Supplemental Manual for Brooks® DeviceNet™ PCs

For PC100 Series

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<table>
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Essential Instructions
Read before proceeding!

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Brooks Instrument designs, manufactures and tests its products to meet many national and international standards. These products must be properly installed, operated and maintained to ensure they continue to operate within their normal specifications. The following instructions must be adhered to and integrated into your safety program when installing, operating and maintaining Brooks Instrument products.

- To ensure proper performance, use qualified personnel to install, operate, update, program and maintain the product.
- Read all instructions prior to installing, operating and servicing the product. If this instruction manual is not the correct manual, please see back cover for local sales office contact information. Save this instruction manual for future reference.
- ⚠ WARNING: Do not operate this instrument in excess of the specifications listed in the Instruction and Operation Manual. Failure to heed this warning can result in serious personal injury and / or damage to the equipment.
- If you do not understand any of the instructions, contact your Brooks Instrument representative for clarification.
- Follow all warnings, cautions and instructions marked on and supplied with the product.
- Install your equipment as specified in the installation instructions of the appropriate instruction manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- Operation: (1) Slowly initiate flow into the system. Open process valves slowly to avoid flow surges. (2) Check for leaks around the flow meter inlet and outlet connections. If no leaks are present, bring the system up to the operating pressure.
- Please make sure that the process line pressure is removed prior to service. When replacement parts are required, ensure that qualified people use replacement parts specified by Brooks Instrument. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look-alike substitutions may result in fire, electrical hazards or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place to prevent electrical shock and personal injury, except when maintenance is being performed by qualified persons.
- ⚠ WARNING: For liquid flow devices, if the inlet and outlet valves adjacent to the devices are to be closed for any reason, the devices must be completely drained. Failure to do so may result in thermal expansion of the liquid that can rupture the device and may cause personal injury.

European Pressure Equipment Directive (PED)

All pressure equipment with an internal pressure greater than 0.5 bar (g) and a size larger than 25mm or 1" (inch) falls under the Pressure Equipment Directive (PED).

- The Specifications Section of this manual contains instructions related to the PED directive.
- Meters described in this manual are in compliance with EN directive 97/23/EC.
- All Brooks Instrument Flowmeters fall under fluid group 1.
- Meters larger than 25mm or 1" (inch) are in compliance with PED category I, II or III.
- Meters of 25mm or 1" (inch) or smaller are Sound Engineering Practice (SEP).

European Electromagnetic Compatibility (EMC)

The Brooks Instrument (electric/electronic) equipment bearing the CE mark has been successfully tested to the regulations of the Electro Magnetic Compatibility (EMC directive 2004/108/EC).
Special attention however is required when selecting the signal cable to be used with CE marked equipment.
Quality of the signal cable, cable glands and connectors:
Brooks Instrument supplies high quality cable(s) which meets the specifications for CE certification.
If you provide your own signal cable you should use a cable which is overall completely screened with a 100% shield.
"D" or "Circular" type connectors used should be shielded with a metal shield. If applicable, metal cable glands must be used providing cable screen clamping.
The cable screen should be connected to the metal shell or gland and shielded at both ends over 360 Degrees.
The shield should be terminated to an earth ground.
Card Edge Connectors are standard non-metallic. The cables used must be screened with 100% shield to comply with CE certification.
The shield should be terminated to an earth ground.
For pin configuration : Please refer to the enclosed Instruction Manual.

ESD (Electrostatic Discharge)

⚠ CAUTION: This instrument contains electronic components that are susceptible to damage by static electricity. Proper handling procedures must be observed during the removal, installation or other handling of internal circuit boards or devices.
Handling Procedure:
1. Power to unit must be removed.
2. Personnel must be grounded, via a wrist strap or other safe, suitable means before any printed circuit card or other internal device is installed, removed or adjusted.
3. Printed circuit cards must be transported in a conductive container. Boards must not be removed from protective enclosure until immediately before installation. Removed boards must immediately be placed in protective container for transport, storage or return to factory.
Comments
This instrument is not unique in its content of ESD (electrostatic discharge) sensitive components. Most modern electronic designs contain components that utilize metal oxide technology (NMOS, SMOS, etc.). Experience has proven that even small amounts of static electricity can damage or destroy these devices. Damaged components, even though they appear to function properly, exhibit early failure.

Dear Customer,

We recommend that you read this manual in its entirety as this will enable efficient and proper use of the DeviceNet PCs. Should you require any additional information concerning the DeviceNet PCs, please feel free to contact your local Brooks Sales and Service Office; see back cover for contact information, or visit us on the web at www.BrooksInstrument.com. We appreciate this opportunity to service your fluid measurement and control requirements, and trust that we will be able to provide you with further assistance in future.

Yours sincerely,

Brooks Instrument

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1. Introduction

Many applications of Pressure devices and Flow Meters/Controllers are moving to increasing use of automation. Automation comes in many forms: PLC's (Programmable Logic Controllers, DCS's (Distributed Control Systems, and PC-based solutions. Digital communications from these varied automation systems and the devices they measure and control are a very effective means of not only accomplishing more effective and rapid system integration, but also providing greatly improved system diagnostics and maintainability. DeviceNet™ is an open digital protocol capable of high speeds and easy system connectivity. Brooks Instrument has several of its devices available on this popular networking standard, and is a member of ODVA™ (Open DeviceNet Vendors Association), the governing standard body for DeviceNet.

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Section 2 - Before Starting

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2. Before Starting

2.1. Background & Assumptions

This manual is a supplement to the PC100 Series Installation and Operation Manual. It is assumed that the owner of this PC100 Series Pressure Controller (PC) is thoroughly familiar with the theory and operation of a PC100 Series PC. If not, it is recommended that the owner read the Operations Manual first before continuing with this supplement.

This manual assumes a basic knowledge and understanding of DeviceNet (its topology and its method of logically accessing the data or parameters contained within a device). This manual also assumes basic knowledge and understanding regarding the operation of Pressure Controllers. This manual is not intended to be a replacement to the ODVA (Open DeviceNet Vendors Association) specification, which is still the authoritative definition and description of DeviceNet communications. It is recommended, but not required for the purposes of this manual, that the user obtain a copy of the DeviceNet specification from ODVA (http://www.odva.org/).

This manual does not make any assumptions about any particular manufacturer of equipment or custom software used by the user to communicate with the Brooks device, but assumes the user has thorough understanding of such equipment and any configuration software.

2.2. Compliance

The PC100 Series Pressure Controller (PC) conforms to the ODVA standards as a Process Control Valve Device Profile adapted to a PC device. The PC100 Series PC device has been operationally certified by ODVA at the Conformance Test Lab in Ann Arbor, Michigan. The test verified that the device conforms to all specifications required of a DeviceNet capable device, the Process Control Valve Device Profile for a PC and its supporting objects.

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2.3. Notations

This section details notations and conventions used throughout the manual. It is recommended that the reader become very familiar with these conventions. Hypertext links are used in the manual to assist in navigating. This manual is best viewed in its electronic form and can be obtained from the Brooks website www.BrooksInstrument.com in Adobe® Acrobat® PDF format. A glossary is provided for reference in Section: 8 Glossary to aid in reviewing and/or to define any unfamiliar terms.

2.3.1. Numbers

Numeric values used throughout this manual will be clearly denoted as to the base numeric system it represents. All hexadecimal number (base 16) will be prefixed with a 0x, like 0xA4. All binary numbers (base 2) will be suffixed with a b, like 1001b. All other numbers not annotated this way will be assumed decimal (base 10).

2.3.2. EPATH

EPATH's will be denoted within brackets [ ] like [0x31, 1, 3], which represents, left to right, the Class ID (hexadecimal), Instance ID (decimal), and Attribute ID (decimal).

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Section 3 - Quick Start

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3. Quick Start

This section assumes the owner of the PC100 Series device has a fully operational and trouble-free communications network with appropriate power supplies as defined in the DeviceNet specification. This section also assumes that there exists, connected to the network, a "master" type of device with Poll I/O scanning capability (generally this is the most common application for a DeviceNet network).

3.1. Step 1: Set Baud Rate and MAC ID

Two sets of switches are provided for setting the communication baud rate and for setting the MAC ID of the device. The default MAC-ID is 63. Set these switches on the PC(s) to the desired values.

3.1.1. Baud Rate

The switch labeled "DATA RATE" sets the baud rate of the PC. Possible values along with their corresponding label are (see figure below): "1" = 125K baud, "2" = 250K baud, "5" = 500K baud, "P" = Software programmable where DeviceNet communications may be used to set the baud rate to one of the above values. The out-of-box default setting is 500K baud.

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Figure 3-1 Baud Rate Switch

3.1.2. MAC ID

Two switches labeled with "NODE ADDRESS" are used to configure the MAC ID of the device. MAC ID stands for Media Access Control Identifier and is used to set the unique address of the device on the network. The possible range of addresses is 00 to 63.

The switch labeled "MSD" is used to set the most significant digit of the address: 00, 10, 20, 30…etc. all the way up to 60. If "MSD" is set in the range labeled as "P", it means the MAC ID of the device may be software programmable through the network.

The switch labeled "LSD' sets the least significant digit of the MAC ID. The out-of-box default setting for the MAC ID is 63.
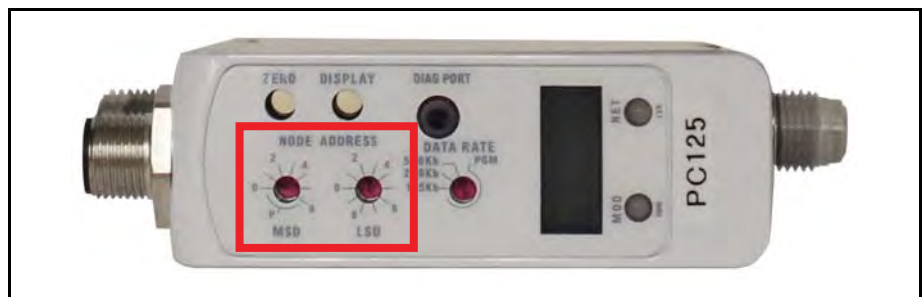
Figure 3-2 MAC ID Switches

Note: Any changes made to the switches, either by externally setting them or through software, will not take effect until the device has been power cycled.

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3.2. Step 2: Configure Scanner

This section contains information that will be needed to configure the scanning device (e.g. PLC, PC, and DCS). You will need to consult the documentation for these systems for proper configuration to the device configuration information below.

The PC100 Series comes from the factory with a default configuration as defined by the PC Device Profile. The table below lists attributes that are of the most interest to owners of this type of device and the factory configured default values. For more information on all the supported attributes in the device, see Section 5 Detail Configuration.

NOTE:
If you ordered your PC100 Series device and requested that the Factory pre-configure the device per your own custom specification, the following tables may not apply.

The default assemblies used for Poll I/O communications. See Appendix A for a complete list of all available assemblies.

Table 3-1 I/O Data Description

	Input Assembly	**Output Assembly**
Assembly Instance	2	7

3.3. Step 3: Plumb to the Device

Ensure gas flow paths are provided to the inlet and outlet connectors of the PC. Ensure pressures are per the specifications stated on the purchase order for the device (or the calibration data sheet shipped with the device).

3.4. Step 4: Connect Device to the Network

Connect the device to the network by attaching the network cable to the DeviceNet M12 connector on top of the device. If power is already been applied to the network, go to Step 6.

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3.4.1. Interface Connector

Power and network signals are interfaced to the PC through the standard 5-pin M12 connector on the device. This connector is specified in the DeviceNet Specification, Edition 3.14, Volume 3, Section 8.5 and is defined as a male, sealed, micro-style connector. The figure below illustrates the electrical connections to the device.
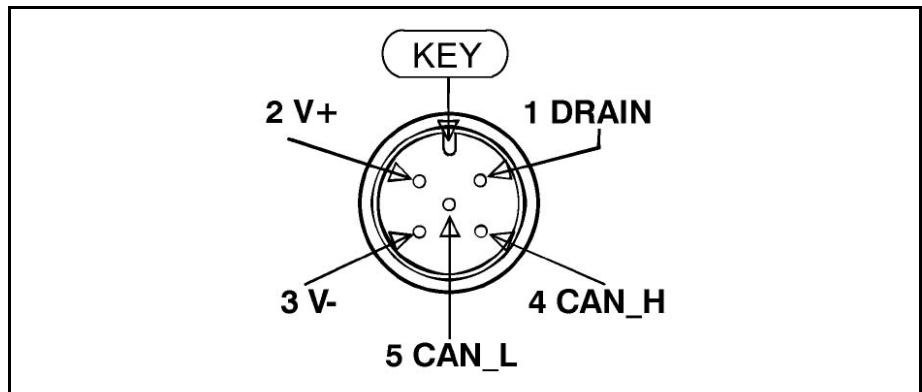
Figure 3-3 Interface Connector

3.5. Step 5: Apply Power to the Network

A DeviceNet network is powered by a (nominal) +24 VDC supply. Ensure that your network is properly powered per the ODVA specifications. Reference DeviceNet Specification Volume 1, Appendix F, Errata 5 for power supply specification.

3.6. Step 6: LED Verification

Two LED's are provided to indicate network status and module status, labeled "NET" and "MOD" respectively. Appendix D provides a table of flash codes for each of the LED's.

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Figure 3-4. MOD and NET LEDs

When power is applied to the device, each LED will flash red, then green a minimum of one time. This is a LED verification test. If this does not occur, go to the Troubleshooting section.

Next the MOD LED ("Module" Status) will then begin to flash red/green indicating that the device is self-testing. When all internal tests have passed, approximately 20 to 30 seconds depending on device type, the MOD LED will turn solid green. If this does not occur, go to the Troubleshooting section.

The NET LED ("Network" Status) will remain off until another node is connected to the network and completes a Duplicate MAC ID check. This implies that under normal operating conditions after the initial NET LED power on sequence has completed a lonely node will never turn on its NET LED.

Once the device is connected to a network of devices the NET LED ("Network" Status) should flash green, indicating that the device MAC ID and Baud Rate are configured properly and the device recognizes the network. It is now capable of establishing "connections." Proceed to Step 7.

If the NET LED is solid green, an active connection has now been established to the device. Proceed to Step 7.

If the NET LED is indicating any other status than those described above, consult Appendix D for LED flash codes or go to the Troubleshooting section.

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3.7. Step 7: Begin Scanning the Network

Enable the scanner to begin scanning the network. If the NET LED on the PC goes to solid green, the scanner has connected to the PC and is now actively polling the PC. Each poll request to the PC contains a setpoint value, and each poll response from the PC contains Status and Pressure information. If the NET LED does not maintain a solid green status while the scanner is actively scanning the network, consult Appendix D for LED flash codes or go to the Troubleshooting section.

3.8. Step 7: Normal Operation

During normal operation the device will change states between either the Idle or Executing states. The current state of the device can be determined by inspecting the Device Status attribute from the S-Device Supervisor instance one [0x30-1-11]. A value of two indicates the device is in the Idle state and a value of four indicates the device is in the Executing state.

The device will be in its safe mode when Idle and the control loop for control type devices will be inactive. The device can be transitioned into the Executing state by either sending the S-Device Supervisor a start service or when the first valid Poll I/O message is received.

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4. Configuration

The type name PC DeviceNet interface conforms to the Process Control Valve profile as specified by the ODVA Common Industrial Protocol Specification.

4.1. Commonly Configured Attributes

The PC100 Series PC supports many different configurable attributes. The out-of-box defaults meet the needs of a great majority of applications, but some applications may require the device to report more information or behave differently than is configured with default settings, such as valve position, safe mode, or Pressure and/or setpoint as real numbers in engineering units etc.

This section covers the more common attributes that are configured to meet the unique needs of applications. The terms "attribute" and "parameters" can be used interchangeably and ultimately refer to the same data item within the PC device. The term "parameter" is widely used within the EDS paradigm whereas "attribute" is used within the DeviceNet specification.

The tables will make reference to both the EDS Parameter name (if the configuration software utilizes the EDS sheet) and the EPATH descriptor (class-instance-attribute) for those who are writing custom or have other types of configuration interfaces.

The following table lists attributes/parameters that will be discussed in this section.

