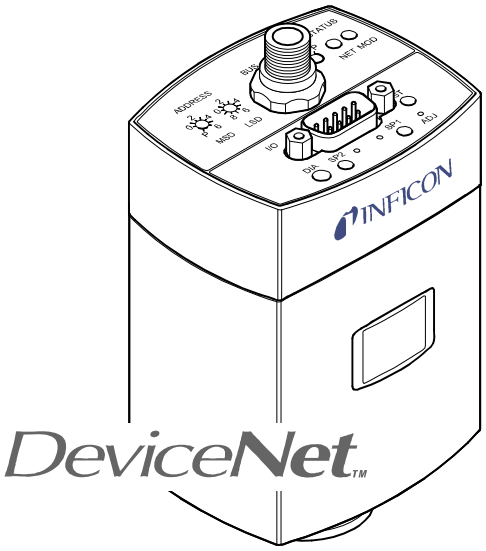
DeviceNet™

for Pirani Capacitance Diaphragm and Pirani Standard Gauges

PCG550, PCG552, PCG554
PSG550, PSG552, PSG554



General Information

Caution

Caution: data transmission errors

Any attempt to simultaneously operate the gauge via the RS232C Serial Interface and a Fieldbus interface (DeviceNet or Profibus) or the diagnostic port may result in incorrect data and data transmission errors.

Therefore, it is inadmissible to simultaneously operate the gauge via the RS232C Serial Interface and DeviceNet, Profibus, or the diagnostic port.

Intended Use

This Communication Protocol contains instructions for operating DeviceNet interfaces (slaves) together with a master.

This manual describes the functionality of DeviceNet for programming purposes. For more information → 🕮 "DeviceNet Specifications" of the Open DeviceNet Vendor Association (ODVA).

For safety information, specifications and operation instructions of the vacuum gauges refer to the appropriate documents (→ 🕮 [1], [2]).

DeviceNet–Interface

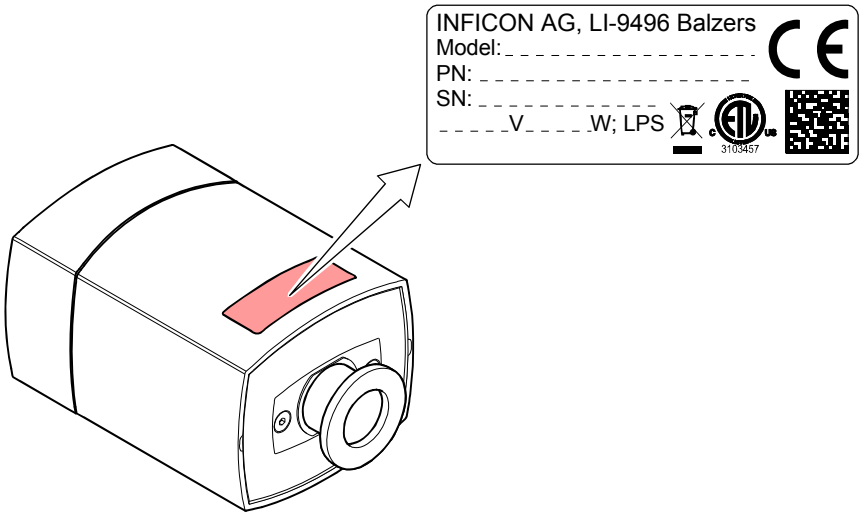
The following description of the DeviceNet interface is compliant to the DeviceNet specification of the Open DeviceNet Vendor Association and to the 🕮 "Interface Guidelines for DeviceNet Devices On Semiconductor Manufacturing Tools".

This manual describes the functionality of a DeviceNet group 2 only slave and supports explicit messaging and the I/O connections change of state/cyclic and polling.

We reserve the right to make technical changes without prior notice.

Product Identification

In all communications with INFICON, please specify the information on the product nameplate. For convenient reference copy that information into the space provided below.

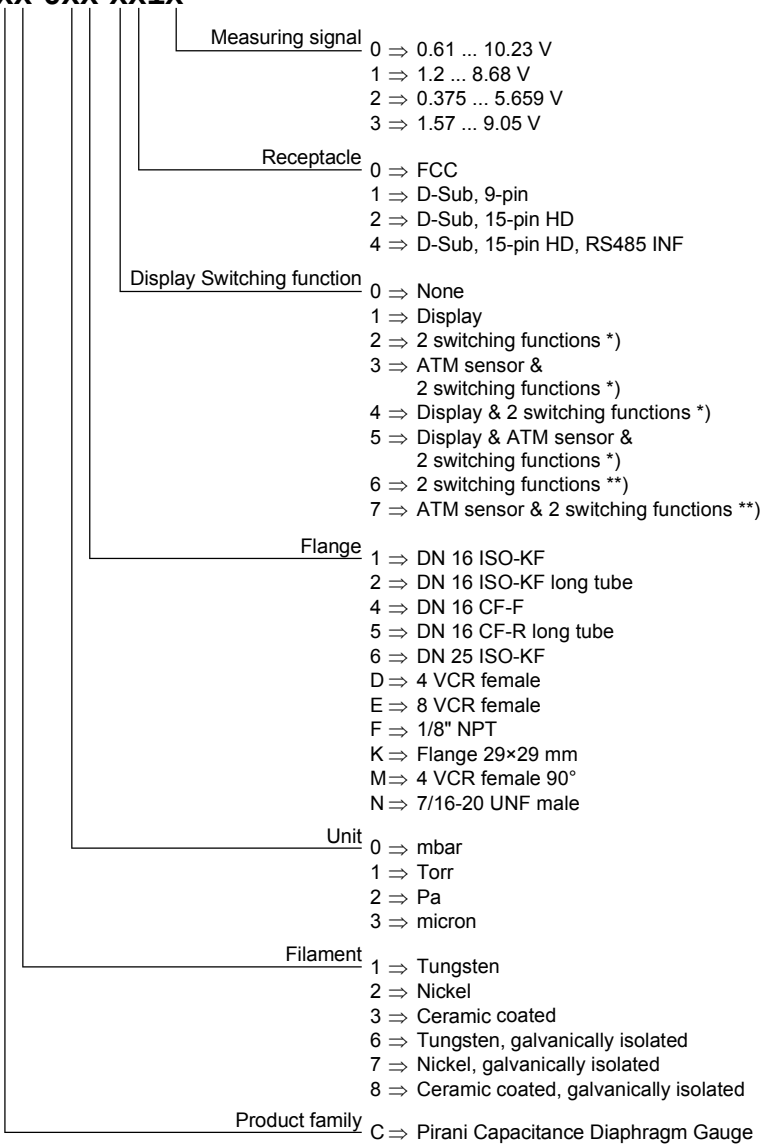


Validity

This document applies to products of the Pirani Capacitance Diaphragm (PCG550, PCG552, PCG554) and Pirani Standard Gauges (PSG550, PSG552, PSG554) with DeviceNet interface.

Part numbers of standard products are indicated below. OEM products have other part numbers and different parameter settings (e.g. factory setting of setpoint) as defined in the corresponding ordering information.

3Pxx-0xx-xx1x



*) Solid state relay
**) Electromechanical relay

The part number (PN) can be taken from the product nameplate.

If not indicated otherwise in the legends, the illustrations in this document correspond to PCG550 gauges with the DN 16 ISO-KF vacuum connection. They apply to other vacuum connections and to the other gauges by analogy.

We reserve the right to make technical changes without prior notice.

Trademark

DeviceNet™ Open DeviceNet Vendor Association Inc.

Contents

For cross-references within this document, the symbol (→ 🗎 XY) is used, for cross-references to further documents, listed under "Further Information", the symbol (→ 🕮 [Z]).

