White Paper

Power Control System Basics



Power Control System Basics

More than Just Paralleling Power Sources

This document provides an overview of Power Control System features and benefits, and describes their application to healthcare, data center, commercial, industrial, and water/wastewater treatment facilities.

INTRODUCTION

Providing reliable electricity requires an ability to connect and control emergency power sources to a facility's electrical system and control the downstream loads. For a facility with elementary backup power requirements, only an enginegenerator and a transfer switch may be necessary. As facility size increases, loads become more critical, and systems become more complex, sophisticated methods for connecting and controlling both power sources and loads become necessary.

REASONS FOR CONNECTING MULTIPLE POWER SOURCES

There are a number of reasons to connect, control, and disconnect multiple power sources and loads using a power control system. The most common is to switch between a utility feed and an emergency power supply consisting of two or more generators. Power control systems can also be used to connect and manage multiple sources in prime power applications, where utility service is unavailable, and to parallel utility and backup power systems to meet operational objectives or control costs. An example of a Power Control System is shown in Figure 1.

As with automatic transfer switches, power control systems also provide the essential function of connecting power sources to loads. Doing so requires synchronizing and paralleling multiple sources - connecting them when the sources exhibit similar voltage, frequency, and phase angle. For this reason, power control systems are often referred to as paralleling switchgear. However, much of the value of these systems is associated with other functions and benefits that they provide. These include:

- **Capacity:** Creating a larger power source by combining generators.
- **Redundancy:** Providing redundant sources to increase reliability and availability, using configurations such as N+1, N+2, 2N, and others.
- Efficiency: Providing features that optimize generator usage and manage the connection of loads according to available capacity and load priorities.



Figure 1: An ASCO 7000 SERIES Power Control System



While most power control systems consist of modular switchgear, the ASCO Model 336 is an exception. It uses proven contactor technology and combines master, generator, and transfer switch controls in a single unit with a small footprint.

- **Economy:** Enabling users to connect utility and cogeneration sources, generate on-site power to offset utility usage during periods of high demand, or respond to utility directives to reduce load in accordance with power contracts.
- Maintainability: Switch sources to facilitate engine-generator maintenance without system downtime.
- Scalability: Provide for the future addition of generation and distribution equipment.

PCS HARDWARE OVERVIEW

Most power control systems consist of switchgear constructed of modules, or sections, dedicated to power generation, distribution and control. These sections are shown in Figure 2, and are the basic building blocks for creating power control switchgear systems. Typical systems include a single master control section. The number and types of the other sections depend on the quantity of power sources and the size and complexity of the power distribution system. By mixing and matching sections together with the components and controls they contain, engineers can provide reliable and sophisticated systems for managing power across a wide range of applications.



Figure 2: Master, Generator, and Distribution Sections are added together to provide sufficient capacity and required features.

Generator Sections

Generator sections are equipped with components that manage engine-generator startup, connection, disconnection, and shutdown. They can directly control engine power and the adding and shedding of generators to and from main bus. Generator sections also can communicate with controllers on generators to effect these operations.

Typical features of generator sections include annunciators that display alarm status, manual generator and synchronizer controls, and paralleling circuit breaker controls. Most often, one section is provided for each generator. In some installations, two generators may be controlled from a single section.

Distribution Sections

Distribution sections contain circuit breakers that connect elements of power distribution systems to energized bus. They can also be equipped to connect load banks that are used to test power sources, without having to transfer live loads to the backup system. Figure 3 illustrates a PCS system with a segmented bus, which offers sophisticated control possibilities for both sources and loads, and is further described in the Bus Segmentation section on Page 6.



Figure 3: A Power Control System controls how power sources and loads connect to each other.

Master Control Section

The Master Control Section provides overall system control as well as direct control of specific equipment. This section contains Programmable Logic Controllers (PLCs) that coordinate system-level action and provide sophisticated features. Master Control Sections provide the following functions:

- Automatic and manual system operation
- Utility circuit breaker control
- Tie circuit breaker control
- Transfer switch operation
- Distribution circuit breaker control
- Load control

SECTION INTEGRATION

All of the sections that comprise a power control system are typically installed in one or more equipment lineups in a facility's power control area. Figure 4 shows the relationship of each section to the overall power system.



Figure 4: A typical power control system configuration

Figure 5 shows an ASCO 7000 SERIES lineup that features a Master Control Section, sections for three enginegenerators, plus two distribution sections.



Figure 5: An example of a PCS equipment lineup.

CAPABILITIES AND ADVANTAGES

Power Control Systems offer sophisticated options for managing and optimizing power in complex electrical systems. Because these systems can control both power sources and power distribution equipment, they provide value by enhancing reliability, providing redundancy, and reducing operating costs. The following paragraphs describe key capabilities.

