FOUNDATION™ Fieldbus in Hazardous Areas

Physical Layer Concept

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NOREX / MTL
FF Basic Information

Fieldbus control system (DCS)

FF Power Supply

Trunk

Spur

Field wiring hub w. Short circuit protect.

31.25 Kbit/s
32 Address
12 dev. @ 1s scan

Min. 9V
Min. 10mA
Typical 12-16 devices.

Tx @ 14 mA
Pos @ 22mA
FF Basic Information

Signaling waveforms for the 31.25 kbit/s Fieldbus

Fieldbus Device

Device Current

0
Receiving
Transmitting

15 to 20 mA p-p

Fieldbus Signal

Voltage

0.75 to 1.0 V p-p

Power
9 to 32 Volts

Time

Fieldbus Network

100 Ohm

C

Power Supply

C

Terminator C is sized to pass 31.25 kbit/s.

Note: As an option, one of the terminators may be center-tapped and grounded to prevent voltage buildup on the fieldbus.
Fieldbus in hazardous areas

Fieldbus control system (DCS)

Hazardous Area protection?

Bulk power

Special protection for fieldbus power supply?

What approvals for wiring hub and junction box?

What approvals for Fieldbus devices?

FIELD

FOUNDATION Fieldbus Devices

Hazardous area

CONTROL ROOM
## Methods of protection

<table>
<thead>
<tr>
<th>Method of protection</th>
<th>Zone 2</th>
<th>Zone 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex d field devices and Ex e junction boxes</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ex i/Intrinsically Safe ENTITY or FISCO</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Exe – Exi/Fieldbus Barrier</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ex nL / FNICO</td>
<td>✓</td>
<td>❌</td>
</tr>
<tr>
<td>Ex nA, Non-Arcing</td>
<td>✓</td>
<td>❌</td>
</tr>
</tbody>
</table>
Ex-d / Ex-e Fieldbus

Fieldbus control system (DCS)

Bulk power

Ordinary Safe Area Power Supply
Single or Redundant

CONTROL ROOM

FIELD

No live maintenance!

Ex-e Field Wiring Hub

Ex-d / Ex-e Instruments

Hazardous area

FOUNDATION Fieldbus Devices
`Entity` Intrinsically Safe Fieldbus

Fieldbus control system (DCS)

Bulk power

IS Fieldbus power supply
Typical 80mA output

CONTROL ROOM

FIELD

Hazardous area

FIELDbus control system (DCS)

Entity certified devices!

Max 4 Fieldbus devices!

FOUNDATION Fieldbus Devices

For all $U_i \geq U_o$
For all $I_i \geq I_o$
All $P_i \geq P_o$
$\sum C_i + C_c \leq C_o$
$\sum L_i + L_c \leq L_o$
Introducing FISCO

- Fieldbus Intrinsically Safe Concept, IEC 60079-27
  - Provides more current to IS trunk than earlier ‘Entity’ model, and hence more field instruments
  - Proven by tests performed at PTB
  - Simplifies design and installation
  - Reduces documentation
  - First simplification of explosion protection techniques for many years!

Source: Dr. Ulrich Johannsmeyer, PTB
FISCO requirements

- All instruments FISCO certified
- Power Supply must be FISCO certified
- Field cables must conform to the following specification:
  - loop resistance must be between 15 and 150ohms/km
  - loop inductance must be between 0.4 and 1mH/km
  - loop capacitance must be between 45 and 200nF/km
  - maximum length of each spur cable is 60m in IIC and IIB
  - maximum length of each trunk cable is 1km in IIC or 5km in IIB

- The limits are not restrictive
  - typical Fieldbus cable has parameters of 50ohms/km, 0.8mH/km and 120nF/km
FISCO installation

Fieldbus control system (DCS)

FISCO power supply (IIB / IIC)

24Vdc

CONTROL ROOM

Intrinsically Safe Field wiring hub

FIELD

Intrinsically safe FISCO Fieldbus devices

Zone 1
Division 1

Live Maintenance !
Multiple hazardous area trunks

Direct parallel connection on safe area side

24Vdc

Trunk #2

Trunk #3

Intrinsically safe FISCO Fieldbus devices

Zone 1

Division 1
Redundant FISCO architecture

Bulk power input 24Vdc → Redundant FISCO power supply

Intrinsically Safe trunk and spurs

Intrinsically safe FISCO Fieldbus devices

FIELD Zone 1

Intrinsically Safe Field wiring hub

CONTROL ROOM
More field devices with FISCO

- Entity, IIC/IIB Gas Groups
  - 80mA available, typically 3 - 4 devices

- FISCO, IIC Gas Groups
  - 120mA available, (140mA) typically 6-8 devices

- FISCO, IIB Gas Groups
  - 265mA available, (280 mA) typically 14-16 device

Zone 1
Division 1
FB Fieldbus Barriers: Exe/Exi concept

- Galvanic isolation and IS “barrier” in the field.
- Ex-e trunk with higher current available
- Zone-1 mountable fieldbus wiring hub for Intrinsically safe fieldbus devices
- Supports FISCO and ‘Entity’ field devices
Fieldbus Barrier