1 Technical Data

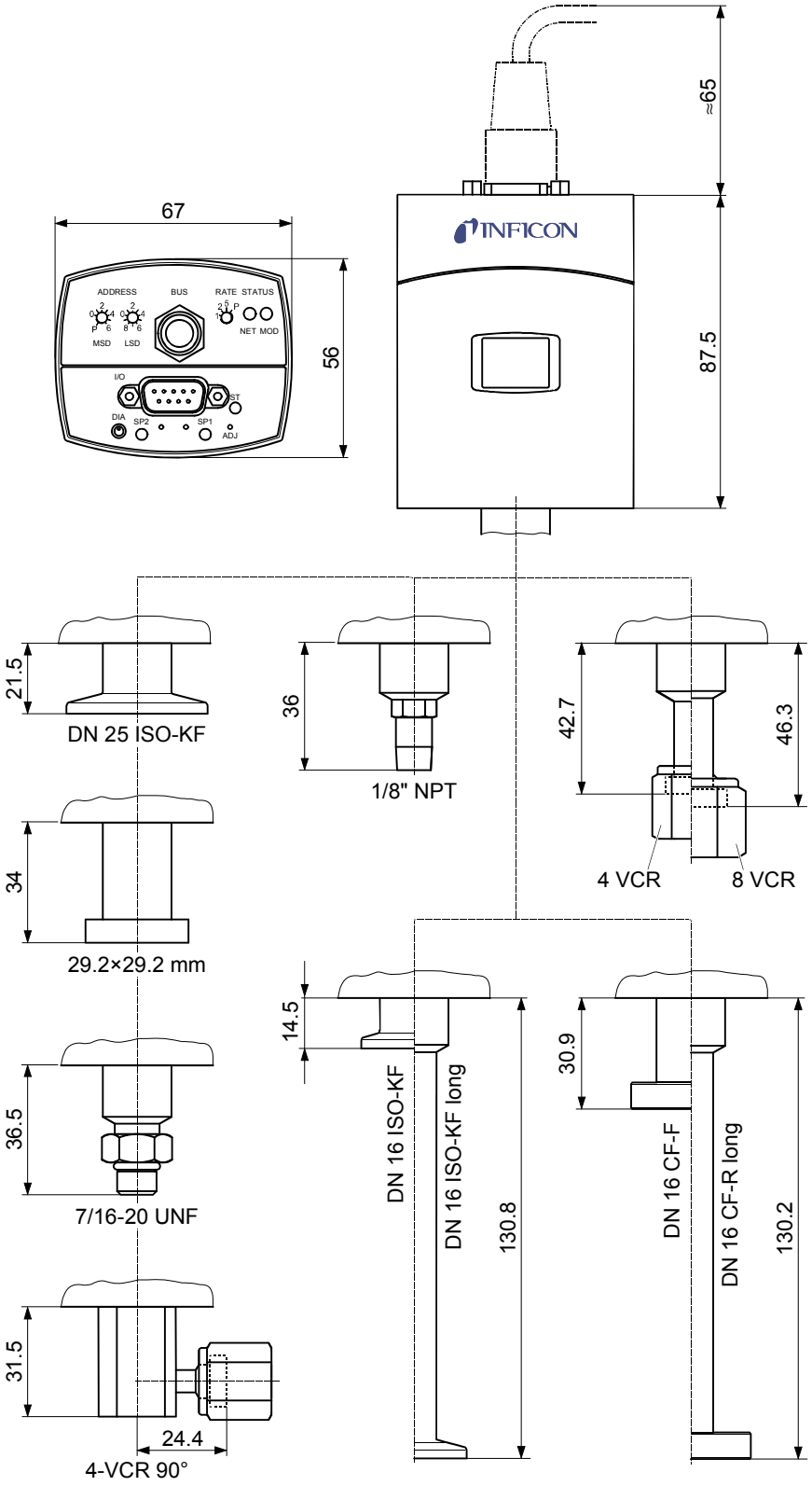
Further technical data → 🕮 [1], [2].

The voltage for the gauge equipped with the DeviceNet interface is supplied via the DeviceNet cable.

DeviceNet interface

Fieldbus name	DeviceNet
Standard applied	→ 🕮 [4]
Communication protocol, data format	→ 🕮 [4]
Interface, physical	CAN bus
Data rate (adjustable via "RATE" switch)	125 kBaud 250 kBaud 500 kBaud (default) "P" (125 kBaud, 250 kBaud, 500 kBaud programmable via DeviceNet
Node address (MAC ID) (Adjustable via "ADDRESS", "MSD", "LSD" switches)	0 … 63_{dec} (default = 63_{dec}) "P" (0 … 63 programmable via DeviceNet)
DeviceNet connector	Micro-Style, 5-pin, male
Cable	Shielded, special DeviceNet cable, 5 conductors (→ 🗎 7 and 🕮 [3])
Cable length, system wiring	according to DeviceNet specifications (→ 🕮 [3], [4])

Dimensions [mm]



2 Interface Connection

Making a DeviceNet interface cable

For operating the PCG5xx / PSG5xx gauge via DeviceNet, an interface cable conforming to the DeviceNet standard is required.

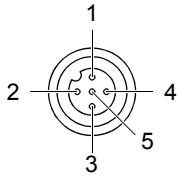
If no such cable is available, make one according to the following indications.

Cable type

A shielded special 5 conductor cable conforming to the DeviceNet standard has to be used (→ 🕮 [3] and [4]).

Procedure

❶ Make the DeviceNet interface cable according to the following indications:

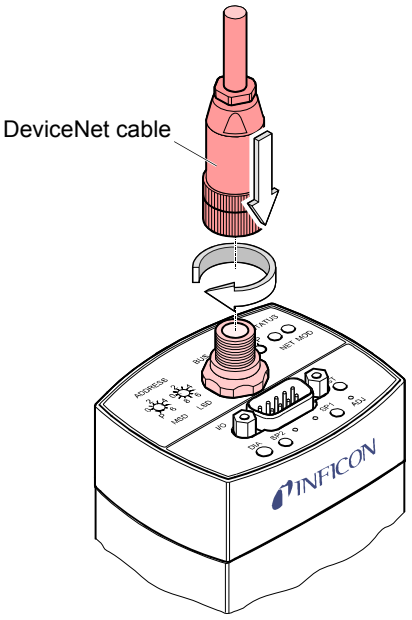


Micro-Style, 5-pin,
(DeviceNet)
female, soldering side

Pin 1	Drain	
Pin 2	Supply	+15 … +30 VDC
Pin 3	Supply common	GND
Pin 4	CAN_H	
Pin 5	CAN_L	

Pin assignment of the FCC, D-Sub and Hirschmann sensor connector according to the respective operating manual (→ 🕮 [1], [2].

❷ Plug the DeviceNet (and sensor) cable connector into the gauge.



❸ Lock the DeviceNet (and sensor) cable connector.

3 Operation

3.1 Introduction

Via the DeviceNet interface, the following and further data are exchanged in the standardized DeviceNet protocol:

- Pressure reading
- Pressure unit (Torr, mbar, Pa)
- Zero adjustment
- Status and error messages
- Status of the switching functions

Caution

Caution: data transmission errors

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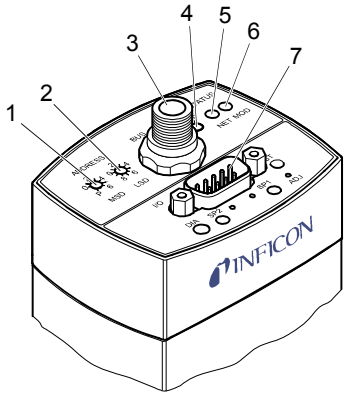
Therefore, it is inadmissible to simultaneously operate the gauge via the RS232C Serial Interface and DeviceNet, Profibus, or the diagnostic port.

3.2 Front View



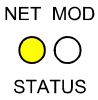
Position	Function
1	Address Switch × 10, decimal
2	Address Switch × 1, decimal
3	DeviceNet connector
4	Data Rate Switch
5	Network Status LED
6	Module Status LED
7	"Sensor cable" connector (Power, analog I/O, RS232C I/O and Relay contacts)

3.3 Indicators and Switches

3.3.1 Module Status LED

Device State	LED State	Description
Power Off	Off	No power applied to device
Device Self-Test	Flashing green/red	Device is in self-test
Device Operational	Green	Device is operating normally.
Unrecoverable Fault	Red	Device has detected an unrecoverable fault
Recoverable Fault	Flashing red	Device has detected a recoverable fault, e.g. missing DeviceNet power supply

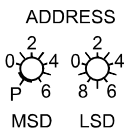
3.3.2 Network Status LED



The network status LED indicates the status of the DeviceNet communication link.

State	LED state	To indicate
Not Powered/not online	Off	Device is not online. • The device has not completed the Duplicate MAC_ID test yet. • The device may not be powered, look at Module Status LED.
Device Self-Test	Flashing green/red	Device is in self-test
Online, not connected	Flashing green	Device is online but has no connections in the established state. • The device has passed the Dup_MAC_ID test, is online, but has no established connections to other nodes. • The device is not allocated to a master.
Link OK online, connected	Green	The device is online and has connections in the established state. • The device is allocated to a master.
Connection time out	Flashing red	One or more I/O Connections are in the timed out state.
Critical link failure	Red	Failed communication device. The device has detected an error that has rendered it incapable of communicating on the network (Duplicate MAC ID, or Bus–off).

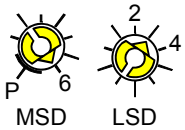
3.3.3 Node Address Switch



During device initialization, the node address switches are read by the device firmware. If the switches specify a valid DeviceNet MAC ID, i.e. a value from 0 … 63, this value is used as the device MAC ID. If the specified MAC ID differs from the value stored in the device's non-volatile RAM (NVRAM), the new MAC ID will be saved in NVRAM. If the switches specify an invalid DeviceNet MAC ID, i.e. a value greater than 63, the current value stored in the device's NVRAM is used as the device MAC ID.

In position <P> of the MSD-switch the MAC ID can be selected via DeviceNet (class 3, instance 1, attribute 1).

Example: Value of the DeviceNet MAC ID = 63:



3.3.4 Data Rate Switch

A single, rotary switch is provided for configuring the data rate of the device. The switch has three valid positions for the DeviceNet data rates, 125, 250, and 500 kBaud, where:

1 ≙ 125 kBaud
2 ≙ 250 kBaud
5 ≙ 500 kBaud

Example: Data rate = 250 kBaud:

All remaining switch positions specify software selection of the data rate.

3.4 Abbreviations

Abbr.	Meaning	
NV	Nonvolatile; attribute value is maintained through power cycles	
V	Volatile	
USINT	Unsigned short integer value	(Range 0 … 255)
INT	Integer value	(Range –32767 … 32768)
UINT	Unsigned integer value	(Range 0 … 65635)
UDINT	Unsigned double integer value	(Range 0 … 4'294'967'295)
FLOAT	Floating point value	(Range according to IEEE 754)
XX_h	Hexadecimal number	(Radix = 16)
XX_d	Decimal number	(Radix = 10)
XX_b	Binary number	(Radix = 2)

3.5 EDS File

The EDS (Electronic Data Sheet) file can be used for the automatic setup of the gauge with a configuration tool. It can be downloaded from our website (→ 🕮 [5]). The package contains two directories: INT and REAL.

