FOUNDATION™ fieldbus Overview

Introduction
Overview
H1 Physical Layer
H1 Segment Wiring
H1 Segment Assembly
Device Alarms
Segment Expansion
Definition & Key Points

FOUNDATION™ fieldbus is:

- An all digital, serial, two-way communication system that interconnects intelligent measurement and control devices
- Essentially a Local Area Network (LAN) for field devices
- The name of the Fieldbus developed by the Fieldbus Foundation

FOUNDATION™ fieldbus allows PID control in the field and in various field devices; i.e., control anywhere. And it uses Device Description Technology similar to HART.
Fieldbus Foundation

End-user Councils ➔ Board of Directors ➔ President ➔ Executive Committee ➔ Quality Assurance ➔ Marketing Committee ➔ Technical Steering Committee ➔ Administration

- North America
- Europe
- Asia Pacific

- Applications
- Specifications
- Standards
- Interoperability
- Profiles
- DD Technology
- Testers/Test Technology

- Application Engineering
- Field Trials
- Training
- Contracts
- Trade Shows
- Newsletters
Fieldbus Foundation

Unlike proprietary network protocols, FOUNDATION™ fieldbus is neither owned by any individual company, or regulated by a single nation or standards body. The technology is controlled by the Fieldbus Foundation, a not-for-profit organization consisting of more than 100 of the world’s leading controls and instrumentation suppliers and end users.

Beginnings

- Established September 1994
- Merger of WorldFIP North American and the Interoperable Systems Project (ISP)
- Not-for-profit corporation
- Approximately 120 of the world’s leading suppliers and end users
- Goal is a single international, interoperable Fieldbus standard
Key Issue: Every Major Process Control Company is a Member

ABB Ltd.
Accutech
AlliedSignal
Amdel, Ltd.
Applied Information Sciences
ASAHI/America
Automation Research Institute of Ministry of Metallurgical Industry
Bailey Japan Co., Ltd.
Baker Hughes INTEQ
Bently Nevada Corporation
Boeing
BP Oil - Alliance Refinery
Bray International, Inc.
Brazilian Petroleum Institute
Chevron Research and Technology
Chinese Fieldbus Foundation
Commission
Chiyoda Corporation
Chubu Electric Power Company
City of Columbus Wastewater Treatment Control System Integration Association
Drexel University
Duke/Fluor Daniel
DuPont Engineering Co.
EL-O-MATIC BV
Elsag Bailey Process Automation
Endress + Hauser GmbH + Co.
Escola Politécnica da Universidade de São Paulo
Exxon Research & Engineering Co.

Ficon Technology, Inc.
Fieldbus Inc.
FINET
Fisher Controls Int., Inc.
Fisher-Rosemount Systems, Inc.
Flour Milling Plant
Fukuda Denso Kogyo Co., Ltd.
GraLab Test Systems Corp.
Groupe Schneider
Hartmann & Braun
Hitachi, Ltd.
Honeywell, Inc.
Huakong Technology Co., Ltd.
Incat
Instrument Control Service, Inc.
Intélection, Inc.
interlinkBT
jet propulsion laboratory, JPL
Joyo Corporation
Kaneka Engineering Corporation
Knock Electronics
Korea Engineering & Technology Co., Ltd.
Kono/Otsu, Inc.
Kvaerner, Houston
Magnetrol International, Inc.
Measurement Technology Ltd.
Micro Motion, Inc.
Mitsubishi Electric Corporation
Mobile Technology Co.
Monsanto Company
Moore Products Co.
National Instruments
NEC Corporation
Neles Controls
NEC Corporation
Nippon Dynamical Co., Ltd.
Nippon Steel Corp.
Nohken, Inc.
Okurara Electric Co., Ltd.
On-Line Instrumentation
Oni Instruments
Ono Sokki
Oxford Instruments
PADS
Panda Automation
Pemex
Petaform
PDVSA - Servicios Automatización
Pepperl + Fuchs
PETO
Phoenix Contact
Pitco Instrumentation
R. Stain Schiltigheim GmbH
Recom Inc.
Research Reactor Institute of Kyoto University
Richard W. Spear Corp.
Richter, Peter, Co.
Rockwell Automation
Rosemount Analytical, Inc.
Rosemount Inc.
SAUDI Arabian Oil Company
Shanoc, Inc.
Shell Oil Co.
Shenyang Institute of Automation
Shimadzu Corporation
Siemens Energy & Automation, Inc.
Sira Test & Certification, Ltd.
Smar International Co.
Smar Research
Softing GmbH
SRC NITEPLOPRIBOR
SRI International
Sterling Valley Associates
Stone & Webster Engineering Corporation
Stonel. Corporation
The Foxboro Company
Tokyo Keiso Co., Ltd.
TopWorx
Toshiba
Valmet Automation, Inc.
VEGA Grieshaber KG
Vale Automation Inc.
Westech Electric
Westlock Controls
Wonderware Corporation
WorldFIP Europe
Yamaha Corporation
Yokogawa Corporation
Yokomichi Eizai Industry System Co., Ltd.
YCV Corporation
Yokogawa Electric Corporation
Yokogawa Industrial Automation
Zhejiang Supcon, Co., Ltd.
PCS Architecture Model

Management Execution
(OPC)

Integrated, Modular
Software
(PCS & Device Manager)

Scalable Platforms
(Hardware)

Intelligent Field Devices

Process Control

Asset Management

Plant-wide Network

H1 Fieldbus Network
PCS Architecture Model

- **Intelligent Field Devices** — Can be remotely configured and calibrated via software using an appropriate host or configurator. Many field devices include PID functions to allow true distributed control and to support the *Control Anywhere* concept.

