

## Series 354

# Granville-Phillips® Series 354 Micro-Ion® Vacuum Gauge Module with DeviceNet™



## Instruction Manual

*Instruction manual part number 354020*

*Revision 03 - November 2008*



## Series 354

# Granville-Phillips® Series 354 Micro-Ion® Vacuum Gauge Module with DeviceNet™

This Instruction Manual is for use with all Granville-Phillips Series 354 Micro-Ion Modules with DeviceNet. A list of applicable catalog numbers is provided on the following page.



### ***Customer Service/Support***

For customer service, 24 hours per day, 7 days per week, every day of the year including holidays, toll-free within the USA, phone 1-800-367-4887

For customer service within the USA, 8 AM to 5 PM, weekdays excluding holidays:

- Toll-free, phone: 1-800-776-6543
- Phone: 1-303-652-4400
- FAX: 1-303-652-2844
- Email: [co-csr@brooks.com](mailto:co-csr@brooks.com)
- World Wide Web: [www.brooks.com](http://www.brooks.com)

## Instruction Manual

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# Granville-Phillips® Series 354 Micro-Ion® Vacuum Gauge Module with DeviceNet™

## Series 354 Micro-Ion Modules - CE Marked

Power supply and cable are not included.

### Module with DeviceNet Interface and 2 setpoint relays:

Module with DeviceNet Interface with no display: 354009 - # # - #

Module with DeviceNet Interface with 3-digit display: 354006 - # # - #

### Ion Gauge Filaments:

Yttria-coated iridium

Tungsten

Y

T

### Flange/Fitting:

NW16KF

NW25KF

NW40KF

1.33 inch (NW16CF) ConFlat-type

2.75 inch (NW35CF) ConFlat-type

1/2 inch VCR-type male

NW16L

40KFL

D

E

K

F

G

H

M

L

### Measurement Units:

Torr

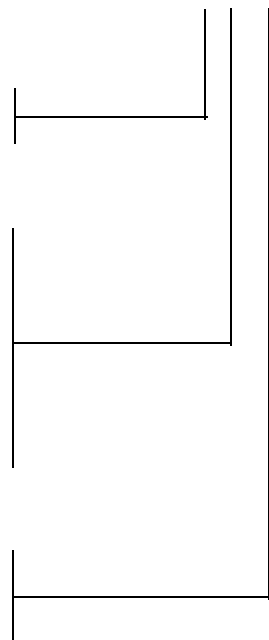
mbar

pascal

T

M

P



ConFlat is a registered trademark of Varian Associates.

VCR and VCO are registered trademarks of Swagelock Company.

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# Chapter 1 Introduction

## 1.1 About These Instructions

These instructions explain how to install, operate, and maintain the Granville-Phillips® Micro-Ion® vacuum gauge module.

The module has DeviceNet interface and two setpoint relays.

- *This chapter* explains caution and warning statements, which must be adhered to at all times; explains your responsibility for reading and following all instructions; defines the terms that are used throughout this instruction manual; explains how to contact customer service; and provides specifications for the module.
- *Chapter 2* explains how to install the module.
- *Chapter 3* explains DeviceNet operation and summarizes DeviceNet polled I/O and explicit messages.
- *Chapter 4* explains troubleshooting; Micro-Ion gauge testing, removal and replacement; and module return procedures.

## 1.2 Cautions and Warnings

This manual contains caution and warning statements with which you *must* comply with to prevent inaccurate measurement, property damage, or personal injury.



### CAUTION

**Caution statements alert you to hazards or unsafe practices that could result in inaccurate measurement, minor personal injury or property damage.**

Each caution statement explains what you must do to prevent or avoid the potential result of the specified hazard or unsafe practice.



### WARNING

**Warning statements alert you to hazards or unsafe practices that could result in severe property damage or personal injury due to electrical shock, fire, or explosion.**

Each warning statement explains what you must do to prevent or avoid the potential result of the specified hazard or unsafe practice.

Caution and warning statements comply with American Institute of Standards Z535.1-2002 through Z535.5-2002, which set forth voluntary

practices regarding the content and appearance of safety signs, symbols, and labels.

Each caution or warning statement explains:

- a. The specific hazard that you *must* prevent or unsafe practice that you *must* avoid,
- b. The potential result of your failure to prevent the specified hazard or avoid the unsafe practice, and
- c. What you *must* do to prevent the specified hazardous result.

### 1.3 System Grounding

Grounding, though simple, is very important! Be certain that ground circuits are correctly used on your ion gauge power supplies, gauges, and vacuum chambers, regardless of their manufacturer. Safe operation of vacuum equipment, including the Series 390 ATM Module, requires grounding of all exposed conductors of the gauges, the controller and the vacuum system. Lethal voltages may be established under some operating conditions unless correct grounding is provided.

Ion producing equipment, such as ionization gauges, mass spectrometers, sputtering systems, etc., from many manufacturers may, under some conditions, provide sufficient electrical conduction via a plasma to couple a high voltage electrode potential to the vacuum chamber. If exposed conductive parts of the gauge, controller, and chamber are not properly grounded, they may attain a potential near that of the high voltage electrode during this coupling. Potential fatal electrical shock could then occur because of the high voltage between these exposed conductors and ground.

### 1.4 Explosion / Implosion

Danger of injury to personnel and damage to equipment exists on all vacuum systems that incorporate gas sources or involve processes capable of pressuring the system above the limits it can safely withstand.

For example, danger of explosion in a vacuum system exists during backfilling from pressurized gas cylinders because many vacuum devices such as ionization gauge tubes, glass windows, glass belljars, etc., are not designed to be pressurized.

Install suitable devices that will limit the pressure from external gas sources to the level that the vacuum system can safely withstand. In addition, install suitable pressure relief valves or rupture disks that will release pressure at a level considerably below that pressure which the system can safely withstand.

Suppliers of pressure relief valves and pressure relief disks are listed in Thomas Register under "Valves, Relief", and "Discs, Rupture".

Confirm that these safety devices are properly installed before installing the Series 354 Module. In addition, check that (1) the proper gas cylinders are installed, (2) gas cylinder valve positions are correct on manual systems, and (3) the automation is correct on automated systems.

- 1.5 Operation**
- It is the installer's responsibility to ensure that the automatic signals provided by the process control module are always used in a safe manner. Carefully check manual operation of the system and the setpoint programming before switching to automatic operation. Where an equipment malfunction could cause a hazardous situation, always provide for fail-safe operation. As an example, in an automatic backfill operation where a malfunction might cause high internal pressures, provide an appropriate pressure relief device.
- 1.6 Read and Follow These Instructions**
- You must comply with all instructions while you are installing, operating, or maintaining the module. Failure to comply with the instructions violates standards of design, manufacture, and intended use of the module. Granville-Phillips and Brooks Automation disclaim all liability for the customer's failure to comply with the instructions.
- *Read instructions* – Read all instructions before installing or operating the product.
  - *Follow instructions* – Follow all installation, operating and maintenance instructions.
  - *Retain instructions* – Retain the instructions for future reference.
  - *Heed warnings and cautions* – Adhere to all warnings and caution statements on the product and in these instructions.
  - *Parts and accessories* – Install only those replacement parts and accessories that are recommended by Granville-Phillips. Substitution of parts is hazardous.

## 1.7 Definitions of Terms

**Table 1-1 Terms Describing the Micro-Ion ATM Module and Components**

Term	Description
Module	The entire Micro-Ion product, which includes the housing, gauge assembly, and electronics assembly.
Gauge assembly	A removable assembly that contains a hot filament Micro-Ion gauge (Bayard-Alpert type ionization gauge) and the vacuum chamber connection.
Electronics assembly	An assembly that contains the electronic circuitry, signal processing microcircuitry, and atmospheric pressure diaphragm sensor.
Micro-Ion gauge	The Bayard-Alpert type ionization gauge, which indicates pressure by producing a current that is proportional to gas density.

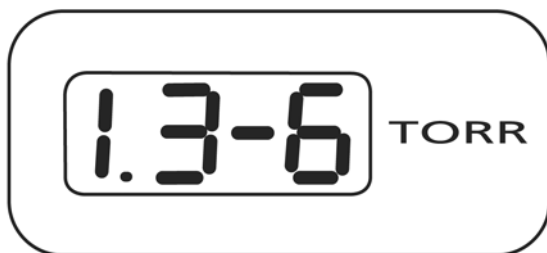
**Table 1-2 Terms Describing the DeviceNet Protocol**

Term	Description
Class	Referred to in DeviceNet language as an “object”. The DeviceNet protocol is divided into various objects that describe behaviors, attributes, or information. For example, class 1 is the identity object that includes information about the identity of the product, such as the vendor identification, product type, product ID, serial number, and firmware revisions.
Instance	Within a class there may be multiple instances. Within the Micro-Ion ATM module there are four possible I/O instances (1–4). For example, the format for polled I/O data is instance 2 in class 5.
Attribute	Data that can be read from the device or written to the DeviceNet network. Attributes exist for each instance within a class. For example, the serial number is attribute 6, instance 1 in class 1 (the identity object).
Master data	The messages sent from the network to the device to set conditions or values in the device.
Device data	The messages sent from the Micro-Ion ATM module to the network to communicate values, attributes, or other information.
Data rate	The rate at which data is transmitted (125, 250, or 500 kbaud, switch selectable).
Explicit messages	Messages that are used for request/response communications enabling module configuration and problem diagnosis. Explicit messages provide multi-purpose, point-to-point communication paths between two modules or other devices.
Polled I/O messages	Messages that are used for time-critical, control-oriented data. Polled I/O messages provide a dedicated, special-purpose communication path between a producing application (host) and one or more consuming applications (modules or other devices).
Address	The address of a device on the DeviceNet network.

**Table 1-3 Terms Describing DeviceNet Data Types**

Term	Description
Data type	The form of the data communicated from the Micro-Ion ATM module or another node on the network. The module supports BOOL, BYTE, SSTRING, REAL, INT, UINT, USINT, EPATH, and WORD data types.
BOOL data	A single ON/OFF bit, where 1 = ON (true), 0 = OFF (false).
BYTE data	An 8-bit string, from most significant to least significant bit.
STRUCT data	A string of bits, each of which can be set to ON (true) = 1 or OFF (false) = 0.
SSTRING data	A character string, one byte per character, with one byte length indicator.
REAL data	A 32-bit floating point value in single precision IEEE 754 format.
INT data	A 2-byte (16-bit) integer value from -32767 to +32767.
UINT data	A 16-bit unsigned integer value from 0 to 65535.
USINT data	An 8-bit unsigned integer value from 0 to 255.
EPATH	DeviceNet path segments requiring abstract syntax encoding.
WORD data	A 16-bit string.

- 1.8 Optional Digital Display** The optional digital display for the Series 354 vacuum gauge module is a 7-segment LED that indicates vacuum pressure. The display pressure range is  $0.1 \times 10^{-10}$  to  $9.9^{-1}$  Torr. The display is OFF when power is OFF or the Micro-Ion gauge is OFF.

**Figure 1-1 Micro-Ion Module Optional Digital Display**

**1.9 Customer Service**

For customer service:

- Phone **1-303-652-4400** or **1-800-776-6543** within the USA
- Worldwide customer support/service 24/7, phone 1-800-367-4887
- email *co-csr@brooks.com*
- For Global Customer Support, go to [www.brooks.com](http://www.brooks.com), click on Contact Us, then click on Global Offices to locate the Brooks Automation office nearest you.