- INT directory: It contains the presetting for the parameters in- and output in the **integer format**. The I/O default assembly object is two.
- REAL directory: It contains the presetting for the parameters in- and output in the **real format**. The I/O default assembly object is five.

4 Object Structure

4.1 Connection Object

Class Code $05_h = 05_d$

The connection class allocates and manages the internal resources associated with both I/O and explicit messaging connections. The specific instance generated by the connection class is referred to as a connection instance or a connection object.

The following Instances of the connection object are supported:

- Instance 1: Explicit messaging
- Instance 2: I/O polling
- Instance 4: I/O change of state/cyclic I/O connection

Please refer to the DeviceNet specification for further information.

4.1.1 Vendor-Specific Object Extension on Instance 2 Poll Connection

For the selection of the active input assembly the following vendor specific attribute can be used.

Vendor specific extension:

Attribute ID	Access rule	NV/ V	Name	DeviceNet Data type	Description of attribute	Semantics
100	Get/Set	NV	Poll produce assembly instance	USINT	Contains the instance number of the assembly used by this connection to send data	1, 2 (default), 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14

This vendor-specific attribute facilitates the configuration of the data assembly, the PCG/PSG55x will send to the DeviceNet master as poll response. It offers the possibility to select a (predefined) data assembly via a configuration tool + EDS file (→ 🖹 10). Attribute 100 allows the user to configure the poll IO data assembly via EDS even if the poll connection of the PCG/PSG55x is in the established state. The assembly number is stored non volatile. Modifications of the poll produce assembly instance will take effect **only** after a reset of the PCG/PSG55x.

Thus, definition of the PCG/PSG55x data assembly can be done in various ways:

1) Standard method (without using attribute 100):
   The DeviceNet master configures the "Produced Connection Path" attribute of the poll connection (connection instance 2) when establishing communication to the PCG/PSG55x. This requires a master to support expanded explicit messaging capabilities.
2) Directly setting attribute 100 e.g. by a configuration tool (e.g. RS networks) + device reset.

4.2 Identity Object

Class Code $01_h = 01_d$

4.2.1 Class Attributes

This object provides identification of and general information about the device.

Attribute ID	Access rule	Name	DeviceNet data type	Description of attribute	Semantics of values
1	Get	Revision	UINT	Revision of this object.	The current value assigned to this attribute is one (01). If updates that require an increase in this value are made, then the value of this attribute increases by one.
2	Get	Max instance	UINT	Maximum instance number of an object currently created in this class level of the device.	The largest Instance number of a created object at this class hierarchy level.

4.2.2 Instance Attributes

Attribute ID	Access rule	NV/V	Name	DeviceNet data type	Description of attribute
1	Get	NV	Vendor ID	UINT	Manufacturer identification Value: 633 (INFICON AG) (default)
2	Get	NV	Device type	UINT	$1C_h$ = Vacuum pressure gauge
3	Get	NV	Product code	UINT	→ "Semantics" section below
4	Get	NV	Revision	STRUCT	Major Revision 1; Minor Revision 1
5	Get	NV	Status	WORD	
6	Get	NV	Serial number	UDINT	
7	Get	NV	Product name	SHORT STRING	→ "Semantics" section below
100	Get	NV	Software Revision Level	SHORT STRING	Revision of the DeviceNet board software (major number) (minor number) (development number) e.g. 01 02 00

4.2.3 Semantics

Relationship between product code and product name.

Product code	Sensor type	Product name
19	CDG, Pirani	PCG550, PCG552, PCG554
20	CDG, Pirani, ATM	PCG550, PCG552, PCG554
21	Pirani	PSG550, PSG552, PSG554

4.2.4 Services

Service Code	Name	Description
5 (05_h)	Reset	0 = last installation, 1 = default installation (factory reset)
14 ($0E_h$)	Get_Attribute_Single	

4.3 S-Device Supervisor Object

Class Code $30_h = 48_d$

4.3.1 Class Attributes

Attribute ID	Access rule	Name	DeviceNet data type	Description of attribute	Semantics of values
1	Get	Revision	UINT	Revision of this object	The current value assigned to this attribute is one (01). If updates that require an increase in this value are made, then the value of this attribute increases by one.
2	Get	Max instance	UINT	Maximum instance number of an object currently created in this class level of the device.	The largest Instance number of a created object at this class hierarchy level.

4.3.2 Instance Attributes

Attribute ID	Access rule	NV/ V	Name	DeviceNet data type	Description of attribute
3	Get	NV	Devicetype	SHORT STRING	ASCII Text, "VG" (vacuum gauge) for PSG55x; “CG” for PCG55x
4	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 example "E54-0997").
5	Get	NV	Manufacturer’s name	SHORT STRING	"INFICON AG" (default)
6	Get	NV	Manufacturer’s model number	SHORT STRING	ASCII text, manufacturer specified
7	Get	NV	Software revision level	SHORT STRING	ASCII text, Revision of the DeviceNet board software, for example "010200"
8	Get	NV	Hardware revision level	SHORT STRING	ASCII text, for example "1.000"
9	Get	NV	Manufacturer’s serial number	SHORT STRING	ASCII text
10	Get	NV	Device configuration	SHORT STRING	→ "Semantics" section below.
11	Get	V	Device status	USINT	→ "Semantics" section below.
12	Get	V	Exception status	BYTE	→ "Semantics" section below.
13	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 2	USINT	Number of common detail bytes
			Detail 0	ARRAY of:	→ "Semantics" section below.
			Detail 1	BYTE	→ "Semantics" section below.
			Device exception detail	STRUCT of:	
			Size	USINT	Number of device detail bytes → "Semantics" section below.
			Detail 0		→ "Semantics" section below.
			Detail 1		→ "Semantics" section below.
			Detail 2		→ "Semantics" section below.
			Detail 3		→ "Semantics" section below.
			Manufacturer exception detail	STRUCT of:	
			Size 1	USINT	Number of manufacturer detail bytes
			Detail 0	ARRAY of:	Manufacturer Specified

Attribute ID	Access rule	NV/ V	Name	DeviceNet data type	Description of attribute
14	Get	V	**Exception detail warning**	STRUCT of:	A structure of three structures containing a bit mapped representation of the warning detail
			Common exception detail	STRUCT of:	
			Size 2	USINT	Number of common detail bytes
			Detail 0	ARRAY of:	→ "Semantics" section below.
			Detail 1	BYTE	→ "Semantics" section below.
			Device exception detail	STRUCT of:	
			Size	USINT	Number of device detail bytes → "Semantics" section below.
			Detail 0	BYTE	→ "Semantics" section below.
			Detail 1	BYTE	→ "Semantics" section below.
			Detail 2	BYTE	→ "Semantics" section below.
			Detail 3	BYTE	→ "Semantics" section below.
			Detail 4	BYTE	→ "Semantics" section below.
			Manufacturer exception detail	STRUCT of:	
			Size 1	USINT	Number of manufacturer detail bytes = 1
			Detail 0	ARRAY of:	Manufacturer specified
15	Set	NV	Alarm enable	BOOL	→ "Semantics" section below.
16	Set	NV	Warning enable	BOOL	→ "Semantics" section below.
101	Get	NV	Software revision base unit	SHORT STRING	ASCII text, for example "010100"
102	Get	V	Run hours	UINT	1 = 1 hour

4.3.3 Semantics

Device configuration (ID 10)

The device configuration string is composed (separated by blanks) depending on the bits set in the DeviceConfig:

Description	Bit		Abbr.
Setpoints	4	0 / 1 = without / with setpoints	SP
Potential separation	5	0 / 1 = without / with potential separation	PS
Tungsten filament	6	0 = tungsten	WO
Nickel filament		1 = nickel	NI
Atmosphere sensor	7	0 / 1 = without / with atmosphere sensor	ATM
Display	8	0 / 1 = without / with display	DIS
DeviceNet	9	0 / 1 = without / with DeviceNet	DN
Profibus	10	0 / 1 = without / with Profibus	PB
Capacitance Diaphragm sensor	15	0 / 1 = without / with CDG	CDG
Analog out	16	0: U = 6.143 +1.286 × log10(p) [0 … 10 V]	AO0
Analog out	17	1: U = 5.5 + log10(p) [1 … 9 V]	AO1
Analog out	18	3: U = 5.875 + log10(p) [1.57 … 9.05 V]	AO3
Heat Transfer (Pirani) vacuum sensor	20	0 / 1 = without / with Pirani	PIR

Example for the return value of Device Configuration:

"P WO ATM DIS DN CDG AO0 PIR"

Device status (ID 11)

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

Attribute value	State
0	Undefined
1	Self testing
2	Idle
3	Self-test exception
4	Executing
5	Abort
6	Critical fault

In case of a self-test exception restart the device with a reset out of the box (identity object class 1, instance 1, service 5, service target value: 1).

Exception status (ID 12)

A single byte attribute whose value indicates the status of the alarms and warnings for the device. The device supports the expanded mode.

For the *expanded mode*, 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.

Exception status bitmap

Bit	Function
0	ALARM / device-common [1)]
1	ALARM / device-specific
2	ALARM / manufacturer-specific
3	reserved, set to 0
4	WARNING / device-common [1)]
5	WARNING / device-specific
6	WARNING / manufacturer-specific
7	1 ≙ Expanded Method

[1)] The alarm or warning is not specific to the device type or device type manufacturer.

