

PROFIBUS/PROFINET System design

Andy Verwer

Technical Officer for PROFIBUS UK
Verwer Training & Consultancy Ltd



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PROFIBUS



- ⇒ PROFIBUS is by a large margin the most widely used fieldbus technology.
- ⇒ PROFIBUS has solutions for a wide range of industries and application areas.
- ⇒ Ethernet is almost exclusively used at the top end of the system for IT, management and SCADA communications.
- ⇒ The use of "Industrial Ethernet", PROFINET is growing, but not as rapidly as initially predicted.

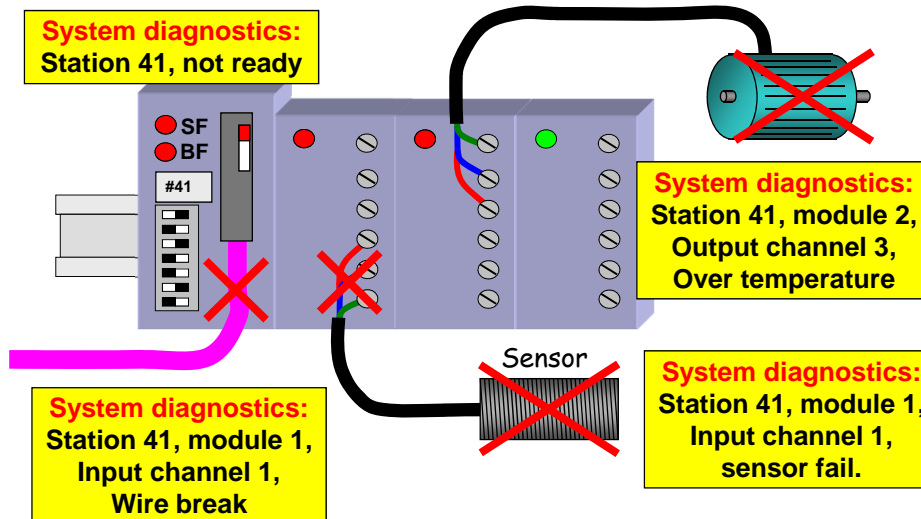
- ⇒ When a new automation or control system project is started there are many key design decisions that must be made at the concept stage.
- ⇒ Decisions are generally based upon:
 - ✓ System Cost,
 - ✓ System Dependability,
 - ✓ System Performance.
- ⇒ Cost is often seen as the "procurement cost", that is the cost to design, purchase, install and commission the system.
- ⇒ However, the total costs should really be based on whole life-cycle of the plant not just procurement.
- ⇒ Life cycle costs include the costs of maintenance, fault-finding, loss of production during down time etc.

- ⇒ Dependability is the availability of the system to deliver the required services. I.e. "keeping the system working".
- ⇒ Dependability depends critically on reliability, but equally important are ease of fault diagnosis, maintainability, repairability etc.
- ⇒ All parts of a complex system can fail. Two key factors to achieving a high availability when failures do occur are:
 - ✓ Rapid diagnosis and short time to repair,
 - ✓ Redundancy.

- ⇒ Systems that provide rapid diagnosis of faults and which allow fast repair will have high availability.
 - ✓ Can be achieved by informed system design with facilities for health-checking and maintenance.
 - ✓ Availability of appropriate fault-finding tools and training in their use.
 - ✓ Automatic reporting/logging of system and device diagnostics.
- ⇒ Redundant systems that can continue to operate in the event of a failure can give highest availability.
 - ✓ But only when combined with good diagnosis and repair.
 - ✓ The system is no longer redundant when a failure has occurred in one channel!

- ⇒ Fieldbus and networked devices are often "intelligent" and incorporate extensive built-in diagnostics and fault reporting capability.
- ⇒ Properly reported device diagnostics can significantly improve the maintainability and availability of a control system.
- ⇒ It is common to miss out diagnostic reporting from supervisory (SCADA) software systems to reduce costs. However, we can see that this is false economy when we look at whole life cycle costs.

System diagnostics:
Station 41, not ready



System diagnostics:
Station 41, module 2,
Output channel 3,
Over temperature

System diagnostics:
Station 41, module 1,
Input channel 1,
Wire break

System diagnostics:
Station 41, module 1,
Input channel 1,
sensor fail.