Table 4-1 Commonly Configured Attributes/Parameters

Attribute	EDS Parameter[1]	EPATH	Default	Semantics
Pressure Sensor Data Type	Pressure Sensor Data Type	[0x31-1-3]	0xC3	Pressure will be reported as a 16-bit signed integer
Actuator Data Type	Valve Data Type	[0x32-1-3]	0xC3	Valve position will be reported as a 16-bit signed integer
Setpoint Data Type	Controller Data Type	[0x33-1-3]	0xC3	Setpoint will be a 16-bit signed integer.
Pressure Sensor Data Units	Pressure Sensor Data Units	[0x31-1-4]	0x1001	See Counts Description in S-Analog Sensor Instance 1 See Counts Range Values
Actuator Data Units	Valve Data Units	[0x32-1-4]	0x1001	See Counts Description See Counts Range Values

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Attribute	EDS Parameter[1]	EPATH	Default	Semantics
Setpoint Data Units	Controller Data Units	[0x33-1-4]	0x1001	See Counts Description See Counts Range Values
Actuator Safe State	Valve Safe State	[0x32-1-21]	0	The valve will close when device is in its Safe State
Selected Pressure Application	Selected Pressure Application	[0x31-1-101]	1	A collection of configuration/linearization values stored in non-volatile memory ranging from one to ten applications
Selected Flow Calibration	Selected Flow Calibration	[0x31-4-35]	1	A collection of configuration/linearization values stored in non-volatile memory ranging from one to ten applications
Flow Sensor Data Type	Flow Sensor Data Type	[0x31-4-3]	0xC3	Flow will be repeated as a 16-bit signed integer
Temperature Sensor Data Type	Temperature Sensor Data Type	[0x31-5-3]	0xC3	Temperature will be repeated as a 16-bit signed integer
Flow Sensor Data Units	Flow Sensor Data Units	[0x31-4-4]	0x1001	See Counts Description in S-Analog Sensor Instance 4 See Counts Range Values
Temperature Sensor Data Units	Temperature Sensor Data Units	[0x31-5-4]	0x1001	See Counts Description in S-Analog Sensor Instance 5 See Counts Range Values

[1] See Appendix G for a complete list of EDS parameters.

4.1.1. I/O Assemblies

Assemblies are a collection of attributes and are an integral part of the I/O data exchange. It is the Assembly that defines what data and how much data is exchanged between the Master and the device in an I/O type of connection. Assemblies are grouped into two categories: Input and Output

From a device perspective, an Input Assembly is the data PRODUCED from the device ONTO the network (or can also be viewed as data "INPUT" to the Master FROM the device). Again, from a device perspective, an Output Assembly is the data CONSUMED from the network INTO the device (or can also be viewed as the data "OUTPUT" from the Master TO the device).

A selection of pre-defined Assemblies is listed in Appendix A. Once the desired Assemblies have been configured in the device, corresponding changes in configuration will probably be required from the Master side of connection.

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NOTE:
For I/O Connections to be established between Master and Slave devices, the I/O data sizes for both Input/Output must match. Selection of an Assembly in the PC device automatically sets the I/O data sizes and no further configuration by the customer is required.

The table below references the parameters/attributes associated with I/O Assembly configuration. To set these attributes, the polled I/O connection must be allocated and the state of the connection must be Configuring.

Table 4-2 Attributes to Configure Default Assemblies

EDS Parameter	EPATH	Configures Connection Type	Valid Assembly Type	Data Size (Bytes)	Out-of Box Default Instance	EPATH
Poll Prod Assy	[0x05-2-14]	Polled	Input	3	2	20 04 24 02 30 03
Poll Cons Assy	[0x05-2-16]	Polled	Output	2	7	20 04 24 07 30 03

4.1.2. The "Inferred" Data Type

It is difficult to talk about I/O Assemblies without talking about Data Type since both are tied very closely together (For more detailed explanation on Data Type, see section below "Data Type").

The Assembly Object is a collection of parameters/attributes. The purpose being that one can move a grouping of data to many attributes at one time as opposed to using individual messages to get or set each attribute. A difficulty occurs when one or more of the attributes in the Assembly have a changeable or dynamic data type. For example, the attribute Pressure in the S-Analog Sensor object has data type that is dependent on the value of attribute Data Type within the same object.

The Assembly objects defined in the PC device profile are considered static, meaning that the number of bytes defined in the Assembly is the number of bytes that will be transferred, no more, no less.

Example:
S-Analog Sensor object's Data Type (Pressure Sensor Data Type parameter) is configured to REAL and Assembly object Instance 1 is used to retrieve the Pressure data. The size of data type REAL is 4 bytes and therefore Pressure will be reported as 4 bytes, but Assembly Instance 1 reports Pressure as 2 bytes. A data size mismatch/conflict has occurred. When a data size mismatch occurs, the Master device usually indicates this condition with an error.

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The solution is to force the Data Type attribute (Pressure Sensor Data Type parameter) to match the "inferred" data type of the Assembly instance. A mechanism is in place such that if an Assembly object has been assigned to an I/O Connection AND the I/O Connection becomes active (transitions to the Established state), the attribute/parameter that defines the data type for the particular object will be forced automatically to the inferred data type of the Assembly.

Example:
In the example above, attribute Data Type (Pressure Sensor Data Type parameter) of the S-Analog Sensor Object will be changed to INT (same as the Assembly), enforcing the data size match between the Pressure data and the Assembly instance.

NOTE:
While the I/O Connection is active, the Data Type parameter/attribute will have "get only" accessibility, effectively locking out any means of modifying the attribute, including the establishment of another I/O Connection, until the original I/O Connection is terminated.

4.1.3. Data Type

The Data Type of an attribute defines the way a data value is represented in the PC and transmitted across the network, such as integer and floating point. Most of the attributes defined in the PC have a static data type, meaning that the data type for that attribute is defined once and never changes.

Several of the key attributes in the PC have a dynamic data type that is defined and configurable via a companion attribute. Pressure in the S-Analog Sensor object (Pressure Sensor Parameter) has a companion attribute to define pressure's data type. Some other key attributes with dynamic data type are Setpoint and Valve Position. It may be desirable when changing Data Units (see Data Units section below) to change the Data Type also. For example, if Pressure and Setpoint are configured to represent Data Units "Percent", then Data Type INT would limit the values to whole numbers from 0 to 100. Therefore, the smallest increment of pressure/setpoint would be 1. However, if Data Type was set to REAL, Pressure/Setpoint could now be floating point numbers between 0.00000 to 100.000.

The following table lists objects and their attributes associated with configuring data type.

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Table 4-3 Configurable Data Type Attributes

EDS Parameter	EPATH	Applicable Units Table	Out-of Box Default
Pressure Sensor Data Type	[0x31-1-3]	Appendix B - Data Type Definitions	INT
Valve Data Type	[0x32-1-3]	Appendix B - Data Type Definitions	INT
Pressure Control Data Type	[0x33-1-3]	Appendix B - Data Type Definitions	INT
Flow Sensor	[0x31-4-3]	Appendix B - Data Type Definitions	INT
Temperature Sensor	[0x31-5-3]	Appendix B - Data Type Definitions	INT

NOTE:
The two data types supported by the PC100 Series for the dynamic data typed attributes are INT and REAL. An INT is a number that is represented by whole numbers ranging from –32768 to 32767. A REAL is a floating-point number ranging from 3.4E38 to -3.4E38.

4.1.4. Data Units

The PC100 Series is capable of reporting pressure and accepting setpoints in values associated to engineering units. This can simplify user interpretation of information from the device by letting the device perform the calculations necessary to interpret the pressure signal from its internal sensor based upon information in the selected calibration. Though some may be more familiar with Counts or Percent from using Analog type PC's, the interpretation of Counts (see section Counts below and Range Definition in Quick Start) can vary.

The following table lists objects and their attributes associated with data units. Data Units attributes have a data type of UINT.

Table 4-4 Configurable Data Units Attributes

EDS Parameter	EPATH	Applicable Units Table	Out-of Box Default
Pressure Sensor Data Units	[0x31-1-4]	Appendix C: Pressure Data Units Table	Counts
Valve Data Units	[0x32-1-4]	Appendix C: Actuator Data Units Table	Counts
Pressure Control Data Units	[0x33-1-4]	Appendix C: Pressure Data Units Table	Counts
Flow Sensor	[0x31-4-4]	Appendix C: Flow Data Units Table	Counts
Temperature Sensor	[0x31-5-4]	Appendix C: Temperature Data Units Table	Counts

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4.1.4.1. Counts

Counts define a range of numbers to represent 0 to 100+% of pressure. The problem with this unit is defining what is 100%. In a PC100 Series, when configured to use the Data Type INT the range of numbers available to define 0-100% is -32768 to 32767. PC100 Series devices force 0% to be 0 Counts, and defaults 100% to 24576 Counts. This 24576 number allows the pressure signal to be indicated as high as 133% of full scale (32767 = 133%). If the user desires to change this upper range number, a service is provided in the S-Analog Sensor object (Set Full Scale Counts) to change this value.

NOTE:
If the value 32767 is used for 100%, be aware that any pressure value that exceeds 100% of full scale cannot be indicated. This is a result of the limitation of a 2 byte signed integer number for which Counts is associated with.

4.1.5. Safe State (That Is, Safe Mode)

The Safe State or Safe Mode of the devices means that the device has transitioned to a state that is considered "safe" whereby it will shut down the normal controller process and place mechanical and sensing mechanisms in the device to a safe condition (e.g.. the actuator may be forced closed). The device will ignore input stimuli, such as setpoint or actuator override. In most cases, the safe mode of the device is equivalent to the operational mode when the device is not powered.

NOTE*:*
Safe State indicates the condition that the actuator will be in when the device is in a particular Operational State. The Safe State condition can be configured by setting the appropriate Safe State attribute in the Analog Actuator Object.

4.1.5.1. The State Machine and Safe Mode

All products in the PC100 Series product line employ an internal State Machine to govern the operation of the device. The state machine is illustrated with supporting diagrams and transition tables in Appendix F. Within each state, the device can enter a mode that defines an operational behavior. One mode in particular is the Safe Mode (a.k.a. the Safe State).

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The device will be in Safe Mode when the device is in any state other than the Executing State. The Executing State can be entered in two ways: first, the establishment and subsequent exchange of non-zero length I/O data through an I/O connection, and second, a directive to the S-Device Supervisor Object using explicit messaging. Likewise, the Executing State will be exited by closing all I/O connections to the device, an I/O Connection timeout (i.e. EPR Timeout), or by a directive to the S-Device Supervisor Object. In addition, a transition out of the Executing State will occur internally by the device if a severe fault condition is detected.

The Safe Mode of the PC device is described in the below tables. The label "default" indicates the out-of-the box default defined by the PC device profile.

4.1.5.2. Valve Safe Mode

Attribute Safe State in S-Analog Actuator Object [0x32-1-21], or EDS Parameter Group Valve. These states apply to both Normally Closes and Normally Open Valves

Table 4-5 Safe State

Value	State
0	Closed (default)
1	Open
2	Hold
3	Safe Value

4.1.6. Pressure Applications Selection

If the PC contains multiple Pressure Applications, the selection of a Pressure Application can be configured in attribute "Pressure Application Instance" of the S-Analog Sensor Object [0x31-1-101], Parameter Pressure Application Instance in the Pressure Sensor group of parameters.

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4.1.7. Pressure Sensor Group

Table 4-6 Supported Pressure Sensor Parameters

EDS Parameter	Values	Description	EPATH
Pressure Sensor Data Type [1, 2, 3]	Appendix B - Data Type Definitions	The data type associated with reporting Pressure	[0x31-1-3]
Pressure Sensor Data Units [2]	See "Pressure Units" table in Appendix C -Data Units	The engineering units associated with reporting Pressure	[0x31-1-4]
Pressure Application	From one up to the number of applications in the device	Sets the calibration values used by the sensor to linearize the Pressure sensor	[0x31-1-101]

4.1.8. Flow Sensor Group

Table 4-7 Supported Flow Sensor Parameters

EDS Parameter	Values	Description	EPATH
Flow Sensor Data Type [4, 5, 6]	Appendix B - Data Type Definitions	The data type associated with reporting Flow	[0x31-4-3]
Flow Sensor Data Units [5]	See "Flow Units" table in Appendix C -Data Units	The engineering units associated with reporting Flow	[0x31-4-4]
Flow Calibration Instance	1–6	The active instance of the Flow Calibration Object.	[0x31-4-35]

---

[1] This parameter is only configurable when the device is in the Idle State (i.e. when the device is not being actively scanned/polled).

[2] This parameter will automatically be set based upon the inferred data type of the selected Assembly used for I/O (i.e. if the Assembly that is selected to report pressure is INT, then this attribute will be automatically set to INT once I/O data exchange begins).

[3] The device only supports values INT and REAL. All others will be rejected.

[4] This parameter is only configurable when the device is in the Idle State (i.e. when the device is not being actively scanned/polled).

[5] This parameter will automatically be set based upon the inferred data type of the selected Assembly used for I/O (i.e. if the Assembly that is selected to report pressure is INT, then this attribute will be automatically set to INT once I/O data exchange begins).

[6] The device only supports values INT and REAL. All others will be rejected.

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4.1.9. Temperature Sensor Group

Table 4-8 Supported Temperature Sensor Parameters

EDS Parameter	Values	Description	EPATH
Temperature Sensor Data Type [1, 2, 3]	Appendix B - Data Type Definitions	The data type associated with reporting Temperature	[0x31-5-3]
Temperature Sensor Data Units[2]	See "Temperature Units" Table in Appendix C -Data Units	The engineering units associated with reporting Temperature	[0x31-5-4]

4.1.10. Valve Group

Table 4-9 Supported Valve Parameters

EDS Parameter	Values	Description	EPATH
Valve Data Type [4, 5]	Appendix B - Data Type Definitions	The data type associated with reporting valve position.	[0x32-1-3]
Valve Data Units [4, 5]	See the Actuator Units Table Appendix C - Data Units	The engineering units associated with reporting valve position.	[0x32-1-4]
Valve Safe State	See Note: Valve Safe State below	Configures the behavior of the valve when the device is in Safe Mode.	[0x32-1-21]
Valve Override [6]	See Note: Valve Override below	Overrides the controller by commanding the valve to one of the selectable values in the table below.	[0x32-1-5]

---

[1] This parameter is only configurable when the device is in the Idle State (i.e. when the device is not being actively scanned/polled).

[2] This parameter will automatically be set based upon the inferred data type of the selected Assembly used for I/O (i.e. if the Assembly that is selected to report pressure is INT, then this attribute will be automatically set to INT once I/O data exchange begins).

[3] The device only supports values INT and REAL. All others will be rejected.

[4] This parameter is only configurable when the device is in the Idle State (i.e. when the device is not being actively scanned/polled).

[5] This parameter will automatically be set based upon the inferred data type of the selected Assembly used for I/O (i.e. if an Assembly is selected that reports valve position, and the inferred data type of the assembly is INT, then this attribute will be automatically set to INT once I/O data exchange begins)

[6] This Override action only occurs when the device is in the Executing State.

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4.1.10.1. Valve Safe State Values

The following table outlines valid safe states for the valve. This table applies for normally closed and normally open valves.

Table 4-10 Valve Safe State Values

Value	State	Description
0	Closed	The valve will be driven closed and the valve position will be 0% or 0 Counts
1	Open	The valve will be driven open and the valve position will be 100% or Full Scale Counts Value
2	Hold Last Value	The valve will be driven to the last updated value just prior to the entering of the safe state.
3	Use Safe Value	The valve will be driven to the value configured in the Safe Value attribute of the S-Analog Actuator

4.1.10.2. Valve Override [1]

The following table outlines the valid valve override types.

Table 4-11 Valve Override Values

Value	State	Description
0	Normal	Valve is under normal operational control
1	Closed	Valve is driven fully closed
2	Open	Valve is driven fully open
3	Hold	Valve is held to last updated value prior to assertion of override
4	Safe State	Valve is driven to the condition specified by Safe State

---

[1] This Override action only occurs when the device is in the Executing State.

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4.1.11. Pressure Control Group [1]

Table 4-12 Supported Pressure Control Parameters

EDS Parameter	Values	Description	EPATH
Pressure Control Data Type [2, 3]	See 7.2. Appendix B - Data Type Definitions on p. 85	The data type associated with the value of Setpoint.	[0x33-1-3]
Pressure Control Data Units [3]	See Table 7-4 Pressure Units on p. 86	The engineering units associated with Setpoint.	[0x33-1-4]
Pressure Control Constant Time Ramp Rate	0 to 86400000 msec	Sets the time the controller will take to move from the current position to the new setpoint position	[0x33-1-19]

4.1.12. Polled Connection Group

Table 4-13 Polled Connection Values

Parameter	Values	Description	EPATH
Poll Prod Assy [2]	See 7.1. Appendix A - Assembly Object Detail on p. 83	This parameter selects the Assembly the Polled I/O Connection will use to produce data	[0x5-2-14]
Poll Cons Assy [2]	See 7.1. Appendix A - Assembly Object Detail on p. 85	This parameter selects the Assembly that the Polled I/O Connection will use to receive data	[0x5-2-16]
Default Poll Prod Assy	See 7.1. Appendix A - Assembly Object Detail on p. 83	Alternate way to set the assembly the Polled I/O Connection will use to produce data. Can be used before the Poll I/O Connection is allocated	[0x5-1-100]
Default Poll Cons Assy	See 7.1. Appendix A - Assembly Object Detail on p. 83	Alternate way to set the assembly the Polled I/O Connection will use to consume data. Can be used before the Poll I/O Connection is allocated	[0x5-1-101]

---

[1] Available for Pressure Controllers Only.

[2] This parameter is only configurable when the device is in the Idle State (i.e. when the device is not being actively scanned/polled).

[3] This parameter will automatically be set based upon the inferred data type of the selected Assembly used for I/O (i.e. if an Assembly is selected that contains Setpoint as one of its data members, and the inferred data type of the assembly is INT, then this attribute will be automatically set to INT once I/O data exchange begins).

