PROFIBUS
Design and
Good Practices
Agenda
PROFIBUS Family
Communication Medias
Topologies
Cable length
Devices Rules
Installation Rules
Troubleshooting
Training

www.profibus.com.sg
To create hierarchy in the network, PROFIBUS defines 2 types of stations: active (masters) and passive (slaves).

- At least 1 master is mandatory.
- PROFIBUS networks allow multiple masters.
- In total 127 stations can be addressed (masters + slaves).
PROFIBUS Supports 3 transmission media

- **RS 485**: 2-wire CU-cable for general purposes
- **Fiber Optic**: Highest EMC protection and wide distances
  - MBP-IS: 2-wire CU-cable with the option for power over the bus and Ex-protection
Total Overview of the Technology

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- Training

- PA Devices
- RIO for PA
- SEMI
- PROFIdrive V2.0 and V3.0
- Identification Systems
- Weighing & Dosage
- Encoder

Common Application Profiles (optional):
- PROFlsafe, Time Stamp, Redundancy, etc.

IEC 61158/61784

PROFIBUS DP

FDL + DP-V0...V2

Physical Layer
- RS 485
- RS 485-IS
- NRZ
- Intrinsic Safety

Fiber Optics:
- Glass Multi Mode
- Glass Single Mode
- PCF / Plastic Fiber

Integration Technologies

Descriptions (GSD, EDD)
Tools (DTM, Configurators)

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PROFIBUS communicates over a two wire bus structure.

- Devices are addressed through a network address (0..126).
- Devices are coupled in parallel to the bus.
- Devices can be hot swapped and position does not matter.
- Each segment is terminated at both end with an active termination.
- Spurs should be avoided as length is very limited.

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**Benefit:** Isolate part of your network from EMC/Noise

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**PROFIBUS DP Topologies – Fiber Optic**

**Classic Topology**
- Fiber optic cable
- Coupler

**Ring Topology**
- Fiber optic cable
- Coupler

**Benefits:** Long distances and EMC/Noise isolation

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Connect your slaves through wireless couplers
PROFIBUS DP Topologies - Redundancy

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PROFIBUS PA Topologies - Overview

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PROFIBUS PA Topologies - Redundancy

**Coupler Redundancy**

- **Coupler-Redundancy**

PROFIBUS DP

- DP/PA-coupler, redundant (M = master)
- IM 153, redundant

**PA Ring Redundancy**

- **Coupler-Redundancy**
- Media redundancy based on a ring topology

PROFIBUS DP

- DP/PA-coupler, redundant (M = Master)
- IM 153, redundant

**Active Field Distributor (AFD)**

- AFD
- PROFIBUS PA

**Active Field Splitter (AFS)**

- AFS
- PROFIBUS PA

- Bus termination
- Automatic bus termination

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Transmission speed (baudrate)

PROFIBUS offers the user the possibility to choose from 10 transmission speeds (RS 485).

<table>
<thead>
<tr>
<th>Transmission Speed (kbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9,6</td>
</tr>
<tr>
<td>19,2</td>
</tr>
<tr>
<td>45,45</td>
</tr>
<tr>
<td>93,75</td>
</tr>
<tr>
<td>187,5</td>
</tr>
<tr>
<td>500</td>
</tr>
<tr>
<td>1500</td>
</tr>
<tr>
<td>3000</td>
</tr>
<tr>
<td>6000</td>
</tr>
<tr>
<td>12000</td>
</tr>
</tbody>
</table>

Remarks:
- The transmission speed determines the maximum cable length and vice versa.
- The transmission speed has to be set identically at all the masters on the same bus.
- Most slaves detect the baudrate automatically.
- Because of economic and technical reasons some products do not support all transmission speeds.
- Some older products do not support 45,45 kbps.
### PROFIBUS DP – Cable Length

#### Baudrate vs Cable Length

<table>
<thead>
<tr>
<th>Baudrate (kbit/s)</th>
<th>9.6</th>
<th>19.2</th>
<th>45.45</th>
<th>93.75</th>
<th>187.5</th>
<th>500</th>
<th>1500</th>
<th>3000</th>
<th>6000</th>
<th>12000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment length (m)</td>
<td>1200</td>
<td>1200</td>
<td>1200</td>
<td>1200</td>
<td>1000</td>
<td>400</td>
<td>200</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Segment length (feet)</td>
<td>3940</td>
<td>3940</td>
<td>3940</td>
<td>3940</td>
<td>3280</td>
<td>1310</td>
<td>656</td>
<td>328</td>
<td>328</td>
<td>328</td>
</tr>
</tbody>
</table>

- **3 baudrate transitions in which the cable length reduces with more than 50%**.

