A newsletter for the customers of
Campbell Scientific, Inc.

The CAMPBELL UPDATE

September, 2001 www.campbellsci.com Volume 12, Issue 2

PConnect software: Palm™ PDA to datalogger

You can now perform most on-site communication tasks without a laptop

With PConnect software, you can use a Palm PDA to communicate with your datalogger.

When visiting your field site, do you find it too cumbersome to use a laptop PC, but you need more power and capability than your keyboard/display can provide? Campbell Scientific can solve your dilemma using a Palm™ handheld. With our new PConnect software, you can perform almost any datalogger communication task—without a laptop.

PConnect is a straightforward program that is compatible with our CR510, CR10(X), 21X, CR23X, and CR7 dataloggers. On-site communication functions include:

- Setting the datalogger's clock
- Transferring datalogger programs
- Monitoring real-time measurements
- Setting input locations, ports, and flags
- Retrieving stored data
- Emulating a datalogger's keyboard / display

PConnect requires a Palm, Inc. or 100% compatible handheld running Palm OS Version 3.3 or later (Handspring's Visors currently not supported) and a Palm serial cable or cradle.

PConnect comes with a custom connector and conduit software that integrates with the Palm HotSync utility to transfer data between the Palm and a PC. PConnect tracks each datalogger station separately, including custom labels that you've entered for monitoring measurements. PConnect stores data internally in Campbell Scientific's compressed binary format to save memory. A 2 Mbyte Palm handheld is suitable for collecting data from a few standard dataloggers, but you will probably want an 8 Mbyte handheld if you work with numerous dataloggers or dataloggers with extended memory. The HotSync conduit process converts the binary format to the more common comma-separated format used by most software packages.

Once the data is stored in your PC, you will be able to use PC208W to review your data and create reports.☑

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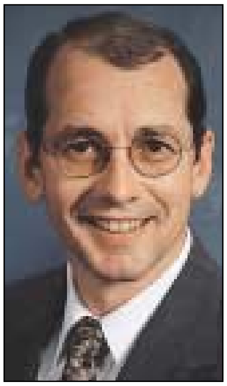
After a few glitches with our database, we now have the mechanism in place for our customers to receive *The Campbell Update* electronically. To be notified via e-mail each time a new version of *The Campbell Update* is available, visit our electronic sign-up form at www.campbellsci.com/campbellupdate.html to enter your contact information. This form will also allow you to opt out of receiving a printed version of the *Update* through the mail. Once our newsletter is released, we will send an e-mail with a link to the location on our Web site where you can download it or view it online.

Message from the President

DSP in electronic measurement instruments

By Paul Campbell



Many of us can relate to the question, "Mom/Dad, can I have the keys to the car?" A simple question, but it's not always simple to give an answer, so we say, "That depends," or "Why?" Hopefully, enough good information is gathered to generate a yes or no answer (or a yes with conditions). One hopes it is the right answer for the circumstances. A simple yes or no is logically unambiguous, yet an ultimate Boolean response may possess more meaning than the myriad possibilities in between.

Campbell Scientific invests a great deal of effort to improve the process of separating signal from noise, thus imparting an output with as much meaning as possible. The same can be said of electronic signal processing and its application to physical measurements. As today's technology packs more computing capacity into smaller, less expensive, and low-power components, there is a trend toward more digital signal processing (DSP).

Let me define DSP as the application of numerical methods to characterize a series of related values in a summary conclusion. Campbell Scientific first implemented DSP in dataloggers in the late 1970s to compute an average wind vector. Other on-site processing such as average and standard deviation were also computed. In 1985, CSI delivered the first 21X Micrologger with Fast Fourier Transform (FFT) capability. The 21X provided a summary output that characterized ocean waves in the frequency domain from measurements gathered in the time domain. The resultant FFT and other data were transmitted from buoy to laboratory via satellite.