- **Scalable platforms** — The PCS host is generally designed to manage large amounts of data. It is equally well suited for small and large applications. The hardware is easily expanded by adding additional controllers and additional I/O capacity.

- **Integrated, modular software (asset management)** — A software package that allows users to commission, configure, calibrate, and troubleshoot devices from a Windows Explorer type screen.

- **Management execution** — With OLE and OPC, data from the PCS system can be communicated via the existing business LAN to other compliant Windows applications such as Excel and Access.
Fieldbus Benefits

Control System Network

Controller

PID

I/O Subsystem

AI  AI  AO

Traditional 4 to 20 mA
One Variable is Passed in One Direction.

Control System Network

Controller

FB I/O

Fieldbus

Multiple Variables Are Communicated Bi-Directionally
Fieldbus Benefits

Traditional 4-20

- One variable passed in one direction
- Two signal wires per device to I/O subsystem

Fieldbus

- Multiple variable communicated directly between devices and/or controller
- Fieldbus Device Alarms
- PlantWeb Alerts
- One twisted pair of wires from field devices to H1 interface (control system)
Fieldbus Benefits

Interoperability

Any device from any manufacturer that conforms to the FOUNDATION™ fieldbus standards will work well with other certified devices. However, the standards for certification are currently set to confirm minimum functionality only.

Minimum functionality means that a device will communicate a value that is expected from its device type; i.e., a temperature transmitter will produce a Fieldbus signal for the measured temperature. The Fieldbus Foundation certification does not guarantee that other device “bells and whistles” such as auto-calibration routines or configuration wizards will be functional and/or interoperable.
Communication Technology

Simplified Fieldbus Communication Model

- Fieldbus Message Specification
- Fieldbus Access Sublayer
- Data Link Layer
- Physical Layer
- Communication "Stack"
- User Application

Blocks:
- Resource
- Transducer
- Function

Communication Management:
- Scheduling
- What data is sent to what other device(s)
- Communication support and management functions

Field Devices and Wiring
Communication Technology

The communication technology that is used in FOUNDATION™ fieldbus is based on a standard (OSI) model, but does not include layers that are not pertinent to critical process control data. The Fieldbus model consists of three major layers.

- Physical Layer
- Communication Stack
- User Application

In general, you may think of the role of each of the layers as follows:

Physical Layer

The physical layer includes the wiring of the field devices and the components that actually interface with the process; e.g., transmitters and valve positioners. The Physical Layer receives encoded messages from the upper layers and converts the messages to physical signals on the Fieldbus transmission medium and vice-versa.
Communication Technology

Communication Stack

The comm stack consists of the three layers of communication which, taken all together, manage communication between two devices or between a device and a host such as DeltaV.

User Application

Fieldbus Foundation has defined a standard User Application based on Blocks; representations of different types of application functions.
Fieldbus Blocks

**Transducer (Servo) Block**
- Interface to Sensors
- Calibrate Information
- Configure Information

**Function Block**
- Define Control System Behavior
- AI, AO, DI, DO, PID, etc.
- Approximately 30 Blocks Defined
- Blocks Configured by Host to Implement a Control Strategy

**Resource Block**
- Device Characteristics
  - Name
  - Manufacturer
  - Serial Number
  - Enable Features

Fieldbus
Fieldbus Blocks

Each Fieldbus device includes three different types of blocks.

Resource Block

The resource block includes read only information that helps to define the device. Information may include:

- Manufacturer Name
- Model Number
- Materials of Construction
- Device Options

Depending on the device, there may also be several configurable parameters. Examples include:

- Mode (Automatic or Out of Service)
- Alarm options
- Security and access limiting features; e.g., write locks, feature disabling, etc.
Fieldbus Blocks

- **Function Block**
  - Define Control System Behavior
  - AI, AO, DI, DO, PID, etc.
  - Approximately 30 Blocks Defined
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- **Transducer (Servo) Block**
  - Interface to Sensors
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- **Resource Block**
  - Device Characteristics
  - Name
  - Manufacturer
  - Serial Number
  - Enable Features
Fieldbus Blocks

Transducer Block

Transducer Blocks are an interface to sensors used to measure temperature, pressure, flow, etc. The transducer block includes calibration and other data. For example:

- **Device calibration information**
- **Sensor data**

The mode of the transducer block (*automatic* or *out of service*) is configurable. In order to perform calibration routines on most devices, the block must be set to OOS (*out of Service*).
Fieldbus Blocks

Transducer (Servo) Block
Interface to Sensors
- Calibrate Information
- Configure Information

Function Block
Define Control System Behavior
- AI, AO, DI, DO, PID, etc.
- Approximately 30 Blocks Defined
- Blocks Configured by Host to Implement a Control Strategy

Resource Block
Device Characteristics
- Name
- Manufacturer
- Serial Number
- Enable Features
Fieldbus Blocks

Function Blocks

The function block(s) in a device depend on the type and style of the device. For example, a pressure transmitter with only one PV may include only one AI block. On the other hand, the transmitter could include a second PV, for example, board temperature, and it could include a PID algorithm.
Role of Function Blocks

Control Modules in PCS hosts — When using PCS as a host, the inputs and outputs of function blocks in various field devices and in the controller are *graphically* linked together to form a complete control strategy called a *control module*. The graphical blocks that are included in the PCS package are sometimes referred to as *Shadow Blocks*. 
Device Descriptions (DDs)

The Fieldbus Foundation provides a standard software library called *Device Description Services* which can read the DD binary. Any host with Device Description Services can interoperate with a FOUNDATION™ device if it has the device's DD.

