Installation and Operation Manual
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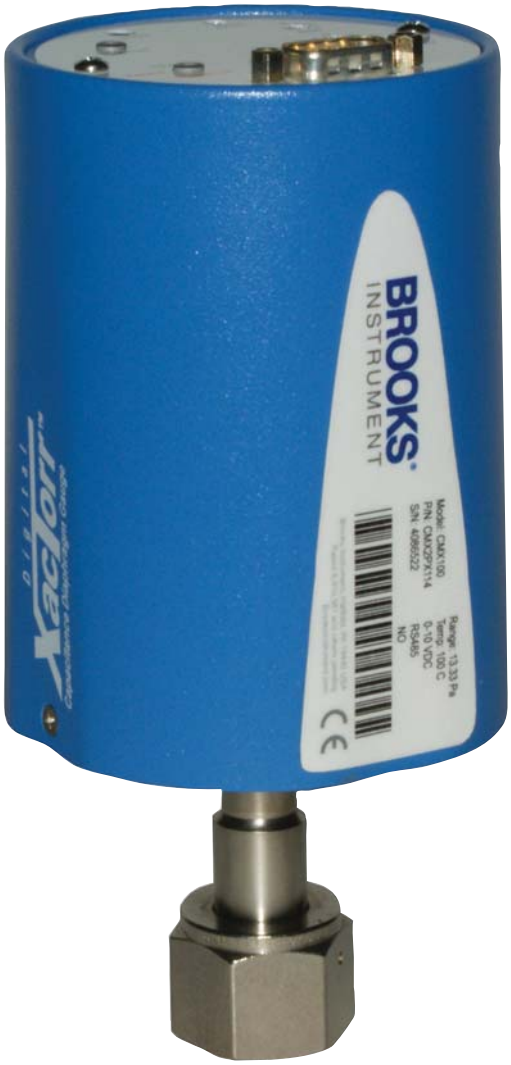
Brooks®CMX Series DeviceNet™ Profile

Heated Digital Capacitance Manometers



Brooks® CMX Series with DeviceNet Profile
Heated Digital Capacitance Manometer

Brooks® CMX Series DeviceNet™ Profile

Essential Instructions
Read before proceeding!

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 (2004/108/EC (EMC directive 89/336/EEC)).
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.

Brooks® CMX Series DeviceNet™ Profile

Dear Customer,

We appreciate this opportunity to service your flow measurement and control requirements with a Brooks Instrument device. Every day, flow customers all over the world turn to Brooks Instrument for solutions to their gas and liquid low-flow applications. Brooks provides an array of flow measurement and control products for various industries from biopharmaceuticals, oil and gas, fuel cell research and chemicals, to medical devices, analytical instrumentation, semiconductor manufacturing, and more.

The Brooks product you have just received is of the highest quality available, offering superior performance, reliability and value to the user. It is designed with the ever changing process conditions, accuracy requirements and hostile process environments in mind to provide you with a lifetime of dependable service.

We recommend that you read this manual in its entirety. Should you require any additional information concerning Brooks products and services, please contact your local Brooks Sales and Service Office listed on the back cover of this manual or visit www.BrooksInstrument.com

Yours sincerely,

Brooks Instrument

Brooks® CMX Series DeviceNet™ Profile

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1.0 INTRODUCTION

This document and the DeviceNet Statement of Compliance (SOC) provide a complete inter operability specification for the CMX Digital Capacitance Manometer device from Brooks. Refer to Figure 1.

Information contained in this Brooks CMX Device Profile was derived from the sources listed in the back of this Device Profile Section.

1.1 CMX UNIT TOP VIEW – INDICATORS, CONNECTORS, AND SWITCHES

Figure 1: CMX Top View With DeviceNet Connector

Table 1: CMX Top - LED Indicators, Switches, and Connector

ITEM	DESCRIPTION
DIAG	2.5mm Diagnostic Port - supports diagnostic functions via an RS-485 based communications protocol.
ZERO	When pressed, the gauge will automatically adjust the pressure signal to zero volts.
MSD ADDRESS	Most Significant address Digit (MAC ID). Valid addresses are 0 - 63 and P (Programmable).
LSD ADDRESS	Least Significant address Digit (MAC ID). Valid addresses are 0 - 63.
9-PIN D SUB (MALE)	Power, analog pressure signal.(Not Shown)
15-PIN D SUB (MALE)	Power, analog pressure signal, and relay contacts.(Not Shown)
READY/FAULT/WARM UP	Temperature of heater indicator LED. Warm up = Amber, At Temperature = Green, Fault = Red
MOD STATUS	Module Status LED, per DeviceNet definition. (Only on DeviceNet models)
NET STATUS	Network Status LED, per DeviceNet definition. (Only on DeviceNet models)
RATE	Sets to DeviceNet data rate: 1 = 125 kbps, 2 = 250 kbps, 5 = 500 kbps, P = Program mode.
5-PIN CONNECTOR	“Micro-style” connector for DeviceNet power and communications.
9-PIN D SUB (FEMALE)	Analog output signal available on DeviceNet models.

1.2 SCOPE AND DEVICE OVERVIEW

Other documents will be referenced that contain information and explanation details related to the CMX unit, but not unique to DeviceNet.

The CMX also complies with the ODVA Semiconductor SIG Interface Guidelines for DeviceNet Devices on Semiconductor Manufacturing Tools.

In addition, the CMX Digital Capacitance Manometer supports DeviceNet objects:

- Identity
- DeviceNet
- Connection
- Assembly
- S-Device Supervisor
- S-Analog Sensor objects.

Supported objects are summarized in the following table.

Table 2: Supported Object Summary

Object Class (Class ID)	Subclass		Optional/Required	Number of Instances
	Class	Inst		
Identity (0x01)	-	-	Required	1
Measure Router (0x02)	-	-	Required	1
DeviceNet (0x03)	-	-	Required	1
Connection (0x05)	-	-	Required*	at least 1 I/O Polled and 1 Explicit
Assembly (0x04)	-	-	Required	2 input assemblies supported.
S-Device Supervisor (0x30)	-	-	Required	1
S-Analog Sensor (0x31)	-	-	Required	1

*CMX supports one I/O Polled and one Explicit Connection

1.3 DEVICE PROFILE – VACUUM GAUGE (TYPE 0X1C)

The CMX Digital Capacitance Manometer is a device that measures the force per unit area (pressure) and reports this value as an analog voltage (0 to 10 VDC), and as a digital value, through the DeviceNet communications interface.

