



Smart Embedded Systems for Solar Energy Stations

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Abstract

In order to mitigate the effects of global warming, many countries have made ambitious plans to invest in different forms of renewable energy, including the use of photovoltaic (PV) solar energy systems. According an estimate from International Energy Agency (IEA), PV solar electricity will become the leading source of energy in the near future.

Since most PV stations are unmanned and dispersed geographically in suburban areas, the computer system that monitors the operations equipment and devices are extremely important. Intelligent systems play a mission-critical role in solar power utility applications.

One of Axiomtek's customers selected the ICO300 controller, combined with the Axiomtek's remote management AXView 2.0 software, to monitor the status of their solar modules and inverters as a predictive maintenance solution. The ICO300 was purposely integrated as a gateway controller and used to transfer solar station's operational data through the cloud to the control center for analysis. The main goal is to use the analytical results to improve operational efficiency. This report is then made available for further actions on their website portal.

Industry Trend

The growing concerns about climate change, greenhouse effects and energy security around the world have fueled a rapid increase in the development of renewable energy operations. Renewable energy produces little or no byproducts such as carbon dioxide or other chemical pollutants, so they have minimal negative impact on the environment. Moreover, renewable energy facilities generally require less maintenance compared to traditional ones, and the abundance of natural resources, such as available sunlight, means a lower cost of operation. The energy source is virtually limitless. With all of these factors combined, solar power is now the most important renewable energy source in terms of globally installed capacity with more than 100 countries utilizing PV solar energy electricity.

The IEA stated in its [Energy Technology Perspectives 2014](#) report that, by 2050, solar energy will most likely become the world's main source of electricity with over 27% of the world's total electricity production. The IEA report stated that PV solar energy is currently a viable alternative at the times of peak demand in many areas, especially those where electricity is provided by fossil fuels.

Infrastructure Features

In addition to being a power generation system provider, Axiomtek's customer also manufactures solar cells and solar module products while also rendering related services. This customer has accumulated a great deal of power plant implementation and development experience including flat-roof type and pitched-roof type solar systems.

Challenges

1. PV solar power generation stations are dispersed geographically with no IT personnel on-site to maintain the technical issues. In order to maintain reliable operation, a decentralized intelligent monitoring system with centralized control is required.
2. Network connectivity, such as 4G, is required to make data collection and remote management feasible in order to have real-time data shown in the station's control room.
3. Most of these intelligent systems collecting data from devices or sensors are placed in harsh environments, so they have to be specifically designed to operate in extreme temperatures and wet/dusty conditions.
4. Built-in intelligent management software is needed in order to help the customer shorten their time to market and reduce development time.

In this case, the customer built a PV solar power station based on a grid-connected PV structure. Many solar panels are combined together to create one solar array are then connected to PV inverters which convert the variable direct current (DC) output of a PV solar panel into a utility frequency alternating current (AC), which can be fed into a commercial electrical grid or used by a local network. These systems also have thermal sensors and pyrometers installed to detect the surrounding environment and a smart meter to record the output volume of the power generation station.

For this application, the customer used Axiomtek's ICO300, with the AXView 2.0 software, as an intelligent IoT device to record and collects the data for all of its connected devices and sensors. The customer also connected PV inverters and smart meters via RS485 (using a daisy chain wiring scheme) and used the Modbus protocol (which is a serial communication protocol and a commonly available means of connecting industrial electronic devices). Real time data was retrieved by ICO300 via RS-485. Aside from acting as a data acquisition system, the ICO300 also plays the role of an Industrial IoT gateway. Utilizing the "cloud agent" program, the intelligent system can forward any collected data using Simple Object Access Protocol (SOAP), a known protocol specification for exchanging structured information in the implementation of web services in computer networks.

Axiomtek's AXView 2.0 is a software service that can monitor the ICO300 behavior; trigger event alerts when abnormalities occur; and share machine information with other remote management systems and the service cloud.

The data is collected and forwarded to the cloud to be processed and analyzed at a control center. The customer also has a monitoring portal for its end-users, allowing them to view real-time data such as the daily power generation volume and the performance of the PV inverters. This data can be accessed via a mobile phone or on a tablet for their convenience.

