

Flexible Control for Generator Fleets

*A Quick and Easy Way to Set Up Multiple Generators
in a Fleet while Adapting to the Site's Requirements*

ABOUT BASLER

Basler Electric is a manufacturer of excitation systems, voltage regulators, genset controls, protective relays, and custom transformers. Basler also offers turnkey engineering services through their E² Power Systems subsidiary.

Basler products control and manage the delivery of electricity and are commonly found in applications such as power plants, substations, hydro dams, agricultural facilities, airports, refineries, telecom facilities, factories, marine applications, and many others.

Basler has been in business since 1942 and our products are in operation in over 145 countries around the world.

Installing and operating generator fleets present unique challenges which can be solved by programmable and flexible controllers. When adapting to changing power requirements at various sites or setting up communications networks, advanced genset controllers can be applied to achieve desired results.

In the portable power industry, generators are often moved from one site and installed at another. This is very common in rental power applications, where generator power is provided as a service, typically at entertainment venues, construction sites, mobile medical facilities, disaster relief sites, and military operations. Often times, generators are taken from inventory and added to a fleet of units in service. In such applications, quick disassembly, mobilization, and reinstallation of multiple generators at a temporary site is critical to operational efficiency. Installers and operators need a quick and easy way of setting up multiple generators in a fleet while adapting to the site's requirements. A genset controller that is flexible to accommodate varying power requirements, facilitates ease of communications setup, and is robust in harsh environments, is well fitted for such applications.

In rental and military applications, it is typical for machines to be configurable to operate at multiple voltages, usually ranging from 480Vac to 120Vac on a 60Hz machine. Some generators are also expected to operate at 60Hz or 50Hz, depending on the country the machine is operating in. Some sites may require three-phase power while others require single phase. Generator manufacturers have developed clever ways of making on the fly adjustments to 10 and 12 lead machines by reconfiguring them with a selector switch. Because portable machines need to be plug-and-play, site operators cannot afford to spend time adjusting settings in genset controllers for every configuration change. Since mobile generators are often deployed in high urgency situations, delays in on-site power generation could result in loss of life, loss of equipment, loss of revenue, and loss of reputation. Due to the time sensitive nature of such mission critical operations, it is of paramount importance for a genset controller to automatically adapt to various operating configurations for control and protection purposes.

Flexible genset controllers support reconfigurable generators, adapting control and protection schemes to changing voltage and frequency configurations.



Typical Portable Genset

The controlling device must be intelligent enough to automatically determine which control scheme applies to each voltage and frequency configuration. Control functions impacted by the voltage and frequency configuration include generator and bus real-time ratings, generator and bus stability detection, breaker control operations, synchronization (25A), synch check (25), paralleling, and load sharing.

Above all, safety comes first! That is why a flexible protection scheme that can accommodate all possible machine configurations is essential. This can be easily achieved by using a genset controller with multiple protective elements that can be used for various operating configurations, with the ability to select or deselect protective elements based on logic conditions. This capability gives system integrators and designers a platform for designing an intelligent system that is versatile enough to meet changing requirements. Commissioning engineers and operators can save a lot of time without needing to make settings changes whenever power requirements change. Errors can also be avoided due to incorrect settings being entered. For more information on how Basler Electric supports configurable machine applications, visit <https://www.basler.com/Product/DGC-2020HD-Digital-Genset-Controller> and download the application note: **Control and Protection for Configurable Machines**.

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While it is important to have a reliable source of on-site power for mission critical operations, it is just as important to ensure that power sources and the balance of plant are effectively controlled. A key ingredient to ensure that generators and Balance of Plant (BOP) equipment are properly controlled and coordinated is the inter-genset communications network. This statement holds true regardless of the type of on-site power operation, whether standby, prime, or continuous power.

The inter-genset communications network forms the backbone of several advanced features of modern control devices. Controllers on gensets, breakers, and balance of plant equipment communicate directly with each other to coordinate their decision making. Inter-genset communications provide an easy and efficient medium to support load sharing, reactive power sharing, generator management, load management, paralleling, system level coordination, and communication with external systems.

