Protection Concepts

CONTENTS

StoneL Corporation
One StoneL Dr
26275 US Highway 59
Fergus Falls, MN 56537
USA
Tel: 218-739-5774
Toll Free: 800-843-7866
Fax: 218-739-5776
Email: sales@stonel.com
www.stonel.com

Explosion Proof/ Flame Proof

Ex

Area Classifications (NEC)
Class I Groups A, B, C, D Divisions 1 & 2
Class II Groups E, F, G Divisions 1 & 2

Area Classifications (IEC)
Ex d IIC, IIB, IIA Zones 1 & 2

Compatible Protocols
Most Field Based Protocols are suitable for use in explosion proof systems provided proper installation methods are used.

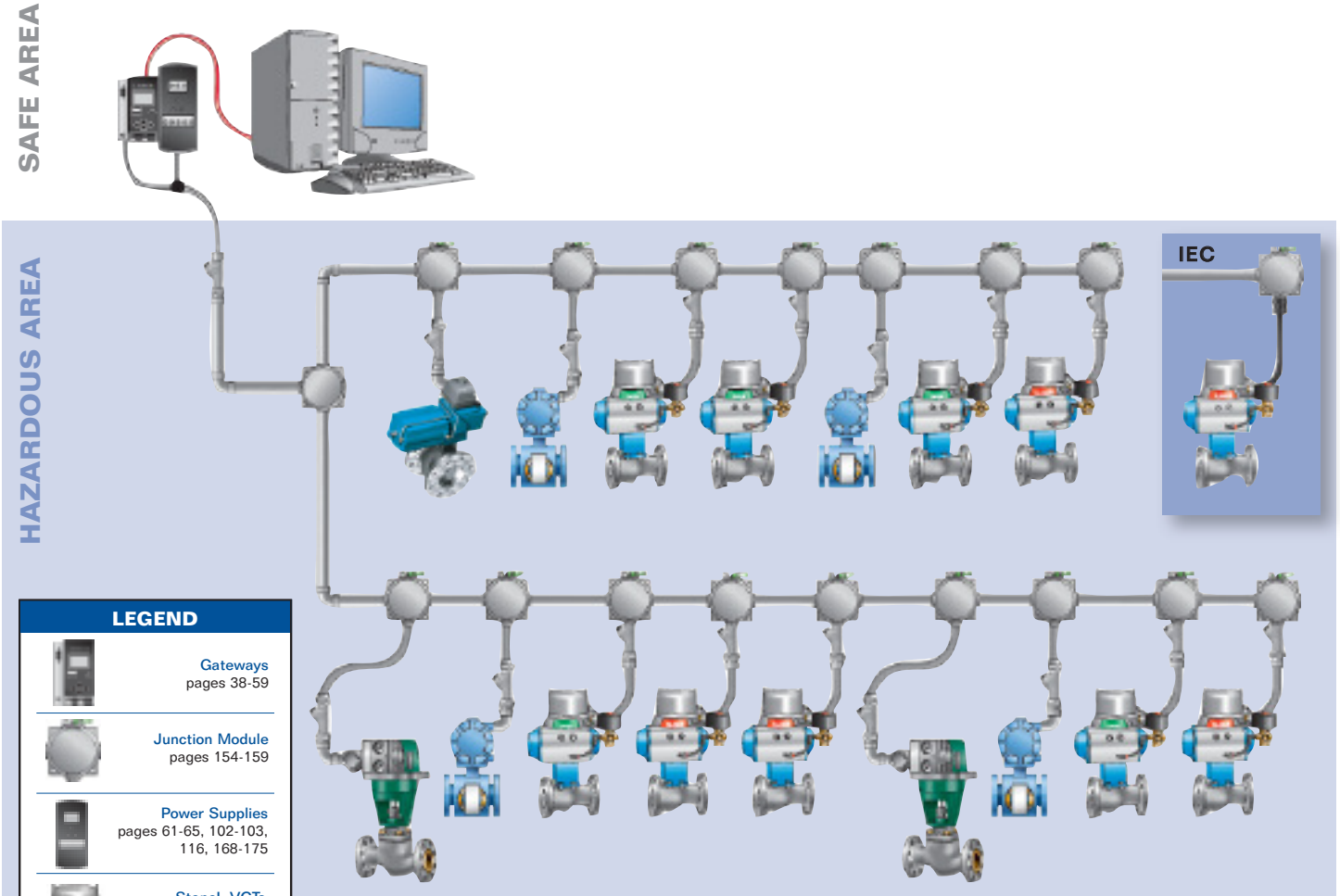
The explosion proof/flame proof philosophy of hazard protection focuses on gas ignition containment. If ignition occurs within instrument enclosures and the conduit system, it is prevented from propogating into the atmosphere. Instrument enclosures and conduit assemblies must be designed to contain pressures well in excess of ignition pressure levels for the gases and dusts to which they will be exposed. Mating surfaces must also be designed so exhausting gases will be sufficiently cooled before being vented into the atmosphere. Sealing components must be used throughout the conduit system to prevent pressure piling from one section of the conduit system into another.

Basic Concept
- Contain ignition inside conduit system and enclosures.
- Cool vented gases to prevent ignition outside of containment vessels.

Advantages
- Well understood in North America and Asia-Pacific markets.
- Unlimited power for instrumentation/bus circuits.

Disadvantages
- Deterioration of conduit and/or housing may degrade protection.
- Enclosures may not be opened with circuits energized.
- Bulky conduit and enclosures are expensive, space consuming and inflexible.

Explosion Proof Network
(Class I & II, Div. 1 and 2; Ex d, Zones 1 and 2)



Consult StoneL's web site at www.stonel.com/fieldlink/approvals for the latest approval information on illustrated StoneL products.

Explosion Proof/ Flame Proof

Ex

NEC References

Field Enclosures: Articles 501.2, 501.3, 501.5, 501.6, and 501.7

Field Wiring: Articles 501.4, 501.5, 501.11, and 501.14

Connections: Articles 501.4, 501.5, 501.12, and 501.13

Field Instrument Components: Articles 501.3, 501.6, 501.7, and 501.10

IEC References

Field Enclosures: IEC 60079-1

Field Wiring: IEC 60079-14

Networking Guidelines (Class I)

Field Enclosures

- Enclosures with suitable construction must comply with explosion standards including threading standards, burst pressure requirements and other requirements as established in NEC Article 501.
- Conduit seals must be installed within 18" from the enclosure unless specifically exempted (enclosures containing nonincendive components and capable of withstanding pressure piling from external ignition may be exempted from use of seal fittings).
- Enclosures may not be opened without deenergizing circuits.

Field Wiring

- Threaded rigid metal conduit or threaded steel intermediate conduit is used with threaded joints having at least 5 threads fully engaged.
- Type MI (Mineral Insulated, metal sheathed) and MC (Metal Clad) cable with suitable termination fittings may be used for flexibility requirements.

Connections

- All fittings must be explosion proof approved. Quick connectors are not suitable for explosion proof applications.

