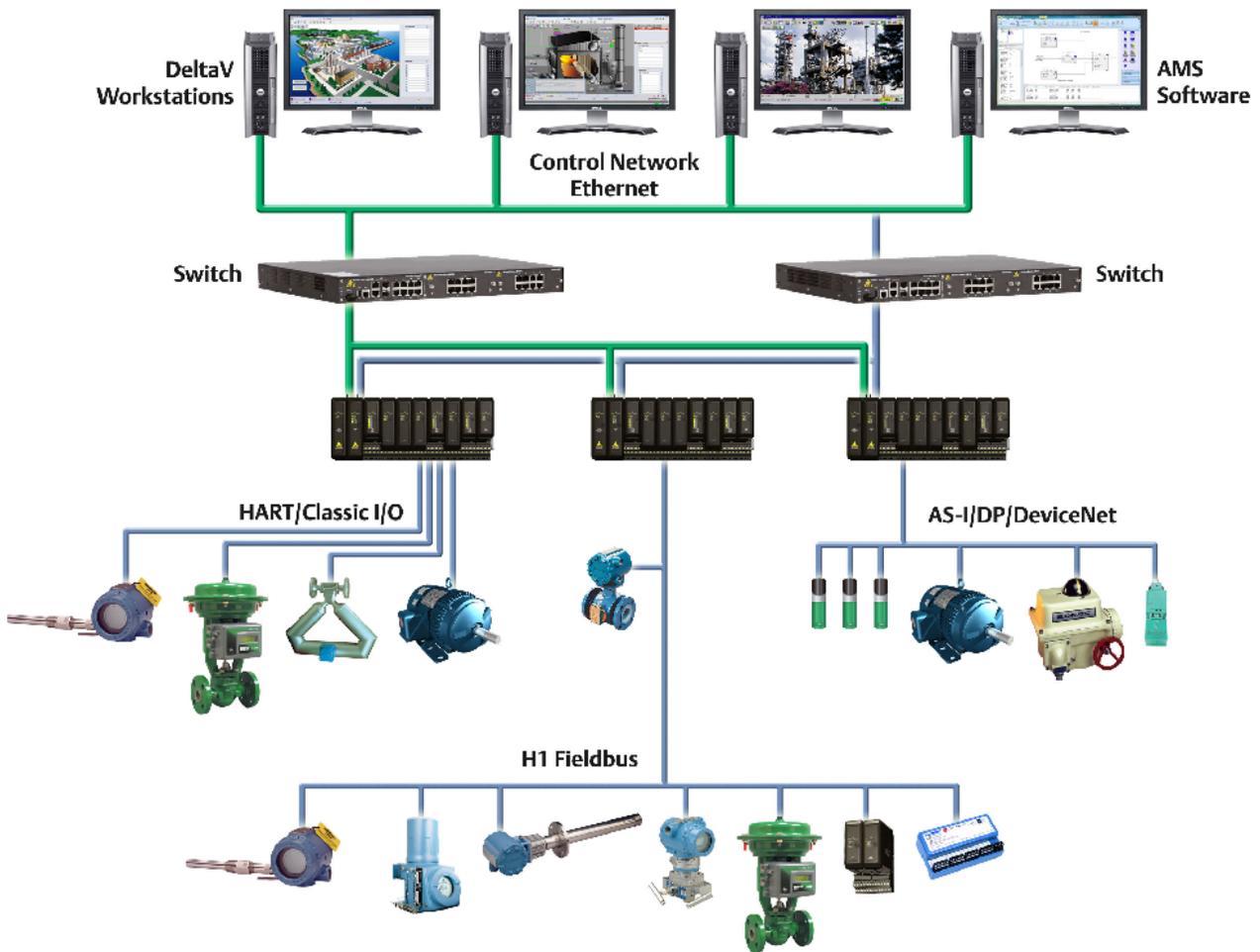


# Buses and the DeltaV™ System

This document describes the implementation of various buses in the DeltaV system and some recommended applications



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## Introduction

This whitepaper describes the supported buses in a DeltaV system and some of the typical applications they are suited for. The DeltaV system gives a seamless interface with CENELEC or IEC standard device buses. Our support of standards ensures your freedom to use the devices you prefer. AS-I bus, Profibus DP, DeviceNet, FOUNDATION fieldbus, HART, and traditional I/O can be easily intermixed on an I/O card basis on the same DeltaV controller. The same configuration, diagnostic, and operator interface techniques are used to configure the system, enabling you to mix and match bus technologies to meet application requirements. The DeltaV system makes it easy to configure and activate the devices. For devices not in the library, users can add devices and customize signal labeling according to specific plant standards.

