Integrated Hardware and Software Yield Better Power Monitor

Low-speed computer room monitors collect measurements of power consumption, temperature, and humidity, sending them to a data manager.

by Greg L. Hurd, Instrumentation and Controls Manager, The RMH Group

The Challenge: Developing a flexible, comprehensive, facility-wide power monitoring system at a reasonable cost.

The Solution: Using 5B Series signal conditioning modules, DAQ boards, and LabVIEW for data analysis and presentation.

Introduction

Data centers, telecommunications centers, high-tech manufacturing facilities, hospitals, laboratories, and other users with critical electronic loads cannot afford to have "dirty power" serving their sensitive equipment and systems. When US WEST, a major telecommunications company in the western United States, searched for new solutions to increase the uptime of the power distribution system at one of its major Denver-area data centers, the RMH Group of Lakewood, CO, provided a PC-based power monitoring system based on LabVIEW and data acquisition (DAQ) boards from National Instruments.

Previous monitors installed at the US WEST facility in Denver provided only localized "snapshots" of power problems. The information gathered was often inadequate to pinpoint the source of the problem and its overall effect on the facility. Because building engineers needed a complete picture of how the entire power distribution system behaves under abnormal conditions – such as how it reacts to a changeable power source and to continually changing nonlinear loads – a facility-wide monitoring system was needed. US WEST selected the RMH design for its flexibility, performance, and reasonable cost.

Hardware Design

While designing a comprehensive yet economical solution for US WEST, RMH needed an integrated set of hardware and software with extended capabilities. LabVIEW software, analog and digital signal conditioners, and high-speed DAQ boards from National Instruments provided the data measurement, display, and analysis capabilities needed to achieve the project objectives.

RMH developed a distributed, PC-based data collection system to capture voltage and current waveforms, breaker status, uninterruptible power supply (UPS) operating status, UPS battery voltages, and low-speed data from resistance-temperature detectors (RTDs), humidity sensors, and watt and var transducers (for measuring real power and reactive volt-amperes, respectively). With the high-speed data capture capability of LabVIEW, the system continuously monitors waveform voltages and currents and saves to disk any out-of-tolerance waveforms at 12 kS/s per channel. It has 12 data collection stations distributed over eight floors of computer rooms and two levels of subbasements. The system is interconnected via Ethernet with a common relational database. It monitors computer rooms for power consumption, temperature, and humidity. It monitors the four main power buses and UPS outputs at the site for power quality using advanced waveform capture routines developed in LabVIEW. RMH uses a separate PC and dynamic data exchange (DDE) technology to manage alarms from any input and annunciate them on remote workstations. It also has an autodialer to provide real-time alarming system-wide and to remote locations. All data collected is deposited into a separate Pentium file server running Windows NT. The system extracts power waveforms and other related data from the database and sends it to remote workstations for analysis with LabVIEW.

Each of the eight high-speed data collection stations is a 486-66 PC with an AT-MIO-16F-5 multifunction DAQ board. Using the circular buffer structure of the 16F board and unique LabVIEW virtual instruments (VIs) results in a 99.5 percent continuity in data collection while simultaneously storing data to hard disk. Ahead of the A/D card, RMH uses 5B Series signal conditioning modules, selected because of their low cost, medium bandwidth, flexible configurations, wide input types, high common-mode voltages, and input/output electrical isolation. The four low-speed data collection stations are 486-66 PCs with AT-MIO-64F-5 DAQ cards. Again, 5B modules accept the 4 to 20 mADC inputs and 24 VDC contact closure inputs representing power, var, degrees F, relative humidity, UPS operating status, and power breaker status.

Software Design

Special VIs were created in LabVIEW to fit the software to the application. For example, power disturbances – transients, harmonics, voltage sags or swells, and dropouts – may remain undetected by many power monitors because they can occur on any phase of the power distribution system, on voltage or current. RMH developed special LabVIEW routines, such as multichannel simultaneous triggering and sine-wave tracking, to ensure that all power disturbances are collected and stored to disk. Complex data reduction VIs were also incorporated into the software to

RMH needed an integrated set of hardware and software with extended capabilities. LabVIEW software, analog and digital signal conditioners, and high-speed DAQ boards from National Instruments provided the capabilities needed to achieve the project objectives.

