FOUNDATION™ Fieldbus
Fieldbus Basics & Its Benefits

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On behalf of
Fieldbus Foundation™
Fieldbus Basics Agenda

H1 Basic Review.

- What is Fieldbus?
- Integrated Architecture.

H1 Benefits.

- More data is available.
- Expanded view of Process and Instruments.
- Reduction in System Hardware.
- Wiring Saving.
- Summary.

FOUNDATION Fieldbus Technology.

- H1 network review technology.
- Intrinsic Safety.
- DD and CFF Files.
- Typical Fieldbus installation.
- Fieldbus Components.
- H1 Fieldbus Model.
Fieldbus Basics Agenda

FOUNDATION Fieldbus Technology, (cont’d).

- Standard Function Blocks.
- Example of a Control Loop.
- H1 Link Master Redundancy.
- H1 Link Active Scheduler.
- H1 Link Schedule Optimization.
- High Speed Ethernet
H1 Basic Review
What is Fieldbus?

1. A fieldbus is an all-digital, serial two-way, multi-drop communication System.
2. H1 link (31.25kbps) interconnects field equipment (Sensors, Actuators & I/O).
3. HSE (High Speed Ethernet, 100mbps) provides integration of high speed controllers, subsystems (via Linking Device) and data servers and workstation.
1. Management Information Systems (MIS), Enterprise Resource Planning (ERP), and Human Machine Interface (HMI) access the H1 Fieldbus information via the Data Servers.
H1 Benefits
More Data is available

1. Fieldbus allows “multiple variables” from each device to be brought into the control system for archiving, trend analysis, process optimization, reporting, predictive maintenance and for asset management.

2. Fieldbus distortion-free characteristics digital communication enables improved control capability which can improve product yields.
Expanded View of Process & Instrument

1. Self Diagnostics and communication capabilities of microprocessor based fieldbus devices helps reduce downtime and improve plant safety.

2. Plant operation and Maintenance personnel can be notified and corrective actions taken quickly and safely.
Reduction in System Hardware

1. Standard Function Blocks is used to implement the Control Strategy.
2. Many control system functions such as AI, PID and AO can be performed by the field device through the use of these Standard Function Blocks.
3. Distribution of control into field devices can reduce the amount of hardware needed.
Wiring Savings

1. The H1 fieldbus allows many devices to be connected to a single wire pair.
2. This results in less wire, fewer intrinsic safety barriers and fewer marshaling cabinets.
Summary

1. Reduced number of wires and marshaling panels.
2. Reduced number of intrinsic safety barriers.
3. Reduced number of Input/Output Converters.
4. Reduced number of Power Supplies and Cabinets.
5. Reduced size of equipment Rooms.
8. Increased accuracy of measurements.
9. Easier evolution due to standardized function blocks.
10. Increased sophistication and flexibility of instrumentation.
11. Increased uptime due to less equipment, better self diagnostics and remote diagnostics.
FOUNDATION fieldbus Technology
H1 Network Review

1. Multi-Drop wire pair with Power and Signal on same cable.
2. Support Intrinsic Safety.
3. Fault Tolerant, can have multiple Link Masters.
4. Function Blocks built into Field Devices.
5. Control on the Wire – single loop integrity
6. Distance up to 1900 meters.
7. Can add Repeaters to extend > 1900 meters.
8. Max. of 4 repeaters can be used to a maximum distance of 9500 meters.
DD and CFF Files

1. Field Devices will consist of:
   - Actual Physical Device.
   - Device Description (DD).
   - Common File Format (CFF).

2. DDs and CFFs will be provided by the Device Supplier or Host Supplier.

3. Standard parameters present in devices. Option to include specific manufacturer parameters.

4. Parameters and Capabilities are defined in device files – DD and CFF.

5. Device files are key to off-line configuration.
Typical Fieldbus Installation

- An example of the Chicken foot (tree) topology.
- Redundant, isolated power conditioning defined by FF-831, Fieldbus PST Specs.
- Typically 10-12 bus-powered fieldbus devices per segment.
- Spur short-circuit protection.
- Up to 1900 meters.
- Maximum of 9500 meters via repeaters.
H1 Fieldbus Model

FOUNDATION fieldbus H1 technology consists of:

- The Physical Layer.
- The Communication Stack.
- The User Application Layer.

