Oil and Gas Well Monitoring using TBox

Introduction:

Servelec Technologies' ultra low and low-power products have been applied to well site installations throughout the world. The product families include the TBox WM 'Wireless Monitor,' TBox LP RTU and the TBox LT 'Lite' Ethernet RTU. Selection among these products depends on the I/O count, whether power is available, and whether Ethernet networking is a requirement.

TBox WM best accommodates low I/O counts (up to 2 AI, 4 DI, 4 DO) while minimising current draw and making operation on batteries feasible. For larger processes (up to 4 AI, 8 DI and 8 DO), TBox LP features very low current draw and can run on batteries or solar power. TBox LT accommodates up to 32 I/O points and provides an Ethernet interface. Current draw is appropriate to solar power systems or other dc power sources.

Basic requirements include monitoring operating pressure, temperature, DP or flow, separator tank levels, compressor status, and valve status; periodically reporting this information to operations management; and reporting on exception when appropriate, for example, when an alarm indicates low flow or low pressure.

Availability of this information not only ensures end-customer satisfaction but also allows a third party service provider to route personnel in the most efficient manner possible.

Inputs/Outputs

Monitoring functionality requires as few as one or two I/O points for TBox WM with increasing requirements accommodated by TBox LP or LT:

- Pressure measurement for the well casing pressure
- Pressure measurement for the well tubing pressure
- Temperature measurement for the gas line to the meter
- Differential pressure measurement across the orifice meter
- Alternately, pulse inputs from a linear meter
- Level measurement for single or dual separator tanks via analog inputs
- Contact input indicating whether the instrument enclosure door is opened
- Contact input indicating the open/closed status of the ESD valve
- Contact input indicating the open/closed status of vent valve
- Optional, discrete outputs to drive an audible alarm or status light
- Optional, discrete outputs to open/close the feed line valve(s)

Power Management

Even at locations with dc instrument power, running power to the RTU and transmitters has become expensive. This necessitates use of an alternative source such as a battery or solar power system.

Power management in the RTU minimises power draw in order to keep power systems costs down. In typical, well monitoring applications, TBox WM can operate for five years using two, internal lithium batteries. TBox LP can operate using either internal lithium batteries or an external solar power system. While the solar power system allows monitoring of a larger number of I/O points and on a higher frequency, TBox LP still conserves power in order to minimise the size — and cost — of the solar panel and battery.

TBox WM Wireless Monitor for Well Applications:

The TBox Wireless Monitor (WM) is a fully integrated solution that provides cost effective monitoring and telemetry for locations with low I/O counts. Two analog inputs interface with low power transducers or 4–20 mA transmitters for level or pressure measurements. Four discrete inputs provide the status of contact inputs from devices such as security alarms and valve limit switches. Four discrete outputs are used to drive indicators or perform control functions such as opening and closing a valve.

TBox WM is also distinguished by a sophisticated, IP/Web technology platform. This technology employs an integral web server, IP communications and 'push' messaging via e-mail, FTP and SMS

text. TBox WM can initiate communications whenever necessary, e.g. upon an alarm, event, or periodic update. There is no need for polling from a top-end or host computer system. This communications strategy best exploits the benefits of inexpensive, public networks.

TBox WM allows users to access site information, anytime, anywhere, using a cellular phone, PDA or laptop computer. This caters to operations management, who are often travelling and making use of a 'mobile office.'

There is no need to operate the system from a central location.

TBox WM is housed in a ready-to-install, IP67 enclosure. Included in the enclosure are the main electronics, communications device, optional liquid crystal display (LCD) and one or two lithium batteries. The dual-battery arrangement doubles the life vs. a single battery and allows the RTU to operate on one battery while the other is replaced. The IP67 rating means that the enclosure is not only weatherproof but can be temporarily submerged.

TBox WM is also approved for operation in Class I, Division 1, Groups C and D hazardous locations. TBox LP is approved for operation in Class I, Division 2, Groups C and D hazardous locations.

