Foundation Fieldbus
Cable Specification FF-844
Status & Outlook

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Overview

- Introduction
- Standards for Fieldbus Cables
- Intrinsic Safety Concept
- Requirements for Foundation Fieldbus
- Cable Design and Materials
- Fire Behaviour
- Installation
- Product Overview ICON®Bus for Foundation Fieldbus
- Conclusion & Outlook
Foundation Fieldbus

- Cables based on one common standard
  - defined cable design parameters
  - defined electrical properties

to

- cover different Fieldbus applications
- guarantee high quality level of product
- enable users to easily select the right cable for their application
Standards for Foundation Fieldbus cables

- Cable specification Foundation Fieldbus FF-844 H1
- Cable design based on EN 50288-7 or UL 13 / UL 2250
  - no listing for EN type products
  - UL type products may be UL listed

- Electrical properties: FF-844 H1 and IEC 61158-2, type A
  - IEC 61158-2, type A
    - has the most severe requirements,
    - restricted to singlepairs, whereas FF-844 H1 specifies multipairs, too
    - IEC 61158-2 types B to D should not be referred to for fieldbus cables
  - FF-844 H1
    - electrical properties of each pair in multipair cables shall be according to IEC 61558-2, type A
Standards

- Standards for Foundation Fieldbus cables
  - Demands on intrinsically safe cables and installations
    - IEC 600079-14, Intrinsically Safe Cables
    - IEC 600079-27, Field Intrinsically Safe COnccept (FISCO)
The Basic Principle of Ignition Protection

Intrinsically Safe “i”

- For the ignition of a potentially explosive atmosphere a specific energy is necessary.
- The ignition protection intrinsically safe makes sure that the “existing” energy can not ignite the explosive atmosphere.
- An intrinsically safe electric circuit may not be the reason for an ignition. This applies for normal operating conditions and in case of faults (e.g. short circuits).
Classification of hazardous areas ("zones") according to IEC 60079-14

Classification depending on risk of ignition

- Zones 0, 1 & 2
classify explosive atmosphere of air / flammable gas, vapour or mist
- Zones 20, 21 & 22
classify explosive atmosphere of air / cloud of combustible dust

- Zones 0 & 20: permanent risk
- Zones 1 & 21: occasional risk
- Zones 2 & 22: risk not likely; when occurring, will persist only for short period
Device category ia and ib, according to standard IEC 60079-11

- Category ia suitable for Zone O:
  - In case of 2 independent faults it is not allowed to have an ignition.

- Category ib suitable for Zone 1 and 2:
  - In case of 1 fault it is not allowed to have an ignition.
Intrinsic Safety

- Demands on Intrinsically Safe Cables according to IEC 60079-14
  - Flame retardant according to IEC 60332-1
    (unless the cables are laid in earth, in sand-filled trenches/ducts or otherwise protected against flame propagation)
  - Mutual capacitance: max. 200 pF/m
  - Inductance: max. 1 µH/m or L/R-Ratio: max. 30 µH/Ohm
    (L: loop inductance / R: Loop resistance)
  - Radial thickness of insulation: min. 0.2 mm
  - Test Voltage Ueff: min. 500 V
  - Diameter of conductor: min. 0.1 mm, has to be applied for single strands of e.g. multistranded conductor too


**Intrinsic Safety**

- **Standard IEC 60079-27, FISCO and FNICO**
  - **Field Non-Incendive COncept (FNICO)**
  - **Field Intrinsically Safe COncept (FISCO)**
    - Demands on ignition protection intrinsically safe IS
    - All participants in the bus (devices) must be “FISCO”-approved
    - Every field device takes up a constant basic current of at least 10mA
    - Only one supply source per fieldbus segment
    - Ignition protection type ia (Zone O), maximum cable length 1000 m and with ignition protection ib (Zone 1 and Zone 2) 1900 m
    - Maximum length of each spur cable: 60 m for device groups IIC, IIB
    - Maximum length of each trunk cable, including all spur cables 1 km for device group IIC and 5 km for device group II
Intrinsic Safety

- **Standard IEC 60079-27, FISCO and FNICO**

  - Parameter for the fieldbus-IS
    - loop resistance \( R = 15 \ldots 150 \ \Omega/km \)
    - loop inductance \( L = 0.4 \ldots 1 \ \text{mH/km} \)
    - mutual capacitance \( C = 45 \ldots 200 \ \text{nF/km} \)
### General requirements for Foundation Fieldbus cables, FF-844 H1, revision 1.2, January 26, 2009

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>characteristic impedance</td>
<td>$100 , \Omega \pm 20%$</td>
</tr>
<tr>
<td>attenuation</td>
<td>$&lt; 3 , \text{dB/km}$</td>
</tr>
<tr>
<td>capacitive unbalance to shield ICON® Bus</td>
<td>$\leq 4 , \text{nF/km}$</td>
</tr>
<tr>
<td></td>
<td>(The higher the value the higher is the interference susceptibility)</td>
</tr>
<tr>
<td>temperature range</td>
<td>$-30^\circ\text{C to } +90^\circ\text{C}$</td>
</tr>
<tr>
<td>conductor</td>
<td>tinned, annealed copper</td>
</tr>
</tbody>
</table>
Conductor materials for fieldbus cables

- Plain, annealed copper
  - suitable for most applications, most common conductor material
  - excluding high temperatures >130°C
- Tinned copper (FF-844 H1 cable specification)
  - temperatures up to 180°C
- Silver plated copper
  - temperatures up to 200°C
- Nickel plated copper
  - temperatures up to 260°C

Restriction to tinned conductors means

- abandonment of the most common conductor material
- exclusion of all high temperatures applications
Cable Design

Conductor dimensions

- FF-844 H1 refers to different standards
  - FF-844 H1 specifies min. AWG 18 (approx. 0.9 mm²)

