Profibus PA and Foundation Fieldbus – a cost comparison

Why Profibus PA is the most economical solution for process industries

BY JAMES POWELL, P. Eng.

There have been many comparisons between Foundation Fieldbus (FF) and PROFIBUS for use on field instruments in the process industries. If you put the two protocols side by side you will see that either will do the job and provide the much published cost savings. Both systems provide you with:

- Bi-directional communications
- Status information on the process variable
- Alerts
- Method to communicate to the instrument over the bus
- Bus power, Intrinsically Safe (IS)

They use the same wiring and all major Distributed Control System (DCS) vendors now support both PROFIBUS and FF, so it is the users decision to choose the best fit.

In all the comparisons between PROFIBUS and FF that I have read, none discuss the cost differences between the two solutions. A comparison is particularly difficult because the design and size of the project have a large impact on the outcome. In this paper we will look at some of the fundamental differences between the two protocols, and how they affect costs.

What is the main difference?

Both PROFIBUS PA (PA) and Foundation Fieldbus started off in the same working group and have much in common. The main difference is where the line between the field instrument and the control system is drawn (Figure 1). In PROFIBUS PA, the input and output blocks located in the DCS in a conventional system, are moved into the field instrument. However, no ‘control’ blocks are moved into the instruments. All control is done in the DCS. In FF, the input and output blocks, along with control blocks have been moved into the field instruments. Consequently ‘control in the field’ is the fundamental difference.
Stack size, power budget and unit costs
Siemens is in the process of adding FF to products that already have PROFIBUS PA capabilities. When Siemens started the project, the company anticipated that since FF and PA both use the same physical layer and ASIC, the PA stack had to be removed and replaced with the FF stack. In addition, a small amount of memory had to be added because the FF is larger than the PA stack. As it turns out, the FF stack is about 350 Kbytes, while the PA stack is about 50 Kbytes (See figure 2). Also, in order to execute all this added code, the clock speed would have to be doubled.

This means that the manufacturing cost for each FF device will be higher than the PA device. When comparing list prices of several vendors of level products, the FF devices are about 100 USD more than the same PA devices.

The increased memory and clock speed also have a second effect: the power requirement on the bus has to increase. We noticed about a 2 mA increase in power requirement for the FF device. For an end user, this is not an issue unless it affects the number of devices that can be put on a segment and thereby adds capital costs.

Number of devices per loop
The number of the devices per loop varies according to the overall design requirements of the project and whether it is intrinsically safe (IS). If the loop is non-IS, then the FF System Engineering guidelines (2), recommend no more than 12 devices per loop. The macrocycle for this type of system depends on the function blocks being used, but it is generally between 0.5 and 1 second long. For the PA system, the general recommendation is not to exceed 24 devices per loop. The device update time for 24 devices is around 400 ms. Being able to put 24 devices on a loop means that you can put double the amount of instruments per loop in PA than you can in FF. This reduces the number of linking devices required for a PA site by half.

Some control loops have a requirement that the control loop update times are under 300 ms. Foundation Fieldbus recommends having no more than 3 devices per loop and use control in the field. For PROFIBUS it depends on the type of instruments used and the data requirements, but typically you could have 15 devices per loop and it would still meet a total control loop update time of 300 ms. This cuts the number of linking devices required for PROFIBUS by five times.

Cost of linking devices
In both PA and FF, there are a number of vendors with different options for linking up to segments. In all cases though, the cost of implementing an FF device is higher due to the complexity of the protocol, e.g. a HSE to H1 linking device cost $500 more than a PROFIBUS DP to PA linking device sold by a major vendor.

Wiring and junction boxes
The wires and junction boxes are the same for PA and FF, except that you need more runs for FF. The increased number of loops means that you need more wires and more junction boxes, which increases overall costs.

Managing complexity
In Figure 2, we showed how much larger the FF stack is compared to the PA stack. The increase in the protocol stack is mainly due to the overhead of the control block for control in the field functionality. This adds complexity that has to be managed throughout the project. End users and company technical support groups reported that PA is easy to use compared to FF.
Another point to consider, is that if you choose PROFIBUS PA for field instruments, and use PROFIBUS DP for drives and I/O, then your staff will be dealing with one protocol (one data packet) and one set of troubleshooting equipment. If you choose FF, then your staff will have to learn two protocols, because FF cannot support drives. This will increase overall costs.

Interestingly enough, the protocol of choice for a secondary bus for FF installations is PROFIBUS DP.

**Example: Tank farm with 100 tanks**

**Foundation Fieldbus Solution**

Loops = 100/12 tanks per loop = 9

Linking device costs: $3,300

Device added price: + $100

**PROFIBUS Solution**

Loops = 100/24 tanks per loop = 5

Linking device costs: $2,750

Device added price: + $0

**Cost difference**

\[
(9 \times 3,300 + 100 \times 100) - (5 \times 2,750 + 100 \times 0)
\]

\[= 39,700 - 13,750 \]

\[= 25,950 \]

From a purely capital cost point of view, implementation of the PA solution is about $26,000 cheaper.

**Conclusions**

From our analysis we have shown how:

- PROFIBUS devices are cheaper
- You can fit far more PA devices on one link
- PA links are cheaper
- PA is easier (less complex)

If you need control in the field, then FF is your protocol. Otherwise, PA is the far more economical solution.

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**References**

(1) FuRIOS 2 study – Fieldbus Ready for Practical Use

(2) Foundation Fieldbus System Engineering guidelines AG-181

**Footnotes**

a – This is the cost of device(s) that will connect the Fieldbus to the high-speed bus. In FF, it would be a linking devices plus a power supply and power conditioner. In Profibus, it would be the cost of a DP/PA coupler and power supply. There are several different solutions for how to connect Fieldbus segments to a high-speed network. For this example, we have picked a major manufacturer who offers both a PA and FF Linking device in order to get a good comparison.

b – “Device added price” refers to the additional cost that a manufacturer will charge for a FF device over a PA device. As stated earlier, FF level devices typically are about $100 more than the same PA level device.

**Figure 3**

The number of linking devices required for FF vs PA.