1.4 OBJECT MODEL FOR DIGITAL CAPACITANCE MANOMETER DEVICE

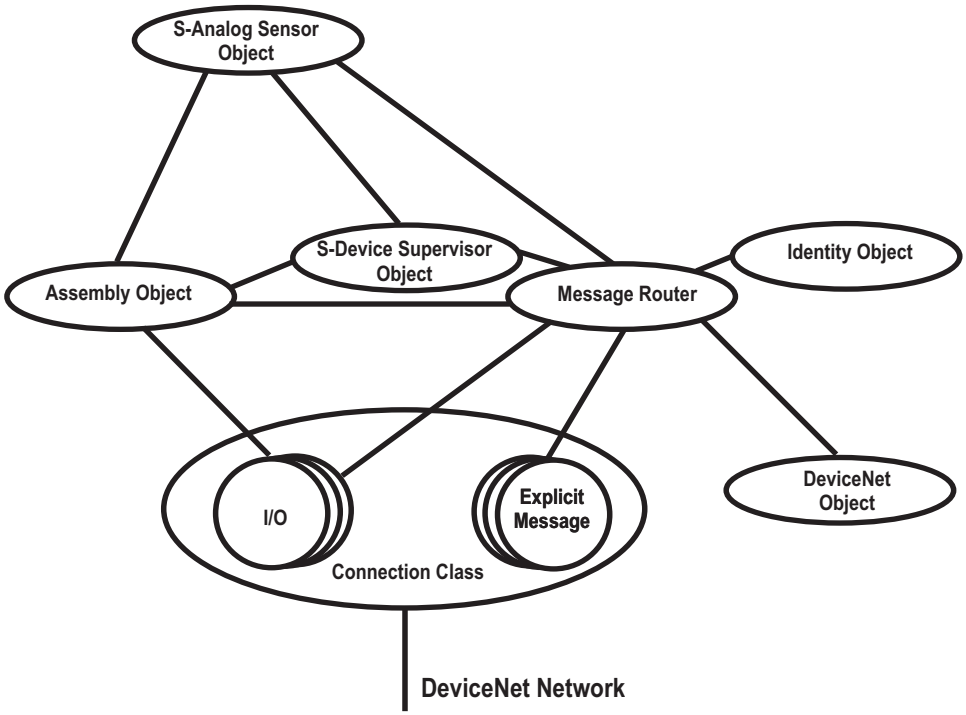

Figure 2: Object Model

1.5 HOW OBJECTS AFFECT BEHAVIOR

Table 3: Object Affect on Behavior

Object	Affect on Behavior
Identity	Supports the Reset service. Upon receipt of a Reset Service Request of any type, the Identity Object sends a Reset Service Request to the S-Device Supervisor.
Message Router	No effect.
DeviceNet	Configures port attributes, node address, and data rate. Allocates Connection channels.
Connection Class	Contains the number of logical ports into or out of the device.
Assembly	Defines input/output and configuration data format.
S-Device Supervisor	Supports the Stop, Start, Reset, Abort, Recover and Perform_Diagnostic Services for ALL Applications Objects in the device and consolidates the Exception Conditions and Application Objects' Status. This object behaves differently from the Identity Object in that the S-Device Supervisor Object provides a single point of access to the Application Objects only; it does not effect the DeviceNet specific objects (Example: Identity, DeviceNet, Connection, and etc.).
S-Analog Sensor	Feeds the process variable to the Single Stage Controller object.

1.6 MODULE STATUS LED INDICATOR

The Module Status LED indicates the status of the capacitance manometer device as shown in the following table:

Table 4: Module Status LED Indicator

Module Status	LED State	Description
Power Off	Off	No power applied to device.
Device Self-test	Flashing Green-Red-Off	Device is in self-test. The LED will flash green for 250 mSec, followed by red for 250 mSec. If the device passes the self-test, the LED will stay green.
Device Operational	Green	Device is operating normal.
Visual Indicator	Flashing Green	An explicit command turns on the visual indicator (wink) function. The flash rate is 500 mSec on and 500 mSec off.
Unrecoverable Fault	Red	Device has detected an unrecoverable fault. It is unable to operate normal in this condition.

1.7 NETWORK STATUS LED INDICATOR

The Network Status LED indicates the status of the communications link, as shown in the following table.

Table 5: Network Status LED Indication

Network Status	LED State	Description
Power Off	Off	No power applied to device, or device is the only node on the network.
On-line, not connected	Flashing Green	Device is operating normal. It is on-line, but no Connections have been established to the device.
Device Operational	Green	Device is operating normal. At least one Connection has been established.
Connection Timeout	Flashing Red	One or more Connections have timed out.
Unrecoverable Fault	Red	Device cannot communicate on the network. May be a duplicate MAC ID detection, or a bus-off condition.

1.8 DATA RATE AND NODE ADDRESS SWITCHES

The Data Rate and Address switches are set prior to connecting the device to the DeviceNet communications link. These switches may be set to the program mode, which will allow the software to set the data rate and address through the DeviceNet protocol.

1.9 IDENTITY OBJECT (CLASS 0X01)

The Identity Object provides general information about the identity of a device. This object is summarized in the following tables.

Table 6: Instance Attributes

Attribute ID	Need in Implementation	Access Rule	Name	DeviceNet Data Type	Description of Attribute
1	Required	Get	Vendor ID	UINT	ODVA Assigned Vendor Number = 110 (0x6e)
2	Required	Get	Device Type	UINT	ODVA Assigned Device Type = 28 (0x1c)
3	Required	Get	Product Code	UINT	(ODVA Assigned product Number = 3, Capacitive Manometer)

Table 6: (Continued)Instance Attributes

Attribute ID	Need in Implementation	Access Rule	Name	DeviceNet Data Type	Description of Attribute
4	Required	Get	Revision	STRUCT of:	Product Software Revision
			Major Revision	USINT	Major revision number (byte value)
			Minor Revision	USINT	Minor revision number (byte value)
5	Required	Get	Status	WORD	DeviceNet Status See Table
6	Required	Get	Serial Number	UDINT	DeviceNet Device Serial Number
7	Required	Get	Product Name	SHORT STRING	“CM” (1-32 CHARACTERS)

All above listed attributes are required in this implementation.

All above value are stored in non-volatile memory, except for Status, which is updated continuously during program run time.

Table 7: Status Bit Definitions

Bit(s)	Called:	Description
0	Owned	True if device is allocated to a master (host).
1		Reserved, set to 0.
2	Configured	True if device has been set to other than “out-of-box” configuration.
3		Reserved, set to 0.
4, 5, 6, & 7		Vendor specific. (not used - set to 0)
8	Minor Recoverable Fault	True indicates the device has detected a problem which it may recover from automatically.
9	Minor Unrecoverable Fault	True indicates the device has detected a problem which it may not be able to recover from automatically.
10	Minor Recoverable Fault	True indicates the device is now in the “Major Recoverable Fault” state.
11	Minor Unrecoverable Fault	True indicates the device is now in the “Major Unrecoverable Fault” state.
12, 13		Reserved, set to 0.
14, 15		Reserved, set to 0.

Table 8: Common Services

Service Code	Need in Implementation		Service name	Description of Service
	Class	Instance		
14 (0x0E)	Conditional	Required	Get_Attributes_Single	Returns the contents of the specified attribute.
5 (0x05)	n/a	Required	Reset	Resets the device to the Self-Testing state. See Table for Reset Service Parameters.

Table 9: RESET Request Service Data Field Parameters

Parameter	Required	Data Type	Description	Semantics of Values
Type	Required	USINT	Type of Reset	0=Power Cycle type [default if parameter omitted] 1=Out-of-Box type

1.10 DeviceNet Object (Class 0x03)

The DeviceNet Object maintains configuration and status of physical attachments to DeviceNet. It also allocates and releases Connection instances associated with the Predefined Master/Slave Connection Set.

Table 10: Instance Attributes Attribute

Attribute ID	Need in Implementation	Access Rule	Name	DeviceNet Data Type	Description of Attribute
1	Optional (Supported)	Set	MAC ID	USINT (byte)	Values 0-63. Default value is 63. See Semantics.
2	Optional (Supported)	Set	Baud Rate	USINT (byte)	Values 0, 1, 2. Default value is 2 (500K baud) See Semantics.
3	Optional (Not Supported)	Get	BOI	USINT (byte)	Bus-Off Interrupt. Default value is 0.
4	Optional (Supported)	Set	Bus-Off Counter	USINT (byte)	Number of times CAN chip went to Bus-Off state.
5	Optional (Supported)	Get	Allocation Information	Struct of: BYTE USINT(byte)	Indicates whether or not the Predefined Master/Slave Connection Set has been allocated. Default values are 0, 255.

Table 11: Common Services

Service Code	Need in Implementation		Service name	Description of Service
	Class	Instance		
14 (0x0E)	Conditional	Required	Get_Attributes_Single	Returns the contents of the specified attribute.
16 (0x10)	n/a	Required	Set_Attributes_Single	Sets the attribute to the specified value.
75 (0x4B)	n/a	Required	Allocate_Master/ Slave_Connection_Set	This is the Service utilized to perform the allocation of the Predefined Master /Slave Connection Set.
76 (0x4C)	n/a	Required	Release_Master/ Slave_Connection_Set	This service is used to de-allocate the Predefined Master/Slave Connection Set within a Slave.