## Types of fieldbuses

Field networks typically reside below a distributed control system (DCS), or other host controller, replacing point-to-point wiring of sensors, actuators, and other I/O devices with an open, multi-drop, bus-type wiring scheme. Sensors, actuators, and other devices formerly hardwired to the host or remote I/O racks now become nodes on a network. Fieldbuses can be categorized into three levels based on differing application requirements and device types. These three levels are bit level, byte level, and block level. These categories are sometimes referred to as sensorbus, devicebus, and fieldbus, respectively.

### Sensorbus

Sensorbus is used when many discrete devices need to transmit only one or perhaps a few bits of information, and at the same time, cost must be minimized. This makes it a very cost-effective solution but with limited or no diagnostic information from the devices or the process. Examples are proximity switches, pushbuttons and motor starters and other simple devices that are not “smart.” A sensorbus network can meet this need and transmit bit level messages to the controller.

Often an I/O brick such as AS-i that allows several sensors or actuators to be attached to one node is used in sensorbus networks, thus distributing the already low interface cost across several physical devices. This also results in a lower node count relative to the number of physical devices. Given the small message size and limited-to-no diagnostics, reduced wiring costs are the primary benefit of using sensorbus networks.

### AS-i

AS-i, or Actuator Sensor Interface, is a bit-level network that was introduced in late 1994. Along with Profibus-DP, and WorldFIP-I/O, AS-i is one of the four technologies included in the CENELEC standard EN 50254, (High Efficiency Buses for Industrial Automation). Gateways are available for the connection of AS-i networks to Profibus-DP, DeviceNet, and ModBus.

The AS-i technology is being leveraged across both industrial automation and electrical distribution businesses, where it is targeted for use with equipment such as switchgear cabinets and motor starters. Also, several manufacturers have implemented AS-i technology in On/Off valve actuators and valve position indicators for the process industries.

To know more about AS-i please visit the following web site: <http://www.as-interface.com>

### Devicebus

With message capacities ranging from several bytes to over 200 bytes, depending on the protocol, devicebus networks are designed to meet the communication needs of higher-level devices. The devicebus networks are typically employed where more information is transferred or diagnostics are required.

Devicebus is intended for bi-directional communications with devices, which can be programmed to a limited degree. Devicebus networks are able to accommodate a much broader range of devices relative to sensorbus networks.

DeviceNet is capable of accommodating a message size of up to 8 bytes. Profibus-DP supports byte level message sizes of up to several hundred bytes. Although devicebus networks may be used for any type of device, they are optimized for discrete sensors and actuators typically used in a logic control application. They are typically optimized for speed, efficiency, and short message lengths.

### **Profibus DP/PA**

Profibus, or PROcess FieldBUS, was a German national standard for digital communication at the fieldbus level, and is now a European standard as part 3 of EN50170. It is also one of the parts of IEC61508.

DP, short for decentralized peripherals, was designed to optimize network throughput in order to meet the networking requirements at the device level. Profibus-DP is an RS-485 based protocol. Distribution of Profibus applications largely reflects the discrete manufacturing orientations of key proponents such as Siemens and Klockner-Moeller. The overwhelming majority of installations are in Europe, particularly Germany, with applications ranging from material handling to control of paper and packaging machines.

PA, short for Process Automation, was designed to provide highly reliable master/slave communications to "smart" sensors and actuators, working under a DP based host system in process applications. Profibus PA messages are containing several floating point process variables, as well their respective statuses, communicated to the host in a Profibus master/slave fashion. Profibus PA is following the same wiring saving idea than Fieldbus, but does not offer Control in the Field Capabilities.

