Commissioning issues and solutions

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Commissioning Process

- Install the Cables
- Check out the cable installation
- Install the Devices
- Check the device installation

- Install the DCS
- Assigning the I/O
- Calibration the Sensor
- Ranging
- Calibration the 4~20mA
- System Ranging
- System Calibration 4~20mA
Commissioning Process Comparison.

4~20mA
- Install the Cables
- Check out the cable installation
- Install the Devices
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- System Ranging
- System Calibration 4~20mA

Foundation Fieldbus
- Install the Cables
- Check out the cable installation
- Install the Devices
- Check the device installation
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- Ranging
- Calibration the 4~20mA
- System Ranging
- System Calibration 4~20mA
Cable installation

4~20mA

Foundation Fieldbus

- Distance and relevant issue
- Artificial hours and relevant cost
- Cable connection Quantity
- Hidden trouble points
Commissioning Process Comparison.

- **4~20mA**
  - Install the Cables
  - Check out the cable installation
  - Install the Devices
  - Check the device installation
  - Install the DCS
  - Assigning the I/O
  - Calibration the Sensor
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  - Calibration the 4~20mA
  - System Ranging
  - System Calibration 4~20mA

- **Foundation Fieldbus**
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  - Check out the cable installation
  - Install the Devices
  - Check the device installation
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  - Calibration the 4~20mA
  - System Ranging
  - System Calibration 4~20mA
Successful Implementation & Improved Operation

Checking of cable installation.

4~20mA

Foundation Fieldbus

- Distance and connection Quantity
- Tools
Commissioning Process Comparison.

**4~20mA**
- Install the Cables
- Check out the cable installation
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- System Ranging
- System Calibration 4~20mA
Install the Device

Foundation Fieldbus

Host

Distribution Block

Power supply / Conditioner

Cable

FF field devices
Commissioning Process Comparison.

- 4~20mA
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Foundation Fieldbus

- Install the Cables
- Check out the cable installation
- Install the Devices
- Check the device installation
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- Calibration the 4~20mA
- System Ranging
- System Calibration 4~20mA
Assigning the I/O

- Foundation fieldbus devices are recognized by three mechanisms: a **traditional node address** for communication, a human **readable device tag** corresponding to the project P&I diagram, and a **unique identifier** allowing the system to automatically resolve any tag or address conflicts.

- The system **automatically assigns** the address to all devices, avoiding human errors such as address duplication associated with manually managed protocols, and saving time.

- Therefore technicians work **based on tag** and need not be concerned with address.

- Thanks to the **unique identifier**, multiple devices can be connected and **commissioned at the same time**. It is plug-'n'-play.
Commissioning Process Comparison.

- 4~20mA
  - Install the Cables
  - Check out the cable installation
  - Install the Devices
  - Check the device installation

- Foundation Fieldbus
  - Install the Cables
  - Check out the cable installation
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  - Check the device installation

- Install the DCS
- Assigning the I/O
- Calibration the Sensor
- Ranging
- Calibration the 4~20mA
- System Ranging
- System Calibration 4~20mA

- Install the DCS
- Assigning the I/O
- Calibration the Sensor
- N/A
- N/A
- N/A
- N/A
Commissioning Process Comparison.

- No range mismatch
- Unit downloaded when device is replaced

4~20mA

Foundation Fieldbus
Typical issues ...

- **Installation and commissioning**
  - Proper termination!
  - Wiring & shorts!
  - Device polarity!
  - Unexpected device behavior!
  - Electro-magnetic interference!
  - Corrosion changes resistance!
  - Degrading insulation!
  - System modifications!
  - Water ingress!
  - Out of spec behavior!

- **Troubleshooting – It would be nice to...**
  - ask an expert that is remote!
  - measure before going in the field!
  - have an oscilloscope handy!
Typical problems

- Improperly closed housing
- Loose wire
- Internally modified
- Error log showing intermittent faults
  - Electro-magnetic interference
  - Faulty field device
  - Cable degradation
  - Wrong termination

Successful implementation & Improved Operation
Need for diagnostics

• Field study by installation and commissioning Engineers around the world shows that more than 80% of the plant disturbances come from the physical layer level be it conventional 4-20mA applications or Fieldbus applications.