Analogue Measurements for Level, Pressure, Differential, Differential Pressure and Temperature

Local Display Options

Communications Operations

Alarm Management

Historical Data Logging and Trending

Web Server

Analogue Measurements for Level, Pressure, Differential Pressure and Temperature

Via one or two, analogue inputs, TBox WM interfaces with transducers or transmitters for level, pressure, differential pressure or temperature.

To simplify the installation, TBox WM provides power to operate the transducer or transmitter. Optimally, low power transducers are used in order to minimise battery drain. Such a transducer provides an output range of 1 -5 V dc and operates using nominal 6 V dc or 12 V dc power. Current draw is typically 3 mA or less.

Many operators prefer an analogue transmitter, which provides a 4–20 mA signal and operates using nominal 12 V dc or 24 V dc power. Although the current draw is much higher, TBox WM is still able to provide power to these transmitters and uses intelligent management to permit operation on a lithium battery.

A key factor is that, in most cases, the measurements need not be continuous. On a user-selected interval, TBox WM will power-up the transmitter, wait for another, user-configured time to allow the transmitter output to stabilise, take a reading, then power-down the transmitter. Typically, readings take place, once-per-hour or once-per day. NOTE: If readings are required significantly more often, up to 'live' once-per-second, TBox LP or LT can be employed, instead, with solar power or commercial dc power.

Power savings using this type of operation are substantial. Consider an analog transmitter that draws 60 mA at 12 V dc. If it is powered-on for one minute every hour, the duty cycle is 1/60 and the equivalent, continuous current draw is only 1 mA. In fact, most transmitters draw less current than the one in the example and many operations require readings on a daily rather than hourly basis.

In contrast to some monitoring products on the market, TBox WM allows both, analog inputs to operate, simultaneously. There is no multiplexing in terms of time or hardware.

Local Display Operation

Even though it consumes very little power, the LCD is normally turned off because local operations are infrequent. A technician will simply press the 'Activate' key on the front panel to powerup the LCD. The LCD will remain active for a user-configured time, typically five minutes. This allows, as an example, the technician to see the live measurements over varying conditions.

The display will also indicate whether there are any alarms such as low flow, low line pressure, low battery, or transducer/transmitter failure.

Communications Operations

In a manner similar to that for external transducers or transmitters, the internal communications device operates intermittently. Depending on the technology employed, the entire module may or may not be completely powered-down in order to minimise the start-up delay time.

TBox WM will initiate communications as specified by the user. 'Push' communications via e-mail, SMS text or FTP will take place on a periodic basis or when an alarm occurs.

An alarm can be a transition on a discrete input or a condition that is determined by programmable logic. An example of the latter is a low pressure in a gas line. TBox WM will set an alarm when the analog input is below a user-configured limit. Multiple limits could be used. Some operations implement three low limits, including low, very low and out-of-service.

Most commonly, periodic communications occur less frequently than readings are taken via the analog inputs.

For example, TBox WM will initiate a call on a daily basis while readings are taken hourly. As determined by the user, the daily call can provide the latest reading, each of the readings since the last call and/or figures from the historical log (please refer to the section, below, for information on the logging capabilities). E-mail and FTP messaging can include files, for example, tabular logs or trend graphs.

Alarm Management

TBox WM uses an alarm management system that not only detects and reports alarms but can be configured to require alarm acknowledgement and escalate unacknowledged alarms.

If configured to do so, an alarm transition will initiate communications. Messaging can be to multiple recipients while escalation can be to multiple groups, each including multiple recipients. Alarm acknowledgement is performed by users via a PC, PDA or mobile device. Using a phone, the user sends a text message to acknowledge the alarm. TBox WM will not only clear the alarm internally, but can initiate programmable logic functions in response to a text message.