## 1.10 Specifications

### Pressure Measurement

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#### Absolute Pressure for N<sub>2</sub> or Air

	Measurements will change with different gases and mixtures.
<i>Absolute Pressure Range</i>	1 x 10 <sup>-9</sup> to 5 x 10 <sup>-2</sup> Torr
<i>X-ray Limit</i>	The X-ray limit is the absolute lowest indication from the gauge. It is not possible to make repeatable measurements near the x-ray limit. 3 x 10 <sup>-10</sup> Torr

### Temperature

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<b>Operating Temperature</b>	10 to 40 ° C (50 to 104 ° F), non-condensing
<b>Storage Temperature</b>	-40 to +70 ° C (-40 to +158 ° F)
<b>Bakeout Temperature</b>	200 ° C (392 ° F) maximum with electronics removed

### DeviceNet

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<b>DeviceNet Output</b>	The Micro-Ion Module has one DeviceNet output.
<i>Messaging</i>	Polled I/O and explicit
<i>Communications Format</i>	BOOL, BYTE, STRUCT, SSTRING, REAL, INT, UINT, USINT, EPATH, and WORD data
<i>Data Rates</i>	125, 250, or 500 kbaud, switch selectable
<i>Address</i>	0–63, selected by using data rate switch
<i>I/O Slave Messaging</i>	Polling, COS, cyclic
<i>NET Status LED Indicator</i>	The NET status LED lights up to indicate if the DeviceNet network has power and is functioning properly.
<i>MOD Status LED Indicator</i>	The MOD status LED lights up to indicate if the module has power or is functioning properly.

### Trip Point Relays

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<b>Relay Type</b>	Two single-pole double-throw (normally open/normally closed) relays. Each relay can be independently assigned to vacuum or differential pressure.
<b>Relay Contact Ratings</b>	Relay contacts are silver alloy-gold clad, rated for 1 A at 30 Vdc. The relays can handle resistive loads.
<i>Maximum</i>	1 A at 30 Vdc resistive, load
<i>Minimum</i>	5 mA at 5 Vdc resistive, load
<b>Relays Assigned to Vacuum Pressure</b>	
<i>Minimum Hysteresis</i>	5%
<i>Range</i>	$1.0 \times 10^{-9}$ to $5 \times 10^{-2}$ Torr

### Micro-Ion Sensor

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<b>Emission Current</b>	0.02 mA, 1.0 mA or 4 mA, automatically set Use RS-485 commands to set switch point for high and low emission currents.
<b>Default Control Settings</b>	
<i>Switch to high Emission</i>	$1 \times 10^{-5}$ Torr with decreasing pressure
<i>Switch to Low Emission</i>	$5 \times 10^{-5}$ Torr with increasing pressure
<i>Gauge Degas</i>	Electron bombardment; 3 W for default time of 2 minutes.
<b>Filaments</b>	Solid tungsten or yttria-coated iridium

**Electrical Connectors**

**I/O Connector**

*Cable Type*

9-pin subminiature D male connector has terminals for the module relays. For cable that connects to the 9-pin I/O connector, install shielded cable with aluminum jacket and a tinned copper braid with a minimum of 65% coverage.

On the module end of the cable, install a metal housing so the shield is continuous from the cable to the gauge housing. Do not ground the shield at the system end.

**DeviceNet Micro Connector**

*Cable Type*

DeviceNet 5-pin micro connector has terminals for a standard micro 5-pin female cable connection.

Install raw cable that has a braided shield over the aluminum foil-shielded signal and power wires.

On the module end of the cable, install a metal housing so the shield is continuous from the cable to the gauge housing. Do not ground the shield at the receiver or output device.

*DeviceNet Power Supply*

24 Vdc, 0.9 A , 24 Watts maximum.

**Ion Gauge Power Connector**

Provides power to the ion gauge sensor within the Module. Should be used if the load on the DeviceNet power bus is too high. 24 Vdc.

**CE Mark Compliance**

Compliance with CE Mark requires metal connector housings and cable with a braided shield. The braided shield must be connected only to the outer shell of the 9-pin subminiature D connector or 5-pin DeviceNet micro connector on the module, not to the receiver or output device.

**Physical Specifications**

**Weight**

368.5 g (13 oz.)

**Case Material**

Powder-coated extruded aluminum

**Materials Exposed to Vacuum**

304 stainless steel, tantalum, tungsten, yttria-coated iridium, alumina, CuAg eutectic, Kovar, gold-plated and nickel-plated Kovar.



## Chapter 2 Installation

The Series 354 Micro-Ion Module contains a Bayard-Alpert type Micro-Ion Gauge.



### WARNING

**Using the module to measure the pressure of flammable or explosive gases can cause a fire or explosion resulting in severe property damage or personal injury.**

Do not use the module to measure the pressure of flammable or explosive gases.



### WARNING

**Exposing the module to moisture can cause fire or electrical shock resulting in severe property damage or personal injury.**

To avoid exposing the module to moisture, install the module in an indoor environment. Do not install the module in any outdoor environment.

### 2.1 Pressure Relief Devices

Before you install the module, you should install appropriate pressure relief devices in the vacuum system.

Brooks Automation does not supply pressure relief valves or rupture disks. Suppliers of pressure relief valves and rupture disks are listed in the *Thomas Register* under "Valves, Relief" and "Discs, Rupture."



### CAUTION

**Operating the module above 1000 Torr (1333 mbar, 133 kPa) true pressure could cause pressure measurement error or product failure.**

To avoid measurement error or product failure due to over pressurization, install pressure relief valves or rupture disks in the system if pressure substantially exceeds 1000 Torr (1333 mbar, 133 kPa).

**2.2 Installation Procedure**

The module installation procedure includes the following steps:

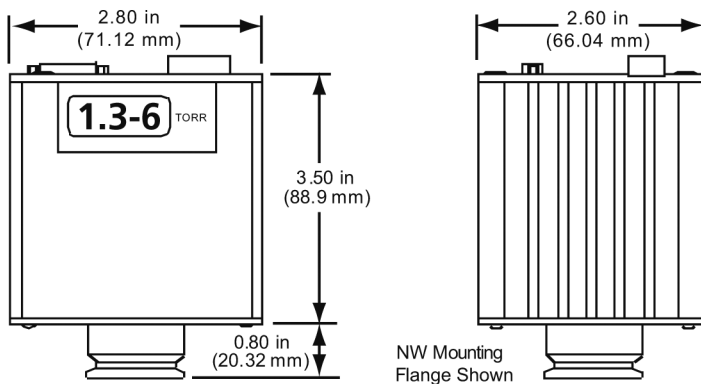
1. Determine the location of the module on the vacuum chamber.
2. Attach the module's flange/ fitting to its mating fitting on the vacuum chamber.
3. Assemble and connect the module wiring.

**Step 1 Location of the Module**

To determine the best location for the module, refer to Figure 2-1 and follow the guidelines below.

- For greatest accuracy and repeatability, locate the module in a stable, room-temperature environment. Ambient temperature should never exceed 40 °C (104 °F) operating, non-condensing, or 70 °C non-operating. Bakeout temperature with the electronics removed from the module is 200 °C.
- Locate the module away from internal and external heat sources and in an area where ambient temperature remains reasonably constant.
- Do not locate the module near the pump, where gauge pressure might be lower than system vacuum pressure.
- Do not locate the module near a gas inlet or other source of contamination, where inflow of gas or particulates causes atmospheric pressure to be higher than system atmosphere.
- Do not locate the module where it will be exposed to corrosive gases such as mercury vapor or fluorine.

**Figure 2-1 Micro-Ion Module Dimensions**



## Step 2 Attach the Module to the Vacuum Chamber

Attach the module's flange/fitting to its mating fitting on the vacuum chamber.

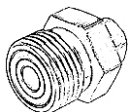


### CAUTION

**Twisting the module to tighten the fitting to the vacuum chamber can damage the module's internal connections.**

- Do not twist the module to tighten the fitting.
- Use appropriate tools to tighten the fitting.

#### VCR type fitting



VCR Type Fitting:

- a. Remove the bead protector cap from the fitting.
- b. Place the gasket into the female nut.
- c. Assemble the components and tighten them to finger-tight.
- d. While holding a back-up wrench stationary, tighten the female nut 1/8 turn past finger-tight on 316 stainless steel or nickel gaskets, or 1/4 turn past finger-tight on copper or aluminum gaskets. *Do not twist the module to tighten the fitting.*

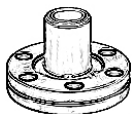
#### KF flange



The KF mounting system requires O-rings and centering rings between mating flanges.

- a. Tighten the clamp to compress the mating flanges together.
- b. Seal the O-ring.

#### ConFlat flange



To minimize the possibility of leaks with ConFlat® flanges, use high strength stainless steel bolts and a new, clean OFHC copper gasket. Avoid scratching the seal surfaces. To avoid contamination, install new metal gaskets.

- a. Finger tighten all bolts.
- b. Use a wrench to continue tightening 1/8 turn at a time in crisscross order (1, 4, 2, 5, 3, 6) until flange faces make contact.
- c. Further tighten each bolt about 1/16 turn.

**Step 3 Assemble and Connect the Wiring**

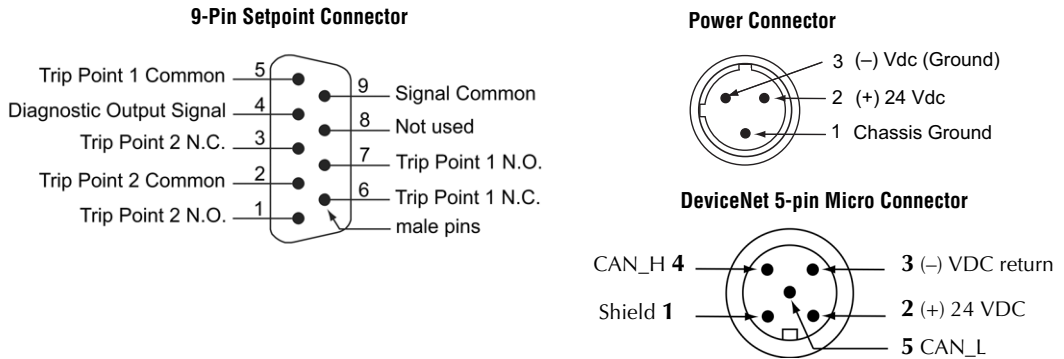
**Connecting Cables**

The cables are user-supplied. Brooks Automation does not supply cables. Install externally shielded cables.

Wiring connects to the power connector, the 9-pin I/O connector, and the DeviceNet 5-pin micro connector. See Figure 2-2, Table 2-1, and Table 2-2.

- Connect the module power-supply wiring and the relay wiring to the 9-pin I/O connector. See Figure 2-2
- Connect the DeviceNet power-supply and network wiring to the DeviceNet 5-pin micro connector. See Figure 2-2

**Figure 2-2 Power, Input/Output, and DeviceNet Connectors**



**CE Mark compliance**

For CE Mark compliance, use the following cable types (or equivalent):

**Cable to 9-pin I/O connector**

For the cable that connects to the 9-pin I/O connector, install shielded cable with aluminum jacket and a tinned copper braid with a minimum of 65% coverage.

On the module end of the cable, install a metal housing, so the shield is continuous from the cable to the gauge housing. Do not ground the shield at the receiver or output device.

Acceptable raw cable parts:

- Belden cable 9947.
- Alpha cable 5110/15C SL005.

Acceptable connector:

- Tyco series ADK for standard 9-pin subminiature-D connectors.

**DeviceNet Cable**

For the DeviceNet cable, install raw cable that has a braided shield over the aluminum foil-shielded signal and power wires.

On the module end of the cable, install a metal housing, so the shield is continuous from the cable to the gauge housing. Do not ground the shield at the receiver or output device.