Exception detail alarm and exception detail warning (ID 13, ID 14)

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

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 and device-specific detail are defined below. A manufacturer-specific detail has a length of 1 byte. A SIZE value of one indicates that one byte 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 representing 8 independent conditions, whereas 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 Expanded method reporting) and the bit (among bits zero through six) of the Exception Status attribute corresponding to the particular exception type is also set to 1.

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 which are 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).

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 the following. The detail element of the structure is an ordered list (i.e. array) of bytes of length [size = 2] which is the value of the structure element size.

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. There is one byte manufacturer exception details defined. The Detail element of the structure is an ordered list (i.e. array) of bytes of length [size = 1] which is the value of the structure element size.

Exception detail alarm (ID 15)

Data component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Common exception detail alarm size	0	0	0	0	0	0	1	0
Common exception detail alarm 0	0	0	0	Data memory	Nonvolatile memory	Code memory	0	0
Common exception detail alarm 1	0	0	0	0	0	0	0	0
Device exception detail alarm size	For PCG55x: 4 For PSG55x: 2							
Device exception detail alarm 0	S-Analog sensor instance 1, sensor alarm byte 0 (PCG55x: sensor instance 1 is a capacitance manometer) (PSG55x: sensor instance 1 is a heat transfer vacuum gauge)							
Device exception detail alarm 1	S-Analog sensor instance 1, sensor alarm byte 1 (PCG55x: sensor instance 1 is a capacitance manometer PSG55x: sensor instance 1 is a heat transfer vacuum gauge)							
Device exception detail alarm 2	PCG55x: S-Analog sensor instance 2, sensor alarm byte 0 PSG55x: not supported							
Device exception detail alarm 3	PCG55x: S-Analog sensor instance 2, sensor alarm byte 1 PSG55x: not supported							
Manufacturer exception detail alarm size	0	0	0	0	0	0	0	1
Manufacturer exception detail alarm 0	0	0	0	0	0	0	0	SerCom Alarm

Exception detail warning
(ID 16)

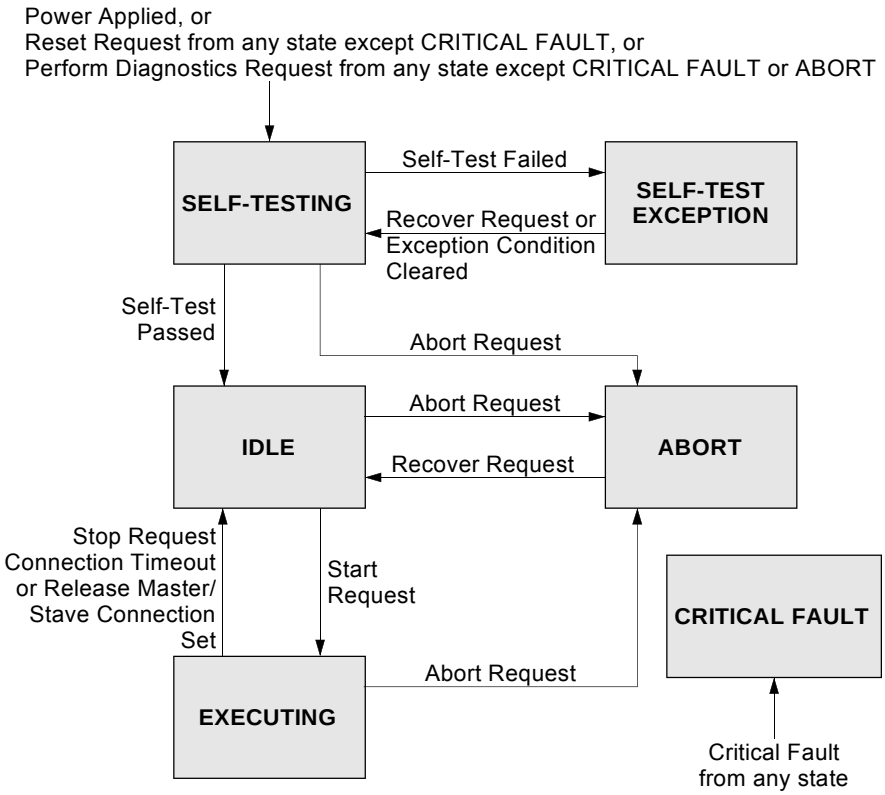
Data component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Common exception detail warning size	0	0	0	0	0	0	1	0
Common exception detail warning 0	0	0	0	Data memory	Nonvolatile memory	Code memory	0	0
Common exception detail warning 1	0	0	0	0	0	0	0	0
Device exception detail warning size	For PCG55x: 5 For PSG55x: 3							
Device exception detail warning 0	S-Analog sensor instance 1, Class level status extension							
Device exception detail warning 1	S-Analog sensor instance 1, sensor warning byte 0 (PCG55x: sensor instance 1 is a capacitance manometer PSG55x: sensor instance 1 is a heat transfer vacuum gauge)							
Device exception detail warning 2	S-Analog sensor instance 1, sensor warning byte 1 (PCG55x: sensor instance 1 is a capacitance manometer PSG55x: sensor instance 1 is a heat transfer vacuum gauge)							
Device exception detail warning 3	S-Analog sensor instance 2, sensor warning byte 0 PSG55x: not supported							
Device exception detail warning 4	S-Analog sensor instance 2, sensor warning byte 1 PSG55x: not supported							
Manufacturer exception detail warning size	0	0	0	0	0	0	0	1
Manufacturer exception detail warning 0	0	0	0	0	0	0	0	SerCom Warning

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).

4.3.4 S-Device Supervisor Object States



Abort - Used to transition the device application objects to the aborted state. This service request may be (and generally will) originated internally, from application objects.

Recover - Used to transition the device application objects, out of the abort state, to the idle state. This service request may be originated internally, from application objects.

Perform_Diagnostics - Used to instruct the DS object to perform a diagnostic test.

4.3.5 S-Device Supervisor Common Services

Service Code	Service Name	Description of Service
$0E_h$	Get_Attributes_Single	Returns the contents of the specified attribute.
10_h	Set_Attributes_Single	Modifies an attribute value.
05_h	Reset	Resets the device to the **Self-Testing** state.
06_h	Start	Starts the device execution.
07_h	Stop	Moves the device to the **Idle** state.

The device transitions from the IDLE state to the EXECUTING state by a START Request (Service Code 06_h) or by the receipt of the first valid I/O data.

You will not get any valid measurement values from the device until this service has been requested or the I/O-poll message has been received.

4.3.6 S-Device Supervisor Object Specific Services

Service Code	Service Name	Description of Service
$4B_h$	Abort	Moves the device to the **Abort** state
$4C_h$	Recover	Moves the device out of the **Abort** state
$4E_h$	Perform_Diagnostics	Causes the device to perform a set of diagnostic routines

Explanation to Service code $4E_h$

- DS Object Service Parameter dictionary

Parameter	Form	Description
TestID	USINT	Type and possibly detail of diagnostic test to be performed

- TestID parameter

  The following values are defined for the TestID parameter for the Perform_Diagnostics Service Request:

Attribute Value	State
0	Standard

  Type "Standard" is specified if there is only one type of diagnostic defined or if there are more than one including a type standard.

4.4 S-Analog Sensor Object Class Code $31_h = 49_d$

4.4.1 Class Attributes

Attribute ID	Access rule	Name	DeviceNet data type	Description of attribute	Semantics of values
1	Get	Revision	UINT	Revision of this object Note: All class definitions are required to include this class attribute.	The current value assigned to this attribute is one (01).
2	Get	Max instance	UINT	Maximum instance number of an object currently created in this class level of the device.	The largest Instance number of a created object at this class hierarchy level.
32	Get	Class Level Status Extension	USINT	Bit 0: Reading Invalid Bit 1: Overrange Exceeded Bit 2: Underrange Exceeded	
94	Get	Active value	INT or specified by data type	Is used by assemblies to produce this class-level attribute, instead of the value (attribute ID 6) of the S-Analog sensor instances.	
95	Get	Active instance number	UINT	Identifies the object instance that is providing the value which is copied into the active value for all input assemblies and the alarm/warning exception details for the S-Device supervisor object. → Behavior section.	Default = 1
96	Get	Number of gauges	USINT	Identifies the number of gauge instances present in the device.	PSG55x: 1 PCG55x: 2
99	Get	Subclass	UINT	Identifies a subset of additional class attributes, services and behaviors.	1 ≙ Instance selector

4.4.2 Semantics

Active value

Assemblies or connections may produce this class-level attribute, instead of the value (attribute ID 6) of the active S-Analog sensor instance. The S-Analog sensor class-level attribute active instance number identifies the object instance that is currently active and providing the value to the active value class-level attribute which is, in turn, produced by the input assemblies that have active value as a member.

Active instance number

The device internally modifies this attribute, as required, to identify the S-Analog sensor object instance providing the value member which is copied into the active value for all input assemblies and the alarm/warning exception details for the S-Device supervisor object.

→ Behavior for more information on the mechanism.

Number of gauges

This attribute is used to determine the size of all input assemblies within a node.

→ respective device profile for its usage within a device type.

4.4.3 Instance Attributes

Two S-Analog sensor instances (instance 1 and instance 2) are available by PCG55x.

Instance 1 represents the physical sensor reading of the capacitance diaphragm gauge.

Instance 2 represents the physical sensor reading of the heat transfer vacuum gauge.

The PSG550 has only the instance1. In this case instance 1 represents the physical sensor reading of the heat transfer vacuum gauge.