- **These lengths are defined for 1 segment with 32 bus loads!**
### PROFIBUS Address Map

<table>
<thead>
<tr>
<th>Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Service-, diagnosis- and programming tool</td>
</tr>
<tr>
<td>1..2</td>
<td>Masters (class 1)</td>
</tr>
<tr>
<td>3..125</td>
<td>Slaves (total 123 or 124)</td>
</tr>
<tr>
<td>126</td>
<td>Address for: “Set Slave Address”</td>
</tr>
<tr>
<td>127</td>
<td>Broadcast address</td>
</tr>
</tbody>
</table>

- Most configuration tools block address 0 and 126 for slaves.
- Address 126 is a default address for slaves with software address settings.
- Address 127 is a broadcast address (only visible with a busmonitor).
- Maximum 124 DP slaves per bus!!!!!!
Device Rules - DP Segments

- **Maximum 32 loads per RS485 segments**

- **Devices that generate new segments:**
  - Repeaters
  - Fiber Optic Couplers
  - Wireless gateways

- **After these devices, PROFIBUS segment rules are the same.**

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**Device Rules - DP Segments**

- Max 30 Stations
- Max 31 Stations

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Installation rules

- Grounding & Shielding
- PROFIBUS is digital communication, not 4-20mA
- Ground at both end
- Ungrounded shield has no effect
### Power Lines
- Digital communication is sensitive to power lines
- Watch out for cable runs in trays
- Respect distances for air separation

![Diagram of power lines too close](image1.png)

**Power line too close**

![Diagram of power lines removed](image2.png)

**Power line are removed**

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Installation rules

Some examples with Power Lines
Installation rules

- Proper wiring and component selection
  - Wiring and cable termination is critical
  - Wrong component selection leads to bad installation
  - Take environment in account (humidity, sunlight…)

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**Recognizing bad installations**
- You cannot use the multimeter, this is digital comm.
- Specific tools are required

**Find wiring errors such as short circuit**
**Identify missing termination and EMC**
**Capture error messages and find the source of your system shutdown**
**Cost and time saving by using the right tools!**

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Good signal

Missing termination

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Troubleshooting - Analyzer

- Capture all PROFIBUS messages
- Useful for random errors
- Shows underlying conditions
- Device diagnostic