- Acceptable raw cable is DeviceNet shielded cable type 578 from Turck.
- Acceptable connector is CM 8151-0 metal connector from Turck.

**Module Power Supply**

The customer supplied power supply should provide operating voltage and current to the Series 354 Micro-Ion Vacuum Gauge Module as specified in Table 2-1 and Table 2-2. Surge current is the maximum momentary current when power is first applied before the ion gauge is turned ON. Operating current is the steady-state current during normal operation with the ion gauge ON.

The Micro-Ion gauge will not activate and an emission error will occur if insufficient power is supplied during Micro-Ion gauge activation.

**Table 2-1 Ion Gauge Powered by DeviceNet**

Connector	Surge Current	Operating Current	Input Voltage
DeviceNet	2.0 A 8 ms	0.9 A	26 Vdc
DeviceNet	1.5 A 8 ms	1.5 A	11 Vdc

**Table 2-2 Ion Gauge Powered by Separate Power Connector**

Connector	Surge Current	Operating Current	Input Voltage
DeviceNet	1.3 A 20ms	0.1 A	26 Vdc
DeviceNet	1.0 A 20 ms	0.2 A	11 Vdc
Power	0.5 A 20 ms	0.8 A	26 Vdc
Power	0.5 A 10 ms	1.5 A	16 Vdc

**DeviceNet Wiring**

The module has a DeviceNet 5-pin micro connector for interfacing through the customer supplied DeviceNet network cable. See Figure 2-2. The DeviceNet connection is a standard 5-pin DeviceNet receptacle that accepts a standard micro 5-pin female cable connection.


Use terminals 2 (Vdc return) and 3 (24 Vdc) on the 5-pin DeviceNet micro connector for the network power supply.

- The DeviceNet interface requires 24 Vdc (11 to 26.4) at 0.2 A maximum.
- Maximum inrush current is 0.25 A.
- Power inputs are reverse-bias protected.

## Grounding

The module contains three separate and isolated grounds: the DeviceNet ground, the analog ground, and the chassis ground. Typical isolation between DeviceNet and chassis grounds is 1 M $\Omega$ .

The module generates 180 Vdc during normal operation and 250 Vdc during Micro-Ion gauge degas.

 **WARNING**

**Improper grounding could cause severe product failure or personal injury.**

Follow ground network requirements for the facility.

- Maintain all exposed conductors at earth ground.
- Ground the module housing to the vacuum chamber as illustrated below.
- Make sure the vacuum port to which the module is mounted is properly grounded.

### ***DeviceNet Grounding***

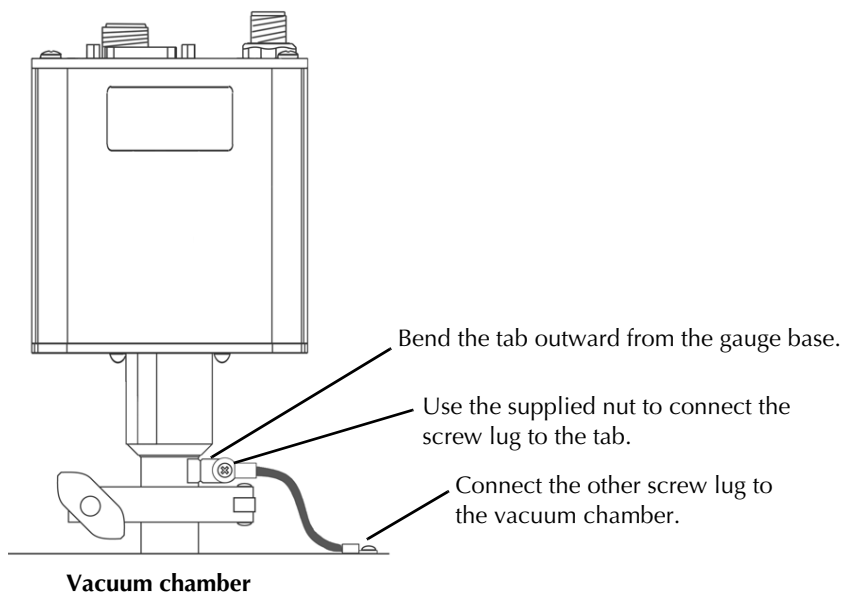
The DeviceNet wiring will be properly grounded via the DeviceNet 5-pin micro connector.

### ***Chassis Ground***

If the module has a VCR type fitting or ConFlat flange, the module chassis will be properly grounded via the vacuum chamber connection.

If the module has a KF flange, the module is shipped with a 3-foot length of braided copper wire, which has a screw lug on each end, and a screw and nut for connecting the copper wire to the gauge base. If a metal clamp and metal gasket will not be installed, follow this procedure to ground the module:

- a. The gauge base has a tab that allows a connection to the copper wire. Bend the tab outward from the gauge base (see Figure 2-3).
- b. Use the supplied screw and nut to connect one screw lug on the braided copper wire to the tab.
- c. Connect the other screw lug to an appropriately grounded point on the vacuum system.

**Figure 2-3 Vacuum Chamber Ground Connections**

### 2.3 Eliminating Radio Frequency Interference

The module has been tested and found to comply with U.S. Federal Communications Commission (FCC) limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits provide reasonable protection against harmful interference when the module operates in a commercial environment.

The module generates and can radiate radio frequency energy. If not installed and used in accordance with the instructions in this manual, the module may cause harmful interference to other electrical equipment.



## Chapter 3 DeviceNet Operation

### 3.1 DeviceNet Operation

The Series 354 Micro-Ion Module has one DeviceNet output and two trip point relays.

You may use polled I/O or explicit messages to read vacuum pressure or differential pressure, assign trip point relays to vacuum pressure or differential pressure, and configure the module

- Table 3-1 lists tasks that may be performed using DeviceNet polled I/O.
- Table 3-2 lists tasks that may be performed using DeviceNet explicit messages.
- For a complete list of DeviceNet messages used by the module, see Messaging Summary beginning on page 49 of this Chapter.

**Table 3-1 Tasks and page references for DeviceNet polled I/O**

Task	Instructions:
Read vacuum pressure	Page 35
Read differential pressure	Page 35
Turn OFF the Micro-Ion gauge	Page 41
Initiate or terminate Micro-Ion gauge degas	Page 42

**Table 3-2 Tasks and page references for DeviceNet explicit messages**

Task	Instructions:
Configure DeviceNet communications	Page 31
Set or get pressure unit	Page 34
Get vacuum pressure	Page 35
Set relay trip points	Page 36
Set relay activation direction	Page 36
Set relay hysteresis	Page 36
Set relay assignments	Page 36
Set disabled/enabled state of relays	Page 36
Get relay trip points	Page 39
Get disabled/enabled state of relays	Page 39
Get activation or deactivation status of relays	Page 40
Get relay hysteresis	Page 40
Set or get Micro-Ion gauge ON/OFF state	Page 41
Get Micro-Ion gauge active filament	Page 42

**Table 3-2** Tasks and page references for DeviceNet explicit messages

Task	Instructions:
Set or get Micro-Ion gauge degas ON/OFF state	Page 42
Set or get emission current switch point for Micro-Ion gauge	Page 43
Reset module to power-up state	Page 45
Get firmware version for module	Page 45
Get software and hardware revisions for module	Page 45
Get status alarms and warnings	Page 61

**WARNING**

**Using the module to measure the pressure of flammable or explosive gases can cause a fire or explosion resulting in severe property damage, personal injury, or death.**

Do not use the module to measure the pressure of flammable or explosive gases.

### 3.2 Preparing to Operate the Micro-Ion Gauge Module

Before putting the module into operation, you must perform the following procedures:

1. Install the module in accordance with the instructions on pages 17–23.
2. Develop a logic diagram of the process control function.
3. Develop a circuit schematic that specifies exactly how each piece of system hardware will connect to the module relays.
4. Attach a copy of the process control circuit diagram to this manual for future reference and troubleshooting.

If you need application assistance, phone a Granville-Phillips application engineer at 1-303-652-4400 or 1-800-776-6543 within the USA, or email [co-csr@brooks.com](mailto:co-csr@brooks.com).

- 3.3 Performance with DeviceNet Protocol** Table 3-3 lists performance characteristics for the Micro-Ion module using DeviceNet protocol.

**Table 3-3 Micro-Ion Module Performance Characteristics with DeviceNet Protocol**

Network Feature	Performance								
Network size	Up to 64 nodes (00 to 63)								
Network length	End-to-end network distance varies with speed								
	<table border="1"> <thead> <tr> <th>Baud rate</th> <th>Distance</th> </tr> </thead> <tbody> <tr> <td>• 125 kbaud</td> <td>• 1,640 feet (500 m)</td> </tr> <tr> <td>• 250 kbaud</td> <td>• 820 feet (250 m)</td> </tr> <tr> <td>• 500 kbaud</td> <td>• 328 feet (100 m)</td> </tr> </tbody> </table>	Baud rate	Distance	• 125 kbaud	• 1,640 feet (500 m)	• 250 kbaud	• 820 feet (250 m)	• 500 kbaud	• 328 feet (100 m)
Baud rate	Distance								
• 125 kbaud	• 1,640 feet (500 m)								
• 250 kbaud	• 820 feet (250 m)								
• 500 kbaud	• 328 feet (100 m)								
Bus topology	<ul style="list-style-type: none"> <li>• Linear (trunkline/dropline)</li> <li>• Power and signal on the same network cable</li> </ul>								
Bus addressing	<ul style="list-style-type: none"> <li>• Peer-to-peer with multi-cast (one-to-many)</li> <li>• Multi-master and master/slave special case</li> <li>• Polled or change-of-state (exception-based)</li> </ul>								
System features	<ul style="list-style-type: none"> <li>• Module can be removed and replaced while network power supply is ON</li> <li>• Module can be programmed while network power supply is ON (program changes will take effect after power has been cycled)</li> </ul>								

- 3.4 DeviceNet Protocol for the Micro-Ion Module** The Micro-Ion Module is based on the Open DeviceNet Vendors Association (ODVA) and S-Analog Sensor Object Class Subclass 01 (Instance Selector) standards. The Micro-Ion Module command set includes public and vendor-specific classes, services, and attributes.
- DeviceNet communication requires identifier fields for the data. The use of identifier fields provides the means for multiple priority levels, efficient transfer of I/O data, and multiple consumers. As a node in the network, the module produces data on the network with a unique address. All devices on the network that need the data listen for messages. When other devices on the network recognize the module's unique address, they use the data.
- For a complete list of DeviceNet messages used by the module, see *Messaging Summary* on page 49. The instructions in this chapter explain how to use the module command set to operate the module.
- 3.5 Operational Tasks** DeviceNet protocol conveys three types of messages, as defined in Table 3-4.
- Once the module is operating, you may use polled I/O or explicit messages

to perform the tasks listed in Table 3-4 and Table 3-5.

**Table 3-4 DeviceNet Message Types**

Message Type	Message Purpose
Polled I/O messages	<ul style="list-style-type: none"> <li>• Used for time critical, control oriented data</li> <li>• Provide a dedicated, special purpose communication path between a producing application and one or more consuming applications</li> </ul>
Change of state I/O messages	<ul style="list-style-type: none"> <li>• Used for time critical, control oriented data</li> <li>• Data transfer initiated by the producing application</li> <li>• Provide a dedicated, special purpose communication path between a producing application and one or more consuming applications</li> </ul>
Explicit messages	<ul style="list-style-type: none"> <li>• Provide multipurpose, point-to-point communication paths between two devices</li> <li>• Provide typical request/response oriented network communications used for performing node configuration and problem diagnosis</li> </ul>

**3.6 DeviceNet Switches and Indicators**

The Micro-Ion Module has address switches for setting the network address and a data rate switch for setting the baud rate.

