PowerCommand® Digital MasterControl™ DMC1000

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Cummins Power Generation

Description

The DMC1000 is a dedicated microprocessor-based controller that provides supervisory and power transfer functions for up to four generator sets. The DMC1000, in conjunction with PowerCommand genset controls, is a fully automatic, distributed logic controller suitable for unattended applications.

The DMC1000 is configurable for use in many power system architectures, including isolated bus paralleling of generator sets in prime power or standby applications, and applications that require control of a normal source main circuit breaker or circuit breaker transfer pair.

When the power transfer function is used, the control is configurable for open transition (load break) transfer and closed transition (utility/mains parallel) operation in both fast (100 ms) and ramping situations. The control system also includes utility paralleling functions for peak-shaving and base-loading.

The DMC1000 incorporates a broad range of operational diagnostic functions to greatly enhance system reliability.

The control system includes an easy-to-use, full-function operator panel and LED annunciators. Common bus and transfer pair system configurations include a breaker auto/manual switch and manual breaker control switches.

Features

True RMS bus metering– Full-function true RMS bus AC metering (generator bus and utility bus).

Load-add and load-shed sequence control– Automatic, re-configurable load sequencing to prevent overloading the generator bus.

LED system status annunciator– Provides operator with visual and audible notification of system status, and displays individual generator set status.

Load demand control system– Switches generator sets off in a user-configurable sequence to conserve fuel and maximize generator set life.

Operator control panel– Includes full system AC metering, system status and alarm history, and password-protected access to adjustable system operating parameters.

Building management system interface– A Modbus® RTU register map is provided for customer use in configuring third-party controls to monitor the system.

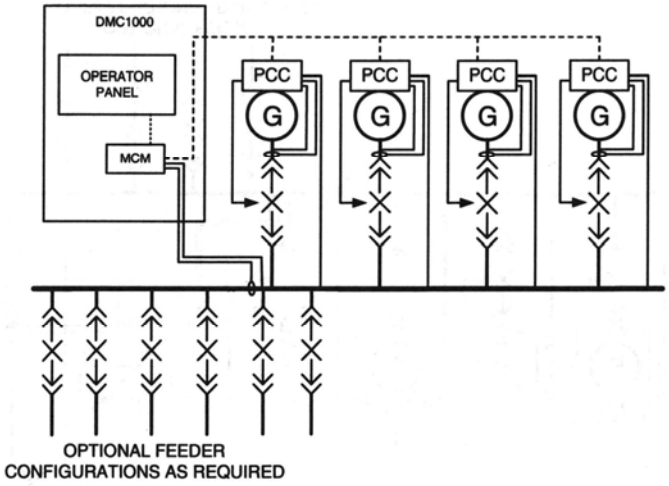
Suitable for use in severe environments– Control system operates over a broad temperature range and is suitable for use in unheated and/or unventilated outdoor enclosures in most areas. The core controls are encapsulated for protection from dust and moisture.

Warranty and service– Products are backed by a comprehensive warranty and a worldwide network of distributors with factory-trained service technicians.

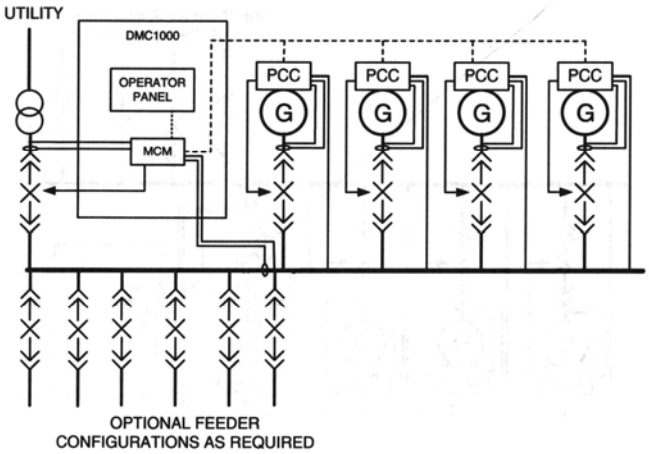
Common system configurations

The DMC1000 provides basic supervisory functions for the gensets, generator bus AC metering, utility bus AC metering, system status and power transfer functions. Possible system configurations include:

Isolated bus with or without genset main - System consists of an isolated bus and may include a genset main breaker. The system controls genset main breaker as a programmable function of bus capacity when required.