Our latest product advancing state-of-the-art DSP is the CR9052DC Anti-Alias Filter & FFT Spectrum Analyzer with DC Excitation for the CR9000 Measurement and Control System. Its filtering capability significantly improves the signal-to-noise ratio previously available using conventional filters. In the FFT spectrum analyzer mode, the CR9052DC can provide real-time spectra from "seamless," synchronized, anti-aliased, 50-kHz, 2048-point time-series snapshots for each of its six analog input channels. This improvement in sorting signal from noise, together with FFT output, has allowed better measurements of structural aging in mechanical joints and beams. This helps to project the useful life of a structure under test, not to mention improved measurements of mechanical resonance for modal analysis and better characterization of audio signals.

The TDR100 Time Domain Reflectometer uses DSP to construct a waveform of reflection amplitude in the time domain. The pulser circuit generates the signal that is applied to the probe at a constant rate while the sample circuit is increasingly delayed by discrete time steps. This equivalent-time sampling technique gives 12 picosecond resolution and is only possible with DSP. For soil water measurements, additional DSP functions are applied to the waveform to determine dielectric constant and signal attenuation which are directly related to water content and bulk electrical conductivity. Simple functions that identify impedance mismatches provide information about cable length or location of cable crimps or faults. These signal processing capabilities in the comparatively small, low-power package of the TDR100, combined with a reasonable price, will lead to new applications of this exciting technology. Possibilities include measuring frequency dependent dielectric properties over a range of environmental conditions. A combination of DSP applications could be used in the same measurement to characterize properties of interest.

The CSAT3 3-D Sonic Anemometer uses DSP extensively. Measurements of wind speed are made on three axes at horizontal angles of 120 degrees with each axis vertically rotated 60 degrees. This sensor orientation minimizes turbulence artifact from the anemometer head assembly. The acoustic transit time going each way between transducers in each of the three axes is measured. Through DSP, the out and back transit times of each axis yield a wind speed along that axis. Subsequent coordinate transformation provides an output of wind speed in each of x, y, and z axes. DSP can resolve the acoustic transit times to better than one nanosecond from a relatively slow (2 MHz) sampling of the acoustic signal. This enhanced resolution allows experimenters to measure extremely small (less than one millimeter per second) changes in wind speed. The entire measurement process can be repeated at a rate up to sixty times per second. DSP technology has allowed the design of a product that sets a standard for the measurement of turbulent transport of boundary layer gases between the earth and the atmosphere.

You may be assured that your measurement work is enhanced using Campbell Scientific dataloggers and other measurement instruments to get the most meaning possible through the use of DSP technology.

New COM210 telephone modems let you hear more

The COM210, our newest telephone modem, supports the same modulations, temperature, and current drain specifications as the COM200. The new on-board speaker allows the customer to hear call negotiations such as the dial tone, modem pickup, and handshaking, which aids in troubleshooting. The COM210 will replace the COM200 on our US and International Price Lists. ☑

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CAMPBELL SCIENTIFIC, INC.
www.campbellsci.com

Printed September, 2001

RF400: A license-free 900 MHz spread spectrum radio

An affordable alternative to narrow-band UHF/VHF

This fall Campbell Scientific will release the RF400, an exciting addition to our array of wireless telemetry options. The RF400 is a 100 mW, 900 MHz, spread spectrum radio/modem that doesn't need individual licensing. The radio offers exceptional sensitivity (-110 dBm). Two RF400s will typically communicate up to one to 10 miles with inexpensive omni-directional antennas, or several times that using higher gain directional antennas—although performance will vary with line-of-sight and RF noise conditions. A variety of high quality antennas and antenna cables for the RF400 will be available through Campbell Scientific.

An SC12 cable connects the RF400 to the datalogger 9-pin CS I/O port and provides communications and power to the radio/modem in the field. For office use as a base station, the radio also has an RS-232 connector that connects directly to a computer serial communication port. An optional wall adapter is available to supply power to the RF400 when the radio is used as a base station or when it is used with older dataloggers.

For most applications the datalogger's sealed rechargeable power supply, charged by a solar panel, powers the RF400. Current drain while transmitting is less than 75 mA. When the power saving settings are used, the average stand-by current can be less than 1 mA. The RF400 has a standard operating temperature range

RF400 does not require the user to obtain an individual FCC license.

