

# PowerCommand<sup>®</sup> Digital MasterControl<sup>™</sup> DMC1000



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## Description

The DMC1000 is a dedicated purpose microprocessor-based controller that provides supervisory and power transfer functions (when required) for up to four generator sets with PowerCommand<sup>®</sup> digital paralleling controls (PCC). The control system, in conjunction with the digital generator set controls, is a fully automatic, distributed logic arrangement suitable for use in unattended applications.

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

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

The DMC1000 is thoroughly prototype-tested and 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-type remote annunciator. Common bus and transfer pair system configurations include a breaker auto/manual switch and manual breaker control switch(es).

The photo on this page illustrates equipment with standard and optional features.

## Features

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

**Load add and load shed sequence control (optional)** - Automatic, reconfigurable sequencing of loads to prevent overload of the generator bus.

**LED system status annunciator** - Provides operator with visual and audible notification of system status and display of individual generator set status.

**Load demand control system** - Allows the system to switch off generator sets 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 also provides a password-protected means to readjust system operating parameters. A second, fully functional and redundant operator panel can be provided for operator convenience in a remote location.

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

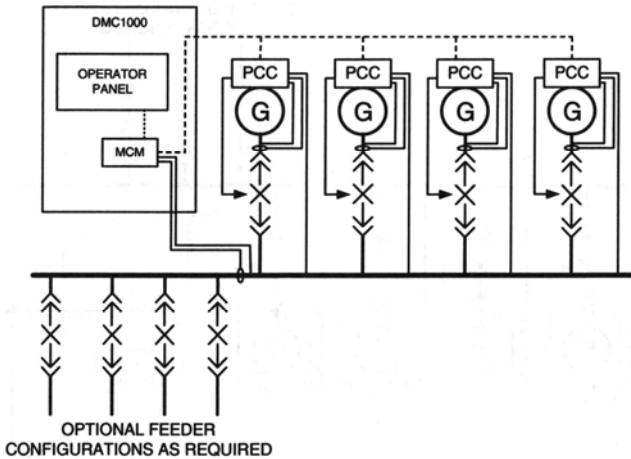
**Suitable for use in severe environments** - Control system is operational over a broad temperature range and is suitable for use in unheated and/or unventilated outdoor enclosures in most areas. The core controls are encapsulated for protection from environmental contamination such as dust and moisture.

**Local service and parts** - The entire Cummins Power Generation system is serviced and supported by a worldwide distribution system with factory-trained and -certified technicians and local parts support.

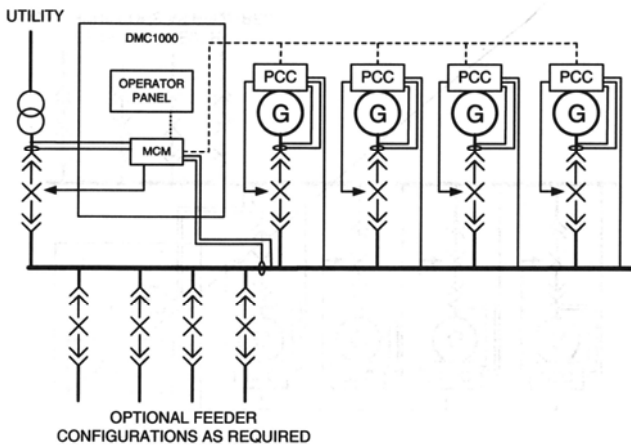
## Common system configurations

The DMC1000 is designed to provide basic supervisory functions for the gensets, generator bus AC metering, utility bus AC metering (when used), system status, and power transfer functions, when necessary. The DMC1000 is configurable for operation in the following system configurations.

**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.

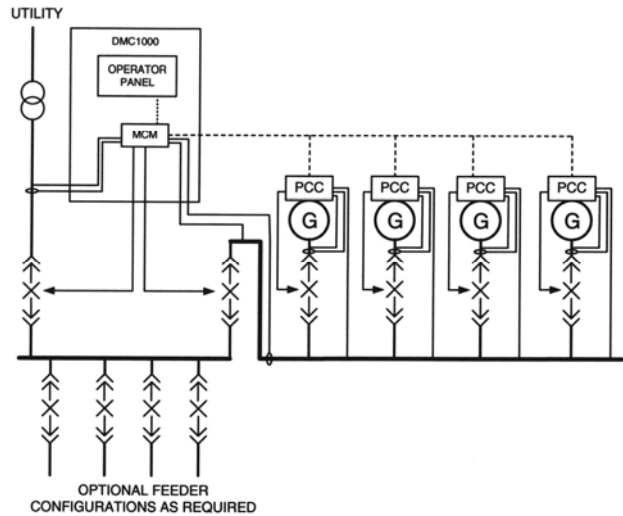


**Common bus** - System consists of a utility main breaker, but no genset main breaker (only individual genset paralleling breakers).