TBox WM also maintains an alarm history, which can be displayed as a web page and attached as a file to e-mail and FTP messages. Each message includes a time and date stamp, signal ID and text description.

Historical Data Logging and Trending

On user-defined intervals, TBox WM will perform statistical calculations on measured inputs and update the historical log. Averages, totals, minimal and maximum can be run over intervals such as hourly, daily, monthly, etc. Historical logs can be displayed as web pages on a PC and transmitted as files with e-mail and FTP messaging. Logs can be maintained in tabular as well as trend graph format. To simplify configuration, Servelec Technologies offers a software tool, Report Studio, which provides powerful trending capabilities.

While the historical information is commonly used for inventory and billing purposes, long-term trends also contribute to continuous improvement programs.

Web Server

The integral web server provides an HMI capability, which can offer significant cost savings versus expensive licensing for SCADA software. Web pages can be accessed by users, anywhere in the world, via the Internet or an intranet.

For well monitoring applications, web pages also comprise an inexpensive HMI for local technicians. Not only is process information provided but system diagnostic information is available in the TBox WM database.

Servelec Technologies' software tools greatly simplify configuration of web pages and eliminate software integration problems. No programming is required. Using WebForm Studio, dynamic objects, entry fields, tables, trends, and links to other pages are simply added with a few clicks.

Programmable Logic

Although most applications are for monitoring and telemetry, TBox supports a programmable logic environment that includes advanced, automation functions. Using Servelec Technologies' TWinSoft, engineers have a choice of programming environments to suit their preferences:

- IEC 61131-3 LD (Ladder Diagram)
- Basic
- Microsoft Automation

TWinSoft contains a complete set of tools, such as editor, debugger, code generator, documentation generator, library manager, archiver, and online control. TWinSoft makes it easy to download identical programs into multiple RTUs and also eases programming changes in order to allow for continuous improvement.

Typically, TBox WM applications will use this functionality for calculations related to alarming, units conversions, timing functions such as rate-of-change and data logging. Nevertheless, programmable control operations can also be performed via the discrete outputs.

Conclusion:

Well site management applications take full advantage of the features offered by Servelec Technologies' TBox product line, in particular, the Wireless Monitor:

Fully integrated — Complete monitoring, telemetry and automation functionality is provided in a ready-to-install IP67 housing that includes the battery-based power source. Operators need not incur any additional costs or scheduling delays for systems integration.

Power management — Very low power consumption allows users to configure scanning and communications strategies that best utilise the included, low cost, lithium battery power source in TBox WM. This integral power source further reduces costs related to integration and installation. TBox LP operates using battery or solar power while TBox LT operates using solar or dc power.

Dual batteries — One or two lithium batteries can be installed inside the TBox WM or LP enclosure. Using two batteries provides double the lifetime vs. a single battery and allows the WM or LP to operate on one battery while the other is replaced.

Integral Web server — This feature provides significant savings vs. SCADA/HMI software, which could require expensive licensing. Web pages are accessible to users anywhere, anytime. PC-based Web pages also provide all, local HMI operations when maintenance personnel visit the sites, thus saving the cost of additional software.

Alarm management — The TBox alarm system detects alarm conditions and reports them using Push Technology. Alarm management ensures that un-acknowledged alarms will be escalated. Even mobile device users can acknowledge alarms and send text commands to a TBox.

Data logging — TBox data logging capability retains historical information, such as production level, in both tabular and trend graph formats and allows users to adapt operations for the highest efficiency. Trends can also assist in maintenance management and continuous improvement.

Push technology — End user operations personnel are immediately notified of alarms and important events without the need for polling the TBox. This takes best advantage of inexpensive data communications plans on public networks.

Programmable automation — A choice of programming via IEC 61131-3 LD (Ladder Diagram), Basic, or Microsoft® Automation provides calculation functions as well as control outputs, e.g. to open and close a feed line valve. These capabilities are very uncommon in products intended for monitoring only.