

# Advanced Logic System® Diesel Load Sequencer

## Background

The increasing recognition of the efficiency, economic advantages and environmental benefits of nuclear power has prompted a renewed interest in nuclear plant license extensions and the accompanying upgrading and maintenance of their Instrumentation and Control (I&C) systems.

New technologies are being applied to nuclear I&C systems to address this need, including FPGA (field programmable gate array)-based systems. These hardware-based systems provide high reliability and deterministic behavior by eliminating weaknesses of software-based systems, such as the asynchronous behavior of operating systems.

Westinghouse has developed and qualified the Advanced Logic System® (ALS®) Platform, an FPGA-based platform for nuclear I&C safety systems. The ALS platform is intended to be the basis for future Westinghouse Class 1E and other systems requiring diverse engineering techniques. The ALS platform supports easy and reliable implementation of both Class 1E and non-1E systems, including diesel load sequencers (DLS).

## Description

The ALS platform DLS has the following principal functions:

- Monitor safety injection and bus under-voltage signals
- Start the emergency diesel generators on a safety injection signal and/or loss-of-off-site power
- Provide load-shed signals to certain engineered-safety-features (ESF) equipment to prepare for sequencing of the components
- Provide an orderly load sequence for ESF equipment to prevent excessive transients on the Class 1E buses and emergency diesel generators

## ALS Platform Equipment

Each ALS platform subsystem may contain the following boards, depending on the desired scope of the system:

- **ALS-102 – Core Logic Board.** This primary decision-making board contains the functional logic for the system and provides data link interfaces to external systems.
- **ALS-321 – Analog Input Board.** This board performs analog-to-digital (A/D) conversion of 4-20mA and 0-10V signals and contains eight input channels.
- **ALS-311 – RTD/TC Input Board.** This board performs A/D conversion of resistance temperature detector (RTD) and thermocouple (TC) signals and contains eight input channels.

- **ALS-302 – Contact Input Board.** This board performs digital-to-digital (D/D) conversion of contact input signals and contains 32 channels.
- **ALS-402 – Contact Output Board.** This board performs D/D conversion of contact output signals and contains 16 channels.
- **ALS-421 – Analog Output Board.** This board performs digital-to-analog (D/A) conversion to generate voltage or current signals and contains eight output channels.
- **ALS-601 – Datalink Board.** This board interfaces with up to eight RS-422/RS-485 datalinks.
- **Coincidence Termination Unit.** In addition to providing easy field terminations, this board performs two-out-of-three voting on the diesel commands, eliminating both single failure and spurious trip concerns.
- **Safety- and nonsafety-grade displays.** Depending on plant requirements, either a safety- or nonsafety-grade display can be provided.

The following figures contain diagrams of the ALS platform equipment used in the Westinghouse DLS.



Typical ALS platform subsystem



ALS platform chassis



ALS platform board



Typical ALS platform DLS user display

## Benefits

Westinghouse offers two different architecture configurations for replacement of diesel sequencers using the ALS platform DLS technology: the primary ALS platform DLS and the redundant ALS platform DLS.

The **primary** ALS platform DLS is a cost-effective functional equivalent to existing equipment with enhancements in human-machine interface (HMI), monitoring and self testing. The primary DLS also has the following advantages:

- Provides the most cost-effective approach to meet requirements for safety and reliability
- Uses minimum floor space to support retrofit constraints
- Minimizes power consumption on AC power distribution system
- Minimizes installation time during an outage
- Provides lower maintenance costs

The **redundant** ALS platform DLS provides functional equivalence to legacy DLS equipment with significant enhancements in independence, reliability, availability, HMI and self testing. It also has the following advantages:

- Provides a cost-effective approach that exceeds requirements for safety and reliability
- Provides triple-redundant sequencers operating in parallel so that no single equipment failure can cause a spurious actuation or failure to actuate
- Improves availability so that a single failure will not cause entry into a limiting condition for operation (LCO)
- Allows “hot swap” board replacement while system remains online
- Minimizes installation time during an outage
- Provides lower maintenance costs

## Experience

Westinghouse has developed reliable safety-related DLS systems for many years using various I&C platforms, including Common Q™-based and other software-based systems. The FPGA-based ALS platform DLS provides even greater reliability and addresses licensing issues related to the use of software-based systems.

Broad experience in plant I&C systems allows Westinghouse to provide extensive support for the installation of DLS systems.

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