To know more about Profibus DP please visit the following web site: <http://www.profibus.com>

### **DeviceNet**

Since its launch in 1994 by Allen-Bradley, the DeviceNet technology has been turned over to the independent Open DeviceNet Vendor Association (ODVA). The overwhelming majority of installations are in North America. DeviceNet offers master/slave and peer-to-peer capabilities with devices from a number of vendors. The goal of DeviceNet is to provide a low-cost communications link and eliminate expensive hard wired I/O. To this end DeviceNet continues to evolve and has adopted some characteristics from ASi. Rockwell Automation and Cutler Hammer continue to be the largest suppliers. Flex I/O is the target Allen-Bradley approach for attaching standard, non-DeviceNet-compatible devices. Analog signals can also be interfaced through Flex I/O, although the DeviceNet protocol is not optimized for analog signals.

To know more about DeviceNet, please visit the following web site: <http://www.odva.org>

### **Fieldbus**

Fieldbus networks are designed to provide highly reliable bi-directional communications between "smart" sensors and actuators and a control system in a time-critical application. Fieldbuses are optimized for messages containing several floating point process variables, all sampled at the same time, and their respective statuses.

One of the objectives for fieldbus is to be the digital replacement for analog 4-20mA transmission of process variables in the process industries. Examples of implemented low-speed fieldbus networks are FOUNDATION fieldbus H1 and Profibus-PA. Due to the differing requirements for process versus discrete installations, fieldbus networks typically have slower transmission rates relative to devicebus or sensorbus networks. Another key differentiator is the addition of a user layer, or layer 8, on top of the typical three-layer communications stack. The user layer portion of FOUNDATION fieldbus includes standard and open function blocks that can be used to implement distributed field control systems (also known as control in the field).

To know more about FOUNDATION Fieldbus please visit the following web site: <http://www.fieldbus.org>

## Application Examples

### Sensorbus

Typical applications for a sensorbus are in the areas of motor and valve control. Devices to directly connect the valve indicator to the AS-i segment are available from several manufacturers. This has the advantage of allowing for up to 31 valves to be controlled on one cable with little or no incremental cost at the device. Schneider Automation and others make motor starters that directly interface to AS-i, or an I/O multiplex may be employed. The primary benefit in both these cases is in wiring savings and installation time, with the drawback being slightly greater risk (more devices affected on a single fault) and limited diagnostics from the devices (essentially equivalent to hard-wired IO). For applications with a high discrete count and short distance from the controller to the devices, AS-i is a good fit.

### Devicebus

Typical applications for a devicebus are in the areas of motor control and variable speed drives (VSD). Both Profibus DP and DeviceNet have support from major manufactures of these devices. The protocol supported does follow the manufacturer's geographic home base, with Allen-Bradley and Cutler Hammer supporting DeviceNet, and Siemens and ABB supporting Profibus DP. Another area in which we see interest in Profibus DP is remote IO subsystems. Stahl makes a subsystem suitable for mounting in a Zone 1 location, which affords some wiring savings. The drawbacks of a discrete bus for remote I/O are the lack of redundancy and, in some cases, the need for separate tools to configure the I/O. Control loop performance should also be considered because the use of remote I/O adds some latency to the loop. These device buses are a good way of interfacing to weigh scales and other ancillary equipment.

### Fieldbus

Typical applications for Foundation fieldbus are in the areas of analog process control, and replacement for conventional 4-20mA devices. The benefits of fieldbus for these applications are not only in wiring savings, but also in the increased diagnostic information that PlantWeb affords. Devices are now available from the major players in process control covering the most common process measurement and valve requirements. We are also starting to see discrete devices on fieldbus, such as valve actuators that allow the user to run a single bus to the field and connect all the devices. Emerson Process Management has developed an I/O multiplex or (H1 Smart Carrier) for connection of conventional discrete devices onto a Foundation fieldbus segment.

## Hazardous Area Application

### Sensorbus

AS-i (along with other sensor buses) has evolved from the factory automation world, and therefore has not typically focused on support for installation in hazardous areas. AS-i supplies power that exceeds the restrictions for intrinsic safety over the network; therefore, we do not expect to see intrinsically safe applications of AS-i technology. However, it can be installed using increased safety with suitable cabling, or explosion-proof if installed in conduit. There are also I/O multiplexes available that use increased safety on the AS-i segment and intrinsically safe field circuits to the connected devices. The DeltaV AS-i card can be installed in the same area classifications as the other DeltaV I/O devices, and several manufacturers are developing AS-i power supplies for mounting in the same locations.

