PC vs. PLC Airfield Lighting Control and Monitoring Systems:

Which One Is Best for My Airport?

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In the early 1990s, computerized control systems first started seeing wide use in airfield lighting control and monitoring systems. Prior to that time, FAA L-821 control panels were typically used to interface with Air Traffic Controllers (ATC). The L-821 typically consisted of an array of ON/OFF switches, rotary switches and pushbuttons. The L-821 was hardwired to the various airfield lighting devices using customized relay or contactor configurations.

Most major airports today use some sort of computerized control system to interface with airfield lighting equipment using fiber optic, hardwired (copper cables), or wireless communication links. Touchscreens are commonly used as the Human Machine Interface (HMI) for ATC. In addition, the use of computers for airfield monitoring has allowed the development of many sophisticated software tools for airfield maintenance troubleshooting. This includes automated series circuit insulation resistance measurement systems, detailed Constant Current Regulator (CCR) input and output monitoring, and sophisticated graphical user interfaces (GUI)–allowing detailed event/alarm data to be graphically displayed in an easy-to-read format.

A committee of industry experts formed in 2003 to develop an FAA Advisory Circular (AC) for these systems. The resulting Advisory Circular, 150/5345-56, is titled "Specification for L-890 Airport Lighting Control and Monitoring System (ALCMS)" and was issued September 30, 2004. This AC allows either PC (Personal Computer) or PLC (Programmable Logic Controller) based systems to be used. Questions often come up about which system should be used for a particular situation. This article aims to answer many of those questions.

In general terms, choice of a particular L-890 architecture depends on what you need to accomplish. This can be a complex decision based on multiple factors or a relatively easy one depending on your airport's specific requirements.

Airfield lighting control and monitoring systems can be generally placed into three categories:

- PLC-based architecture
- PC-based architecture
- Hybrid PC/PLC-based architecture

What applications are better suited to a PLC-based system?

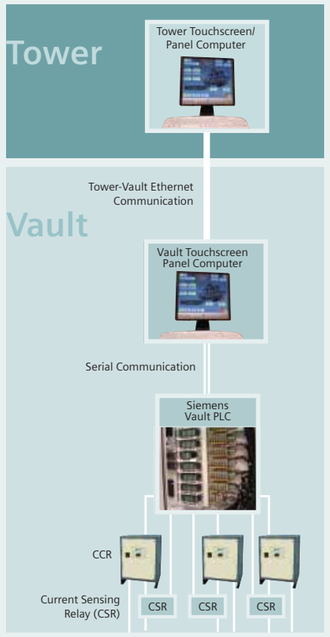
In general, PLC systems are ideal for small to medium ALCMS applications where basic monitoring, such as CCR status and ON/OFF monitoring, is needed, but more advanced monitoring is not required. And, a PLC system uses various modules that are easy to integrate and easy to replace.
A PLC architecture is optimized to run sequential processes, increasing reliability. PLC architectures can be implemented in a number of different ways. A block diagram of a typical PLC system for a small to medium ALCMS application is shown to right.

It is also possible to scale up the functional capabilities of a PLC-based system with the appropriate external devices via a simple contact closure. Separate L-827/L-829 monitors, for example, can be connected to PLC inputs to provide overall fault monitoring. Also, separate megging systems can be connected to provide overall caution/fault status indications.

What applications are better suited to a PC-based architecture?