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4.1.13. Device Info Group

All values associated with this group are Read Only

Table 4-14 Supported Device Info Parameters

Parameter	Values	Description	EPATH
Device Type	"PCV"	The SEMI Standard specified name which identifies the Device Model used by this device	[0x30-1-3]
SEMI Standard Rev. Level	"E54-0997"	The revision level of the SEMI S/A Network Standard to which this device complies	[0x30-1-4]
Mfr. Name	"Brooks Instrument"	The name of the manufacturer of the device	[0x30-1-5]
Mfr. Model Number		The model number of the device assigned by Brooks Instrument	[0x30-1-6]
Software Rev		The firmware revision contained in the device	[0x30-1-7]
Hardware Rev.		The hardware revision of the electronics contained in the device	[0x30-1-8]
Mfr. Serial Number		The serial number assigned to the device by Brooks Instrument	[0x30-1-9]
Device Config		Any additional configuration information related to the device	[0x30-1-10]

4.1.14. Soft Start (Ramp) Control Group [1]

These parameters are repeated for convenience from the Pressure Control Group above.

Table 4-15 Supported Soft Start Parameters

Parameter	Values	Description	EPATH
Pressure Control Constant Time Ramp Rate	0 to 86400000 msec	See Pressure Control Group	[0x33-1-19]

---

[1] Available for Pressure Controllers only.

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4.1.15. Alarms/Warnings Group

Table 4-16 Alarms/Warnings

Parameter	Values	Description	EPATH
Device Alarm On	True(=1) or False(=0)	Enables the reporting of individual object's alarms via the S-Device Supervisor object attributes Status[11] and Exception Detail Alarms[13].	[0x30-1-15]
Device Warning On	True(=1) or False(=0)	Enables the reporting of individual object's warnings via the S-Device Supervisor object attributes Status[11] and Exception Detail Warnings[14].	[0x30-1-16]
Pressure Sensor Alarm On	True(=1) or False(=0)	Enables the reporting of alarms associated with the pressure sensor via the S-Analog Sensor Object Instance 1 attribute Status[7]. Additionally, if the Device Alarms[15] are enabled, these alarms will also be reported via the S-Device Supervisors Status[11] and Exception Detail Alarms[13].	[0x31-1-8]
Pressure Sensor Warn On	True(=1) or False(=0)	Enables the reporting of warnings associated with the pressure sensor via the S-Analog Sensor Object Instance 1 attribute Status[7]. Additionally, if the Device Warnings[16] are enabled, these warnings will also be reported via the S-Device Supervisors Status[11] and Exception Detail Warnings[14].	[0x31-1-9]
Act. Alarm On	True(=1) or False(=0)	Enables the reporting of alarms associated with the actuator via the S-Analog Actuator Object attribute Status[7]. Additionally, if the Device Alarms[15] are enabled, these alarms will also be reported via the S-Device Supervisors Status[11] and Exception Detail Alarms[13].	[0x33-2-8]
Act. Warn On	True(=1) or False(=0)	Enables the reporting of warnings associated with the actuator via the S-Analog Actuator Object attribute Status[7]. Additionally, if the Device Warnings[16] are enabled, these warnings will also be reported via the S-Device Supervisors Status[11] and Exception Detail Warnings[14].	[0x33-2-9]
Pressure Ctrl. Alarm On	True(=1) or False(=0)	Enables the reporting of alarms associated with the pressure controller via the S-Single State Controller Object Instance 1 attribute Status[10]. Additionally, if the Device Alarms[15] are enabled, these alarms will also be reported via the S-Device Supervisors Status[11] and Exception Detail Alarms[13].	[0x33-1-11]
Pressure Ctrl. Warn On	True(=1) or False(=0)	Enables the reporting of warnings associated with the pressure controller via the S-Single State Controller Object Instance 1 attribute Status[7]. Additionally, if the Device Warnings[16] are enabled, these warnings will also be reported via the S-Device Supervisors Status[11] and Exception Detail Warnings[14].	[0x33-1-12]
Flow Sensor Alarm On	True(=1) or False(=0)	Enables the reporting of alarms associated with the flow sensor via the S-Analog Sensor Object Instance 4 attribute Status[7]. Additionally, if the Device Alarms[15] are enabled, these alarms will also be reported via the S-Device Supervisors Status[11] and Exception Detail Alarms[13].	[0x31-4-8]

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Parameter	Values	Description	EPATH
Flow Sensor Warning On	True(=1) or False(=0)	Enables the reporting of warnings associated with the flow sensor via the S-Analog Sensor Object Instance 4 attribute Status[7]. Additionally, if the Device Warnings[16] are enabled, these warnings will also be reported via the S-Device Supervisors Status[11] and Exception Detail Warnings[14].	[0x31-4-9]
Temperature Sensor Alarm On	True(=1) or False(=0)	Enables the reporting of alarms associated with the temperature sensor via the S-Analog Sensor Object Instance 5 attribute Status[7]. Additionally, if the Device Alarms[15] are enabled, these alarms will also be reported via the S-Device Supervisors Status[11] and Exception Detail Alarms[13].	[0x31-5-8]
Temperature Sensor Warning On	True(=1) or False(=0)	Enables the reporting of warnings associated with the temperature sensor via the S-Analog Sensor Object Instance 5 attribute Status[7]. Additionally, if the Device Warnings[16] are enabled, these warnings will also be reported via the S-Device Supervisors Status[11] and Exception Detail Warnings[14].	[0x31-5-9]

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5.   Detailed Configuration

NOTE:
This section is recommended for advance users of DeviceNet and Brooks PC products.

This section details all of the Classes, Instances, Attributes and Services supported by the PC100 Series PC. Differences between the PC device types are noted as exceptions in each sub-section. The PC100 DeviceNet Interface conforms to the Process Control Valve device profile as specified by the ODVA Common Protocol Specification.

The classes detailed in the following sections can be categorized into the following functional groups to indicate what aspect of the device is being configured:

Communications

Classes in this category define how the device communicates on DeviceNet. A great majority of the information that is accessible is very well defined in the DeviceNet specification and therefore does not require much custom configuration. If the user of this device would like to do custom configuration in this category, it is strongly recommended that the user have a thorough understanding of these classes and DeviceNet protocols. More detail can be found about these classes in the DeviceNet specification.

Data Flow

Classes in this category define how data is moved to and from Application classes to the Communication classes. Again, much of what is detailed in this category is provided for informational purposes and is very limited in its ability to be customized

Application

This category of classes defines how the device is to function. In this case, the attributes in these classes configure the behavior of a PC. Of all the categories listed here, this is the most customizable.

The table below lists the classes accessible in the PC100 Series and their associated category. It also indicates if the class is present in either of the PC device types.

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Table 5-1 Accessible Classes

Class		Category	No Of Instances
Identity Object	[0x1]	Communications	1
DeviceNet Object	[0x3]	Communications	1
Assembly Object	[0x4]	Data Flow	14
Connection Object	[0x5]	Communications	2
S-Device Supervisor Object	[0x30]	Application	1
S-Analog Sensor Object	[0x31]	Application	3
S-Analog Actuator Object	[0x32]	Application	1
S-Single Stage Controller Object	[0x33]	Application	1
S-Gas Calibration Object	[0x34]	Application	1 .. 6

In the ODVA DeviceNet specification, Instance 0 of both attributes and services are referred to as Class Level attributes and services. Instance 1 and higher are referred to as Instance Level attributes and services. This document will refer to all Levels by their instance number to avoid possible confusion.

The following details the meaning of the table heading names:

Attribute ID: The ID number of the attribute.

Name: The ODVA DeviceNet Specification label for the attribute.

Data Type: The ODVA DeviceNet Data Type for this attribute. See Appendix B for the definition of each data type.

Access Rule: "Get" means that the value of this attribute is "Read Only". "Set" means that the value of this attribute can be read and/or written.

NV: "NV" = The value of the attribute is stored in non-volatile memory and its value will be retained after a power cycle.

V: "V" = The value of the attribute is in volatile memory and its value will be returned to default after a power cycle.

Description: A brief description of the meaning of the attribute.

Notes: Any additional notations of importance about the attribute. These notes will be found in the same section as the table.

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5.1. Identity Object [0x1]

The Identity Object contains informational attributes that uniquely describe the device.

Example:
The use of attributes Vendor ID, Device Type, Product Code, and Serial Number together uniquely describe this device from any other device.

5.1.1. Attributes

Table 5-2 Identity Object Instance 1 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	Vendor ID	UINT	Get	NV	ID Number assigned to vendor by ODVA	Default: 246 (Brooks Instrument ID)
2	Device Type	UINT	Get	NV	Numeric identifier indicating the ODVA Device Profile implemented by the device.	PCV = 29 (0x1D)
3	Product Code	UINT	Get	NV	Identification of a particular product of an individual vendor.	Default: 724
4	Revision	STRUCT of:	Get	NV	Revision of the device the Identity Object represents	See "Note: Revision" below.
	Major Revision	USINT				
	Major Revision	USINT				
5	Status	WORD	Get	V	Summary status of the device.	See "Note: Status" below.
6	Serial Number	UDINT	Get	NV	Serial number of device.	See "Note: Serial Number" below.
7	Product Name	Short String	Get	NV	Human readable Identification.	Default: "PC125".

5.1.1.1. Note: Device Type

Not to be confused with the S-Device Supervisor Object's attribute Device Type that is string value defined in the Device Profile implemented by this device.

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5.1.1.2. Note: Revision

The ODVA specification defines Major Revision as a significant change to the fit, form, or function of the product. Minor Revision is defined as changes that do not affect user configuration choices such as bug fixes, hardware component change, labeling change, etc.

5.1.1.3. Note: Status

The S-Device Supervisor object has an attribute called Device Status that operates in parallel to this attribute and provides additional device information that is not available using this attribute. It is recommended that users use the S-Device Supervisor Device Status attribute for determining the status of the device. The table below defines the valid values that can be returned when reading the Identity Object Status attribute. Note that the Status attribute values are Bit oriented.

Table 5-3 Identity Object [0x1] Status

Bit	Description
0	Set to 1 when the device has been allocated.
1 – 8	Reserved, always zero
9	Minor Recoverable Fault
10	Major Recoverable Fault, S-Device Supervisor object Device Status Attribute = Critical Fault
11-15	Reserved, always zero

5.1.1.4. Note: Serial Number

This Serial Number attribute differs from the S-Device Supervisor Serial Number attribute whereby the Identity Object attribute is strictly a numeric value that is guaranteed to be unique by the manufacturer across all of the manufacturer's DeviceNet products. The S-Device Supervisor attribute Serial Number is a string value that should represent the manufacturer's method of defining serial numbers for its products.

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5.1.2. Services

Table 5-4 Identity Object Instance 0 Services

Service Code	Service Name	Service Description	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single

Table 5-5 Identity Object Instance 1 Services

Service Code	Service Name	Service Description	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single
0x05	Reset	Resets the DeviceNet interface of the device.	See 'Service Reset' Details Below

5.1.2.1. Service Details

5.1.2.1.1. Reset

Table 5-6 Reset Service Arguments

Parameter Name	Data Type	Required	Parameter Value	Semantics
Type	USINT	N	0	Emulate as closely as possible cycling power on the item the Identity Object represents. This value is the default if this parameter is omitted (default).
			1	Return as closely as possible to the out–of–box configuration, then as closely as possible emulate cycling power.

Table 5-7 Reset Service Response

Parameter Name	Data Type	Required	Parameter Value	Semantics
NO RESPONSE DATA				

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5.2. DeviceNet Object [0x3]

The DeviceNet Object is responsible for maintaining and managing the DeviceNet communications interface for the device. Information concerning the MAC ID and Baud Rate of the device can be found here.

This object also is responsible for managing the pre-defined Master/Slave Connection Set. Through this object, services are provided to allocate and release connections associated with the connection set.

5.2.1. Rules Governing Master/Slave Connections

- When allocating Master/Slave connections using the Allocate service, the entire allocation request must be valid or else the allocation is rejected.

- When allocating any of the Master/Slave I/O Connections, the Explicit Connection must have already been allocated first. Or, if the Explicit Connection has not been allocated, it can be allocated in the same request as the I/O Connections.

- A Master/Slave Connection that is already allocated cannot be allocated again unless it is first released. The allocation of a Connection that has already been allocated AND not released will be considered an invalid request.

- Multiple Master/Slave Connections can be requested in the same allocation request.

- Once a Master has made a successful allocation request to a slave, no other Master may make allocation requests to the slave until all Master/Slave connections are released.

- Any Master may release Master/Slave connections in any Slave

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5.2.2. Attributes

Table 5-8 DeviceNet Object Instance 0 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	Revision	UINT	Get	NV	Revision of the DeviceNet object class definition upon which the implementation is based.	Default: 0x0002.

Table 5-9 DeviceNet Object Instance 1 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	MAC ID	USINT	Cond.	NV	The node address of this device	See "Note: MAC ID" below. Default: 0x01.
2	Baud Rate	USINT	Cond.	NV	The communication data rate	See "Note: Baud Rate" below. Default: 0x02.
3	BOI	BOOL	Set	V	Bus Off Interrupt	See "Note: BOI" below. Default: 0x00
4	Bus Off Counter	USINT	Set	V	Number of times CAN went to the Bus-Off-State	Range 0-255. Default: 0x00.
5	Allocation Information	STRUCT of:	Get	V		
	Allocation Choice Byte	BYTE			The current Master/Slave Connection set Connections that have been allocated	Default: 0x03.
	Master's MAC ID	USINT			The node address of the current Master	See "Note: Allocation Information" below. Default: 0x00.
6	MAC ID Switch Changed	BOOL	Get	V	The Node Address Switch(es) have changed since last power-up/reset	See "Note: MAC ID Switch change. Default: 0x00.
7	Baud Rate Switch Changed	BOOL	Get	V	The Baud Rate Switch has changed since the last power-up/reset	See "Note: Baud Rate Switch change. Default: 0x00.
8	ID Switch Value	USINT	Get	V	Actual value of the Node Address switches	Default: 0x01.
9	Baud Rate Switch Value	USINT	Get	V	Actual value of the Baud Rate switch	Default: 0x02.

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5.2.2.1. Note: MAC ID Switch Changed

If either of the MAC ID switch positions have changed and the device has not been subsequently power cycled this attribute will be set to true. Once the device has been power cycled this attribute will return to a value of false.

5.2.2.2. Note: Baud Rate Switch Changed

If the Baud Rate switch has been changed and the device has not been subsequently power cycled this attribute will be set to true. Once the device has been power cycled this attribute will return to a value of false.

5.2.2.3. Note: MAC ID

The valid range of values for this attribute is 0 to 63. Setting the MAC ID switches on top of the device can configure the node address of this device. Reading this attribute will return the node address as configured by the switches. However, if switch "MSD" is placed in the range labeled "P", the node address must be configured by setting this attribute using the Set Attribute Single service. In either case, once the MAC ID has been configured, the value is retained in non-volatile memory, and the device must be power cycled, or a Reset service must be sent to the Identity Object for the changes to take effect. If the device cannot determine what its MAC ID should be, the MAC ID defaults to 63.

NOTE:
If the "MSD" switch is not in the range labeled "P", the Set Attribute Single service will return the error code 0x0E ("Attribute not settable").

5.2.2.4. Note: Baud Rate

The valid values for this attribute are:

Table 5-10 Baud Rate Values

Value	Meaning
0	125
1	250
2	500

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Setting the Baud Rate switch on top of the device can configure the communication's data rate of this device. Reading this attribute will return the node address as configured by the switches. However, if the Baud Rate switch is placed in the range labeled "P", the data rate must be configured by setting this attribute using the Set Attribute Single service. In either case, once the Baud Rate has been configured, the value is retained in non-volatile memory, and the device must be power cycled, or a Reset service must be sent to the Identity Object for the changes to take effect. If the device cannot determine what its Baud Rate should be, the device defaults to 500K.

NOTE:
If the Baud Rate switch is not in the range labeled "P", the Set Attribute Single service will return the error code 0x0E ("Attribute not settable").

5.2.2.5. Note: BOI

This attribute configures the action that the device will take in processing the Bus Off Interrupt. Valid values are:

Table 5-11 BOI Values

Value	Meaning
0	Hold the CAN chip in its bus-off (reset) state upon detection of a bus-off indication.
1	Upon detection of a bus-off condition, if possible, fully reset the CAN chip and continue communicating.

5.2.2.6. Note: Allocation Information

Part of the information contained in this attribute indicates the Master/Slave Connections that are currently allocated and active. The table below details the bit mapping of this BYTE descriptor.