The system controls utility main breaker and genset paralleling breakers (via inhibit). 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.

**Transfer pair** - System consists of a breaker pair - one a generator bus main, the other 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 operational modes.

## Construction

The control system is housed in a rigid freestanding or wall mounted metal enclosed structure requiring front access only. The sheet metal components of the system are primed with a rust-inhibiting primer and finished with satin finish light grey.

Control components are totally isolated from power-carrying components by metal or insulating barriers.

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

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

## Construction specifications

	IEC configuration	UL/CSA configuration
Enclosure type	IP40	NEMA 1
Control wiring	85 °C/600 V	105 °C/600 V
Approval	<ul style="list-style-type: none"> <li>• CE Marked</li> <li>• BS EN ISO 60439 1</li> </ul>	UL891 Listed/CSA certified
Operating range	<ul style="list-style-type: none"> <li>• -20 to +70 °C</li> <li>• Up to 95% humidity (non-condensing)</li> <li>• Up to 2000 M</li> </ul>	<ul style="list-style-type: none"> <li>• -40 to +70 °C (control only)</li> <li>• -20 to +70 °C (HMI)</li> <li>• Up to 95% humidity (non-condensing)</li> <li>• Up to 5000 M</li> </ul>

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## Operator panel



The DMC1000 is provided with an operator panel that displays system status and allows operator adjustment of system functions. A redundant operator panel, up to 12000 meters (4000 ft) distant, may also be used. The display is composed of a backlit LCD display with a series of six status LED lamps. The display is accompanied by six tactile-feel membrane switches that are used to navigate through menus for system control, monitoring and adjustments. A main screen one-line diagram with AC data gives a quick overview of current system status. Control and adjustments are password protected. The graphical display is capable of providing 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 generator sets 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 that an abnormal condition exists in the control system that requires operator attention.
- Remote start (green) - Indicates that a remote system has signaled the generator sets to start and run.
- Auto (green) - Indicates that the control system is ready to operate in fully unattended, automatic mode, 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 as well as countdown of any timer that is currently in effect, such as a retransfer timer.
- System control - The control menus allow initiating a test, base load, or peak shave operation as well as easy access to adjustments for relevant operating set points.

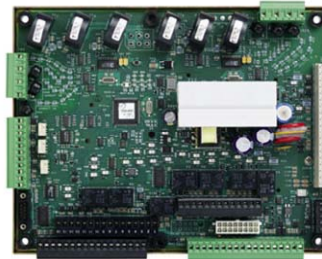
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- Adjustments - The adjustment screens allow complete configuring, set up and fine tuning of the controller settings.
- Monitoring - The monitor screens provide organized access to all controller data including AC data, load demand status information, breaker position information and analog and discrete input and 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 LED system status display, a backlit LCD display panel and tactile-feel pushbutton switches to allow operator viewing of detailed system data and configuration of the control system to current and future needs.

## Control functions



Control functions in the system are managed by the PowerCommand MCM3320 control (MCM). This control is a fully configurable, microprocessor-based controller and provides all core system functions in a flexible, reliable, prototype-tested configuration.

The MCM is a single-board, encapsulated control module that interfaces to external components through locking plug-in terminal blocks suitable for wiring up to 2.5 mm (12 gage). It 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 retransfer
- Synchronizing
- OK to close
- Base load mode
- Peak shave mode
- 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** - Control incorporates a digital master synchronizing function to force 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 a minimum of 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 otherwise inadequate.

**Sync check** - The independent sync check function determines when permissive conditions have been met to allow breaker closure. Adjustable criteria are: phase difference from 0.1-20 degrees, frequency difference from 0.001-1.0 Hz, voltage difference from 0.5-10% and a dwell time from 0.5-5.0 seconds. Internally the sync check is used to perform closed transition operations.

**Dual source bus AC metering** - The control provides comprehensive 3-phase AC metering functions for both monitored sources, including: 3-phase voltage (L-L and L-N) and current, frequency, 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 480 V and up to 35 kV with external transformers. Current sensing is accomplished with either 5 A or 1 CT secondaries and with up to 10,000 A primary.

**Power transfer control** - Provides integrated automatic power transfer functions including source availability sensing, gensets start/stop and transfer pair monitoring and control. The transfer/retransfer is 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, retransferring when utility source returns.