The RF400 is a 25-channel frequency-hopping spread spectrum radio. Frequency hopping reduces susceptibility to interference from RF sources such as pagers and cellular phones. By selecting different frequency-hopping patterns, interference from other FCC Part 15 devices, such as wireless telephones, is minimized.

The RF400's setup menu can be

See RF400 on Page 4

You can monitor an ac electrical line by routing a cable through the hole of the CS10.

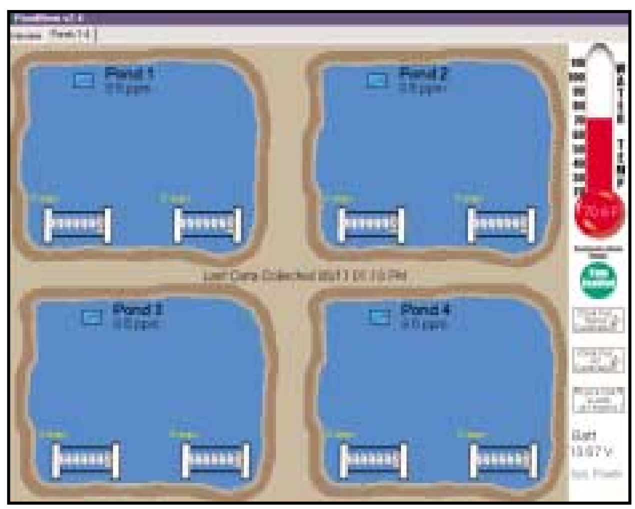
CS10 Current Transformer now available

The CS10 sensor consists of a CR Magnetic's CR8459 Current Transformer encapsulated in epoxy. It measures ac electrical current over a 0 to 200 Ampere range with an accuracy of ±10% of actual value. The CS10 outputs a millivolt signal allowing it to be directly connected to our dataloggers. Common applications include efficiency studies, intermittent fault detection, rough submetering, and monitoring motor or generator load conditions. ☑

PondView helps managers control, monitor remote aquaculture systems

User-friendly interface details vital conditions

A growing number of catfish and shrimp farmers are incorporating Campbell Scientific equipment in their aquaculture operations. Our system's capabilities allow farm managers to monitor and control the water quality and aeration equipment in up to 36 ponds throughout their operation.



Farm managers can easily view real-time dissolved oxygen levels, water temperature, and current drawn by aerator motors directly from their computer.

PondView Support Software is a user-friendly interface for monitoring and controlling remote, pond-based systems from a PC. With PondView, the farm manager can view real-time dissolved oxygen levels of each pond, electrical current being drawn by each aerator motor, and water temperature.

The PondView display can activate an audio/visual alarm to alert personnel of possible problems. To evaluate trends, a 7-day graph of dissolved oxygen is also provided. PondView requires LoggerNet 1.1 and Windows NT or 2000 to be installed on your computer. ☑

CSI offers OPC server for third-party SCADA

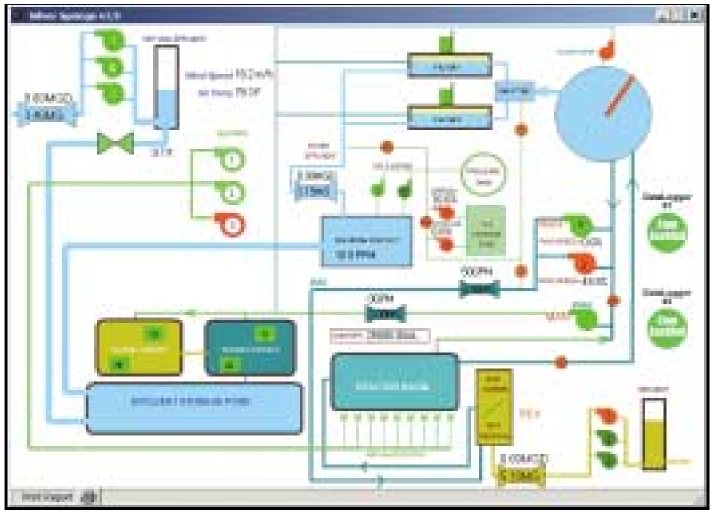
Supervisory Control and Data Acquisition (SCADA) systems aren't new; they've been used to monitor and control complex systems such as water and wastewater plants for years. SCADA systems have been limited to a computer equipped with PLCs (programmable logic controllers) to communicate with a network of RTUs (remote terminal units) used as monitoring and control devices. The RTUs simply measured the sensors and sent the information back to the control computer.