## **Devicebus**

Profibus DP and DeviceNet (and other device buses) have evolved from the factory automation world as well, and as such, have not typically focused on support for installation in hazardous areas. DeviceNet supplies power over the network that exceeds the restrictions for intrinsic safety; therefore, we do not expect to see intrinsically safe applications of DeviceNet technology. However it can be installed explosion proof if installed in conduit. Profibus DP uses either RS485 or fiber-optic communications, and there are isolators available for making Profibus DP intrinsically safe.

There are also I/O multiplexes available that use intrinsic safety on the DP segment and intrinsically safe field circuits to the connected devices. The DeltaV Profibus DP card can be installed in the same area classifications as the other DeltaV I/O devices.

## **Fieldbus**

FOUNDATION fieldbus was designed from the start to support intrinsically safe connections. Intrinsically safe fieldbus isolators are available, and several vendors are developing methods for connecting more devices on an I.S. segment. There is also work under way to allow easy connection of several I.S. segments to one non-I.S. segment, thus allowing for a full complement of devices to be connected to the DeltaV interface. Emerson Performance Solutions has developed solutions for installation in a hazardous location using explosion-proof techniques. The FISCO model developed by PTB also holds promise for connecting more devices on an I.S. segment by allowing for more energy than the classic entity approval. Isolators are available from several vendors that conform to the FISCO model. (This is the same model used by Profibus PA.)

## **DeltaV Support**

### **AS-i bus Card**

The DeltaV AS-i bus card supports this digital, serial, bi-directional communications protocol and bus system that is used to connect simple binary on-off devices such as actuators, sensors, and discrete devices in the field. DeltaV AS-i card uses an automatic addressing system via the bus connection. This smart design gives each field device a specific tag name that identifies the device for configuration and diagnostic purposes. The DeltaV system auto-senses AS-i devices and provides smooth activation of new devices.

The AS-i bus uses a two-conductor cable to supply both power and data for the field devices. The AS-i bus is designed to operate over distances of up to 100 meters (more if extenders or repeaters are used). No terminators are needed anywhere on the AS-i bus.

The AS-i bus requires use of a special AS-i power supply that provides electrical isolation from the data signals. For convenience, a special AS-i yellow bus cable can be purchased that provides a simple cabling and connection method to most AS-i devices. This cable has a mechanical profile that provides foolproof, correct connections via insulation displacement connection (IDC) technology built into the AS-i devices. This cabling method ensures fast connection and disconnection. Conventional round profile cable can also be used with AS-i devices, since many vendors supply screw terminal options. Black (for DC) and red (for AC) color-coded cables are also available for field devices that require external power connections. Many low- or medium-powered devices are simply powered off the AS-i yellow cable and do not require external power.

The DeltaV AS-i card has two AS-i master ports. It controls communications on the AS-i network by polling the network devices, issuing commands, and receiving and processing replies from the network devices. Temperature and certification specifications are the same as other DeltaV I/O.

Each AS-i network can include up to 31 slave devices. Each slave can connect up to four conventional non-smart inputs and four non-smart outputs, meaning that up to 124 inputs and 124 outputs can be involved in each AS-i network. Network topology can include branches and stars (using passive splitters or hubs). The only limit is that the total length of AS-i cable anywhere between extenders or repeaters is limited to 100 meters. Repeaters generally require a separate AS-i power supply on the far side of the repeater.

**Profibus DP Card**

The Profibus DP technology is based on the master/slave principle and it allows you to run up to sixty-four slaves on a pair of wires (or segment). The DeltaV Profibus card supports one segment per card. This card has the same temperature and certification specifications as other DeltaV I/O cards.

In addition to that, the DeltaV Profibus DP solution is really robust since it offers a redundant card. A redundant pair of Profibus DP cards provides continued communications between the DeltaV system and the slaves even if the primary card fails, adding availability and robustness to the system.