Table 5-12 Allocation Information

Bit	7	6	5	4	3	2	1	0
Description	0	0	0	0	0	0	Polled	Explicit Message

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5.2.3. Services

Table 5-13 DeviceNet Object Instance 0 Services

Service Code	Service Name	Service Description	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single

Table 5-14 DeviceNet Object Instance 1 Services

Service Code	Service Name	Service Description Details	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single
0x10	Set Attribute Single	Sets the contents of the specified attribute	Appendix E: Set Attribute Single
0x4B	Allocate Master/Slave Connection	Requests the instantiation of a Master/Slave Connection	Allocate Master/Slave Connection
0x4C	Release Master/Slave Connection	Releases (deletes) a Master/Slave Connection	Release Master/Slave Connection

5.2.4. Service Details

5.2.4.1. Allocate Master/Slave Connection

Table 5-15 Allocate Service Arguments

Parameter Name	Data Type	Required	Parameter Value	Semantics
Allocation Choice Byte	BYTE	Y	See Allocation Choice Byte Values Below	Selects the Master/Slave connection to be allocated (opened) in the slave device.
Allocator's MAC ID	USINT	Y	0 to 63	The MAC ID of the Master Device issuing this request

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Table 5-16 Allocation Choice Byte Values

Bit	7	6	5	4	3	2	1	0
Description	0	0	0	0	0	0	Polled	Explicit Message

Table 5-17 Allocate Service Response

Parameter Name	Data Type	Required Value	Parameter	Semantics
Message Body Format	BYTE	Y		Sets the format of the Explicit Message body to be used between the Client (Master) and the slave device. This value can be ignored by the Client

5.2.4.2. Release Master/Slave Connection

Table 5-18 Release Service Arguments

Parameter Name	Data Type	Required	Parameter Value	Semantics
Release Choice Byte	BYTE	Y	See Release Choice Byte Value Below	Selects the Master/Slave connection to release (close) in the slave device.

Table 5-19 Release Choice Byte Value

Bit	7	6	5	4	3	2	1	0
Description	0	0	0	0	0	0	Polled	Explicit Message

Table 5-20 Release Service Response

Parameter Name	Data Type	Required	Parameter Value	Description
NO RESPONSE DATA				

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5.3. Assembly Object [0x4]

The Assembly Object contains a list of attributes that data can be written to (sink) and read from (source) via the Data Buffer attribute contained in this object. The Assembly Object is generally assigned as the endpoint of an I/O Connection object (assigned via the Path attributes in the Connection Object). In this way, multiple pieces of data can be moved to and from the device with a reduced number of network messages.

5.3.1. Attributes

Table 5-21 Assembly Object Instance 1..n Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	Number of Members in List	UINT	Get	NV	Lists the number of members in this Assembly instance	
2	Member List	ARRAY of STRUCT:	Get	NV	The member list is an array of DeviceNet paths	
	Member Data Description	UINT			Size of member data	Size in bits
	Member Path Size	UINT			Size of member path	Size in bytes
	Member Path	EPATH			Path to the attribute this member points to	
3	Data Buffer	ARRAY of BYTE	Set		The data buffer to sink or source the member(s) data	The size of this attribute can be determined by adding together the Member Data Description for each member in the Assembly

5.3.2. Services

Table 5-22 Assembly Object Instance 0 Services

Service Code	Service Name	Service Description	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single

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Table 5-23 Assembly Object Instance 1..n Services

Service Code	Service Name	Service Description	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single
0x10	Set Attribute Single	Sets the contents of the specified attribute with the value passed with this service	Appendix E: Set Attribute Single

5.3.3. Service Details

NONE

5.4. Connection Object [0x5]

5.4.1. Rules Governing Master/Slave Connections [0x5]

The Connection Object configures the characteristics and behavior of a logical connection in the device. A Connection is allocated (opened) in the device by the Master via the Allocate M/S Connection Request service in the DeviceNet Object. Configuration of the Connection Object attributes for the requested connection is done automatically in the device and generally need no further modification except for setting the Expected Packet Rate attribute (Attribute 9). However, it is within this object that selection of Input/Output assemblies may be configured. There are two ways to perform this configuration:

Modification of Attribute 100 and 101 in the M/S Explicit Connection

OR

Modification of the Produce and Consume Path attributes (Attribute 14 and 15 respectively) in the I/O Connection Objects

OR

Via diagnostic port using Brooks Diagnostic Software.

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5.4.2.   Attributes

5.4.2.1.   Explicit Connection Attributes

Table 5-24 Instance 1 - M/S Explicit Connection Attributes

Attrib ID	Name	Data Type	Access Rule	Description	Notes
1	State	USINT	Get	State of Object	Note: "State" below Default: 0x03 (Established State).
2	Instance Type	USINT	Get	Indicates type of Connection	Default: 0x00 (Explicit Connection).
3	Transport Class & Trigger	USINT	Set [1]	Defines behavior of Connection Placed in CAN Identifier	Note: "Transport Class & Trigger" below. Default: 0x83.
4	Produced Connection ID	UINT	Get	Placed in CAN Identifier Field when the Connection transmits	
5	Consume Connection ID	UINT	Get	CAN Identifier Field value that denotes message to be received	
6	Initial Comm Characteristics	BYTE	Get	Defines the Message Group(s) across which productions and consumptions associated with this Connection occur	Note: "Initial Comm Characteristics" below. Default: 0x21.
7	Produced Connection Size	UINT	Set [1]	Maximum number of bytes transmitted across this Connection	Default: 0x017C.
8	Consumed Connection Size	UINT	Get	Maximum number of bytes received across this Connection	Default: 0x017C.
9	Expected Packet Rate (EPR)	UINT	Set	Defines timing associated with this Connection in milliseconds	Default: 2500.
12	Watchdog Timeout Action	USINT	Set	Specifies how the Connection will handle inactivity/watchdog timeouts	Note: "Watchdog Timeout Action" below. Default: 0x01.
13	Produce Connection Path Length	UINT	Get	Number of bytes in the Produced Connection Path attribute	Default: 0x0000.
14	Produce Connection Path	EPATH	Set [1]	Specifies the application object data to be produced by this Connection	Default: Empty.

---

[1] Settable while the connection is in the Configuring State.

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Attrib ID	Name	Data Type	Access Rule	Description	Notes
15	Consume Connection Path Length	UINT	Get	Number of bytes in the Consume Connection Path attribute	Default: 0x0000.
16	Consume Connection Path	EPATH	Set 1	Specifies the application object to receive data by this Connection	Default: Empty.
100	Default Polled I/O Conn. Produce Assembly Instance	UINT	Set	Specifies the default Assembly Object instance to be set in the Produce Connection Path when the Polled I/O Connection object is allocated.	The value of this attribute is stored in non-volatile memory.
101	Default Polled I/O Conn. Consume Assembly Instance	UINT	Set	Specifies the default Assembly Object instance to be set in the Consume Connection Path when the Polled I/O Connection object is allocated.	The value of this attribute is stored in non-volatile memory.

5.4.2.2. Poll I/O Connection Attributes

Table 5-25 Instance 2 - M/S Polled I/O Connection Attributes

Attrib ID	Name	Data Type	Access Rule	Description	Notes
1	State	USINT	Get	State of Object	Note: "State" below. Default: 0x01 (Configuring State).
2	Instance Type	USINT	Get	Indicates type of Connection	Default: 0x01.
3	Transport Class & Trigger	USINT	Set 1	Defines behavior of Connection	Note: "Transport Class & Trigger" below. Default: 0x82.
4	Produced Connection ID	UINT	Get	Placed in CAN Identifier Field when the Connection transmits	
5	Consume Connection ID	UINT	Get	CAN Identifier Field value that denotes message to be received	
6	Initial Comm Characteristics	BYTE	Get	Defines the Message Group(s) across which productions and consumptions associated with this Connection occur	Note: "Initial Comm Characteristics" below. Default: 0x01.

---

[1] Settable while the connection is in the Configuring State.

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Attrib ID	Name	Data Type	Access Rule	Description	Notes
7	Produced Connection Size	UINT	Set 1	Maximum number of bytes transmitted across this Connection	Defined by the size of the Application Data object pointed to by Produce Connection Path attribute.
8	Consumed Connection Size	UINT	Get	Maximum number of bytes received across this Connection	Defined by the size of the Application Data object pointed to by Produce Connection Path attribute.
9	Expected Packet Rate (EPR)	UINT	Set	Defines timing associated with this Connection	Must be configured. Once this value is set, the Polled I/O Connection transitions to the Established State.
12	Watchdog Timeout Action	USINT	Set	Specifies how the Connection will handle inactivity/watchdog timeouts	Note: "Watchdog Timeout Action" below. Default: 0x00 (Timed Out Stat).
13	Produce Connection Path Length	UINT	Get	Number of bytes in the Produced Connection Path attribute	Default: 0x0006.
14	Produce Connection Path	EPATH	Set 1	Specifies the application object data to be produced by this Connection	This attribute is settable only in the Configuring State. Default: 20 04 24 02 30 03.
15	Consume Connection Path Length	UINT	Get	Number of bytes in the Consume Connection Path attribute	Default: 0x0006.
16	Consume Connection Path	EPATH	Set 1	Specifies the application object to receive data by this Connection	This attribute is settable only in the Configuring State. Default: 20 04 24 07 30 03.

Note 1: This attribute is settable only if the state of this instance is in the "configuring" state. See 5.2.1. Rules Governing Master/Slave Connections on p. 30.

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5.4.2.3. Note: State

Table 5-26 Rules Governing Master/Slave Connections [0x5]

Value	State	Description
0	Non-Existent	The Connection has not yet been instantiated
1	Configuring	The Connection has been instantiated, but not properly configured. Upon completion of configuration the Apply service must be sent to the Connection
2	Waiting for Connection ID	The Connection is waiting exclusively for the Produce or Consume Connection ID's to be set
3	Established	The Connection has been properly configured and applied
4	Timed Out	The Inactivity/Watchdog has timed out and may have transitioned to this state if the Watchdog Timeout Action attribute has been configured to do so. See Attribute 12.
5	Deferred Delete	If the Connection Object is of Explicit Message Connection type (see Attribute 2) and the Inactivity/Watchdog has timed out, the Connection may transition to this state if the Watchdog Timeout Action attribute has been configured to do so. See Attribute 12.

5.4.2.4. Note: Transport Class & Trigger

Table 5-27 Bit Descriptions

Bit	7	6	5	4	3	2	1	0
Description	Direction	Production Trigger				Transport Class		

Table 5-28 Direction

Value	Description
0	Client
1	Server

Table 5-29 Production Trigger

Value	Description
2	Application Object

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Table 5-30 Transport Class

Value	Description
0	Class 0
1	Reserved
2	Class 2
3	Class 3

5.4.2.5. Note: Initial Comm. Characteristics

Table 5-31 Bit Descriptions

Bit	7	6	5	4	3	2	1	0
Description	Initial Production Characteristics				Initial Consume Characteristics			

Table 5-32 Initial Production Characteristics

Value	Description
0	Produce Across Message Group 1
1	Produce Across Message Group 2 (Destination)
2	Produce Across Message Group 2 (Source)
3	Produce Across Message Group 3

Table 5-33 Initial Consume Characteristics

Value	Description
0	Consume Across Message Group 1
1	Consume Across Message Group 2 (Destination)
2	Consume Across Message Group 2 (Source)
3	Consume Across Message Group 3

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5.4.2.6. Note: Watchdog Timeout Action

Table 5-34 Watchdog Timeout Action

Value	Timeout Action	Description
0	Transition to Timed Out	The Connection transitions to the Timed Out state and remains in that state until Deleted or Reset. Invalid value for Explicit Connections
1	Auto Delete	The Connection Class automatically deletes the Connection if an Inactivity/Watchdog timeout occurs
2	Auto Reset	The Connection remains in the Established State and restarts the Inactivity/Watchdog timer
3	Deferred Delete	The Connection transitions to the Deferred Delete state if any child connection instances are in the Established state. If no child connection instances are in the Established state the connection is deleted. This value is invalid for I/O Messaging Connections.

5.4.3. Services

Table 5-35 Connection Object Instance 0 Services

Service Code	Service Name	Service Description	Details
		NO INSTANCE 0 SERVICES ARE SUPPORTED	

Table 5-36 Connection Object Instance 1 Services

Service Code	Service Name	Service Description	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single
0x10	Set Attribute Single	Sets the contents of the specified attribute with the value passed with this service	Appendix E: Set Attribute Single
0x5	Reset	Used to reset the Inactivity/Watchdog timer and transition the Connection back to the Established state.	No Arguments or Response Data

5.4.4. Service Details

NONE.

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5.5. S-Device Supervisor Object [0x30]

The S-Device Supervisor Object oversees device operation and status. This object maintains an internal state machine that is used to govern the behavior of the Sensor, Actuator, and Controller objects. Also contained in this object are informational attributes extending to those provided in the Identity Object.

5.5.1. Attributes

Table 5-37 S-Device Supervisor Instance 0 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	Revision	UINT	Get	NV	Revision of the S-Device Supervisor object class definition upon which the implementation is based.	Default: 0x0002.

Table 5-38 S-Device Supervisor Instance 1 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	Number of Attributes	USINT	Get	NV	Number of attributes supported by the object instance	Default: 16
2	Attribute List	Array of USINT	Get	NV	List of attributes supported by the object instance	
3	Device Type	SHORT STRING	Get	NV	SEMI Standard specified name which identifies the Device Model within the *Hierarchy of Semiconductor Equipment Devices*	Max. 8 characters. Default: "PCV".
4	SEMI Standard Revision Level	SHORT STRING	Get	NV	Specifies the revision level of the SEMI S/A Network Standard to which this device complies	Default: "E54-0997".
5	Manufacturer's Name	SHORT STRING	Get	NV	The name of the manufacturer of the device.	Max. 20 characters. Default: "Brooks Instrument".
6	Manufacturer's Model Number	SHORT STRING	Get	NV	The manufacturer specified model number for the device	
7	Software Revision Level	SHORT STRING	Get	NV	Revision level of the firmware in the device.	Note: "Software Revision Level" below.

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Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
8	Hardware Revision Level	SHORT STRING	Get	NV	Revision level of the hardware in the device.	
9	Manufacturer's Serial Number	SHORT STRING	Get	NV	Serial number of device assigned by the manufacturer	Max. 30 characters.
10	Device Configuration	SHORT STRING	Get	NV	Any additional manufacturer specific information about the device	Max. 50 characters.
11	Device Status	USINT	Get	V	The current operational state of the state.	Note: 'Device Status' below
12	Exception Status	BYTE	Get	V	Summary status of the current warning and alarm status in the device	Note: "Exception Status" below.
13	Exception Detail Alarm	STRUCT of:	Get	V	A complex structure made up of 3 levels of alarm exception details.	
	Common Exception Detail	STRUCT of:			Common detail bytes defined by the Supervisor Object	See "Note: Exception Detail Alarm – Common Exception Detail" below.
	Size	USINT				
	Detail	ARRAY of:				
	Detail n	BYTE				
	Device Exception Detail	STRUCT of:			Device detail bytes defined for PC device types.	See "Note: Exception Detail Alarm – Device Exception Detail" below.
	Size	USINT				
	Detail	ARRAY of:				
	Detail n	BYTE				
	Manufacturer Exception Detail	STRUCT of:			Manufacturer detail bytes as defined by Brooks Instrument	See "Note: Exception Detail Alarm – Manufacturer Exception Detail" below.
	Size	USINT				
	Detail	ARRAY of:				
	Detail n	BYTE				

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Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
14	Exception Detail Warning	STRUCT of:	Get	V	A complex structure made up of 3 levels of alarm exception details.	
	Common Exception Detail	STRUCT of:			Common detail bytes defined by the Supervisor Object	See "Note: Exception Detail Warning – Common Exception Detail" below.
	Size	USINT				
	Detail	ARRAY of:				
	Detail n	BYTE				
	Device Exception Detail	STRUCT of:			Device detail bytes defined for PC device types.	See "Note: Exception Detail Warning – Device Exception Detail" below.
	Size	USINT				
	Detail	ARRAY of:				
	Detail n	BYTE				
	Manufacturer Exception Detail	STRUCT of:			Manufacturer detail bytes as defined by Brooks Instrument	See "Note: Exception Detail Warning – Manufacturer Exception Detail" below.
	Size	USINT				
	Detail	ARRAY of:				
	Detail n	BYTE				
15	Alarm Enable	BOOL	Set	NV	Enables/Disables the Supervisor Object's processing of Alarm information	Default: 0x01.
16	Warning Enable	BOOL	Set	NV	Enables/Disables the Supervisor Object's processing of Warning information	Default: 0x01.

5.5.1.1. Note: Software Revision Level

This attribute represents the current firmware revision running in the device. Brooks Instrument defines the format of this revision level. The format of this attribute is comprised of major and minor revision, separated by a decimal point; for example, **1.04**

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5.5.1.2. Note: Device Status

The value of this attribute represents the current operational state of the device. The values are defined in the following table. A State Event Matrix and State Event Diagram are outlines in Appendix F - State Machine.

Table 5-39 Device Status

Attrib	Operational	Safe	Description
0	Undefined	Y	
1	Self Testing	Y	All object instances exist and have been initialized. Exception Status bits have been reset. The device is executing internal tests to determine if the device is qualified to begin normal monitoring and control operations.
2	Idle	Y	The device is ready for normal monitoring and control operations.
3	Self Test Exception	Y	The device has detected an exceptional condition during self-test. The details of the exception are stored in the exception detail attributes of the Supervisor Object.
4	Executing	N	The device is performing normal control and monitoring operations
5	Abort	Y	The device is idle, but is NOT ready for normal monitoring and control operations. A Recover Request must be initiated to reach a ready condition.
6	Critical Fault	Y	The Supervisor Object and device are in a fault state from which there is no recovery.

5.5.1.3. Note: Exception Status

Exception Status for this device utilizes the Expanded Method outlined in the ODVA specification for the S-Device Supervisor Object. This is indicated by setting bit 7 in this attribute to 1.