Today, there is a growing awareness of the value that an independently powered, programmable device with memory, such as a datalogger, adds at the remote sites. The problem has been interfacing the datalogger with the existing SCADA software.

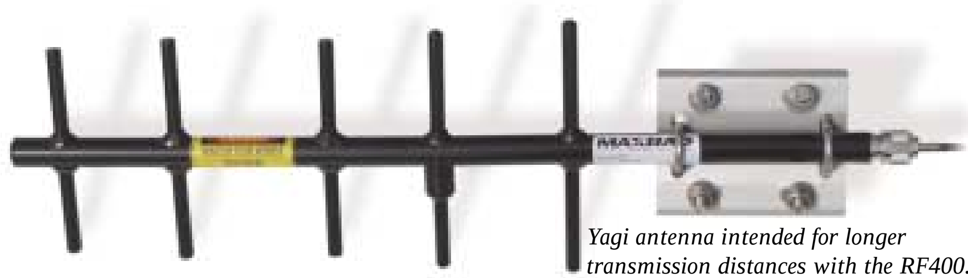
Enter OPC, which stands for OLE for Process Control. OLE is Microsoft's Object Linking and Embedding protocol for communications between software applications.

In the past few years, a number of very sophisticated HMI applications—including National Instruments' LabVIEW and Lookout, Iconics' Graphworks, CI Technologies' CITECT, Wonderware's InTouch—have

See SCADA on Page 6



Complex SCADA systems can be easily managed using Campbell Scientific's hardware and software in conjunction with third-party software.



Yagi antenna intended for longer transmission distances with the RF400.

RF400

Continued from Page 3

accessed using most terminal software programs, including Windows HyperTerminal. The setup options allow you to choose different addresses for multiple dataloggers in a point-to-multipoint network. Green and red status LEDs give you assurance that the radios are configured and operating properly. Settings are stored in non-volatile memory, and are retained if power is lost.

Two radios can be used as a wireless, half-duplex, 9600 bps connection between a computer running PC208W and a Campbell Scientific datalogger. Contact an applications engineer for more details or to discuss the suitability of the RF400 for your application. ☑

CSI honored by local cycling club

Campbell Scientific, Inc., recently received the "Bicycle-Commuter Considerate Employer" award from the Cache Valley Veloists, a local bicycle club that promotes bicycle use and touring.

The award was presented in conjunction with "Bike to Work Week" in May. The club's award recognizes a local employer who encourages, supports, and provides accommodations for employees who choose to commute to work on their bicycles.

The 14014 Charger connects to an ac power source then outputs a charging voltage to the datalogger's charging port or power terminals.

14014 compatible with power supplies

New lightweight charger ideal for worldwide use

The 14014 is a versatile ac-to-dc transformer that features a universal input for compatibility with a variety of power cords. It produces 24 Watts continuous at 18 Vdc (nominal), can source 1.3 Amperes (peak), and has an isolated ground. The 14014 is rated to an input voltage of 90 to 264 Vac, an input frequency of 47 to 63 Hz, and a temperature range of 0° to 70°C (derated at temperatures greater than 40°C).

The power supply carries the CE mark and approvals for UL, CSA, and TUV safety standards, making it ideal for use around the world. The 14014 is compatible with our PS12LA, PS512M, CH12R, and CH512R power supplies.

CR10X chosen for new Hukseflux TP02 system

The CR10X's capabilities made it a perfect match to measure and control Hukseflux's TP02 probe.

By Kees van der Bos, Hukseflux

Hukseflux recently introduced its new TP02 Non-Steady-State Probe for the measurement of soil thermal conductivity. The measurement process consists of heating a line source then monitoring the rising temperature.