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

Sensors and timers include:

- Undervoltage sensor - 3-phase L-N or L-L under voltage sensing adjustable for pickup from 85-100% of nominal. Dropout adjustable from 75-98% of pickup. Dropout delay adjustable from 0.1-30 sec.
- Overvoltage sensor - 3-phase L-N or L-L over voltage sensing adjustable for 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 adjustable from 45-65 Hz. Dropout bandwidth adjustable 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 relationship. Default setting is disabled.
- Phase rotation sensor - Checks for valid phase rotation of source. Default setting is disabled.
- Breaker tripped - If the breaker tripped input is active, the associated source will be considered unavailable.
- Genset online capacity sensor - Optionally enabled sensor. Use to require minimum kW capacity online before closing generator bus main breaker.
- Timers - Control provides adjustable start delay from 0-3600 sec, stop delay from 0-3600 sec, transfer delay from 0-120 sec, retransfer delay from 0-1800 sec, programmed transition delay from 0-60 sec and maximum parallel time from 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. Upon breaker failure, appropriate control action is taken to maintain system integrity (max 30 VDC, 10 A or 250 VAC, 10 A).

**Extended paralleling** - In extended paralleling mode (when enabled) the controller will start gensets and parallel to a utility source, then govern the real and reactive power output of the gensets based on the desired control point. 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 also be independently configured for either the genset bus metering point or the utility metering point. This flexibility would allow 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

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while the system is in operation. Set points can be adjusted via hardwired analog input or adjusted through an operator panel display or service tool.

**Scheduler** - The scheduler (when enabled) allows the system to be operated at preset times in either 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 for one hour every Tuesday at 2 a.m. can be programmed. Up to six different exceptions can also be set up to block a program from running during a specific date and time period.

**Load demand** - Load demand (when enabled) 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 (optional)** - 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.

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**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 the *Intelligent protective action* section for details. Diagnostics can be mapped to any of 8 configurable low-side driver outputs for external use such as driving relays, lamps or as signals to other system devices.

- 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 genset bus load relative to the online capacity and monitors bus frequency. On a configurable basis, control will initiate a bus overload warning if the bus kW load exceeds an adjustable threshold (80-140%) for an adjustable delay (0-120 s), or if the bus frequency falls below an adjustable threshold (0.1-10 Hz) for an adjustable delay (0-20 s), 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 by the control, it will provide as much corrective action as possible to keep the system operating.

**Utility main breaker fail to close warning** - Control will start the gensets and transfer load to the genset bus and remain there until the operator resets the fault condition and resolves the problem.

### Genset main breaker fail to close warning -

Control will return to the utility source and will not retry until operator resets the fault condition and resolves the problem.

**Breaker position contact warning** - Control will check for current above a threshold on all three phases. If criteria is 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 retransfer, but fail to sync occurs, the control can be configured to perform the retransfer using open transition.

## Control interface - outputs

**Configurable customer outputs** - Control includes eight output signals (low-side relay drivers) for use by external equipment. These are configurable for any available control warning or event. Default settings are: common warning, fail to sync, genset bus available, utility bus available, fail to disconnect, sync check ok and sync output limit. External relays can be powered from the controller.

**Generator set signals** - For each generator set in the control 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** - This communication 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 as long as any generator set battery bank in the system is available. 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 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 24 VDC, except during engine cranking)
- High DC voltage (battery voltage greater than 32 VDC)

## Optional 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.

## System annunciator panels



A standard system annunciator panel provides LED indication of the following alarm and status conditions:

- Utility (mains) available
- Utility (mains) connected
- Genset bus available
- Genset bus connected
- Not in auto
- Common alarm
- Fail to sync
- Genset 1 running
- Genset 2 running
- Genset 3 running

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- Genset 4 running
- Test
- Extended parallel
- Genset bus overload
- Load demand mode
- Spares (4)

An optional 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) see document S-1475 for more information on this module

## Optional bar graph interfaces



**(HMI112)**

The control is available with optional bar graph displays. Two displays are used with one bar graph dedicated to the utility source and the other to the genset bus. 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

## Software

InPower is a PC-based software service tool that is designed to directly communicate to PowerCommand products to facilitate setup, service and monitoring of these products.

## Certifications

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

- UL 508 recognized
- CE Mark
- ISO 7637, pulses #2, 3a, 3b, 5, 7
- BS EN 60439-1:1999
- BS ISO 8528-4:2005
- BS EN 60204-1:1993
- BS EN ISO 12100-2:2003
- EN55011, Class B Radiated Emissions
- EN55011, Class B Conducted Emissions
- IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity. Similar waveforms are described in ANSI/IEEE 62.41-1991
- IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity
- IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
- IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
- IEC 1000-4-6 Conducted Field Immunity
- IEC 1000-4-11 Voltage Dip Immunity

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

## Warranty

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

Various warranty options are available. Consult your local distributor for details.

## Options and accessories

- Load shed relays (standard 6 levels)
- Load add relays (standard 6 levels)
- Freestanding cabinet
- DC station battery system
- Utility interconnection equipment, including protection relay(s), as required for local application requirements
- Single NER (neutral earth relay control)
- Bar graph display for each source bus
- Load status annunciator

## See your distributor for more information

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