1.10.1 Semantics

The Mac ID and Baud Rate are switch selectable. Baud Rate will be 125K, 250K, or 500K baud if the switch is set to 1, 2, 5 respectively. The MAC ID switch sets the unit's DeviceNet address to 0-63, according to the switch settings. Both switches may be placed in the "P" position, which selects "programmable" MAC ID or Baud Rate. If the switch is placed in the "P" position, the MAC ID or Baud Rate will assume the last valid value.

MAC ID and Baud Rate attributes are software settable ONLY when the switches are in the "P" position. Behavior related to the MAC ID and the Baud Rate attributes conforms to the requirements defined in the Open DeviceNet Vendor Association Semiconductor Special Interest Group (SIG) Interface Guidelines Conformance Test Procedure (Section 5.6).

1.11 Assembly Object (Class 0x04)

The Assembly Object groups attributes of multiple objects into a single block of data, which can be produced over an explicit messaging Connection. Two instances of the Assembly Object are supported with one instance attribute. The device profile does NOT allow “mixed” integer and real assemblies to be allowed at the same time. That is, it is not allowed to produce an integer assembly and consume a floating-point assembly over a polled Connection. See the Device Profile (Version J) for more detail.

1.11.1 I/O Assembly Object Instance Data Attribute Format

The manufacturer of a Vacuum Gauge Device must specify which Assembly Instances are supported by the device. CMX supports the following assemblies.

Table 12: Object Instances and Attributes

Assembly Instance	DeviceNet Data Type	Access Rule	Attribute	Description
2	USINT/UINT	Get	3	Pressure data, (UINT) and status byte value.
5	USINT/REAL	Get	3	Pressure data, (REAL) and status byte value.

Table 13: Common Services

Service Code	Need in Implementation		Service Name	Description of Service
	Class	Instance		
14 (0x0E)	Conditional	Required	Get_Attributes_Single	Returns the contents of the specified attribute.

1.11.2 Object Instances

Both the Produced and Consumed Paths must reference either integer OR real assemblies.

1.12 CONNECTION OBJECT (CLASS 0X05)

The Connection Class allocates and manages internal resources associated with both I/O and Explicit Messaging Connections. The Explicit and I/O Connection Objects manage the communication aspects associated with a particular application to application network relationships. The CMX supports both the Explicit and Polled or I/O Connections.

Table 14: Instance Attributes (Explicit Connection)

Attribute ID	Access Rule	Name	DeviceNet Data Type	Default Value	Description of Attribute
1	Get	State	USINT(byte)	03	State of the explicit instance
2	Get	Instance Type	USINT(byte)	00	Indicates an explicit Messaging Connection.
3	Get	Transport Class Trigger	Byte	0x83	Defines behavior of the Connection
4	Get	Produced Connection ID	UINT		Placed in CAN Identifier Field when Connection transmits.
5	Get	Consumed Connection ID	UINT		CAN Identifier Field value that denotes message to be received.

Table 14: (Continued)Instance Attributes (Explicit Connection)

Attribute ID	Access Rule	Name	DeviceNet Data Type	Default Value	Description of Attribute
6	Get	Initial Communications Characteristics	Byte	0x21	Defines the Message Group(s) across which productions and consumptions associated with the Connection occur.
7	Get	Produced Connection Size	UINT	20 (0x14)	Maximum number of bytes transmitted across this Connection.
8	Get	Consumed Connection Size	UINT	20 (0x14)	Maximum number of bytes transmitted across this Connection.
9	Set/Get	Expected Packet Rate	UINT	2500 (0x09C4)	Defines timing associated with this Connection.
12	Get	Watchdog timeout Action	USINT(byte	1	Defines how to handle Inactivity/Watchdog time-outs.
13	Get	Produced Path Length	UINT	0	Number of bytes in the produced_Connection_path length.
14	Get	Produced Connection Length	Array of USINT	Empty	Specifies the Application Object(s) whose data is to be produced by this Connection Object.
15	Get	Consumed Path Length	UINT	0	Number of bytes in the consumed_Connection_path length.
16	Get	Consumed Connection Path	Array of USINT	Empty	Specifies the Application Object(s) whose data is to be consumed by this Connection Object.
17	Get	Production Inhibit Time	UINT	0	Defines minimum time between new data production. This attribute is required for I/O Client Connections.
NOTE: All above listed attribute ID's are required in this implementation.					

Table 15: Instance Attributes (Polled Connection

Attribute ID	Access Rule	Name	DeviceNet Data Type	Default Value	Description of Attribute
1	Get	State	USINT(byte)	03	State of the object.
2	Get	Instance Type	USINT(byte)	00	Indicates either I/O or Messaging Connection.
3	Get	Transport Class Trigger	Byte	0x83	Defines behavior of the Connection.
4	Get	Produced Connection ID	UINT		Placed in CAN Identifier Field when Connection transmits.
5	Get	Consumed Connection ID	UINT		CAN Identifier Field value that denotes message to be received.
6	Get	Initial Communications Characteristics	Byte	01	Defines the Message Group(s) across which productions and consumptions associated with the Connection occur.
7	Get	Produced Connection Size	UINT	3*/5	Maximum number of bytes transmitted across this Connection. (value determined by assembly instance)

Table 15: (Continued) Instance Attributes (Polled Connection

Attribute ID	Access Rule	Name	DeviceNet Data Type	Default Value	Description of Attribute
8	Get	Consumed Connection Size	UINT	0	Maximum number of bytes transmitted across this Connection.
9	Set/Get	Expected Packet Rate	UINT	0	Defines timing associated with this Connection.
12	Get	Watchdog timeout Action	USINT(byte)	0	Defines how to handle Inactivity/Watchdog time-outs.
13	Get	Produced Path Length	UINT	6	Number of bytes in the produced_Connection_path length.
14	Get	Produced Connection Length	Array of USINT	Array of hex UNITS	Specifies the Application Object(s) whose data is to be produced by this Connection Object.
15	Get	Consumed Path Length	UINT	0	Number of bytes in the consumed_Connection_path length.
16	Get	Consumed Connection Path	Array of USINT	Empty	Specifies the Application Object(s) whose data is to be consumed by this Connection Object.
17	Get	Production Inhibit Time	UINT	0	Defines minimum time between new data production. This attribute is required for I/O Client Connections.

*Produced and Consumed Connection Path attributes are settable ONLY when the I/O Connection is in the “Configuring” state. These attributes MUST reference consistent data types at the time the I/O Connection transitions to the Established State. See Vacuum/ Pressure Gauge Device Profile, Version J for more information regarding consistent data types.
NOTE: All attribute ID’s listed above are required in this implementation.

Table 16: Common Services

Service Code	Need in Implementation		Service name	Description of Service
	Class	Instance		
14 (0x0E)	Conditional	Required	Get_Attributes_Single	Returns the contents of the specified attribute.
16 (0x10)	n/a	Required	Set_Attributes_Single	Sets the attribute to the specified value.

1.13 S-DEVICE SUPERVISOR OBJECT (CLASS 0X30)

This object models the interface, functions and behavior associated with the management of application objects for devices within the “*Hierarchy of Semiconductor Equipment Devices*”. Throughout this DeviceNet Standard, objects belonging to this hierarchy are identified as such by a naming convention that includes a prefix of “S-” in the object class name. This “*Hierarchy of Semiconductor Equipment Devices*” is completely defined in this object definition such that all objects belonging to this hierarchy require the existence of an S-Device Supervisor object to manage its functions and behaviors.

The S-Device Supervisor object centralizes application object state definitions and related status information, exception status indications (alarms and warnings), and defines a behavior model which is assumed by objects identified as belonging to the *Hierarchy of Semiconductor Equipment Devices*. If a reset is

requested of the S-Device Supervisor object instance, it will reset this object instance as well as all of its associated application objects.