**DD’s**
- Define Standard Block Parameters and Supplier Unique Parameters
- Are loaded into a host that supports DD Services
- Are unique for every different device
- Revision level must match device revision
Device Descriptions (DDs)

Device Descriptions (DD’s) are a key element of the User Layer technology that enables interoperability. DD’s are used to describe:

- Standard block parameters
- Supplier unique parameters

DDs allow any compliant host to interoperate these parameters. The DD is fundamentally an extended description of the device parameters used by the host.

The Fieldbus Foundation provides DDs for all standard blocks.

Device suppliers typically prepare an incremental DD which adds additional functionality.

Device suppliers register common DD's with the Fieldbus Foundation. These registered DDs are available to the users with a subscription process.
Communication Scheduling

Absolute Link Schedule Start Time

Offset = 0 for AI Execution

Offset = 20 for AI Communication

Offset = 30 for PID Execution

Sequence Repeats

Scheduled Execution
- Does Not Require Bus Time
- Internal to Device

Scheduled Communication
- Requires Bus Time
- Communicate Data to Other Devices

Unscheduled Communication
- Requires Bus Time
- Occurs When Bus is Free
- Alarms
- Time Synchronization
- PN and Live List Maintenance
- Token Passing

Device 1
Macrocycle

LAS
Macrocycle

Unscheduled
Communication
Permitted

Device 2
Macrocycle

n - Length of Macrocycle is determined

Study Day
London

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Communication Scheduling

Distribution of control to the field device is made possible by synchronizing:

- Function block execution
- Communication of function block parameters on the Fieldbus

**Macrocyle** - A single iteration of a schedule within a segment. The *schedule macro-cycle* is the user-specified execution time for all the Fieldbus function blocks on the segment. Change the scheduled macrocycle by clicking

\[
\text{DeltaV Explorer} \rightarrow \text{Fieldbus port} \rightarrow \text{Properties} \rightarrow \text{General tab}
\]

Valid choices are 250 msec, 500 msec, 1 sec (default), 2 sec and 5 sec. The schedule macrocycle should always be set greater than, or equal to, the required macrocycle.

The *required macrocycle* is the actual execution time plus any publisher CD time. This is calculated by the LAS (H1 card). Check the required macrocycle by clicking

\[
\text{DeltaV Explorer} \rightarrow \text{H1 port} \rightarrow \text{Properties} \rightarrow \text{Advanced tab}
\]

If the required macrocycle is calculated for a time greater than the schedule macrocycle, the required macrocycle takes precedence over the configured macrocycle.
**Device Types**

**Linkmaster Device**
- Host H1 Card
- Maintains Live List - PN
- Manages Macrocycle - CD (Scheduled Communication)
- Issues Pass Token - PT (Unscheduled Communication)

**Basic Devices**
- Field Instruments
  - Respond to PN
  - Respond to CD
  - Respond to PT

**Publish Message**
- Device X Data
- Device Y Data
- Device Z Data

- Device Y does not subscribe to Device X
- Device Z does not subscribe to Device X
Device Types

Linkmaster

Link Master devices are capable of becoming the Link Active Scheduler (LAS). The PCS H1 card is the master device in the PlantWeb solution. Field devices may also have Link Master capabilities and would be a backup LAS if the master fails. The Link Master performs many functions, including the following:

Scheduled Communications

- **Macrocyle** — The LAS maintains a list of transmit times for all data buffers in all connected devices.

- **CD (Compel Data)** — When it is time for a particular device to transmit the contents of its buffer, the LAS sends a CD (Compel Data) message to the device.

- **Publish/Subscribe** — Upon receipt of a CD, the device publishes (sends) data to all devices on the Fieldbus. Devices that are configured to receive the data are called *subscribers*. 
Device Types

Publish/Subscribe

The H1 card* supports a maximum of publisher and subscriber links per port not to exceed a total x* links. For example, a card can support 20 publisher and five subscriber links or five publisher and 20 subscriber links.

A link is defined as a connection between a Fieldbus parameter in one device on the segment and a Fieldbus parameter in another device on the segment.

More specifically, a subscriber link is an input parameter in a Fieldbus device receiving an output from a Fieldbus device parameter or PCS controller on the segment. A publisher link is an output from a PCS controller or Fieldbus device to the input of a parameter in a Fieldbus device.

Basic Devices

Basic devices are those that do not have the capability of becoming the LAS.
Device Types

Unscheduled Communications

- **Probe Node (PN) and Live List Maintenance** — Between transmissions of scheduled messages, the LAS regularly issues a PN (probe node) message to determine if any changes have been made to the list of devices on the “live list”. If devices have been added or removed, the LAS revises the Live List.