**Address Switches**

Use the address switches to set the media access control identifier (MAC ID), which the network master uses to address the module. When the device powers up or is reset by the network, the device firmware will read the address switch settings. Figure 3-1 illustrates the address switches.

Specific address values range from 0 to 63.

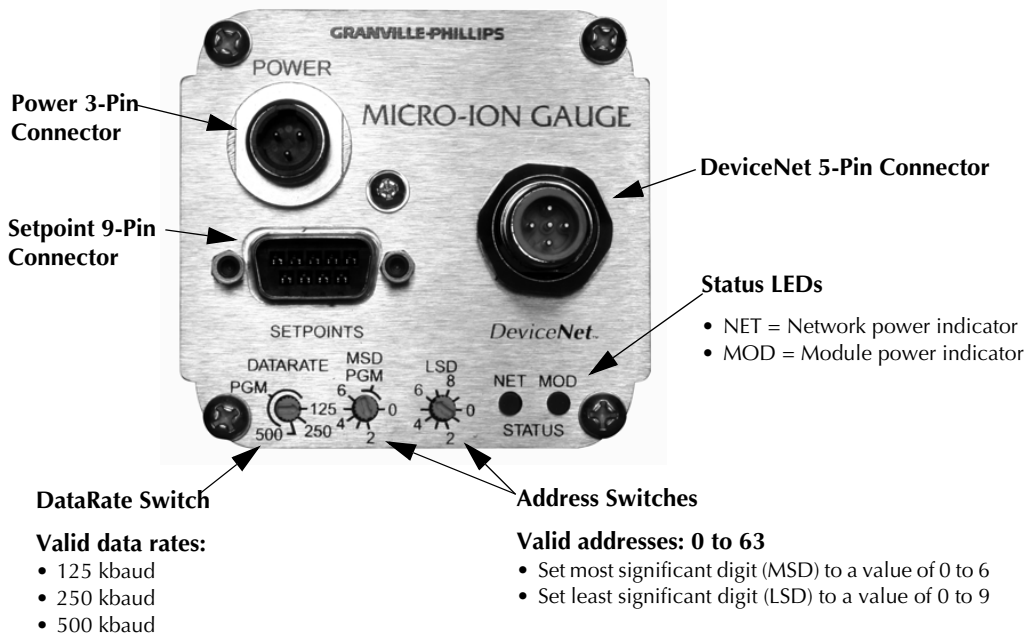
- Set the switch labeled “MSD,” to a value of 0 to 6 for the most significant (first) digit.
- Set the switch labeled “LSD,” to a value of 0 to 9 for the least significant (second) digit.

If a valid address between 0 and 63 is set, and it differs from the current address stored in non-volatile RAM (NVRAM), the new address will be saved in memory. If the data rate switch is set to the PGM setting, the firmware will use the data rate that is stored in NVRAM.

Upon connection to the DeviceNet network, the module requests a duplicate address check.

- If another device on the network has the same address as the module, the module will not join the network.
- If the address is unique, the module will join the network and the net status indicator will blink green until a connection to the master node is established.

Figure 3-1 Address Switches and Status LEDs

**DataRate Switch**

Use the DataRate switch to select the rate at which data is sent and received on the network.

- You may select a data rate of 125 kbaud, 250 kbaud, or 500 kbaud.
- When the device powers up or is reset by the network, the device firmware will read the rate switch setting.

If the selected data rate differs from the value stored in NVRAM, the new data rate will be saved in memory. If the rate switch is set to the P setting, the firmware will use the data rate that is stored in NVRAM.

**3.7 Status LEDs**

Figure 3-1 illustrates the two status LEDs, labeled NET and MOD.

- The MOD (module) status LED indicates if the module has power or is functioning properly.
- The NET (DeviceNet network) status LED indicates if the DeviceNet network has power and is functioning properly.

Table 3-5 and Table 3-6 list states for each LED and the corresponding network or module status.

**Table 3-5 NET (DeviceNet Network) LED Status**

NET LED State	Network Status	Description
OFF	Not powered	<ul style="list-style-type: none"> <li>The module is not on line</li> <li>The module has not completed the DUP_MAC_ID test</li> </ul>
Blinking green/red	Self test	Module is in self test
Blinking green	On line, not connected	The module has passed the DUP_MAC_ID test and is on line, but has not established connection with master node
Solid green	On line, connected	<ul style="list-style-type: none"> <li>The module is allocated to a master</li> <li>The device is operating normally</li> </ul>
Blinking red	Connection time out	All connections have timed out
Solid red	Critical link failure	The module has detected an error that has made it incapable of communicating on the network

**Table 3-6 MOD (Module) LED Status**

MOD LED State	Module Status	Description
OFF	Power OFF	No power applied to module
Blinking green/red	Self test	Module is in self test
Solid green	Operational	Module is operating normally
Solid red	Unrecoverable fault	Module has detected a fault

- 3.8 DeviceNet Communication Configuration**
1. Turn OFF the external power supply.
  2. Set the address switches to the desired address (0 to 63).
  3. Set the data rate switch to the desired setting (125, 250, or 500 kbaud).
  4. Turn ON the external power supply.
  5. Refer to Table 3-7 and Table 3-8 to allocate a connection for the module to the network master. **You must set the bit to 1 (polled) or 0 (explicit messages) to perform tasks explained in this chapter.**
    - Set the bit contents to 1 to enable polled I/O.
    - Set the bit contents to 0 to enable explicit messages.

**Table 3-7 Network Master Connection**

Service	Class	Instance	Attribute	Data Type	Allocation Choice Bits
4B <sub>hex</sub>	3	1	None	STRUCT	0=Explicit message 1=Polled 2=Bit strobed <sup>(a)</sup> 3=Reserved <sup>(a)</sup> 4=Change of state <sup>(a)</sup> 5=Cyclic <sup>(a)</sup> 6=Acknowledge suppression <sup>(a)</sup> 7=Connection <sup>(a)</sup>

<sup>(a)</sup> Not supported, value = 0.

**Table 3-8 Network master connections allocation choice bits**

Assembly Number	STRUCT Data: One Byte Format							
	Bit 7 Connection	Bit 6 Acknowledge suppression	Bit 5 0	Bit 4 0	Bit 3 Reserved	Bit 2 Bit strobed	Bit 1 Polled	Bit 0 Explicit message
1								

6. Refer to Table 3-9 to configure the expected packet rate for messages. The expected packet rate is the rate at which the module expects to send data to and receive a packet of data from the network.
  - The default expected packet rate for explicit messaging is 2500 msec (2.5 sec.).
  - For polled I/O, set the expected packet rate to 0 (none).
  - If data will be requested at a rate slower than every 2500 msec, you must change or disable the expected packet rate to prevent the connection from timing out.

**Table 3-9 Expected Packet Rate****Expected Packet Rate for Explicit Messaging**

Service	Class	Instance	Attribute	Master Data	Data type	Description
10 <sub>hex</sub>	5	1	9	data such as 09 C4 <sub>hex</sub> (default)	UINT	Rate at which module sends data to and receives data from network <ul style="list-style-type: none"> <li>• Default is 2500 msec (2.5 sec.)</li> <li>• Valid time is ≤ 2500 msec (2.5 sec.)</li> </ul>

**Expected packet rate for polled I/O**

Service	Class	Instance	Attribute	Master Data	Data Type	Description
10 <sub>hex</sub>	5	2	9	00 00	UINT	Disable expected packet rate

7. If the connection allocation bit 1 (polled) is set (see Step 5 on page 31), refer to Table 3-10 to configure the polled data input format and status byte and Table 3-11 to configure the polled data output format.
  - You may configure the module to send data to the network in unsigned integer (UINT), or floating point data (REAL) formats, with or without a status byte.
  - The default configuration sends pressure in floating point data format with one byte of status data.

**Table 3-10 Configuring Polled Input I/O Data Format**

Format	Service	Class	Instance	Attribute	UINT Data
2 bytes UINT vacuum pressure	10 <sub>hex</sub>	4	0	65 <sub>hex</sub>	01 <sub>hex</sub>
1 BYTE exception status 2 bytes UINT vacuum pressure	10 <sub>hex</sub>	4	0	65 <sub>hex</sub>	02 <sub>hex</sub>
4 bytes REAL vacuum pressure	10 <sub>hex</sub>	4	0	65 <sub>hex</sub>	04 <sub>hex</sub>
<b>Default configuration:</b> 1 BYTE exception status 4 bytes REAL vacuum pressure	10 <sub>hex</sub>	4	0	65 <sub>hex</sub>	05 <sub>hex</sub>

**Table 3-11 Configuring Polled Output I/O Data Format**

Format	Service	Class	Instance	Attribute	UINT data
1 BYTE control ( <b>default</b> )	0E <sub>hex</sub>	4	0	66 <sub>hex</sub>	01 <sub>hex</sub>
0 BYTE control	0E <sub>hex</sub>	4	0	66 <sub>hex</sub>	00 <sub>hex</sub>

8. If the connection allocation bit 1 (polled) is set (see Step 5 on page 31), you may configure the module to receive one byte of input data that controls the Micro-Ion Gauge, as listed in Table 3-12.

Bit 6 in the one byte format turns the Micro-Ion gauge ON or OFF. If bit 6 is set to 1, the gauge will turn ON. See Table 3-13.

**Table 3-12 Writing Micro-Ion Gauge Control Data - Polled I/O**

Assembly Number	USINT Data: One Byte Format							
	Bit 7 High Emission	Bit 6 Ion Gauge	Bit 5 Medium Emission	Bit 4 0	Bit 3 0	Bit 2 Enable Filament 2	Bit 1 Enable Filament 1	Bit 0 Initiate or terminate Micro-Ion gauge degas
1								

**Table 3-13 Micro-Ion Gauge Control Bits**

Parameter	Description
Degas	When Bit 0 is set to 1, degas will begin if the ion gauge is ON
Enable Filament 1	When Bit 1 is set to 1, filament 1 will turn on if the ion gauge is ON
Enable Filament 2	When bit 2 is set to 2, filament 1 will turn on when the gauge is ON. If both bits 1 and 2 are set to 1, both filaments will turn on when the gauge is ON. If both bits 1 and 2 are set to 0, the last programmed value will be used to turn on the filaments.
Bits 3 and 4	Reserved - should always be set to 0
Medium Emission	When bit 5 is set to 1, the ion gauge will operate at medium emission when the gauge is ON.
Ion Gauge	When bit 6 is set to 1, the ion gauge will be ON and allow a reading of pressure. If a fault condition occurs, the state of the ion gauge will be OFF and the fault condition must be cleared before pulling this bit to 0, then 1 again to light the ion gauge.
High Emission	When bit 7 is set to 1, the ion gauge will operate at high emission when the gauge is ON. The state of bit 5 is irrelevant when bit 7 is set to 1. If both bits 5 and 7 are set to 0, the ion gauge will operate at low emission.

**3.9 Pressure Units and Values**

You may use explicit messages to set the pressure unit.

You may use explicit messages or input polled I/O to read values that represent measured pressure. You must calculate measured pressure from the values represented by the explicit message or input polled I/O.

If you get pressure using input polled I/O or from the assembly object using explicit messaging, values are available with or without warning and alarm status or trip point status.

**Set or Get Pressure Unit**

Use the explicit messages listed in Table 3-14 to set or get the unit of pressure.