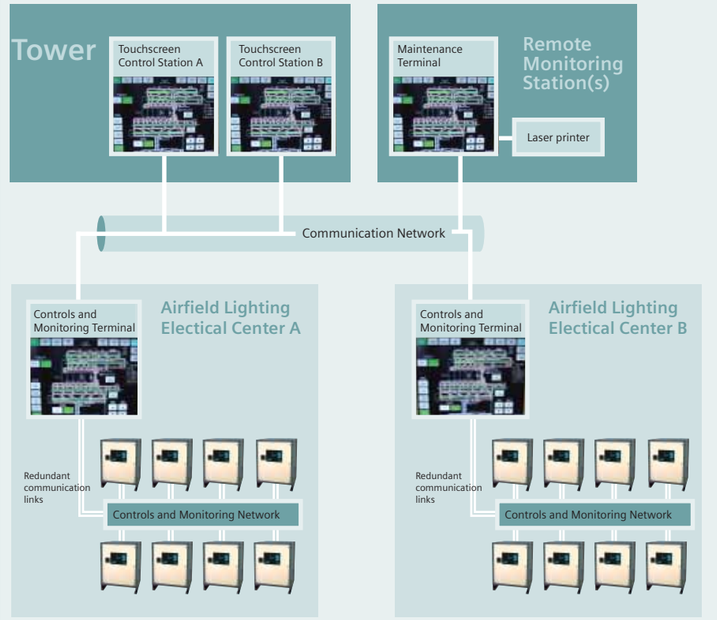
In general, a PC-based control system is ideal for medium to large applications that require detailed FAA L-827/L-829 CCR monitoring or that have Surface Movement Guidance and Control System (SMGCS) - monitored Runway Guard Lights or Stop Bars as part of the requirements. High level ALCMS applications require additional data manipulation, storage and reporting characteristics that are difficult to implement in a standard PLC.

PLC-based Architecture



PC-based ALCMS architectures are configured to maximize reliability. These systems typically use industrial computers and redundant hardware and communication links. Also, a hot-standby computer architecture (dual-redundant computers) is much easier to realize in PC-based systems (It is possible to implement a PLC hot-standby system, but it is more costly and software intensive). PCs have standard development platforms, available high-end application software, well-known programming languages and familiar graphical interfaces (Windows®). Also, megging systems can be merged into a fully redundant control and monitoring architecture. This provides detailed megging data, which can be viewed at any node in the system. A block diagram of a typical PC system is shown to the right.

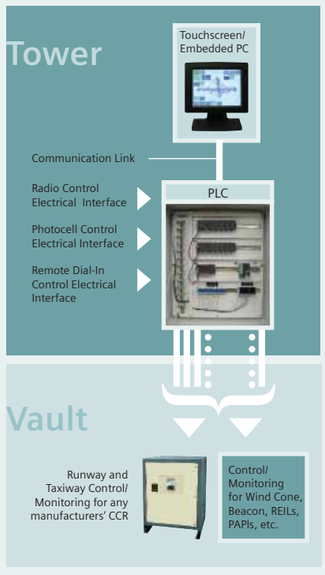
PC-based Architecture



Can I use a hybrid PC/PLC-based system to get the best of both worlds?

For larger applications, the need for a database, the elimination of multiple hardwired control points and the benefit of only having to be concerned with troubleshooting a single type of device—PCs—indicates that an all PC-based system is the best choice. For smaller applications, an integrated Touchscreen/PC can be used to operate Touchscreen graphics and can also connect to a standard PLC for remote control and simple contact monitoring. This is exactly what we implement in our Navigator™ system, which is intended for smaller applications with up to 18 controllable items. A block diagram of the Navigator system is shown to right.

Hybrid PC/PLC-based architecture



Following are a series of questions to help you decide which system is right for your airport

What are my operations going to be?

- VFR/IFR – If either no monitoring or basic monitoring (on/off current sensing or alarm contact closure monitoring), a hybrid PC/PLC may be better.
- CAT I – Depending on the application requirements, a PLC may be better, especially if basic advanced monitoring (L-827/L-829 contact closure) is acceptable.
- CAT II/CAT III or (possibly) CAT I – A PC-based system is usually better because advanced monitoring is typically required.

What does the airport currently use for control and/or what are their control expectations?

- L-821: If all their existing functionality can be included in the PLC, then a PLC-based system would be best.
- Is it a busy airport that wants to simplify operations? If yes, then a PC-based system would be best.

Can circuit status monitoring be reported manually or are frequent updates needed?