4.4.3.1 PCG55x - Instance Attributes of Instance 1

Following is the instance 1 with the subclass extension of the capacitance manometer (diaphragm gauge) part of the gauge (valid for PCG55x).

Attribute ID	Access rule	NV/ V	Name	DeviceNet data type	Description of attribute	Semantics of values
3	→ "Semantics" section below	NV	Data type	USINT	Determines the data type of *value* and all related attributes as specified in this table.	→ "Semantics" section below. Int ≙ $C3_h$ [default] float ≙ CA_h
4	→ "Semantics" section below	NV	Data units	UINT	Determines the units context of *value* and all related attributes.	→ "Semantics" section below. Supported Values: Counts ≙ 1001_h [default] mbar ≙ 1308_h Torr ≙ 1301_h Pascal ≙ 1309_h
5	Get	V	Reading valid	BOOL	Indicates that the *value* attribute contains a valid value.	0 = invalid 1 = valid (invalid: e.g., sensor is out of its specified range)
6	Get	V	Value	INT or specified by *data type*	Analog input value	The corrected, converted, calibrated final value of the sensor. → "Semantics" section below.
7	Get	V	Status	BYTE	Alarm and warning state of this object instance.	→ "Semantics" section below.
10	Get	NV	Full Scale	INT or specified by *data type*	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*
25	Set	NV	Safe state	USINT	Specifies the behavior for the *value* for states other than execute	→ "Semantics" section below. [default] = 0
26	Set	NV	Safe value	INT or specified by *data type*	The value to be used for safe state = safe value	→ "Semantics" section below. [default] = 0
32	Get	NV	Overrange	INT or specified by *data type*	Specifies the highest valid *value*	The value above which attribute *reading valid* is set to invalid. [default] = maximum allowable value for the *data type*
33	Get	NV	Underrange	INT or specified by *data type*	Specifies the lowest valid *value*	The value below which attribute *reading valid* is set to invalid. [default] = minimum allowable value for the *data type*
94	Get	V	Sensor warning	Struct of byte	Bit definitions of sensor warnings	0 = [default] → "Semantics" section below
95	Get	V	Sensor alarm	Struct of byte	Bit definitions of sensor alarms	0 = [default] → "Semantics" section below
96	Get	V	Status extension	BYTE	Bit-mapped byte providing additional status bits of an S-Analog sensor instance.	0 = [default] → "Semantics" section below
99	Get	NV	Subclass	UINT	Identifies a subset of additional instance attributes, services and behaviors.	3 = Capacitance Manometer
100	Set	NV	Auto Zero Adjust	BOOL	Used to calibrate the CDG Zero pressure value periodically	0 -> deactivated; 1 -> activated [default];

4.4.3.2 Semantics

Data type

All Data Type attributes use the enumerated values **integer or float**.

The Data Type value will be set automatically based upon the first valid I/O connection established by the device.

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*.

If the data type is set to **integer** and the data unit is chosen with **Counts** a pressure level can be calculated back with (e.g. in mbar):

$$P_{mbar} = \frac{10^{\frac{Value_{integer}-1}{3511}}}{2^{20}}$$

Using data type integer in combination with a pressure unit (mbar, Torr or Pa) will obviously not produce reasonable values below 1.

The output of the data type "float" in combination with the data unit "Counts" is in a fixpoint format with 1 bit for the sign, 11 bits for the integer and 20 bits for the decimal part. To convert it into a normal float format the output has to be divided by 2^{20}.

Data unit

The Data Unit is only settable in the IDLE state.

Value

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.

Status

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

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

Safe state

This attribute specifies what value will be held in *value* for states other than executing. The purpose of this mechanism is to allow other devices, who may be using this *value* to transition to (or remain in) a safe state in the event of this device transitioning to a FAULT, IDLE, or ABORT state. The following values are defined:

Attribute value	State
0	Zero
1	Full scale
2	Hold last value
3	Use safe value

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.

The output at the class attribute 94 (Active value) of the S-Analog Sensor Object is always related to the current active instance (this could be instance 1 or 2).

If you always want to have the same Active value in the idle or error case the equal safe value must be set in both instances.

Sensor alarm

16 Bits are used as sensor faults. Sensor alarm byte 0 is mapped to the device exception detail alarm 0, sensor alarm byte 1 is mapped to the device exception detail alarm 1.

Data component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sensor alarm byte 0	0	0	0	0	0	0	0	0
Sensor alarm byte 1	0	0	0	0	0	0	Electronics failure	0

Sensor warning

16 Bits are used as sensor warnings. Sensor warning byte 0 is mapped to the device exception detail warning 1, sensor warning byte 1 is mapped to the device exception detail warning 2.

Data component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sensor warning byte 0	0	0	0	0	0	0	0	0
Sensor warning byte 1	0	0	0	0	0	0	Electronics warning	0

Status extension

8 Bits providing the current sensor alarm state of the instance. They are mapped to device exception detail warning 0.

Data component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sensor alarm byte 0	0	0	0	0	0	Underrange exceeded	Overrange exceeded	Reading invalid [1)]

[1)] Logical inversion of reading valid

4.4.3.3 Common Services

The S-Analog Sensor Object provides the following common services:

Service Code	Service Name	Description of Service
$0E_h$	Get_Attribute_Single	Returns the contents of the specified attribute.
10_h	Set_Attribute_Single	Modifies an attribute value.

4.4.3.4 Object–Specific Services

The S-Analog Sensor Object provides the following common services:

Service Code	Service Name	Description of Service
$4B_h$	Zero_Adjust	Used to calibrate the zero pressure value.

The Zero_Adjust service is used to cause the S-Analog sensor object device to correct its offset error ones. This functionality can also be executed periodically by setting the attribute 100 to true.

Zero_Adjust Request Service Data Field Parameters

Parameter	Data Type	Description	Semantics of Values
Zero_Adjust parameter or target value	UINT or FLOAT depending on data type	The target value for the zero calibration	The value to which the attribute 6 (value) will be set ➔ this value is always "0". If not specified, the default value of zero is used.

4.4.3.5 Behavior

Data type

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.

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 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 1 specifies INT data types and assembly object instance ID 2 specifies REAL data types.

After the device is on-line, it is configured with an I/O connection to assembly instance ID 2. 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. Any subsequent attempt to connect to assembly instance ID 1 would then be rejected and result in an INVALID ATTRIBUTE VALUE error with the additional error code indicating the ID of the offending attribute, which in this case would be the connection path.

4.4.3.6 PCG55x - Instance Attributes of Instance 2

Following is the instance 2 with the subclass extension of the heat transfer manometer part of the gauge (valid for PCG55x).

Attribute ID	Access rule	NV/ V	Name	DeviceNet data type	Description of attribute	Semantics of values
3	→ "Semantics"	NV	Data type	USINT	Determines the data type of *value* and all related attributes as specified in this table.	→ "Semantics" section below [default] = INT
4	→ "Semantics"	NV	Data units	UINT	Determines the units context of *value* and all related attributes.	[default] = Counts
5	Get	V	Reading valid	BOOL	Indicates that the *value* attribute contains a valid value.	0 = invalid 1 = valid (invalid: e.g., sensor is out of its specified range)
6	Get	V	Value	INT or REAL	Analog input value.	The corrected, converted, calibrated final value of the sensor. → "Semantics" section
7	Get	V	Status	BYTE	Alarm and warning state of this object instance.	= 0
10	Get	NV	Full scale	INT or REAL	The *value* of full scale for the sensor.	[default] = maximum allowable value for the *data type*
25	Set	NV	Safe state	USINT	Specifies the behavior for the *value* for states other than execute.	→ "Semantics" section below [default] = 0
26	Set	NV	Safe value	INT or specified by *data type*	The Value to be used for safe state = safe value	→ "Semantics" section below [default] = 0
32	Get	NV	Overrange	INT or REAL	Specifies the highest valid *value.*	The value above which attribute *reading valid* is set to invalid. [default] = maximum allowable value for the *data type*
33	Get	NV	Under-range	INT or REAL	Specifies the lowest valid *value.*	The value below which attribute *reading valid* is set to invalid. [default] = minimum allowable value for the *data type*
94	Get	V	Sensor warning	Structure of byte	Bit definitions of sensor warnings.	default = 0 → "Semantics" section below
95	Get	V	Sensor alarm	Structure of byte	Bit definitions of sensor alarms.	default = 0 → "Semantics" section below
96	Get	V	Status extension	Byte	Bit-mapped byte providing additional status bits of an S-Analog sensor instance.	default = 0 → "Semantics" section below
99	Get	V	Subclass	UINT	Identifies a subset of additional instance attributes, services and behaviors.	2 = Heat Transfer Vacuum Gauge
101	Set	NV	Pirani OFF Cmd	USINT	Flag to switch off the Pirani in a dangerous environment	0 = Pirani is always on; 1 = Pirani switches off at 120% of s32CombineUpperLimit; 2 = Pirani is always off If the Pirani is switched off, the measurement part (wheatstone bridge) is not powered and the instance outputs it's "Safe State" value In this case the Status extension is also set to "Reading Invalid"
102	Set	NV	Pirani Adjust Hv Pressure	INT or specified by *data type*	Target value for the high vacuum (hv) adjustment	<1E-4mbar = standard hv adjustment, other values = adjustment to this value

4.4.3.7 Semantics of S-Analog Sensor Instance 2

Data type → Instance 1

Data units → Instance 1

Value → Instance 1

Safe state → Instance 1

Safe value → Instance 1

Sensor warning — 16 bits are used as sensor warnings.