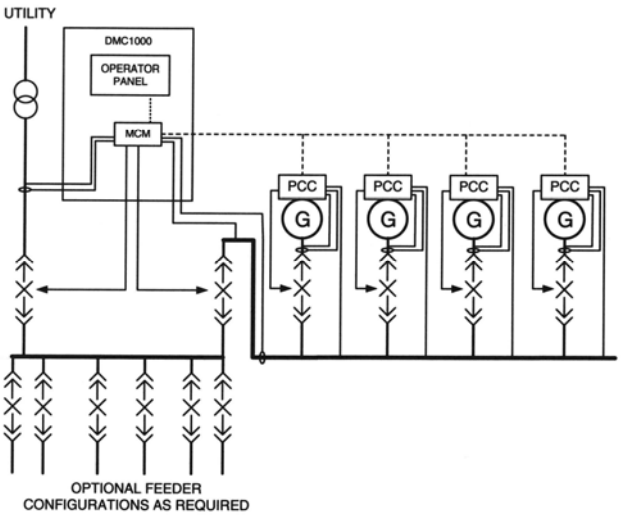


Common bus - System consists of a utility main breaker, but no genset main breaker (only individual genset paralleling breakers).



The system controls utility main breaker and genset paralleling breakers. Operation sequences are configurable for open transition transfer and ramping closed transition transfer. The system is suitable for use in peak-shaving and base-loading applications. Utility interconnection relay and DC station battery system provided with closed transition transfer applications.

Transfer pair - System consists of a breaker pair including a generator bus main and a utility main.



DMC1000 controls both breakers in open transition, fast closed transition, or ramping closed transition modes. It can also be programmed to exercise the generator set bus in parallel with the utility in either peak-shave or base-load modes. Utility inter-connection relay and DC station battery system provided with closed transition transfer applications.

Construction

The control system is housed in a rigid free-standing or wall-mounted painted metal enclosure with front access.

All control wiring is rated and sized as required for safe, reliable operation. Each wire, device and functional component is permanently identified.

Fuses are installed in DIN-rail mounted safety fuse holders. Terminal blocks are provided for all field connections on DIN-rail mounted devices.

Construction specifications

	UL/CSA configuration
Enclosure type	NEMA 1
Control wiring	105 °C/600 V
Operating range	• -40 to +70 °C • Up to 95% humidity (non-condensing) • Up to 6500 feet
	Protective relay(when used) • -20 to +70 °C

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Operator panel

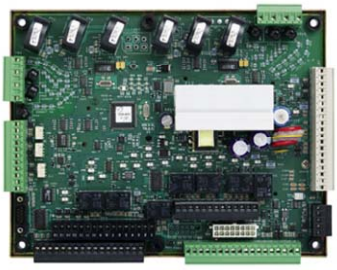
The DMC1000 operator panel displays system status and allows the operator to adjust functions. The display is composed of a backlit LCD display with a series of six status LED lamps, and six tactile membrane switches for navigating menus for system control, monitoring and adjustments. A main screen one-line diagram with AC data provides a quick overview of current system status. Control and adjustments are password protected. The graphical display provides up to six lines of data with approximately 21 characters per line. It is adjustable for screen contrast and brightness.

The operator panel includes LED indicating lamps for the following functions:

- Utility parallel (green) - Lighted when gensets are paralleled to utility/mains service.
- Lockout (red) - Indicates that the control system has experienced a local or remote failure that prevents automatic operation.
- Warning (amber) - Indicates an abnormal condition in the control system that requires operator attention.
- Remote start (green) - Indicates a remote system has signaled the generator sets to start and run.
- Auto (green) – Indicates the control system is ready to operate automatically, unattended, as programmed.
- Manual (amber) - The system has been commanded to a manual condition in which no automatic control actions will be taken.
- LCD display - The home screen (shown above) provides information in a one-line format relevant to the current system operating state. Information includes source availability, source connected status, voltage, frequency and power data. Faults can also be reset from the home screen.
- System status - The top line provides the current system status and displays time remaining on any active count-down timer.
- System control - Menus for initiating a test, base-load, or peak-shave operation, as well as easy access to adjustments for relevant operating set points.
- Adjustments - The adjustment screens allow complete configuring, setup and fine tuning of the controller settings.
- Monitoring - The monitor screens provide access to all controller data including AC data, load demand status, breaker position, and analog and discrete input/output readings.
- Faults - Diagnostics pop up on the display when they occur and can be acknowledged with a single key press. Fault history information can be viewed through the menu navigation.

The operator panel includes an LED system status display, backlit LCD display panel and tactile pushbutton switches to allow the operator to view detailed system data and configure the control system for current and future needs.