**Table 3-14 Pressure Measurement Units**

Service	Class	Instance	Attribute	Typical Device Data	Data Type	Description
0E <sub>hex</sub>	31 <sub>hex</sub>	1	4	01 03	UINT	Get pressure unit
10 <sub>hex</sub>	31 <sub>hex</sub>	1	4	01 03	UINT	Set pressure unit <ul style="list-style-type: none"> <li>• 769 = Torr</li> <li>• 776 = mbar</li> <li>• 777 = pascal</li> </ul>

**Data Conversion**

Refer to Table 3-15 to convert explicit message or input polled I/O data to meaningful values representing exception status, trip point status, vacuum pressure, or differential pressure.

**Table 3-15 Converting BYTE, UINT, INT, or REAL Data to Exception Status, Trip Point Status, or Pressure Values**

Represented Value	Data Type	Converting Data to Exception Status, Trip Point Status, or Pressure Value
Exception status	BYTE	8-bit string, from most significant to least significant bit: <ul style="list-style-type: none"> <li>• Bit 1 = Alarm</li> <li>• Bit 5 = Warning</li> </ul>
Trip point status	BYTE	8-bit string, from most significant to least significant bit: <ul style="list-style-type: none"> <li>• Bit 0 = Relay 1 is activated</li> <li>• Bit 1 = Relay 2 is activated</li> <li>• Bit 2 = Micro-Ion gauge emission current is 4.0 mA (high emission)</li> </ul>
Vacuum pressure	UINT	16-bit unsigned integer value from 0 to 65535, from integer count: $\text{Vacuum pressure} = 10^{(\text{Integer counts}/406.25) - 12.699}$
Vacuum pressure	REAL	32-bit floating point value in single precision IEEE 754 format, in pressure unit defined by the user (Torr, mbar, or pascal).

**Get Vacuum Pressure**

You may use explicit messages or input polled I/O to read values that represent measured pressure. You must calculate measured pressure from the values represented by the explicit message or input polled I/O.

If you get pressure using input polled I/O or from the assembly object using explicit messaging, values are available with or without warning and alarm status or trip point status.

**Using DeviceNet explicit messages:**

You may read measured pressure in the assembly object, analog sensor object (instance 0), analog sensor object Conductron sensor (instance 1), analog sensor object Micro-Ion gauge (instance 2), or analog sensor object differential pressure (instance 3).

- The explicit messages for each object are listed in Table 3-16.
- You *must* refer to Table 3-15 to convert the BYTE, UINT, INT, or REAL data to meaningful values representing exception status, trip point status, vacuum pressure, or differential pressure.

**Table 3-16 Explicit Messages for Measured Pressure Values**

**Pressure values are transmitted in low byte to high byte order.**

Service	Class	Instance	Attribute	Typical Device Data	Data Type	Description
0E <sub>hex</sub>	31 <sub>hex</sub>	1	6	BD 37 86 35 <sub>hex</sub>	REAL	Get REAL vacuum pressure from Micro-Ion gauge ( $1 \times 10^{-6}$ Torr)
0E <sub>hex</sub>	4	1	3	A1 0A <sub>hex</sub>	UINT	Get UINT vacuum pressure ( $1 \times 10^{-6}$ Torr)
0E <sub>hex</sub>	4	2	3	00 A1 0A <sub>hex</sub>	STRUCT	Get BYTE exception status Get UINT vacuum pressure
0E <sub>hex</sub>	4	4	3	BD 37 86 35 <sub>hex</sub>	REAL	Get REAL vacuum pressure ( $1 \times 10^{-6}$ Torr)
0E <sub>hex</sub>	4	5	3	00 BD 37 86 35 <sub>hex</sub>	STRUCT	Get BYTE exception status Get REAL vacuum pressure

**Using input polled I/O:**

When a master polls the module for measured pressure, the format of the returned pressure value depends on the data type. See Table 3-17.

- To configure the data format for input polled I/O, see Step 7 on page 32.
- You *must* refer to Table 3-15 to convert the BYTE, UINT, INT, or REAL data to meaningful values representing exception status, trip point status, vacuum pressure, or differential pressure.

**Table 3-17 Input Polled I/O for Pressure Values**

**Pressure values are transmitted in low byte to high byte order.**

Instance	Typical device data	Data type	Description
1	A1 0A <sub>hex</sub>	UINT	UINT vacuum pressure (1x10 <sup>-6</sup> Torr)
2	00 A1 0A <sub>hex</sub>	STRUCT	BYTE exception status UINT vacuum pressure
4	BD 37 86 35 <sub>hex</sub>	REAL	REAL vacuum pressure
5 (Default)	BD 37 86 35 <sub>hex</sub>	STRUCT	BYTE exception status REAL vacuum pressure(1x10 <sup>-6</sup> Torr)

**3.10 Process Control Relays**

You may use explicit messages to perform the following tasks:

- Setting or getting relay trip points
- Setting or getting relay activation direction (polarity)
- Setting or getting relay hysteresis
- Setting or getting relay assignments
- Setting or getting disabled/enabled state of relays

The module has two single-pole double-throw (normally open/normally closed) relays. Each relay can be independently assigned to vacuum or differential pressure. Each relay has a programmable activation direction and trip point. The trip point is a value representing pressure at which the relay activates.

- When the module is shipped from the factory, relay trip points are out of range, disabled, and will not operate.
- You must configure relays to make them operable.

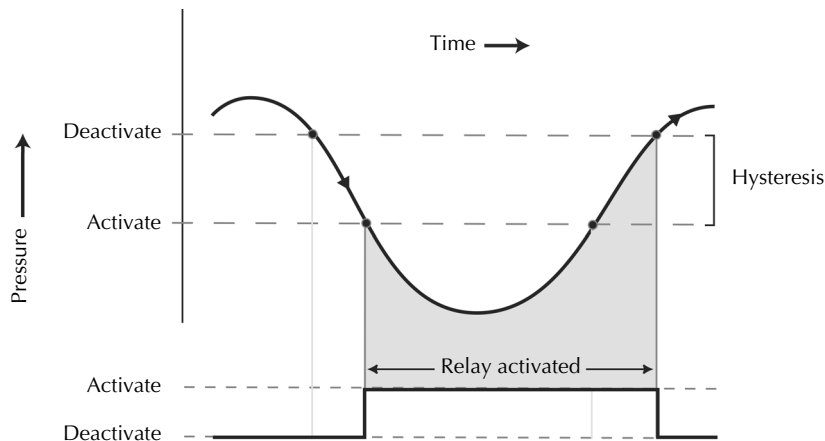
In default mode, trip point relays activate with decreasing pressure and deactivate at a higher pressure than the activation pressure, as illustrated in Figure 3-2.

You can reverse relay polarity, so trip point relays activate with increasing pressure and deactivate at a lower pressure than the activation pressure, as illustrated in Figure 3-3.

- You may change the deactivation pressure by entering REAL data that represents hysteresis as a percentage of the activation pressure.
- Valid hysteresis values are any activation pressure percentage, from 5% to 100%, that is divisible by 5.

Use the explicit messages listed in Table 3-19 to configure trip point relays.

**Figure 3-2 Default Behavior of Relays Activating with Decreasing Pressure**



**Figure 3-3 Default Behavior of Relays Activating with Increasing Pressure**

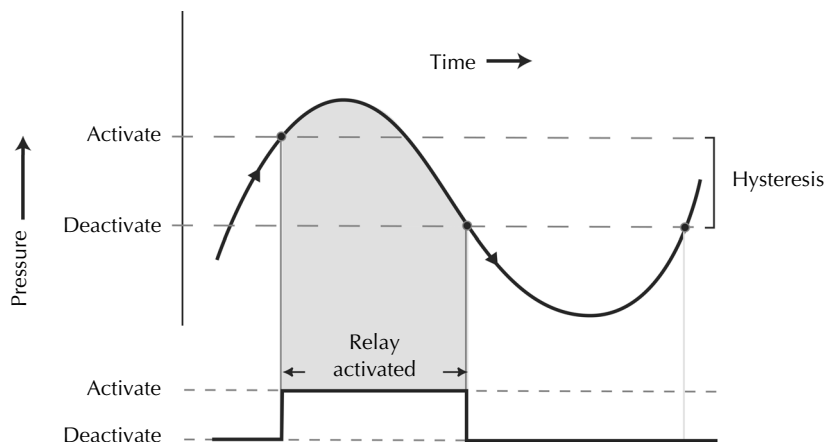


Table 3-18 lists minimum hysteresis for trip point relays based on the relay assignment.

**Table 3-18 Relay Assignments and Minimum Hysteresis**

Relay Assignment	Hysteresis
Vacuum pressure	5%

You can change the deactivation pressure by entering REAL data that represents hysteresis as a percentage of the activation pressure.

Use the explicit messages listed in Table 3-19 to configure trip point relays.

**Table 3-19 Trip Point Relay Configuration Commands**

**Trip Point Relay 1**

Service	Class	Instance	Attribute	Typical Master Data	Data Type	Description
10 <sub>hex</sub>	35 <sub>hex</sub>	1	5	BD 37 86 35 <sub>hex</sub> (1 x 10 <sup>-6</sup> )	REAL	Set pressure at which relay 1 activates
10 <sub>hex</sub>	35 <sub>hex</sub>	1	6	0	BOOL	1=Enable relay 1 0=Disable relay 1
10 <sub>hex</sub>	35 <sub>hex</sub>	1	8	0	BOOL	0 = Activate with decreasing pressure 1 = Activate with increasing pressure
10 <sub>hex</sub>	35 <sub>hex</sub>	1	0A <sub>hex</sub>	00 00 70 41 <sub>hex</sub> (15%)	REAL	Set hysteresis • Percentage of activation pressure
Service	Class	Instance	Attribute	Typical Device Data	Data Type	Description
0E <sub>hex</sub>	35 <sub>hex</sub>	1	0E <sub>hex</sub>	24 00	EPATH	Get relay 1 assignment • 24 00=Vacuum pressure

**Table 3-19 Trip Point Relay Configuration Commands (continued)****Trip Point Relay 2**

Service	Class	Instance	Attribute	Typical Master Data	Data Type	Description
10 <sub>hex</sub>	35 <sub>hex</sub>	2	5	BD 37 86 35 <sub>hex</sub> (1 x 10 <sup>-6</sup> )	REAL	Set pressure at which relay 2 activates
10 <sub>hex</sub>	35 <sub>hex</sub>	2	6	0	BOOL	1=Enable relay 2 0=Disable relay 2
10 <sub>hex</sub>	35 <sub>hex</sub>	2	8	0	BOOL	0 = Activate with decreasing pressure 1 = Activate with increasing pressure
10 <sub>hex</sub>	35 <sub>hex</sub>	2	0A <sub>hex</sub>	00 00 70 41 <sub>hex</sub> (15%)	REAL	Set hysteresis • Percentage of activation pressure
Service	Class	Instance	Attribute	Typical Device Data	Data Type	Description
0E <sub>hex</sub>	35 <sub>hex</sub>	2	0E <sub>hex</sub>	24 00	EPATH	Get relay 2 assignment • 24 00=Vacuum pressure

**Get Relay Trip Points**

Use the explicit messages listed in Table 3-20 to get the pressure value at which a relay activates.

**Table 3-20 Relay Trip Points**

Service	Class	Instance	Attribute	Typical Device Data	Data Type	Description
0E <sub>hex</sub>	35 <sub>hex</sub>	1	5	BD 37 86 35 <sub>hex</sub> (1 x 10 <sup>-6</sup> )	REAL	Get pressure at which relay 1 activates
0E <sub>hex</sub>	35 <sub>hex</sub>	2	5	BD 37 86 35 <sub>hex</sub> (1 x 10 <sup>-6</sup> )	REAL	Get pressure at which relay 2 activates

**Get Enable/Disable Status of Relays**

Use the explicit messages listed in Table 3-21 to get the enabled or disabled status of a relay.