The table below shows the format of bits in this attribute. The setting of any of these bits is obtained by taking the logical "OR" of the related exception detail bits. For example, if any of the bits in the Device Common Alarm Detail are set, bit 0 of this attribute will be set to 1.

Table 5-40 Exception Status

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	Warning Mfr. Specific	Warning Device Specific	Warning Device Common	0	Alarm Mfr. Specific	Alarm Device Specific	Alarm Device Common
	See "Note: Exception Detail Warning – Manufacturer	See "Note: Exception Detail Warning – Device	See "Note: Exception Detail Warning – Common		See "Note: Exception Detail Alarm – Manufacturer	See "Note: Exception Detail Alarm – Device	See "Note: Exception Detail Alarm – Common

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Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Exception Detail"	Exception Detail"	Exception Detail"		Exception Detail"	Exception Detail"	Exception Detail"

5.5.1.4. Note: Exception Detail Alarm – Common Exception Detail

Table 5-41 Alarm – Common Exception Detail

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Detail Size	2							
Detail Byte 0	0	0	0	RAM	NV RAM	Flash Memory	0	Diagnostic
Detail Byte 1	0	0	0	0	0	0	0	0

5.5.1.5. Note: Exception Detail Alarm – Device Exception Detail

Table 5-42 Alarm – Device Exception Detail

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Detail Size	0	0	0	0	0	1	0	1
Detail Byte 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Process Variable Control S-Single Stage Controller (1)	Process Variable High S-Analog Sensor (1)	Process Variable Low S-Analog Sensor (1)	Reserved 0
Detail Byte 1	Temp. Low S-Analog Sensor (5)	Reserved 0	Flow High S-Analog Sensor (4)	Flow Low S-Analog Sensor (4)	Reserved 0	Reserved 0	Reserved 0	Reserved 0
Detail Byte 2	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Temp. High S-Analog Sensor (5)
Detail Byte 3	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0

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	Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
Detail Byte 4	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0

5.5.1.6. Note: Exception Detail Alarm – Manufacturer Exception Detail

Table 5-43 Alarm – Manufacturer Exception Detail

	Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
Detail Size	0	0	0	0	0	0	0	1
Detail Byte 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Actuator High (1)	Actuator Low (1)

5.5.1.7. Note: Exception Detail Warning – Common Exception Detail

Table 5-44 Warning – Common Exception Detail

	Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
Detail Size	2							
Detail Byte 0	0	0	0	0	0	0	0	Diagnostic
Detail Byte 1	0	0	0	0	0	0	0	0

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5.5.1.8. Note: Exception Detail Warning – Device Exception Detail

Table 5-45 Warning – Device Exception Detail

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Detail Size	0	0	0	0	0	1	0	1
Detail Byte 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Process Variable Control S-Single Stage Controller (1)	Process Variable High S-Analog Sensor (1)	Process Variable Low S-Analog Sensor (1)	Not Reading Valid[1] S-Analog Sensor (1)
Detail Byte 1	Temp. Low S-Analog Sensor (5)	Not Reading Valid[1] S-Analog Sensor (5)	Flow High S-Analog Sensor (4)	Flow Low S-Analog Sensor (4)	Not Reading Valid[1] S-Analog Sensor (4)	Reserved 0	Reserved 0	Reserved 0
Detail Byte 2	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Temp. High S-Analog Sensor (5)
Detail Byte 3	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0
Detail Byte 4	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0

5.5.1.9. Note: Exception Detail Warning – Manufacturer Exception Detail

Table 5-46 Warning – Manufacturer Exception Detail

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Detail Size	0	0	0	0	0	0	0	1
Detail Byte 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Actuator High (1)	Actuator Low (1)

---

[1] Only used in the Warning Exception Detail, this bit is always = 0 in the Alarm Exception Detail. "Not" indicates the use of the negation of "Reading Valid."

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5.5.2. Services

Table 5-47 S-Device Supervisor Instance 0 Services

Service Code	Service Name	Service Description	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single

Table 5-48 S-Device Supervisor Instance 1 Services

Service Code	Service Name	Service Description	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single
0x10	Set Attribute Single	Sets the contents of the specified attribute with the value passed with this service	Appendix E: Set Attribute Single
0x05	Reset	Resets the device to the Self-Testing state	Acceptance of these services is dependent upon the current device operational state.
0x06	Start	Moves the device to the Executing State	
0x07	Stop	Moves the device to the Idle State	
0x4B	Abort	Moves the device to the Abort State	See State Event Matrix or Diagram in Appendix F - State Machine.
0x4C	Recover	Moves the device out of the Abort State	
0x4E	Perform Diagnostics	Causes the device to perform a set of diagnostic routines.	For details on Perform Diagnostic Service go to Perform Diagnostics in Service Details section

5.5.2.1. Service Details

5.5.2.2. Perform Diagnostics

Table 5-49 Diagnostics Service Arguments

Parameter Name	Data Type	Required	Parameter Value	Semantics
Test ID	USINT	N	See Test ID Table Below	The identifier of the diagnostic test to be performed. See Table Below

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Table 5-50 Test ID

Test ID	Description
0 (default)	Standard

Table 5-51 Diagnostic Service Response

Parameter Name	Data Type	Required Value	Parameter	Description
NO RESPONSE DATA				

5.6. S-Analog Sensor Object [0x31]

The S-Analog Sensor Object is responsible for reporting sensor values. The sensor object can linearize the sensor values and convert measurements into engineering data units.

The PC100 Series supports the following instances of the S-Analog Sensor Object:

Instance	Sensor
0	Class
1	Pressure
4	Flow
5	Temperature

5.6.1. Instance 0

Table 5-52 S-Analog Sensor Instance 0 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	Revision	UINT	Get	NV	Revision of the S-Analog Sensor object class definition upon which the implementation is based.	Default: 0x0001.

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Table 5-53 S-Analog Actuator Instance 0 Services

Service Code	Service Name	Service Description	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single

5.6.2. Instance 1 - Pressure

Table 5-54 S-Analog Sensor Instance 1 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	Num Attr	USINT	Get	NV	Number of Supported Attributes	Default: 18.
2	Attr List	Array of USINT	Get	NV	Attribute List	
3	Data Type	USINT	Cond.	NV	Defines the Data Type of Pressure[6] and other attributes in this object.	See "Note: Data Type" below. Default: 0xC3.
4	Data Units	ENGUNITS	Cond.	NV	Defines the Engineering Units context of Pressure[6] and other attributes in this object.	See "Note: Data Units" below. Default: 0x1001 (Counts).
5	Reading Valid	BOOL	Get	V	Indicates that Pressure[6] has a valid value.	0 = Invalid Sensor Value 1 = Valid Sensor Value
6	Pressure	Specified by Attrib. 3 & 4	Get	V	The amount of pressure as measured by the sensor.	This value is corrected, converted, and calibrated to report the actual value of Pressure.
7	Status	BYTE	Get	V	Alarm and Warning status for the S-Analog Sensor Object	See "Note: Status" below.
8	Alarm Enable	BOOL	Set	NV	Enables the setting of the alarm status bits	See "Note: Alarms" below. 0 = disable 1 = enable Default: 0x00.
9	Warning Enable	BOOL	Set	NV	Enables the display of the warning status bits	See "Note: Warnings" below. 0 = disable 1 = enable Default: 0x00.

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
10	Full Scale	Specified by Attrib. 3 & 4	Get	NV	The pressure value that represents 100% of the currently selected calibration full scale	See "Note: Full Scale Structure" below.
17	Alarm Trip Point High	Specified by Attrib. 3 & 4	Set	NV	Determines the Pressure[6] value above which an Alarm Condition will occur	See "Note: Alarms" below. Default: 32767.
18	Alarm Trip Point Low	Specified by Attrib. 3 & 4	Set	NV	Determines the Pressure[6] Value below which an Alarm Condition Will occur	See "Note: Alarms" below. Default: -32768.
20	Alarm Settling Time	UINT	Set	NV	Determines the time that the Pressure[6] value must exceed the Trip Point before the exception condition is generated.	See "Note: Alarms" below. Time in milliseconds. Default: 0.
21	Warning Trip Point High	Specified by Attrib. 3 & 4	Set	NV	Determines the Pressure[6] value above which a Warning Condition will occur	See "Note: Warnings" below. Default: 32767.
22	Warning Trip Point Low	Specified by Attrib. 3 & 4	Set	NV	Determines the Pressure[6] value below which a Warning Condition will occur	See "Note: Warnings" below. Default: -32768.
24	Warning Settling Time	UINT	Set	NV	Determines the time that the Pressure[6] value must exceed the Trip Point before the exception condition is generated.	See "Note: Warnings" below. Time in milliseconds. Default: 0.
28	Auto-zero Status	BOOL	Get	V	Indicates the status of the automatic nulling	Default: 0.
99	Subclass	UINT	Get	NV	Identifies a subset of additional instance attributes, services, and behaviors for the Sensor Object	Default: 0x0006.
101	Pressure Application	UINT	Set	NV	Configures which Application configurations currently active for this object.	
110	Full Scale	STRUCT of:	Get	NV	A structure that contains both the pressure value that represents 100% of the currently selected calibration full scale and the engineering units assigned to that value.	
	Amount	REAL				
	Units	ENG UNITS				

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5.6.3. Instance 4 - Flow

Table 5-55 S-Analog Sensor Instance 4 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	Num Attr	USINT	Get	NV	Number of Supported Attributes	Default: 19.
2	Attr List	Array of USINT	Get	NV	Attribute List	
3	Data Type	USINT	Cond.	NV	Defines the Data Type of Flow[6] and other attributes in this object.	See "Note: Data Type" below. Default: 0xC3.
4	Data Units	ENGUNITS	Cond.	NV	Defines the Engineering Units context of Flow[6] and other attributes in this object.	See "Note: Data Units" below. Default: 0x1001 (Counts).
5	Reading Valid	BOOL	Get	V	Indicates that Flow[6] has a valid value.	0 = Invalid Sensor Value 1 = Valid Sensor Value
6	Flow	Specified by Attrib. 3 & 4	Get	V	The amount of flow as measured by the sensor.	This value is corrected, converted, and calibrated to report the actual value of Flow.
7	Status	BYTE	Get	V	Alarm and Warning status for the S-Analog Sensor Object	See "Note: Status" below.
8	Alarm Enable	BOOL	Set	NV	Enables the setting of the alarm status bits	See "Note: Alarms" below. 0 = disable 1 = enable Default: 0x00.
9	Warning Enable	BOOL	Set	NV	Enables the display of the warning status bits	See "Note: Warnings" below. 0 = disable 1 = enable Default: 0x00.
10	Full Scale	Specified by Attrib. 3 & 4	Get	NV	The flow value that represents 100% of the currently selected calibration full scale	See "Note: Full Scale Structure" below.
17	Alarm Trip Point High	Specified by Attrib. 3 & 4	Set	NV	Determines the Flow[6] value above which an Alarm Condition will occur	See "Note: Alarms" below. Default: 32767.
18	Alarm Trip Point Low	Specified by Attrib. 3 & 4	Set	NV	Determines the Flow[6] Value below which an Alarm Condition Will occur	See "Note: Alarms" below. Default: -32768.

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Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
20	Alarm Settling Time	UINT	Set	NV	Determines the time that the Flow[6] value must exceed the Trip Point before the exception condition is generated.	See "Note: Alarms" below. Time in milliseconds. Default: 0.
21	Warning Trip Point High	Specified by Attrib. 3 & 4	Set	NV	Determines the Flow[6] value above which a Warning Condition will occur	See "Note: Warnings" below. Default: 32767.
22	Warning Trip Point Low	Specified by Attrib. 3 & 4	Set	NV	Determines the Flow[6] value below which a Warning Condition will occur	See "Note: Warnings" below. Default: -32768.
24	Warning Settling Time	UINT	Set	NV	Determines the time that the Flow[6] value must exceed the Trip Point before the exception condition is generated.	See "Note: Warnings" below. Time in milliseconds. Default: 0.
28	Auto-zero Status	BOOL	Get	V	Indicates the status of the automatic nulling	Default: 0.
35	Calibration Object Instance	UINT	Set	NV	Configures which Calibration Object Instance is currently active for this object.	
99	Subclass	UINT	Get	NV	Identifies a subset of additional instance attributes, services, and behaviors for the Sensor Object	Default: 0x0000 (no subclass).
110	Full Scale	STRUCT of:	Get	NV	A structure that contains both the flow value that represents 100% of the currently selected calibration full scale and the engineering units assigned to that value.	
	Amount	REAL				
	Units	ENG UNITS				

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5.6.4. Instance 5 - Temperature

Table 5-56 S-Analog Sensor Instance 5 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	Num Attr	USINT	Get	NV	Number of Supported Attributes	Default: 19.
2	Attr List	Array of USINT	Get	NV	Attribute List	
3	Data Type	USINT	Cond.	NV	Defines the Data Type of Temperature[6] and other attributes in this object.	See "Note: Data Type" below. Default: 0xC3.
4	Data Units	ENGUNITS	Cond.	NV	Defines the Engineering Units context of Temperature[6] and other attributes in this object.	See "Note: Data Units" below. Default: 0x1001 (Counts).
5	Reading Valid	BOOL	Get	V	Indicates that Temperature[6] has a valid value.	0 = Invalid Sensor Value 1 = Valid Sensor Value
6	Temperature	Specified by Attrib. 3 & 4	Get	V	The amount of temperature as measured by the sensor.	This value is corrected, converted, and calibrated to report the actual value of Temperature.
7	Status	BYTE	Get	V	Alarm and Warning status for the S-Analog Sensor Object	See "Note: Status" below.
8	Alarm Enable	BOOL	Set	NV	Enables the setting of the alarm status bits	See "Note: Alarms" below. 0 = disable 1 = enable Default: 0x00.
9	Warning Enable	BOOL	Set	NV	Enables the display of the warning status bits	See "Note: Warnings" below. 0 = disable 1 = enable Default: 0x00.
10	Full Scale	Specified by Attrib. 3 & 4	Get	NV	The temperature value that represents 100% of the currently selected calibration full scale	See "Note: Full Scale Structure" below
17	Alarm Trip Point High	Specified by Attrib. 3 & 4	Set	NV	Determines the Temperature[6] value above which an Alarm Condition will occur	See "Note: Alarms" below. Default: 32767.
18	Alarm Trip Point Low	Specified by Attrib. 3 & 4	Set	NV	Determines the Temperature[6] Value below which an Alarm Condition Will occur	See "Note: Alarms" below. Default: -32768.

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Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
20	Alarm Settling Time	UINT	Set	NV	Determines the time that the Temperature[6] value must exceed the Trip Point before the exception condition is generated.	See "Note: Alarms" below. Time in milliseconds. Default: 0.
21	Warning Trip Point High	Specified by Attrib. 3 & 4	Set	NV	Determines the Temperature[6] value above which a Warning Condition will occur	See "Note: Warnings" below. Default: 32767.
22	Warning Trip Point Low	Specified by Attrib. 3 & 4	Set	NV	Determines the Temperature[6] value below which a Warning Condition will occur	See "Note: Warnings" below. Default: -32768.
24	Warning Settling Time	UINT	Set	NV	Determines the time that the Temperature[6] value must exceed the Trip Point before the exception condition is generated.	See "Note: Warnings" below. Time in milliseconds. Default: 0.
28	Auto-zero Status	BOOL	Get	V	Indicates the status of the automatic nulling	Default: 0.
35	Temperature Application Instance	UINT	Set	NV	See Notes.	NOTE: This attribute exists for ODVA profile conformance and does not have any effect on the Temperature Instance.
99	Subclass	UINT	Get	NV	Identifies a subset of additional instance attributes, services, and behaviors for the Sensor Object	Default: 0x0000 (no subclass).
110	Full Scale	STRUCT of:	Get	NV	A structure that contains both the temperature value that represents 100% of the currently selected calibration full scale and the engineering units assigned to that value.	
	Amount	REAL				
	Units	ENG UNITS				

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5.6.4.1. Note: Status

The following tables define the bits in the status bye for each instance of the S-Analog Sensor Object. The value of 1=Set and 0 = Cleared

Table 5-57 Status for Instance 1, Pressure

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	Low Pressure Warning	High Pressure Warning	Low Pressure Alarm	High Pressure Alarm

Table 5-58 Status for Instance 4, Flow

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	Low Flow Warning	High Flow Warning	Low Flow Alarm	High Flow Alarm

Table 5-59 Status for Instance 5, Temperature

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	Low Temperature Warning	High Temperature Warning	Low Temperature Alarm	High Temperature Alarm

5.6.4.2. Note: Full Scale

The value of attribute 10, Full Scale, will depend upon the value configured for attribute 4, Data Units. The following table describes the behavior of this attribute.

Table 5-60 Full Scale Attribute

Data Units	Full Scale Definitions
Counts (All Instances)	Default = 24576 for Full Scale[10]. This allows for an overshoot indication of 133% of the calibrated full scale (e.g., 32767 = 133%). To change this, utilize the Set Full Scale Counts service to set the desired 100% full scale. A good formula to use is: Full Scale Counts = (100% / Desired Percent Overshoot) X 32767
Percent (All Instances)	The value will always be 100.

