WIRELESS REMOTE MONITORING OF CATHODIC PROTECTION SYSTEMS

John Hawkyard MICorr
Deputy General Manager
Rawabi Corrosion Technology Co Ltd
Al-Khobar
Cathodic Protection is an electrochemical technique which has been used for many years to prevent the corrosion of buried and/or immersed metallic surfaces. It utilizes the application of small amounts of electrical current (d.c.) to the protected surface to counteract the natural corrosion currents existing at the metal surface.

The whole of the structure under protection is forced to act as the cathode of an electrochemical cell, hence the term CATHODIC PROTECTION (CP).

The types of structures which may be protected using CP are wide ranging and include:
- Cross-country pipelines (Oil, Gas, Water etc)

- Storage Tanks
  - Fuel, Product, Water
  - Internal (Water), External (Floor Plates)

- Industrial Plant Piping Systems

- Concrete Structures
One of the critical issues facing owners and operators of CP systems is that of Monitoring and Maintenance.

Monitoring of CP Systems

You will find that the company don't allocate a large budget for corrosion monitoring.

C.A.T.
by Roger King
Installations may be in remote or difficult to access areas

Working environments are often hazardous

Monitoring can be time consuming and a drain on personnel resources
The Need for Remote Monitoring

- Improperly executed Monitoring and Maintenance regimes are a frequent cause of premature system failure.
- Remember – incorrect operation of CP systems may result in lack of protection and may even cause harm.
Asset owners and operators have been examining a number of Remote Monitoring (RM) technologies for CP systems.

Emerging wireless technologies have expanded the possibilities for remote CP application.

Uptake however has been limited due to factors such as:
- High implementation cost
- Recurring licensing fees/costs
- Requirements for satellite uplink/downlinks via 3rd parties
- Etc..
Recent world-wide, major corrosion events are now leading companies to look for new, low cost alternatives for cathodic protection remote monitoring.

The benefits to asset owners are obvious:

- Reduced ‘windshield time’
- Reduced operator exposure to potentially hazardous environments
- ‘Real time’ access to accurate system operational data
- Automated reporting and alarming via inputs to existing SCADA systems

Enables more effective use of personnel resources to achieve timely and targeted maintenance tasks.
Recent technology development of low cost, fully integrated, cathodic protection remote monitoring units (CP RMU) may provide the answer.

New, unlicensed, frequency hopping spread spectrum, wireless, application specific CP RMU’s extend current technology with increased economical viability enabling more companies to remotely monitor more assets.
Correctly referred to as frequency hopping, spread spectrum radio technology, it is simply a wireless radio communication design that, rather than operating at a fixed frequency within a band, as with licensed radios, the radio communication signal actually hops from one frequency to another in a fast, well-choreographed, engineered manner along with other similarly programmed radios within the network.

Frequency hopping spread spectrum, (FHSS), technology allows multiple users to set up multiple networks within the same radio frequency band, greatly increasing the utilization of the narrow communication band.
What is Frequency Hopping Spread Spectrum Wireless Technology?

FHSS: Hopping through the spectrum

Frequency

902 MHz
916 MHz
928 MHz

Power

F11 F6 F13 F3 F10 F1 F8 F5 F12 F2 F15 F7 F16 F4 F14 F9
Provided all radios within each network hop at the same rate within the same frequency band, network communications are effective.

Provided all networks within the band hop at different rates from each other using frequency hopping techniques, then network communications are effective.

Early FHSS systems did not include the same levels of proprietary communication protocols, encryption, network ID’s, hopping patterns, packet size selection, or hopping frequencies thus were prone to failure due to data collisions, lost data or corrupted data.

FHSS radios offered today have 6-level security features, proprietary protocols and can hop up to 1,000 times per second - making data collisions almost impossible.