- **Pass Token (PT)** — Between transmissions of scheduled messages, each device is given an opportunity to transmit unscheduled messages. The LAS grants permission to access the Fieldbus for unscheduled communication by issuing a (PT) pass token to the device. When the device receives the token, it is allowed to send messages. Unscheduled transmissions are generally for changes in configuration data, changes in setpoints, alarm information, and other non control-critical information.
FOUNDATION™ fieldbus
Physical Layer

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Physical Layer

Communication “Stack”

Fieldbus Wire

Physical Layer

Voltage

Time

Fieldbus Messages

User Application

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Physical Layer

The Physical Layer is defined by approved *International Electrotechnical Commission (IEC)*\(^1\) and *International Society of Measurement and Control (ISA)*\(^2\) standards:

2. *ISA S50.02-1992* *ISA Physical Layer Standard FF-816 31.25 Kbytes/s Physical Layer Profile Specification*

The Physical Layer receives messages from the communication stack, converts them into physical signals and transmits them on the wire. Conversely the Physical Layer detects electrical signals on the wire and converts them into messages.

Conversion tasks include adding and removing preambles, start, and end delimiters.
Manchester Encoding

Clock

Data

Manchester Biphase-L Encoding
Manchester Encoding

Fieldbus signals are encoded using the Manchester Biphasel-L technique. The signal is called *synchronous serial* because the clock information is embedded in the serial data stream. The clock and data signals are combined to produce the signal as shown above.

Fieldbus signals are interpreted as a logic “0” when a positive transition occurs in the middle of a bit time. A logic “1” is interpreted when a negative transition occurs in the middle of a bit time.
Special Characters

Clock

Preamble

Start Delimiter

End Delimiter
Special Characters

Special characters are defined for the preamble, start delimiter, and end delimiter.

The preamble is used by the receiver to synchronize its internal clock with the incoming Fieldbus signal.

Special N+ and N- signals do not transition in the middle of a bit time. The receiver uses the start delimiter to find the beginning of a Fieldbus message. The receiver accepts data until the special end delimiter is detected.
FOUNDATION fieldbus Signal

- **Device Current**
  - Receiving: 0 to 5 mA
  - Transmitting: 15 to 20 mA p-p

- **Voltage**
  - Power: 9 to 32 Volts
  - Fieldbus Signal: 0.75 to 1.0V p-p

- **Time**

- **Diagram Components**
  - Power Supply
  - 100 Ohm
  - 1 mf

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The Power Supply provides 9 to 32 Volts DC. The transmitting device delivers ±20mA at 31.25 Kbytes/s into a 50 ohm equivalent load to create a 1.0 volt peak-peak voltage. However, for I.S. applications, the allowed power supply voltage depends on the barrier rating.
Topology

Fieldbus devices may be powered from the Fieldbus (2-wire) or external (4-wire). Terminators must be installed at each end of the bus.

1900M Max.
16 Devices Max.
Topology

Control Room Equipment

Trunk

Junction Box

Spurs

Splices

<table>
<thead>
<tr>
<th>Total Device</th>
<th>1 Device</th>
<th>2 Devices</th>
<th>3 Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-12</td>
<td>120 m</td>
<td>90 m</td>
<td>60 m</td>
</tr>
<tr>
<td>13-14</td>
<td>90 m</td>
<td>60 m</td>
<td>30 m</td>
</tr>
<tr>
<td>15-16</td>
<td>60 m</td>
<td>30 m</td>
<td>1 m</td>
</tr>
</tbody>
</table>

* Guidelines

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Topography

Fieldbus allows for splices or spurs. *Splices* are connections less than one meter from the main trunk. *Spurs* are connections in which the distance from the main trunk to the instrument are 1 to 120 meters.

- The spur length must be reduced by 30 meters for each additional device on a spur.
- The number of devices possible on the Fieldbus will vary depending on factors such as the power consumption of each device, the type of cable used, use of repeaters, etc.

**Definitions:**

- *Trunk* — Main communication bus acting as a source of main supply to many other lines (spurs).
- *Segment* — Section of cable that is terminated in its electrical characteristic impedance by terminators (connects to H1 Fieldbus interface port).
- *Network* — All of the media, connectors, and associated elements by which a given set of communication devices are connected.
Topology

- **Point to Point** — Used for a single instrument to DeltaV.

- **Bus with Spurs** — Used for low density applications, where instruments are isolated and separated by a significant distance. Spurs may range from 1 to 120 meters.

- **Daisy-Chain** — Used when junction boxes are not available. The bus is interconnected at the terminals of each device. This topology is not recommended because disconnecting one device may risk losing communication with multiple devices.

- **Tree** — Used for high density applications, where a cluster of instruments are relatively close to each other.

- **Bridge** — Active device used to connect Fieldbus segments of different speeds together to form a larger network.