Field Instrument Components

- Meters, instruments and relays may be used inside enclosures suitable for explosion proof applications and identified as a complete assembly.
- Switches, circuit breakers, motor controllers and fuses must be contained within an explosion proof enclosure and identified as a complete assembly.

Economic Analysis

Installation Cost Comparison (calculated per field device)

	Conventional	AS-Interface	FF*
Computer I/O; Master/Gateway	$ 70	$ 50	$ 160
Conduit, Cable Tray, Wiring and Fittings	$1,600	$ 350	$ 380
Valve Monitor/VCT and Pneumatic Valve	$ 420	$ 590	$ 900
Switched Protected Drop Connector	NA	$ 170	$ 170
Installation and Commissioning Labor	$ 800	$ 350	$ 350
Power Supply	$ 50	$ 30	$ 60
Total Installed Cost	$2,940	$1,540	$2,020

*Foundation Fieldbus is not directly comparable. Analog instruments may require less adder over conventional 4 to 20 mA instruments making this system cost effective when combining analog and discrete field instruments on the same segment. Functionality for FOUNDATION Fieldbus devices is also significantly greater, offering increased diagnostic and operational capabilities.

Total Installation savings
$1,400 per field device or
$22,400 for a 16 device segment

Basic Assumptions:

- Number of field devices on the segment is not limited by electrical energy to the segment.
- One network segment consists of 16 field devices.
- Field devices are located in a cluster located an average distance of 200 feet (61m) from marshalling cabinet.
- Total bus network is 300 feet (91m) long.
- All network drop legs are short circuit protected and may be deenergized in the field.
- Seal fittings are required in order to remove field devices from deenergized drop leg if bus remains energized.
- Costs may vary depending on specific application.

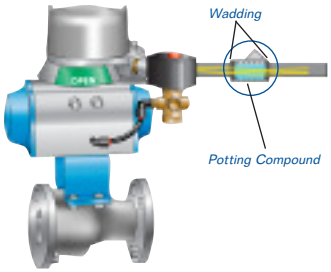
Additional Savings with Bus Network Installation:

- Conduit, wiring and marshalling enclosures consume less space.
- Less infrastructure is required to support conduit and enclosures.
- Devices may be added later or system changed for minimal cost (may use up to 31 devices with AS-Interface; 62 devices with extended addressing).
- Field devices may be capable of providing diagnostics for maintenance.
- Multi-point variables may be included in one field device, dramatically reducing instrument costs.

*A Special Note on Seal-Offs (Division 1 and 2)

Seal-Offs or seal fittings are used to prevent the propagation of ignited gases into other parts of the conduit system. StoneL components are designed to operate safely without seal fittings in both Division 1 and 2 areas.

Cost savings for eliminating seal-offs are estimated to be $100 per installation.



Explosion Proof with Nonincendive Equipment

Ex + NIE

Area Classifications (NEC)
Class I Groups A, B, C, D Division 2
Class II Groups E, F, G Division 2

Area Classifications (IEC)
Ex nA IIC, IIB, IIA Zone 2

Compatible Protocols
Most Field Based Protocols are suitable for use in explosion proof systems with nonincendive equipment provided proper installation methods are used and nonincendive components are properly certified.

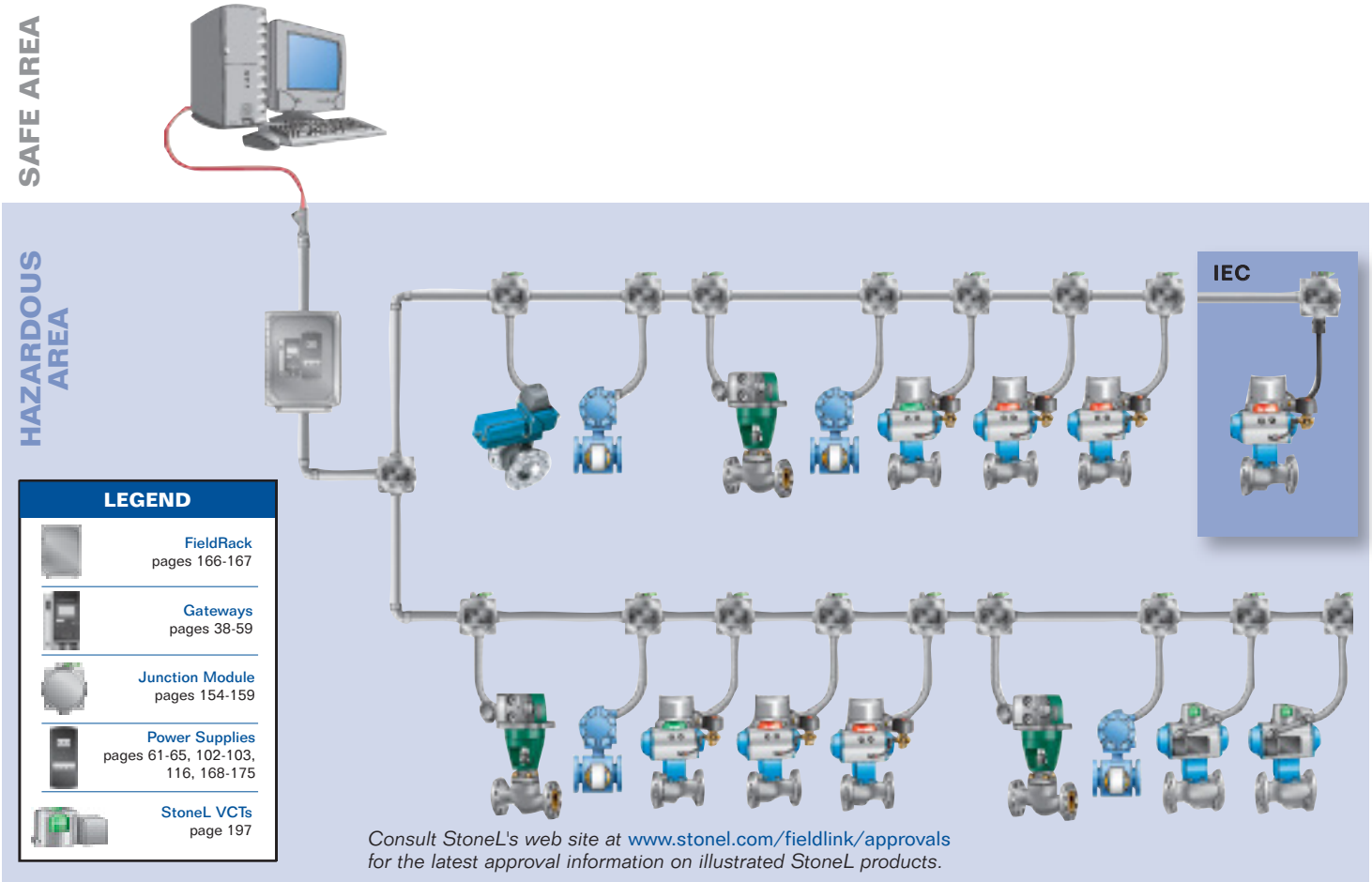
In division 2/zone 2 areas nonincendive devices may be installed in explosion proof systems. Division 2/zone 2 explosion proof conduit systems may also be installed with less robust enclosures and conduits. Since the combustible gases are present under abnormal conditions the probability of ignition is reduced significantly. As a result fewer precautions are needed in order to assure safe operation.