Control functions



Control functions are managed by the PowerCommand MCM3320, a fully configurable, microprocessor-based controller providing all core system functions in a flexible, reliable, prototype-tested configuration.

The MCM is a single-board, encapsulated control module that includes a series of integrated operator display functions.

On-board LEDs provide the following service status indications:

- Control operating (green flashing)
- Utility connected (green)
- Utility available (green)
- Generator bus connected (amber)
- Generator bus available (amber) (MCM)
- Common warning (amber)
- Not in auto (red flashing)
- Fail to synchronize (red)
- Synchronizing (green flashing)
- Sync check OK (green)

An on-board alphanumeric coded display provides the following status indications:

- Timing to start
- Timing to stop
- Timing program transition
- Timing to transfer
- Timing to re-transfer
- Synchronizing
- OK to close
- Base-load mode
- Peak-shave mode

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- Ramping load on
- Ramping load off
- Manual mode
- Standby mode
- Utility failed
- Test mode
- Inhibit
- Extended parallel

The display also provides fault information to the user.

Bus synchronizing– Forces a bus of connected generator sets to match the frequency, phase and voltage of another source, such as a utility grid. The synchronizer includes provisions for proper operation even with highly distorted bus voltage waveforms and will accommodate up to 20 gensets. The synchronizer can match other sources over a range of 90-110% of nominal voltage and up to +/- 3 Hz. The synchronizer function is configurable for slip frequency synchronizing for applications requiring a known direction of power flow at instant of breaker closure, or for applications where phase synchronization performance is inadequate.

Sync check– Independently determines when permissive conditions have been met to allow breaker closure. Adjustable criteria include:

- Phase difference: 0.1-20 degrees
- Frequency difference: 0.001-1.0 Hz
- Voltage difference: 0.5-10%
- Dwell time: 0.5-5.0 seconds

Internally the sync check is used to perform closed transition operations.

Dual source bus AC metering– Provides comprehensive 3-phase AC metering functions for both monitored sources, including:

- 3-phase voltage (L-L and L-N) and current
- Frequency and phase rotation
- Individual phase and totalized values of kW, kVAR, kVA and Power Factor
- Totalized positive and negative kW hours, kVAR hours and kVA hours.

Three-wire or four-wire voltage connection with direct sensing of voltages to 480V and up to 35 kV with external transformers. Current sensing is accomplished with either 5 amp or 1 CT secondaries and with up to 10,000 amps primary.

Power transfer control– Provides integrated automatic transfer functions including source availability sensing, gensets start/stop and transfer pair monitoring and control. Configurable for open transition, fast closed transition (less than 100 ms interconnect time), or soft closed transition (load ramping) sequences of operation. Utility source failure will automatically start gensets and transfer load, re-transferring when utility source returns.

Test will start gensets and transfer load if test with load is enabled.

Sensors and adjustable timers include:

- Under-voltage sensor - 3-phase L-N or L-L
  - Pickup from 85-100% of nominal
  - Dropout adjustable from 75-98% of pickup
  - Dropout delay adjustable from 0.1-30 sec
- Over-voltage sensor - 3-phase L-N or L-L
  - Pickup from 95-99% of dropout
  - Dropout adjustable from 105-135% of nominal
  - Dropout delay adjustable from 0.5-120 sec
  - Default setting is disabled
- Over/under frequency sensor –
  - Center frequency from 45-65 Hz.
  - Dropout bandwidth from 0.3-5% of center frequency beyond pickup bandwidth.
  - Pickup bandwidth adjustable from 0.3-20% of center frequency.
  - Default setting is disabled
- Loss of phase sensor –
  - Detects out-of-range voltage phase angle
  - Default setting is disabled
- Phase rotation sensor –
  - Checks for valid phase rotation of source
  - Default setting is disabled
- Breaker tripped –
  - If activated, the associated source is unavailable
- Genset online capacity sensor -
  - Requires minimum kW capacity online before closing generator bus main breaker
- Adjustable timers –
  - Start delay: 0-3600 sec
  - Stop delay: 0-3600 sec
  - Transfer delay: 0-120 sec
  - Re-transfer delay: 0-1800 sec
  - Programmed transition delay: 0-60 sec
  - Maximum parallel time: 0-800 sec

Breaker control– Utility main and genset main breaker interfaces include separate relays for opening and closing breaker, as well as inputs for both “a” and “b” breaker position contacts and tripped status. Breaker diagnostics include contact failure, fail-to-close, fail-to-open, fail-to-disconnect and tripped. If a breaker fails, appropriate control action is taken to maintain system integrity (max 30 VDC, 10 amp or 250 VAC, 10 amp).

