fax 65 6417 2399

Brazil
Rua Jati, 310, Cumbica
Guarulhos, SP 07180-900
Brazil

Phone 55 11 2186 4195
Fax 55 11 2186 4729

China
No. 2 Rongchang East Street
Beijing Economic and Technological Development Area
Beijing 100176
P.R. China

Phone 86 10 5902 3000
Fax 86 10 5902 3199

Europe, CIS, Middle East and Africa
Manston Park Columbus Ave.
Manston Ramsgate, Kent CT 12 5BF
United Kingdom

Phone 44 1843 255000
Fax 44 1843 255902

India
35A/1/2, Erandaqana
Pune 411 038
India

Phone 91 020 6602 7525
Fax 91 020 6602 8090

Latin America
3350 Southwest 148th Ave.
Suite 205, Miramar, FL 33027
USA

Phone 954 431 5511
Fax 954 433 5797

Mexico
Eje 122 No. 200 Zona Industrial
San Luis Potosí, S.L.P. 78395
Mexico

Phone 52 444 870 6700
Fax 52 444 824 0082

North America
1400 73rd Ave. NE
Minneapolis, MN 55432
USA

Phone 763 574 5000
USA Toll-free 877 769 7669
Fax 763 574 5298

Our energy working for you.™
power.cummins.com

5410772 (F-1821a) A4 05/2017

For more information contact your local Cummins distributor.
To find the one nearest you visit
power.cummins.com