- **Gateway** — Active device used to connect Fieldbus segments to other types of communication protocols; i.e., Ethernet, RS232.
Typical Wire Interconnection

Junction Box

To Control Room
## Cable Requirements

<table>
<thead>
<tr>
<th>Cable Type and Description</th>
<th>Size</th>
<th>Max Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A: Shielded, twisted-pair</td>
<td>0.8 mm²</td>
<td>1900 m (6232 ft.)</td>
</tr>
<tr>
<td></td>
<td>(#18 AWG)</td>
<td></td>
</tr>
<tr>
<td>Type B: Multi-twisted-pair, with shield</td>
<td>0.3 mm²</td>
<td>1200 m (3936 ft.)</td>
</tr>
<tr>
<td></td>
<td>(#22 AWG)</td>
<td></td>
</tr>
<tr>
<td>Type C: Multi-twisted-pair, without shield</td>
<td>0.15 mm²</td>
<td>400 m (1312 ft.)</td>
</tr>
<tr>
<td></td>
<td>(#26 AWG)</td>
<td></td>
</tr>
<tr>
<td>Type D: Multi-core, without twisted pairs</td>
<td>1.25 mm²</td>
<td>200 m (656 ft.)</td>
</tr>
<tr>
<td>and having an overall shield</td>
<td>(#16 AWG)</td>
<td></td>
</tr>
</tbody>
</table>
FOUNDATION™ fieldbus Wiring & Installation

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Segment Expansion
Traditional analog installations carry a single analog value on one pair of wires. In Fieldbus, the single pair of wires becomes a Segment.
This existing pair of wires can be turned into a Fieldbus segment by:

- Replacing the control system’s analog card with an H1 Fieldbus Interface.
- Replacing the analog field device with a Fieldbus device.
- Adding 24 VDC and a Power Supply (power conditioner with a specific impedance profile).
- Adding Terminators
Terminators

- Terminators prevent distortion and signal loss.
- Terminators are an impedance matching module used at or near each end of the transmission line.
- Two and only two per segment.
Expanding the Segment

This segment has just been expanded. Should the terminator be moved from its original location to the last device on the segment?

This would only be necessary if the additional cable was a long stretch (>100m).
Terminators

The rule for locating terminators is one that may be bent. The right hand terminator, shown above, is located at the junction box. Ideally it should have been placed at the field device with the longest spur. It was assumed that the spurs were approximately the same length. Had one spur been significantly longer, then the terminator should have been placed out at that device.
Cable Length Restrictions

Total segment length is limited to 1900 meters. The total segment length is calculated as follows:

- Total Segment Length = Trunk + All Spurs
- Total Segment Length = 950
- Trunk = 800
- Spurs = 50 + 20 + 20 + 60
## Cable Requirements

<table>
<thead>
<tr>
<th>Cable Type and Description</th>
<th>Size</th>
<th>Max Length</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type A</strong>: Shielded, twisted-pair</td>
<td>0.8 mm² (#18 AWG)</td>
<td>1900 m (6232 ft.)</td>
</tr>
<tr>
<td><strong>Type B</strong>: Multi-twisted-pair, with shield</td>
<td>0.3 mm² (#22 AWG)</td>
<td>1200 m (3936 ft.)</td>
</tr>
<tr>
<td><strong>Type C</strong>: Multi-twisted-pair, without shield</td>
<td>0.15 mm² (#26 AWG)</td>
<td>400 m (1312 ft.)</td>
</tr>
<tr>
<td><strong>Type D</strong>: Multi-core, without twisted pairs</td>
<td>1.25 mm² (#16 AWG)</td>
<td>200 m (656 ft.)</td>
</tr>
</tbody>
</table>
Mixing Cable Types

Adding to a Fieldbus segment may require mixing cable types. In the figure below, the new cable will be 940 meters requiring a type B cable. The following formula should be considered when mixing cable types.

\[ \frac{L_X}{MAX_X} + \frac{L_Y}{MAX_Y} < 1 \]

Max length:
- A - 1900m
- B - 1200m
- C - 400m
- D - 200m
Mixing Cable Types

\[
\frac{LX}{MAXX} + \frac{LY}{MAXY} < 1
\]

where:  
- \( LX \) = length of cable X  
- \( LY \) = length of cable Y  
- \( MAXX \) = maximum length for X alone  
- \( MAXY \) = maximum length for Y alone

Example: (100m Type D) and (940m Type B)  
\[
\frac{100}{200} + \frac{940}{1200} < 1  
\]
\[
.5 + .78 < 1  
\]
\[
1.28 < 1 \quad \text{Not Recommended!}
\]

Example: (100m Type D) and (940m Type A)  
\[
\frac{100}{200} + \frac{940}{1900} < 1  
\]
\[
.5 + .49 < 1  
\]
\[
.99 < 1 \quad \text{Acceptable}
\]
Power Requirements

The 24 VDC Bulk or Phoenix-Contact 24VDC tested and proven Power Supplies. Off-the-shelf power supplies will work provided:

- The DC output return is to be isolated from ground if the Power Conditioner does not provide a isolation transformer.
- Recommend using the MTL 5995 which does provide an isolation transformer.
- Must have impedance matching with the Power Conditioner.
- Must meet noise requirements per the specification.
Power Requirements

Two-wire Fieldbus devices (drawing power from the bus) require 9-32 VDC. Sizing a power supply requires the following considerations:

- Current consumption of each device.
- Location of device on the network.
- Location of the power supply.
- Resistance of each section of cable.
- Power supply voltage.
Maximum Segment Distances