Data component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sensor warning byte 0	0	0	0	0	0	0	0	0
Sensor warning byte 1	0	0	0	0	0	0	Electronics Warning	0

Sensor alarm — 16 Bits are used as sensor faults.

Data component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sensor alarm byte 0	0	0	0	0	0	0	0	Sensor Element Failure
Sensor alarm byte 1	0	0	0	0	0	0	Electronics Failure	0

Status extension — 8 bits providing the current sensor alarm state of the instance

Data component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sensor alarm byte 0	0	0	0	0	0	Underrange exceeded	Overrange exceeded	Reading invalid [1)]

[1)] Logical inversion of reading valid

4.4.3.8 Common Services of S-Analog Sensor Instance 2

The S-Analog sensor object provides the following common services:

Service code	Service name	Description of service
$0E_h$	Get_Attribute_Single	Returns the contents of the specified attribute.
10_h	Set_Attribute_Single	Modifies an attribute value.

4.4.3.9 User Adjust Service

Service Code	Service Name	Description of Service
$4C_h$	Gain Adjust	Performs an Atmosphere Adjust for the Pirani-Sensor
$4B_h$	Zero Adjust	Performs an High Vaccum Adjust for the Pirani-Sensor

Gain Adjust Request Service Data Field Parameters

Parameter	Data Type	Description	Semantics of Values
Gain Adjust parameter	UINT or FLOAT depending on data type	The target value for the zero calibration	The value to which the attribute 6 (value)will be set

Zero Adjust Request Service Data Field Parameters

Parameter	Data Type	Description	Semantics of Values
Zero Adjust parameter or target value	UINT or FLOAT depending on data type	The target value for the zero calibration	The value to which the attribute 6 (value) will be set ➔ this value is always "0". If not specified, the default value of zero is used.

There are no state transitions associated with the invocation of this service. It is, therefore, incumbent upon the user to establish the device into the desired configuration prior to, and during the execution of this service. This will generally involve exposing the sensor to a known environment and treating the values read during execution of the services accordingly.

A success service response indicates that the service was accepted and the application process started.

To perform the Gain Adjust Request vent the gauge to atmosphere and then start the Gain Adjust Service without any target value.

To perform the Zero Adjust Request vent the gauge to high vaccum (≤5E-5mbar) and then start the Zero Adjust Service without any target value.

4.4.3.10 PCG55x - Instance Attributes of Instance 3

Following is the instance 3 with the subclass extension of the Atmosphere Pressure Sensor of the gauge (valid for PCG55x).

Attribute ID	Access rule	NV/ V	Name	DeviceNet data type	Description of attribute	Semantics of values
3	→ "Semantics"	NV	Data type	USINT	Determines the data type of *value* and all related attributes as specified in this table.	→ "Semantics" section below [default] = INT
4	→ "Semantics"	NV	Data units	UINT	Determines the units context of *value* and all related attributes.	[default] = Counts
5	Get	V	Reading valid	BOOL	Indicates that the *value* attribute contains a valid value.	0 = invalid 1 = valid (invalid: e.g., sensor is out of its specified range)
6	Get	V	Value	INT or REAL	Analog input value.	The corrected, converted, calibrated final value of the sensor. → "Semantics" section
7	Get	V	Status	BYTE	Alarm and warning state of this object instance.	= 0
10	Get	NV	Full scale	INT or REAL	The *value* of full scale for the sensor.	[default] = maximum allowable value for the *data type*
25	Set	NV	Safe state	USINT	Specifies the behavior for the *value* for states other than execute.	→ "Semantics" section below [default] = 0
26	Set	NV	Safe value	INT or specified by *data type*	The Value to be used for safe state = safe value	→ "Semantics" section below [default] = 0
32	Get	NV	Overrange	INT or REAL	Specifies the highest valid *value.*	The value above which attribute *reading valid* is set to invalid. [default] = maximum allowable value for the *data type*
33	Get	NV	Under-range	INT or REAL	Specifies the lowest valid *value.*	The value below which attribute *reading valid* is set to invalid. [default] = minimum allowable value for the *data type*
94	Get	V	Sensor warning	Structure of byte	Bit definitions of sensor warnings.	default = 0 → "Semantics" section below
95	Get	V	Sensor alarm	Structure of byte	Bit definitions of sensor alarms.	default = 0 → "Semantics" section below
96	Get	V	Status extension	Byte	Bit-mapped byte providing additional status bits of an S-Analog sensor instance.	default = 0 → "Semantics" section below
99	Get	V	Subclass	UINT	Identifies a subset of additional instance attributes, services and behaviors.	3 = Capacitance Manometer

4.4.3.11 Semantics of S-Analog Sensor Instance 3

Data type

All Data Type attributes use the enumerated values **integer or float**.

The Data Type value will be set automatically based upon the first valid I/O connection established by the device.

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*.

If the data type is set to **integer** and the data unit is chosen with **Counts** a pressure level can be calculated back with (e.g. in mbar):

$$P_{mbar} = \frac{Value_{\text{int}\,eger}}{16}$$

Using data type integer in combination with a pressure unit (mbar, Torr or Pa) will obviously not produce reasonable values below 1.

The output of the data type "float" in combination with the data unit "Counts" is in a fixpoint format with 1 bit for the sign, 11 bits for the integer and 20 bits for the decimal part. To convert it into a normal float format the output has to be divided by 2^{20}.

Data units → Instance 1

Value → Instance 1

Safe state → Instance 1

Safe value → Instance 1

Sensor warning

16 bits are used as sensor warnings.

Data component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sensor warning byte 0	0	0	0	0	0	0	0	0
Sensor warning byte 1	0	0	0	0	0	0	0	0

Sensor alarm

16 bits are used as sensor faults.

Data component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sensor alarm byte 0	0	0	0	0	0	0	0	Diaphragm Failure
Sensor alarm byte 1	0	0	0	0	0	0	0	0

Status extension

8 bits providing the current sensor alarm state of the instance

Data component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sensor alarm byte 0	0	0	0	0	0	Underrange exceeded	Overrange exceeded	Reading invalid [1)]

[1)] Logical inversion of reading valid

4.4.3.12 Common Services of S-Analog Sensor Instance 2

The S-Analog sensor object provides the following common services:

Service code	Service name	Description of service
$0E_h$	Get_Attribute_Single	Returns the contents of the specified attribute.
10_h	Set_Attribute_Single	Modifies an attribute value.

4.4.3.13 User Adjust Service

Service Code	Service Name	Description of Service
32_h	User Atmosphere Adjust	Performs an Atmosphere Adjust: Piezo will be adjusted to the Capacitance Diaphragm Gauge.

Gain Adjust Request Service Data Field Parameters

Parameter	Data Type	Semantics of Values
User Atmosphere Adjust parameter	BOOL	0 = disable adjustment 1 = Execute one User Atmosphere Adjust

To perform the User Atmosphere Adjust Request the flange input has to be in the same environment as the electronic part and then start the User Atmosphere Adjust Service with the value 1.

4.4.3.14 PSG55x - Instance Attributes of Instance 1

Following is the instance 1 with the subclass extension of the heat transfer manometer part of the gauge (valid for PSG55x).

Attribute ID	Access rule	NV/ V	Name	DeviceNet data type	Description of attribute	Semantics of values
3	→ "Semantics"	NV	Data type	USINT	Determines the data type of *value* and all related attributes as specified in this table.	→ "Semantics" section below [default] = INT
4	→ "Semantics"	NV	Data units	UINT	Determines the units context of *value* and all related attributes.	[default] = Counts
5	Get	V	Reading valid	BOOL	Indicates that the *value* attribute contains a valid value.	0 = invalid 1 = valid (invalid: e.g., sensor is out of its specified range)
6	Get	V	Value	INT or REAL	Analog input value.	The corrected, converted, calibrated final value of the sensor. → "Semantics" section
7	Get	V	Status	BYTE	Alarm and warning state of this object instance.	= 0
10	Get	NV	Full scale	INT or REAL	The *value* of full scale for the sensor.	[default] = maximum allowable value for the *data type*
25	Set	NV	Safe state	USINT	Specifies the behavior for the *value* for states other than execute.	→ "Semantics" section below [default] = 0
26	Set	NV	Safe value	INT or specified by *data type*	The Value to be used for safe state = safe value	→ "Semantics" section below [default] = 0
32	Get	NV	Overrange	INT or REAL	Specifies the highest valid *value.*	The value above which attribute *reading valid* is set to invalid. [default] = maximum allowable value for the *data type*
33	Get	NV	Underrange	INT or REAL	Specifies the lowest valid *value.*	The value below which attribute *reading valid* is set to invalid. [default] = minimum allowable value for the *data type*
94	Get	V	Sensor warning	Structure of byte	Bit definitions of sensor warnings.	default = 0 → "Semantics" section below
95	Get	V	Sensor alarm	Structure of byte	Bit definitions of sensor alarms.	default = 0 → "Semantics" section below

Attribute ID	Access rule	NV/ V	Name	DeviceNet data type	Description of attribute	Semantics of values
96	Get	V	Status extension	Byte	Bit-mapped byte providing additional status bits of an S-Analog sensor instance.	default = 0 → "Semantics" section below
99	Get	V	Subclass	UINT	Identifies a subset of additional instance attributes, services and behaviors.	2 = Heat Transfer Vacuum Gauge
101	Set	NV	Pirani OFF Cmd	USINT	Flag to switch off the Pirani in a dangerous environment	0 = Pirani is always on; 1 = Pirani switches off at 120% of s32CombineUpperLimit; 2 = Pirani is always off If the Pirani is switched off, the measurement part (wheatstone bridge) is not powered and the instance outputs it's "Safe State" value In this case the Status extension is also set to "Reading Invalid"
102	Set	NV	Pirani Adjust Hv Pressure	INT or specified by *data type*	Target value for the high vacuum (hv) adjustment	<1E-4mbar = standard hv adjustment, other values = adjustment to this value

4.4.3.15 Semantics of S-Analog Sensor Instance 1

Data type → Instance 1 PCG55x

Data units → Instance 1 PCG55x

Value → Instance 1 PCG55x

Safe state → Instance 1 PCG55x

Safe value → Instance 1 PCG55x

Sensor warning 16 bits are used as sensor warnings.