The DeltaV Profibus DP card uses standard RS485 cabling and two wires for data transmission that is really easy to install. The bus structure permits addition and removal of stations or step-by-step commissioning of the system without influencing the other stations. Future expansions have no effect on stations already in operation.

Transmission speeds between 9.6 kbit/sec and 1.5 Mbit/sec can be selected. One unique transmission speed is selected for all devices on the bus when the system is commissioned.

Profibus DP transmission speeds and cable lengths						
Baud rate (kbit/sec)	9.6	19.2	93.75	187.5	500	1500
Distance/segment	1200m	1200m	1200m	1000m	400m	200m

With Profibus DP, you can assume any address on the segment. You have a jumper in the terminal block that configures the unit with or without the terminator. If it is configured without the terminator, there is a connection to two other screw terminals, so you can wire to and from a device. If it is configured to provide a terminator in the term block, the DeltaV system needs to be at one of the ends of the segment.

When Profibus PA Devices should be connected to a Profibus DP Card via Transparent DP/PA Coupler, the Transmission speed of the DP Card needs to be set to 93.75 kbit/sec.

Profibus DP Card transmission speed and cable length with DP/PA Coupler						
Baud rate (kbit/sec)			93.75			
Distance/segment			1200m			

With a transparent Profibus DP/PA Coupler on the Segment, you can still assume any address on the segment. You have the same jumper in the terminal block that needs to be configured (with or without the terminator) The transparent Profibus DP/PA Coupler should represent the end of the Segment, while being the terminating point of the segment.

## DP Slave

A DP slave is a peripheral device (I/O device, drive, HMI, valve, etc.) that collects input information and sends output information to the master. There are also devices that supply only input or only output information.

The amount of input and output information depends on the device type. A maximum of 244 bytes of input information and 244 bytes of output information is permitted.

The DeltaV Profibus DP interface card (master) cyclically reads the input information from the slaves and cyclically writes the output information to the slaves. In addition to cyclic user data transmission, Profibus-DP provides powerful functions for diagnostics and configuration.

The extensive diagnostic functions of Profibus DP enable fast location of faults. The diagnostic messages are transmitted over the bus and collected at the master. These messages are divided into the following three levels:

**Station-related diagnostics.** These messages concern the general operational status of the whole device (i.e., over temperature or low voltage).

**Module-related diagnostics.** These messages indicate that a fault is present in a specific I/O range (i.e., 8-bit output module) of a station.

**Channel-related diagnostics.** These messages indicate an error at an individual input/output bit (i.e., short circuit on output 7).

## PA Slave

A PA slave is a Process Automation device, typically residing in harsh process control environments (transmitter, on/off or control valve) that collects input information or receives output information to/from the master. There are also devices that supply only input or only output information.

The amount of input and output information depends on the device type. A maximum of 244 bytes of input information and 244 bytes of output information is permitted.

The DeltaV Profibus DP interface card (master) cyclically reads the input information from the slaves using a transparent DP/PA Coupler and cyclically writes the output information to the PA slaves. In addition to cyclic user data transmission, Profibus- PA provides powerful functions for diagnostics and configuration (via the Profibus DP Interface).

The extensive diagnostic functions of Profibus PA (via DP) enable fast location of faults. The diagnostic messages are transmitted over the bus and collected at the master. These messages are divided into the following three levels:

## GSD Files

A GSD file is used to identify a Profibus-DP device (master or slave). It contains data making it possible to have manufacturer-independent configuration tools. Typical information in a GSD file is vendor information, Baud rates supported, timing information, options/features supported, and available I/O signals. A GSD file must be available for every DP slave. The DeltaV system uses the information in the GSD file to set up the communications to the slave device. The GSD can be imported into the DeltaV system to add the new slave to the library. In the future, the GSD file will be replaced by an EDDL (Electronic Device Definition Language) file. With this EDDL we expect to have more diagnostic information from the slaves and better integration with other applications like AMS.

### DeviceNet Card

The DeltaV DeviceNet interface card is a field-proven interface for discrete actuators and sensors. It is easy to install, reliable, and simple to use. High data throughput, simple installation, good diagnostic capabilities and error-free proven transmission technology make the DeltaV DeviceNet a good interface solution for complex devices.