Devices are connected at one end of the cable with the Power Supply at the other end. Additional assumptions:

- Power Supply Vo = 19 VDC @ 350ma
- Minimum Device voltage = 9VDC
- Maximum Voltage drop from cable = 10VDC
- Cable Resistance (Type A) = 22 Ohms/km x 2 (loop) = 44Ohms/km
- Current required = 20 ma / Device
- Maximum Distance (km) = Allowed Loop V drop/Loop Current/Loop resistance per km
- Maximum Distance for 10 devices (10 Volts/ .2 Amps) / 44 Ohms/km = 1.136km = 1136 meters

<table>
<thead>
<tr>
<th>Distance Meters</th>
<th>1900</th>
<th>1900</th>
<th>1900</th>
<th>1623</th>
<th>1262</th>
<th>1033</th>
<th>874</th>
<th>757</th>
<th>710</th>
</tr>
</thead>
<tbody>
<tr>
<td># Devices</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>13</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Load mA</td>
<td>20</td>
<td>60</td>
<td>100</td>
<td>140</td>
<td>180</td>
<td>220</td>
<td>260</td>
<td>300</td>
<td>320</td>
</tr>
</tbody>
</table>
DC Circuit Analysis

The example below requires 13 devices on a 1km segment. The previous table indicates 874 meters maximum distance for 13 devices. However, with further analysis:

- Voltage drop must be less than 10VDC
  \[ V \text{ drop} = \text{Load Current} \times \text{Loop Resistance} \]
- Voltage drop from 13 devices at 0.6km = \( 0.260 \text{ A} \times 44 \text{ Ohms/km} \times 0.6 \text{ km} = 6.86 \text{ V} \)
- Voltage drop additional for the 7 devices across 0.4km = \( 0.14 \text{ A} \times 44 \text{ Ohms/km} \times 0.4 \text{ km} = 2.46 \text{ V} \)
- Voltage drop = 9.32V Acceptable
Grounding Requirements

1. Grounding practices should follow current plant standards and local safety codes.

2. Do not ground either conductor of the Fieldbus twisted pair.
Shielding Requirements

Shielding guidelines:

- Shielded cable is preferred.
- Connect shield to ground at one end.
- Connect each spur’s shield to the trunk shield and connect the overall shield to ground at one point.
Review

- List four items required to build a Fieldbus segment.
- Define Fieldbus segment.
- State one absolute rule for locating a terminator.
- Write the formula for calculating the Total Segment Length.
- List the maximum length of a segment using cable type A.
- Write the formula to determine if two different cable types are acceptable for a given length of a Fieldbus segment.
- State the number of connection points to ground that should be made for a Fieldbus segment’s shield.
Assembling an H1 Segment

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Overview
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H1 Segment Wiring
H1 Segment Assembly
Device Alarms
Segment Expansion
Important: Series 1 H1 Terminal Block connection only! Refer to page 4-24 for Series 2 H1 Terminal Block connections.
H1 Fieldbus Interface

LEDs:

*Green* - On powered and self tests are good.

*Red* - Failed and/or not communicating to the controller.

*Yellow* (top port 1)
- *Off* - not enabled or not communicating.
- *Blinking* - communicating without any function blocks configured on the segment, or a communication problem exists.
- *On* - good communications and at least 1 function block configured on the segment.

*Yellow* (bottom port 2) - Same.

H1 Card supports 64 function blocks (maximum)

*Note: 1, 2, 7 and 8 are optional 24 VIN.*
**H1 Fieldbus Simplex Terminal**

Screw Terminal 1 and 7 are 24 VIN(+) Not available presently.

Screw Terminal 2 and 8 are 24 VIN(-) Not available presently.

**H1 Terminal Block Series 2**
Screw Terminal 1 and 7 are 24 VIN(+) Not available presently.

Screw Terminal 2 and 8 are 24 VIN(-) Not available presently.
Enabling H1 Ports - Advanced Tab

**Schedule**
- Required macrocycle (ms): 210
- Minimum schedule spacing (ms): 80
- Linkmaster enabled

**Addresses**
- Segment address: 0
- Port device address: 16
- Time Master address: 16
Enabling H1 Ports - Advanced Tab

The Advanced tab provides the following information:

- **Schedule** — the calculated macrocycle (ms) based on the configuration effecting this port
- **Minimum** — the scheduled spacing ms, minimum CD spacing. This value should only be changed as recommended by Emerson Process Management.

*Important: Do not change*

- **Addresses** — the H1 card on the Fieldbus segment
Diagnostics Auto-sense Devices

### Contents of 'P01 (auto-sense when selected)'

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>PhysDev...</th>
<th>State</th>
<th>DevID</th>
<th>NodeAddr</th>
<th>ManufID</th>
<th>DevType</th>
<th>DevRev</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10 / P01</td>
<td>C10 / P01</td>
<td>Backup</td>
<td>SECONDARY Delta... 17 Fisher... SECONDARY Delta/ H1 Card 1 L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>001151...</td>
<td>001151...</td>
<td>Standby</td>
<td>00115130512800000003... 234 Rose... 001151305128000000033... 7 L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>000151...</td>
<td>000151...</td>
<td>Spare</td>
<td>0011513244-FT-TE... 250 Rose... 0011513244-FT-TE... 0x81... Unknow...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>005100...</td>
<td>005100...</td>
<td>Spare</td>
<td>0051000100FisherD... 251 Fisher... 0051000100FisherD...C0230... Unknow...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CInteg</td>
<td>BAD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Status</td>
<td>1 or more func...</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NDevices</td>
<td>4 Current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Integrity History