<table>
<thead>
<tr>
<th>FrameNr</th>
<th>Timestamp</th>
<th>Idle time</th>
<th>Attention</th>
<th>Frame</th>
<th>Addr</th>
<th>Service</th>
<th>Msg type</th>
<th>Req/Res</th>
</tr>
</thead>
<tbody>
<tr>
<td>3664497</td>
<td>22-May-2...</td>
<td>43 Bit</td>
<td></td>
<td>SD4</td>
<td>0-&gt;2</td>
<td>Token pass</td>
<td>Pass token</td>
<td>Req</td>
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<td>3664498</td>
<td>22-May-2...</td>
<td>40 Bit</td>
<td></td>
<td>SD2</td>
<td>2-&gt;10</td>
<td>SRD_HIGH</td>
<td>Data Exchange</td>
<td>Req</td>
</tr>
<tr>
<td>3664499</td>
<td>22-May-2...</td>
<td>16 Bit</td>
<td></td>
<td>SD2</td>
<td>2&lt;10</td>
<td>DL</td>
<td>Data Exchange</td>
<td>Res</td>
</tr>
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<td>3664500</td>
<td>22-May-2...</td>
<td>39 Bit</td>
<td></td>
<td>SD2</td>
<td>2-&gt;12</td>
<td>SRD_HIGH</td>
<td>Data Exchange</td>
<td>Req</td>
</tr>
<tr>
<td>3664501</td>
<td>22-May-2...</td>
<td>18 Bit</td>
<td></td>
<td>SD2</td>
<td>2&lt;12</td>
<td>DL</td>
<td>Data Exchange</td>
<td>Res</td>
</tr>
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<td>3664502</td>
<td>22-May-2...</td>
<td>39 Bit</td>
<td></td>
<td>SD2</td>
<td>2-&gt;14</td>
<td>SRD_HIGH</td>
<td>Data Exchange</td>
<td>Req</td>
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<tr>
<td>3664503</td>
<td>22-May-2...</td>
<td>17 Bit</td>
<td></td>
<td>SD2</td>
<td>2&lt;14</td>
<td>DL</td>
<td>Data Exchange</td>
<td>Res</td>
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<td>3664504</td>
<td>22-May-2...</td>
<td>39 Bit</td>
<td></td>
<td>SD2</td>
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<td>Data Exchange</td>
<td>Req</td>
</tr>
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<td>3664505</td>
<td>22-May-2...</td>
<td>36 Bit</td>
<td>Parity error</td>
<td>SD2</td>
<td>2&lt;20</td>
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<td>Req</td>
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<td>22-May-2...</td>
<td>172 Bit</td>
<td></td>
<td>SD2</td>
<td>2-&gt;21</td>
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<td>Data Exchange</td>
<td>Req</td>
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<td>3664507</td>
<td>22-May-2...</td>
<td>316 Bit</td>
<td></td>
<td>SD2</td>
<td>2&lt;21</td>
<td>DL</td>
<td>Data Exchange</td>
<td>Res</td>
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<tr>
<td>3664508</td>
<td>22-May-2...</td>
<td>307 Bit</td>
<td>Repeat (lost)</td>
<td>SD2</td>
<td>2-&gt;21</td>
<td>SRD_HIGH</td>
<td>Data Exchange</td>
<td>Req</td>
</tr>
<tr>
<td>3664509</td>
<td>22-May-2...</td>
<td>316 Bit</td>
<td></td>
<td>SD2</td>
<td>2&lt;22</td>
<td>SRD_HIGH</td>
<td>Data Exchange</td>
<td>Req</td>
</tr>
<tr>
<td>3664510</td>
<td>22-May-2...</td>
<td>307 Bit</td>
<td>Repeat (lost)</td>
<td>SD2</td>
<td>2-&gt;22</td>
<td>SRD_HIGH</td>
<td>Data Exchange</td>
<td>Req</td>
</tr>
<tr>
<td>3664511</td>
<td>22-May-2...</td>
<td>316 Bit</td>
<td></td>
<td>SD2</td>
<td>2&lt;23</td>
<td>SRD_HIGH</td>
<td>Data Exchange</td>
<td>Req</td>
</tr>
<tr>
<td>3664512</td>
<td>22-May-2...</td>
<td>307 Bit</td>
<td>Repeat</td>
<td>SD2</td>
<td>2-&gt;23</td>
<td>SRD_HIGH</td>
<td>Data Exchange</td>
<td>Req</td>
</tr>
<tr>
<td>3664513</td>
<td>22-May-2...</td>
<td>36 Bit</td>
<td></td>
<td>SD2</td>
<td>2&lt;23</td>
<td>DL</td>
<td>Data Exchange</td>
<td>Res</td>
</tr>
<tr>
<td>3664514</td>
<td>22-May-2...</td>
<td>39 Bit</td>
<td></td>
<td>SD2</td>
<td>2&lt;24</td>
<td>DL</td>
<td>Data Exchange</td>
<td>Res</td>
</tr>
<tr>
<td>3664515</td>
<td>22-May-2...</td>
<td>35 Bit</td>
<td></td>
<td>SD2</td>
<td>2-&gt;24</td>
<td>SRD_HIGH</td>
<td>Data Exchange</td>
<td>Req</td>
</tr>
<tr>
<td>3664516</td>
<td>22-May-2...</td>
<td>40 Bit</td>
<td></td>
<td>SD2</td>
<td>2-&gt;24</td>
<td>SRD_HIGH</td>
<td>Data Exchange</td>
<td>Req</td>
</tr>
<tr>
<td>3664517</td>
<td>22-May-2...</td>
<td>49 Bit</td>
<td></td>
<td>SD2</td>
<td>2&lt;25</td>
<td>DL</td>
<td>Data Exchange</td>
<td>Res</td>
</tr>
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<td>3664518</td>
<td>22-May-2...</td>
<td>40 Bit</td>
<td></td>
<td>SD2</td>
<td>2-&gt;25</td>
<td>SRD_HIGH</td>
<td>Data Exchange</td>
<td>Req</td>
</tr>
<tr>
<td>3664519</td>
<td>22-May-2...</td>
<td>54 Bit</td>
<td></td>
<td>SD2</td>
<td>2&lt;25</td>
<td>DL</td>
<td>Data Exchange</td>
<td>Res</td>
</tr>
<tr>
<td>3664520</td>
<td>22-May-2...</td>
<td>40 Bit</td>
<td></td>
<td>SD2</td>
<td>2&lt;26</td>
<td>SRD_HIGH</td>
<td>Data Exchange</td>
<td>Req</td>
</tr>
<tr>
<td>3664521</td>
<td>22-May-2...</td>
<td>62 Bit</td>
<td></td>
<td>SD2</td>
<td>2&lt;27</td>
<td>DL</td>
<td>Data Exchange</td>
<td>Res</td>
</tr>
</tbody>
</table>

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Certified Training by PROFIBUS International

Benefits
- Avoid basic errors that cost time and money
- Quality assurance for design and commissioning
- Faster project delivery
- Better installation, longer operation

Various courses available
- PROFIBUS Certified Engineer
- PROFIBUS Certified PA Module
- PROFIBUS Certified Installer
- PROFINET Certified Engineer

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The end

Thank you for listening

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