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Data_Link 2000

APPLICATION NOTE AN013

CSO Monitoring

Summary

The European Water Framework Directive (WFD), which came into force across Europe in December 2000, places an obligation on water companies to monitor waste water discharges through Combined Sewer Outflows (CSO's). This introduces a requirement for specific telemetry equipment for installation at small unpowered sites, to monitor the water level and/or flow, report it at regular interval, and report alarm conditions.

Most water companies ultimately need to pass the data into a central computer, which will log it and generate appropriate alarms and reports. In some cases this will be an existing regional telemetry system, in others it may be a dedicated computer system.

Churchill Controls are addressing this requirement in three phases:

1. **Use battery-powered *Nano_Link* outstations, packaged with appropriate transducers, to relay the relevant readings to a *Micro_Link* base-station via de-regulated radio, which will then pass the data into a third-party regional telemetry outstation. The regional telemetry system will therefore receive 'live' data which it can process as required. This solution can be constructed from existing products, with no special development. It assumes there is a regional telemetry outstation within radio range. If the application allows aerials to be mounted on masts the range could be up to 20Km. If the aerials are restricted to ground level the range could be up to about 5Km. If the aerials have to be installed below ground level, the range will be limited to about 500m. However, the range can be extended if provision is made for radio repeaters at appropriate locations.**

2. **Develop a variant of the existing product using a GSM cellular radio modem in place of the de-regulated radio, packaged with appropriate transducers. Provided the outstation is within range of a GSM base-station the data can be passed to a telemetry base-station and/or mobile telephones located anywhere. A base-station is being developed as a software package to run on a PC. The base-station will retrieve the data from the outstations and pass it to a third-party software package via a standard software interface. The third party package could be either an existing regional telemetry system base-station or a SCADA system.**

3. **Both of the above solutions will use the existing outstation hardware design, and conventional transducers. The third phase will be to derive a dedicated product, optimised for this application, combining the transducer and the telemetry outstation into a single product. This will offer the opportunity for cost and size reduction, and may allow the battery life to be further optimised.**

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1 Outstation Physical Requirements

The application imposes some relatively severe physical constraints on the outstation/transducer combination:

1.1 Size

Since the unit may be mounted within a manhole or a street bollard it must be relatively small. Target overall maximum dimensions (excluding the transducer head and the aerial) are 200mm x 150mm x 300mm. This can be achieved using existing products by fitting a ***Nano_Link*** outstation and a Pulsar 136 control unit within a single overall enclosure. Products designed under phase 3 may merge the ***Nano_Link*** and the 136 into a single unit, thus overcoming the 'enclosures within and enclosure' construction, reducing size and cost.

1.2 Protection

If the unit is mounted within an underground chamber there is a potential risk of flooding, so the enclosure should be protected to IP68 (submersion under 2m of water for 24 hours). Since the unit is battery powered, access is required to change the battery. The design must therefore be such that the user can restore the IP68 seal after changing the battery.

1.3 Flammability

Zoned sewer chambers are generally rated as Zone 1 IIA. If the unit is mounted in such a chamber it must be ATEX certified for this usage. It is assumed that the unit would be secured to the wall of the chamber, so the certification must also apply when in maintenance conditions, such as changing the battery.

The certification requirements can be overcome if the unit is installed in a safe area, with only the transducer head in the hazardous area. In this case the head must be certified, and an appropriate barrier must be maintained between the hazardous and safe areas.

We are initially assuming the unit will be used in a safe area, but any newly-developed products will be designed such that they could be submitted for ATEX approval if required.

2 Outstation Electrical Requirements

2.1 Power Supply

The unit must be capable of operating for at least 12 months from an internal battery pack. The current outstation design can operate from an internal battery pack comprising three Duracell Alkaline D cells, which are low cost and readily available. The battery life depends on the system configuration, but is typically in excess of 2 years. The outstation also derives a regulated supply of 10V for powering transducers when required.

An alternative power supply is available using a 12V sealed lead acid battery charged from a solar panel. This will power the unit indefinitely.

Any new designs will use a similar power philosophy.

2.2 Signal inputs

2.2.1 Analogues

The current design includes two analogue inputs, each compatible with strain gauge, voltage and current output transducers. The analogue accuracy is ±0.1%, with 12 bit resolution (i.e. 0…4000). CSO applications typically need only one analogue signal, namely water level.

Any new designs will maintain this specification.

2.2.2 Digitals

The current design includes 4 digital inputs, for use with external volt-free contacts. As well as monitoring the current state, the ***Nano_Link*** outstation also maintains a totalised count of changes on each input, so they can alternatively be used to monitor flow meters. CSO applications will probably not use the digital inputs, although they could be used to monitor, for example, alarm trip switches on access doors.

2.3 Serial Interface

In addition to the above, the existing ***Nano_Link*** outstation also includes a serial I^2C interface. This can be used to add I/O expansion modules (e.g. a 16-channel digital input module), and could be used to directly access transducers, if they have a compatible interface.

For future designs we will investigate alternative serial interface hardware to interface directly with transducers. However, the choice is somewhat restricted by the requirement for low power consumption.