What is Frequency Hopping Spread Spectrum Wireless Technology?
Today, FHSS Manufacturers offer wireless CP RMU products with a wide variety of selection, security, encryption and speed specifications as follows:

1. High Speed Communications: 115.2 Kbps true data throughput
2. Long range: up to 60 kilometers line of sight, ability to extend range through infinite repeaters.
3. Error Free Communications: 32 bit CRC with automatic retransmission.
4. Industrial Grade Specifications: Temperature cycle tested -40ºC to +75ºC.
5. Repeater Capabilities: Each CP RMU can perform as a remote test site, a repeater site and as a simultaneous test site/repeater. Repeaters can infinitely repeat.
6. Wide Supply Voltage Range: Supply voltage 10 to 30 VDC.
7. Ultra Low Power Consumption: Current draw as low as 6 mA, 12 VDC in sleep mode, and less than 86 mA in receiving mode. In sleep mode, CP RMU can awaken, synchronize and be ready to transmit data is less than 150 microseconds.
8. Separate Diagnostics Serial Ports: Allows real time simultaneous local diagnostics and setup without tying up main CP RMU communication port.

What is Frequency Hopping Spread Spectrum Wireless Technology?
FHSS Technology has come a long way since the 1930’s

FHSS technology offers the end user the flexibility of installing remote monitoring equipment where it makes sense without concerns over monthly fees, radio band licensing, network interferences or security.

- No monthly recurring fees or costs
- No initial or monthly licensing fees
- Minimized network interferences
- Maximum network security
- Operates behind company firewall
- Own your own data
- Open protocol communications
- Maximum system flexibility
- Infinite repeatability
- Maximum implementation into cabinetry
- Minimized field wiring

FHSS Technology has come a long way since the 1930’s.
Cathodic protection remote monitoring units, RMU’s, typically monitor and report key corrosion protection activities including:

- Pipe-to-soil potential
- Rectifier output voltage
- Rectifier output current
- Rectifier input power status

CP RMU’s can offer remote operation of CP activities such as rectifier interruption for maintenance purposes.

Modern CP RMU’s also monitor radio temperature and if connected to a solar power generation system will also monitor the battery voltage of the back up battery supply.
A typical CP RMU Installation Schematic

Test Station
- Radio Communication Antennae
- Solar Charging Panel
- Cathodic Protection Monitoring Radio
- Backup Battery
- 3 inch Conduit Mounting Bracket
- Rectifier Surface Mount Adapter Bracket

Cathodic Protection Monitoring Radio
- Radio Communication Port
- Solar Panel/Battery Charging Connector
- I/O Termination Block
- RS232/485 Communication Port
- Diagnostics Communication Port
- Cathodic Protection Monitoring Port

AC Input Power Supply

Ground Surface

Remote Rectifier Monitoring Station

Wire Bond

Buried Steel Pipe (Cathode)

Protective Current

Permanent Ground Reference Electrode

Anode(s)
In addition to monitoring the four process variables mentioned previously, FHSS CP RMU’s may have additional channels to monitor, record and report:

- Pipeline pressure
- Pipeline temperature
- Pump station sump level
- Pump status on/off
- Tank level
- Ambient temperature
A system of cathodic protection radios form a comprehensive data communication network. Integrating cathodic protection remote monitoring radios into an existing network extends the reach and robustness of the entire network.
The FHSS CP MRU monitors, records and stores the measured variables, mentioned previously, within the radio and makes them available to a centrally located, remote data acquisition computer offering supervisory control of CP functionality.

The centrally located, data acquisition computer will collect all the field data from the CP RMU’s and store them within a local data base.

CP RMU’s communicate to the centrally located, data acquisition computer, much like many remote field located RTU’s and PLC’s using a communication protocol of either a proprietary nature or an open communication protocol such as OPC or Modbus.

The communication protocol is the language used by the remote field device to transmit data from the remote device to the central SCADA computer.