Bus Load Optimization

By measuring real-time loads, Bus Load Optimization can add or shed loads according to remaining generator capacity and assigned load priorities. Figure 6 shows how ATSs may be added to maximize usage of generation capacity.



Figure 6: Bus Optimization optimizes usage of available power.

Generator Load Demand

Generator Load Demand maximizes efficiency by connecting only the number of generators required to meet real-time demands, as shown in Figure 8. Load management schemes conserve fuel and reduce maintenance requirements by operating fewer generators at outputs nearer to their rated capacity.



Figure 7: Generator Load Demand adds or sheds generation capacity according to demand.

Bus Segmentation

Within a PCS, buses can be segmented to connect fewer devices to each bus. Placing a tie breaker (a breaker that allows power to flow in either direction) between the segments offers operational benefits. Multiple engine-generators can be concurrently started and connected to their respective loads without waiting for all of the power sources to synchronize, thus reducing time to bring backup power online. Multiple bus segments can also be synchronized and connected to create a single bus structure that offers reserve capacity, redundancy, or allows excess generator capacity to be shed.

Custom Operating Sequences

Power Control Systems employ custom operating sequences that are key to meeting unique facility requirements. For example, a facility's two utility power sources may each feed separate buses connected by a tie breaker. If Source 1 fails, the tie breaker will close and Source 2 will supply all of the loads. To enable the PCS to adjust to system conditions, custom sequences are created to respond to a loss of Source 1, a loss of Source 2, a loss of both sources, and the return of those sources. In addition, sequences can ensure sufficient capacity by paralleling an on-site generator with one source in the event of failure of the second source. By utilizing custom operating sequences, PCS systems ensure that facilities benefit from all of the functionality their power systems can offer.

Automated Testing

Power control systems can be configured to simplify testing of critical power equipment. Custom sequences can be used to automate testing activities ranging from simple generator exercises that ensure proper function to system-wide tests that simulate outages or other events. By integrating a load bank into a power control system, backup power testing can be completed without having to engage live loads.

Vendor and Fuel Neutrality

Power control systems provide signals to engine-generator controls to adjust power output. Power control systems can control engine-generator sets from a variety of manufacturers (Figure 8). This provides flexibility when adding generators to existing systems, and avoids compelling users to acquire additional units from manufacturers of previously purchased engine-generators.



Figure 8: Power Control Systems can integrate engine-generators from different manufacturers.

Power control systems can also accommodate multiple fuel types. Diesel and natural gas engines offer different operating characteristics and respond to changes in load at different rates. Power control systems can be configured to successfully control equipment fired by diesel or natural gas by adding or shedding loads in ways that minimize engine stress, regardless of fuel type.

System Modifications

In many instances, both the function and service life of power control systems can be extended by modifying rather than replacing systems. Where sufficient bus capacity exists, generator and distribution sections can be added to increase system capacity. When controllers and PLCs become obsolete, direct component replacements can enable continued service. Systems can also be updated by completing section-level replacements that swap entire doors and panels and their obsolete components with pre-wired equipment that facilitates quick installation. In addition, modern control and communication functions can be added to existing systems by installing the latest metering, monitoring, and control solutions using Modbus, BACnet, and TCIP protocols. These communication protocols enable connection to building and emergency power monitoring systems as well as to ASCO Critical Power Management Systems.

APPLICATIONS

Power Control Systems are highly configurable and multiple sections can be integrated according to exact requirements for specific facilities. As a result, power control systems offer great flexibility to meet nearly any power system need. Figure 9 below shows example configurations for water/wastewater, data center, distributed generation, healthcare, and industrial applications. Features and configurations beyond those shown can be adapted for other applications.



Figure 9: Power Control Systems are highly configurable. This chart shows how different features might be applied to facilities in different industries.

SUMMARY

Power Control Systems are comprised of Master Control, Generator, and Distribution Sections that can be equipped with a wide range of devices, as well as sections that manage utility feeds and tie breakers when required. Because of their modular construction, these systems can be scaled and configured to connect critical power sources and critical loads, and offer a wide range of solutions for creating capacity, ensuring reliability and redundancy, and reducing costs. Bus load optimization, generator load demand, bus segmentation, custom operating sequences, future expansion, and vendor neutrality are just a few of the high-value benefits these systems offer to water/wastewater, data center, distributed generation, healthcare, and industrial applications. Power Control Systems offer the widest and most sophisticated range of solutions for connecting multiple power sources and controlling complex power distribution systems.

ASCO Power Technologies - Global Headquarters 160 Park Avenue Florham Park, NJ 07932 Tel: 800 800 ASCO customercare@ascopower.com

> whitepapers.ascopower.com www.ascoapu.com

www.ascopower.com

The ASCO and ASCO Power Technologies marks are owned by Emerson Electric Co. or its affiliates and utilized herein under license. ©2017 ASCO Power Technologies. All Rights Reserved.

ASCO. Innovative Solutions.