Basic Concept
- Used as part of an explosion proof system in division 2/zone 2 areas.
- Enclosures may be general purpose and must be rated as nonincendive equipment.
- Nonincendive components must not create arcs or sparks (solid state) or have arcs contained within an hermetically sealed chamber. Component surface temperatures must not exceed ignition levels of gas-air mixture or cause excessive dehydration or carbonization which may spontaneously ignite dust-air mixture.

Advantages
- Lower cost enclosures.
- Less space consumed.
- Enclosures may be opened with circuits energized.
- No seal-offs are required on nonincendive devices.
- Non-metallic enclosures are acceptable.
- Substantial electric power is available for instrumentation.

Disadvantages
- Circuits have electric shock hazard.
- Division 2/zone 2 areas only.

Explosion Proof and Nonincendive Network
(Class I and II, Div. 2; Ex nA, Zone 2)



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Explosion Proof with Nonincendive Equipment

Ex + NIE

NEC References

Field Enclosures: Articles 501.2, 501.3, 501.5, 501.6, and 501.7

Field Wiring: Articles 501.4, 501.5, 501.11, and 501.14

Connections: Articles 501.3 (B)(6), 501.4, 501.12, and 501.13

Field Instrument Components: Articles 501.3, 501.6, 501.7, and 501.10

IEC References

Electrical Apparatus: 60079-15

Electrical Installations: 60079-14

Networking Guidelines (Class I)

Field Enclosures

- General purpose enclosures (NEMA 4, IP54 or better) are suitable for use with nonincendive components (nonincendive equipment).
- Conduit seals are not required for nonincendive equipment.
- Enclosures may be opened without deenergizing circuits. However, wiring may not be manipulated while circuits are energized.

Field Wiring

- Threaded rigid metal conduit with a minimum of 5 threads of engagement.
- Type MI (mineral insulated, metal sheathed) and MC (metal clad) cable with suitable termination fittings.
- Liquidtight may be used where flexibility is required
- Flexible cord listed for extra-hard usage and provided with listed bushed fittings.

Connections

- Approved explosion proof fittings.
- Quick connectors are suitable provided all of the following conditions are met:
  1. Power is removed from the circuit before plugging or unplugging.
  2. Current does not exceed 3 amps @ 120VAC.
  3. Cord is listed for hard usage with receptacle and plug of the locking and grounding type.
  4. A label is attached to the receptacle warning against unplugging while energized.

Field Instrument Components

- Nonincendive components consist of:
  1. Current interrupting contacts which are hermetically sealed against external gases.
  2. Non-arcing (e.g. solid state) where the maximum operating surface temperature does not exceed 80% of the ignition temperature of the exposed gases.

Economic Analysis

Installation Cost Comparison (calculated per field device)

	Conventional	AS-Interface	FF*
Computer I/O; Master/Gateway	$ 70	$ 50	$ 160
Conduit, Cable Tray, Wiring and Fittings	$1,400	$ 290	$ 290
Valve Monitor/VCT and Pneumatic Valve	$ 315	$ 450	$1,025
Switched Protected Drop Connector	NA	$ 160	$ 160
Installation and Commissioning Labor	$ 600	$ 250	$ 250
Power Supply	$ 50	$ 30	$ 30
Total Installed Cost	$2,435	$1,230	$1,915

*Foundation Fieldbus is not directly comparable. Analog instruments may require less adder over conventional 4 to 20 mA instruments making this system cost effective when combining analog and discrete field instruments on the same segment. Functionality for Foundation Fieldbus devices is also significantly greater, offering increased diagnostic and operational capabilities.

Total Installation savings
$1,205 per field device or
$19,280 for a 16 device segment

Basic Assumptions

- Number of field devices on segment is not limited by electrical energy to the segment.
- One network segment consists of 16 field devices.
- Field devices are located in a cluster located an average distance of 200 feet (61m) from marshalling cabinet.
- Total bus network is 300 feet (91m) long.
- All network drop legs are short circuit protected and may be deenergized in the field.
- Seal fittings are not required at field devices.
- While bus remains energized field devices may be removed by switching off drop circuit.
- Costs may vary depending on specific application.

Additional Savings with Bus Network Installation

- Conduit, wiring and marshalling enclosures consume less space.
- Less infrastructure is required to support conduit and enclosures.
- Devices may be added later or system changed for minimal cost (number of devices per segment protocol dependent)
- Field devices may be capable of providing diagnostics for maintenance.
- Multi-point variables may be included in one field device, dramatically reducing instrument costs.

Tray Cabling with Nonincendive Equipment

Tr Cbl + NIE

Area Classifications (NEC)
Class I Groups A, B, C, D Division 2
Class II Groups E, F, G Division 2

Area Classifications (IEC)
Ex nA, IIC, IIB, IIA Zone 2

Compatible Protocols
Most Field Based Protocols are suitable for use with ITC or PLTC wiring and nonincendive equipment provided proper installation methods are used and nonincendive components are properly certified.

Significant power may be provided using these tray type cable systems enabling bus networks to operate at up to 5 amps for ITC and 3 amps for PLTC. When using either PLTC or ITC, structual support must be provided for the cabling with trays or other means and the power supply must be current limiting. Cabling may be connected into nonincendive equipment using compression fittings or connectors designed for hazardous division 2/zone 2 applications.