Similarly, the Identity object provides an interface to the S-Device Supervisor object. A reset request to the Identity object (of any type) causes a reset request to the S-Device Supervisor object. Further relationships are specified in the Behavior section below.

Additionally, some device attributes are defined which are required in order to specify device models such that they are compliant with the SEMI® S/A Network Standard*, from which the *Hierarchy of Semiconductor Equipment Devices* is derived. Objects defined to exist within the *Hierarchy of Semiconductor Equipment Devices* are done so in order to simplify the management and description of object behavior while insuring compliance with the SEMI Standard.

By association with this object, the Start, Stop, Reset, Abort, Recover and Perform_Diagnostic Services are inherently supported by all objects within the *Hierarchy of Semiconductor Equipment Devices*. These services are not accessible over the network for the associated object instances.

*SEMI®, Standard E54: *Sensor/Actuator Network Common Device Model*.

1.13.1 S-Device Supervisor Class Attributes

The Object Class Attribute ID 1-7 are reserved. See DeviceNet Volume II, Section 5-4.1. for more specification detail on these attributes.

Table 17: S-Device Supervisor Class Attributes

Attribute ID	Need in Implementation	Access Rule	Name	DeviceNet Data Type	Description of Attribute
1 thru 7	These class attributes are either optional or conditional and are described in 1.7 Network Status LED Indicator of this specification.				
97 & 98	Reserved by DeviceNet				
99	Conditional*	Get	Subclass	UINT	Identifies a subset of additional attributes, services and behaviors. The subclasses for this object are specified at the end of the object specification section.

*If the value of Subclass is 00, which identifies “no subclass”, then this attribute is OPTIONAL in implementation, otherwise, this attribute is REQUIRED.

1.13.2 S-Device Supervisor Instance Attributes

DeviceNet reserves Attribute ID 100-199 (64_{hex} - $C7_{hex}$) for Vendor Defined Attributes. See Volume II, Section 7 for more information on Object Definitions.

NOTE: All required attributes are supported. Optional attributes are indicated as (Supported) or (Not Supported).

Table 18: S-Device Supervisor Instance Attributes

Attribute ID	Need in Implementation	Access Rule	NV*	Name	DeviceNet Data Type	Description of Attribute
3	Required	Get	NV	Device Type	SHORT STRING	ASCII Text, Max. 8 Characters default = “VG”.

Table 18: (Continued) S-Device Supervisor Instance Attributes

Attribute ID	Need in Implementation	Access Rule	NV*	Name	DeviceNet Data Type	Description of Attribute
4	Required	Get	NV	SEMI Standard Revision Level	SHORT STRING	Specifies the revision level of the SEMI S/A Network Standard to which the device complies. For this revision, this attribute must be “E54-0997”.
5	Required	Get	NV	Manufacturer’s Name	SHORT STRING	ACSCII Text, Max. 20 Characters, default = “Brooks”.
6	Required	Get	NV	Manufacturer’s Model Number	SHORT STRING	ACSCII Text, Max. 20 Characters, Manufacturer Specified.
7	Required	Get	NV	Software Revision Level	SHORT STRING	ACSCII Text, Max. 6 Characters, See “Semantics” on page 12.
8	Required	Get	NV	Hardware Revision Level	SHORT STRING	ACSCII Text, Max. 6 Characters, See “Semantics” on page 12.
9	Required	Get	NV	Manufacturer’s Serial Number	SHORT STRING	ACSCII Text, Max. 30 Characters, Manufacturer Specified. See “Semantics” on page 12.
10	Required	Get	NV	Device Configuration	SHORT STRING	ACSCII Text, Max. 50 Characters, Manufacturer Specified. Optional additional information about the device configuration.
11	Required	Get	NV	Device Status	USINT(byte)	See “Semantics” on page 12.
12	Required	Get	NV	Exception Status	Byte	See “Semantics” on page 12.
13	Conditional based on Exception Status Bit 7 (Supported)	Get	V	Exception Detail Alarm	STRUCT of:	A structure of three structures containing a bit mapped representation of the alarm detail.
				Common Exception Detail	STRUCT of:	—
				Size	USINT (byte)	Number of Common Detail Bytes.
				Detail	ARRAY of:	See “Semantics” on page 12.
				Detail n	Byte	See “Semantics” on page 12.
				Device Exception Detail	STRUCT of:	—
				Size	USINT (byte)	Number of Device Detail Bytes.
				Detail	ARRAY of:	See Device Profile.
				Detail n	Byte	See Device Profile.
				Manufacturer Exception Detail	STRUCT of:	—
				Size	USINT (byte)	Number of Manufacturer Detail Bytes.
				Detail	ARRAY of:	Manufacturer Specified.
				Detail n	Byte	Manufacturer Specified.

Table 18: (Continued) S-Device Supervisor Instance Attributes

Attribute ID	Need in Implementation	Access Rule	NV*	Name	DeviceNet Data Type	Description of Attribute
14	Conditional based on Exception Status Bit 7 (Supported)	Get	V	Exception Detail Alarm	STRUCT of:	A structure of three structures containing a bit mapped representation of the alarm detail.
				Common Exception Detail	STRUCT of:	
				Size	USINT (byte)	Number of Common Detail Bytes.
				Detail	ARRAY of:	See “Semantics” on page 12.
				Detail n	Byte	See “Semantics” on page 12.
				Device Exception Detail	STRUCT of:	
				Size	USINT (byte)	Number of Device Detail Bytes.
				Detail	ARRAY of:	See Device Profile.
				Detail n	Byte	See Device Profile.
				Manufacturer Exception Detail	STRUCT of:	
				Size	USINT (byte)	Number of Manufacturer Detail Bytes.
				Detail	ARRAY of:	Manufacturer Specified.
				Detail n	Byte	Manufacturer Specified.
				Exception Detail Alarm	STRUCT of:	A structure of three structures containing a bit mapped representation of the alarm detail.
15	Required	Set	NV	Alarm Enable	BOOL	See “Semantics” on page 12.
16	Required	Set	NV	Warning Enable	BOOL	See “Semantics” on page 12.
97-98	Reserved by DeviceNet					
99	Conditional** (Supported)	Get	NV	Subclass	UINT	Identifies a subset of additional attributes, services and behaviors. The subclasses for this object are specified at the end of this object specification section.

*NV = Nonvolatile; attribute value is maintained through power cycles; V = Volatile

**If the value of Subclass is 00 which identifies “no subclass”, then this attribute is OPTIONAL in implementation, otherwise, this attribute is REQUIRED.

1.14 SEMANTICS

1.14.1 Device Type

The Device Type attribute identifies the Specific Device Model to which the device is modeled within the *Hierarchy of Semiconductor Equipment Devices*. The value of this string is specified in the SEMI standard suite referenced in the introduction section of this object definition and is represented for reference in the applicable device profile where used. For the Capacitance Manometer device, the Vacuum Gauge, “VG” term is used.

1.14.2 Manufacturer's Name

The Manufacturer's Name attribute identifies the manufacturer of the device. It is the responsibility of the manufacturer to insure that this ASCII coded text string is sufficiently long to insure uniqueness among manufacturers. The Device Manufacturer attribute is not guaranteed, by specification, to be unique. Therefore, it is not a substitute for the corresponding attribute of the Identity Object and should not be used for identification purposes. "Brooks" is the default manufacture's name.

1.14.3 Software Revision Level

This is an ASCII coded text string representing the revision of the software corresponding to the specific device identified by the Identity object and the S-Device Supervisor object.

1.14.4 Hardware Revision Level

This is an ASCII coded text string representing the revision of the hardware, which is identified by the Identity object and the S-Device Supervisor object. The manufacturer of the device must control this revision such that modifications to the device hardware may be tracked.