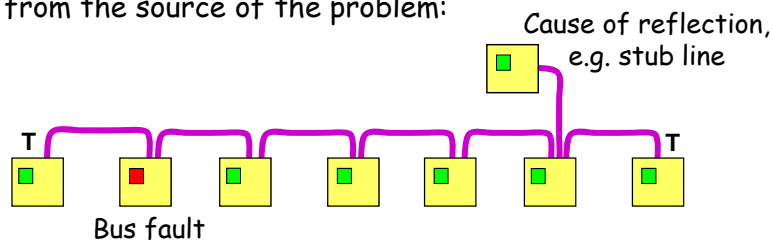
⇒ Device diagnostics and status information.

- ✓ Standardised diagnostics showing communications errors.
- ✓ Standardised module and channel related diagnostics showing peripheral errors.
- ✓ Manufacturer-specific diagnostics for specialist devices and conditions.
- ✓ Standardised status information for process measurements and actuator commands
- ✓ Standardised alarm and module status handling.

⇒ Diagnostics is the jewel in the PROFIBUS/NET crown.

⇒ But is often under-utilised or even disabled!

- ⇒ Unfortunately, the fieldbus and networking revolution has made some aspects of fault-finding more difficult.
- ⇒ Communication faults on networks are notoriously difficult to diagnose and locate, particularly when the fault is intermittent.
- ⇒ The main problem is that the devices that are most affected are often at the opposite end of the segment from the source of the problem:



- ⇒ Another common problem is where particular devices are incorporated which have odd or proprietary communication connection such as Modbus, RS232 etc.
- ⇒ Gateways are available from many manufacturers that can easily convert between such protocols to PROFIBUS or PROFINET.
- ⇒ However, the use of such devices increases system complexity and more importantly, makes fault-finding much more difficult.
- ⇒ The gateway will hide faults on the far side.
- ⇒ There are thousands of products available with a PROFIBUS interface, so there is no reason these days to use proprietary or "odd-ball" communications.

- ⇒ "Performance" can be measured in many ways: Quality of product, reduction of wastage or operating costs. minimisation of production or idle time etc.
- ⇒ For a control system we require to have good regulation and control which is robust in the event of external variations and perturbations.
- ⇒ The good performance of a control system means that it will allow optimisation of selected performance measures such as quality, variability, cost, waste etc without compromising "dependability".

- ⇒ Many installations are operating at a bit-rate which is set with little thought.
- ⇒ It is well known that communication errors become more critical at higher bit rates.
- ⇒ A good piece of advice when designing a network is thus to:

Design for the highest possible bit rate.
Operate at the lowest possible bit rate.

- ⇒ In this way, we maximise the tolerance margin for communication faults which may occur during the life of the plant.

Why do PROFIBUS projects go pear shaped?

- Even when the layout is according to the guidelines we can still have problems when dealing with faults, replacing devices, extending or altering the network.
- The designer should be aware of the inbuilt diagnostic capability of most PROFIBUS devices and how these can be easily used to help diagnose failures that may occur in the life of the plant.
- Diagnostics without reporting are useless. The diagnostic messages need to be pushed to the maintenance staff to deal with before further failures occur. Multiple errors are always difficult to deal with.

Some basic network design considerations

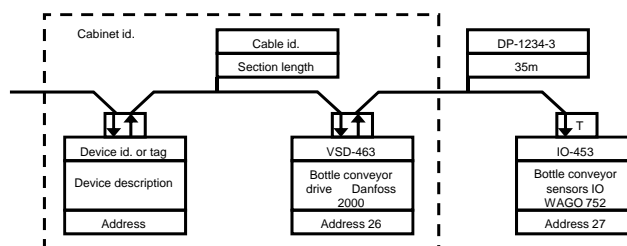
- There are a huge number of ways to layout a network. Some of the key decisions are:
 - Which bus to use - PROFIBUS, PROFINET, DP, PA, AS-i?
 - Connection of devices via remote IO or integrated fieldbus?
 - Networks topology for maximum fault tolerance.
 - Appropriate use of redundancy and catering for common mode failures.
 - Control loop timing and bus speed requirements.
 - How to best arrange for device access for engineering and diagnostic reporting.
 - How to best monitor network and device health.