After relays have been made operable, you may use explicit messages to disable any specified relay. If you disable a relay, you must re-enable it to make it operable. You must reconfigure the relay to re-enable it.

**Table 3-21 Relay Enabled/Disabled Status**

Service	Class	Instance	Attribute	Typical Device Data	Data Type	Description
0E <sub>hex</sub>	35 <sub>hex</sub>	1	6	0	BOOL	0 = Relay 1 is disabled 1 = Relay 1 is enabled
0E <sub>hex</sub>	35 <sub>hex</sub>	2	6	0	BOOL	0 = Relay 2 is disabled 1 = Relay 2 is enabled

**Get Activation or Deactivation Status of Relays**

Use the explicit messages listed in Table 3-22 to get the activation or deactivation state of a relay.

**Table 3-22 Relay Activation/Deactivation Status**

Service	Class	Instance	Attribute	Typical Device Data	Data Type	Description
0E <sub>hex</sub>	35 <sub>hex</sub>	1	7	0	BOOL	0 = Relay 1 is deactivated 1 = Relay 1 is activated
0E <sub>hex</sub>	35 <sub>hex</sub>	2	7	0	BOOL	0 = Relay 2 is deactivated 1 = Relay 2 is activated

**Get Relay Hysteresis**

Use the explicit messages listed in Table 3-23 to get the hysteresis for a relay. The returned value is a percentage of activation pressure.

**Table 3-23 Relay Hysteresis**

Service	Class	Instance	Attribute	Typical device data	Data type	Description
0E <sub>hex</sub>	35 <sub>hex</sub>	1	0A <sub>hex</sub>	00 00 70 41 <sub>hex</sub> (15%)	REAL	• Percentage of activation pressure
0E <sub>hex</sub>	35 <sub>hex</sub>	2	0A <sub>hex</sub>	00 00 70 41 <sub>hex</sub> (15%)	REAL	• Percentage of activation pressure

**3.11 Micro-Ion Gauge Controls**

You may use explicit messages to perform the following tasks:

- Turn the Micro-Ion gauge ON or OFF
- Get the Micro-Ion gauge ON/OFF state
- Set or get the Micro-Ion gauge active filament
- Set or get the Micro-Ion gauge degas ON or OFF state
- Set the emission current switch point for Micro-Ion gauge

You may use polled I/O to perform the following tasks:

- Turn the Micro-Ion gauge OFF/ON
- Initiate or terminate the Micro-Ion gauge degas
- Select filament 1 or 2
- Select emission level

**Turn the Micro-Ion Gauge ON or OFF**

You may use explicit messages or polled I/O to turn the Micro-Ion gauge OFF or ON.

**Using DeviceNet explicit messages:**

Use the explicit message listed in Table 3-24 to turn the Micro-Ion gauge OFF or ON.

**Table 3-24 Micro-Ion Gauge ON/OFF Command**

Service	Class	Instance	Attribute	Typical master data	Data type	Description
62 <sub>hex</sub>	31 <sub>hex</sub>	1	None	0	USINT	Set Micro-Ion gauge ON/OFF state <ul style="list-style-type: none"> <li>• 0 = Turn Micro-Ion gauge OFF</li> <li>• 1 = Turn Micro-Ion gauge ON</li> </ul>

**Using input polled I/O:**

The master can input data to the device to turn the Micro-Ion gauge OFF or ON. See Table 3-12 and Table 3-13 on page 33.

**Get Micro-Ion gauge ON/OFF Status**

Use the explicit message listed in Table 3-25 to get the Micro-Ion gauge ON/OFF status.

**Table 3-25 Micro-Ion Gauge ON/OFF Status**

Service	Class	Instance	Attribute	Typical device data	Data type	Description
0E <sub>hex</sub>	31 <sub>hex</sub>	1	5D <sub>hex</sub>	0	BOOL	0 = Micro-Ion Gauge is OFF 1 = Micro-Ion Gauge is ON

**Get or Set Active Filament**

Use the explicit message listed in Table 3-26 to get or set the active filament.

**Table 3-26 Active Filament**

Service	Class	Instance	Attribute	Typical Device Data	Data Type	Description
0E <sub>hex</sub>	31 <sub>hex</sub>	1	59 <sub>hex</sub>	1	USINT	Bit 0 = Get Filament 1 Bit 1 = Get Filament 2
Service	Class	Instance	Attribute	Typical Master Data	Data Type	Description
10 <sub>hex</sub>	31 <sub>hex</sub>	1	59 <sub>hex</sub>	1	USINT	Bit 0 = Set Filament 1 Bit 1 = Set Filament 2

**Initiate or Terminate Micro-Ion Gauge Degas**

You may use explicit messages or polled I/O to initiate or terminate the Micro-Ion gauge degas cycle.

**Using DeviceNet explicit messages:**

To degas the Micro-Ion Gauge, follow these steps:

1. Turn ON the Micro-Ion Gauge. (See page 41.)
2. Make sure vacuum pressure is lower than  $5 \times 10^{-5}$  Torr ( $6.66 \times 10^{-5}$  mbar,  $6.66 \times 10^{-3}$  pascal).
3. Refer to Table 3-27 and set the command bit to 1 (ON) to initiate the degas cycle. The time for gauge degas is two minutes.
4. *If you want to terminate the Micro-Ion Gauge degas cycle before it is completed, set the command bit to 0 (OFF).*

**Table 3-27 Micro-Ion Gauge Degas Commands**

Service	Class	Instance	Attribute	Typical Master Data	Data Type	Description
61 <sub>hex</sub>	31 <sub>hex</sub>	2	None	0	USINT	Set Micro-Ion degas state <ul style="list-style-type: none"> <li>• 0=Terminate degas cycle</li> <li>• 1=Initiate degas cycle</li> </ul>

**Using output polled I/O:**

The master can input data to the device to turn the degas function ON or OFF. Table 3-13 lists degas control bit.

**Get Micro-Ion Gauge Degas ON/OFF State**

Use the explicit message listed in Table 3-28 to get the Micro-Ion gauge degas state.

**Table 3-28 Micro-Ion Gauge Degas State**

Service	Class	Instance	Attribute	Typical Device Data	Data Type	Description
0E <sub>hex</sub>	31 <sub>hex</sub>	2	58 <sub>hex</sub>	0	USINT	<ul style="list-style-type: none"> <li>• 0=Degas is ON (in progress)</li> <li>• 1=Degas is OFF</li> </ul>

**Set or Get Micro-Ion Gauge Emission Current**

The Micro-Ion gauge can operate at three emission current levels.

- In low-emission mode, the current level is 0.02 mA.
- In medium-emission mode, the current level is 1 mA.
- In high-emission mode, the current level is 4 mA.

When vacuum pressure is low enough, set the gauge status to ON. The Micro-Ion gauge turns ON at the low emission current level (0.02 mA).

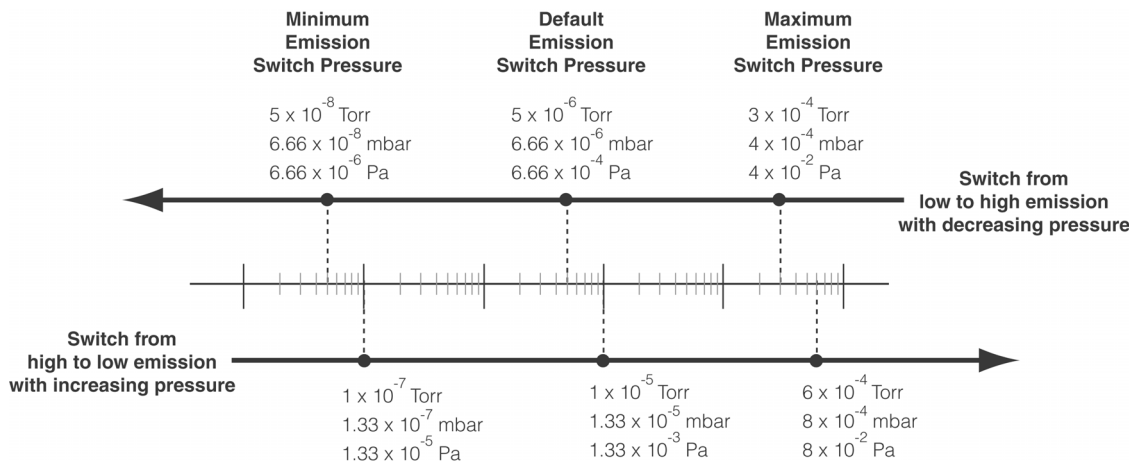
As pressure continues to decrease, the Micro-Ion gauge switches from low emission current to high emission current (4 mA). If pressure increases after the current level has gone from low to high, the gauge switches back to low emission current. Table 3-29 lists default, minimum, and maximum pressure values at which the gauge switches emission current levels.

**Table 3-29 Micro-Ion Gauge Emission Current Pressure Values**

Emission Current Setting	Default Switch Points
Switch to high emission current (4 mA) with decreasing pressure	$1 \times 10^{-5}$ Torr $6.66 \times 10^{-6}$ mbar $6.66 \times 10^{-4}$ pascal
Switch to low emission current (0.02 mA) with increasing pressure	$5 \times 10^{-5}$ Torr $1.33 \times 10^{-5}$ mbar $1.33 \times 10^{-3}$ pascal

The switch back to low emission current with increasing pressure is 500% greater than the switch to high emission current with decreasing pressure, as illustrated in Figure 3-4. For example, in default mode, the current level switches from low to high emission at  $1 \times 10^{-5}$  Torr ( $6.66 \times 10^{-6}$  mbar,  $6.66 \times 10^{-4}$  pascal), then switches back to low emission at  $5 \times 10^{-5}$  Torr ( $1.33 \times 10^{-5}$  mbar,  $1.33 \times 10^{-3}$  pascal).

Figure 3-4 Example Emission Current Switch Points



Use the explicit message listed in Table 3-30 to adjust the pressure value at which the Micro-Ion gauge switches from high emission (4.0 mA) to low emission (0.02 mA) with increasing pressure.

Table 3-30 Emission current switch point command

Service	Class	Instance	Attribute	Typical Master Data	Data Type	Description
10 <sub>hex</sub>	35 <sub>hex</sub>	3	5	AC C5 A7 36 <sub>hex</sub> ( $5 \times 10^{-6}$ Torr)		SET emission current switch point, emission ranging ( $5 \times 10^{-6}$ Torr)

Use the explicit command listed in Table 3-31 to get the emission current switch point.

Table 3-31 Emission Current Switch Point

Service	Class	Instance	Attribute	Typical Device Data	Data Type	Description
0E <sub>hex</sub>	35 <sub>hex</sub>	3	5	AC C5 A7 36 <sub>hex</sub> ( $5 \times 10^{-6}$ Torr)	REAL	GET emission current switch point, emission ranging ( $5 \times 10^{-6}$ Torr)

- 3.12 Reset Module to Power-up State** Use the explicit message listed in Table 3-32 to reset the module to power-up status.
- Resetting the module to power-up status has the same effect as cycling power to the module. Communication is re-enabled two seconds after you've sent the explicit message.

**Table 3-32 Reset to Power-up State Command**

Service	Class	Instance	Attribute	Master Data	Data Type	Description
05 <sub>hex</sub>	1	1	None	None	None	Reset module to power-up state

- 3.13 Get Firmware Version** Use the explicit messages listed in Table 3-33 to get the firmware version for the module.

**Table 3-33 Firmware Version Command**

Service	Class	Instance	Attribute	Device Data	Data Type	Description
0E <sub>hex</sub>	1	1	4	01 01	None	Get firmware version

- 3.14 Get Software and Hardware Revision Levels** Use the explicit messages listed in Table 3-34 to get the software and hardware revision levels for the module.

