Fieldbus Foundation – India Committee

Fieldbus Foundation
FFIC + ISA Fieldbus Foundation Conference-2010

Date : 6th February, 2010 (Saturday)
Time : from 09:00 am to 05:30 pm.
Venue : IIT Convention Centre
         Gajendra Circle, IIT Campus,
         Adayar, Chennai.

Author
Fieldbus Physical Layer Design

Jayanta Ghosh
MTL Cooper Crouse Hinds

On behalf of
Fieldbus Foundation ™ India Committee
What is a Fieldbus?

Foundation Fieldbus is the most advanced and scalable process automation infrastructure. It is more than a replacement for 4-20mA. It manages data communication, plant assets and plant events, and it is Open and standards-based.

A fieldbus is a serial digital bus optimised for response time and predictable data transmission between field devices, sensors and actuators.
Topics for the day ..........

- Physical layer firmwares ....
- Wiring and Interconnection
- Topologies
- Design & Design tools
- Good Installation practices
- Good Earthing/Grounding/Testing
Physical layer elements – For all areas & purpose

- Host Computer
- 24VDC Power supply / Conditioner
- FF Power Supply & Conditioner & Terminator
- Wiring Block & Terminator
- H1 Interface
- Cable
- Trunk
- (non-IS) Spurs
- Device 1
- Device 2
- Device 3

This concept is typically applied to:
- Any kind of instrument in the safe (non hazardous) area
- Any FF field instruments in Zone 2
- Any FF Field instrument in Zone 1
Cable Length Calculation Limits

<table>
<thead>
<tr>
<th>Cable Type</th>
<th>H1 Total Length*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1900 m / 6234 ft</td>
</tr>
<tr>
<td>B</td>
<td>1200 m / 3937 ft</td>
</tr>
<tr>
<td>C</td>
<td>400 m  / 1312 ft</td>
</tr>
<tr>
<td>D</td>
<td>200 m  / 656 ft</td>
</tr>
</tbody>
</table>

# of Devices | Total Max Spur Length**
---|------------------------
25 - 32 | 1 m  /  3 ft
19 - 24 | 30 m /  98 ft
15 - 18 | 60 m / 197 ft
13 - 14 | 90 m / 295 ft
2 - 12  | 120 m / 394 ft

* Total length including all spurs
** Maximum length of any spur

Terminators and power supplies not shown
Example: Type A cable: Shielded twisted pair

- Recommended
- “Type A” does not specify the diameter; You can get type A cable in AWG 22, AWG 18, AWG 16, etc
- “Type A” is also available as multicore: as long as individual pairs are twisted and shielded, it is “type A”
Different FFPS available:
Field Wiring Blocks available
Fieldbus for safe area application

- Host control system
- Instrument Management Software (including fieldbus diagnostics)
- Fieldbus power supply system
- Field junction box
- Controller I/O
  - Basic failure alarms
Fieldbus for Hazardous Area - Zone 1 & 2....Two methods

Energy Limited Trunk
- FISCO (Intrinsically Safe) for Zone 1
- FNICO (Non Incendive) for Zone 2

High Energy Trunk
- Fieldbus Barrier (IS & Non IS combination)
Energy limited trunk - Principle

Control system

24Vdc

Entity/FNICO/FISCO power supply

CONTROL ROOM

Live-workable trunk

FIELD

Live-workable spurs

© 2010 Fieldbus Foundation
Typical Segment Calculation: 12 fieldbus devices in IIB

- For 12 fieldbus devices @ 17mA/device
  - Consider one device in short-circuit
  - $\Sigma i = (11 \times 17) + 42 + 3 = 232\text{mA}$
- Assume 9.5V @ field devices
  - 0.5V margin over FF limit
- Assume 1.5mm$^2$ cable
  - 24.0 ohms/km loop
- Assume 60m spur length:
  - Voltage drop in spur = $0.017 \times 24 \times (60/1000) = 0.03\text{V}$
- Voltage @ Megablock trunk
  - $= 9.5 + 0.03 + 0.1 = 9.63\text{V}$
- Max. voltage drop in cable
  - $= 12.9 - 9.63 = 3.27\text{V}$
- $R_{\text{cable max}} = 3.27/0.232 = 14.09\text{ ohms}$
- Max cable length
  - $= (14.09 \times 1000)/24 = 585\text{m}$
Typical Segment Calculation: 8 fieldbus devices in IIB

- For 8 fieldbus devices @ 17mA/device
  - Consider one device in short-circuit
  - \( \Sigma i = (7 \times 17) + 42 + 3 = 164mA \)
- Assume 9.5V @ field devices
  - 0.5V margin over FF limit
- Assume 1.5mm\(^2\) cable
  - 24.0 ohms/km loop
- Assume 60m spur length:
  - Voltage drop in spur = \(0.017 \times 24 \times (60/1000)\) = 0.03V
- Voltage @ Megablock trunk
  = 9.5 + 0.03 + 0.1 = 9.63V
- Max. voltage drop in cable
  = 12.9 – 9.63 = 3.27V
- \( R_{cable\ max} = \frac{3.27}{0.164} = 19.94 \) ohms
- Max cable length
  = \((19.94 \times 1000)/24 = 831m \)
High Energy Trunk concept for Zone 1 & Zone 2

- High energy Ex e trunk
- Control system
- Redundant FF power supply

GAS
- Zone 1
- Division 2

DUST
- Zone 21

FIELD
- Zone 1/0
- Division 1

FISCO or Entity fieldbus devices

Live-workable Ex i spurs

© 2010 Fieldbus Foundation
High Energy Trunk concept (HET/HPT)

Control system

Redundant FF power supply

GAS

Zone 1
Division 2

High energy
Ex e trunk

CONTROL ROOM

DUST

FIELD

Zone 21

9311-FB
fieldbus barriers

Live-workable
Ex i spurs

Zone 1/0
Division 1

FISCO or Entity fieldbus devices

Zone 21/20

© 2010 Fieldbus Foundation
High Energy Trunk Solution with components....