1.14.5 Manufacturer's Serial Number

This attribute is a string representation of the manufacturer's serial number of the device, formatted to fit the appropriate manufacturing tracking systems. This is not the same as the Identity Object's serial number, which is used to uniquely identify the device in the network environment.

1.14.6 Device Status

This attribute represents the current state of the device. Its value changes as the state of the device changes. The following values are defined:

Table 19: Device Status

Attribute Value	State
0	Undefined
1	Self Testing
2	Idle
3	Self-Test Exception
4	Executing
5	Abort
6	Critical Fault
7-50	Reserved by DeviceNet
51-99	Device Specified (None Used)
100-255	Vendor Specified (None Used)

1.14.7 Exception Status

A single byte attribute whose value indicates that the status of the alarms and warnings for the device. This indication may be provided in one of two methods: Basic or Expanded.

For the *Basic Method*, bit seven of the Exception Status attribute is set to zero; all exceptions are reported exclusively through communication of this Exception Status attribute. The format of bits zero through six in this mode is device spe-

cific; the format may be further specified in an appropriate device profile specification; if it is not specified, then the format of bits zero through six is equivalent to that specified for the expanded method.

For the *Expanded Method*, bit seven of Exception Status attribute is set to one; exceptions are reported through the communication of this Exception Status attribute, formatted as specified in the table below. In addition, the Exception Detail attributes are supported. The Exception Status bits are determined by a logical “OR” of the related Exception Detail bits, as indicated.

Table 20: Exception Status Bit Map, Bit 7 Set to 1

0	ALARM/device-common*
1	ALARM/device-specific
2	ALARM/manufacturer-specific
3	reserved -- set to 0
4	WARNING/device-common*
5	WARNING/device-specific
6	WARNING/manufacturer-specific
7	1 = Expanded Method

*The alarm or warning is not specific to the device type or device type manufacturer.

1.14.8 Exception Detail Alarm and Exception Detail Warning

The formats of these two attributes are identical. Therefore, they are described together here:

Attributes that relate the detailed status of the alarms or warnings associated with the device. Each attribute is a structure containing three members; these three members respectively relate the detailed status of exceptions that are common (i.e., not device-specific), device-specific but not manufacturer-specific, and manufacturer-specific. The common detail is defined below. The device-specific detail is defined in the appropriate Device Profile. The manufacturer defines the manufacturer-specific detail. A SIZE value of zero indicates that no detail is defined for the associated exception detail structure.

Each of the three structure members is defined as a structure containing an ordered list (i.e., array) of bytes of length SIZE, and an unsigned integer whose value is SIZE. Each of the bytes in each array has a specific mapping. This mapping is formatted as 8 bits, which represents 8 independent conditions. A value of 1 indicates that the condition is set (or present), and a value of 0 indicates that the condition is cleared (or not present). Note that if a device does not support an exception detail, the corresponding bit is never set. The bitmaps for alarms and warnings in the corresponding attributes are structured in parallel so that a condition may have either alarm or warning set depending on severity. If a condition inherently cannot be both alarm and warning, then the parallel bit position corresponding to the other state will remain "0." The existence of an exception detail variable structure is dependent on the value of the Exception Status Attribute. The existence of an exception detail variable structure is only required if bit seven of the Exception Status attribute is set to 1, indicating the Expanded method reporting. Bits 0-6 of the Exception Status attribute correspond to the particular exception type.

1.14.9 Common Exception Detail

This structure relates exception conditions (i.e., alarms or warnings) which are common to all devices within the *Hierarchy of Semiconductor Equipment Devices*. The Detail element of the structure is an ordered list (i.e., array) of bytes of length [SIZE], which is the value of the structure element Size. For each byte in the Detail field, all bits not identified are reserved for future standardization.

The first byte in this attribute is CommonExceptionDetail[0]. Additional exception details, if provided, are named CommonExceptionDetail[1],..... CommonExceptionDetail[SIZE]. The specific exception associated with each of the bitmaps is given in the table below. The SIZE for this revision is two, (2). The criteria details for each exception condition are outside the scope of this document. If a device does not support an exception detail, the corresponding bit is never set.

Table 21: Common Exception Detail Attribute Values

Bit	Common Exception Detail [Byte 0]
0	Internal diagnostic exception
1	Microprocessor exception
2	EPROM exception
3	EEPROM exception**
4	RAM exception
5	Reserved by DeviceNet
6	Internal real-time exception
7	Reserved by DeviceNet

** Exception Supported

Bit	Common Exception Detail [Byte 1]
0	Power supply over current
1	Reserved power supply
2	Power supply output voltage **
3	Power supply input voltage
4	Scheduled maintenance due
5	Notify Manufacturer
6	Reset exception
7	Reserved by DeviceNet

** Exception Supported

1.14.10 Device Exception Detail

This structure, similar in form to Common Exception Detail, relates exception conditions, which are specific to individual devices on the network and are defined in their respective device profiles. The Detail element of the structure is an ordered list (example: array) of bytes of length [SIZE], which is the value of the structure element size. For a detailed description of this attribute, consult the appropriate specific device profile.

1.14.11 Manufacturer Exception Detail

This structure, similar in form to Common Exception Detail, relates exception conditions, which are specific to the manufacturers of individual devices on the network and are defined by them in their product documentation. The Detail element of the structure is an ordered list (i.e., array) of bytes of length [SIZE], which is the value of the structure element size. For a detailed description of this attribute, consult the appropriate specific device manufacturer documentation.

1.14.11.1 Exception Detail Format Summary

Table 22: Exception Detail Format

Data Component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
CM Device Exception Detail Size	0	0	0	0	0	0	0	1
CM Device Exception Detail	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Reserved 0	Under range Exceeded	Over range Exceeded	Reading Valid* S-Analog Sensor
Manufacturer Exception Detail Size	0	0	0	0	0	0	0	1
Manufacturer Exception Detail	0	0	0	0	0	0	0	Over Temp

* Only used in the Warning Exception Detail. This bit is always = 0 in the Alarm Exception Detail.

1.14.12 Alarm Enable and Warning Enable

These Boolean attributes are used to enable (1) or disable (0) the S-Device Supervisor object's process of setting Exception bits. When disabled, corresponding bits are never set; and, if they were set, disabling clears them. Also, alarm and warning states are not retained; when enabled, bits will be set only if the corresponding condition is true. The default-state for these Enable attributes is enabled (1).

Table 23: S-Device Supervisor Common Services

Service Code	Need in Implementation		Service Name	Description of Service
	Class	Instance		
(0x0E) 14	Conditional	Required	Get_Attribute_Single	Returns the contents of the specified attribute.
(0x10) 16	n/a	Required	Set_Attribute_Single	Modifies an attribute value.
5	n/a	Required	Reset	Resets the device to the Self-Testing state.
6	n/a	Required	Start	Starts the device execution by moving the device to the Executing state.
7	n/a	Optional (Supported)	Stop	Moves the device to the Idle state.

See the DeviceNet Communication Model and Protocol for definitions of these common services.

Table 24: S-Device Supervisor Object-Specific Services

	Need in Implementation		Service Name	Description of Service
	Class	Instance		
(0x4B) 75	n/a	Required	Abort	Moves the device to the Abort state.
(0x4C) 76	n/a	Required	Recover	Moves the device out of the Abort state.
(0x4E) 78	n/a	Required	Perform_Diagnostics	Causes the device to perform a set of diagnostic routines.

Abort — Used to transition the device application objects to the aborted state. This service request may be (and generally will be) originated internally, from application objects.
Recover — Used to transition the device application objects from the abort state to the idle state. This service request may be originated internally, from application objects.
Perform_Diagnostics — Used to instruct the S-Device Supervisor object to perform a diagnostic test. A diagnostic test is either of type *common* or *device-dependent*. *Common* diagnostic tests include RAM, EPROM, non-volatile memory, and communications. *Common* diagnostic tests are implementation-specific. All detail of *device-dependent* diagnostics is outside the scope of this document.