**Table 3-34 Software and Hardware Revision Commands**

Service	Class	Instance	Attribute	Device Data	Data Type	Description
0E <sub>hex</sub>	30 <sub>hex</sub>	1	7	"1.01"	SSTRING	Get software revision level
0E <sub>hex</sub>	30 <sub>hex</sub>	1	8	"1.01"	SSTRING	Get hardware revision level

**3.15 Factory Defaults**

Micro-Ion Modules are shipped with the default settings listed in Table 3-35. If options in your application require settings different from the factory defaults listed in Table 3-35, you may change the settings.

- Some settings can be changed only through the DeviceNet interface.
- You may reconfigure options before or after completing the basic setup procedures described in this chapter.

**Table 3-35 Factory Default Settings**

Parameter	Default Setting
Digital communication	Baud rate: 500 kbaud
Relay 1 trip point	Disabled
Relay 2 trip point	Disabled
Trip point polarity	<ul style="list-style-type: none"> <li>• 20% hysteresis</li> <li>• Polarity default set for decreasing pressure</li> </ul>
Micro-Ion gauge emission current switch point	<ul style="list-style-type: none"> <li>• 500% hysteresis</li> <li>• With decreasing pressure:  <math>1 \times 10^{-5}</math> Torr  <math>6.66 \times 10^{-6}</math> mbar  <math>6.66 \times 10^{-4}</math> pascal</li> <li>• With increasing pressure:  <math>5 \times 10^{-5}</math> Torr  <math>1.33 \times 10^{-5}</math> mbar  <math>1.33 \times 10^{-3}</math> pascal</li> </ul>
Unit of measure	As specified by the catalog number: <ul style="list-style-type: none"> <li>• T = Torr</li> <li>• M = mbar</li> <li>• P = pascal</li> </ul>

**3.16 DeviceNet Error Codes**

You may use DeviceNet explicit messages or polled I/O to find out if an alarm or warning has been reported. To select polled I/O or explicit messages, see page 31.

**Using Polled I/O**

An alarm or warning is indicated by the status byte in the input assembly, instance 2 or instance 5. An alarm is bit weight 1, and a warning is bit weight 5, as listed in Table 3-36.

**Table 3-36 Module Alarm and Warning Status for Polled I/O**

Instance	BYTE Data: One Byte Format							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2 or 5	0	0	Warning	0	0	0	Alarm	0

**Using Explicit Messages** Alarms, warnings, and status messages are available from the objects listed in Table 3-37.

**Table 3-37 DeviceNet Explicit Messages Indicating Alarms, Warning, or Status**

Object	Service	Class	Instance	Attribute
Identity object	0E <sub>hex</sub>	1	1	5
Device supervisor object	0E <sub>hex</sub>	30 <sub>hex</sub>	1	0C <sub>hex</sub>
Analog sensor object, instance 1, Micro-Ion gauge	0E <sub>hex</sub>	31 <sub>hex</sub>	1	5
Analog sensor object, instance 1, Micro-Ion gauge	0E <sub>hex</sub>	31 <sub>hex</sub>	1	7
Analog sensor object, instance 1, Micro-Ion gauge	0E <sub>hex</sub>	31 <sub>hex</sub>	1	5F <sub>hex</sub>
Analog sensor object, instance 1, Micro-Ion gauge	0E <sub>hex</sub>	31 <sub>hex</sub>	1	60 <sub>hex</sub>

**Table 3-38 Status and Fault Information from Identity Object**

Service	Class	Instance	Attribute	Typical Device Data	Data Type	Description
0E <sub>hex</sub>	1	1	5	00 00	WORD	Status and fault information
<b>Troubleshooting status and fault information</b>						
Instance	Attribute	Bit	Cause	Solution		
1	5	0	An object is allocated	No solution necessary		
1	5	2	Device is configured	No solution necessary		
1	5	8	Low electrometer reading	Module electronics failure or the gauge need to be degassed		
1	5	11	Unrecoverable fault	Replace the module assembly or send it to the factory for repair		

**Table 3-39 Exception Status from Device Supervisor Object**

Service	Class	Instance	Attribute	Typical Device Data	Data Type	Description
0E <sub>hex</sub>	30 <sub>hex</sub>	1	0C <sub>hex</sub>	0	BYTE	Get exception status
<b>Troubleshooting Exception Status</b>						
Instance	Attribute	Bit	Cause	Solution		
1	0C <sub>hex</sub>	1	Analog sensor alarm	Replace the module assembly or send it to the factory for repair		
1	0C <sub>hex</sub>	5	Low electrometer reading	Module electronics failure or the gauge need to be degassed		

**Table 3-40 Reading Valid, Status, Alarm, and Warning Information from Analog Sensor Object, Instance 1**

Service	Class	Instance	Attribute	Typical Device Data	Data Type	Description
0E <sub>hex</sub>	31 <sub>hex</sub>	1	5	1	BOOL	Get reading valid, 0 or 1
0E <sub>hex</sub>	31 <sub>hex</sub>	1	7	0	BYTE	Get status, alarm or warning
0E <sub>hex</sub>	31 <sub>hex</sub>	1	5F <sub>hex</sub>	0	BYTE	High-voltage or emission failure
0E <sub>hex</sub>	31 <sub>hex</sub>	1	60 <sub>hex</sub>	0	BYTE	Reading invalid <ul style="list-style-type: none"> <li>• 0=No solution necessary</li> <li>• 1=Get status from instance 1, attribute 7</li> </ul>
<b>Troubleshooting reading valid, status, alarm, and warning information</b>						
Instance	Attribute	Bit	Cause	Solution		
1	5	0	Reading is valid, Micro-Ion gauge is ON and operating normally	No solution necessary		
1	7	0	Micro-Ion gauge grid voltage or emission failure	Cycle power to module		
1	5F <sub>hex</sub>	Byte 0, bit 0	Micro-Ion gauge filament 1 failure	Switch to filament 2		
1	5F <sub>hex</sub>	Byte 0, bit 1	Micro-Ion gauge filament 2 failure	Switch to filament 1		
1	5F <sub>hex</sub>	Byte 1, bit 2	Micro-Ion gauge high-voltage failure	Cycle power to module		
12	60 <sub>hex</sub>	0	Reading invalid	0=No solution necessary 1=Get status from instance 2, attribute 7		
1	5F <sub>hex</sub>	Byte 1, bit 4	Overpressure shutdown	Reduce system pressure		

### 3.17 Messaging Summary

This messaging summary lists all of the possible DeviceNet Communications, including I/O and Explicit messages. Required, optional, and device specific objects are included.

**Table 3-41 Input I/O (to Master)**

Instance	Master Data	Device Data	Data Type	Description	Type
1	None	00 00	UINT	UINT vacuum pressure	Open
2	None	00 00 00	STRUCT	BYTE exception status UINT vacuum pressure	Open
4	None	00 00 00 00	REAL	REAL vacuum pressure	Open
5	None	00 00 00 00 00	STRUCT	BYTE exception status REAL vacuum pressure	Open

**Table 3-42 Output I/O (from Master)**

Instance	Master Data	Device Data	Data Type	Description	Type
1	00	None	BYTE	Bit 1 = F.11 enable Bit 2 = F.12 enable Bit 5 = Medium emission Bit 6 = Micro-Ion gauge ON Bit 7 = High emission Bit 0 = Degas ON	Vendor

### 3.18 Explicit Message Summary

**Table 3-43 Identity Object**

Service	Class	Instance	Attribute	Master Data	Device Data	Data type	Description	Type
0E <sub>hex</sub>	1	1	1	None	00 5C <sub>hex</sub>	UINT	Vendor identification	Open
0E <sub>hex</sub>	1	1	2	None	00 1C <sub>hex</sub>	UINT	Product type	Open
0E <sub>hex</sub>	1	1	3	None	01 00	UINT	354 product ID	Open
0E <sub>hex</sub>	1	1	4	None	01 01	STRUCT	Firmware revision	Open
0E <sub>hex</sub>	1	1	5	None	00 00	WORD	Status and fault information	Open
0E <sub>hex</sub>	1	1	6	None	00 00 00 00	UDINT	Serial number	Open
0E <sub>hex</sub>	1	1	7	None	"GP354"	S_STRING	Identification	Open
05 <sub>hex</sub>	1	1	None	None	None		Reset module to power-up state	Open

Table 3-44 DeviceNet Object

Service	Class	Instance	Attribute	Master Data	Device Data	Data Type	Description	Type
0E <sub>hex</sub>	3	0	1	None	00 02	UINT	Object revision	Open
0E <sub>hex</sub>	3	1	1	None	0	USINT	Get node address, range 0–63	Open
10 <sub>hex</sub>	3	1	1	0	Success		Set node address if switch set to “PGM”	Open
0E <sub>hex</sub>	3	1	2	None	0	USINT	Get baud rate, range 0–2	Open
10 <sub>hex</sub>	3	1	2	0	Success		Set baud rate if switch set to “PGM”	Open
0E <sub>hex</sub>	3	1	3	None	0	BOOL	Get bus-off interrupt, range 0–1	Open
0E <sub>hex</sub>	3	1	4	None	0	USINT	Get bus-off counter, range 0–255	Open
10 <sub>hex</sub>	3	1	4	0	Success		Set bus-off counter	Open
0E <sub>hex</sub>	3	1	5	None	00 00	STRUCT	Get allocation choice, range 0–3 Get master ID, range 0–63	Open
4B <sub>hex</sub>	3	1	None	03 00	Success	STRUCT	Set allocation choice, range 0–3 Set master ID, range 0–63	Open
4C <sub>hex</sub>	3	1	None	3	Success	BYTE	Release allocation, range 0–3	Open

Table 3-45 Assembly Object

Service	Class	Instance	Attribute	Master Data	Device Data	Data Type	Description	Type
0E <sub>hex</sub>	4	0	65 <sub>hex</sub>	None	5	USINT	Get I/O produced instance selection, range 1–20	Vendor
10 <sub>hex</sub>	4	0	65 <sub>hex</sub>	5	Success	USINT	Set I/O produced instance selection, range 1–20	Vendor
0E <sub>hex</sub>	4	0	66 <sub>hex</sub>	None	1	USINT	Get I/O consumed instance selection, range 0 or 1	Vendor
10 <sub>hex</sub>	4	0	66 <sub>hex</sub>	1	Success	USINT	Set I/O consumed instance selection, range 0 or 1	Vendor
0E <sub>hex</sub>	4	1	3	None	00 00	UINT	Get UINT vacuum pressure	Open
10 <sub>hex</sub>	4	2	3	00	Success	STRUCT	Set IG state	Vendor
0E <sub>hex</sub>	4	2	3	None	00 00 00	STRUCT	Get BYTE exception status Get UINT vacuum pressure	Open
0E <sub>hex</sub>	4	4	3	None	00 00 00 00	REAL	Get REAL pressure	Open
0E <sub>hex</sub>	4	5	3	None	00 00 00 00 00	STRUCT	Get BYTE exception status Get REAL vacuum pressure	Open