Does airport operations perform a visual lighting check every day to generate a lamp-out report? If so, the airport may not require reports on the total number of lamps-out to be generated automatically. So, if either no monitoring or basic status monitoring (i.e. current sensing; relay contact feedback) is all that is required, a hybrid PC/PLC or PLC is better.

A PC-based system is better if the airport requires advanced monitoring, such as the detailed circuit status information provided by a FAA L-827/ L-829 CCR electronic monitor. This type

of information includes: number of lamps-out; CCR input and/or output current, voltage, VA, wattage; CCR output drop in VA (Low VA); and CCR output insulation resistance value. If the airport needs this type of information quickly, or it needs individual airfield fixture (i.e. Stop Bar or Runway Guard Light) monitoring or complex analog (current/voltage) monitoring, a PC-based system is better. A PLC-based system cannot inherently perform FAA L-827/L-829 monitoring functions unless a separate subsystem is connected into the system.

Is a series circuit Insulation Resistance Monitoring System (IRMS) required? Either PLC- or PC-based systems can have IRMS functionality. Because PLC systems do not have standard modules for airfield series circuit IRMS monitoring, this would need to be tied into the PLC as a separate system. An IRMS is commonly integrated with PC-based systems, allowing airfield series circuit insulation resistance trends to be easily viewed and analyzed on a monitor. Also, in a distributed PC-based architecture, there is no single point of failure in the IRMS system.

Is latching remote control required?

If it is required that, in case of a complete control system failure, all controlled items (such as CCRs) stay in their last state (latched) or go to a preconfigured state, a PC-based system is best. In a PC-based system, the local control/monitoring device—in our case, the Advanced Control Equipment (ACE™) unit—has a hardwired output to the controlled item from latching relays.

Standard PLC output modules do not have latching outputs. Per FAA AC 150/5345-56, par. 7.1, latching outputs are required for CAT II/III operations. Hybrid PC/PLC or PLC systems do, however, have the ability to set their output points to a preset state if the microprocessor fails (assuming internal power is present in the PLC cabinet) or last commanded state if the communication link fails and assuming internal power is present in the PLC cabinet. Also note that it is possible to add latching functionality to a PLC, but separate latching relay modules must be added to each of the required output points.

Do you want to minimize installation cost/time at a larger airport?

If the application is complex, with many CCRs and control points, then a PC is the most cost-effective system with the quickest installation turnaround, because a redundant communication cable is daisy-chained between each local control/monitoring device—in our case, the ACE unit. An equivalent PLC system using PLC I/O modules would require hundreds to thousands of individual wires (using many additional conduits) to implement equivalent control/monitoring functionality. This would not be a significant issue, however, if there is only a small number of CCRs at the airport.

What are the future applications?

You also will want to determine what type of changes may occur in the future. A hybrid PC/PLC or a PLC may be better if basic monitoring is needed today and future upgrades will have the same requirements. Equipment interface upgrades may consist of simply adding I/O modules for control/monitoring.

A PC-based system is best for a larger airport that wants to simplify its operations while retaining the ability to easily make modifications or upgrades later on. A PC will be easier to upgrade to a more complex system or if significant design changes are needed after installation.

What is the project budget?

- <$35K — Hybrid PC/PLC with basic monitoring is the best.
- <$50K — PLC with basic monitoring is best.
- $50K to 100K — PLC or PC. The choice depends on the application requirements.
- >$100K — PC with advanced monitoring is best.

Which system is easier to maintain?

It depends. A PLC-based system is easier to troubleshoot for simple applications if the airport maintenance staff is familiar with the specific PLC type. PLC modules are very easy to replace and mechanically rugged. And, replacement parts are often available locally.

For complex ALCMS applications, a PC-based system is often easy to troubleshoot, because detailed alarm and event views are provided that pinpoint the source of the problem. PC subsystems and components are typically available locally or are readily available from the manufacturer. For example, SAS maximizes the use of commercial off-the-shelf parts to reduce cost and increase spare parts availability. The entire ACE unit (the L-827/L-829 control/monitoring part of the system) can be easily replaced. Industries are becoming more distributed and the requirement for the reporting and collection of data has pushed PCs to become even more industrial and robust. With innovative technologies such as redundant power supplies and flash drives, the PC has become a very reliable choice for control applications.