1.15 S-ANALOG SENSOR OBJECT (CLASS 0X31)

The S-Analog Sensor Object models the acquisition of a reading from a physical sensor in a device. Associated with an analog sensor is a reading that has been acquired and corrected with an offset and a gain coefficient, optionally, settable in the object. Additional correction algorithms may be specified by other objects identified in the device profile or as extensions specified by the manufacturer.

This object is a member of the *Hierarchy of Semiconductor Equipment Devices*. The S-Device Supervisor Object manages the behavior of the S-Analog Sensor Object.

S-Analog Sensor Class Attributes

The Object Class Attribute ID 1-7 are reserved. See DeviceNet Volume II, Section 5-4.1., for more specification detail on these attributes.

Table 25: S-Analog Sensor Class Attributes

	Need in Implementation	Access Rule	Name	DeviceNet Data Type	Description of Attribute
1	Optional	Get	Revision	UINT	Value is 0x0001 for this object.
2 thru 7	These class attributes are optional and are described in the specifications mentioned above.				
97 & 98	Reserved by DeviceNet				
99	Conditional* (Not Supported)	Get	Subclass	UINT	Identifies a subset of additional attributes, services and behavior.

*If the value of Subclass is 00, which identifies “no subclass”, then this attribute is OPTIONAL in implementation, otherwise, this attribute is REQUIRED.

1.15.1 S-Analog Sensor Instance Attributes

Certain minimal implementations may support any optional “Set” attributes as “Get Only” and still be compliant with this object specification. All required attributes must be supported as specified.

Table 26: S-Analog Sensor Instance Attributes

	Need in Implementation	Access Rule	NV*	Name	DeviceNet Data Type	Description of Attribute	Semantic of Values
3	Optional (Supported)	Set[1]/Get	NV	Data Type	USINT (byte)	Determines the Data Type of *Value* and all related attributes as specified in this table.	See Semantic section. [default] = INT (0xC3 INT and Real supported)
4	Optional (Supported)	Set[1]/Get	NV	Data Units	UINT	Determines the Units context of *Value* and all related attributes.	See Semantics section. [default] = Counts (0x1001).
5	Required	Get	V	Reading Valid	BOOL	Indicates that the *Value* attribute contains a valid value.	0 = invalid 1 = valid (invalid: example, not yet warmed up).
6	Required	Get	V	Value	INT or specified by *Data Type* if supported.	Analog input value.	The corrected, converted, calibrated final value of the sensor. Range is one of: 0-6000H (0-100%) 0-7FFFH (0-100%). See Semantics section.
7	Required	Get	V	Status	Byte	Alarm,/Warning State of this object instance.	See Semantics section.
8	Optional (Supported)	Set	V	Alarm Enable	BOOL	Enables the setting of the Alarm Status Bits.	0 = disable [default] 1 = enable
9	Optional (Supported)	Set	NV	Warning Enable	BOOL	Enables the setting of the Warning Status Bits.	0 = disable [default] 1 = enable
10	Optional (Supported)	Get	NV	Full Scale	INT or specified by *Data Type* if supported.	The *Value* of Full Scale for the sensor.	The value of attribute Value corresponding to the Full Scale calibrated measurement of the sensor. [default] = maximum allowable value for the *Data Type*. See Semantics section.
16	Optional (Not Supported)	Set	NV	Offset-B	INT or specified by *Data Type* if supported.	An amount added to derive *Value*.	0 = [default] See “Semantics” on page 12.
97 & 98	Reserved By DeviceNet.						

Table 26: (Continued)S-Analog Sensor Instance Attributes

	Need in Implementation	Access Rule	NV*	Name	DeviceNet Data Type	Description of Attribute	Semantic of Values
99	Conditional[3] (Supported)	Get	NV	Subclass	UINT	Identifies a subset of additional attributes, services, and behaviors. The subclasses for this object are specified at the end of this object specification section.	0= No Subclass n= subclass as defined herein

[1]Data Type and Data Units are ONLY settable under certain conditions (see semantics).

[2]Attribute is settable; however, it should only be set while in the Idle state (see semantics).

[3]If the value of Subclass is 00, then this attribute is Optional in implementation, otherwise, this attribute is REQUIRED.

1.15.2 Semantics

1.15.2.1 Data Type (Attribute ID # 3)

All Data Type attributes use the enumerated values specified in DeviceNet Specification, Vol. I, Appendix J-6.1.

The *Data Type* attribute is settable only in the *Idle State* and only if no attribute belonging to the object instance is the endpoint of an I/O Connection in the *Established State*.

The two *Data Type* attributes that are supported are defined as follows:

Table 27: Data Type Supported

Value (hex)	Data Type	Description
0xC3	INT	16-bit signed integer data types. Note that some related attribute values may also be defined as UINT.
0xCA	REAL	32-bit floating point value, as defined by IEEE-754 standard.

1.15.2.2 Data Units

Specifies the context of *Value* and related attributes (such as, offset and trip points) for this object instance. See Appendix K, Vol. 1 of the ODVA specifications for a list of values. A request to set attribute to an unsupported value will return an error response.

The *Data Units* attribute is settable only in the *Idle State*.

1.15.2.3 Value, Offset (A and B) and Gain

An S-Analog Sensor object instance derives a reading from a physical analog sensor. The reading is converted to the data type and units specified for the ***Value*** attribute. The ***Offset-A, Offset-B*** and ***Gain*** attributes are applied to the sensor reading as specified by the following formula:

Value = *Gain* • (Sensor Reading + O*ffset-A*) + *Offset-B*

Typically, the *Offset-A* or *Offset*-B attributes are modified by the Zero-Adjust service and the *Gain* attribute is modified by the Gain_Adjust services; particularly,

when the device utilizes a non-linear conversion algorithm. However, support of these services is not required.

See Behavior section.

1.15.2.4 Status

Status is a bit mapped byte, which indicates the Alarm and Warning Exception status of the object instance. The following definition applies:

Table 28: Status Bits

Bit	Definition
0	High Alarm Exception: 0 = cleared; 1 = set
1	Low Alarm Exception: 0 = cleared; 1 = set
2	High Warning Exception: 0 = cleared; 1 = set
3	Low Warning Exception: 0 = cleared; 1 = set
4	Reserved
5	Reserved
6	Reserved
7	Reserved

1.15.2.5 Trip Points, Hysteresis and Settling Time

Trip Point High is the level above which the *Value* attribute will cause an Alarm or Warning exception condition.

Trip Point Low is the level below which the *Value* attribute will cause an Alarm or Warning exception condition.

A Hysteresis value specifies the amount by which the *Value* attribute must transition in order to clear an Alarm or Warning condition. For example: A Trip Point High value of 100 and a hysteresis value of 2 will result in an exception condition being set when the *Value* is above 100 and cleared when the *Value* drops below 98. Similarly, A Trip Point Low value of 100 and a hysteresis value of 2 will result in an exception condition being set when the *Value* is below 100 and cleared when the *Value* increases above 102.

The Settling Time determines the amount of time that the *Value* attribute must exceed the Trip Point before the exception condition is generated. The Settling Time also applies to the clearing of the condition.

1.15.2.6 Safe State

This attribute specifies what value will be held in *Value* for states other than Executing. See the S-Device Supervisor object definition in Section 6 for a description of object states. The purpose of this mechanism is to allow other devices, that may be using this *Value*, to transition to, or remain in, a safe state in the event of this device transitions to a FAULT, IDLE, or ABORT state. The following values are defined:

Table 29: Safe State Attributes

Attribute Value	State
0	Zero
1	Full Scale
2	Hold Last Value
3	Use Safe Value

Table 29: (Continued)Safe State Attributes

Attribute Value	State
4-50	Reserved
51-99	Device Specific
100-255	Vendor Specific

1.15.2.7 Safe Value

For Safe State set to Use Safe Value, this attribute holds the value to which the *Value* attribute will be set for object instance states other than Executing.