The Open Systems Interconnect (OSI) layered communication model is used to model these components.

- Physical Layer is OSI layer 1.
- Data Link Layer is OSI layer 2.
- FMS is OSI layer 7.
- Communication stack is comprised of layer 2 and layer 7.
- Fieldbus does not use OSI layer 3, 4, 5 and 6.
- FAS maps the FMS into DLL.
1. The Physical Layer receives messages from the communication stack and converts the messages into physical signals on the fieldbus transmission medium and vice versa.

2. Conversion includes adding and removing preambles, start delimiters and end delimiters.
1. The Communication Stack comprises of Layer 2 and 7.

2. Layer 2, the Data Link Layer (DLL) controls transmission of messages onto the fieldbus, through a deterministic centralized bus scheduler call the Link Active Scheduler (LAS).

3. FAS uses the scheduled and unscheduled features of the DLL to provide a service for the FMS.

3. FMS services allow user applications to send messages to each other across the fieldbus using a standard set of messages.
1. The Fieldbus Foundation has defined a standard User Application Layer based on “Blocks”.

2. Blocks are representations of different types of application functions.

3. The types of blocks used in a User Application are described as:
   - Resource Block,
   - Transducer Block,
   - Function Blocks.

4. Devices are configured using Resource Block and Transducer Block.

5. The Control Strategy is built using Function Blocks.
Resource Block

1. The Resource Block describes characteristics of the fieldbus device such as device name, manufacturer and serial number, etc.

2. There is only one Resource Block in a device.
Transducer Block

1. Transducer Blocks are used to configure devices.
2. Transducer Blocks are required to Read sensors value and command output value.

Control Builder Project tab
Function Blocks

1. The Control System Strategy is built using Function Blocks. Input and output parameters of Function Blocks can be linked over the fieldbus.

2. The execution of each Function Blocks is precisely scheduled and there can be many function blocks in a single user application.
1. The Fieldbus Foundation has defined 10 Standard Function Blocks for Basic Control.

<table>
<thead>
<tr>
<th>Function Blocks</th>
<th>Abbreviation</th>
<th>Class Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog Input</td>
<td>AI</td>
<td>Input</td>
</tr>
<tr>
<td>Analog Output</td>
<td>AO</td>
<td>Output</td>
</tr>
<tr>
<td>Bias/Gain</td>
<td>BG</td>
<td>Control</td>
</tr>
<tr>
<td>Control Selector</td>
<td>CS</td>
<td>Control</td>
</tr>
<tr>
<td>Discrete Input</td>
<td>DI</td>
<td>Input</td>
</tr>
<tr>
<td>Discrete Output</td>
<td>DO</td>
<td>Output</td>
</tr>
<tr>
<td>Manual Loader</td>
<td>ML</td>
<td>Control</td>
</tr>
<tr>
<td>Proportional/Derivative</td>
<td>PD</td>
<td>Control</td>
</tr>
<tr>
<td>Proportional/Integral/Derivative</td>
<td>PID</td>
<td>Control</td>
</tr>
<tr>
<td>Ratio</td>
<td>RA</td>
<td>Control</td>
</tr>
</tbody>
</table>
2. Eleven other Standard Function Blocks are also defined for Complex Control.

<table>
<thead>
<tr>
<th>Function Blocks</th>
<th>Abbreviation</th>
<th>Class Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Control</td>
<td>DC</td>
<td>Control</td>
</tr>
<tr>
<td>Output Splitter</td>
<td>OS</td>
<td>Control</td>
</tr>
<tr>
<td>Signal Characterizer</td>
<td>SC</td>
<td>Control</td>
</tr>
<tr>
<td>Lead Lag</td>
<td>LL</td>
<td>Control</td>
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<tr>
<td>Deadtime</td>
<td>DT</td>
<td>Control</td>
</tr>
<tr>
<td>Integrator (Totalizer)</td>
<td>IT</td>
<td>Control</td>
</tr>
<tr>
<td>Setpoint Ramp Generator</td>
<td>SPG</td>
<td>Control</td>
</tr>
<tr>
<td>Input Selector</td>
<td>IS</td>
<td>Control</td>
</tr>
<tr>
<td>Arithmetic</td>
<td>AR</td>
<td>Control</td>
</tr>
<tr>
<td>Timer</td>
<td>TMR</td>
<td>Control</td>
</tr>
<tr>
<td>Analog Alarm</td>
<td>AAL</td>
<td>Control</td>
</tr>
</tbody>
</table>
3. Four other Standard Multiple Input/Output Function Blocks are also defined for Control.