Extended paralleling– Starts gensets and parallels to a utility source, then governs the real and reactive power output. The control point for the real power (kW) can be configured for either the genset bus metering point (base-load) or the utility metering point (peak-shave). The control point for the reactive power (kVAR or power factor) can be independently configured for either the genset bus metering point or the utility metering point. Allows base kW load from the gensets while maintaining the utility power factor at a reasonable value to avoid penalties due to low power factor. The system always operates within genset ratings. The control point can be changed while the system is in operation. Set points can be adjusted via operator panel display or service tool.

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Scheduler– Allows the system to be operated at preset times in test without load, test with load, or extended parallel mode. A real-time clock is built in. Up to 12 different programs can be set for day of week, time of day, duration, repeat interval and mode. For example, a test with load can be scheduled to run for one hour every Tuesday at 2 a.m. Up to six different exceptions can be set up to block a program from running during a specific time period.

Load demand– Load demand will attempt to match generating capacity to load, typically for the conservation of fuel or optimizing of generator set life. The load demand function will support from two to four gensets. Shutdown sequence can either be a fixed sequence or can be based on running hours. With fixed sequence method, the sequence can be changed while the system is in operation. Running hours method will attempt to equalize genset hours over time by exchanging stopped and running gensets. To protect system integrity, load demand will restart all gensets whenever an overload condition is detected. The minimum amount of capacity to maintain online is adjustable. Initial delay for load demand to begin operation is adjustable from 1-60 minutes. Shutdown threshold is adjustable from 20-100% of online capacity minus one. Shutdown delay is adjustable from 1-60 minutes. Restart threshold is adjustable from 20-100% of online capacity. Run hours differential is adjustable from 1-500 hours.

Load add/shed– Load add and shed will control and monitor up to six load step levels (such as feeder breaker or automatic transfer switches) in any combination. Up to six levels of load-add, and up to five levels of load-shed may be defined. The load add/shed function will support up to four gensets. Loads can be added as gensets come online as well as on a timed basis. Loads are shed on a timed basis when an overload condition is detected, protecting system integrity. Shed loads can be restored through operator action. Manual load-add and shed is also provided. Load-add delay is adjustable from 1-60 sec. Load-shed delay is adjustable from 1-10 sec.

Data logging– The control maintains a record of up to 20 control operations, warning conditions and other events. Records are time-stamped.

Fault simulation mode– The control, in conjunction with InPower™ software, will accept commands to allow a technician to verify the proper operation of the control and its interface by simulating failure modes or by forcing the control to operate outside of its normal operating ranges. InPower also provides a complete list of faults and settings for the protective functions provided by the controller.

Protective Functions– The control provides the following system protective functions for each breaker or bus. Note that each protective function will cause the control to take intelligent corrective action to best resolve the problem until an operator can address it. See “Intelligent protective action” below for details.

- Breaker fail-to-close warning – When the controller signals a circuit breaker to close, it will monitor the breaker auxiliary contacts and verify that the breaker has closed. If the control does not sense a breaker closure within an adjustable time period after the close signal, the fail-to-close warning will be initiated.
- Breaker position contact warning – The controller will monitor both “a” and “b” position contacts from the breaker. If the contacts disagree as to the breaker position, the breaker position contact warning will be initiated.
- Breaker fail-to-open warning – The control system monitors the operation of breakers that have been signaled to open. If the breaker does not open within an adjustable time delay, a breaker fail to open warning is initiated.
- Breaker tripped warning – The control accepts inputs to monitor breaker trip/bell alarm contact and will initiate a breaker tripped warning if it should activate.
- Fail to disconnect warning – If the controller is unable to open either breaker, a fail to disconnect warning is initiated. Typically, this would be mapped to a configurable output, allowing an external device to trip a breaker.
- Fail to synchronize warning – Indicates that the generator set bus could not be brought to synchronization with the system bus. Configurable for adjustable time delay of 10-120 seconds.
- Bus overload warning – The control monitors bus frequency and genset bus load relative to the online capacity. When configured, the control will initiate a bus overload warning if the bus kW load exceeds an adjustable threshold (80-140%) for an adjustable delay (0-120 sec), or if the bus frequency falls below an adjustable threshold (0.1-10 Hz) for an adjustable delay (0-20 sec), or both.
- Maximum parallel time warning – During closed transition load transfers, control independently monitors paralleled time. If time is exceeded, warning is initiated and genset bus is disconnected.