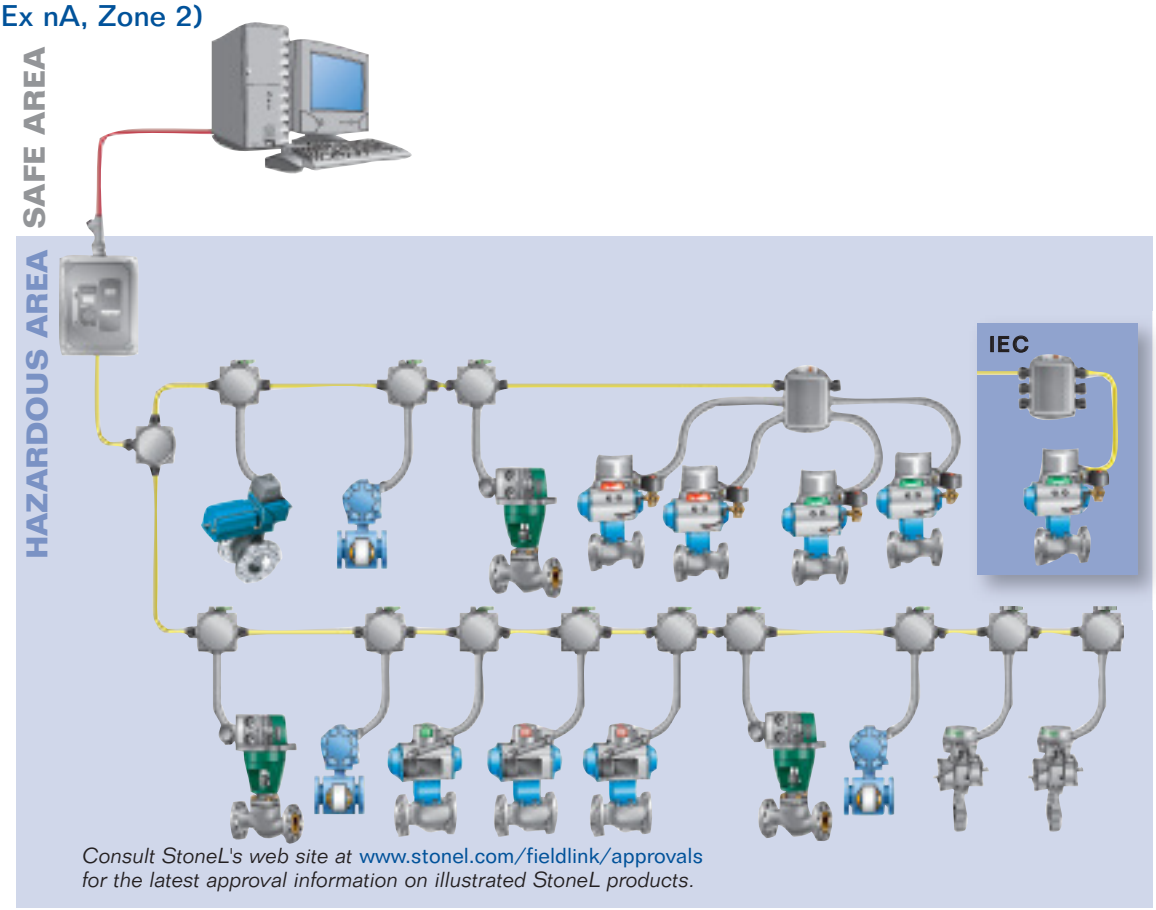
IEC requirements are less stringent than NEC standards with current limited to 6 amps and voltages not to exceed 250V.

Basic Concept
- ITC limited to 5 amps with 20 gauge or larger wiring using standard networking voltages; PLTC limited to 100 watts (e.g. 3.3 amps @ 30VDC or 4.1 amps @ 24VDC).
- Cabling must be PLTC or ITC and must be supported by cable tray, angles, struts, channels, messenger wire or other mechanical means.
- Circuits must have a current limited power supply (class 2 approved power supply is required for PLTC.
- IEC allows thermoplastic or elastomoric sheathed cable for fixed wiring installations. No specific support structures are required.

Advantages
- Significant power for bus networks.
- Low cost wiring and instrument enclosures.
- Limited shock and ignition hazard (using class 2 power supply).
- Suitable for all fieldbus protocols.

Disadvantages
- PLTC and ITC wiring concepts are not well known.
- Limited to division 2/zone 2 areas.

Tray Cabling with Nonincendive Equipment Network
(Class I and II, Div. 2; Ex nA, Zone 2)



LEGEND

FieldBlock pages 160-165
FieldRack pages 166-167
Gateways pages 38-59
Junction Module pages 154-159
Power Supplies pages 61-65, 102-103, 116, 168-175
StoneL VCTs page 197

Consult StoneL's web site at www.stonel.com/fieldlink/approvals for the latest approval information on illustrated StoneL products.

Tray Cabling with Nonincendive Equipment

Tr Cbl + NIE

NEC References

Field Enclosures: Article 501.3 (B)(4)

Field Wiring:
PLTC - Article 725 (26 to 71)
ITC - Article 727

Connections: Articles 501.3 (B)(6), 501.4, 501.12, and 501.13

Field Instrument Components: Articles 501.3, 501.6, 501.7, and 501.10

IEC References

Electrical Apparatus: 60079-15

Electrical Installations: 60079-14

Networking Guidelines (Class I)

Field Enclosures

- Same as those described on page 19 for NIE.

Field Wiring

- ITC (Instrument Tray Cable) must be limited to 150 volts and 5 amps for 20 gauge wire or larger or 3 amps for 22 gauge.
- ITC applications must have a power supply with overcurrent protection that does not exceed current limits for respective wire gauges.
- PLTC (Power Limited Tray Cable) must be limited to 100 watts and 60 VDC (e.g. 3.3 amps @ 30VDC or 4.1 amps @ 24 VDC).
- PLTC applications must have a class 2 approved power supply.
- PLTC and ITC used in cable tray systems must have a separation of at least 2 in. (5 cm) or a mechanical barrier from higher power circuits.
- PLTC and ITC may be used as open wiring between cable tray and instruments for up to 15m (50 ft.) and must be mechanically protected by angles, struts, channels or other mechanical means or supported by messenger wire.
- PLTC and ITC may be used as open wiring between cable tray and instruments for up to 15m (50 ft.) where cable complies with MC (metal clad) and is identified for such use.
- May also use field wiring as described on page 19.

Connections

- Same connections described on page 19.
- PLTC and ITC may be connected using compression type fittings installed in a manner to avoid tensile stress at the termination points.
- Flexible cord and quick connectors are suitable provided all conditions are met as described on page 19 for Class I Division 2 locations.

Field Instrument Components

- Same as nonincendive components described on page 19.

Economic Analysis

Installation Cost Comparison (calculated per field device)

	Conventional	AS-Interface	FF*
Computer I/O; Master/Gateway	$ 70	$ 50	$ 160
Conduit, Cable Tray, Wiring and Fittings	$ 750	$ 160	$ 160
Valve Monitor/VCT and Pneumatic Valve	$ 315	$ 450	$1,025
Switched Protected Drop Connector	NA	$ 100	$ 100
Installation and Commissioning Labor	$ 500	$ 150	$ 150
Power Supply	$ 50	$ 30	$ 30
Total Installed Cost	$1,685	$ 940	$1,625

*Foundation Fieldbus is not directly comparable. Analog instruments may require less adder over conventional 4 to 20 mA instruments making this system cost effective when combining analog and discrete field instruments on the same segment. Functionality for Foundation Fieldbus devices is also significantly greater, offering increased diagnostic and operational capabilities.

Total Installation savings
$745 per field device or
$11,920 for a 16 device segment

Basic Assumptions

- Number of field devices on segment is not limited by electrical energy to the segment
- One network segment consists of 16 field devices.
- Field devices are located in a cluster located an average distance of 200 feet (61m) from marshalling cabinet.
- Total bus network is 300 feet (91m) long.
- All network drop legs are short circuit protected and may be deenergized in the field
- Seal fittings are not required at field devices.
- Field devices may be removed by switching off drop circuit while bus remains energized.
- Costs may vary depending on specific application.

Additional Savings with Bus Network Installation

- Conduit, wiring and marshalling enclosures consume less space.
- Less infrastructure is required to support conduit and enclosures.
- Devices may be added later or system changed for minimal cost (number of devices per segment protocol dependent).
- Field devices may be capable of providing diagnostics for maintenance.
- Multi-Point variables may be included in one field device dramatically reducing instrument costs.

