Fieldbus Foundation – India Marketing Committee

Fieldbus Foundation
Paradigm Change in Instrumentation Technology

Date         : 26th of September, 2008 (Friday)
Time         : from 09:00 am to 06:00 pm.
Venue        : Automation 2008 Conference Hall.
               : Conference Hall, Bombay Exhibition Centre (NSE),
               : Goregaon (East), Mumbai INDIA

Fieldbus Engineering Methodology

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Emerson Process Management,
Asia Pacific

2008 FFIMC - Automation 2008-Mumbai
Designing Fieldbus Segments

- Segment Design Considerations
- Constraint Checks
- Communications Processing
- Components Selection
Segment Design Considerations

- Instrument Functionality
- Instrument Location
- Process Control Requirements
- Availability Requirements
Instrument Functionality

- Pick the right instrument for the application
- Find out which function blocks are available with an instrument
- Most common function blocks are AI, AO, PID, DI, DO
Transmitter

- PID with Auto Tuning
- Output Splitter (OS)
- Control Selector (SEL)
- Arithmetic
- Integrator
- Signal Characterizer
Multi Input Temperature Transmitters

Classic & HART I/O

H1

8 RTD/ TC Inputs

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Discrete I/Os Transmitter

Classic & HART I/O

8 DI / 8 DO & logic
Process Control Requirements

- How are the measurements being used?
- Monitor only or used in PID control?
- Required update time?
- Input processing, such as P-T compensation?
- Output processing, such as split-range?
Process Control Requirements

- The measurement device and control element of a PID loop *must* be on the same segment for Control-in-field (CIF)

- The PID Function Block can be located in the transmitter (CIF), valve (CIF), *or*... control can be in the *controller* (CIC)

- Where to locate the PID block(s) depends on the complexity of the control strategy
Availability Requirements

- Redundancy requirements
- Equipment segregation
- Distribution of critical loops
- Component redundancy
  - Fieldbus Power supplies/Power Conditioners
  - H1 card
  - LAS (Back up LAS in a field device)
Designing For Process Modularity

Segment 1

- D-38004
- D-38003
- D-36003
- D-36004

Segment 2

- Hot Oil Return
- Fuel Gas Header
- Condensate Stripper
- Raw Methanol Stripper

Components:

- TT101A
- TT101B
- LT101
- PT401
- FT501

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Process Safety Levels (Client Driven)

Level 1 Valves
Failure of this valve will result in a total system trip, causing a shutdown of the entire unit, or other unavoidable losses in excess of $100M. Level 1 valves and their associated measurement shall reside on H1 segments with no other devices. The ISD shall show the criticality rating and shall prominently display that no additional devices shall be loaded on this segment.

Level 2 Valves
Failure of a level 2 valve will result in an emergency situation, where prompt operator action would be required to "save" the unit from imminent total shutdown. The material and energy capacity of associated vessels, geographic location, and elevation/accessibility of such valves should be considered. Failure of a level 2 valve will result in a total system trip, causing a shutdown of the entire unit, or other unavoidable losses in excess of $100M. However, the level 2 valve's process dynamics allow time for quick recovery from the failure, either by quickly fixing a fault or by taking manual control. Level 2 valves and their associated measurement shall reside on H1 segments with no other level 1 or 2 valves. The ISD shall show the criticality rating.

Level 3 Valves
Failure of this valve will not result in any short-term risk of total unit shutdown. Level 3 valves can go to their fail position without requiring any immediate operator action. Level 3 valves can reside on cards or segments with other level 3 valves, or on a segment with a level 2 valve. Consideration should be given to the impact of common mode failures among level 3 and level 2 & 3 valves on the same segment.

EXAMPLE ONLY – VARIES WITH CUSTOMER
Assigning Fieldbus Devices to a Segment

- Maximum 16 devices per segment
- Recommended loading
  - Total of 12 devices per segment
  - Total of 4 control loops per segment
- Devices should be placed on segments based on location, control function, and reliability requirements
Constraint Checks

- Distance Limits
- Spur Length
- Power Consumption
- Voltage Drop
- Communications Processing
Spur Length

Trunk

Terminator T Terminator T

Spur
Combination Topology

Most Common
Fieldbus Network Components (non-IS)

- **Segment / Trunk**
  - The section of the fieldbus that is terminated.
  - Max. 1900 m per segment
  - Max. 32 devices per segment

- **Spur**
  - Branch line from Segment
  - Distribute devices along the Segment
  - Final Circuit
  - Max. length 120 m

```plaintext
T1 + S1 + S2 + S21 + S22 + S23 + ... + Sn < 1900 m
```
Voltage Drop

Fieldbus Power Supply 19 V

3000 feet

#18 AWG, 6.4 Ω/1000 ft

26 ma
22 ma
11 ma
15 ma

Total = 69 ma

Voltage = 19 - [ (3000 x 6.4/1000 x 69/1000) x 2 ]
Voltage = 19 - 2.65
Voltage = 16.35
Segment Power Considerations

- Non-IS Application (Safe)
- Intrinsic Safety Models
  - Entity (IS)
  - FISCO (Zone 1)
  - FNICO (Non incendive)
- Field Barriers
Power Conditioner
(Examples)