• Unless the engineers sufficiently trained for Fieldbus applications the most common mistakes are made at the physical layer level such as wiring faults, wrong termination etc.
Check Points (1)

- Are two (and only two) terminators connected per bus? Be especially careful where redundant power is used.
- Is the display of the not communicating device working
  - having any indication at all?
- Is the power supply at the terminals of the not communicating DEVICE sufficient > 9 V?
  Is the polarity correct?
- Verify continuity of wires, and that short circuits are not caused by junction box water filling.
Check Points (2)

- Ensure that shields are grounded only in one place. Ensure that the Fieldbus signal wires are not grounded.
- Ensure that the spur lengths are within the given limitations, and that the total cable length of trunk plus all spurs does not exceed the limit given for the specific cable type.
- Is there any "INIT" or "FAIL" indication in the display? Is it constant or flashing?
Earthing (Grounding)

- Don't ground shield in both ends
- Make sure shield or ground wire does not get in touch with instrument housing
- Other earth points along the wire
- Open earth connection at host to measure

Earthing point for surge protector, not fieldbus shield
Cable Resistance

- Resistance:
  - Conductor to conductor > 50 K ohms
  - Conductor to shield >20 M ohms
  - Conductor to instrument earth >20 M ohms
  - Shield to instrument earth >20 M ohms
- Disconnect shield from ground/earth to measure
- Disconnect devices if using high voltage
Cable Capacitance

- Capacitance:
  - Conductor to conductor \(~1\ \mu\text{F}\)
  - Conductor to shield \(<300\ \text{nF}\)
  - Conductor to instrument earth \(<300\ \text{nF}\)
  - Shield to instrument earth \(<300\ \text{nF}\)
Power Supply Example

- **Number of devices:**
  - Impedance output voltage is 19 V
  - Cable loop resistance for 1.9 km is 84 ohm
  - Device needs minimum 9 V
  - Maximum voltage drop is therefore 10 V (19-9)
  - Maximum total current draw thus is 120 mA (10/84)
  - Each device needs 20 mA (many devices are as little as 12-15 mA)
  - Maximum 6 devices, or shorter cable (120/20)

- **Cable length:**
  - Impedance output voltage is 19 V
  - Device needs 20 mA and minimum 9 V
  - Maximum voltage drop is therefore 10 V (19-9)
  - Total current draw for 12 devices thus is 240 mA (12 x 20)
  - Maximum cable loop resistance is therefore 42 ohm (10/0.24)
  - Cable resistance is 22 ohm/km- in each direction
  - Maximum 0.95 km, or less devices (42/(2 x 22))
Assists Engineers in segment design, current consumption and cable length calculations

www.segmentchecker.com
Commissioning in the Past.

- Always on the critical path
- Labor intensive
- Requires
  - Screw driver
  - Check sheet
  - Pencil
  - Multimeter
  - Oscilloscope
- Connect one device at a time
- Disconnect after testing
Commissioning Tool available.

- A portable tool for commissioning, monitoring, troubleshooting and printout.
Commissioning Tools.

Successful Implementation & Improved Operation
Fieldbus Tester

- Voltage (> 9 V)
- LAS signal level (> 150 mV)
- Number of devices
- Lowest device signal level (> 150 mV)
- Average noise (< 75 mV)
- Peak noise (< 75 mV)
- Signal level of new device (> 150 mV)
- Inverted signal
- Frame error
  - Invalid signal
  - Preamble error
  -Delimiter error
  - Control byte error
  - Address byte error

<table>
<thead>
<tr>
<th>Signal Level</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 350 mV</td>
<td>Excellent</td>
</tr>
<tr>
<td>200-350 mV</td>
<td>Good</td>
</tr>
<tr>
<td>150-200 mV</td>
<td>Fair</td>
</tr>
<tr>
<td>&lt; 150 mV</td>
<td>Poor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Noise Level</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 25 mV</td>
<td>Excellent</td>
</tr>
<tr>
<td>25-50 mV</td>
<td>Good</td>
</tr>
<tr>
<td>50-75 mV</td>
<td>Fair</td>
</tr>
<tr>
<td>&gt; 75 mV</td>
<td>Poor</td>
</tr>
</tbody>
</table>

Draws 15 mA from the bus!
Fieldbus Wiring Validator

- Used together with Fieldbus Tester (Relcom FBT-3)
- Test the wiring, terminators, and junction bricks/couplers
  - No Fieldbus devices, host, or power shall be connected
- Simulates power and communication, in place of host
- Permits tester to monitor:
  - Voltage (drop)
  - Signal level (attenuation)
  - Noise level

Additionally check:
- Lead-to-lead resistance
- Lead-to-drain/shield resistance
- Drain/shield-to-device
All shall be > 100 kohm
Oscilloscope

- Well formed waveform:
  - Sloped raising edge
  - Flattish top
  - Sloped falling edge
  - Flattish bottom
- Symmetrical
Terminator

- If a terminator is missing the signal amplitude will be too high
- If too many terminators are present the signal amplitude will be too low
Noise

- Noise generated from loose connection.
- Terminal corroded
Portable Diagnostic Module DM-AM

- Features of the Diagnostic Module
  - User-configurable warning and alarm levels for long-term diagnostic
  - Alarming with time stamping (final version)
  - History/trending for all measured values stored in the diagnostic module (final version)
  - DCS system integration with OPC (final version)