1.15.2.8 S-Analog Sensor Common Services

The S-Analog Sensor Object provides the following Common Services:

Table 30: S-Analog Sensor Common Services

Service Code	Need in Implementation		Service name	Description of Service
	Class	Instance		
OEhex 14dec	Conditional*	Required	Get_Attributes_Single	Returns the contents of the specified attribute.
10hex 16dec	n/a	Required	Set_Attributes_Single	Modifies an attribute value.

*The Get_Attributes_Single Communication Model and Protocol for definitions of these common services.

See the DeviceNet Communication Model and Protocol for definitions of these common services.

1.15.3 S-Analog Sensor Object–Specific Services

Table 31: S-Analog Sensor Object-Specified Services

Service Code	Need in Implementation		Service name	Description of Service
	Class	Instance		
4Bhex 75dec	n/a*	Operational (Supported)	Zero_Adjust	Causes the device to modify attribute *Offset-A* and/or *Offset-B* such that attribute *Value* equals the Target Value sent with the request.
4Chex 76dec	n/a	Operational (Not Supported)	Gain_Adjust	Causes the device to modify attribute *Gain* such that attribute *Value* equals the Target Value sent with the request.

The Zero_Adjust and Gain_Adjust services are used to cause the S-Analog Sensor Object device to modify its *Offset-A* and/or *Offset-B* and *Gain* attribute values based upon manufacturer specific algorithms. The target value specified in the service request represents the actual parametric measurement that the physical sensor should be reporting at the time of the request.

1.15.4 Behavior

The S-Device Supervisor Object manages the behavior of the S-Analog Sensor Object. See section 6 of this document. An S-Analog Sensor object instance acquires a reading from a physical sensor, as identified by the application of the object, and applies an algorithm to modify the reading into the appropriate *Data*

Type and *Data Units*. Optionally, additional corrective algorithms are applied to further correct for various calibration effects. These additional algorithms are specified in other objects, as identified in the device profile, or as extensions, specified by the manufacturer.

All Full Scale, Trip Point, Over range and Under range calculations, as specified above, utilize the *Value* attribute.

1.15.5 Data Type

If the implementation of this object specifies more than one valid Data Type value, in the device profile or by vendor, then the following behavior with respect to *Data Type* applies: The Data Type value will be set automatically based upon the first valid I/O Connection established by the device. This configuration will then remain in effect for this object instance, even after all I/O Connections are lost. For devices that support only one Data Type, this behavior is not supported.

If no established I/O Connections exist, which include an attribute from this object, then the *Data Type* attribute is settable provided that the object is in the *Idle State*.

The following example demonstrates this behavior:

A device profile specifies an instance of the S-Analog Sensor object as well as two static Assembly object instances, both with data attribute components mapped to this object instance. Assembly object instance ID 2 specifies INT data types and Assembly object instance ID 5 specifies REAL data types.

After the device is On-Line, it is configured with an I/O Connection to Assembly instance ID 5. When the Connection transitions to the *Established State*, this object instance attribute *Data Type* is automatically set with the value for REAL before any data is communicated to, or from, the object instance.

1.15.6 CMX Implementation

Data Type values supported are Integer (0xC3) and Real (0xCA). Data Units supported are Counts (0x1001) and SCCM (0x1400). Both Data Type and Data Units attributes are settable. The supported combinations of Data Type and Data Units on CMX are Integer-Counts (default), Real-SCCM, Integer-SCCM, and Real-Counts. The full-scale range for indicated flow is determined by the full-scale attribute (31H, 1,10).

1.16 DEVICENET COMMUNICATION PROTOCOL EXAMPLE

The example shown below assumes the following:

Slave device (CMX) is at address 60, (0x3C).

Host (master) address is 2.

Each item line shows the master request message and the slave device response message. Note that the data shown will most likely be unique for every device on the network. In this typical scenario, the host would periodically poll the slave device (example: item lines 12 through 15), as long as necessary while the process is being monitored. Once the release Connection request is made (item 16), the host (master) must re-establish the explicit and polled I/O Connections to get new polled I/O data from the slave. Basically, this means starting over from item 1.

1.17 Command Summary

Table 32: DeviceNet Communications Protocol Example

Item	Master Identifier, Data		Slave Identifier, Data		Description
1	5E6	2 4b 3 1 1 2	5E3	2 cb 0	Allocate explicit Connection
2	5E4	2 10 5 1 9 0 0	5E3	2 90 0 0	Set explicit epr time to 0,(no time out). This step is optional.
3	5E4	2 e 5 1 8	5E3	2 8e 14 0	Get explicit max consumed connect size. This is the maximum amount of data the slave will receive.
4	5E4	42 e 1 1 1	5E3	42 8e 6e 0	Get vendor ID. Vendor ID for Brooks is 110 (0x6E).
5	5E4	2 e 1 1 2	5E3	2 8e 1c 0	Get device type (vacuum gauge = 28).
6	5E4	42 e 1 1 3	5E3	42 8e 3 0	Get product code. The ODVA assigned number for a capacitance diaphragm manometer is 3.
7	5E4	2 e 5 2 7	5E3	2 8e 5 0	Get produced I/O size. The default CMX assembly will transmit 5 bytes of data for poll responses; 1 status byte and 4 bytes real data.
8	5E4	2 e 5 2 8	5E3	2 8e 0 0	Get consumed I/O size. The CMX device consumes no data for polled I/O requests.
9	5E4	2 e 1 1 4	5E3	2 8e 1 a	Get software revision, major/minor. For this example, the revision is 1.10.
10	5E4	2 4b 3 1 2 2	5E3	2 cb 0	Allocate polled I/O Connection.
11	5E4	2 10 5 2 9 e 83	5E3	2 90 e8 3	Set polled I/O epr timeout to 1000 mSec.
12	5E5		3FC	80 0 0 0 0	Poll request w/no data and poll response.
13	5E5		3FC	80 0 0 0 0	Poll request w/no data and poll response.
14	5E5		3FC	80 0 0 0 0	Poll request w/no data and poll response.
15	5E5		3FC	80 0 0 0 0	Poll request w/no data and poll response.
16	5E4	2 4c 3 1 1	5E3	2 cc	Release explicit Connection.

The following table lists the valid Class/Object models, and all associated instances and attributes.

Table 33: Command Summary

Class / Object ID	Instance ID	Attribute ID	Description	Data Type	Access	Factor Default Value
0x01 Identity	00x00	0x01	Class Revision level.	UINT	R	0x0001
	0x01	0x01	Vendor ID	UINT	R	110,(0x6E)
		0x02	Device Type	UINT	R	28, (0x1C)
		0x03	Product code	UINT	R	3
		0x04	Software revision	Struct of: USINT USINT	R	[current rev]
		0x05	Status	WORD	R	0
		0x06	Serial Number	UDINT	R	[set during factory test]
		0x07	Product name	Short String	R	“CM”
0x02 Message Router		0x01	No services are supported for the Message Router object		R	

