Foundation Fieldbus End User Council Australia Inc.
9 Corcoran St Duncraig, WA 6023
P.O.Box Z5546 Perth, WA 6831
AUSTRALIA
ABN 60 120 236 370

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FOUNDATION Fieldbus – ready for take-off? Account by a field device manufacturer

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Dipl.-Ing. Guido Koenig

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SAMSON AG D-60314 Frankfurt am Main Germany

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In the last few years, more and more process plants have been equipped with FOUNDATION Fieldbus technology beyond prototype stage. A broad spectrum of registered field devices, installation components and process control systems complying with the FOUNDATION Fieldbus protocol are available. In the following, an overview of the current situation with analyzing possible improvements or additions will be given.

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1. IEC 61158-2 physical layer – options & restrictions

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The physical layer of FOUNDATION Fieldbus H1 according to IEC 61158-2 was tailored to the specific requirements of the process engineering industry. Two-wire technology, cable lengths of up to 1,900 m per bus segment with a maximum of 32 devices, flexible topology and the suitability for use in hazardous areas allow users to easily change to the Fieldbus technology.

Nevertheless, the relatively low transfer rates of 31.25 kbit/s impose restrictions on the number of devices per segment. In common FOUNDATION-Fieldbus-compatible process control systems, the maximum number of devices is limited to 16 per segment. In practice, however, typical bus segments connect only eight to ten field devices. In addition, the maximum cable length of 1,900 m is hardly ever used in practice, as the voltage in the Type A cable (AWG 18) defined in IEC 61158-2 falls below the minimum terminal voltage of 9 V at the field device after a cable length of only 800 to 900 m.
A flexible topology requires rugged linking devices like junction boxes or T-connectors, which reduce the cost advantage over the conventional technology.

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2. Fieldbus installation in hazardous area locations

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The implementation of a Fieldbus system in process engineering also depends on the possibility of using it in hazardous areas. It is not sufficient to simply list all possible types of protection available for FOUNDATION Fieldbus systems. The focus should rather be on providing the best possible explosion-protection concept for the end user with regard to the installation of a Fieldbus system. To exchange field devices or enlarge the plant, it is necessary that Fieldbus devices can be installed and removed during operation. In addition, the end user wants to carry out maintenance and servicing work on site while the device is operating. Several field devices are directly connected via the Fieldbus. As a result, a type of protection requiring that the device is disconnected or that the electrical power supply needs to be interrupted for maintenance either causes undesirable repercussions on the entire bus segment, or requires the use of power-switch-off units for each device. This will, however, eliminate the cost advantage of the Fieldbus system.

Only intrinsically-safe installations fully comply with the above-mentioned requirements imposed by the end user. Additionally, they can be applied without restrictions up to Zone 0 / Division 1 hazardous locations.

Field devices with type of protection "Intrinsic safety" require little power. Therefore, the number of devices per Fieldbus segment can be maximized. Nevertheless, the maximum amount of energy to be fed into an intrinsically-safe bus segment is limited. The initially favored FOUNDATION Fieldbus "Entity" model allowed for a maximum of six devices in a typical bus segment of gas group IIC. In addition, it is much more complex, and thus more expensive, to furnish the required system safety analysis for an intrinsically-safe circuit than for a conventional circuit using 4 to 20 mA. Based on the studies conducted by Physikalisch Technische Bundesanstalt in Braunschweig, Germany, the model known as the "Fieldbus Intrinsically Safe Concept“ (FISCO) was developed. The FISCO model works together perfectly with the IEC 61158-2 standard. The permissible cable specifications of the FISCO model are met by the Type A cable. FISCO is valid in IIC applications for bus segments with up to ten devices and a cable length of up to 1,000 m. The clear advantage of the FISCO model is that no system safety analysis is required, which presents a considerable cost advantage. As a result, intrinsically-safe Fieldbus installations for hazardous areas according to FISCO fully comply with the requirements of the end user as well as with the number of devices and segment lengths commonly implemented in practice.

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3. Field device engineering and diagnostics

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A further great advantage of using FOUNDATION Fieldbus is the possibility of directly and automatically transmitting status and diagnosis information about the field instruments. With conventional devices, this is rather cost-intensive or not possible at all. The information is clearly defined through the Device Description (DD). Access and interpretation of these data is assured by the central control system or other engineering components. Compared to other Fieldbus systems, the FOUNDATION Fieldbus DD technology does not only allow that measured values and set points are exchanged between bus devices, it also enables full access to field device parameters.

Complex field devices with extended diagnosis functions and routines for preventative maintenance reveal the limits of the DD technology. The connections between these routines are too complex to be implemented with the Device Description Language. Additionally, it is impossible to guarantee a uniform, platform-independent look and feel when using DD, as the user interface is part of the implementing tool. New concepts like the FDT/DTM model have already been implemented with HART and PROFIBUS devices, so that first practical experiences could be gained. Such models can lift these restrictions and provide the end user with a uniform, platform-independent interface to display even the most complex diagnosis information.

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4. Fieldbus devices – necessity for local operation ?