Tray Cabling with Nonincendive Wiring Drops and Associated Apparatus

Tr Cbl + NIW

Area Classifications (NEC)
Class I Groups A, B, C, D Division 2
Class II Groups E, F, G Division 2

Area Classifications (IEC)
Ex nL, IIC, IIB, IIA Zone 2

Compatible Protocols
Foundation Fieldbus, Profibus PA and AS-Interface are compatible with PLTC or ITC and nonincendive wiring concepts.

When using Tray Cabling (PLTC, ITC or IEC flexible cabling) concepts on the bus trunk with nonincendive field wiring drop legs, cabling system may be built for the entire bus structure maximizing flexibility and minimizing costs. Nonincendive field wiring and associated apparatus must not have sufficient energy to ignite the gas-air or dust-air mixture under normal conditions. Energy must be limited to the nonincendive field wiring and energy storage of the associated apparatus (field instruments) must be limited. The bus trunk using Tray Cabling concepts may carry 5 amps (IEC 6 amps) and the drop leg, using nonincendive field wiring concepts, may carry up to 0.15 amps at bus level voltages. This provides ample power for multiple drops and individual devices.

Basic Concept
- Utilize Tray Cabling concepts for trunk infrastructure (See pages 20 & 21).
- Utilize nonicendive field wiring and associated apparatus for drop connections and field devices.
- Nonincendive field wiring and associated apparatus are not capable, under normal operation, of igniting the gas, vapor or dust-air mixture. (Normal operation includes opening, shorting or grounding the field wiring.)

Advantages
- High power to bus trunk with few limitations (5 amps; IEC 6 amps)
- Relatively high power to each device (typically 130mA @ 30VDC)
- Limited shock and ignition hazard
- Low cost wiring and instrumentation enclosures
- May use general purpose wiring from protected drop connector to field device
- Takes advantages of best of both protection concepts to optimize safety, hazard protection and minimize costs
- Nonincendive wiring apparatus (field device) may have wiring manipulated while hot.

Disadvantages
- PLTC, ITC and nonincendive wiring techniques are not well known
- Limited to division 2, zone 2 areas
- Limited product availability
- Limited availability of nonincendive wiring associated apparatus (May use IS devices).

Tray Cabling with Nonincendive Wiring Drops Network
(Class I and II, Div. 2; Ex nL, Zone 2)

LEGEND


FieldRack
pages 166-167


Gateways
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Junction Module
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FieldBlock
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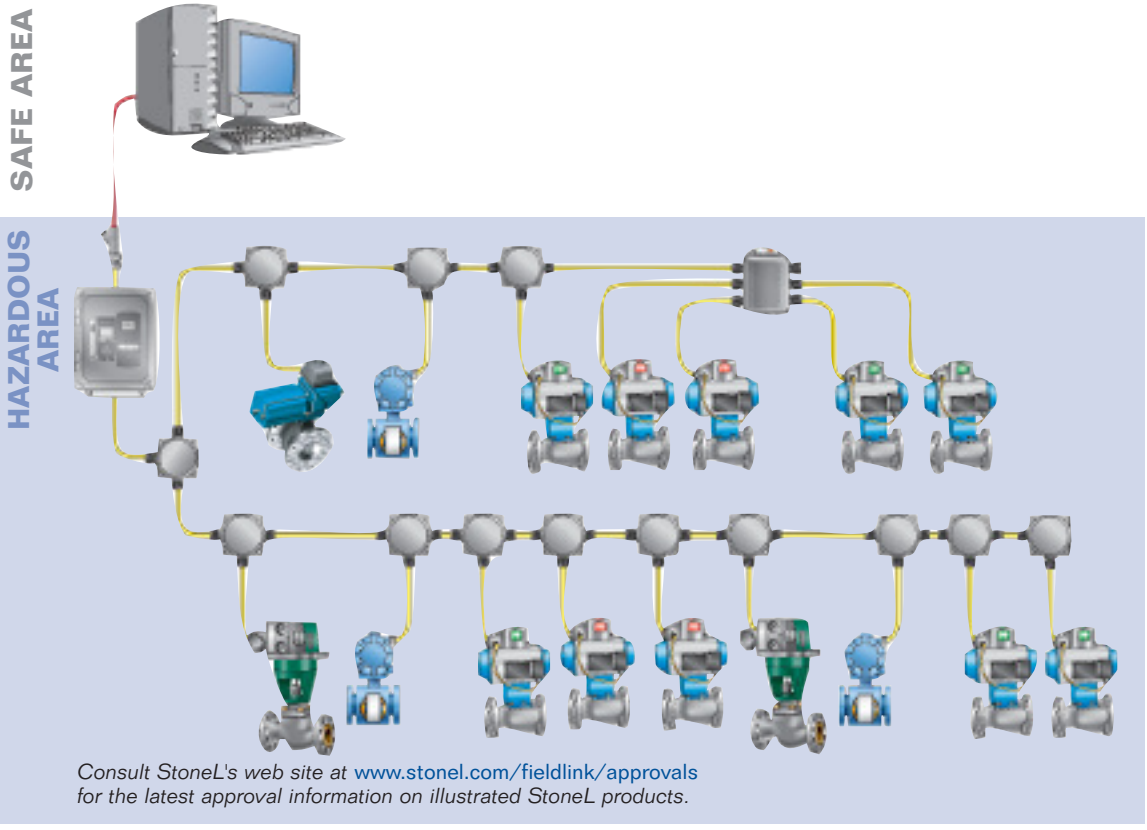
Power Supplies
pages 61-65, 102-103, 116, 168-175


StoneL VCTs
page 197



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Tray Cabling with Nonincendive Wiring Drops and Associated Apparatus

Tr Cbl + NIW

NEC References

Field Enclosures
Nonincendive Equipment in Trunk: Articles 501.2, 501.3, 501.5, 501.6 and 501.7
Nonincendive Wiring Apparatus in Drop Leg: Articles 500.1, 500.2, and 501.4(B)(3); also refer to FM document Class Number 3611 section 7

Field Wiring
Trunk: Articles 501.4(B)(4 & 5), Articles 725 (26 to 71), and Article 727
Drop Leg: Articles 500.2 and 501.4(B)(3); also refer to FM document Class Number 3611 section 7

Connections
Trunk: Articles 501.3(B)(6) and 501.4(B)(2)
Drop Leg: Article 501.4(B)(3)

Field Instrument Components:
Trunk: Article 501.3 (B)(1,2,3 & 5)
Drop Leg: Articles 500.1 and 500.2

IEC References

Electrical Apparatus: 60079-15

Electrical Installations: 60079-14

Economic Analysis

Installation Cost Comparison (calculated per field device)

	Conventional	AS-Interface	FF*
Computer I/O; Master/Gateway	$ 70	$ 50	$ 160
Barriers	$ 100	$ 0	$ 0
Conduit, Cable Tray, Wiring and Fittings	$ 600	$ 110	$ 110
Valve Monitor/VCT and Pneumatic Valve	$ 415	$ 505	$ 850
Voltage and Current Limiting Drop Connector**	$ 0	$ 70	$ 70
Installation and Commissioning Labor	$ 350	$ 100	$ 100
Power Supply	$ 10	$ 30	$ 30
Total Installed Cost	$1,545	$ 865	$1,320

*Foundation Fieldbus is not directly comparable. Analog instruments may require less adder over conventional 4 to 20 mA instruments making this system cost effective when combining analog and discrete field instruments on the same segment. Functionality for FOUNDATION Fieldbus devices is also significantly greater, offering increased diagnostic and operational capabilities.

