Embedded Computers for Substation Automation

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Power substations play a critical role in transporting electricity from power plants to homes, businesses, and factories. However, a typical power grid can be comprised of hundreds of substations that need to monitored and controlled. Thanks to the rapid growth of computer and communication technology, power substations are becoming more automated and increasingly deploy intelligent devices to monitor and control unmanned facilities. Key factors to establishing successful substation automation systems include faster and more reliable networking solutions such as embedded computers. This white paper discusses how embedded computer systems can provide reliable automation for power substation networks.

Application Requirements for Substation Automation

There are three physical layers in substation automation: the bay layer, the communication layer, and the substation layer. The bay layer consists of protection units and control units, and is based on the RS-485 bus. The communication layer serves as the core of the whole remote monitoring system. It not only collects data from the protection units and sends it to the back-end control center, but transmits commands from the control center to the control units, such as switching on and off the various system devices, capacitors, and converter transformer taps. The substation layer provides 100Mbps...
Ethernet support for back-end servers, security workstations, as well as prevention mechanisms to protect against misused circuit breakers and electrical isolation interference. Generally speaking, the bay layer devices collect real-time data and transmit it to the communication layer, which sends it to the substation layer. The communication layer essentially functions as a transitional center that receives data from both the bay and substation layers so its performance and reliability ensures stable operation for the whole system.

**Embedded Technology in Substation Automation**

Compared to the traditional IPC (industrial PC), the embedded computer is a revolutionary technology that considerably changes the structure of control systems. By replacing the PC’s hard drive with flash or DOM (disk on module) memory, the RISC-based structure of embedded computers provides users with fanless operation and low power consumption. Structurally speaking, embedded technology reduces many unstable factors associated with traditional IPCs that usually require add-on boards or cards for system expansion. Add-on expansion boards/cards seldom meet strict anti-vibration and anti-shock demands of harsh industrial conditions. To solve this problem, embedded systems use a highly integrated layout design for all interfaces including serial ports, Ethernet ports, and DI/DO. This significantly enhances system reliability and operation stability. Moreover, embedded computers usually come pre-installed with either Linux or Windows operating systems for a ready-to-run platform that satisfies real-time industrial application demands, and ensures system maintenance costs and effort.
In response to the rising trend in deploying embedded systems in substation automation, more and more companies, including traditional IPC manufacturers, are producing embedded computers to tap into this growing market. However, many IPC manufacturers simply just downsize the dimensions of their computers without making any significant changes to the hardware and software design. Drawing from over 20 years of experience in providing leading industrial networking solutions for power automation, transportation automation, and other industrial-grade applications, Moxa has found that system integrators repeatedly demand an embedded system with serial-to-Ethernet communication and programmability.

Moxa’s DA-660 series embedded computers were developed to address these specific needs and provide integrators with multiple Ethernet ports for substation automation. Embedded with various application programs, the DA-660 series can perform numerous industrial automation tasks including data control, data acquisition, and numeric computing.

**Features of the Moxa DA-660 Series**

Front view of the DA-662:

Rear view of the DA-662:
**Hardware**
- 19-inch rackmount design for easy installation
- Fanless, no hard drive, and low power consumption (20w) design for longer MTBF
- Integrated multiple serial ports and LAN ports for connecting devices
- 16 RS-232/422/485 software-selectable serial ports support non-standard baudrates with the speed between 50 bps to 921.6 Kbps, offering a flexible field site device connection
- Wide range of power input voltages from 100 to 240V AC/DC
- 16 LED indicators for serial port transmission status
- Supports CF, USB, and PCMCIA sockets for expansion

**Software**
- Dual unit, dual LAN design for network redundancy
- 10-second quick system boot up time
- Pre-installed web server, supports PHP/XML for remote monitoring
- Protocol converter and MySQL database embedded for different protocol communications and data storage
- Supports JFFS2 and TFAT file systems to prevent data loss during power failures
- Supports Watchdog Timer
- Supports Moxa Device Manager (MDM) to manage the hardware and software resources in the system
- Pre-installed with NTP Client for network NTP timing function
- Supports PPP dial-up
The DA-660 Series in Substation Automation for a Steel Factory

A steel factory in China needed a way to remotely monitor and control over 100 substations in its power network. Instead of dedicated communication units, the factory used several control units with serial port cards for data acquisition, analysis, and handling. As these units were highly susceptible to frequent shutdowns and computer viruses, they could not guarantee stable and reliable operation. Moreover, a single unit was burdened with multiple tasks including data acquisition, protocol conversion, front-end data handling, and back-end data analysis, straining system performance and efficiency even more. In addition, programmers needed to replace the RAM and hard disk components, increasing system maintenance costs and effort.

To solve these problems and construct a reliable remote monitoring system, the factory used Moxa’s DA-662-16-LX embedded computers as the dedicated control units for system protection, data acquisition, protocol conversion, and front-end data processing. In addition to processing collected data, the DA-662-16-LX embedded computers transmit all processed data to the DCS (distributed control system) through the computers’ Ethernet ports with IEC 104 protocol. By deploying this new system, the factory has been able to considerably reduce its system construction and maintenance costs. Each substation in the factory’s power network of over 100 substations previously required three people for 24-hour monitoring. Now, only 20 people are needed for the whole substation network as on-site monitoring has been replaced by a remote monitoring system that can be maintained from the control center.
Summary

Embedded systems offer a great alternative to traditional IPC solutions for specific automation tasks such as power substation automation. For example, each Moxa DA-660 series embedded computer is specially designed for the electromagnetic environment, installation method, and input voltage of the intended field site. They offer an industrial-grade hardware platform, a tailor-made embedded system, and a ready-to-run software platform with serial communication drivers to significantly reduce system development effort and time. This is particularly helpful for system integrators as they no longer need to develop the network from the basic hardware layer. With all these features and benefits, Moxa’s DA-660 series embedded computers have been widely recognized and deployed in the Chinese substation automation market.

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