Fieldbus control system

Increased safety (Ex e) trunk

Power supply
Singel or Redundant
Up to 8 channel modules available

CONTROL ROOM

FIELD

Fieldbus Barriers

IS spurs

Intrinsically safe Fieldbus Devices
Fieldbus Barrier across Zones
Comparision of Protection Techniques used in Hazardous Area
## ‘Entity’ IS vs. FISCO

<table>
<thead>
<tr>
<th>Feature</th>
<th>Entity IS</th>
<th>FISCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsically safe trunk and spurs?</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>‘Live-working’ permitted in any part of field network?</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Simple safety documentation?</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Eliminate cable parameter calculations?</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Gas Group IIB option?</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Max output current</td>
<td>80mA</td>
<td>265mA</td>
</tr>
<tr>
<td>Max spur length</td>
<td>120m</td>
<td>60m</td>
</tr>
</tbody>
</table>
## FISCO vs. Fieldbus Barrier

<table>
<thead>
<tr>
<th></th>
<th>FISCO</th>
<th>Fieldbus Barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS Spur? Live Maintenance?</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>IS Trunk? Live Maintenance?</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Simple documentation?</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Redundant Power</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Redundant Field Wiring Hub</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Compatible with FISCO field devices?</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Compatible with Entity field devices?</td>
<td>✓ Only with spur connector!</td>
<td>✓</td>
</tr>
</tbody>
</table>
Introducing FNICO

**Fieldbus Non-Incendive Concept**
- For fieldbus in Zone 2 and Division 2 hazardous areas
- Complete field network is Non-Incendive EEx nL
- Live-workable throughout without gas clearance, just like Intrinsic Safety
- Based on FISCO, the Fieldbus Intrinsically Safe Concept
- Easy to install, easy to document, easy to maintain.
Key benefits of FNICO

- **Wide choice of suitable field devices:**
  - IS ‘Entity’ certified
  - FISCO certified
  - Ex nL certified

- **Relaxed installation rules**
  - Don’t need to comply with IS segregation rules
  - FNICO cables can share cable trunking with non-IS circuits

- **More available current than FISCO in IIC/Group A:**
  - FISCO: 120mA
  - FNICO: 180mA
Typical FNICO installation

Fieldbus control system (DCS)

FNICO power supply

24Vdc

CONTROL ROOM

FIELD

Ex n or Intrinsically Safe Field wiring hub

Division 2 Zone 2

Non-incendive or Intrinsically safe Fieldbus devices

Also has repeater function for multiple trunks

Live-workable Non-incendive trunk and spurs

Non-incendive or Intrinsically safe Fieldbus devices
How many field devices?
FISCO / FNICO

- **Entity, IIC/IIB Gas Groups**
  - 80mA available, typically 3 - 4 devices

- **FISCO, IIC Gas Groups**
  - 120mA available, typically 6-8 devices

- **FISCO, IIB Gas Groups**
  - 265mA available, typically 14-16 devices

- **FNICO, IIB Gas Groups**
  - 320mA available, typically 18-20 devices

Assumes 17mA per field device

- **Zone 1/Division 1**
- **Zone 2/Division 2**
FF Installation Advices
Surge protection for fieldbus

Fieldbus installations are more vulnerable to surge damage than conventional ‘point-to-point’ wiring

- DIN rail mount Fieldbus surge protector for the power supply, host and Fieldbus Barrier
- Threaded entry Fieldbus surge protector for field instrument

- Recommended surge:
  - If >100m between devices
  - OR >10m vertically
Fieldbus Maintenance and Diagnosis

- Diagnostic modules
- Fieldbus testers

- Devices on net
- # transmissions
- # failed transmissions
- Retransmission rate
- Average noise in diff.bandwidth
- Peak noise in diff.bandwidth
- Voltage level of all devices
- Signal level of all devices
- Short Circuit of all dev.
How to connect Non FF Field Devices to FF?
Digital IO and Temperatur Mux

- 8 DI / 4 DO (low power)
- ATEX certified zone 1 & 2

- 8 ch Temp. Multiplekser
- RTD and THC
FF Remote IO

- Remote IO for Zone1
- IO modules for Exi and Exe
FF Displays

Field Mounting

- 1 Address on the net
- FISCO compliant
- ATEX certified zone 1 & 2
- Non-Hazardous area

Panel Mounting
FF Structure Example
Typical Cabinet Layout

32 segments per cabinet side:

24 segments per cabinet side: with bulk power supply
In summary...

- **FISCO - IS solution for Zone 1**
  - Intrinsically safe wiring: safe maintenance

- **Fieldbus Barrier - High power Trunk Zone 1**
  - More field devices per segment in IIC gases
  - Compatible with FISCO and ENTITY

- **FNICO delivers “FISCO benefits” in Zone 2**

- Advanced Diagnosis available

- Many ways to include non-FF signals

- Don’t forget surge protection!

- REMEMBER GROUNDING!
Thank you!