Intelligent protective action

When abnormal situations are detected, the control will provide as much corrective action as possible to keep the system operating.

Utility main breaker fail-to-close warning– Starts the gensets and transfers load to the genset bus until the operator resets the fault condition and resolves the problem.

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Genset main breaker fail-to-close warning– Returns to the utility source and won't retry until the operator resets the fault condition and resolves the problem.

Breaker position contact warning– Checks for current above a threshold on all three phases. If criteria are met, control will remain on the source. If not, control will attempt to transfer to other source.

Fail-to-synchronize warning– If the control is trying to perform a closed transition re-transfer, but fail-to-sync occurs, the control can be configured to perform the re-transfer using open transition.

Control interface - outputs

Generator set signals– For each generator set in the system, the control provides start command, load demand control, and control of the generator set excitation and fuel control systems for load control while paralleled with the utility service (mains).

Genset main and utility main breaker interfaces– Dedicated separate relays are provided for breaker open and breaker close circuits.

Network connections

Serial interface communications port– Allows the control to communicate with a personal computer running InPower service and maintenance software.

Modbus RTU Interface– Provides a standard register map of system data for use in monitoring by a remote device. Controller is a Modbus RTU slave device capable of communication on either RS232 or RS485. Modbus address is configurable. A complete array of system control, adjustments and monitoring data are available and are documented in a published register map.

Control **power**

Control power for the system is derived from the generator set 24 VDC starting batteries. A solid-state, no-break "best battery" selector system is provided so that control voltage is available from any generator set battery bank in the system. All incoming battery banks are isolated to prevent the failure of one battery bank from disabling the entire system. The core system control has redundant control power inputs for added reliability, as well as separate high/low DC voltage monitoring.

The PowerCommand controls mounted on every 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 24 VDC, except during engine cranking)
- High DC voltage (battery voltage greater than 32 VDC)

Load add/shed modules

(AUX101, AUX102)

These modules provide the relay outputs and switch position inputs for controlling and monitoring up to 6 sets of load feeder breakers or 6 sets of transfer switches. Relay contacts are rated 2 amp at 30 VDC. Medium voltage applications require external interposing relays.

System annunciator panels

Annunciator panels provide LED indication of the following alarm and status conditions:

DMC 1000 annunciator

- Utility available
- Utility connected
- Genset available
- Genset bus live
- Manual mode ON
- Common warning
- Fail-to-sync
- Genset 1 available
- Genset 2 available
- Genset 3 available
- Genset 4 available
- Test mode ON
- Extended paralleling ON
- Bus under frequency mode
- Load demand ON
- Controller malfunction

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Load add/shed annunciator

- Load add Level 1 ON
- Load add Level 2 ON
- Load add Level 3 ON
- Load add Level 4 ON
- Load add Level 5 ON
- Load add Level 6 ON
- Load shed Level 1 ON
- Load shed Level 2 ON
- Load shed Level 3 ON
- Load shed Level 4 ON
- Load shed Level 5 ON
- Genset 1 running
- Check genset 1
- Genset 2 running
- Check genset 2
- Genset 3 running
- Check genset 3
- Genset 4 running
- Check genset 4

An additional system annunciator panel provides LED indication of the following alarm and status conditions:

- Level x loads on (one for each of 6 levels)
- Level x load shed (one for each of 5 levels)

Bar graph interfaces

(HMI112)

The control comes with one bar graph for the genset bus and a second bar graph for the utility source, when applicable.

The bar graphs provide a dynamic visual indication of the following readings for each source:

- L1 current percent
- L2 current percent
- L3 current percent
- Total kW percent
- Power factor
- Frequency percent
- L1L2 voltage percent
- L2L3 voltage percent
- L3L1 voltage percent
- Load add/shed modules

InPower Software

PC-based software service tool communicates with PowerCommand components to facilitate setup, service and monitoring.

Certifications

PowerCommand DMC1000 meets or exceeds the requirements of the following codes and standards:

- UL 891 listed
- CSA certified
- PowerCommand control systems are designed and manufactured in ISO 9001-certified facilities.

Warranty

As components of a Cummins Power Generation system, PowerCommand controls are covered by a standard one-year limited warranty. Warranty options are available; consult your local distributor for details.

Options and accessories

- Freestanding cabinet
- Wall-mounted cabinet (not available with transfer pair or common bus topologies)

For more information, contact your local distributor

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