**Modbus** is a serial communications protocol published by Modicon in 1979 for use with its programmable logic controllers. It has become a de facto standard communications protocol in industry, and is now the most commonly available means of connecting industrial electronic devices. The main reasons for the extensive use of Modbus over other communications protocols are:
1. It is openly published and royalty-free.
2. Relatively easy industrial network to deploy
3. It moves raw bits or words without placing many restrictions on vendors
Many companies already own and operate a centralized located computer network specifically designed and implemented for the express purpose of remotely collecting field data from remote terminal units, RTU’s, programmable logic controllers, PLC’s and now cathodic protection remote monitor units.

The SCADA computer or computer network is used to drive the software processes to collect field data into a central database for local storage, field event alarming, regulatory and company reporting, CP value trending and for further technical and engineering analysis.
The SCADA software enables CP personnel and operators to manage and manipulate the collected CP field data into proper formats.

SCADA software typically will format the collected data into the following:

- **Reporting** (daily operator reports, company reports, regulatory reporting)
- **Alarming** (Identifies and classifies CP field events for local display or remote operator notification via cell phone, pager)
- **Trending** (trending tools enable engineers to monitor long term events over time and track overall system performance)
- **Graphical User Interface** (operators can quickly identify CP system performance and optimization using recognizable, intuitive graphic representations of company piping and structure systems.)
Typical CP RMU Data Collection Computer screen shot illustrating the format of collected field data:

<table>
<thead>
<tr>
<th>#</th>
<th>CP RMU Station ID Number</th>
<th>CP RMU Station Description</th>
<th>Select Devices</th>
<th>Rectifier Input</th>
<th>Rectifier Shunt Voltage (mVDC)</th>
<th>Rectifier Amperage</th>
<th>Rectifier Voltage (VDC)</th>
<th>Pipe-Soil Potential (mVDC)</th>
<th>CP RMU Temp (°F)</th>
<th>CP RMU Battery Voltage (VDC)</th>
<th>Discrete Output Control</th>
<th>Analog Input Value</th>
<th>CP RMU Polling Status</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
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<td>☑️</td>
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<td>117.080</td>
<td>11.71</td>
<td>0.000</td>
<td>6.38</td>
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<td>15.45</td>
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</tbody>
</table>
Once the initial systems are in place, it can open the door to additional data collection opportunities benefiting not only the Cathodic Protection group, but other operational groups within the company as well.

Plan for this.
When evaluating and selecting cathodic protection remote monitoring equipment, take the following into consideration to ensure the best long term performance of both architecture and equipment is achieved:

1. CP RMU’s should directly read the CP test points with no additional transducers required.
2. CP RMU’s should communicate with an open communication protocol such as OPC or Modbus.
3. LIGHTNING is the leading cause of CP RMU failure. Ensure that your CP remote monitors have adequate surge protection, or better yet, full isolation.
4. CP RMU’s should have an extended warranty.

At no time are remote monitoring electronics directly connected to unprotected field wiring or pipeline structures.
CP RMU System Considerations

5. CP RMU’s should have user programmable flexibility, measuring and storing field data as frequently as hourly to as infrequently as monthly.

6. CP RMU’s should use sleep mode technology, low power modes, and possibly have an integrated solar power regulator to minimize power draw for remote solar powered applications with battery backup.

7. To minimize installation costs, CP remote monitoring equipment can be installed within existing rectifier cabinetry or in standard enclosures for remote locations.

8. Preferably, the CP RMU will have no monthly recurring fees.

9. Ideally, the CP RMU will not require data importation from outside the protection and security of the company firewall.

10. Infinite repeater capability of the FHSS CP RMU’s provides more paths and opportunities to get data back to the centrally located data collection system.
Aging buried metal pipelines and structures protected from corrosion for many years by remote cathodic protection test sites and impressed current rectifiers can now be economically remotely monitored and operationally optimized using new frequency hopping spread spectrum, wireless CP RMU technology.

This new, low cost technology is license free, with no recurring costs, is fully open, firewall secure, robust, lightening isolated and relatively easy to deploy.

Past wide-scale deployment of existing SCADA systems over the past 15 years and the advent of new low cost, easy to use PC-based SCADA systems, FHSS CP remote monitoring is now more economically viable.
Questions?