Table 33: (Continued)Command Summary

Class / Object ID	Instance ID	Attribute ID	Description	Data Type	Access	Factor Default Value
0x03 DeviceNet	0x00	0x01	Class revision level	UINT	R	0x0002
	0x01	0x01	Node Address	USINT	R/W	63
		0x02	(Baud) Data Rate	USINT	R/W	2 = 500 Kb
		0x03	Bus-off interrupt	BOOL	R	0
		0x05	Allocation Information	Struct of: USINT USINT	R	0, 255
0x04 Assembly	0x00	0x01	Class revision level	UINT	R	0x0002
	0x02	0x03	Poll response, pressure data, integer value	Struct of: USINT USINT	R	
	0x05	0x03	Poll response, pressure data, real (float) value	Struct of: USINT USINT	R	
0x05 Connection	0x00	0x01	Class revision level	UINT		0x0001
	0x01	Refer to Explicit Connection Object, section 10, Table 14				
	0x02	Refer to Polled I/O Connection Object, section 10, Table 15				
0x30 S-Device Supervisor	0X00	0x01	class revision level	UINT	R	0x0001
	0X01	0x03	Device Type	Short String	R	“VG
		0x04	SEMI Standard revision level	Short String	R	“E54-0997”
		0x05	Manufacturer’s Name	Short String	R	“Brooks”
		0x06	Manufacturer’s Model Number	Short String	R	“XCG”
		0x07	Software Revision Level	Short String	R	Current rev level, example, “1.002”
		0x08	Hardware Revision Level	Short String	R	Current rev level, example, “A”
		0x09	Manufacturer’s serial Number	Short String	R	ASCII version of serial number
		0x0A	Device Configuration	Short String	R	[device specific]
		0x0B	Device Status	USINT	R	
		0x0C	Exception Status	Byte	R	
		0x0D	Exception Detail Alarm	STRUCT	R	
		0x0E	Exception Detail Warning	BOOL	R	
		0x0F	Alarm Disable	BOOL	R	0 (disabled)
		0x10	Warning Enable	DATE	R	0 (disabled
		0x13	Last Maintenance Date	DATE	R	YYYYMMDD
		0x14	Next Maintenance Date	UINT	R	YYYYMMDD
		0x17	Run Hours	DATE	R	
		0x64	Factory Calibration Date		R	YYYYMMDD

Table 33: (Continued)Command Summary

Class / Object ID	Instance ID	Attribute ID	Description	Data Type	Access	Factor Default Value
0x31 S-Analog Sensor	0x00	0x01	Class Revision Level	UINT	R	0x001
	0X01	0x03	Data Type	USINT	R/W	0xC3 (INT)
		0x04	Data Units	ENG-UNITS	R/W	0x1001 (counts)
		0x05	Reading Value	BOOL	R	
		0x06	Value (pressure)	INT or REAL	R	
		0x07	Status	Byte	R	

1.18 Abbreviations, Acronyms Definitions and Terminology

Table 34: DeviceNet Profile Glossary

Term	Description
Attribute.	Elementary data type as defined by the ODVA DeviceNet Specification.
ARRAY	A listing or grouping of elements of the same data type
BOOL	Boolean value, which is assigned either 0 or 1.
CAN	Controller Area Network: specification of the physical layer, signaling and media access control used by DeviceNet.
BYTE	8-bit string, which can be used as a bit-mapped variable.
CID	Connection IDentifier; (the 11 DeviceNet Identifier bits).
DCM	Digital Capacitance Manometer
DeviceNet	Protocol using CAN technology, using a Connection-based model to provide a low-level network between industrial devices, controllers, sensors, actuators, etc.
DSP	Digital Signal Processor
EEPROM	Electrically Erasable Programmable Read Only Memory
INT	Signed 16-bit integer value between –32,768 and 32,767.
mSec	millisecond, 0.001 second
ODVA	Open DeviceNet Vendor Association, the organization that manages DeviceNet protocol and interface guidelines.
PSIA	Pounds per Square Inch Absolute
RAM	Random Access Memory
REAL	32-bit floating point value, per the IEEE 754 basic single floating point format.
Short-String	ASCII character string with 1 byte per character – a 1 byte character length precedes the string.
SINT	Short INT, signed 8-bit value.
TI	Texas Instruments.
UDINT	Unsigned (double) 32-bit integer value
UINT	Unsigned 16-bit integer value ranging from 0 through 65,535.
ULINT	Unsigned (long) 64-bit integer value.
USINT	Unsigned (short) 8-bit integer value ranging from 0 through 255.
WORD	16-bit string, usually used as a bit-mapped variable.

1.19 REFERENCES

1. S-Device Supervisor Object, Open DeviceNet Vendors Association (ODVA) DeviceNet Specification Enhancement 93-01, Version J., February 27, 1999.
2. S-Analog Sensor Object, Open DeviceNet Vendors Association (ODVA) DeviceNet Specification Enhancement 93-01, Version J., February 27, 1999.
3. Open DeviceNet Vendors Association (ODVA) DeviceNet Specification, Volume 1 and 2, Version 2.0, December 2, 1998.

GLOSSARY

ADC	Analog to Digital Converter.
CAN	Controller Area Network: specification of the physical layer, signaling and media access control used by DeviceNet Identifier bits).
CID	Connection Identifier (the 11 DeviceNet Identifier bits).
CM	Capacitance Manometer
DeviceNet	Protocol using CAN technology, using a Connection-based model to provide a low-level network between industrial devices, controller, sensor, actuators, and etc.
DSP	Digital Signal Processor.
ER	Extended Range.
EEPROM	Electrically Erasable Programmable Read Only Memory.
Hz	(Hertz) cycles per second- unit of measure for frequency.
kPa	Thousand (1,000) Pascals.
LED	Light Emitting Diode.
MDP	Message Decoder Processor, (Celerity' RS-485 communication protocol).
MPa	Million (1,000,000) Pascals.
mSec	Millisecond (.001 second).
ODVA	Open DeviceNet Vendor Association, the organization that manages DeviceNet protocol and interface guidelines.
PC	Personal Computer.
PCB	Printed Circuit Board.
PDA	Short for *personal digital assistant,* a handheld device that combines computing, telephone/fax, Internet and networking features.
PSIA	Pounds per Square Inch Absolute.
RAM	Random Access Memory.
RS-232C	A long-established standard, defined by an industry trade group, the Electronic Industries Association (EIA) - "C" is the current version - that describes the physical interface and protocol for relatively low-speed serial data communication between computers and related devices. It was, originally for teletypewriter devices.

RS-485	An Electronic Industries Association (EIA) standard, RS 485 is used for multipoint communications: more devices may be connected to a single signal cable - similar to e.g. ETHERNET networks, which use coaxial cable. Most RS 485 systems use Master/Slave architecture, where each slave unit has its unique address and responds only to packets addressed to this unit. These packets are generated by Master (e.g. PC), which periodically polls all connected slave units.
TCFO	Temperature Coefficient Full Scale OffSet.
TCZO	Temperature Coefficient Zero OffSet.
RTU	Ready to Use.
UDINT	Unsigned (double) 32 bit integer value.
UINT	Unsigned 16 bit integer value ranging from 0 through 65,535.
ULINT	Unsigned (long) 64 bit integer value.
USINT	Unsigned (short) 8 bit integer value ranging from 0 through 255.
WORD	16 bit string, usually used as a bit-mapped variable.

PRESSURE UNIT CONVERSIONS

FIND GIVEN	Pa	bar	mbar	at	atm	Torr	psi
1 Pa = 1 N/m^2	1	1×10^{-5}	1×10^{-2}	1.0197×10^{-5}	9.8692×10^{-6}	750.06×10^{-5}	1.4504×10^{-4}
1 bar = 0.1 MPa	1×10^{-5}	1 (=1000 mbar)	1×10^{3}	1.0197	0.98692	750.06	14.5032
1 mbar = 1×10^{2} Pa	1×10^{2}	1×10^{-3}	1	1.0197×10^{-3}	0.98692×10^{-3}	0.75006	14.5032×10^{-3}
1 at = 1 kg/cm^2	98066.5	$\approx$ 0.981	980.68	1	0.96784	735.56	14.2247
1 atm = 760 Torr	101325	1.013	1013.25	1.03323	1	760	14.6972
1 Torr $\equiv$ 1 mm Hg	133.322	$\approx$ 0.00133	1.333	0.00136	1.3158×10^{-3}	1	1.01934
1 psi	6894.8	0.06895	68.95	0.0703	0.06804	51.715	1

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