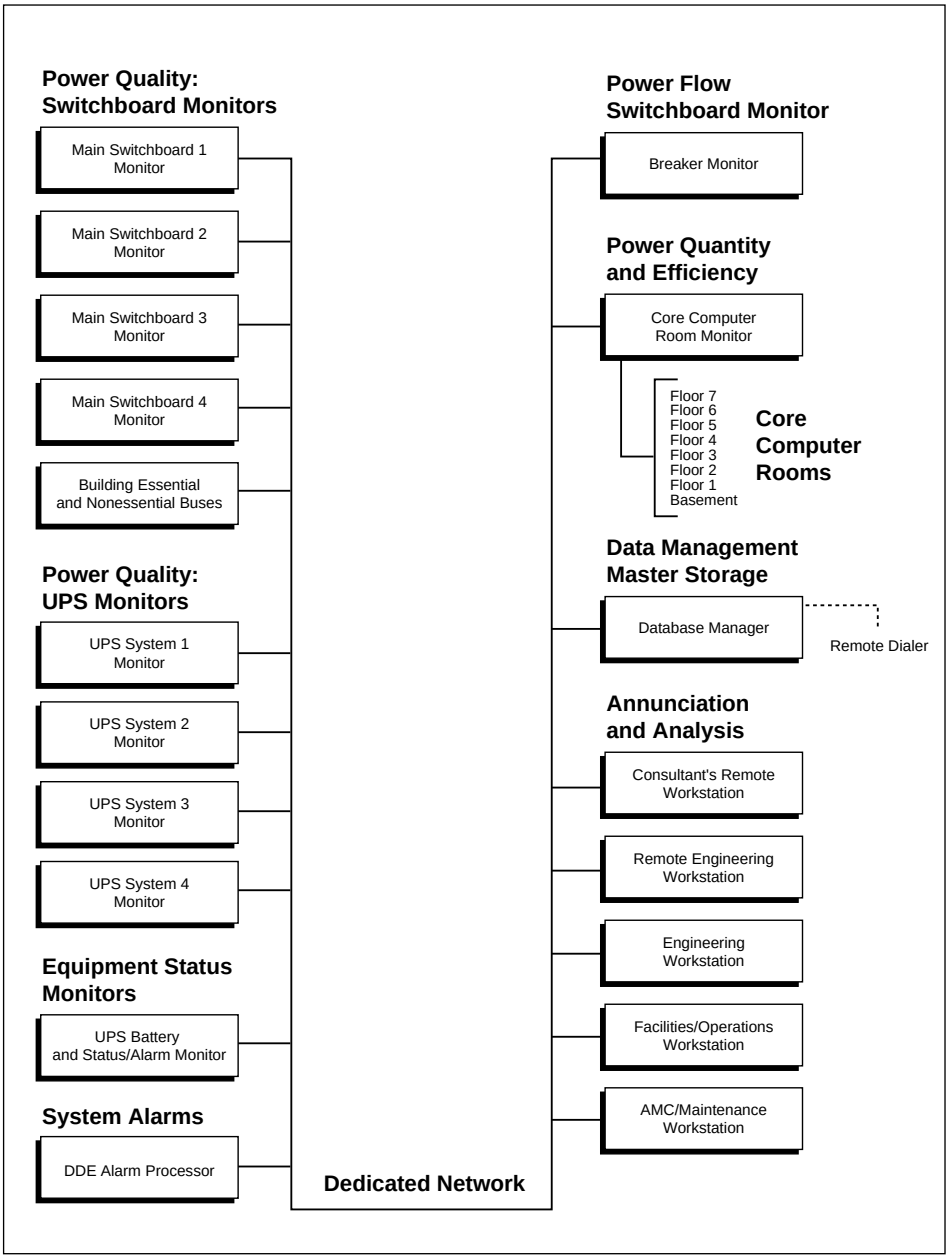
prevent repetitive harmonic waveform data from piling up in the database.

All workstations use the data display and analysis functions of LabVIEW. Using DDE routines, the system can send prioritized alarms to the database, workstations, and modems within seconds after detection of a disturbance. RMH developed custom routines for remote alarm annunciation via autodialers and for access on remote workstations. The designers provided simplified man-machine interface menus so that nontechnical personnel, such as security guards,

Each LabVIEW workstation is loaded with comprehensive algorithms to calculate and display frequency spectra, true power factor, distortion power factor, phase imbalance, alarm summaries, power consumption trends, and other advanced functions not normally found in off-the-shelf disturbance analyzers.

can monitor alarms and electrical system performance. For in-depth investigation and analysis, RMH created more complex menus for the maintenance and engineering staff. Although all workstations are configured identically, they have a keylock system so that employees can access the system only at levels appropriate to their job functions.

Each LabVIEW workstation is loaded with comprehensive algorithms to calculate and display frequency spectra, true power factor, distortion power factor, phase imbalance, alarm summaries, power consumption trends, and other advanced functions not normally found in off-the-shelf disturbance analyzers. RMH wrote VIs for all power calculations and spectrum analyses, as well as to provide true power factors at 60 Hz and at each harmonic. The system can analyze up through the 70th harmonic. We can extract data from the database to analyze each power disturbance as it occurs, build historical trends, map power usage around the facility, or test electrical system equipment during periodic maintenance.



PC-based data collection stations, which include National Instruments DAQ boards and signal conditioners, are distributed throughout the facility and are connected to a common relational database by a dedicated Ethernet link.

Results

The RMH power monitoring system project at US WEST won first place in the special projects category of the American Consulting Engineers Council of Colorado's 1995 Excel lence Awards. The system is installed permanently and runs continuously. The US WEST technical staff can now understand and address power problems more completely and more efficiently than previously possible. The distribution system performs more reliably and adjustments can be made to accommodate future changes in computer loads.

For more information, contact The RMH Group, 12600 W. Colfax Avenue, Suite A-400, Lakewood, CO 80215, tel: (303) 239-2767, fax: (303) 235-0218.