<table>
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<tr>
<th>Function Blocks</th>
<th>Abbreviation</th>
<th>Class Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Analog Input</td>
<td>MAI</td>
<td>Input</td>
</tr>
<tr>
<td>Multiple Analog Output</td>
<td>MAO</td>
<td>Output</td>
</tr>
<tr>
<td>Multiple Discrete Input</td>
<td>MDI</td>
<td>Input</td>
</tr>
<tr>
<td>Multiple Discrete Output</td>
<td>MDO</td>
<td>Output</td>
</tr>
</tbody>
</table>
1. Control Strategy can be built using Function Blocks built into field devices.

2. A simple temperature transmitter may contain an AI function block. A Control Valve might contain a PID function block as well as the expected AO Block.

3. Thus, a complete control loop can be built using a simple transmitter and a control valve. Control in the Field does not need a Controller.
H1 Link Master Redundancy

1. Two types of devices are defined in the Data Link Layer (DLL). Link Master and Basic Device.

2. Link Master Device are capable of becoming Link Active Scheduler (LAS). Basic Device do not have this capability.
H1 Link Active Scheduler

1. LAS provides scheduled communication(*) control on the H1 network.
2. LAS provides unscheduled communication(**) control on the H1 network.
3. LAS maintain a live list (devices that response to the pass token) which it uses to recognize devices on each H1 Link.
4. Provides Data Link Time Synchronization so that all devices have exactly the same data link time.
5. Insures LAS Backup or LAS Redundancy. If one LAS fails, one of the Link Master will become the LAS and operation continues.

(*) Sends a compel data (CD) message to a device which allows the device to publish specific data when it receives the CD message.

(**) Issues a pass token to a device which allows the device to send message until it has finished or the token hold time expires.
H1 Link Active Scheduler

1. PID Loop scheduled and unscheduled communication.
Link Schedule Optimization

1. Makes effective use of Fieldbus bandwidth.
2. Important for Control on the Wire.
3. Allow for better time management on the Link.
4. Link Schedule Optimization provides a quantum improvement in the efficiency of Fieldbus Link bandwidth use.
Link Schedule Optimization

Optimizing Fieldbus Link Schedules Makes a Difference!

• An Example - Triple Transmitters (Un-optimized)
Link Schedule Optimization

Optimizing Fieldbus Link Schedules Makes a Difference!

• An Example - Triple Transmitters (Optimized)

- More uninterrupted communications intervals.
- Better unscheduled throughput.
- Faster display call-ups, etc.
- Reduced latency.

Macrocycle Time ➔
HIGH SPEED ETHERNET (HSE)
FF Integrated Architecture
HSE – Subsystem Integration

High Performance Control Backbone
Standard Ethernet Equipment and Wiring
Standard Function Blocks **PLUS**
Flexible Function Blocks for Discrete/Batch/PLC
Redundant HSE Interfaces and Devices
Linking Devices (LD) Integrate H1
HSE Provides the Open Interface for Data Servers
High Speed Ethernet Devices

HSE Client

100 Mbit/s Switch

Gateway

I/O Network

HSE Field Device

Linking Device

Plant

Plant

Plant
HSE - LAN Redundancy

HSE Client

Gateway

I/O Network

HSE Field Device

Linking Device

H1

Plant

H1

Plant

H1

Plant
HSE - Device Redundancy

HSE Client

HSE Field Device

Gateway

Linking Device

I/O Network

Plant

H1

Plant

H1

Plant
Thank you

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