Since on-site preventive maintenance service is very costly and takes a lot of time, this monitoring system also implements predictive maintenance service for solar panels. By analyzing the operational data from PV inverters, sensors and smart meters in the cloud, the monitoring system can predict when each device is going to break down so that the system can send a Short Message Service (SMS) to a technician to eliminate the downtime associated with a faulty device.

Application-Solar System Structure

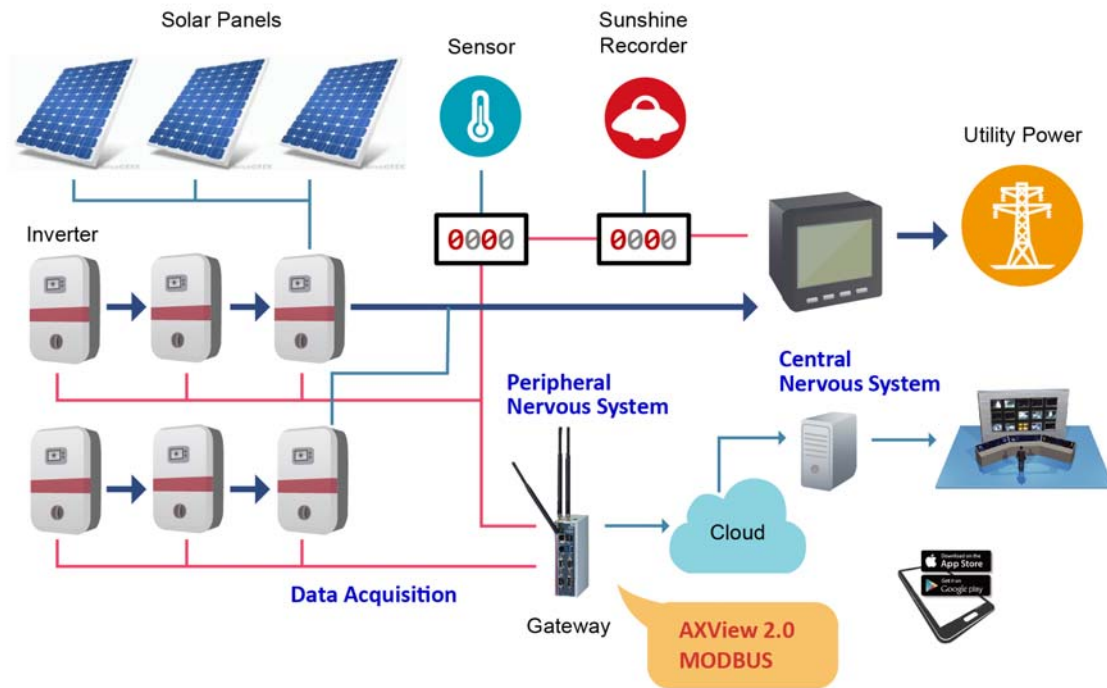


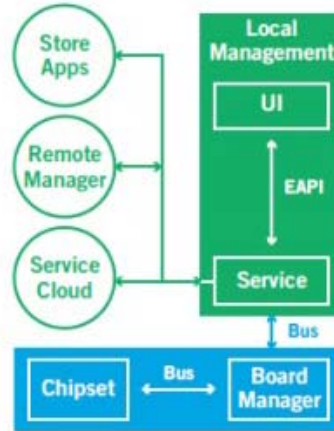
Figure 1: System Design Structure

System Design Features

Axiomtek's ICO300 offers a fanless, rugged design and utilizes the low power consumption and most advanced 22nm Intel® Atom™ processor E3815 (1.46 GHz) in the market. It supports DDR3L system memory of up to 4GB. This Intel® IoT gateway solution is feature-rich, with expansive wireless connectivity options including one full-size PCI Express Mini Card, one SIM socket, four RS-232/422/485 ports, and two isolated Gigabit Ethernet ports. Other features include two high-speed USB 2.0 ports, RTC battery function, and wide voltage range 12V - 24V DC power input with terminal block. Since PV solar stations are often located outdoors, the ICO300 supports an extended operating temperature range of -20°C to +70°C to ensure reliable operation in harsh weather environments. The reliable ICO300 embedded system is a perfect solution for IoT, industrial and embedded applications such as PV solar power generation stations, facility monitoring systems and other challenging operations in harsh environments.