- Single
- Redundant, Multi-segment
- FISCO, FNICO

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Wiring Blocks (Examples)

Fieldbus Barriers
Ex me [ia]

Zone 1/0
Ex ia

Zone 2
Ex nL

Zone 1
Ex me
Fieldbus Design Tools (Examples)
1.2 Segment Summary

Summary Details
Number of Devices on Segment: 5
Minimum Voltage At Device: 18.4 volts
Total Segment Length: 106.0m

1.3 Device Summary

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
<th>Revision</th>
<th>Address</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCV-103 [DVC5000f]</td>
<td>DVC5000f AO/PID Digital Valve Controller</td>
<td>7</td>
<td>35</td>
<td>18.4 volts</td>
</tr>
<tr>
<td>PT-102 [3051]</td>
<td>3051 Pressure Transmitter</td>
<td>6</td>
<td>34</td>
<td>18.4 volts</td>
</tr>
<tr>
<td>TT-101A-H [848T]</td>
<td>848T Multi-Point Temperature Transmitter</td>
<td>1</td>
<td>33</td>
<td>18.4 volts</td>
</tr>
<tr>
<td>TT-104 [3244MV]</td>
<td>3244MV Temperature Transmitter</td>
<td>3</td>
<td>32</td>
<td>18.4 volts</td>
</tr>
<tr>
<td>QT-105 [4081pH]</td>
<td>4081pH Transmitter</td>
<td>2</td>
<td>31</td>
<td>18.4 volts</td>
</tr>
</tbody>
</table>

1.4 Cable Summary

<table>
<thead>
<tr>
<th>Tag</th>
<th>Cable Type</th>
<th>Length Connection 1</th>
<th>Connection 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>[No Tag]</td>
<td>FF Type A 0.8mm²/2 (18 AWG)</td>
<td>1.0m Terminal</td>
<td>Terminal</td>
</tr>
<tr>
<td>[No Tag]</td>
<td>FF Type A 0.8mm²/2 (18 AWG)</td>
<td>100.0m Terminal</td>
<td>Pin</td>
</tr>
</tbody>
</table>
Link Active Scheduler runs segment

- Link Active Scheduler (LAS) is the data “Traffic Cop” of the segment
  - Controls all access to the segment
  - Keeps track of who is on the segment
  - Runs Macro Cycle
  - Time Clock for segment

- LAS can be in any device on segment that has the capability
  - All host have LAS
  - Many devices have LAS
Communications Processing

- The LAS allocates both scheduled (for closed loop control) and unscheduled (Set point, monitoring loops, alarms) time on the bus
- Macrocycle time depends on block execution speed, number of blocks, communications between blocks, etc.
Scheduling

FUNCTION BLOCK SCHEDULING

Scheduled Function Block Execution

Scheduled Cyclic Communication

Unscheduled Communication

LAS Schedule

Macrocycle

Time

LAS Schedule

Macrocycle

AI

PID

AO
Function Blocks in FOUNDATION™ fieldbus Solutions
Control in the Field - An Example

AIN-PID-AOUT Loop

Flow Transmitter

PID

IN

OUT

BKCAL_IN

AOUT

CAS_IN

BKCAL_OUT

Valve
This sample loop on a segment results in a minimum 105 ms macrocycle time.
Communications Processing

Adding a second loop on the segment results in a longer macro-cycle time, but not twice as long (30ms compelled data time).
Advantages of Control in the Field

FOUNDATION™ fieldbus allows for control in the field!

- Deterministic Control
- Single loop integrity available
- Faster Speed of response
- Free up controller to handle advanced applications (embedded APC)
- Devices with more function blocks offer more flexibility for Control in the Field
Instrument data Sheets for Ff devices

- Working voltage (9-32 volts)
- Maximum current draw from bus
- Function block requirements
- Block execution speeds
- Standard/Advanced Diagnostics requirements
- Interoperability tested (ITK4.0 – FF base standard)
- Polarity sensitivity
- Capacity for instantiable function blocks
- LAS capability
- Device revision
- Channel number and description
- Any local indicator required
Fieldbus View Macrocycle

Graphs the macrocycle for a given segment

Quickly evaluate Fieldbus segment communications
Segment Design Drawing

- May be used in place of loop drawings
- Will show general topology of segment
- Can be used for documentation of design constraints
  - Segment & spur length
  - Voltage drop and current draw
  - Loop execution requirements
  - Process Criticality Level
Fieldbus Design Tools and Documents

The following is a summary of common tools/documents used in Fieldbus Design and Implementation:

- **Fieldbus Design Methodology (FDS)**: A document that spells out factors to take into consideration during the design process.

- **Segment Design Tool**: In the form of drag and drop to check segment design.

- **Vendor-specific documents for Procedures, Application Notes and Design Review**.

- **Foundation Fieldbus Installation Guide**.

- **Fieldbus Pre-commissioning Procedure**.

- **Fieldbus Troubleshooting Guide**.
Designing Fieldbus Segments - Summary

1. Select the proper instrumentation
2. Group according to location & control function
3. Lay out fieldbus segment
4. Check segment length & spur length
5. Check current draw & voltage drop
6. Check communications loading
7. Choose wiring methods
8. Choose components