Solvents Plant

Introduction

A Solvents plant obtains its feedstock by pipeline from a refinery 3.2km away. A telemetry system using a leased telephone line provided remote monitoring of pipeline pressure at the refinery and warning of feed valve closing.

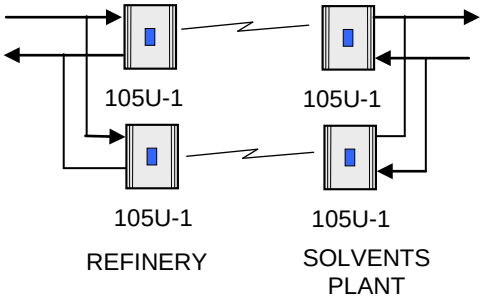
Because of reliability problems with the telephone line system, a 105U wireless I/O system was installed as backup. This system also picked up the metering signal at the refinery, and sent a remote trip signal back to the refinery. A 105U-1 was installed at the refinery valve station, and another 105U-1 in the Solvents Plant control room. Signals from this 105U-1 were connected into the plant PLC system.

With continued problems with the telephone line, it was later decided to remove the telemetry system and install a redundant wireless system.

Redundant System

The plant required maximum redundancy, with every element of the wireless system being duplicated. The two systems operate on different radio channels.

Even though each system uses a different frequency, the modules at the same station will "hear" the other module as loud "noise" because of the close proximity of the two antennas. It is necessary to configure the modules such that they will transmit at different times.



Refinery Valve Station

Two 105U-1 units are installed in the control cabinet at the refinery valve station. The 105U modules pick up a pressure analogue signal; a valve closed position signal (discrete input) and a pulse signal from the pipeline flow meter. These signals are transmitted to outputs at the 105U's at the Solvents plant. Each refinery 105U has one output sent from the Solvents plant - this output is to trip the feed valve in an emergency. A second output on each module is used for local indication of "comms OK".

Analogue Input

A pressure transmitter provides a 4-20mA signal to the refinery DCS - a signal isolator in the loop provides an isolated 4-20mA signal to the original 105U module. A second isolator is installed to provide another isolated signal to the second 105U. Both analogue inputs are loop powered from the 105U.

The two modules at the valve station are configured slightly differently such that they will not transmit at the same time. Because of "process noise" in the pressure signal, a high analogue sensitivity is used to avoid un-necessary radio transmissions. The Solvents plant uses the pressure signal for early warning of any large pressure changes coming down the pipeline - they do not require fine accuracy. A sensitivity of 5% and debounce time of 0.5 second is configured on the first module and sensitivity 5% and debounce 2 seconds on the second - the different debounce will be enough to allow one module to transmit any changes before the second. If there is a 10% pressure change, both modules will report this change quickly, but the module with low debounce will

report it first. Update times of 10 minutes and 11 minutes are configured - again to stagger the radio transmissions.

Discrete Input

The closed limit switch on the feed valve to the pipeline is connected to the 105U modules via two relays. The relays provide isolation between the two 105U modules such that if a fault occurs in one module it cannot affect the other.

For the discrete inputs, one module is configured with a debounce time of 1.5 seconds - the other module has the default value of 0.5 sec. If the valve closes, one module will report the change within 0.5 seconds, and the other after 1.5 seconds, staggering the radio transmissions.

Pulse Input

The refinery flowmeter has a pulse output (one pulse per litre) - this signal is used by the refinery to bill the Solvents plant. The Solvents plant has their own flowmeter at their end of the pipeline, but desired a real-time reflection of the refinery meter signal for leak detection purposes and to check meter accuracy. Two solid-state relays were connected to the pulse signal from the refinery meter - the relay outputs were then connected as pulse inputs to DI1 on the 105U modules (DI1 is the only pulse input on a 105U-1).

Pulse inputs only have update transmissions, no change transmissions. Update times of 1 minute and 1.5 minutes are configured on the two modules.