AXView 2.0

Axiomtek's AXView 2.0 software comes with cloud service and M2M protocols. It is a highly integrated software management system that provides remote management architecture and an easy-to-use application programming interface.

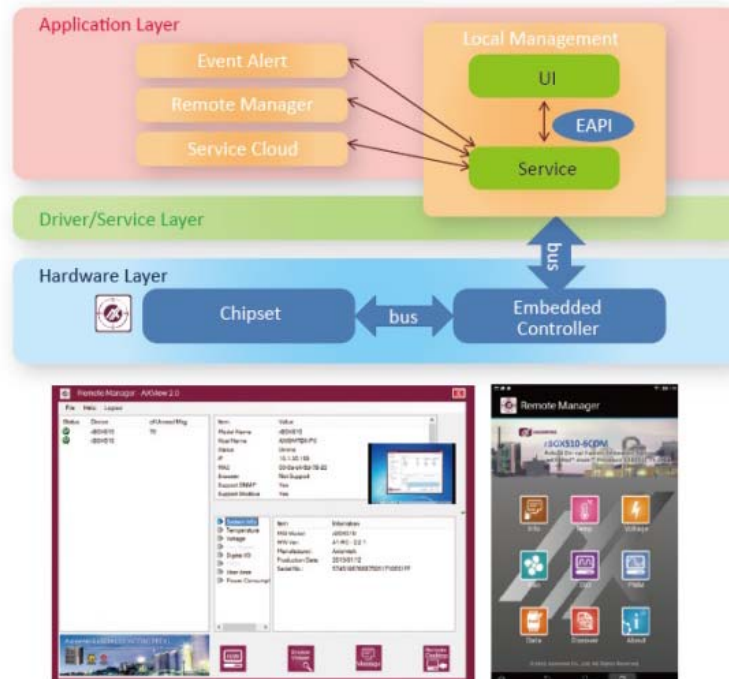


Local Hardware Monitoring Service Agent

The agent is a software service that monitors local hardware devices, sends alerts and shares device health information through remote management systems when abnormalities happen.

Remote Management System

The remote management system is an alert receiver. Users can enter the service cloud by keying in their IP address to connect to the cloud. Once connected, any event alert sent by the local hardware monitoring service agent will be pushed to your phablet automatically.



Service Cloud

The service Cloud is a new AXView 2.0 feature compared to version 1.0. It can store, forward and review machine health information for behavior analysis. AXView 2.0 also provides software packages to assist users in constructing their own cloud.

EAPI

AXView 2.0 supports Embedded Application Programming Interface (EAPI) compliance with PICMG EAPI standards and extends its features to support access to special system information, hardware health status, system behavior and unique system designs such as battery backup memory area, panel backlight, DIO and dual hardware watchdogs.

To learn more about Axiomtek's [industrial barebone system](#), [fanless embedded system](#) and [rBOX DIN-rail embedded controllers](#), contact us at info@axiomtek.com.tw.

About Axiomtek Co., Ltd.

[Axiomtek](#) Co. Ltd. is one of the world's leading designers/manufacturers of PC-based industrial computer products. From our roots as a turnkey systems integrator specializing in data acquisition and control systems, Axiomtek has mirrored the PC evolution in various industries by shifting our focus toward the design and manufacture of PC-based industrial automation solutions.

Axiomtek Co., Ltd. established in 1990, has more than 60 distributor partners globally. Axiomtek offers Industrial PCs (IPC), Single Board Computers and System on Modules (slot CPU card, small form factor embedded boards & SoM), Fanless & Rugged Embedded System (eBOX and rBOX), Intelligent Transportation System (tBOX), Industrial Firewall Platform, Industrial IoT Gateway Solution, EtherCAT Master Controller, Touch Panel Computers (TPC), Medical PCs (MPC), Human Machine Interface (HMI), Digital Signage and Players (DS), Industrial Network and Network Appliances (NA).

As an associate member of the Intel® Internet of Things Solutions Alliance, [Axiomtek](#) continuously develops and delivers cutting edge solutions based on the latest Intel® platforms.