- Features of the PC Tool
  - Commissioning tool for easy warning and alarm level definition
  - Documentation tool, file or print out
  - Expert system wizard to isolate cause of deviation or errors (final version)
  - Build in Fieldbus oscilloscope
MTL FBT6

- Fieldbus powered
- LC display
- Does the same function as FBT3 and additionally
- Device add & drop indication
- Shield short indication when + or – shorted to shield
- The address and signal level of each device on the network is displayed in turn by pushing the “SELECT” button.
- Checks for any device not responding to a LAS pass token and indicates the address of the last device that failed to respond to the LAS pass token
- Upload measurement data to a PC via USB port

Draws power from the bus!
Emerson Field Communicator 375

- Configures Fieldbus devices in the field
- Measures and monitors
  - DC voltage
  - Average noise
  - Signal level per segment
- Certified for Intrinsic safe applications
Online Diagnostic tools

• Usually integrated in the Power conditioner system
• Can also be used for data storage and trending
• Analyses complicated Fieldbus issues
• Some tools integrated with Fieldbus Oscilloscope
• Some tools generate automatic commissioning report
• Can transport the data on H1 bus or separate protocol like RS485 and Ethernet
Control the physical layer

- Supervision and diagnostics
  - Measurements, trending, alarming
- Part of the Power Hub
- Online and in real-time with remote access
  - from the control room and
  - via Internet
- Simple-to-use DTMs
  - Signal measurements
  - Color-coded status indicators
  - Built-in oscilloscope for greatest detail
- NOT a Fieldbus Device
Snapshot Functionality

- Automatically generated documentation
- Baseline report for online comparison and trending
- Live supervision during operation
Architecture, Diagnostic Bus
Snapshot Functionality

- Automatically generated documentation
- Baseline report for online comparison and trending
- Live supervision during operation

<table>
<thead>
<tr>
<th>Min</th>
<th>Max</th>
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<tbody>
<tr>
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<table>
<thead>
<tr>
<th>Field Devices detected</th>
<th>Field Connexx</th>
<th>Physical Layer Measurement Report</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pri. Pwr Voltage:</strong></td>
<td>24.4V</td>
<td><strong>Date:</strong> 13.02.2006 10:59:16</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td><strong>Description:</strong> Test 2</td>
</tr>
<tr>
<td><strong>Sec. Pwr Voltage:</strong></td>
<td>24.5V</td>
<td><strong>Field Type:</strong> FOUNDATION Fieldbus</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td><strong>Segment Tag:</strong> Test_Segment_TAG</td>
</tr>
<tr>
<td><strong>Segment Voltage:</strong></td>
<td>29.5V</td>
<td><strong>Measurement Equipment:</strong></td>
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<tr>
<td></td>
<td>-</td>
<td><strong>Type:</strong></td>
</tr>
<tr>
<td><strong>Current:</strong></td>
<td>- 63mA</td>
<td><strong>Serial Number:</strong></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td><strong>Software Version:</strong> 1.1</td>
</tr>
<tr>
<td><strong>Unbalance:</strong></td>
<td>- 2%</td>
<td><strong>Result:</strong></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td><strong>Min Value:</strong></td>
</tr>
<tr>
<td><strong>Noise:</strong></td>
<td>- 39mV</td>
<td><strong>Max Value:</strong></td>
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<tr>
<td></td>
<td>24</td>
<td><strong>Value:</strong></td>
</tr>
<tr>
<td><strong>Jitter:</strong></td>
<td>- 1.1us</td>
<td><strong>Fail:</strong></td>
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<tr>
<td></td>
<td>24</td>
<td><strong>Module A:</strong></td>
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<tr>
<td><strong>Signal Level:</strong></td>
<td>- 760mV</td>
<td><strong>Module B:</strong></td>
</tr>
<tr>
<td></td>
<td>16</td>
<td><strong>Board Type:</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Layer Measurement Report</th>
<th>Field Connexx</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Result:</strong></td>
<td>OK</td>
</tr>
</tbody>
</table>

- Field Connexx
- Physical Layer Measurement Report

<table>
<thead>
<tr>
<th>Board and Power Supply Module Details</th>
<th>Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Board Type:</strong> Power Hub</td>
<td>-</td>
</tr>
<tr>
<td><strong>Board Redundancy:</strong> Redundant</td>
<td>-</td>
</tr>
<tr>
<td><strong>Module A/B Mismatch:</strong> OK</td>
<td>-</td>
</tr>
<tr>
<td><strong>Module A:</strong> Isolated Module</td>
<td>OK</td>
</tr>
<tr>
<td><strong>Module B:</strong> Isolated Module</td>
<td>OK</td>
</tr>
</tbody>
</table>
Ideal troubleshooting tool

- Pinpoint problems directly
- Complete instead of partial tests
- Without checking each instrument one by one
- Right at your workstation
- Quickly identify the kind of failure
- Receive data that enables you to examine: EMC, software, hardware, wiring, etc...
- Use measurement techniques of fieldbus experts
- Allow Internet access for a designated fieldbus expert to evaluate your fieldbus segment from remote

Termination Fault
Please verify if your segment installaton is properly terminated. A proper termination includes a two sided termination within the trunk each located at the end of the line.