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Data Units	Full Scale Definitions
Any Pressure Engineering Unit (Instance 1)	Full Scale[10] will be determined by using a full scale value contained in the Pressure Applications set of data. This value will be converted to the configured Data Unit[4]. Example: If Instance 1 of a Pressure Application has a full scale value of 20 torr, and the desired Data Units[4] in the Sensor Object is milli-torr, the value of Full Scale[10] will be 20000.
Any Flow Engineering Unit (Instance 4)	Full Scale[10] will be determined by using the attribute Calibration Full Scale [0x34,1,6] of the S-Gas Calibration Object as configured by the Selected Gas Calibration Object Instance[35] and converted to the configured Data Unit[4]. Example: If Instance 1 of an S-Gas Calibration Object has a Calibration Full Scale[6] of 100 l/sec, and the desired Data Units[4] in the Sensor Object is SCCM, the value of Full Scale[10] will be 6000000 (Note: Mass units will take into account the density when doing the conversion).
Any Temperature Engineering Unit (Instance 5)	Full Scale[10] will be Full Scale of the temperature sensor converted to the data units specified by attribute 4.

5.6.4.3. Note: Data Type

The value of attributes 1, 4, and 5 is limited to INT or REAL. These attributes can only be set when the device is not in the Operational State of Executing. If any of the attributes in this object use the attribute Data Type[3] to define their data type and the attribute is the end point of an active I/O connection, then the access rule for the attribute Data Type[3] becomes Get and thus cannot be set until the I/O connection becomes inactive. Additionally, the inferred data type of an Assembly object (see The "Inferred" Data Type) will modify this value if the Assembly object has been assigned to an active I/O connection.

Example 1:
If the value (attribute ID 6) is exchanged via the Polled I/O connection, Data Type[3] cannot be modified until that Polled I/O Connection is terminated.

Example 2:
If Assembly instance 1 is assigned to the Polled I/O connection produce path, the value of Data Type[3] will be set to INT when the Polled I/O connection transitions to the Active state. When the Polled I/O connection is terminated, the value of this attribute will remain INT. It will not return to the value prior to commissioning the Polled I/O connection.

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5.6.4.4. Note: Data Units

The value of this attribute is limited to the values specified in the units tables in Appendix C - Data Units. This attribute can only be set when the device is not in the Operational State of Executing. See Example 1 above in "Note: Data Type."

5.6.4.5. Note: Value

The value attribute is reported as specified by the Data Type and Data Units attributes.

When the units are set to Counts, the value is converted to counts per the following tables.

*Table 5-61 **Value-to-Counts Conversion for Pressure and Flow*

Counts Range	< 0	0 - 24576	24577 - 27033	27034 - 32767
Pressure and Flow	Less than calibrated zero	0% to 100% of Full Scale	100+% to 110% of Full Scale	110+% to 133% of Full Scale

*Table 5-62 **Value-to-Counts Conversion for Temperature*

Counts Range	< 0	0 - 24576	24577 - 32767
Temperature	Not valid	0 - 500°K	500 - 665°K

A 16-bit signed integer (-32768 to 32767) is used to represent the value in data units of counts[1].

5.6.4.6. Note: Pressure Application Instance

The value of this attribute is limited to the number of Pressure Application instances configured in the device. The minimum value is 1, which is also the default value.

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[1] The Data Units Counts is a dimensionless unit that defines a range of numbers to represent a quantity. See the Configuration section for more information on Data Units counts.

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5.6.4.7. Note: Alarms

Enable the reporting of Alarms for the S-Analog Sensor object via Alarm Enable[8] attribute. When the value (attribute ID 6) exceeds the limits set by Alarm Trip Point High[17] or Alarm Trip Point Low[18], a corresponding bit from the Status[7] attribute is set; see Status above.

The attribute Alarm Settling Time[20] sets the interval of a timer that masks the reporting of alarms. Once the timer expires, if an alarm condition still exists, the warning is reported.

If alarms are enabled in the S-Device Supervisor Object, the actuator alarms are reported via the Exception Status [12] and corresponding Exception Detail Alarm[13] of the S-Device Supervisor Object.

5.6.4.8. Note: Warnings

Enable the reporting of Warnings for the S-Analog Sensor object via Warning Enable[9] attribute. When the value (attribute ID 6) exceeds the limits set by Warning Trip Point High[21] or Warning Trip Point Low[22], a corresponding bit from the Status[7] attribute is set; see Status above.

The attribute Warning Settling Time[24] sets the interval of a timer that masks the reporting of warnings. Once the timer expires, if a warning condition still exists, the warning is reported.

If warnings are enabled in the S-Device Supervisor Object the actuator warnings are reported via the Exception Status [12] and corresponding Exception Detail Warning[14] of the S-Device Supervisor Object.

5.6.4.9. Note: Full Scale Structure

This structure provides the physical full scale of the sensor in the calibration units.

Table 5-63 Full Scale Structure Definition

Structure Member	Data
Amount	Physical Full Scale for the sensor in engineering units.
Units	Engineering Units for each sensor as defined at the time of calibration.

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5.6.5. Services

Table 5-64 S-Analog Sensor Instance 0 Services

Service Code	Service Name	Service Description	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single

Table 5-65 S-Analog Sensor Instance 1, 4, and 5 Services

Service Code	Service Name	Service Description	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single
0x10	Set Attribute Single	Sets the contents of the specified attribute with the value passed with this service	Appendix E: Set Attribute Single
0x4B	Zero Adjust	Indicates to the device that the current Pressure or Flow Sensor value is zero.	Zero Pressure or Flow based on active instance.
0x32	Set Full Scale Counts	Defines the Counts value that represents 100% of the calibration full scale	This only affects the way the value of Pressure[6] is reported in relation]to the Full Scale[10] when the Units[4] is set to Counts.

5.6.5.1. Service Details

5.6.5.2. Set Full Scale Counts

Table 5-66 Set Full-Scale Counts Service Arguments

Parameter Name	Data Type	Required	Parameter Value	Semantics
Full Scale Counts	INT	Y	-32768 to 32767	The Counts value that defines 100% of the full scale. The value that is passed here in this argument will be reported in attribute Full Scale[10].

Table 5-67 Set Full-Scale Counts Service Response

Parameter Name	Data Type	Required Value	Parameter	Description
NO SUCCESS RESPONSE DATA				

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5.7. S-Analog Actuator Object [0x32]

The S-Analog Actuator is responsible for management of the actuator device controlling the process.

5.7.1. Attributes

Table 5-68 S-Analog Actuator Instance 0 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Default Value
1	Revision	UINT	Get	NV	Revision of the S-Analog Actuator object class definition upon which the implementation is based.	Default: 0x0001.

Table 5-69 S-Analog Actuator Instance 1 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	Num Attr	USINT	Get	NV	Number of supported attributes	Default: 20
2	Attr List	Array of USINT	Get	NV	Attribute list	
3	Data Type	USINT	Cond.	NV	Defines the Data Type of Value[6] and other attributes in this object.	See "Note: Data Type" below. Default: 0xC3 (Int).
4	Data Units	ENGUNITS	Cond.	NV	Defines the Engineering Units context of Value[6] and other attributes in this object.	See "Note: Data Units" below. Default: 0x1001 (Counts).
5	Override	USINT	Set	V	Specifies a direct override of the physical actuator	See "Note: Override" below.
6	Value	Specified by Attrib. 3 & 4	Get	V	The value of the analog output signal used to drive the physical actuator	See "Note: Value" below.
7	Status	BYTE	Get	V	Alarm and Warning status for the S-Analog Actuator Object	See "Note: Status" below.

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Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
8	Alarm Enable	BOOL	Set	NV	Enables setting of the Alarm bit	See "Note: Alarms" below. 0 = disabled (the default) 1 = enabled
9	Warning Enable	BOOL	Set	NV	Enables setting of the Warning bit	See "Note: Warnings" below. 0 = disabled (the default) 1 = enabled
15	Alarm Trip Point High	Specified by Attrib. 3 & 4	Set	NV	Determines the Value[6] above which an Alarm condition will occur.	See "Note: Alarms" below. Default: 32767.
16	Alarm Trip Point Low	Specified by Attrib. 3 & 4	Set	NV	Determines the Value[6] below which an Alarm condition will occur.	See "Note: Alarms" below. Default: -32768.
18	Warning Trip Point High	Specified by Attrib. 3 & 4	Set	NV	Determines the Value[6] above which a warning condition will occur.	See "Note: Warnings" below. Default: 32767.
19	Warning Trip Point Low	Specified by Attrib. 3 & 4	Set	NV	Determines the Value[6] below which a warning condition will occur.	See "Note: Warnings" below. Default: -32768.
21	Safe State	USINT	Set	NV	Specifies the behavior for the physical actuator in an Operational State other than Executing State	See "Note: Safe State" below. Default: 0.
22	Safe Value	Specified by Attrib. 3 & 4	Set	NV	The analog output signal value that is indicated by Attrib. 6 if the Safe State[21] is configured to "Use Safe Value"	Default: 0.

5.7.1.1. Note: Data Type

The value of this attribute is limited to INT or REAL. This attribute can only be set when the device is not in the Operational State of Executing. If any of the attributes in this object use the attribute Data Type[3] to define their data type and the attribute is the end point of an active I/O connection, then the access rule for the attribute Data Type[3] becomes Get and thus cannot be set until the I/O connected becomes inactive. Additionally, the inferred data type of an Assembly object (see The "Inferred" Data Type) will modify this value if the Assembly object has been assigned to an active I/O connection.

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Example 1:
If the value of Value[6] is being exchanged via the Polled I/O connection, attribute 3 cannot be modified until that Polled I/O Connection is terminated.

Example 2:
If Assembly instance 3 is assigned to the Polled I/O connection produce path, the value of attribute 3 will be set to INT when the Polled I/O connection transitions to the Active state. When the Polled I/O connection is terminated, the value of this attribute will remain INT. It will not return to the value prior to commissioning the Polled I/O connection.

5.7.1.2. Note: Data Units

The value of this attribute is limited to the values specified in the table in Appendix C - Actuator Data Units. This attribute can only be set when the device is not in the Operational State of Executing. See Example 1 above in Note: Data Type.

5.7.1.3. Note: Override

The following table outlines the valid actuator override types.

Table 5-70 Override

Value	State	Description
0	Normal	Actuator is under normal operational control
1	Closed	Actuator is driven fully closed (Value[6] = 0% or 0 Counts)
2	Open	Actuator is driven fully open (Value[6] = 100% or 24576 Counts)
3	Hold	Actuator is held to last updated analog output signal prior to assertion of override
4	Safe State	Actuator is driven to the condition specified by the Safe State[21] attribute

5.7.1.4. Note: Value

To interpret the value of this attribute, it is important to understand the following terms:

Operational Range:

This is the range that is reported by Value[6]. The operational range of the actuator is full range that the actuator can be driven to move. This corresponds to Value[6] values of 0 to 100% (0 to 24576 Counts).

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Nominal Control Range:

The nominal control range is a set of values that the actuator is driven to that maps directly between zero Flow and maximum rated flow for the device. This set of values is a sub-range within the large operational range of the actuator. Note that the actuator value in a pressure controller is such that the device controls the flow required to maintain a setpoint or increase or decrease pressure to a new setpoint. Example, the nominal control range for a 0 to 100 SCCM device flowing nitrogen could be as follows:

at 0 SCCM Actuator = 20% (4915 counts)
at 100 SCCM, Actuator = 30% (7373counts)..

Under normal operational control (no override), the actuator generally operates in the nominal control range. The upper end of the control range is not an absolute limit under normal control. The controller will drive the actuator to whatever value is necessary to control Pressure and/or Flow. For example, if a restriction occurred upstream of the device resulting in reduced supply to the device, the controller will drive the actuator beyond the nominal control range to maintain control.

5.7.1.5. Note: Status

The following table defines the bits in this status byte. The value of 1 = Set and 0 = Cleared.

Table 5-71 Status

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	Low Warning	High Warning	Low Alarm	High Alarm

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5.7.1.6. Note: Safe State

The following table outlines valid values for this attribute. This table applies for normally closed and normally open valves.

Table 5-72 Safe State

Value	State	Description
0	Closed	The actuator will be driven closed and the value of Value[6] will be 0% or 0 Counts
1	Open	The actuator will be driven open and the value of Value[6] will be 100% or 24576 Counts
2	Hold Last Value	The actuator will be driven to the last updated value of the analog output just prior to the entering of the safe state.
3	Use Safe Value	The actuator will be driven to the value configured in Safe Value[22] and Value[6] = Safe Value[22]

5.7.1.7. Note: Alarms

Enable the reporting of Alarms for the S-Analog Actuator object via Alarm Enable[8] attribute. When Value[6] exceeds the limits set by Alarm Trip Point High[15] or Alarm Trip Point Low[16] a corresponding bit from the Status[7] attribute is set, see Status above. If alarms are enabled in the S-Device Supervisor Object the actuator alarms are reported via the Exception Status [12] and corresponding Exception Detail Alarm[13] of the S-Device Supervisor Object.

5.7.1.8. Note: Warnings

Enable the reporting of Warnings for the S-Analog Actuator object via Warning Enable[9] attribute. When Value[6] exceeds the limits set by Warning Trip Point High[18] or Warning Trip Point Low[19] a corresponding bit from the Status[7] attribute is set, see Status above. If warnings are enabled in the S-Device Supervisor Object the actuator warnings are reported via the Exception Status [12] and corresponding Exception Detail Warning[14] of the S-Device Supervisor Object.

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5.7.2. Services

Table 5-73 S-Analog Actuator Instance 1 Services

Service Code	Service Name	Service Description	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single
0x10	Set Attribute Single	Sets the contents of the specified attribute with the value passed with this service	Appendix E: Set Attribute Single

5.7.2.1. Service Details

NONE

5.8. S-Single Stage Controller Object [0x33]

The S-Single Stage Controller object is responsible for closing the loop between the measured process variable (via the S-Analog Sensor) and the control variable (via the S-Analog Actuator).

5.8.1. Attributes

Table 5-74 S-Single Stage Controller Instance 0 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	Revision	UINT	Get	NV	Revision of the S-Single Stage Controller object class definition upon which the implementation is based.	Default: 0x0001.

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Table 5-75 S-Single Stage Controller Instance 1 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	Num Attr	USINT	Get	NV	Number of Supported Attributes	Default: 13
2	Attr List	Array of USINT	Get	NV	Attribute List	
3	Data Type	USINT	Cond.	NV	Defines the Data Type of Setpoint[6] and other attributes in this object.	See "Note: Data Type" below. Default: 0xC3 (Int).
4	Data Units	ENGUNITS	Cond.	NV	Defines the Engineering Units context of Setpoint[6] and other attributes in this object	See "Note: Data Units" below. Default: 0x1001 (Counts).
5	Control Mode	USINT	Set	V	Specifies the operational mode of the controller	Default: Normal(0). See "Note: Control Mode" below.
6	Setpoint	Specified by Attrib. 3 & 4	Set	V	The sensor value that the device will maintain at steady state condition.	
7	Process Var	Specified by Attrib. 3 & 4	Get	V	The measured process parameter	Linked to S-Analog Sensor Object, Instance 1 or 4, Attribute 6, Pressure or Flow.
10	Status	BYTE	Get	V	Alarm and Warning status for the S-Single Stage Controller Object	See "Note: Status" below.
11	Alarm Enable	BOOL	Set	NV	Enables setting of the Alarm bit	See "Note: Alarms" below. 0 = disabled (the default) 1 = enabled
12	Warning Enable	BOOL	Set	NV	Enables setting of the Warning bit	See "Note: Warnings" below. 0 = disabled (the default) 1 = enabled
13	Alarm Settling Time	UINT	Set	NV	Number of milliseconds allowed for the control-loop to settle to within the error band	See "Note: Alarms" below. Default: 0.

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Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
14	Alarm Error Band	Specified by Attrib. 3 & 4	Set	NV	The maximum deviation band by which Setpoint must equal the Process Variable before an alarm is enunciated.	See "Note: Alarms" below. Default: 0.
15	Warning Settling Time	UINT	Set	NV	Number of milliseconds allowed for the control-loop to settle to within the error band	See "Note: Warnings" below. Default: 0.
16	Warning Error Band	Specified by Attrib. 3 & 4	Set	NV	The maximum deviation band by which Setpoint must equal the Process Variable before a warning is enunciated.	See "Note: Warnings" below. Default: 0.
19	Constant Time Ramp Rate	UDINT	Set	NV	The amount of time, in milliseconds, the controller will take to "ramp" Pressure from its current value to its final value as commanded in Setpoint[6]	Default: 0 (Disabled).

5.8.1.1. Note: Data Type

The value of this attribute is limited to INT or REAL. This attribute can only be set when the device is not in the Operational State of Executing. If any of the attributes in this object use the attribute Data Type[3] to define their data type and the attribute is the end point of an active I/O connection, then the access rule for the attribute Data Type[3] becomes Get and thus cannot be set until the I/O connection becomes inactive. Additionally, the inferred data type of an Assembly object (see The "Inferred" Data Type) will modify this value if the Assembly object has been assigned to an active I/O connection.

Example 1:
If the value of Setpoint[6] is exchanged via the Polled I/O connection, Data Type[3] cannot be modified until that Polled I/O Connection is terminated.