The CR10X was chosen to perform the measurement and control process. The CR10X is a perfect match because it can provide accurate differential voltage measurements, switchable 12 V power, current measurements, and post-processing for calculating the end result. The TP02-CR10X combination complies with the requirements of ASTM 5334 for thermal conductivity measurement of soil and soft rock. Contact Hukseflux at www.hukseflux.com for more details and specifications.

Automated Weather Stations: Proceedings available as book

A book entitled *Automated Weather Stations for Applications in Agriculture and Water Resources Management: Current Use and Future Perspectives* is now available. Edited by Kenneth Hubbard and M.V.K. Sivakumar, the book was compiled from the Proceedings of the International Workshop held 6-10 March, 2000 in Lincoln, Nebraska.

Topics include Site Selection, Data Management, Statewide and Regional AWS Networks, Communication with AWS, and Current Uses of Technology. Those interested in purchasing a copy are encouraged to contact:

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University of Nebraska
Lincoln, NE 68583-0728

M.V.K. Sivakumar, Chief
Agricultural Meteorology Division
World Meteorological Organization
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Switzerland

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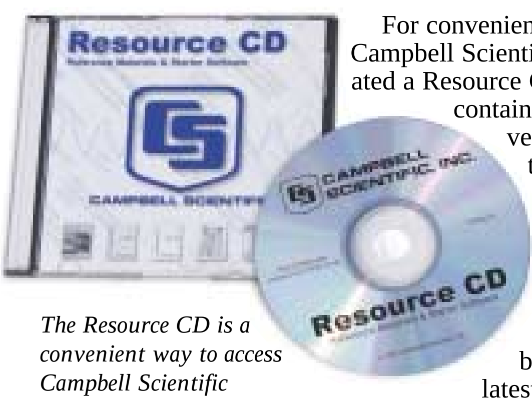

The Resource CD is a convenient way to access Campbell Scientific documentation.

For convenient, portable access to Campbell Scientific documents, we have created a Resource CD-ROM. This CD-ROM contains our free software and PDF versions of our product literature and manuals. To obtain a copy, contact one of our applications engineers or visit our Web site at www.campbellsci.com/sendinfo.html

The Resource CD will be updated quarterly; for the latest product information visit our Web site.

The CS547A measures conductivity and temperature in surface water, ground water, or lab applications.

Epoxy encased CS547A probe replaces CS547

The CS547A Conductivity and Temperature Probe has replaced the CS547. The CS547A measures electrical conductivity using three cylindrical stainless steel electrodes. To reduce electrochemical reactions, minimize corrosion, and extend the probe's life, the electrodes are ac coupled, and a bipolar excitation is applied. Temperature is measured with a thermistor.

The probe is entirely encased in epoxy that is resistant to corrosion. Its rounded ends facilitate installation and removal. For ground water applications, a weighted option is available. One A547 Conductivity Interface is required for each CS547A used directly with the datalogger. Multiple CS547As can be measured with one A547 connected to an AM16/32 or AM416 multiplexer. ☑

Comprehensive training course now available for LoggerNet

A new training course for LoggerNet Datalogger Support Software and the CR10X-TD (Table Data Operating System) is available. This comprehensive course introduces the CR10X-TD, its programming, and basic operation of the client-server LoggerNet software.

Advanced topics include RF data retrieval, "data advise" data collection for real-time data systems, and command-line operation of LoggerNet. Visit www.campbellsci.com/training.html for a full course description and local travel information.

The next course is November 13-16, 2001. Course fees of $650 per person include a training manual and the use of a CR10X-TD, computer, and sensors. ☑

The operation of irrigation pumps is controlled by a datalogger digital I/O ports while flags trigger alarm call-outs to cellphones. Water Reuse Facility, Silver Springs, NV, USA

SCADA

Continued from Page 4

integrated OPC as an interface between the control computer and the RTUs.

Campbell Scientific now supports the OPC standard with a LoggerNet client product, the CSI OPC Server. The CSI OPC Server acts as a "bridge" between the LoggerNet Server and a third party client. This allows you to monitor measurements, control datalogger ports and flags, and set input locations in the datalogger. The CSI OPC Server acts as a server to the SCADA software, but runs as an add-on client to the LoggerNet Server. The SCADA software can run on a different PC than LoggerNet. However, the CSI OPC Server must be running on the same PC as the SCADA software and that PC must have a TCP/IP link to the PC running LoggerNet.