Why to PROFIBUS projects go pear shaped?

- There are well documented specifications, guidelines and rules. These need to be understood by designers, installers and engineers.
- It is just as important that the reasons for these rules are understood. This lessens the risk of people breaking or bypassing the rules.
- There is also lots of guidance and good practice that has been developed over 25 years of PROFIBUS use. This is not always incorporated into the documentation, but is part of the accredited training that is available from training centres.

Drawing standards

- Loop drawings were traditionally used to describe the wiring and layout of traditional automation systems.
- These are useless for fieldbus. We need schematic representations with layout (as installed) and important device information.



- The first step to a successful project should be

1. Training

- PROFIBUS training courses are available for:
 - Installers,
 - System Designers,
 - Commissioning Engineers,
 - Maintenance staff,
- Installer, commissioning & maintenance and Engineer training is well established. Further many industry sectors specify that their staff, contractors and sub contractors must be appropriately trained.

- This training is widely accepted as the minimum standard of training for anyone who is working in PROFIBUS systems at a technical level.
- Available as a one-day training course for individuals or as on-site training for groups of 6 or more.
- It teaches the basic principles of PROFIBUS and covers the basic layout, installation and testing of the physical layer.
- It is also essential basic training for system designers, maintenance and all engineering staff.
- Extra days can be added to extend the training for maintenance, design and engineering staff.

- Many of the errors that can be seen in installations are traceable to fundamental decisions that are taken at the early stages of a project.
- For example:
 - use of inappropriate fieldbus for an application;
 - lack of awareness of maintenance features and fault-finding capability;
 - over-complex or inappropriate system architecture;
 - Lack of appreciation of common tools or techniques;
 - Use of manufacturer specific solutions when open standardised open solutions are available.
 - Design decisions based on equipment purchasing cost rather than whole life-cycle costs.

- A New Certified System Design course has been developed this year to cater for these needs.
- This is a two-day additional training over and above the Installer course.
- System Designer certification will allow providers to ensure that their designers are aware of the common design pitfalls and are able to produce systems that are cost effective, efficient and maintainable.
- Specification of Certified System Designers on a project can provide end users with an internationally accepted quality standard.

1. Ensure that everyone involved in the project at a technical level is trained to at least Installer level.
2. Design staff should also be trained to design level, before the project starts. Two days additional training is recommended.
3. Follow the extensive guidance that is available from PI and from competency and training centres.
4. Make sure that designers are fully aware of the methods for diagnosing and locating faults. Ensure that health checking and performance monitoring facilities are incorporated into the network.

5. Try to avoid manufacturer specific solutions. Open standards should mean vendor independent solutions. Choose best of breed devices that deliver the performance and maintainability that you require.
6. Be aware that the project cost is not just the procurement cost, but includes the whole life cycle costs of maintenance, repair, extension and replacement.
7. Be careful to avoid products that are not properly engineered. A PROFIBUS interface does not mean that the device is well designed or that the diagnostic features available within PROFIBUS have been used to best advantage. Use certified products if possible.

8. Invest in tools and training for your maintenance staff. When errors occur these tools will allow quick diagnosis and fault location.
9. Plan for system health checking at the design stage. Health checking will allow you to detect non-critical errors and performance deterioration before plant failure occurs. Modern tools are available that can provide automated health checking on a 24/7 basis.
10. Prepare appropriate schematic drawings showing the plant as installed, not as designed.

11. Join the PROFIBUS Group to benefit from the extensive group experience, obtain discounts on training and get access to the extensive library of information and guidelines

Call in at the PROFIBUS stand for a membership pack,

or visit the PROFIBUS International web site

www.profibus.com

or contact the PROFIBUS UK User Group at

uk@profibus.com

Training providers



- Certified, non-certified and customised PROFIBUS and PROFINET training is offered through:
- PROFIBUS International Competence Centre
 - Manchester Metropolitan University
 - (<http://www.sci-eng.mmu.ac.uk/ascent/>)
- PROFIBUS International Training Centre
 - Verwer Training & Consultancy Ltd
 - (<http://www.verwertraining.com/>)



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