Example 2:
If Assembly instance 7 is assigned to the Polled I/O connection consume path, the value of Data Type[3] will be set to INT when the Polled I/O connection transitions to the Active state. When the Polled I/O connection is terminated, the value of this attribute will remain INT. It will not return to the value prior to commissioning the Polled I/O connection.

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5.8.1.2. Note: Data Units

The value of this attribute is limited to the values specified in the Pressure Units table in Appendix C - Data Units. This attribute can only be set when the device is not in the Operational State of Executing. See Example 1 above in Note: Data Type.

The numeric range definitions for Setpoint are:

Table 5-76 ***Setpoint

Counts Range	< 0	0 – 24576	24577 -27033	27034 - 32767
Setpoint	Not Valid. The minimum value for setpoint will be clamped to 0% of Full Scale	0% to 100%of Full Scale	100+% to 110% of Full Scale	Not Valid. The maximum value for setpoint will be clamped to 110% of Full Scale

A 16-bit signed integer (-32768 to 32767) is used to represent the setpoint value in data units of counts.[1]

5.8.1.3. Note: Control Mode

The following table outlines the valid actuator Control mode types.

Table 5-77 Control Mode

Value	State	Description
0	Normal	Actuator is under normal operational control
1	Closed	Actuator is driven fully closed (Value[6] = 0% or 0 Counts)
2	Open	Actuator is driven fully open (Value[6] = 100% or 24576 Counts)
3	Hold	Actuator is held to last updated analog output signal prior to assertion of Control mode
4	Safe State	Actuator is driven to the condition specified by the Safe State[21] attribute

---

[1] The Data Units Counts is a dimensionless unit that defines a range of numbers to represent a quantity. See Configuration Section for more information on Data Units counts.

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5.8.1.4. Note: Status

The following table defines the bits in this status byte. The value of 1 = Set and 0 = Cleared.

Table 5-78 Status

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	Controller Warning	Controller Alarm

5.8.1.5. Note: Alarms

Enable the reporting of Alarms for the S-Single Stage Controller via Alarm Enable[11] attribute. When the process value (Pressure) exceeds Setpoint[6] by the limits established by Alarm Error Band [14] a corresponding bit from the Status[7] attribute is set, see Status above.

The attribute Alarm Settling Time[13] sets the interval of a timer that masks the reporting of alarms until the control loop can stabilize the process value (Pressure) on the commanded Setpoint[6]. Once the timer expires if an alarm condition still exists the warning is reported.

If alarms are enabled in the S-Device Supervisor Object the controller alarms are reported via the Exception Status [12] and corresponding Exception Detail Alarm[13] of the S-Device Supervisor Object.

5.8.1.6. Note: Warnings

Enable the reporting of Warnings for the S-Single Stage Controller object via Warning Enable[12] attribute. When the process value (Pressure) exceeds Setpoint[6] by the limits established by Warning Error Band [16] a corresponding bit from the Status[7] attribute is set, see Status above.

The attribute Warning Settling Time[15] sets the interval of a timer that masks the reporting of warnings until the control loop can stabilize the process value (Pressure) on the commanded Setpoint[6]. Once the timer expires if a warning condition still exists the warning is reported.

If warnings are enabled in the S-Device Supervisor Object the controller warnings are reported via the Exception Status [12] and corresponding Exception Detail Warning[14] of the S-Device Supervisor Object.

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5.8.2. Services

Table 5-79 S-Single Stage Controller Instance 0 Services

Service Code	Service Name	Service Description	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single
0x10	Set Attribute Single	Sets the contents of the specified attribute with the value passed with this service	Appendix E: Set Attribute Single

Table 5-80 S-Single Stage Controller Instance 1 Services

Service Code	Service Name	Service Description	Details
0x0E	Get Attribute Single	Returns the contents of the specified attribute	Appendix E: Get Attribute Single
0x10	Set Attribute Single	Sets the contents of the specified attribute with the value passed with this service	Appendix E: Set Attribute Single

5.8.2.1. Service Details

NONE

5.9. S-Gas Calibration Object [0x34]

An S-Gas Calibration Object affects the behavior of an associated S-Analog Sensor object instance; a device profile will show a relationship between these two objects where an S-Gas Calibration Object is used. The S-Analog Sensor object uses a selection attribute as the gas type selection mechanism. The S-Gas Calibration Object provides the data with which a device enacts the appropriate calibration algorithm for a given gas type. Each S-Gas Calibration Object Instance contains a set of attribute values for one particular calibration set; each identified by the Gas Standard Number.

The S-Gas Calibration class level object provides a service for retrieving a list of all valid object instances. The service response includes a list of elements. Each element includes the Instance ID, Gas Standard Number and the valid S-Analog Sensor object instance ID for which the instance is valid.

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There may be more than one instance with the same Gas Standard Number. These instances may be differentiated by Full Scale, Gas Symbol, Additional Scaler and/or other parametric distinctions, including valid S-Analog Sensor object instance ID. The distinctions may, or may not, be evident in the Get_All_Instances service response, depending upon what the distinction is.

S-Gas Calibration Objects most often utilize the region of Manufacturer Specified Attributes (ID > 100) for specific calibration parameters.

This object is a member of the *Hierarchy of Semiconductor Equipment Devices*. As such, its behavior is managed by the Device Supervisor Object. See 5.5. S-Device Supervisor Object [0x30] on p. 44.

The S-Gas Calibration object makes use of a list of Standard Gas Type Numbers. This list is described in publication:

> SEMI E52-95 "Practice for Referencing Gases Used in Digital Mass Flow Controllers", Semiconductor Equipment and Materials International (SEMI), Mountain View, CA 94043-4080.

Note: It is implied that the reference above is to the latest revision as specified by SEMI.

5.9.1. Attributes

Table 5-81 S-Gas Calibration Instance 0 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	Revision	UINT	Get	NV	Revision of the S-Analog Actuator object class definition upon which the implementation is based.	Default: 0x0001.
170	Bin ID	UINT	Get	NV	Specifies the Device Bin number for this device.	
171	Gas Table Revision	UINT	Get	NV	Revision of the Supported Gas Table.	Default: 5

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Table 5-82 S- Gas Calibration Instance 1 Attributes

Attrib ID	Name	Data Type	Access Rule	NV	Description	Notes
1	Num Attr	USINT	Get	NV	Number of attributes supported	Default: 11
2	Attr List	ARRAY OF USINT	Get	NV	List of attributes supported by this object instance	
3	Gas Numb	UINT	Get	NV	Gas Type Number	Default: 0 (no gas type specified).
4	Valid Sensor Inst	UINT	Get	NV	S-Analog Sensor object instance ID for which this object instance is valid	0 = No Valid Sensor (the default) n = Instance ID
5	Gas Symbol	SHORT STRING	Set	NV	Gas Type Name	Default: null.
6	Full Scale	STRUCT of:	Get	NV	Full Scale of the device using this object instance	Default: 0, 0.
		REAL			Amount	The amount of measured parameter corresponding to full scale.
		UINT			Units	The units for the above.
8	Calibration Date	DATE	Get	NV	Date of Calibration	The date this object instance was last calibrated. Default: 0.
9	Calibration Gas Number	UINT	Get	NV	Calibration Gas	The gas number of the gas used to calibrate this object instance. Default: 0.
95	Calibration Pressure	REAL	Get	NV	The gas pressure in kiloPascal.	The Standard Pressure with respect to the calibration conditions. Default: 101.32
96	Calibration Temperature	REAL	Get	NV	The gas temperature in Degrees C.	The Standard Temperature with respect to calibration conditions. Default: 0.0
99	Subclass	UINT	Get	NV	Identifies a subset of additional attributes, services and behaviors. The subclasses for this object are specified at the end of this object specification section.	Subclass 1 Standard Temperature and Pressure.

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5.9.2. Semantics

Gas Standard Number

Used to identify a gas standard number, for which the object instance is currently calibrated. See Instance Application Example below.

For the actual coding of the values, see section 5.9 of the SEMI publication E52-95: *Practice for Referencing Gases Used in Digital Mass Flow Controllers.*

Since the actual attributes, and their context, for the parameterization of object instances for particular gas types is beyond the scope of this standard (i.e., vendor specific), the Access Rule for this attribute has been specified as Get. Vendors may choose to specify an Access Rule of Set for this attribute.

Valid Sensor Instances

This attribute specifies the S-Analog Sensor object instance for which the S-Gas Calibration object instance is valid. An S-Gas Calibration object instance will be valid for zero or one S-Analog Sensor object instances.

Gas Symbol

This optional attribute is a string-coded representation of the name of the gas for which the object instance has been configured. It is coded as a user-defined text symbol or it is coded as defined in the SEMI publication E52-95: *Practice for Referencing Gases Used in Digital Mass Flow Controllers.*

This attribute may indicate a different gas from the one, which has been specified by the Gas Standard Number. See Instance Application Example below.

Full Scale

This optional attribute identifies the amount of measured parameter (e.g., Mass Flow) corresponding to the Full Scale of the associated S-Analog Sensor object. A primary purpose for this attribute is to allow for simple S-Analog Sensor object implementations where the Value is reported in raw units; this attribute allows a mapping to engineering units.

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For example, the Full Scale for a S-Gas Calibration object may be 100 SCCM, while the Full Scale for the associated S-Analog Sensor object may be 0x6000 counts (i.e., S-Analog Sensor object Data Type = INT and Data Units = Counts).

5.9.3. S-Gas Calibration Common Services

Table 5-83 S- Gas Calibration Common Services

Service Code	Need in Implementation		Service Name	Description of Service
	Class	**Instance**		
0Ehex 14dec	Required	Required	Get_Attribute_Single	Returns the contents of the specified attribute.
10hex 16dec	Required	Required	Set_Attribute_Single	Modifies an attribute value.

5.9.4. S-Gas Calibration Object–Specific Services

Table 5-84 S-Gas Calibration Object–Specific Services

Service Code	Need in Implementation		Service Name	Description of Service
	Class	**Instance**		
4Bhex 75dec	Required	n/a	Get_All_Instances	Requests a list of all available object instances with their respective gas numbers

If a gas instance is changed or added, the device must be reset before performing the "get_all_instances" service.

Table 5-85 Success Response Service Data Field Parameters

Parameter	Required	Data Type	Description	Semantics of Values
Size of List	Required	UINT	Specifies the number of elements in the Array	Number of gas calibrations in the list
List of Gas Calibrations	Required if Size > 0	ARRAY of	Supported List	The list of gas calibrations
		STRUCT of	Supported Gas Type	

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Parameter	Required	Data Type	Description	Semantics of Values
		UINT	S-Gas Calibration Object Instance ID	[34-n-4], where n is the instance value 1 – 6.
		UINT	Gas Standard Number	[34-n-3], where n is the instance value 1 – 6.
		UINT	Valid Sensor Instance	

On the PC100 Series: Gas instance 6 is considered the "test" gas instance. There are a total of 6 gas instances, (sometimes referred to as "gas pages") available.

5.9.5. S-Gas Calibration Object Behavior

The behavior of this object is managed by the Device Supervisor Object, defined in 5.5. S-Device Supervisor Object [0x30] on p. 44.

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Section 6 - Troubleshooting

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6. Troubleshooting

Problem	Possible Causes
Scanner is actively scanning the network, but the NET LED is flashing green	The MAC ID of the device is not programmed in the scan list of the scanner or does not match a MAC ID already programmed in the scanner
Scanner is actively scanning the network, but the NET LED on the device alternates between solid green state for a short time, then flashing green state for a short time.	Produce/Consume I/O data size mismatch. The I/O data sizes programmed in the scanner is different from the Produce/Consume I/O data size in the device
When power is applied to the device network communications are disrupted	The Power Supply for the network is undersized to handle the additional load, causing the power supply to "droop" The baud rate setting on the device does not match the network baud rate.
When power is applied to the device, the NET LED and MOD LED goes solid red	The MAC ID of the device is the same as the MAC ID of another device on the network. The Baud Rate switch setting on the device does not match the network baud rate. The device was forced off the bus because of communications error (a.k.a. Bus Off condition). If the problem persists, contact Brooks service.
When power is applied to the device, the NET LED remains off	The device is the only device connected on the network.
The NET LED is flashing red	The I/O connection is timed out.
The device never comes out of Self-Test (MOD LED continually flashes red/green).	Cycle power to the device. If problem persists, contact Brooks service.
The MOD LED is solid RED	An internal fault in the device was detected. Cycle power to the device. If the problem persists, contact Brooks service.
When power is applied to the device, both LED's continually cycle through the power-on LED test (each LED will cycle red then green).	An internal fault has occurred in the device on power-up. Contact Brooks service.
A setpoint value is being sent to the device but the PC fails to control pressure (i.e. no actuator movement, low or no Pressure indication)	Check Data Units for the Sensor Object and Controller Object. Make sure the Data Units for both match and that they configured to the desired values.

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7.   Appendix

7.1.   Appendix A - Assembly Object Detail

The following table details each of the Assembly Objects supported by the PC. The DeviceNet specification defines Input and Output relative to the network (i.e., the data being PRODUCED from the device as an INPUT into the network or the data being CONSUMED by the device is an OUTPUT from the network).

Table 7-1 I/O Assembly Data Mapping

Data Component Name	Class		Instance Number	Attribute		
	Name	Number		Name	Number	Type
Pressure	S-Single Stage Controller	33$_{hex}$	1	Process Variable	7	*
Flow	S-Analog Sensor	31$_{hex}$	4	Value	6	**
Temperature	S-Analog Sensor	31$_{hex}$	5	Value	6	**
Control Mode	S-Single Stage Controller	33$_{hex}$	1	Control Mode	5	USINT
Control Setpoint	S-Single Stage Controller	33$_{hex}$	1	Setpoint	6	*
Exception Status	S-Device Supervisor	30$_{hex}$	1	Exception Status	12	BYTE

* As specified by S-Single Stage Controller *Data Type* attribute.

** As specified by S-Analog Sensor *Data Type* attribute.

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7.1.1. Assembly Details

Table 7-2 I/O Assembly Instances

Number	Required	Type	Byte	Data Description
1	N	Input	0-1	INT Pressure
2	Y (default)	Input	0 1-2	Exception Status INT-Pressure
4	N	Input	0 1-2 3-4	Exception Status INT-Pressure INT-Control Setpoint
7	Y (default)	Output	0-1 2-3	INT-Control Setpoint INT-Control Instance (not used; set to 0)
12	N	Input	0 1-2 3-4	Exception Status INT-Pressure INT-Flow
15	N	Input	0 1-2 3-4	Exception Status INT-Pressure INT-Temperature
16	N	Input	0 1-2 3-4 5-6	Exception Status INT-Pressure INT-Flow INT-Temperature
17	N	Input	0-3	FP-Pressure
18	Y	Input	0 1-4	Exception Status FP-Pressure
20	N	Input	0 1-4 5-8	Exception Status FP-Pressure FP-Control Setpoint
23	Y	Output	0-3 4-5	FP-Control Setpoint Control Instance (not used; set to 0)
27	N	Input	0 1-4 5-8	Exception Status FP-Pressure FP-Flow
30	N	Input	0 1-4 5-8	Exception Status FP-Pressure FP-Temperature

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Number	Required	Type	Byte	Data Description
31	N	Input	0	Exception Status
			1-4	FP-Pressure
			5-8	FP-Flow
			9-12	FP-Temperature

7.2. Appendix B - Data Type Definitions

The following table list DeviceNet data types used throughout this manual and in the DeviceNet specification.

The column C/C++ Encoding is given as a comparative common example reference.

Table 7-3 Data Types

Data Type	Size (bytes)	Description	Range	C/C++ Keyword
BOOL	1	A true/false represented as 0 = false and 1 = true	0 and 1	bool
SINT	1	An 8-bit signed integer value	-128 to 127	char
USINT	1	An 8-bit unsigned integer value	0 to 255	unsigned char
INT	2	A 16-bit signed integer value	-32768 to 32767	short int
UINT	2	A 16-bit unsigned integer value	0 to 65535	unsigned short int
DINT	4	A 32-bit signed integer value	-2147483648 to 2147483647	int
UDINT	4	A 32-bit unsigned integer	0 to 4294967296	unsigned int
REAL	4	An IEEE single precision floating point number	3.4E38 to -3.4E38	float
DREAL	8	An IEEE double precision floating point number		Long
ENGUNIT	1	An enumerated value representing an engineering unit of measure	4096 - 65535	N/A
BYTE	1	An 8-bit Bitfield	N/A	N/A
SHORT STRING	Up to 128 bytes	A character array where the first byte is the number of characters in the array, and the subsequent bytes contain the ASCII characters. This is not a NULL terminated string.	N/A	N/A

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7.3. Appendix C – Data Units

Table 7-4 Pressure Units

Description	Symbol	Units Code	
		Decimal	**Hex**
Counts	-	4097	0x1001
Percent	%	4103	0x1007
Kilopascal	kPa	4874	0x130A
Torr	torr	4865	0x1301
Pounds per square inch unreferenced or differential pressure	psi	4864	0x1300

Table 7-5 Actuator Units

Description	Symbol	Units Code	
		Decimal	**Hex**
Counts	-	4097	0x1001
Percent	%	4103	0x1007

Table 7-6 Flow Units

Description	Symbol	Units Code	
		Decimal	**Hex**
Counts	-	4097	0x1001
Percent	%	4103	0x1007
Standard cubic centimeter per minute	SCCM	5120	0x1400
Standard liter per minute	SLM	5121	0x1401

Table 7-7 Temperature Units

Description	Symbol	Units Code	
		Decimal	**Hex**
Counts	-	4097	0x1001

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Description	Symbol	Units Code	
Percent	%	4103	0x1007
Degrees Celsius	°C	4608	0x1200
Degrees Fahrenheit	°F	4609	0x1201
Degrees Kelvin	°K	4610	0x1202

7.4. Appendix D - LED Flash Codes

The following tables assume power has been applied to the network and the device has been properly connected to the network.