### Process History View
Communications started - Checking integrity... GOOD
Communications started - Checking integrity... GOOD
Communications started - Checking integrity... GOOD
Communications started - Checking integrity... GOOD
Communications started - Checking integrity... GOOD
Diagnostics Auto-sense Devices

Expand the Fieldbus H1 card, select the port, right mouse Rescan Port:

- **Name Column** — All fieldbus devices sensed on the port, as well as integrity, status and number of devices

- **State Column** — The current state of the device or placeholder

- **DevID Column** — Manufacture serial number

- **Node Address Column** — Current address of the fieldbus device

- **DevRev** — Revision of the fieldbus device when state is Standby or Commissioned
Segment Checkout Using the Fluke 123 Meter

Before you can use the Fluke 123 test tool, you must first attached the unit’s AC adapter, input connectors and power up the device.

As illustrated below, plug the test tool’s AC adapter into a standard electrical outlet before plugging the adapter’s cable jack into the device. Once connected, press the power button in the lower left corner of the control panel to power up the device.
Segment Checkout Using the Fluke 123 Meter

Connect the *Input A*, *Input B* and *COM* cables to their respective ports on the top of the test tool as illustrated below.
Commonly-used Buttons

- F4 (Enter)
- Arrow Buttons
- Time
- Scope Menu
- Input A Setup
- mV - V
- Power On/Off
Commonly-used Buttons

You will be required to use a number of the Fluke 123 test tool’s buttons during the following procedures. These commonly-used buttons include:

- Input A setup
- Power On/Off
- mV - V
- Scope Menu
- F4 (Enter)
- Time
- Arrow
### Segment Checkout Measuring Resistance

Measure resistance on the H1 segment conductors at the **removed MTL terminal block connector coming in from the field.**

<table>
<thead>
<tr>
<th>Measure resistance from</th>
<th>Expected result</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) to (-) signal</td>
<td>Expected = &gt; 50 K $\Omega$ (1) Actual =</td>
</tr>
<tr>
<td>(+) to shield</td>
<td>Expected = open circuit $&gt;$ 20 M$\Omega$ Actual =</td>
</tr>
<tr>
<td>(-) to shield</td>
<td>Expected = open circuit $&gt;$ 20 M$\Omega$ Actual =</td>
</tr>
<tr>
<td>(+) to ground bar</td>
<td>Expected = open circuit $&gt;$ 20 M$\Omega$ Actual =</td>
</tr>
<tr>
<td>(-) to ground bar</td>
<td>Expected = open circuit $&gt;$ 20 M$\Omega$ Actual =</td>
</tr>
<tr>
<td>Shield to ground bar</td>
<td>Expected = open circuit $&gt;$ 20 M$\Omega$ Actual =</td>
</tr>
</tbody>
</table>

(1) *This value will change due to the capacitor charging in the termination RC circuit and the capacitance in the Fieldbus cables.*
### Segment Checkout Measuring Capacitance

Measure capacitance on the H1 segment conductors at the removed MTL terminal block connector coming in from the field.

<table>
<thead>
<tr>
<th>Measure capacitance from the</th>
<th>Expected result</th>
<th>Actual =</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) to (-) signal</td>
<td>Expected = 1 µF$^2$</td>
<td></td>
</tr>
<tr>
<td>(+) to shield</td>
<td>Expected = &lt; 300 nF</td>
<td></td>
</tr>
<tr>
<td>(-) to shield</td>
<td>Expected = &lt; 300 nF$^3$</td>
<td></td>
</tr>
<tr>
<td>(+) to ground bar</td>
<td>Expected = &lt; 300 nF$^3$</td>
<td></td>
</tr>
<tr>
<td>(-) to ground bar</td>
<td>Expected = &lt; 300 nF$^3$</td>
<td></td>
</tr>
<tr>
<td>Shield to ground bar</td>
<td>Expected = &lt; 300 nF$^3$</td>
<td></td>
</tr>
</tbody>
</table>

$^3$ An actual reading that is much greater or varies in a capacitor charging manner to a high capacitance value (>1µF) indicates a poor quality, noisy ground on the shield ground bar. Be sure to correct this ground problem to prevent communication errors on the Fieldbus segment.
Checking MTL Switch Positions

Rear view of MTL 5995 Power Supply (DIN Rail Side)
# Segment Checkout Measuring AC Waveform

Measure the AC waveform at the MTL terminal block connector going to the field.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Expected result</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) to (−) signal</td>
<td>Expected = 500 − 900 mV  Actual = pp</td>
</tr>
</tbody>
</table>
Segment Checkout Measuring AC Waveform

Expected waveform with two terminators and 1000ft. of cable
Segment Checkout Measuring AC Waveform

Waveform with one terminators and 1000ft. of cable
Segment Checkout Measuring AC Waveform

Waveform with three terminators and 1000ft. of cable
# Segment Checkout Measuring DC Voltage

Measure the DC voltage at the MTL terminal block connector going to the field.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Expected result</th>
<th>Actual =</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) to (-) signal</td>
<td>Expected = 19 VDC</td>
<td></td>
</tr>
</tbody>
</table>
Fieldbus Device Alarm Overview

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Segment Expansion
Fieldbus Device Alarms

The *Abnormal alarm* is *not enabled* by default. To enable the *Abnormal alarm* select the *alarm* in DeltaV Explorer, click the right mouse button and select *Properties* from the pop-up menu which appears.