The DeltaV DeviceNet card uses standard DeviceNet cabling. The interface is also based on the master/slave principle. Sixty-one slaves may run on a cable (or segment). One DeviceNet segment is supported on a single interface. Temperature and certification specifications are the same as other DeltaV I/O.

The DeviceNet transmission technology is easy to install. The bus structure permits addition and removal of stations or step-by-step commissioning of the system without influencing the other stations. Future expansions have no effect on stations already in operation. Transmission speeds between 125 kbit/sec and 500 kbit/sec can be selected. One unique transmission speed is selected for all devices on the bus when the system is commissioned.

DeviceNet transmissions speeds and cable lengths			
Baud rate (kbit/sec)	125	250	500
Distance/segment	500m	250m	100m

Performance of the DeviceNet segment will be a function of the number of devices connected and the baud rate: typically, an additional 80 to 100 milliseconds' latency will be introduced rather than directly connecting the signal.

### DeviceNet Slave

A DeviceNet slave is a peripheral device (I/O device, drive, HMI, valve, etc.) that collects input information and sends output information to the master. There are also devices that supply only input or only output information. The amount of input and output information depends on the device type. Only slave devices that support polling may be used. The DeltaV DeviceNet card (master) cyclically reads the input information from the slaves and cyclically writes the output information to the slaves. In addition to cyclic user data transmission, DeviceNet provides powerful functions for diagnostics and configuration.

### EDS Files

An EDS file is used to identify a DeviceNet device (master or slave). It contains data making it possible to have manufacturer-independent configuration tools. Typical information in an EDS file is vendor information, device identification, and configuration and diagnostic parameter information. An EDS file must be available for every DeviceNet slave. The DeltaV system uses the information in the EDS file to set up the communications to the slave device. The EDS can be imported into the DeltaV system to add the new slave to the library.

### Fieldbus H1 Card

The DeltaV H1 card supports the FOUNDATION fieldbus protocol that takes advantage of all the smart device capabilities, providing a large amount of information by supporting multiple variables per devices and a high level of diagnostics from the field devices. All this is possible through a single fieldbus connection, making it also very cost-effective due to savings on the wiring. The FOUNDATION fieldbus technology allows multi-drop of 16 devices on one port, and the DeltaV H1 card has two ports built in.

The fieldbus solution on the DeltaV system is really robust since it offers a redundant H1 card. A redundant pair of H1 cards provides continued communications between the DeltaV system and fieldbus segment devices even if the primary card fails. This solution provides not only H1 card redundancy but also redundant integrated bus power, adding availability and robustness to the system.

In addition, the H1 card features secure uninterrupted control because it offers backup Link Active Schedule (LAS) to ensure secure control when upgrading a card or in the case of card failure. LAS control is automatically transferred to the backup device when upgrading or experiencing card failure. Control is automatically transferred back to the H1 Interface Card when the system detects a new card. *This process requires no user interaction.*

The FOUNDATION fieldbus technology also provides third-party device support. Fieldbus devices not manufactured by Emerson Process Management divisions are categorized as third-party devices. The DeltaV system provides third-party device support for devices that have successfully passed rigorous testing by Emerson Process Management and are registered by the Fieldbus Foundation. This testing ensures reliability and safety and allows you to benefit from the open fieldbus architecture when selecting field devices. This increases your process control system's level of sophistication by using different FOUNDATION fieldbus I/O devices.

## AMS

In addition to all these benefits, you can go one step further and use Asset Management Suite (AMS) with your DeltaV system to connect to your FOUNDATION fieldbus devices from the control room. Using AMS allows you to access all of your fieldbus devices for configuration, status, troubleshooting, diagnostic, and performance monitoring. This helps you to increase product quality and minimize unplanned downtime by not having to send a technician to the field to fix your smart devices. With this dynamic application, you can improve the productivity and profitability of your process control system.

## Conclusion

Each bus technology has its own benefits based on the amount of devices they support in the segment and the amount of information they provide to you. The DeltaV system offers you the freedom to choose the appropriate technology for your application by supporting sensor, device, and fieldbus technologies. You can choose the most efficient and effective DeltaV interface for your needs, based on your operating philosophy and plant constraints.

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