Table 7-8 NET LED Flash Codes

Flash Code	Description
Off	The device is the only node on the network
Flashing Green	Baud Rate and MAC ID are configured correctly. The device recognizes the network but no connection has been made to the device
Solid Green	A Connection has been established to the device
Flashing Red	An I/O Connection to the device has timed out
Solid Red	The Baud Rate Switch is set to a different baud rate than the network OR The MAC ID of the device is identical to another node on the network OR The device has gone Bus Off, indicating network communication errors.

Table 7-9 MOD LED Flash Codes

Flash Code	Description
Flashing Red-Green	The device is in the Self-Test mode
Solid Green	All self-tests have passed. No faults have been detected
Flashing Red	A recoverable fault has been detected or the device has been commanded into the Abort state
Solid Red	An unrecoverable fault has occurred

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7.5. Appendix E – Service Summary and Details

Table 7-10 Get Attribute Single Service Parameters

Parameter Name	Data Type	Required	Description	Default
Attribute ID	USINT	Y	The attribute ID of the attribute to be read.	None

Table 7-11 Success Response Data

Return Value	Data Type	Description
Attribute Value	The Data Type of the Attribute being read	

Table 7-12 Set Attribute Single Service Parameters

Parameter Name	Data Type	Required	Description	Default
Attribute ID	USINT	Y	The attribute ID of the attribute to be read.	None
Attribute Value	(Equivalent to the data type of the Attribute)	Y	The value to which the attribute will be set	None

Table 7-13 Success Response Data

Return Value	Data Type	Description
NO SUCCESS RESPONSE DATA		

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7.6.   Appendix F - State
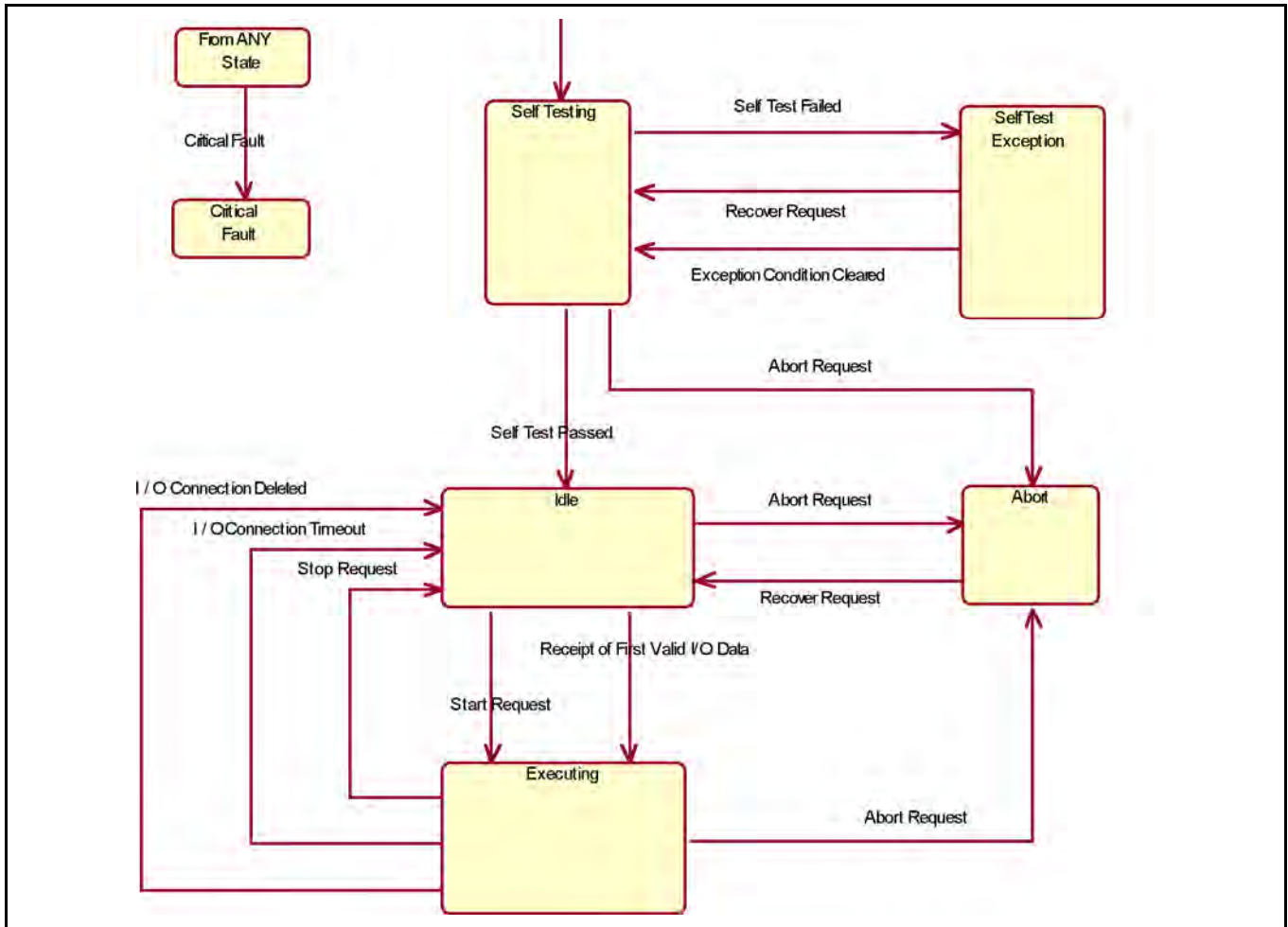
Figure 7-1 S-Device Supervisor State Machine Diagram

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Part Number: 541B206AAG
February, 2016

Table 7-14 S-Device Supervisor State Event Matrix

EVENT	STATE					
	Idle	Self-Testing	Self-Test Exception	Executing	Abort (Recoverable Fault)	Critical Fault
Power Applied	-	Default Entry Point: Device performs its Self-Test Application Process	-	-	-	Transition to SELF-TESTING
Self-Test Passed	Not Applicable	Transition to IDLE	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Self-Test Failed	Not Applicable	Set appropriate Exception Status Bits and Transition to SELF-TEST EXCEPTION	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Exception Condition Cleared	Not Applicable	Not Applicable	Set appropriate Exception Status Bits and Transition to SELF-TESTING	Not Applicable	Not Applicable	Not Applicable
Critical Fault	Transition to CRITICAL FAULT	Transition to CRITICAL FAULT	Transition to CRITICAL FAULT	Transition to CRITICAL FAULT	Transition to CRITICAL FAULT	Ignore Event
Reset Request	Transition to SELF-TESTING	Restart SELF-TESTING	Transition to SELF-TESTING	Transition to SELF-TESTING	Transition to SELF-TESTING	Ignore Event
Start Request	Transition to EXECUTING	Error OSC[1]	Error OSC[1]	Error AIRS[2]	Error OSC[1]	Ignore Event
Stop Request	Error AIRS[2]	Error OSC[1]	Error OSC[1]	Transition to IDLE	Error OSC[1]	Ignore Event
Abort Request	Transition to ABORT	Transition to ABORT	Error OSC[1]	Transition to ABORT	Error AIRS[2]	Ignore Event
Recover Request	Error OSC[1]	Restart SELF-TESTING	Transition to SELF-TESTING	Error OSC[1]	Transition to IDLE	Ignore Event
Perform Diagnostics Request	Transition to SELF-TESTING	Restart SELF-TESTING	Transition to SELF-TESTING	Transition to SELF-TESTING	Perform all device diagnostics test.	Ignore Event
Connection Timeout	Ignore Event	Ignore Event	Ignore Event	Transition to IDLE	Ignore Event	Ignore Event
Receipt of First Valid I/O Data	Transition to EXECUTING	Ignore Event	Ignore Event	Normal Response	Ignore Event	Ignore Event
I/O Connection Deleted	Ignore Event	Ignore Event	Ignore Event	Transition to IDLE	Ignore Event	Ignore Event

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[1] Error OSC = Error Response "Object State Conflict" (Code 0C$_{hex}$)

[2] Error AIRS = Error Response "Already in Requested Mode/State" (Code 0B$_{hex}$)

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Section 7 - Appendix

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7.7. Appendix G - EDS Parameter Configuration

This section describes the parameters defined in the EDS file. These parameters are grouped logically in the following categories:

Table 7-15 Parameter Groups

Group Number	Group Name	Description
1	Polled Connection	These parameters select the I/O Data Assembly to be used with the Polled I/O Connection. The attributes associated with these parameters are found in the Connection Object – Explicit Connection Instance.
2	Device Info	These are informational parameters. The attributes associated with these parameters are found in the S-Device Supervisor Object.
3	Pressure Sensor	These parameters are associated with configuring the pressure sensor. The attributes associated with these parameters are found in the S-Analog Sensor Object.
4	Flow Sensor	These parameters are associated with configuring the flow sensor. The attributes associated with these parameters are found in the S-Analog Sensor Object.
5	Temperature Sensor	These parameters are associated with configuring the temperature sensor. The attributes associated with these parameters are found in the S-Analog Sensor Object.
6	Valve	These parameters are associated with configuring the Valve. The attributes associated with these parameters are found in the S-Analog Actuator Object.
7	Pressure Control	These parameters are associated with configuring the pressure control behavior. The attributes associated with these parameters are found in the S-Single Stage Controller Object.
8	Soft-Start Control	These parameters configure the soft-start control (ramping) feature of the device. The attributes associated with these parameters are found in the S-Single Stage Controller Object.
9	Alarms and Warnings	These parameters are used to enable or disable reporting of both the individual and overall device alarms and warnings. The attributes associated with these parameters are found in the S-Device Supervisor Object, S-Analog Sensor Object, S-Analog Actuator Object and S-Single Stage Controller Object.

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Section 8 - Glossary

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8. Glossary

This section is intended as a brief overview of DeviceNet terminology used throughout this manual.

Assembly

An Assembly is a Class that defines a collection of EPATH(s). This collection allows multiple attributes to be virtually accessed all at once. Each instance of an Assembly defines a unique set of EPATH(s).

Example:
The movement of data in an I/O type Connection is defined by the Produce and Consume Path attributes (see EPATH). Only one EPATH can be assigned to each of these attributes, thus limiting the amount of data that can be moved through an I/O type Connection. The solution to move more data through the I/O type Connection is to assign the Produce and Consume EPATH attributes of the Connection to "point" to an Assembly, which in turn contains multiple EPATH's.

Attribute

A Parameter or Data Item that may be read or written and is used for the purpose of configuration or is used to obtain information.

Example:
The attribute Data Units defines the engineering units pressure will be reported in. The attribute Value indicates the current pressure. Attributes can be read/write or read only.

Baud Rate

The data rate, or speed, that the device will communicate. The baud rate is set using the Baud Rate switch found on the top cover of the PC100 Series PC will configure this. The choices are 125k, 250k, and 500k.

Class

A logical collection of related Attributes that define a particular function and/or behavior.

Example:
The class S-Analog Sensor contains information about configuring a sensor, the current status of the sensor, and/or the current value of what is being sensed.

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Connection

A connection is a logical link between two devices by which messages are transferred. A device can have 1 or more simultaneous Connections. In most typical applications, data is exchanged using 1 Explicit Connection and 1 I/O Connection. The DeviceNet specification has defined a pre-configured set of Connections referred to as the Master/Slave (M/S) Connection Set.

Device Profile

A specification that defines a set of DeviceNet objects that uniquely represents a particular device of that type or class. The device profile can further define attributes, services, assemblies, etc. that a device must support to be considered part of that type or class of device. These profiles are found in the ODVA specification, Vol. 2. The PC100 Series PC conforms to the vendor-specific device profile.

EDS

The Electronic Data Sheet (EDS) is a specially formatted text description for a device that describes the I/O characteristics and configurable parameters that are accessible via the DeviceNet network. EDS files can be read by configuration software used to configure DeviceNet networks (ex: RsNetworx from Allen-Bradley)

EPATH (formerly known as PATH)

An EPATH is a unique identifier (sometimes referred to as a pointer) comprised of a Class ID, an Instance ID, and an Attribute ID. Some Classes have EPATH attributes that point to a particular data item. An example of this would be the Connection Class that contains two attributes, Produce Path and Consume Path. These attributes define where incoming data is sent to, and outgoing data comes from. I/O Connections make use of these two particular attributes.

Expected Packet Rate (EPR)

The EPR is an attribute in the Connection Class that defines the maximum amount of time (in msec) messages should be received by the Connection (implementation of this value is dependent upon the Connection type, Explicit or I/O, but the behavior is the same in all Connection types). If the time between received messages for that connection exceeds the EPR, the Connection times out. This may result in the Connection being released by the device.

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Explicit Connection

An Explicit Connection dictates a request and response exchange between two devices. The device sending the request must get a response from the device receiving the request message. Embedded in the Explicit Message is information about the Class, Instance, Attribute, Service, and any service data needed to process the message. As a result, processing of Explicit Messages generally takes longer than I/O messaging. This is why Explicit Connections are typically used for commissioning/configuration.

I/O Connection

I/O Connections are used for the exchange of data only. How a device processes the data and/or responds with data via an I/O Connection is defined within the Produce and Consume Path attributes of the I/O Connection instance (See EPATH and Assembly above).

Instance

An instance of a Class is a particular invocation of a Class (sometimes referred to as an Object). An Instance of a Class is unique in describing the behavior for a particular kind of object. Each instance of the class contains the same set of attributes defined by the class. The uniqueness of the instance is defined by the attribute values.

Example:
Assume that a device contains two sensors, one to measure pressure, and the other to measure temperature. To access information about one or the other sensor, two Instances of the class *S-Analog Sensor* class would need to exist. Each sensor would have the same attribute set because they were both created from the class S-Analog Sensor, but the values in each attribute set would be unique to the sensor to describe pressure or to describe temperature.

Example:
The class Connection contains information about configuring a Connection. With most kinds of DeviceNet devices, multiple Connections are established within a device to exchange information. In most cases one Explicit type Connection is created to configure the device, another I/O type Connection is created to transfer larger amounts of data. Each type of Connection is created from the Connection class. Each Connection has unique information in its Attribute set that defines the behavior of the Connection et. al. an Explicit type Connection or an I/O type Connection.

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MAC ID

The Media Access Control Identifier, more commonly known as the network address of the device. Setting the MAC ID switches found on the top cover of the PC100 Series PC will configure this address. The range of addresses is 0 to 63.

Master/Slave

Master/Slave refers to the relationship between one controlling device (Master) and one or more subordinate devices (Slaves). This is a typical application of a DeviceNet network where the Master has the capability to establish Connections with more than one Slave. The (Master) then sends to each Slave control data and receives from each (Slave) device status and/or operational data. An example would be a (Master) device sending a setpoint to one or more pressure controllers (Slaves), and each controller would respond with pressure data.

M/S Polled I/O Connection

The M/S Polled I/O Connection establishes a data exchange between Master and Slave devices whereby the Master device sends an I/O message with 0 or more data to a Slave device, and the Slave device must respond with 0 or more data bytes.

Polling

A request/response method of exchanging data.

Safe State (Safe Mode)

An operational mode or state that is considered "safe" whereby the normal controller process is shut down and mechanical and sensing mechanisms are placed in a safe condition.

Service

A service is a pre-defined action that a Class provides. The most commonly used services are used to configure the device such as Get Attribute (0x0E) or Set Attribute (0x10). Other types of services may directly affect the behavior of a Class (or Object) such as Reset (0x5), Stop (0x6), or Start (0x7). There are many more services not listed here and each Class specifies which Services it supports.

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Scanning

A technique of exchanging data with devices on a network whereby the Master device (scanner) polls each device on a network sequentially, continuing through the list of all devices connected to the network before starting the process again.

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Brooks Instrument
407 West Vine Street
P.O. Box 903
Hatfield, PA 19440-0903 USA
T (215) 362 3700
F (215) 362 3745
E-Mail BrooksAm@BrooksInstrument.com
www.BrooksInstrument.com

Brooks Instrument
Neonstraat 3
6718 WX Ede, Netherlands
T +31 (0) 318 549 300
F +31 (0) 318 549 309
E-Mail BrooksEu@BrooksInstrument.com

Brooks Instrument
ITW Japan Ltd.
1-4-4 Kitasuna Koto-Ku
Tokyo, 136-0073 Japan
T +81 3 5633 7100
F +81 3 5633 7101
E-Mail Sales-Japan@BrooksInstrument.com

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