FOUNDATION™ Fieldbus Fieldbus Basics & its Benefits

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On behalf of
Fieldbus Foundation™
Fieldbus Basics - Agenda

1. H1 Basic Review.

2. H1 Benefits.

3. FOUNDATION Fieldbus Terminologies.
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.
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. Each H1 interface card can typically connect up to 4 segments.

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, decrease CPU loadings and enable faster loop executions.
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.

![Diagram showing the comparison between traditional 4-20mA wiring and H1 fieldbus wiring.](image)
Summary

1. Reduced number (or size) of:
   a. wires and marshaling panels.
   b. intrinsic safety barriers.
   c. Input/Output Converters.
   d. Power Supplies and Cabinets.
   e. equipment Rooms.

2. Remote configuration of devices.

3. More information available for Operations and Maintenance, due to more information coming from sophisticated devices. Device diagnostics enable predictive maintenance programs.

4. “Control in the field” due to standardized function blocks.
FOUNDATION fieldbus Terminologies
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.

Distance > 1900 meters

Fieldbus Signal

- Power 9 to 32 Volts
- Voltage 0.75 to 1.0 V p-p

Control on the Wire - single loop integrity

Max. of 4 repeaters can be used to a maximum distance of 9500 meters.
Intrinsic Safety

Entity, FISCO, FNICO, High Power Trunk…
DD and CFF Files

1. Device supplier provide devices together with
   • Device Description (DD).
   • Common File Format (CFF).

2. Device Descriptor (DD) File allow operation of devices from different suppliers on the same fieldbus with single host system.

3. Common File Format (CFF) is a file which describes the functions and capabilities of a field device. The CFF file is used in conjunction with the Device Descriptor file to enable a host system to perform offline engineering without the devices.
Typical Fieldbus Installation

- An example of the Chicken foot (tree) topology.
- Redundant, isolated power conditioning defined by FF-831 specs.
- Typically 10-12 bus-powered fieldbus devices per segment.
- Spur short-circuit protection.
Fieldbus Component

**Foundation™ Fieldbus System**

- Power Supply
- Workstation
- HMI
- Terminator
- Fieldbus Interface Module
- Fieldbus Controller
- Safe Area (Host)
- Hazardous Area (Field)
- HSE Cable
- Fieldbus Controller
- H1 Bus (Trunk)
- Transmitters
- Analyzer
- Actuator Valve
- Junction Box
- H1 Bus Wire (Spurs)
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.
H1 Fieldbus Model

1. The Communication Stack comprises of Layer 2 and 7.

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.
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.
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>
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<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>
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</table>
2. These are some of the other Standard Function Blocks available for Complex Control.

<table>
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<tr>
<th>Function Blocks</th>
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<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>
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<td>Lead Lag</td>
<td>LL</td>
<td>Control</td>
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<tr>
<td>Deadtime</td>
<td>DT</td>
<td>Control</td>
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<td>Integrator (Totalizer)</td>
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<td>Control</td>
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<tr>
<td>Setpoint Ramp Generator</td>
<td>SPG</td>
<td>Control</td>
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<tr>
<td>Input Selector</td>
<td>IS</td>
<td>Control</td>
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<tr>
<td>Arithmetic</td>
<td>AR</td>
<td>Control</td>
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<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>
H1 Link Active Scheduler

1. LAS provides scheduled(*) and unscheduled communication(**) control on the H1 network.

2. LAS maintain a live list (devices that response to the pass token) which it uses to recognize devices on each H1 Link.

3. Provides Data Link Time Synchronization so that all devices have exactly the same data link time.

4. Facilitates 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.
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.
1. PID Loop scheduled and unscheduled communication.

Function blocks:
- AI 110
- PID 110
- AO 110

Device 1
Device 2

Scheduled Communication

Unscheduled Communication

Function Block Execution

Closed loop control

Scheduled

Unscheduled

Alarms/Events
Maintenance/Diagnostic Information
Program Invocation
Permissives/Interlocks
Display Information
Trend Information
Configuration
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 ➔

Fieldbus Foundation
Freedom to Choose. Power to Integrate.

Vietnam FF Seminar
18 Mar 2010
HIGH SPEED ETHERNET (HSE)
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
- Gateway
- Linking Device
- HSE Field Device
- I/O Network
- 100 Mbit/s Switch

Diagram showing the connection between HSE Client, Gateway, Linking Device, HSE Field Device, and I/O Network through a 100 Mbit/s Switch.

Legend:
- H1
- Plant

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HSE - Device Redundancy
Thank you

www.fieldbus.org