Setup of the CSI OPC Server is easy. Most SCADA applications that support OPC will let you drag and drop graphical objects onto a screen and then set the properties for those objects, including the data source. Typically, SCADA software has a button or control to let you select data from "OPC Tags." Once LoggerNet is running and the CSI OPC Server is installed and registered on the SCADA computer, the CSI OPC Server automatically displays the dataloggers, data tables and values being collected by LoggerNet.

The CSI OPC Server lets you adjust input locations, flags, ports, and variables in the dataloggers right from the SCADA application. OPC provides a complete measurement and control system using Campbell Scientific dataloggers and your third party application.

To order, specify PC-OPC for one copy, or PC-OPC/10 for 10 copies. ☑

Decade of strong sales leads to new Campbell Scientific Spain

By Stuart Creswell, Marketing Officer
Campbell Scientific Ltd

Campbell Scientific Ltd (our European affiliate), has established Campbell Scientific Spain following a decade of increased sales in that country. The new company has offices at Pasaje Font close to The Temple de Sagrada Familiar in Barcelona. Campbell Scientific Spain is headed by Jaume Pallares Bassets, whose experience and enthusiasm for Campbell products will help the new company grow quickly.

"In Spain, Campbell products have a very good reputation for high quality and reliability," reports Jaume, and early sales support this. Sales in the first month included a weather station destined for Antarctica and a major order for CR510 dataloggers. The CR510s will be used in wind prospecting projects by EHN, an organization that provides 30 percent of Spain's wind power capacity and almost 5 percent of the global capacity.

"The establishment of the new company in Spain is part of our continuing goal to provide excellent service to our customers," states Dick Saffell, Managing Director of Campbell Scientific Ltd. "The new company will provide sales and technical support to the large number of customers in Spain, and provide maintenance and calibration facilities for more than 500 weather stations now installed in that territory."

Campbell Scientific Spain joins Campbell Scientific France as an affiliate company within the European Community.

In this newsletter: ☑ = more literature available, = more infomation available on our Web site

Campbell Scientific Calendar

Date	Event	Location
October		
2-4	Sensors Expo	Philadelphia, PA
2-4	CR10X/PC208W Training Course	Logan, UT
14-17	WEFTEC	Atlanta, GA
21-25	ASA, CSSA, SSSA	Charlotte, NC
23-25	CR9000/PC9000 Training Course	Logan, UT
November		
4-6	Irrigation Association	San Antonio, TX
6-8	CR10X/PC208W Training Course	Logan, UT
7-9	NALMS	Madison, WI
13-16	LoggerNet Training Course	Logan, UT
28-30	Joint Water & Irrigation Conference	Rapid City, SD
December		
4-6	CR10X/PC208W Training Course	Logan, UT
9-13	Entomological Society of America	San Diego, CA
10-14	American Geophysical Union	San Francisco, CA
January 2002		
8-10	CR10X/PC208W Training Course	Logan, UT
14-17	American Meteorological Society	Orlando, FL
27-30	Aquaculture America	San Diego, CA

Twin suspension cables on the north side of the Williamsburg Bridge point toward Manhattan. The traffic lanes below are cantilevered and outside the suspension, attributes that made the monitoring both vital and unique.

CR9000s make real-time measurements on New York's Williamsburg Bridge

Strain gages monitor structural performance

Lehigh University researchers have been on the forefront of field instrumentation and testing of bridges, buildings and other structures for over 50 years. They have developed a vast database and considerable experience in the field testing and evaluation of highway and rail structures. Field testing and evaluation is a particularly challenging area of structural research. It is the only method to accurately evaluate the true behavior of a structure in real-time under actual loads. Field measurements are the link that connects and validates laboratory testing and computer modeling to the behavior of real structures.