In the past, operators depended strictly on the speed droop and voltage droop characteristics of a genset to control load (kW) and reactive power (kvar) sharing. During commissioning, the droop settings would be adjusted to optimize load and reactive power sharing. As the kW on each machine increased from No Load (NL) to Full Load (FL), the generator frequency would decrease. Likewise, as the KVar on each machine increased from NL to FL, the voltage would decrease. Hence, it was not possible to maintain consistent voltages and frequencies throughout each machine's load profile.

With the introduction of advanced Proportional-Integral-Derivative (PID) controllers in genset controllers, network load sharing resolved this problem by allowing multiple machines to load share while maintaining the system frequency. Controllers are able to communicate among themselves to determine how much load is on the network, how many machines are online, and share kW proportionally among the machines. KVar is shared in a similar manner. Because the frequencies and voltages are kept consistent, power quality is maintained.



Load Sharing with Multiple Machines

Peer-to-peer networking among genset controllers allows a distributed control architecture. This approach improves system resilience by introducing network redundancy using ring and mesh networks.

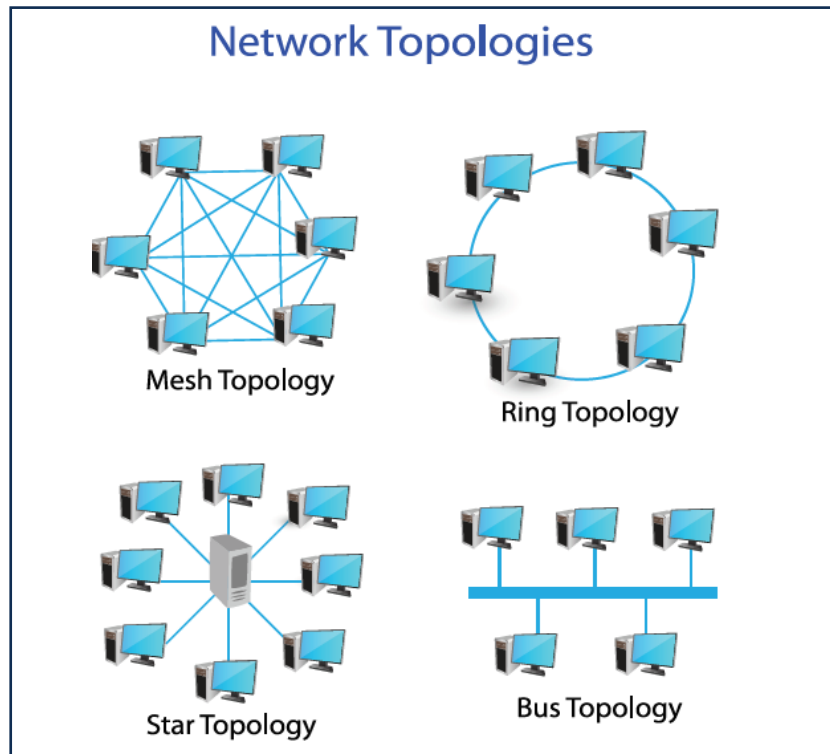
If a section of the system were to experience a communication loss during operation, logic conditions can be programmed to set the off-network machines into droop override mode so that the remaining machines on the network would not get overloaded. Once communications are restored to the off-network machines, they can participate in network load sharing as before.

On the same inter-genset communications network, generators can be automatically dispatched to meet system load levels according to their assigned priorities, thus maintaining system stability. Automatic load shedding and load adding can also be implemented based on generator availability and load levels. The list of features and functions that are supported by an inter-genset communications network such as dead bus breaker close arbitration, rapid synchronization, and communication with external systems is non-exhaustive.