** Drop connector acts as a barrier for nonincendive drops.

Total Installation savings
$680 per field device or
$10,880 for a 16 device segment

Basic Assumptions

- Number of field devices on the segment not limited by electrical energy to segment.
- One network segment consists of 16 field devices.
- Field devices are in a cluster, located an average distance of 200 feet (61m) from marshalling cabinet.
- Total bus network is 300 feet (91m) long.
- Field devices may be removed while bus is energized.
- Cost may vary depending on specific application.

Installation Guidelines (Class I)

Field Enclosures

- Trunk: Nonincendive equipment with general purpose enclosures.
- Drop leg: General purpose equipment (NEMA 4, IP54 or better) may be used.

Field Wiring

- Trunk: utilize PLTC or ITC concepts as described on page 21 for Tray Cable.
  - Power supply must be suitable for PLTC or ITC concepts (see page 21).
- Drop leg: utilize nonincendive field wiring concepts which allows general purpose wiring. Cable capacitance and inductance is negligible for 20 gauge wire and larger with lengths under 300 meters (984 feet).

Connections

- Trunk: utilize standard connections suitable for PLTC and ITC (see page 21)
  - Quick connectors may be used on trunk with limitations as specified on page 19 for Class I and II, Division 2 locations.
- Drop leg: current limiting and voltage protected device must supply drop which coordinates with maximum possible associated apparatus operating voltage. Short circuit current at maximum possible operating voltage must not be capable of igniting gas or dusts in the atmosphere.
  - Quick connectors may be used for nonincendive wiring drops without limitation.

Field Instrument Components

- Trunk components must be nonincendive as described on page 19 for NIE.
- Drop connectors must be rated as nonincendive equipment and have drop leg voltage and current limiting capability.
- Drop connector and field instrument (associated apparatus) parameters must coordinate as follows:

Drop Connector		Field Instrument
Voc	<	Vmax
Isc	<	Imax

- Field instrument capacitance and inductance must be limited. At 38VDC allowable capacitance and inductance is as follows:
  Ci< 738 nF
  Li< 20 mH @ 200mA
- Intrinsically safe apparatus may be used as nonincendive wiring apparatus.

Additional Savings with Bus Network Installation

- Conduit, wiring and marshalling enclosures consume less space.
- Less infrastructure is required to support conduit and enclosures.
- Devices may be added later or system changed for minimal cost (number of devices per segment protocol dependent).
- Field devices may be capable of providing diagnostics for maintenance.
- Multi-Point variables may be included in one field device dramatically reducing instrument costs.

Intrinsically Safe

IS

Area Classifications (NEC)
Class I Groups A, B, C, D Division 1 & 2
Class II Groups E, F, G Division 1 & 2

Area Classifications (IEC)
Ex ia IIC, IIB, IIA Zones 0, 1 & 2

Compatible Protocols
Foundation Fieldbus and Profibus PA

NEC References
Field Enclosures: Articles 504.10, 504.30 (A)(3), and 517.64

Field Wiring: Articles 504.2, 504.30, 504.50, 504.7, and 504.80

Connections: Article 504.80

Field Instrument Components: Articles 504.2, 504.4, and 504.10

IEC References
Electrical Apparatus: 60079-11, 60079-27 (FISCO and FNICO)

Electrical installations: 60079-14, 60079-25, 61158-2

Simple devices include:
- RTDs
- Thermal Couples
- Switches (must not generate low voltage and current)
- LEDs

Intrinsically Safe devices include:
- Transmitters
- Positioners
- Solenoid Valves
- Any Communication Enabled Field Device

In an intrinsically safe (IS) circuit, electrical and thermal energies are limited under normal and abnormal conditions to levels incapable of igniting hazardous mixtures when present in their most ignitable concentrations. Therefore electrical energy into the circuit and energy storage in the circuit must be limited under normal operating conditions and under single fault conditions. An IS barrier is used to limit energy into the electrical circuit under fault conditions. Total capacitance and inductance must also be kept below published limits in order to prevent energy stored in the cabling and field devices from causing ignition.

Basic Concept
- Prevents ignition of gases.
- No ignition under normal or abnormal circumstances.
- Limits electrical energy input into the circuit.
- Limits energy storage in the circuit.
- Circuit has over-voltage and short circuit protection.

Advantages
- Low cost wiring and instrumentation enclosures.
- No shock hazard.
- Instruments may be serviced while hot (may require protected drop connectors to prevent faults from disrupting bus communication).

Disadvantages
- Limited power delivery holding maximum number of devices per segment to 4 or 5.
- Use of barriers reduces available voltage to instruments.
- Communication protocols limited to those with physical layer 61158-2 (Foundation Fieldbus H1 and Profibus PA).

Installation Guidelines (Class I; Ex ia)

Field Enclosures
- General purpose enclosures may be used with intrinsically safe components.

Field Wiring
- General purpose cabling requirements apply.
- Intrinsic safety barriers are required, which limit voltage and current under open circuit and short circuit fault conditions.
- Current levels are limited depending on IS methodology used.
- Cable capacitance and inductance must be held below established levels (FISCO) or combined with field devices (Entity) to determine suitability.

Connections
- No connector restrictions on intrinsically safe wiring.

Field Instrument Components
- Must be classified IS or simple.
- IS device must be approved.

Instrinsically Safe Field Devices

Intrinsically safe field devices are classified as simple or intrinsically safe. Simple devices must not generate more than 1.5 V, O.10 A and 25mW or if a passive component, must not dissipate more than 1.3 watts.

Simple devices may be connected to an IS barrier without special considerations since they do not generate or store significant electrical energy.

Intrinsically safe apparatus have electrical parameters in excess of the values for simple apparatus. They are considered to be energy storing and require evaluation by an appropriate testing agency. Consult the product manufacturer if there is any doubt whether a device is simple or intrinsically safe.

Intrinsically Safe

IS

Bus Network Wiring

↓

Use Fieldbus Intrinsically Safe Concept (FISCO)

Conventional Point-to-Point Wiring

↓

Use Entity Concept

Figure 1

Intrinsically Safe Methodologies

Two methods used to properly construct an IS bus networking circuit are the Entity Concept and the FISCO model. The Entity Concept may be used in conventional and bus networking installations. The FISCO model may be used only for buses with the 61158-2 physical layer and offers greater flexibility for these applications.

Because FISCO has been designed around bus networking applications it promises to be used more widely as understanding of the concept grows. The following is a discussion of the two models in bus networking applications.

The Entity Concept

The entity concept has traditionally been used on point-to-point wiring systems in the process industries. Key criteria of the Entity Concept include:

- Barrier and field device entity parameters must match.
- Cable inductance and capacitance are considered concentrated and must be added to total circuit values.
- Barriers are typically limited to 60mA and 1.2W for hydrogen environments, significantly restricting the number of field devices on the network segment.