It is well known that accurate interpretations of structural behavior require accurate data. However, it is much more difficult to collect data several hundred feet in the air over a river, in the wind and cold, than it is in a laboratory. Aside from environmental obstacles, there are many variables that must be addressed prior to making an accurate interpretation of the measurements. Thus, a thorough understanding of data acquisition systems, sensors and structural behavior is essential. Of utmost importance is a data acquisition system that can consistently perform under these adverse conditions. Lehigh University researchers have found the Campbell Scientific CR9000 Measurement and Control Systems to be extremely robust, and capable of withstanding the harshest field environments. They are the workhorses of our infrastructure monitoring program.

Continued on next page

APPLICATION AT A GLANCE

Application type:
Structural monitoring

Project area:
New York, New York, USA

Author:
Rob Connor, ATLSS
Lehigh University

Contracting agencies:
City of New York

Datalogger(s):
Campbell Scientific CR9000s

Communication links:
PCMCIA cards, telephone

Measured parameters:
Strain, vibration

Continued from previous page

An example of a recently completed field testing project involves on-site measurements and long-term remote monitoring of the Williamsburg Bridge in New York City, which is currently undergoing a major rehabilitation. A significant portion of this project involves the replacement of the existing concrete-filled grid deck on both the south and north inner and outer roadways with a steel orthotropic deck. Along with a comprehensive laboratory testing program, an in-depth field instrumentation and testing program was also conducted on the south outer roadway. This study was performed to investigate in-situ stress-ranges and better characterize the behavior of this complex structural system and its relationship to the laboratory response. Data were collected using a CR9000. During controlled load tests, data were collected from 82 strain gages at sampling rates as high as 200 Hz. All data were temporarily stored on PCMCIA cards installed in the datalogger. These data were subsequently copied to the laptop at the end of each test for processing and back-up. The compact and rugged CR9000 performed superbly throughout the testing program. The ability to observe and review data in real-time was invaluable during the testing.

A second portion of the program consisted of nearly seven months of remote monitoring. Data were collected using the CR9000 system described above. Program upload and data download were achieved with two modems specially configured by Lehigh University's Advanced Technology for Large Structural Systems (ATLSS) researchers. One modem was placed at the site, the other in an office at the ATLSS laboratory. The data were downloaded to a desktop PC every one to 14 days. The entire data acquisition system was stored in a steel box that was bolted to the west face of floorbeam 64E.

Access to the structure was very difficult. The constant traffic and remote location of the logger posed a special problem to the monitoring program. Convenient, regular access was simply not possible. The CR9000 permitted Lehigh researchers to collect a considerable amount of data remotely, eliminating repeated trips to the bridge itself.

To minimize the volume of data collected, time histories were not recorded continuously. Rather, the CR9000 was programmed to begin recording when the stresses induced by live loads exceeded predetermined triggers. The appropriate magnitude of the triggers was determined *apriori* from the controlled load tests.

For example, assume it was determined that heavy trucks were observed to produce a peak stress of 6.0 ksi at a given location. Software triggers were then set at 5.9 ksi for these gages. If the stress exceeded that value, the time history was recorded. Data were also recorded prior to the trigger event for a specified amount of time, say five seconds (i.e., a five-second buffer was maintained). The CR9000 continued to record for an additional specified time period, again, say five seconds and then stopped recording. These channels monitored as triggered time histories were automatically re-zeroed on the hour and half hour using a digital balance algorithm. The appropriate length for the buffer and total recording time was determined on-site. This technique provided sufficient time-dependent data and a method of verification for high stress-range events to ensure that spurious signals were excluded from the stress-range histograms.

Stress-range histograms were developed using the rainflow cycle counting method contained in the CR9000's instruction set. The stress-range histograms were generated continuously and did not operate on triggers, thus all cycles were counted. In addition, the histogram was updated every 10 minutes. Thus, in the event of a power failure, a minimal amount of data were lost. The stress-range bins were divided into 0.5 ksi intervals. The results of the research will be incorporated in the AASHTO LRFD Bridge Design Specifications.

(Top) *An enclosure housing a CR9000 system is bolted to a floor beam underneath the Williamsburg Bridge in New York City.*

(Left) *The CR9000 system took strain measurements on 82 sensors at rates up to 200 Hz. Data were telemetered via phone to researchers at Lehigh University in Bethlehem, Pennsylvania.*

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