Device Error Fault
The Field Device has a malfunction in its fieldbus specific electronics and sends out an increased Signal Voltage Level to the Fieldbus network. The Field Device may need a replacement. Please use the enhanced function of the Oscilloscope to verify the signal level of the Device.

Configuration Fault
The limit value to be supervised is wrongly configured and does not match to the Field Device's typical signal level value. Please verify the value and adjust it in accordance to the typical and rated signal level of that specific Field Device.
Oscilloscope function
MTL F809F on-line fieldbus diagnostics

Host control system

Instrument Management Software (including fieldbus diagnostics)

On-line Diagnostic Module

power supply system

Controller I/O

Alarm

Fieldbus
MTL F809F on-line fieldbus diagnostics
MTL F809F on-line fieldbus diagnostics
TURCK on-line Fieldbus diagnostics

Diagnostic Power Conditioner System
- Segment and system diagnostics
- Commissioning support
- Longterm diagnostics via FF-HSE
- FF functions blocks for diagnostic alarms
- Diagnostics via DTM and/or DD
- Redundant power supply
- High output power for extended fieldbus segments (800 mA, 30 VDC)
- Complete galvanic isolation
TURCK on-line Fieldbus diagnostics

**Ambience Alarms**
- Alarm temperature (HI) 150
- Alarm temperature (LO) -60

**Electrical Alarms**
- Pre-alarm supply voltage 1 (V)... 21.00 V
- Main alarm supply voltage... 20.00 V

**Communications Alarms**
- Pre-alarm LAS level (LO) 0.3 mV

**Temperature**

The ambient temperature is measured on the ADU (Advanced Diagnostic Unit) with a temperature sensor. Defined measuring range between -50...150°C.

This parameter allows the setting of the threshold for the temperature, which would activate a pre-alarm for the temperature in case of underrange (Temperature Low).

This parameter has an influence on the control in the measuring function. The alarm threshold will be indicated (yellow) according to this parameter adjustment.

**Default value:** -10°C
Questions?
Welding, variable frequency drives (VFD), Motors, machinery:

- Increase of HF noise
- Increasing number of retransmissions
- Can be a combination of both
Case study: faults in operation

Cable jacket stripped back too far can cause instrument malfunction:

- Water ingress
- Wires shorted to housing
- Corrosion
- Tearing wires (increasing resistance)

- Increasing number of retransmissions
- Signal amplitude rises
- Increase of FF noise
- Can be a combination of above
Wires coming out of ferrules:

**Spur:**
- Device drops off (may or may not return)
- Increasing number of retransmissions

**Trunk:**
- Devices drop off (may or may not return)
- Signal amplitude sometimes ok, sometimes high
- Increasing number of retransmissions
Bend radius too tight, Upward facing gland risks water ingress

Two cables into one gland prevents sealing of gland
Corroded terminals:
- Increasing number of retransmissions
- Increase of FF noise
- Can be a combination of both
<table>
<thead>
<tr>
<th>Measurement Tools of the Trade</th>
<th>Multi-meter</th>
<th>Handheld Tester</th>
<th>Handheld Communicator</th>
<th>Oscilloscope</th>
<th>Notebook Bus Analyzer</th>
<th>Advanced Diagnostic Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment voltage</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Segment current</td>
<td>☐</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Segment noise (low freq.)</td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td>✓</td>
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<tr>
<td>Segment noise (high freq.)</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
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<td>✓</td>
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<tr>
<td>Segment signal level</td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td>✓</td>
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<tr>
<td>Segment signal jitter</td>
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<td></td>
<td></td>
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<td>✓</td>
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<tr>
<td>Instrument signal level</td>
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<td>✓</td>
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<tr>
<td>Instrument signal jitter</td>
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<td>✓</td>
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<tr>
<td>Instrument noise (individual)</td>
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<tr>
<td>Fieldbus termination</td>
<td>=</td>
<td>=</td>
<td>=</td>
<td>●</td>
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<td>Segment earth fault (imbalance)</td>
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<td></td>
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<td>✓</td>
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<tr>
<td>Device communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

- ● Supported
- ☐ Requires shutdown
- = Result incomplete
- ✓ Fully supported