Intrinsically Safe Apparatus		Associated Apparatus
Lowest Vmax in segment	>	Voc (open circuit voltage)
Lowest Imax in segment	>	Isc (short circuit current)
Lowest Pmax in segment	>	Pt (transfer power)
Total of Cin devices + C cable	<	Ca (allowed capacitance)
Total of Lin devices	<	La (allowed inductance)

Parameter Evaluation to Determine Barrier for the Intrinsically Safe Entity Concept

Tag	Vmax	Imax	Pmax	Ci	Li	Inom
T1	24 V	250 mA	1.5 W	.05 µF	.08 mH	16 mA
T2	28 V	250 mA	1.2 W	.08 µF	.02 mH	18 mA
T3	26 V	250 mA	1.4 W	.02 µF	.10 mH	24 mA
Cable				.03 µF		
	Voc	**Isc**	**Pt**	**Ca**	**La**	**Inom**
Barrier Match	24 V	250 mA	1.2 W	.18 µF	.2 mH	58 mA

Entity Parameter Matching

In order to properly apply the entity concept the IS Barrier (associated apparatus) must be properly matched with the field devices (instrinsically safe apparatus) and cabling. ***Figure 1*** is a table for proper matching of the entity parameters.

Intrinsically Safe Entity Concept Example (Class I, Div. 1 and 2; Ex ia, Zones 0, 1, and 2)

The parameters for each of the devices must be evaluated to determine the appropriate barrier for the segment as follows:

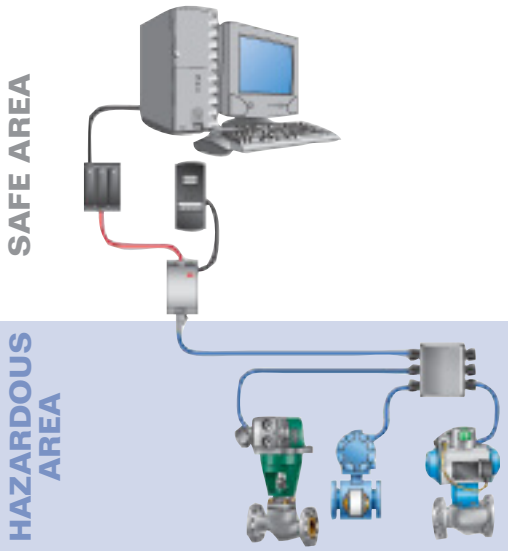
The Barrier selected must have the following parameters:

Voc	<	24 Volts
Isc	<	250 milliamps
Pt	<	1.2 Watts
Ca	>	0.18 microFarads
La	>	0.20 millihenries

Before making a final barrier selection the voltage drop must be determined taking into account the barrier resistance, cable resistance and nominal current. See page 30 for special note on voltage drop for bus network circuits.

Intrinsically Safe Entity Concept Bus Network

(Class I, II and III, Div. 1 and 2; Ex ia IIC, Zones 0, 1 and 2)



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Intrinsically Safe

IS

The FISCO Model

The FISCO (Fieldbus Intrinsically Safe Concept) model was developed based on emperical studies performed on IEC 61158-2 installations by PTB in Germany. The test results have been accepted worldwide and are now being used by most testing bodies. With the FISCO model greater flexibility is allowed provided the field devices and cabling meet specific parameters.

FISCO Model Features

- Device entity parameters for inductance and capacitance are considered negligible (must be less than .01mH and .005μF respectively).
- Cable inductance and capacitance are not considered concentrated so are not added to calculations (R loop must be 15Ω to 150Ω/km; L must be .4 to 1mH/km and C must be .045 to .2 μF/km).
- Maximum cable span limited to 60m for drops and trunk to 1km lengths for IIC (Groups A-D) and 5km length for IIB (Groups C-D).
- Barriers typically are limited to 100mA and 1.8W for hydrogen environments enabling use of more field devices per segment.

Intrinsically Safe FISCO Model Example

Using the FISCO model, inductance and capacitance for both cabling and field devices do not have to be considered, provided they fall within the above defined parameters.

Parameter Evaluation to Determine Barrier for the FISCO Model

Tag	Vmax	Imax	Pmax	Inom
T1	24 V	250 mA	2 W	16 mA
T2	28 V	220 mA	2 W	18 mA
T3	26 V	250 mA	2.4 W	24 mA
T4	28 V	220 mA	2.2 W	20 mA

	Voc	Isc	Po	Inom
Barrier Match	24 V	220 mA	2 W	78 mA

The Barrier selected must have the following parameters:

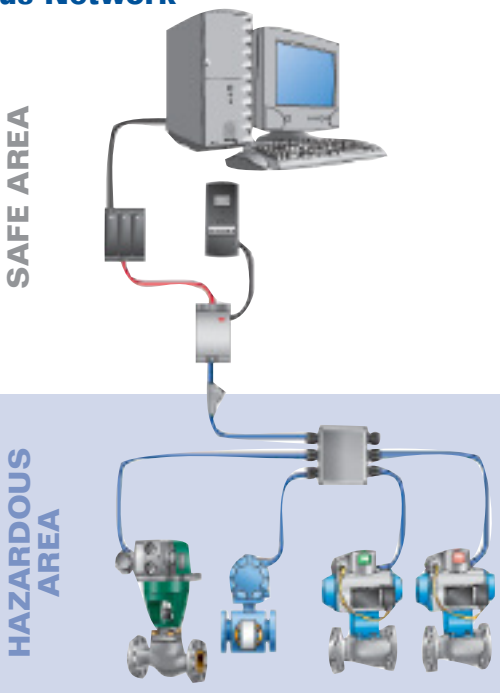
Connection to Fieldbus per FISCO

Voc	<	24 Volts
Isc	<	220 milliamps
Po	<	2 Watts

Voltage drop must also be considered before making a final determination on the proper barrier. See the example on page 30 for proper voltage drop determinations. As a general rule the FISCO model allows more flexibility using a repeater barrier because the supply voltage after the barrier does not drop linearly with current flow.

Intrinsically Safe FISCO Bus Network

(Class I, Div. 1 and 2;
Ex ia IIC, Zones 0, 1 and 2)



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Intrinsically Safe

IS

Basic Assumptions

- FISCO IS model is used.
- One host and one power supply 4 segments each with 4 devices.
- Field devices are located in a cluster located an average distance of 200 feet (61m) from marshalling cabinet.
- Each segment is 200 feet (61m) long.
- All network drop legs are short circuit protected.
- Field devices may be removed while bus is energized.