- Common conductor makeups are
  solid, 7-stranded, flexible stranded (i.e. 19 stranded)

<table>
<thead>
<tr>
<th>standard</th>
<th>specified unit</th>
<th>dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>FF-844 H1</td>
<td>AWG</td>
<td>18 (min.)</td>
</tr>
<tr>
<td>EN 50288-7</td>
<td>mm²</td>
<td>0.5 / 0.75 / 1.0 / 1.5 / 2.5</td>
</tr>
<tr>
<td>UL 13 / UL 2250</td>
<td>AWG</td>
<td>22 (min.)</td>
</tr>
</tbody>
</table>
Commonly used insulation materials

- foam skin polyethylene (02YS)
- solid polyethylene (2Y)
- crosslinked polyethylene (2X)
- perfluoro alkoxyalkane (PFA) for temperatures >150°C

Comparison of some properties of insulation materials

<table>
<thead>
<tr>
<th>property</th>
<th>foam skin PE</th>
<th>solid PE</th>
<th>XPE</th>
<th>FEP</th>
<th>PFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>signal velocity [% of (c_0)]</td>
<td>77</td>
<td>66</td>
<td>66</td>
<td>69</td>
<td>71</td>
</tr>
<tr>
<td>max. temperature</td>
<td>70°C</td>
<td>70°C</td>
<td>90°C</td>
<td>200°C</td>
<td>260°C</td>
</tr>
</tbody>
</table>

Restriction to min. 90°C in FF-844 H1 means

- exclusion of the best material in terms of signal velocity
Screens for Foundation Fieldbus cables

- overall screen for singlepair cables
- individual and overall screen for multipair cables

Screen types
- plastic coated aluminium tape in contact with drain wire (ST)
- plastic coated aluminium tape in contact with copper wire braid (ST+C)
- plastic coated aluminium tape in contact with drain wire and copper wire braid (ST+Ce)
Armour types

- copolymer coated, corrugated, overlapped steel tape (SR)
- round steel wire armour (SWA)
- steel wire braid (Q)
Extended chemical protection

- special oil resistant PVC, Yö
- multi layer sheath, (L)2Y4Y, “ALNYC*”)’ sheath
  - a multilayer sheath can replace a lead sheath.
  - inner layer of plastic coated aluminium tape (L)
  - inner sheath of polyethylene (2Y)
  - outer sheath of polyamide (4Y)

*) ALNYC:
   - AL Aluminium tape, polyethylene laminated
   - NYC Sheath of polyamide, Nylon Coating

lead sheath (M)
- layer of lead
- cover (sheath) of plastic
Sheath materials

- Polyvinyl chloride (PVC)
  - is the most common material
  - flame retardant, but
  - emits corrosive and poisonous gases in case of fire

- Low smoke, zero halogen, flame retardant compound (LSZH)
  - for extended safety in case of fire
  - low smoke emission, no corrosive or poisonous gases in case of fire
  - for protection of human life and material assets

- High temperature applications
  - Perfluoroethylene propylene copolymer (FEP)
  - Perfluoro alkoxyalkane (PFA)

- Other materials
  - to be selected based on application
Flame retardence behaviour

Generally cables pass several fire tests

- single cable tests IEC 60332-1, UL 1581
- bunched cable tests IEC 60332-3-24, UL 1685

To increase safety low smoke, zero halogen cable designs are available

- smoke emission IEC 61034, light transmittance min. 60% (PVC max. 40%)
- halogen content IEC 60754-1
- corrosivity of smoke gases IEC 60754-2

These LSZH designs are especially suited for

- low smoke, no corrosive and/or poisonous gases in case of fire
- for protection of human life and high value material assets
Fast Assembly (FA)

- For quick and easy installation
- Using special stripping tool
- Cable design with extruded inner sheath and without drain wire
FOUNDATION Fieldbus FF (H1) spur and trunk cables, single pair (excerpt)

- fixed installation indoor and outdoor, on racks, in conduits

- suitable for fast assembly

- flexible installation indoor and outdoor, on racks, in conduits

- fixed installation indoor and outdoor, on racks, in conduits. For direct burial
FOUNDATION Fieldbus FF (H1) spur and trunk cables, multi pair (excerpt)

- in addition to single pair designs multi pair versions are available
- electrical properties of each pair are like in single pair cable
- installation area like single pair designs

- fixed installation
- flexible installation
- Fast Assembly
- armoured for direct burial
Foundation Fieldbus by LEONI Kerpen GmbH

- FF-844 H1
- IEC 61158-2, type A
- EN 50288-7 or UL13/UL2250
- ISA S50.02-1992 (physical layer standard) for FF Fieldbus

- Multipair cables with “Type A” properties
- Foundation Fieldbus cables with UL-approval
- Different armour types
- Cables with chemical protection
- High temperature versions
- Tailor made solutions
Foundation Fieldbus cable specification

- provides a very good frame for design and properties of fieldbus cables
- is focused on high quality products
- refers to designs based on common standards

Further improvements

- conductor to be selected based on application (copper; plain, tinned, silver- or nickel plated)
- temperature range (min. requirements) -30°C to +70°C
  - include foamskin PE as best insulation material in terms of electrical properties
- generally refer to IEC 61158-2, type A for electrical properties
What is the dedication of the Foundation Fieldbus cable specification

- set a common standard for high quality fieldbus cables
  - referring to state-of-the-art standards
- cover today’s established fieldbus technologies
  - ensure use of the best suited materials
- be open for higher level applications like
  - at high temperatures
  - more stringent electrical requirements than type “A”
- ensure a standard in accordance with related equipment standards, like for connectors, field devices

Other topics to ensure
- customer related requirements
- possible local requirements