MICROPROCESSOR-BASED DOOR CONTROL:
System Architecture and Operation

Leach International's newly developed Door Control System utilizes the latest proven technology in digital control and solid-state devices, yet retains the key security and safety features of high-integrity relays.

This microprocessor-based system is compatible with many standard networks and can be monitored, controlled and configured remotely through the network. Flexible architecture allows this system to be adapted to an existing installation with minimal or no changes in the wiring and harnesses.

In this new design, a Neuron processor and LonWorks network are used; however, the network interface can be changed easily to comply with different requirements. Following is a detailed description of the Microprocessor-based Door Control System.

System Architecture

To facilitate the compatibility of the Microprocessor-based Door Control System with both new and older model cars currently in use, Leach has designed this system with a flexible and expandable architecture. Due to the flexibility of the design it is also suitable for installation on the fixed platform doors used on various systems. A simplified architecture for the Door Control System is shown in the block diagram below.

This flexible architecture allows the system to be tailored and configured as "distributed" or "centralized" for compatibility with door systems in existing and new cars, dependent upon their current or proposed system architecture.

In this architecture, a General Door Control Panel interfaces with the Trainlines (including LonWorks) and controls the doors via Remote Door Leaf Control Panels. The Remote units receive the commands from the General unit and interface with the Door Motor(s) and limit switch signals from the door leaves. The interface between the General unit and the Remote units can

Door Control System Block Diagram
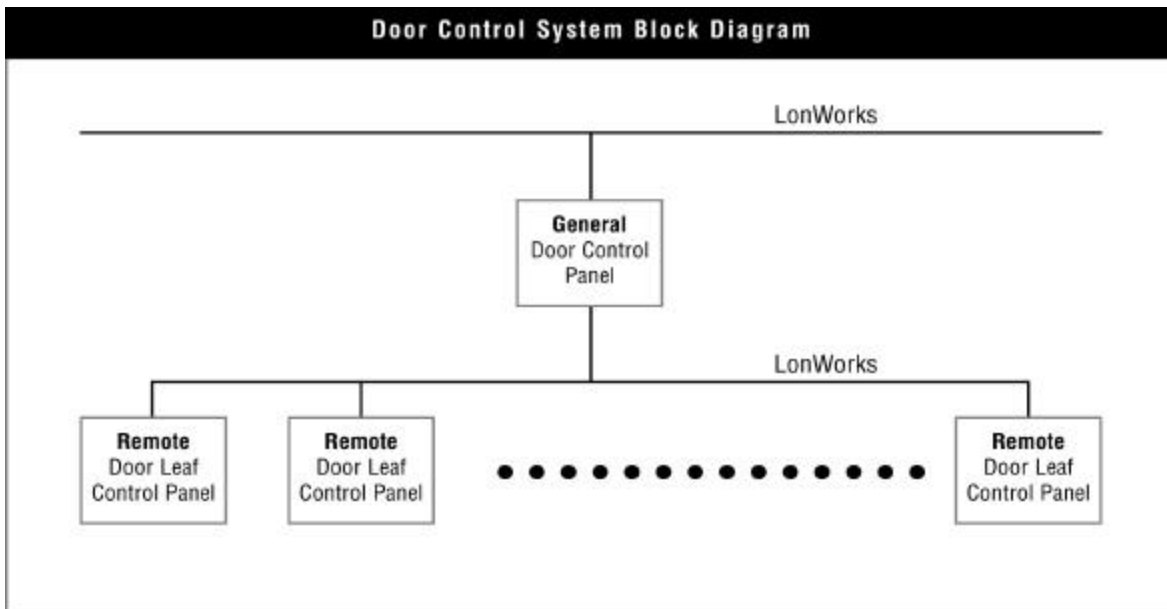
be accomplished through discrete signals or through the LonWorks network. With the use of LonWorks, for safety reasons, some of the discrete signals are also used to actuate the critical safety isolation relays.