Data component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sensor warning byte 0	0	0	0	0	0	0	0	0
Sensor warning byte 1	0	0	0	0	0	0	Electronics Warning	0

Sensor alarm 16 bits are used as sensor faults.

Data component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sensor alarm byte 0	0	0	0	0	0	0	0	Sensor Element Failure
Sensor alarm byte 1	0	0	0	0	0	0	Electronics Failure	0

Status extension 8 bits providing the current sensor alarm state of the instance

Data component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sensor alarm byte 0	0	0	0	0	0	Underrange exceeded	Overrange exceeded	Reading invalid [1)]

[1)] Logical inversion of reading valid

4.4.3.16 Common Services of S-Analog Sensor Instance 1

The S-Analog sensor object provides the following common services:

Service code	Service name	Description of service
$0E_h$	Get_Attribute_Single	Returns the contents of the specified attribute.
10_h	Set_Attribute_Single	Modifies an attribute value.

4.4.3.17 User Adjust Service

Service Code	Service Name	Description of Service
$4C_h$	Gain Adjust	Performs an Atmosphere Adjust for the Pirani-Sensor
$4B_h$	Zero Adjust	Performs an High Vaccum Adjust for the Pirani-Sensor

Gain Adjust Request Service Data Field Parameters

Parameter	Data Type	Description	Semantics of Values
Gain Adjust parameter	UINT or FLOAT depending on data type	The target value for the zero calibration	The value to which the attribute 6 (value) will be set (only adjustment to 1000 mbar possible)

Zero Adjust Request Service Data Field Parameters

Parameter	Data Type	Description	Semantics of Values
Zero Adjust parameter or target value	UINT or FLOAT depending on data type	The target value for the zero calibration	The value to which the attribute 6 (value) will be set ➔ this value is always "0". If not specified, the default value of zero is used.

There are no state transitions associated with the invocation of this service. It is, therefore, incumbent upon the user to establish the device into the desired configuration prior to, and during the execution of this service. This will generally involve exposing the sensor to a known environment and treating the values read during execution of the services accordingly.

A success service response indicates that the service was accepted and the application process started.

To perform the Gain Adjust Request vent the gauge to atmosphere and then start the Gain Adjust Service without any target value.

To perform the Zero Adjust Request vent the gauge to high vaccum (≤5E-5mbar) and then start the Zero Adjust Service without any target value.

4.5 Trip Point Object

Class Code $35_h = 53_d$

The Trip Point Object models the action of trip points (two relays) of the PCG/PSG (corresponding to physical outputs) (Discrete Output Object). A trip point value, designated as a high or low trip point, is compared to the specified source value. This trip point is intended to be used as a process control indicator.

4.5.1 Class Attributes

Attribute ID	Access rule	Name	DeviceNet data type	Description of attribute
1	Get	Revision	UINT	Revision of this object. Note: All class definitions are required to include this class attribute.
2	Get	Max instance	UINT	Maximum instance number of an object currently created in this class level of the device.

4.5.2 Instance Attributes of Trip Point Objects Instance 1 & 2

Attribute ID	Access rule	NV/ V	Name	DeviceNet data type	Description of attribute	Semantics of values
3	Set	NV	High trip point	INT or based data type attribute	Defines the value at or above which a trip point condition will occur.	→ "Semantics" section below [default = defined by vendor]
4	Set	NV	High trip enable	BOOL	Enables the high trip point setting.	[default = defined by vendor]
5	Set	NV	Low trip point	INT or based data type attribute	Defines the value at or below which a trip point condition will occur.	→ "Semantics" section below [default = defined by vendor]
6	Set	NV	Low trip enable	BOOL	Enables the low trip point setting.	[default = defined by vendor]
7	Get	V	Output Status	BOOL	State of this object instance.	0 = trip point condition does not exist (unasserted) 1 = trip point condition exists (asserted)
12	Get	NV	Destination	Packed EPATH	Specifies the path of the destination attribute whose value will be set by *output.*	Path to attribute 3 of Instance 1 or 2 of DOP Object.
13	Get	V	Output	BOOL	Output of the object the value of which is sent to *destination.*	= Status of the relay
14	Get	NV	Source	Packed EPATH	Specifies the path of the source attribute whose value is retrieved for *Input.*	Path to attribute 6 of instance 1 of S-analog sensor object
15	Get	V	Input	INT or specified by *data type*	Input to the object whose value is retrieved from *source.*	Value of attribute 6 of instance 1 of S-analog sensor object
16	Get	NV	Data units	ENGUNITS	Units of input, trip point.	
17	Get	NV	Data type	USINT	Data type of input.	[default] = INT
18	Set	NV	Trip Point High Hysteresis	Same as *High/Low Point* Data Type	Determines the amount by which the *Input* must recover to clear a trip point high condition	[default = defined by vendor]
19	Set	NV	Trip Point Low Hysteresis	Same as *High/Low Point* Data Type	Determines the amount by which the *Input* must recover to clear a trip point low condition	[default = defined by vendor]
20	Get	V	Trip Status	USINT	Describes the activator for the trip point condition. Activator may be a High Trip Point condition and/or a Low Trip Point condition.	0 = no trip point condition exists 1 = low trip point condition exists 2 = high trip point condition exists 3 = high and low trip condition exist 4-255 = reserved
101	Set	NV	Factor of ATM	REAL	Multiplier for ATM control	If with the Attribute 102 the amt mode is chosen, this value will be multiplied with pressure value from S-Analog Sensor Instance 3 (ATM sensor) and copied into High or Low Trip Point (→ Attribute 102).
102	Set	NV	Setpoint Mode	USINT	Mode of the setpoints	Atm Mode, 0 = standard setpoint 1 = LTP is in ATM Mode 2 = HTP is in ATM Mode 3 = LTP and HTP are in ATM Mode 4 … 7 = the same as 0 … 3, but the change with push-buttons isn't allowed

4.5.3 Semantics

Setpoint function

If "Low Trip Enable" is set, the setpoint function is used (automatically attr. 102 is set to zero and the functionality ATM detection is disabled).

Low trip point is compared to the *input* value to generate a trip point condition.

Status will be set if the input value is at or below the *low trip point.*

If the pressure increases above the low trip point and hysteresis, the *status* will be reset.

This behaviour is similar at the high trip point: Status will be set if the input value is at or above the high trip point. If the pressure decreases below the high trip point – hysteresis, the Status will be reset.

ATM detection

This functionality is used to compare the pressure measured by the PCG/PSG with the atmospheric pressure.

To activate the ATM detection attribute 102 must be set to 1, 2 or 3.

Attribute 101 is used to define a value "Factor of Atmosphere". This value will be multiplied with the pressure from the S-Analog sensor instance 2 (ATM sensor). Then the result will be copied into attr. 3 or 5 (depending on the value of attribute 102). If a value is written to percentage of atmosphere, the low trip enable is set to zero.

Status has the same behaviour as in the description of the "Setpoint function".

Hysteresis

The Hysteresis value specifies the amount by which the Input value must transition in order to clear a trip point condition.

The following relationship demonstrates the logic for a Low Trip Point:

For *Status* not set:	If (*Input* ≤ *Trip Point Low*)
	Then set *Status*
For Status set:	If (Input > Trip Point Low +Hysteresis)
	Then clear Status

Data type

All Data Type attributes use the enumerated values **integer or float**.

The Data Type value will be set automatically based upon the first valid I/O connection established by the device.

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*.

If the data type is set to **integer** and the data unit is chosen with **Counts**, the conversion into pressure and vice versa is as follows (e.g. for mbar):

$$P_{mbar} = \frac{10^{\frac{Value_{integer}-1}{3511}}}{2^{20}}$$

$$Value_{integer} = 3511 * \log(P_{mbar} * 2^{20}) + 1$$

Using data type integer in combination with a pressure unit (mbar, Torr or Pa) will obviously not produce reasonable values below 1.

Setpoint Mode

The following different modes are available:

Mode	Functionality Low Trip Point	Functionality High Trip Point
0	Setpoint Mode: Value settable by pushbutton and DeviceNet	Setpoint Mode: Value settable by pushbutton and DeviceNet
1	ATM mode: Trip point value calculated by Faktor of ATM	Setpoint Mode: Value settable by pushbutton and DeviceNet
2	Setpoint Mode: Value settable by pushbutton and DeviceNet	ATM mode: Trip point value calculated by Faktor of ATM
3 [1)]	ATM mode: Trip point value calculated by Faktor of ATM	ATM mode: Trip point value calculated by Faktor of ATM
4	Setpoint Mode: Value settable only by DeviceNet	Setpoint Mode: Value settable only by DeviceNet

1) Mode 3 doesn't make sense because both trip points have the same level: the setpoint is always on.