Also note that PLC-based systems that use a Touchscreen or need a database for alarm/event reporting typically require some sort of PC/microprocessor in the tower or maintenance center, requiring maintenance personnel to know how to troubleshoot both PLC and PC subsystems. So, in this case, it may make sense to use only PCs throughout the system.

Author Profile: *Ed Runyon has worked in airfield lighting for more than 25 years and has served on various FAA committees, including the ones that developed the Runway Guard Light and L-890 ALCMS specifications and also the LED Engineering Brief.*

Siemens Airfield Solutions
ALCMS Architecture Design Comparison Table

Design Parameter	Hybrid PC/PLC (Navigator™)	PLC	PC
Small to medium ALCMS applications with only basic control and monitoring	Best	OK, but not as cost-effective as Hybrid PC/PLC	OK, but not as cost-effective as PLC or Hybrid PC/PLC
Medium to large applications that require advanced (i.e., FAA-L-827/L-829) monitoring	Full L-827/L-829 monitoring not available	Full L-827/L-829 monitoring not available unless a separate subsystem is connected into the system	Best
Small number (≤18) of controllable elements (such as CCRs) with only basic monitoring desired	Best	OK, but not as cost-effective as Hybrid PC/PLC	OK, but not as cost-effective as PLC or Hybrid PC/PLC
Operations are VFR/IFR	Best	OK, but not as cost-effective as Hybrid PC/PLC	OK, but not as cost-effective as PLC or Hybrid PC/PLC
Operations are Cat II/III	Not available	Not the best solution because advanced monitoring required	Best
Control expectations	Best if only L-821 ON/OFF switch contact control desired	Best if only L-821 ON/OFF switch contact control desired and alarm database is required	Best for a busy airport that wants to simplify its operations
Basic monitoring only	Best	Best	OK, but not as cost-effective as PLC or Hybrid PC/PLC
Advanced monitoring required	Not available	May not be possible	Best
Airport has SMGCS operations	Not available	Possible, but not the optimum solution	Best
Hot-standby architecture	Not available	Can be done, but implementation is more costly and software intensive	Best
IRMS required	Not available	Possible, but tied into the PLC as a separate system	Can be easily integrated into the system
Latching outputs required	Not available in PLC modules.	Not available in PLC modules. Requires separate latching relay modification kits	Best
Only Preset output required	OK	OK	OK
Minimal installation cost/time	OK, if there is only a small number of CCRs at the airport	OK, if there is only a small number of CCRs at the airport	Best if application is complex with many CCRs and control points
Upgradability for future applications	Easily upgraded for basic control/monitoring applications, assuming resulting total number of controllable items are small	Easily upgraded for basic control/monitoring applications	Can be upgraded for any application
Reliability	Highly reliable, especially with the use of flash hard drives	Highly reliable	Highly reliable with redundant architecture and industrial PC
Purchase Cost	Low for a small to medium size airport with only basic monitoring requirements	Low for a small to medium size airport with only basic monitoring requirements	Low for a medium to large airport with more advanced monitoring requirements
Maintenance staff technical experience	Best if the application is not complex and someone on staff has PLC experience	Best if the application is not complex and someone on staff has PLC experience	Best if the application has advanced monitoring and someone on staff has PC experience
Ease of maintenance	Easier to troubleshoot if airport maintenance staff familiar with PCs and PLCs	Easier to troubleshoot for basic control/monitoring applications if airport maintenance staff familiar with the specific PLC type	Easier to troubleshoot for advanced control/monitoring applications, if airport maintenance staff familiar with PCs
Interactive maintenance/ troubleshooting tools	Not available	Standard PLC has some limited maintenance screens. Possible if a computer is separately added into system to generate graphics.	Has fully interactive Windows-based Graphical User Interface (GUI)

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