Economic Analysis

Installation Cost Comparison (calculated per field device)

	Conventional	FF
Computer I/O; Master/Gateway	$ 70	$ 160
Barriers	$ 100	$ 190
Conduit, Cable Tray, Wiring and Fittings	$ 600	$ 220
Valve Monitor/VCT and Pneumatic Valve	$ 415*	$ 850*
Switched Drop Connector	$ 0	$ 70
Installation and Commissioning Labor	$ 350	$ 150
Power Supply	$ 10	$ 30
Total Installed Cost	$1,545	$1,670

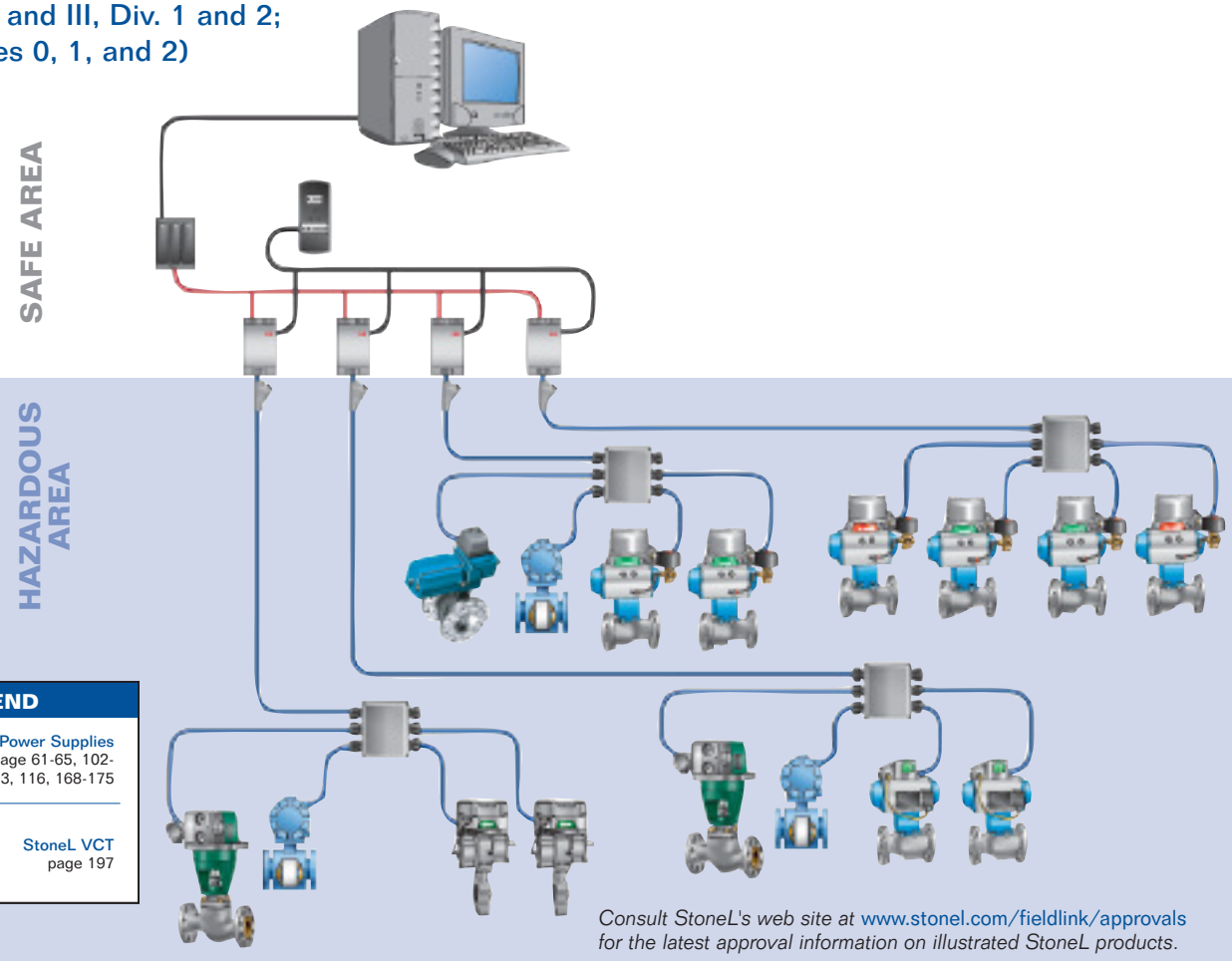
* Analysis with analog devices may result in lower differential costs between conventional and FOUNDATION Fieldbus insturments.

Additional Savings with Bus Network Installation

- Wiring and marshalling enclosures consume less space.
- Less infrastructure is required to support conduit and enclosures.
- Field devices are cabable of providing diagnostics for maintenance.
- Multi-Point variables may be included in one field device dramatically reducing instrument costs.

Intrinsically Safe Bus Network

(Class I, II and III, Div. 1 and 2; Ex ia, Zones 0, 1, and 2)



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Nonincendive Wiring

NIW

Area Classifications (NEC)
Class I Groups A, B, C, D Division 1
Class II Groups E, F, G Division 2

Area Classifcations (IEC)
Ex nL IIC, IIB, IIA Zones 0, 1 & 2

Compatible Protocols
Foundation Fieldbus H1 and Profibus PA

NEC References: 500.2, 501.4,

IEC References: 60079-27, 60079-15

The FNICO (Fieldbus Nonincendive Concept) model

Like FISCO, FNICO was developed based on studies of the 61158-2 physical layer standard in division 2, zone 2 areas combining multiple devices on a single segment topology. When considering ignition hazards more flexibility is allowed than single point to point wiring provided standard parameters are met for field instruments (associated apparatus) and cabling.

FNICO Requirements

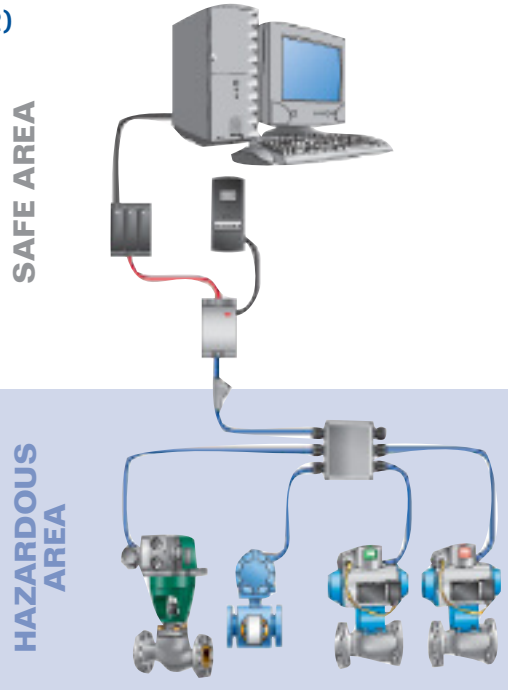
- Device input parameters are considered negligible (Ci must be less than .005µF and Li less than 20µH)
- Field devices must be suitable for IIC group temperature classified in accordance with Ex nL (Nonincendive field wiring associated apparatus)
- Cable inductance and capacitance are not considered. (Same as FISCO)
- Typical power on the network is limited to 200 mA @ 14v for hydrogen enviroments.

FNICO evaluation is the same as FISCO evaluation illustrated on page 26.

Special Application Note

When considering division 2, zone 2 applications, a system combining tray cabling and nonincendive field wiring (Tr Cbl + NIW) drops may provide greater flexibility and enable the network to operate with higher trunk current flows (see pages 22-23). However, FNICO used on the entire network will allow the trunk cable network to be manipulated without removing power.

Nonincendive FNICO Bus Network
(Class I, Div. 2; Ex nL, Zone 2)



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