- Live disconnect switches: allow replacement of a faulty fieldbus barrier
- Ex e wiring block under plastic cover: allows opening compartment to access switches
- Separate terminator: segment still terminated even if any of the fieldbus barriers removed
- Surge protection: often required since built-in SP’s are only basic (for very small surges)
- Wiring, ducting: clean wiring required to avoid wrong maintenance
- Wiring blocks: Required for incoming field wiring as terminals on FBB are not replaceable
**Advanced HET**

- Pluggable trunk surge protector (optional)
- Pluggable Terminator
- Trunk terminals
- Trunk Terminal Assembly (TTA) housing

“Live pluggable” 6-spur Fieldbus Barrier module

- Spur surge protector (optional)
- Screw-secured, pluggable spur terminals

© 2010 Fieldbus Foundation
“Hot-pluggable” system components

All system components are pluggable, even in the hazardous area:

- Safer, easier maintenance
- Allows expansion from 6 to 12 spurs per enclosure
- Install trunk and/or spur surge protection modules during initial installation or as retro-fit
- Faster fault diagnosis by substitution
Pluggable Fieldbus Barrier modules

Fieldbus Barrier modules may be removed and replaced while powered in the hazardous area without ‘gas clearance’
- no additional isolating switches
“Honey, I shrunk the Fieldbus Barrier”

New generation Fieldbus barriers are up to 50% smaller than conventional Fieldbus Barrier implementations, leading to significant savings in infrastructure and installation costs.
On-line diagnostic monitoring

Host control system

Instrument Management Software (including fieldbus diagnostics)

Fieldbus power supply system

Controller I/O

On-line Diagnostic Module

Field junction box

© 2010 Fieldbus Foundation
Good diagnostic information

No, this guy did not swallow a shoe.

Tools need to be suitable for the people who use it!
Examples of useful diagnostics

- **Shield short**
  - Easy to measure and understand
  - Further measurements can identify location

- **Signal level**
  - Minimum level is specified by Fieldbus specification
  - Low or high levels on all devices suggests incorrect bus termination
  - If only one device, suggests problem on single spur

- **DC voltage**
  - Indicates correct function of power supply/conditioner

- **Noise**
  - Maximum level is specified by Fieldbus specification
  - Tri-band measurement helps identify source

- **Retransmissions**
  - Good measurement of physical layer health
  - Re-tries can obscure faulty device or network
Lightning strike effects

A Typical scenario: A transmitter mounted at top of vessel separated from JB. Distance to JB is 50m.

Typical inductance across conductor/plant bond = 0.1uH/m

\[ V = L \times \frac{di}{dt} = 0.1 \text{ uH/m} \times 50 \text{m} \times 100 \text{kA} / 10 \mu s \]

Lightning Surge current at top of vessel = 100kA

Rise time = 10us

\[ V = 0.1 \times 50 \times 100,000 / 10 \times 10^{-6} \]

Therefore 50kV could appear across the transmitter electronics and the instrument cable based on a typical surge current of 100kA.
Surge protection applied to Trunk & Spurs

Physical separation of device 8 exceeds 50m horizontally/5m vertically

Trunk length >50m

FF Power Supply or FISCO supply

Host

Bulk Power supply

A₁

B₁

JB

L₁

L₂

L₃

L₄

L₅

L₆

L₇

L₈
Hand held Fieldbus Signal Generators & testers
Good Wiring Practices

1. Test segment wiring before connecting components
2. Avoid damaging the wire when removing insulation
3. Ground the cable shield only at one point (at the control room end)
4. Insulate the ungrounded end of the cable shield (at the instrument)
5. Use crimp ferrules
   - Ferrule diameter must fit wire
   - Crimp tool must fit ferrule
   - Ferrule must fit terminals
6. Maintain polarity and associated color codes throughout the segment
Good Wiring Practices

- Lessons learned:
  - Torque screwdriver
  - Wire end ferrules
  - Right (!) wire strippers
  - Fieldbus tester

Choose right size

Harms wire strands
Project Procedure

Best practice:

- Bench test
  Functional tests and interoperability test
- FAT
- SAT
Installation Guidelines

10 Cable Tests
   - Experience has shown that new cable irregularities are so infrequent that it is more efficient to check cable after installation

10 Cable Installation
   - Verify that cable is properly installed, bypassing impact from wiring components

10 Segment Checkout
   - Check of proper wiring of wiring components

10 Device installation
   - Check of proper device installation

10 Loop checkout
   - Functional test
Installation tools

Portable fieldbus diagnostic test equipment

- Measures relevant fieldbus parameters
- Establish baseline after commissioning
Connect at respective location to obtain accurate measurement.
Earthing/Grounding

- Grounding in the control room
- One point grounding only
- Continuous shield from control room to the field
- Shield not connected at the field instrument

© 2010 Fieldbus Foundation
Earthing/Grounding

- Host Computer
- H1 Interface
- 24VDC
- FF Power Supply & Conditioner & Terminator
- Wiring Block & Terminator
- Device 1
- Device 2
- Device 3
Earthing/Grounding

Host Computer

H1 Interface

24VDC

FF Power Supply & Conditioner & Terminator

Fieldbus barrier & Terminator

Fieldbus barrier / Megablock

Intrinsically Safe Spurs

Device 1

Device 2

Device 3
Thank you all................

And

Keep enjoying the benefits of Fieldbus technology of today, tomorrow & thereafter................

See you all now & then