Since this network is so critical to on-site power operation, communication failures need to be mitigated against. Multiple network architecture design approaches can help with such mitigation. In general, control can be centralized, distributed, or can comprise of elements of both. Centralized architectures such as a star topology introduce a single point of failure because if the central node fails, the entire system malfunctions. Besides, the central node creates a bottleneck, through which all network traffic must be transmitted, often resulting in slower data transmission speeds.

With peer to peer networking, multiple genset controllers can form a distributed control architecture. This approach opens up opportunities for more topologies with redundancy such as mesh and ring. Modern ethernet networks use switched connections, allowing point-to-point network architectures, thus moving away from bus topologies where one cable is shared by all devices on the network. In Ethernet networks, ring topologies can be built by incorporating network switches with ring management capability, thereby increasing network redundancy. Ring and mesh networks are more robust against communication failures than bus networks due to their inherent redundancy. When communication is lost to a controller in a ring or mesh network, communication activities supported by that specific controller such as load sharing and generator sequencing may be lost, while the rest of the system continues to function normally.

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Further, loss of communication to individual controllers can be reduced by using genset controllers equipped with redundant communication ports. In this type of setup, if there is a communication failure on the primary port, all communications automatically failover to the redundant port resulting in even more overall system reliability.

The type of communication infrastructure can also significantly affect system performance for generator fleets. On CANBus networks, noise signals from nearby ac wiring and other Electromagnetic Interference (EMI) sources can cause communication disturbances and errors in equipment operation. In addition, CANBus networks typically transmit data at speeds less than 1 Mbps while ethernet networks can transmit data at up to 100 Mbps.

With the Internet of Things (IOT) being incorporated into smart Building Management Systems (BMS), genset and balance of plant data is often transmitted to a separate BMS network. The interface to the BMS is typically through Ethernet communications. In addition, multiple external devices and systems such as SCADA and PLC get integrated with genset controllers through an Ethernet interface. Hence, it is beneficial for generator fleets to incorporate the use of genset controllers equipped with Ethernet communications, thus eliminating the need for protocol converters, which could introduce more points of failure. For information on how to implement redundant ethernet communications using Basler Electric Controls, visit <https://www.basler.com/Product/DGC-2020HD-Digital-Genset-Controller> and download the application note: **Improving On-Site Power Reliability with Redundant Communications**.

For large generator fleets, the setup of the communications network can be time consuming and tedious. It can also become difficult to track settings for multiple devices in the fleet. For this reason, the

Automatic IP configuration reduces network setup time in large generator fleets.

communications settings cannot be static. To solve this problem, automatic configuration of Internet Protocol (IP) addresses, subnet masks, and default gateways has been implemented in advanced genset and power management controllers. Each controller is assigned an IP address when it joins the network, making the Ethernet communications plug-and-play. This capability saves time, increases the ease of setup, and reduces erroneous settings. For information on how to implement automatic configuration of Ethernet communication settings, refer to Chapter 5 of the *DGC-2020HD Configuration Instruction Manual*.

Because of the mission critical nature of many on-site power operations, it is important for end users and operators to have control of their power security. That means having access to configuration files that are loaded into their controllers. This flexibility allows qualified personnel to make needed updates and changes to software and firmware to ensure controllers are performing at their optimum level. In the event of an emergency, time does not permit procuring software licenses or requesting the support of service personnel who have exclusive access to configure genset and power management controllers. Securing access to intelligent devices can be managed by setting up password protected user accounts with the appropriate level of access. A well-managed security system helps ensure that only the right persons have access to control devices, thereby helping end users make their operations and maintenance activities more efficient and cost effective.

In conclusion, the successful commissioning and operation of a generator fleet hinges heavily on the capabilities of the control system. Genset controllers, tie breaker controllers and all power management devices must be adaptable to changing power requirements, easy to setup, robust, and must deliver superior performance. With a highly capable controls solution, system integrators, designers, commissioning engineers, operators, and field service personnel are equipped with a platform to build a resilient system that delivers excellent performance.

To learn more, please email usatechsupport@basler.com or call 618.654.2341 to speak with a Basler representative.

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