2.4 Method of operation

2.4.1 De-regulated Radio Systems

The software for de-regulated radio assumes that the poll rate will be sufficiently fast to allow the base-station to treat all data as 'live', so there is no need for logging within the outstation. For example, if the base-station polls each outstation every 60 seconds, any change of input states at the outstation will be copied to the base-station within 60 seconds. However, the system can also be configured to report exceptions as they happen. A battery-powered outstation will register digital input changes immediately. Analogue readings will only be reported by exception if they differ by more than a defined amount from the last value reported. To conserve power a battery-powered outstation only reads its analogue inputs when required, which is normally when the base-station polls the outstation. To exception report analogue changes, therefore, the user must also configure the amount by which an analogue is allowed to change before being reported, and the rate at which the outstation is to read the analogue inputs (e.g. every 5 minutes).

A system with battery-powered outstations can therefore be configured to transmit all changes by exception, so the base-station poll rate becomes simply a confidence check that the outstation is still functioning. The confidence poll rate could be once per day, which would greatly extend the battery life if there a few changes of inputs states at the outstation.

The base-station comprises a ***Micro_Link*** module. All the system configuration is contained in a configuration file on a PC. The user can create and modify this file, then download it into the base-station via a laptop computer. It is not necessary to visit the outstations to change the system configuration.

The ***Micro_Link*** base-station can replicate the outstation input states and analogue and digital outputs, which can be hardwired to a regional telemetry outstation (RTS). However, it also includes a serial interface port that can be configured to use a variety of protocols, including Modbus. If this is supported by the RTS, therefore, the connection between them can be simplified.

2.4.2 GMS radio systems

Since there is a cost associated with each call, it is desirable that calls should be kept to a minimum. The outstation therefore logs all data at regular intervals. It also logs digital changes as they occur, with a time-stamp against each change. The user can also configure the outstation to call the base station immediately an event defines as an alarm occurs (e.g. a digital changing state or a significant analogue change).

The base-station can instruct the outstation to call it at regular intervals (e.g. every 24 hours), when the base-station can extract logged data from it.

To conserve power, battery-powered outstations switch off the GSM modem whenever it is not needed. If the base-station needs to call the outstation it sends it a GSM message, which is store in the GSM network until the outstation next goes on line. The outstation switches on it's GSM modem every hour to check for messages from the base-station. In most instances the message will ask the outstation to call the base-station.

The outstation can also report alarm conditions to mobile telephones, using GSM text messaging. There is also a facility for a user to modify the outstation configuration by sending it text messages.

The base-station comprises a GSM modem connected to a PC. Two software package are provided for the PC, one to configure the system and the other to interrogate outstations. The configuration package allows the user to set all configuration parameters, including plain English names, engineering units and outstation telephone numbers. These are automatically downloaded to the outstations. The interrogation package retrieves data from the outstations and stores it into a database that can be accessed by any SCADA system or regional telemetry base-station.

3 Transducers

The existing ***Nano_Link*** design is compatible with a wide range of transducers. It will power the transducer with 10VDC when it needs to take a reading, and remove power at all other times to conserve the battery. It can accept signal levels of 4…20mA, 0…100mV. Interface adaptors are available for transducers with other power and/or signal level requirements.

3.1 Ultrasonics

For CSO monitoring the favoured transducer technology is ultrasonic. However, most ultrasonic transducers on the market are not compatible with battery operation. Churchill Controls have therefore developed a partnership with Pulsar Process Measurements, who have designed a product optimised for this application.

The Pulsar Black Box 136 comprises a head unit that is ATEX certified and a control unit that can be mounted adjacent to the outstation. The control unit can be powered from the outstation 10V output, and presents the level as a 0…5V signal. An interface adaptor will therefore be supplied to convert this to 0…100mV.

A CSO monitoring outstation can be configured from existing products by incorporating a ***Nano_Link*** outstation and a Pulsar 136 control unit in one enclosure. The ***Nano_Link*** battery can be used to power the 136. A lead from the 136 will pass through a gland in the enclosure to the Pulsar head.

The Pulsar head is ATEX certified, using encapsulation as the method of isolation. The only barrier that may be needed between the head and the remaining equipment is a gas-tight seal.

3.2 Pressure Transducers

If the application requires the use of pressure transducers, ***Nano_Link*** can be supplied with submersible devices, such as those manufactured by Druck. Low cost units are simply differential strain gauges that can be interfaced directly to ***Nano_Link***. Alternatively, pressure transmitters can be used that incorporate signal conditioning to give a 0…5V or 4…20mA output. Again, these can be interfaced directly to ***Nano_Link***, using an interface adaptor if necessary.

ATEX certified pressure transducers are generally intrinsically safe, so an intrinsic safety barrier is needed between the transducer and the outstation. This can be mounted within the outstation enclosure.

3.3 Flowstick

The Flowstick is a robust device that measures flow by the deflection of a paddle that hangs vertically in the water. A potentiometer is rotated by the paddle when any flow takes place.

An interface adaptor has been designed to convert the potentiometer movement into a 0…100mV signal that can be read by ***Nano_Link***.

3.4 Stormswitch

This comprises a float on a hinged arm that activates a switch contact when the level exceeds a defined value. The output is a volt-free contact that can be connected directly to a digital input on ***Nano_Link***.