FOUNDATION™ Fieldbus
Fieldbus Basics

Nik Suzaimi

Berkat Honeywell Sdn Bhd, MALAYSIA
On behalf of
Fieldbus Foundation™

Honeywell
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.
- 4-20mA versus Fieldbus.

FOUNDATION Fieldbus Technology.
- H1 network review technology. Intrinsic Safety.
- DD and CFF Files.
- Typical Fieldbus installation.
- Fieldbus Components.
- H1 Fieldbus Model
- 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 for Better Decision Making

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.
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 reduced the amount of hardware and cabinet footprint needed.
Sample Implementation

- **192 segments per cabinet**
  - Assuming using 8-segment redundant H1 card

- **Certified for installation in Class 1 Division 2 / Zone 2 hazardous locations**

- **Translates to 3,072 FF devices per System Cabinet**
  - It could be more when each FF device may provide up to 16 process values (i.e., Temperature Multiplexers)

**3,072 FF devices per System Cabinet**
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.

Traditional 4-20mA wiring, One I.S Barrier, One wiring for each Device

One I.S Barrier, One Wire for Many Devices
Summary

• Control in-the-field
  – Reduced loading on DCS Controllers

• Reduced number of intrinsic safety barriers
  – Only H1 card in the Marshalling

• Reduced number of Input/Output Converters

• Reduced number of Power Supplies and Cabinets.

• Reduced size of equipment Rooms.

• Remote configuration of devices.

• Increased accuracy of measurements

• Easier evolution due to standardized function blocks

• Increased sophistication and flexibility of instrumentation

• Increased uptime due to less equipment,

• better self diagnostics and remote diagnostics

• More information available for Operations.

Significant Contribution to Weight Reduction on your Offshore Platforms
1. A H1 fieldbus retains and optimizes the desired features of the 4-20mA analog system:
   - single Loop integrity.
   - a standardized physical interface to the wire.
   - a bus-powered devices on a single wire pair.
   - intrinsic safety options.

2. In addition, FOUNDATION Fieldbus enables:
   - 25 x faster communication speed compared to HART
   - increased capabilities (due to full digital communication).
   - reduced wiring and terminations (multiple device on one wire).
   - increased selection of suppliers (due to interoperability)
   - reduced control room loading (control on wire)
   - connection to HSE backbone.
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. Add Repeaters to extend > 1900 meters
8. Max. of 4 repeaters can be used to a maximum distance of 9500 meters
Intrinsic Safety

- Control room
- Field
- Power supply
- Conditioner
- Host Control System
- Trunk
- Wiring block
- I.S Interface
- I.S certified devices
- Field device
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.
DD and CFF Files

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

2. 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 configure the system off-line.

3. CFF files are standard ASCII text file.
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.
- 120 m distance from FF JB to FF Device
- Spur short-circuit protection.
- Up to 1900 meters.
- Maximum of 9500 meters via repeaters.
Fieldbus Component

**FOUNDATION™ Fieldbus System**

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

© 1994 – 2008 Fieldbus Foundation
**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 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.
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.
# Standard Function Blocks

## Examples

<table>
<thead>
<tr>
<th>Function Blocks</th>
<th>Function Blocks</th>
<th>Function Blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog Input</td>
<td>Device Control</td>
<td>Multiple Analog Input</td>
</tr>
<tr>
<td>Analog Output</td>
<td>Output Splitter</td>
<td>Multiple Analog Output</td>
</tr>
<tr>
<td>Bias/Gain</td>
<td>Signal Characterizer</td>
<td>Multiple Discrete Input</td>
</tr>
<tr>
<td>Control Selector</td>
<td>Lead Lag</td>
<td>Multiple Discrete Output</td>
</tr>
<tr>
<td>Discrete Input</td>
<td>Deadtime</td>
<td></td>
</tr>
<tr>
<td>Discrete Output</td>
<td>Integrator (Totalizer)</td>
<td></td>
</tr>
<tr>
<td>Manual Loader</td>
<td>Setpoint Ramp</td>
<td></td>
</tr>
<tr>
<td>Proportional/Derivative</td>
<td>Generator</td>
<td></td>
</tr>
<tr>
<td>Proportional/Integral</td>
<td>Input Selector</td>
<td></td>
</tr>
<tr>
<td>Ratio</td>
<td>Arithmetic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Timer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Analog Alarm</td>
<td></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 need a Controller.

Example of a complete control loop using Function Blocks located in fieldbus Devices.

Example of a complete control module strategy Control on the Wire.

Offload your DCS Controller loading by control on-the-wire
Foundation Fieldbus Control Integration

Control on-the-wire?
The one we know: Control on the DCS

- All CONTROL Function Blocks executed in the DCS
- DCS provide primary PID Control
- Fieldbus Device is purely supplying Input (AI) and output (AO) Connection
FF Way : Control on the Wire

- All Function Blocks executed in the device..
  - Primary PID Control executed by the FF Device itself
- DCS simply the MMI to change control loop Mode, Setpoint, etc
- PID Execution sitting on the device itself
- DCS Controller is not required at all, for some vendor implementation
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 maintains a live list (devices that respond to the pass token) 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.
1. PID Loop scheduled and unscheduled communication.

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

Scheduled Communication

Closed loop control

Scheduled

Unscheduled

- Alarms/Events
- Maintenance/Diagnostic Information
- Program Invocation
- Permissives/Interlocks
- Display Information
- Trend Information
- Configuration
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 (before)

Unoptimized Schedule
5 control loops – 1065 msec
(note too big for 1 sec macrocycle)

This schedule is invalid - it either does not fit into macrocycle or time allotted for publications is exceeded.
Link Schedule Optimization (after)

Optimized Schedule

5 control loops -- <365 msec
(now fits with room to spare!)
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 - LAN Redundancy

HSE Client

Gateway

HSE Field Device

I/O Network

Linking Device

H1

Plant

H1

Plant

H1

Plant
HSE - Device Redundancy
Thank you

www.fieldbus.org