Placing a check mark in the box adjacent to *Enable* turns on the alarm allowing the Abnormal alarms to report from the Fieldbus device to DeltaV.

At this time the alarm priority may be changed from the *Priority* drop-down menu.
PlantWeb Alerts

Contents of 'Fieldbus Device Alarms'

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Enabled</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADVISE_ALM</td>
<td>Fieldbus Device Al...</td>
<td>Yes</td>
<td>ADVISORY</td>
</tr>
<tr>
<td>COMM_ALM</td>
<td>Fieldbus Device Al...</td>
<td>Yes</td>
<td>WARNING</td>
</tr>
<tr>
<td>FAILED_ALM</td>
<td>Fieldbus Device Al...</td>
<td>Yes</td>
<td>WARNING</td>
</tr>
<tr>
<td>MAINT_ALM</td>
<td>Fieldbus Device Al...</td>
<td>Yes</td>
<td>ADVISORY</td>
</tr>
</tbody>
</table>
PlantWeb Alerts

Fieldbus devices that support PlantWeb Alerts provide additional functionality. These devices support four alarms:

- **Advisory (ADVISE_ALM)** — the device has identified a condition that does not fall into any other category. The severity of an advisory alarm depends on the device type. Usually minor device problems.

- **Not Communicating (COMM_ALM)** — the device has stopped communicating.

- **Failed (FAILED_ALM)** — the device has determined that it can not perform its critical functions. Failed conditions require immediate action.

- **Maintenance (MAINT_ALM)** — the device has determined that maintenance may soon be needed. If ignored, this alarm could eventually lead to device failure. Maintenance conditions require prompt action.
PlantWeb Alerts

All PlantWeb Alert priorities are enabled by default.

Change the priority of a specific alert by selecting the alert in PCS Explorer, clicking the right mouse button and selecting Properties from the menu.

The alarm priority may be changed from the Priority drop down menu.
NE107 Alerts

One advantage of Foundation Fieldbus is that it’s a continuously evolving specification.

The Fieldbus Foundation updated its specification in August 2010, to incorporate NE 107, and it’s supported in Version 6.0 of the Interoperability Test Kit.

A series of new field diagnostic alarms correspond to the five primary diagnostic categories NAMUR outlined.
NE107 Alerts

The series of new field diagnostic alarms corresponds to the primary diagnostic categories outlined by NAMUR in its document.
Device Alarm Configuration

To configure a device alarm, select the device on the PCS Explorer, click the right mouse button and select the Properties option from the pop-up menu which appears.
Device Alarm Configuration

The *General* tab displays the same information as previous versions of the DeltaV software. Select the new *Alarms & Displays* tab to enable device alarms.
Device Alarm Configuration

Check the *Enable Device Alarms* box to enable device alarms for the Fieldbus device.

*AREA_A* is the *Plant Area* for VALVE_1’s alarms. It is currently grayed out and cannot be defined in this menu. The Plant Area is defined in one of two ways.

The device’s display characteristics may be defined with device alarms enabled.

Click the *Browse* button to define a *Primary control* display.

The faceplate defaults to the pre-configured picture *FFDEV_FP*. 
Device Compare

To compare a *device*, select the *device* on the PCS Explorer, click the right mouse button and select the *Compare* option from the pop-up menu which appears.
Device Compare

The *Compare Devices* dialog box appears. The *Compare* field is completed with the device tag of the selected device. The *To:* field contains the same tag by default. To select a different device, either type the device tag name in the *To:* field or click Browse to locate the tag in the DeltaV system.
Device Compare

The *Compare Configurations* dialog box appears for both the *Resource* and *Transducer* blocks.
Device Compare

The Compare Configurations dialog box’s tabs permits you to compare parameters for two Fieldbus devices. The two devices, or placeholders, must be of the same type and revision. You may also transfer parameter information between:

- **Two configurations of a single Fieldbus device** — current to historical or historical to another historical
- **Two commissioned Fieldbus devices** — current to current, current to historical, historical to current, historical to historical
- A placeholder and a Standby Fieldbus device during commissioning of the standby device
- A placeholder and a commissioned Fieldbus device
- Two placeholders
- Green tabs indicate a difference between compared devices.
- Both a field and its associated tab are highlighted in yellow when a parameter is modified.
- Other fields may be yellow due to an association with the field that was changed.
Segment Expansion

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Segment Expansion

To H1 Card

- **DVC**
- **PID**
- **Plant Demand (Hand Valve)**
- **3051**
- **AO**
- **PI**

**Plant Air Supply 100 PSI**

**Air Tank**

**LOOP 1**

**Plant Demand (Hand Valve)**

**DVC**

**PID**

**Plant Air Supply 100 PSI**

**Air Tank**

**LOOP 2**