In the distributed configuration, the Remote Door Control Panels will be located at the doors. In the centralized configuration, the Remote units are co-located with the General unit. With this architecture, the safety, integrity, and reliability of the system are significantly improved, while wiring and interconnections are minimized.

- To insure safety and prevent accidental operation of the doors, Leach electromechanical relays are used when physical isolation is essential. These relays are controlled by the Trainlines, and completely disable the outputs when the train is in motion.
- To improve integrity, self-diagnostics and redundancies are incorporated in the design and critical components are monitored by the processor.
- To improve reliability, part-counts are minimized by using highly integrated electronic circuits.

Operation

The new Door Control System utilizes a microprocessor to control the operation of the doors. To assure that the doors are not accidentally opened, the system is only enabled when the Zero Speed Relay (ZSR) is energized. As long as the train is in motion, none of the doors can be commanded to open or accidentally be opened. This relay applies the power and ground to the output drivers and the Door Motor. Once energized, the microprocessor waits for the command to open or close the door. The command can be issued to the Door Control System through the network or by using discrete signals. When the command is received and validated by the General unit, it is re-transmitted to the Remote units. No single-point failure will cause a door to open when the train is moving.

The control of the door leaves is actually performed by the Remote units. The Remote unit controls the direction, as well as speed of the Door Motor. The Remote unit monitors the limit switches (or proximity sensors) and controls the motor accordingly. The corresponding Remote unit manages the speed and timing of each leaf. As soon as one of the doors is opened, the Propulsion Interlock Relays are de-energized and the train propulsion is disabled. IF one of the doors is open, the train cannot move. When all doors are closed and locked, the Propulsion Interlock Relays are energized and the interlock for the train propulsion is disabled.

If a door meets an obstacle, it will retract and make another attempt to close. Several options, including a partial retract and a full retract, are available. The obstacle-detection circuit can be completely disabled, if desired. All these features and parameters are remotely programmable without physically accessing the unit.

LonWorks Interface

LonWorks is IECE certified for rail use and is an open architecture network which provides a safe and easy way to remotely control and monitor the doors.

A single twisted-pair wire can monitor and manage the entire system. The existing wiring can also be used as the medium for the network, substantially reducing wiring and interconnections.

Commands can be issued to the doors through the network. The status of all the doors, as well as overall health of the system, can be reported back to a host (Vehicle Monitoring System) through the network. Using the network, doors can be individually programmed or disabled. These operations can be performed remotely.

The system also can be interrogated through the network. Information collected and compiled by the General units will be transmitted to the requester. This information can aid the maintenance crew in diagnosing the system and pinpointing a problem. Data also can be used for trend or statistical analysis.

Adjustments

Any adjustments to door timing and other system parameters can be performed remotely using LonWorks network. The time delays, speed, time-to-close and time-to-open, can be individually adjusted remotely through the network. The self-calibration feature allows the motor speed to be adjusted by the software in order to achieve the desired time-to-close and time-to-open, regardless of the line voltage.

Self Diagnostics

To assure reliable operation, a self-check is performed at power-up. This includes the checksum as well as memory contents. If any problem is detected, it will be recorded. In addition, all vital signals are also monitored and, if the desired response is not received within the prescribed period, the failure is identified and recorded. A watchdog timer assures that the processor is executing the software and has not failed due to a soft error.

The diagnostic capabilities of the system allow the problems to be easily and quickly identified to the LRU level, thus reducing the Mean Time to Repair (MTTR). They also enable the maintenance crew to be alerted to potential problems.

Data Retention & Reporting

As indicated earlier, the system is capable of storing and reporting the information about the doors or the system. All the abnormal conditions with respect to the doors, including obstacle detections, are time-stamped and recorded. To assure that the data is not lost during power-down or power failure, nonvolatile RAM (NOVRAM) is used to retain the data. This information can be transmitted through the network to the host system upon request. The amount of information and the frequency of the recording can be varied within the resources of the system.

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Further information on detailed system performance and measured improvements in system integrity, reliability and fault identification, with respect to your particular application parameters, may be obtained by contacting Leach International, Buena Park, CA, or a local Leach representative.