4.5.4 Common Services

The trip point object provides the following common services:

Service code	Service name	Description of service
$0E_h$	Get_Attribute_Single	Returns the contents of the specified attribute.
10_h	Set_Attribute_Single	Modifies an attribute value.

4.6 Discrete Output Point Object

Class Code $09_h = 09_d$

4.6.1 Class Attributes

Attribute ID	Access rule	Name	DeviceNet data type	Description of attribute
1	Get	Revision	UINT	Revision of this object. Note: All class definitions are required to include this class attribute.
2	Get	Max instance	UINT	Maximum instance number of an object currently created in this class level of the device.

4.6.2 Instance Attributes of Instance 1 & 2

Attribute ID	Access rule	Name	DeviceNet data type	Description of attribute	Semantics of values
3	Get	Value	BOOL	Output point value.	0 = Off 1 = On (activated)

4.6.3 Common Services

The discrete output point object provides the following common services:

Service code	Service name	Description of service
$0E_h$	Get_Attribute_Single	Returns the contents of the specified attribute.

5 I/O Assembly Object

Class Code $04_h = 04_d$

A collection of assembly objects allows the sending of attributes from different application objects in one message (i.e. Polling I/O).

5.1 I/O Assembly Object Instance Data Attribute Format

The *S-Analog Sensor* object definition specifies a behavior that modifies the *Data Type* of certain attributes based upon the first valid I/O connection established to an Assembly Object instance. In order to maintain consistency, this device type will only allow connections to either INT or REAL based Assembly instances. Once a valid connection is established, attempts to configure connections, or otherwise access data, to a different type of Assembly instance will return a RESOURCE UNAVAILABLE error.

The I/O Assembly DATA attribute has the format shown below:

Instance	Type	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	Input	0 - 1	INT Pressure Value							
2 (default)	Input	0	Exception Status							
		1 - 2	INT Pressure Value							
3	Input	0	Exception Status							
		1	0	0	0	0	0	0	Trip Status Inst. 2	Trip Status Inst. 1
		2 - 3	INT Pressure Value							
4	Input	0 - 3	REAL Pressure Value							
5	Input	0	Exception Status							
		1 - 4	REAL Pressure Value							
6	Input	0	Exception Status							
		1	0	0	0	0	0	0	Trip Status Inst. 2	Trip Status Inst. 1
		2 - 5	REAL Pressure Value							
8	Input	0	Exception Status							
9	Input	0 - 1	Active Instance							
		2 - 3	INT Active Pressure Value							
10	Input	0	Exception Status							
		1 - 2	Active Instance							
		3 - 4	INT Active Pressure Value							
11	Input	0	Exception Status							
		1	0	0	0	0	0	0	Trip Status Inst. 2	Trip Status Inst. 1
		2 - 3	Active Instance							
		4 - 5	INT Active Pressure Value							
12	Input	0 - 1	Active Instance							
		2 - 5	REAL Active Pressure Value							
13	Input	0	Exception Status							
		1 - 2	Active Instance							
		3 - 6	REAL Active Pressure Value							
14	Input	0	Exception Status							
		1	0	0	0	0	0	0	Trip Status Inst. 2	Trip Status Inst. 1
		2 - 3	Active Instance							
		4 - 7	REAL Active Pressure Value							

Appendix

A: Conversion of a Floating Number According to IEEE 754

General

Number received

$AA\ BB\ CC\ DD_h$ (4-Byte, floating format)

Legend:
- XX_h Hexadecimal number (Radix = 16)
- XX_d Decimal number (Radix = 10)
- XX_b Binary number (Radix = 2)

1. Reverse the sequence of the HEX words

DD_h	CC_h	BB_h	AA_h

2. Separate into bytes

$SEEE\ EEEE_b$	$EMMM\ MMMM_b$	$MMMM\ MMMM_b$	$MMMM\ MMMM_b$

Sign | 8-Bit exponent | 23-Bit mantissa

S	$EEEE\ EEEE_b$	$MMM\ MMMM\ MMMM\ MMMM\ MMMM\ MMMM_b$

3. Calculate

⇩	⇩	⇩
		$1+\left(\frac{MMM\ MMMM\ MMMM\ MMMM\ MMMM\ MMMM_b}{2^{23}}\right)$
		$=1+\left(\frac{NNNNN_d}{8388608_d}\right)$
		⇩
Sign =	Exponent =	Mantissa =
-1^S	XYZ_d	$RSTUV_d$

Converted number

$$\text{Sign} \times 2^{(\text{Exponent}-127)} \times \text{Mantissa}$$

Example

Number received

$00\ 00\ CA\ 42_h$ (4-Byte, floating format)

1. Convert sequence of the HEX words

42_h	CA_h	00_h	00_h

2. Separate into bytes

$0100\ 0010_b$	$1100\ 1010_b$	$0000\ 0000_b$	$0000\ 0000_b$

Sign | 8-Bit exponent | 23-Bit mantissa

3. Calculate

0	$1000\ 0101_b$	$100\ 1010\ 0000\ 0000\ 0000\ 0000_b$
⇩	⇩	⇩
-1^0		$1+\left(\frac{100\ 1010\ 0000\ 0000\ 0000\ 0000_b}{2^{23}}\right)$ $= 1+\left(\frac{4849664_d}{8388608_d}\right)$
⇩	⇩	⇩
Sign =	Exponent =	Mantissa =
1	**133**	**1.578125**

Converted number

$$1 \times 2^{(133-127)} \times 1.578125 = 101$$

B: Typical Start-Up Procedure

The start up of a device is divided into the steps:

- Allocation process
- Setting of the EPR attribute
- Choice of the input and output assemblies

Allocation process

Send an allocation string as defined in the DeviceNet specification to the device you want to allocate.

Set the bits in the allocation choice byte to 1 for these connections you want to use.

Example

Master MAC ID: 0
Allocation choice: Explicit, poll
Slave address: 2

⇒ Allocation string: 416 00 4B 03 01 57 00
Slave's explicit/unconnected response message: 413 00 CB 00

Within the first allocation message the explicit connection has to be established.

Setting of the EPR attribute (expected packet rate)

After the allocation, the device activates an INACTIVITY WATCHDOG TIMER. This timer has to be set for every single connection (connection object, attribute 9) which is allocated in the allocation choice byte. This attribute defaults to 2500 (2500 milliseconds) within explicit messaging connections, and to zero within an I/O connection. If the INACTIVITY WATCHDOG TIMER expires, the established connection will be released. With every message the device receives, this timer is reloaded with the value specified in the according connection object and so it doesn't expire. The value zero deactivates the INACTIVITY WATCHDOG TIMER.

So in this step the inactivity watchdog timer has to be set. In testing mode you could use the value 0 to deactivate the inactivity watchdog timer.

In the following you see the strings for setting the EPR attribute (addresses as specified above):

ID	Message body	
414	00 10 05 01 09 00 00	set EPR of the explicit connection to zero
414	00 10 05 02 09 00 00	set EPR of the poll connection to zero

The responses of the slave are:

ID	Message body	
413	00 90 00 00	set EPR of the explicit connection to zero

Choice of the input and output assemblies

You can specify which of the several in a device predefined input/output assemblies should be used for **every single** connection.

Reading or setting of the input/output assemblies is possible only if the corresponding connection (polling, change of state, bit strobe) has been allocated in the allocation message.

Reading the configured assemblies

If you want to read the number of the chosen assembly, you must read the attributes 14 and 16 in the corresponding Instance of the connection object (object ID 5).

For reading this value, the connection has to be established. The EPR attribute may be set.

Instance 2: Polling

Setting of assemblies

If you want to set the number of the chosen assembly, you must set the attributes 14 and 16 in the corresponding instance of the connection object.

For setting this value, the connection has to be allocated, but the EPR attribute has not to be set to any value.

Examples

Read a configured assembly (addresses as specified above)

Get single request:

ID	Message body	
414	00 0E 05 02 0E	Get produced connection path (request for input assembly by master).

Get single response:

ID	Message body	
413	00 8E 20 04 24 05 30 03	Response from slave

The addressing format of the attribute values differ from the normal mode. A connection path attribute that specifies class 4, instance 5, and attribute ID 3 is illustrated below:

	Class #4
20	04

	Instance #5
24	05

	Attribute #3
30	03

The instance defines the assembly you want to use. This format has to be used by the master in the request and is used by the slave in the response.

Set the input assembly 04 for a poll connection (addresses as specified above)

Set single request:

ID	Message body	
414	80 00 10 05 02 10 20 04	First fragment
414	80 81 24 04 30 03	Second fragment

Because the message body is greater than 8 bytes, the fragmented protocol has to be used.

Set single response:

ID	Message body	
413	80 C0 00	Response on first fragment
413	80 C1 00	Response on second fragment

C: Further Information

🕮 [1] www.inficon.com
Operating Manual
PCG550, PCG552, PCG554
tina56d1 (German)
tina56e1 (English)
INFICON AG, LI–9496 Balzers, Liechtenstein

🕮 [2] www.inficon.com
Operating Manual
PSG550, PSG552, PSG554
tina60d1 (German)
tina60e1 (English)
INFICON AG, LI–9496 Balzers, Liechtenstein

🕮 [3] www.odva.org
Open DeviceNet Vendor Association, Inc.
DeviceNet™ Specifications

🕮 [4] Common Industrial Protocol (CIP™) Ed. 3.5 and DeviceNet™ Adaption of CIP Ed. 1.6 (Open DeviceNet Vendor Association)

🕮 [5] www.inficon.com
Product descriptions and downloads
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