Discrete Outputs

DO1 on each module is a trip signal for the feed valve. If the Solvents plant needs to trip the feed from the refinery, it can activate these trip contacts. The discrete outputs on the 105U-1 modules are dry relay contacts. The trip circuit is designed for “energise to trip” such that one module can fail without tripping the pipeline feed. The output contacts are paralleled (such that either contact can energise the trip circuit) and connected into the existing trip circuit on the valve.

Comms OK Output

DO4 on each module is set up as a “comms OK” output. The outputs are not connected to external circuits, but used as a maintenance diagnostic - that is, maintenance staff know that if the DO4 LED is on, comms is OK for that module. If the LED is off, comms failure has occurred.

The modules at the Solvents plant are configured such that DO4 on each module will normally be “on”. A reset time is configured for DO4 such that it will reset if it does not receive an update from its remote module. The reset time is set slightly more than the corresponding update time at the remote module.

Installation

The refinery valve station has 220V power. Separate 220V/24VDC supplies were installed for the two 105U modules and each module was connected to a 5 amphour sealed gell-cell as power backup. The instrument loop signals at the valve station are powered by backed-up DCS power supplies, however because the DCS loops are isolated from the 105U’s, separate backup is required.

A radio test showed that unity gain antennas at 3m height gave only a marginal path (average –100dBm). Although the distance was only 3.2km, the path was obstructed by pine trees and other industrial plants. It was decided to use 3 element Yagi antennas at the refinery, with 20m coaxial cable kits. Because the valve station was outside of the main refinery plant area, lightning surge suppressors were used on the coaxial connection of the modules. The net antenna/cable gain was close to unity gain. This improvement is enough make the radio signal reliable - the final measured signal was –90dBm..

The two antennas are mounted on a 10m pole beside the control cabinet, with 2m vertical separation between the two antennas such that their gain pattern is not affected. The top antenna is mounted 1m from the top of

the pole such that the top of the pole provides “lightning shadow” protection for the antennas. The pole, control cabinet and surge suppressors are well grounded to a common ground point.

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Two 105U-1 modules are installed in the control room panel. I/O signals are connected to the plant PLC. The modules are powered from the plant 24VDC UPS system so no battery backup is required. Antennas are mounted on a nearby tank. Antennas selected are 5dB collinear antennas with 20m coaxial cable. The two antennas are mounted 3m apart to avoid any distortion of their transmission pattern. The control room is surrounded by high steelwork, which provides good lightning protection for the antennas. Although surge diverters are not necessary in this type of installation, the customer elected to use them for added protection.

Analogue Outputs

The pressure signal from the refinery end appears as an analogue output at each module. These outputs are connected to two analogue inputs on the PLC.

Discrete Outputs

The valve closed signal from the refinery end appears as a discrete output at each module. These outputs are connected to two discrete inputs on the PLC.

Pulse Outputs

The flow total signal from the refinery end appears as a pulse output at each module. These outputs are connected to two pulse inputs on the PLC. The “output time” for the pulse outputs is configured at 10 seconds. This means that whenever a radio message is received at either module with a new pulse total, the increase in the count is output as pulses over the next 10 seconds. If there has been an increase of 50 in the total, then 50 pulses will be output over the next 10 seconds. In this way, the plant PLC is updated quickly with the new flow total.

Discrete Input

An output from the PLC is connected thru a relay to an input on each 105U module (the relay provides isolation between the two modules). This signal is for tripping the remote feed valve. The discrete input on both modules is mapped to DO1 at the remote modules at the refinery. Different debounce times and update times are configured to stagger radio transmissions.

Comms OK to the Refinery

A mapping is made to the refinery units to provide the “comms OK” feature as discussed above. The “Lo Volts” internal input is mapped to DO4 at the remote modules. The mapping is inverted so the output will be on.

Comms Fail to the PLC

A “comms fail” mapping is configured to DO2 on each module, and these outputs are wired to inputs on the PLC. If either module is not successful in transmitting to its remote module, DO2 will activate, and notify the PLC that one of the 905U systems is not working. The PLC will then ignore the signals from that 105U.

A reset time of 10 minutes is configured on DO2. If a “comms fail” event occurs, DO2 will activate for 10 minutes and then reset, provided communications has been re-established.