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Field instruments using the FOUNDATION Fieldbus protocol can be configured and parameterized quickly and conveniently via the communication connection. In contrast to HART communication, however, there is no suitable handheld terminal for field use yet. As a result, status information can only be gathered from the displays integrated into the field devices themselves, which presents a considerable disadvantage especially in hazardous locations. When service or maintenance work is performed, it can be helpful to have a device on site which allows the operator to fully adjust parameters in the field.

Most often, there are no (expensive) Fieldbus installations in repair shops for control valves. Therefore, on-site operation or a separate tool for adjustment, which directly grants serial access to the field device, are required for valve maintenance.

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5. Fieldbus systems reliability and redundancy

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Quite often, bus systems – not only those for critical applications – use a redundant design to guarantee greater reliability and availability. Usually, this redundancy is achieved by using redundant physical media. There is no such media redundancy for Fieldbus systems based on IEC 61158-2. Neither are there any FOUNDATION Fieldbus field devices which can be physically connected to two independent bus segments. An unconventional way of achieving redundancy can be to use valve positioners. Apart from the connection to the FOUNDATION Fieldbus, they can integrate traditional options like limit switches and a forced fail-safe venting function. Consequently, a control valve can be moved to fail-safe position or the final position can be fed back into the system using binary signals in an independent Fieldbus segment. Despite redundant power supply and bus interface modules, the biggest danger for a Fieldbus segment are short circuits in the bus itself, which cause a failure of all devices connected to the affected bus segment. Recent developments at least guarantee that other bus devices are protected against the feedback of shorts from field device spurs. These "multi barriers" or "FieldLinks“, however, only offer restricted configuration options, cause an additional voltage drop or power consumption and are not compatible with all field instruments. In addition, they do not help solve the problem of short circuits in the bus trunk.

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6. Binary signal devices and their integration into fieldbus systems

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Providing vast opportunities for data exchange and diagnosis, FOUNDATION Fieldbus is the best possible solution for smart field devices. In many process engineering applications, however, binary sensors and actuators make up 60 to 80 % of the instrumentation. While automated isolating valves can be equipped with parameters and functions for monitoring and diagnosis, other binary sensors only return a single digital information. Fieldbus-enabling binary sensors and actuators can account for up to 75 % of the devices' price. As a result, connecting binary field instruments to the bus increases the cost of the entire system without correspondingly enhancing its functionality. An elegant way of solving this problem are remote I/O systems, which can be installed in hazardous locations. They are connected to the High Speed Ethernet (HSE) network of FOUNDATION Fieldbus. As the remote I/O systems are installed close to the device, they offer a low-cost connection of the conventional binary sensors and actuators and are capable of providing additional functions at a central location. An ideal combination for connecting all field devices cost-efficiently without sacrificing functionality could be to use a unit composed of a remote I/O system and a linking device installed in Zone 1. Unfortunately, linking devices for installation in Zone 1 are not available yet, neither are the segment repeaters required to extend the cable length of the bus in hazardous areas. "ValveLinks" might be used as an interim solution. They can integrate up to four isolating valves including control and final position feedback functions as one bus device without requiring additional auxiliary energy.

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7. Back-up strategies

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The possibility of producing field instruments which use FOUNDATION Fieldbus as Link Master opens up ample opportunities for developing back-up and recovery strategies, which become effective in case the communication between the control system and the bus segments is interrupted. In contrast to traditional master/slave systems, the end user can either continue to operate the concerned part of the plant in case of an error, but he can also hold it at the last status or specifically shut down the affected sections depending on the application. Using the Link Active Scheduler (LAS) back-up and recovery function, the associated system configuration can easily be implemented. We all know that the process control circuits can be transferred to the individual field devices with FOUNDATION Fieldbus technology. When comparing the available PID function blocks, system-based blocks have considerable advantages over field-device-based blocks when it comes to performance and handling critical situations.

We can thus assume that critical and fast control loops, in particular, are implemented using the traditional methods. Consequently, a back-up function for PID function blocks similar to the LAS back-up strategy would be helpful. Unfortunately, a simple version of such a function is not available. As a result, the end user is either forced to transfer the process control loops directly into the field devices, thus having to accept possible functional restrictions, or he must develop a back-up strategy for the process control loops, which implies complex configuration.

On the whole, FOUNDATION Fieldbus has achieved a position which allows it to make use of the advantages of the Fieldbus technology. End users can choose from a wide range of available FOUNDATION Fieldbus devices and components, which facilitates the implementation of different applications with transparent data exchange and complete diagnosis functions down to field level.

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8. References

Fieldbus Foundation “FOUNDATION Fieldbus Technical Overview”
FD-043 Revision 2.0 (1996)

Fieldbus Foundation “FOUNDATION Fieldbus Application Guide – 31.25 kbit/s Wiring and Installation” AG-140 Revision 1.0 (1996)

Fieldbus Foundation “FOUNDATION Fieldbus Application Guide – 31.25 kbit/s Intrinsically safe systems” AG-163 Revision 1.0 (1996)

IEC (DKE –DIN/VDE) “Draft IEC 31G/89/NP FISCO Concept for intrinsically safe fieldbus systems” (2001)

Heetkamp, E. and Baltus C. “Fieldbus – a new hardware concept” *FF General Assembly Heidelberg* (2002)

Douma, B.S. and Eigenraam, P. “Foundation Fieldbus End-users experiences with FF technology” *FF General Assembly Heidelberg* (2002)