Table 3-46 Connection Object, Explicit Message Connection

Service	Class	Instance	Attribute	Master Data	Device Data	Data Type	Description	Type
0E <sub>hex</sub>	5	1	1	None	3	USINT	Get state of the object, range 0–5	Open
0E <sub>hex</sub>	5	1	2	None	0	USINT	Get instance type, explicit	Open
0E <sub>hex</sub>	5	1	3	None	83 <sub>hex</sub>	BYTE	Get transport class trigger	Open
0E <sub>hex</sub>	5	1	4	None	FB 05	UINT	Get produced connection ID	Open
0E <sub>hex</sub>	5	1	5	None	FC 05	UINT	Get consumed connection ID	Open
0E <sub>hex</sub>	5	1	6	None	21 <sub>hex</sub>	BYTE	Get initial communication characteristics	Open
0E <sub>hex</sub>	5	1	7	None	18 00	UINT	Get produced connection size	Open
0E <sub>hex</sub>	5	1	8	None	18 00	UINT	Get consumed connection size	Open
0E <sub>hex</sub>	5	1	9	None	C4 <sub>hex</sub> 09	UINT	Get expected packet rate, range 0–65535	Open
10 <sub>hex</sub>	5	1	9	00 00	Success	UINT	Set expected packet rate	Open
0E <sub>hex</sub>	5	1	0C <sub>hex</sub>	None	1	USINT	Get watchdog timeout action, 1 or 3	Open
10 <sub>hex</sub>	5	1	0C <sub>hex</sub>	0	Success	UINT	Set watchdog timeout action	Open
0E <sub>hex</sub>	5	1	0D <sub>hex</sub>	None	00 00	UINT	Get produced connection path length	Open
0E <sub>hex</sub>	5	1	0E <sub>hex</sub>	None	4	EPATH	Get produced connection path	Open
0E <sub>hex</sub>	5	1	0F <sub>hex</sub>	None	00 00	UINT	Get consumed connection path length	Open
0E <sub>hex</sub>	5	1	10 <sub>hex</sub>	None	4	EPATH	Get consumed connection path	Open
0E <sub>hex</sub>	5	1	11 <sub>hex</sub>	None	00 00	UINT	Get production inhibit time	Open
05 <sub>hex</sub>	5	1	None	None	Success	None	Reset inactivity/watchdog timer	Open

**Table 3-47 Connection Object, I/O Connection**

Service	Class	Instance	Attribute	Master Data	Device Data	Data Type	Description	Type
0E <sub>hex</sub>	5	2	1	None	3	USINT	Get state of the object, range 0–5	Open
0E <sub>hex</sub>	5	2	2	None	1	USINT	Get instance type, I/O	Open
0E <sub>hex</sub>	5	2	3	None	82 <sub>hex</sub>	BYTE	Get transport class trigger	Open
0E <sub>hex</sub>	5	2	4	None	FF 03	UINT	Get produced connection ID	Open
0E <sub>hex</sub>	5	2	5	None	FD 05	UINT	Get consumed connection ID	Open
0E <sub>hex</sub>	5	2	6	None	01 <sub>hex</sub>	BYTE	Get initial communication characteristics	Open
0E <sub>hex</sub>	5	2	7	None	05 00	UINT	Get produced connection size	Open
0E <sub>hex</sub>	5	2	8	None	01 00	UINT	Get consumed connection size	Open
0E <sub>hex</sub>	5	2	9	None	00 00	UINT	Get expected packet rate, range 0–65535	Open
10 <sub>hex</sub>	5	2	9	00 00	Success	UINT	Set expected packet rate	Open
0E <sub>hex</sub>	5	2	0C <sub>hex</sub>	None	0	USINT	Get watchdog timeout action	Open
0E <sub>hex</sub>	5	2	0D <sub>hex</sub>	None	06 00	UINT	Get produced connection path length	Open
0E <sub>hex</sub>	5	2	0E <sub>hex</sub>	None	5	EPATH	Set produced connection path length, 1–5 or 15–20	Open
0E <sub>hex</sub>	5	2	0F <sub>hex</sub>	None	06 00	UINT	Get consumed connection path length	Open
0E <sub>hex</sub>	5	2	10 <sub>hex</sub>	None	1	EPATH	Set consumed connection path length, 0 or 1	Open
05 <sub>hex</sub>	5	1	None	None	Success	None	Reset inactivity/watchdog timer	Open

Table 3-48 Device Supervisor Object

Service	Class	Instance	Attribute	Master Data	Device Data	Data Type	Description	Type
0E <sub>hex</sub>	30 <sub>hex</sub>	1	3	None	"VG"	SSTRING	Get device type, combination gauge	Open
0E <sub>hex</sub>	30 <sub>hex</sub>	1	4	None	"E54-0997"	SSTRING	Get revision level, SEMI S/A standard	Open
0E <sub>hex</sub>	30 <sub>hex</sub>	1	5	None	""	SSTRING	Get manufacturer's name, "GRANVILLE-PHILLIPS"	Open
0E <sub>hex</sub>	30 <sub>hex</sub>	1	6	None	"354XXX"	SSTRING	Get manufacturer's model number	Open
0E <sub>hex</sub>	30 <sub>hex</sub>	1	7	None	"1.01"	SSTRING	Get software revision level	Open
0E <sub>hex</sub>	30 <sub>hex</sub>	1	8	None	"1.01"	SSTRING	Get hardware revision level	Open
0E <sub>hex</sub>	30 <sub>hex</sub>	1	0B <sub>hex</sub>	None	4	USINT	Get device status	Open
0E <sub>hex</sub>	30 <sub>hex</sub>	1	0C <sub>hex</sub>	None	0	BYTE	Get exception status	Open
0E <sub>hex</sub>	30 <sub>hex</sub>	1	0F <sub>hex</sub>	None	0	BOOL	Get alarm enable	Open
10 <sub>hex</sub>	30 <sub>hex</sub>	1	0F <sub>hex</sub>	0	Success		Set alarm enable	
0E <sub>hex</sub>	30 <sub>hex</sub>	1	10 <sub>hex</sub>	None	0	BOOL	Get warning enable	Open
10 <sub>hex</sub>	30 <sub>hex</sub>	1	10 <sub>hex</sub>	0	Success		Set warning enable	
05 <sub>hex</sub>	30 <sub>hex</sub>	1	None	None	Success	None	Reset object service	Open
06 <sub>hex</sub>	30 <sub>hex</sub>	1	None	None	Success	None	Start device execution (No effect on device)	Open
4B <sub>hex</sub>	30 <sub>hex</sub>	1	None	None	Success	None	Abort device activity (No effect on device)	Open
4C <sub>hex</sub>	30 <sub>hex</sub>	1	None	None	Success	None	Recover from abort state (No effect on device)	Open
4D <sub>hex</sub>	30 <sub>hex</sub>	1	None	None	Success	None	Perform diagnostics (No effect on device)	Open

Table 3-49 Analog Sensor Object, Instance 0

Service	Class	Instance	Attribute	Master Data	Device Data	Data Type	Description	Type
0E <sub>hex</sub>	31 <sub>hex</sub>	0	5E <sub>hex</sub>	None	00 00 00 00	REAL	Active value, vacuum pressure	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	0	5F <sub>hex</sub>	None	01 00	UINT	Active instance number, 1 or 2	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	0	60 <sub>hex</sub>	None	3	USINT	Number of gauges, 2 or 3	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	0	63 <sub>hex</sub>	None	1	UINT	Instance selector, 1 for combination gauge	Open

Table 3-50 Analog Sensor Object, Instance 1, Micro-Ion Gauge

Service	Class	Instance	Attribute	Master Data	Device Data	Data Type	Description	Type
0E <sub>hex</sub>	31 <sub>hex</sub>	1	4	None	01 03	UINT	Get pressure unit, 769 = Torr 776 = mbar, 777 = pascal	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	5	None	1	BOOL	Get reading valid, 0 or 1	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	6	None	00 00 00 00	REAL	Get pressure reading (Value)	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	7	None	0	BYTE	Get status, alarm or warning	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	0B <sub>hex</sub>	None	CA <sub>hex</sub>	USINT	Get offset A data type	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	0C <sub>hex</sub>	None	00 00 00 00	REAL	Get offset A - an amount added prior to gain to derive value	Open
10 <sub>hex</sub>	31 <sub>hex</sub>	1	0C <sub>hex</sub>	00 00 00 00	Success	REAL	Set offset A - Do Not change this attribute	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	0D <sub>hex</sub>	None	CA <sub>hex</sub>	USINT	Get gain data type	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	0E <sub>hex</sub>	None	00 00 00 00	REAL	Get gain - an amount scaled to derive value	Open
10 <sub>hex</sub>	31 <sub>hex</sub>	1	0E <sub>hex</sub>	00 00 00 00	Success	REAL	Set gain - Do Not change this attribute	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	0F <sub>hex</sub>	None	00 00 00 00	REAL	Get unity gain resequence - value of gain attribute equal to gain of 1.0	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	11 <sub>hex</sub>	None	AC C5 A7 37	REAL	Get alarm trip point high - the ion current value above which an alarm will occur and turn OFF the IG	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	23 <sub>hex</sub>	None	00	UINT	Get gas calibration object instance 0 = disabled	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	58 <sub>hex</sub>	None	0	BOOL	Get degas state	Open
10 <sub>hex</sub>	31 <sub>hex</sub>	1	58 <sub>hex</sub>	0	Success	BOOL	Set degas state 0 = Degas is OFF, 1 = Degas is ON	Vendor
0E <sub>hex</sub>	31 <sub>hex</sub>	1	59 <sub>hex</sub>	None	0	USINT	Get active filament Bit 01 = filament 1, Bit 02 = filament 2 Bit 03 = both filaments	Open
10 <sub>hex</sub>	31 <sub>hex</sub>	1	59 <sub>hex</sub>	01	Success	USINT	Set active filament Bit 01 = filament 1, Bit 02 = filament 2 Bit 03 = both filaments	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	5A <sub>hex</sub>	None	00 00 A0 41	REAL	Get sensitivity - Range 2 to 128 - Default = 20	Open
10 <sub>hex</sub>	31 <sub>hex</sub>	1	5A <sub>hex</sub>	00 00 A0 41	Success	REAL	Set sensitivity	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	5B <sub>hex</sub>	None	6F 12 83 3A	REAL	Get emission current Example, 1 mA	Open
10 <sub>hex</sub>	31 <sub>hex</sub>	1	5B <sub>hex</sub>	6F 12 83 3B	Success	REAL	Set emission current 20µA, 1mA, 4mA	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	5D <sub>hex</sub>	None	0	BOOL	Get Micro-Ion gauge ON/OFF state	Open

**Table 3-50 Analog Sensor Object, Instance 1, Micro-Ion Gauge**

10 <sub>hex</sub>	31 <sub>hex</sub>	1	5D <sub>hex</sub>	0	Success	BOOL	Set Micro-Ion gauge ON/OFF state 0 = Turn gauge OFF 1 = Turn gauge ON	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	5F <sub>hex</sub>	None	00 00	UINT	Get sensor alarm	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	60 <sub>hex</sub>	None	1	BYTE	Get status extension	Open
0E <sub>hex</sub>	31 <sub>hex</sub>	1	63 <sub>hex</sub>	None	05 00	UINT	Get subclass number	Open
61 <sub>hex</sub>	31 <sub>hex</sub>	1	None	0	Success	USINT	Set degas state 0 = Degas is OFF, 1 = Degas is ON	Open
62 <sub>hex</sub>	31 <sub>hex</sub>	1	None	0	Success	USINT	Set Micro-Ion gauge ON/OFF state 0 = Turn gauge OFF 1 = Turn gauge ON	Open
63 <sub>hex</sub>	31 <sub>hex</sub>	1	None	None	Success	None	Clear emission OFF alarm	Open

**Table 3-51 S-Gas Calibration Object**

Service	Class	Instance	Attribute	Master Data	Device Data	Data Type	Description	Type
0E <sub>hex</sub>	34 <sub>hex</sub>	1	3	None	0D <sub>hex</sub>	UINT	Gas type number	Open
0E <sub>hex</sub>	34 <sub>hex</sub>	1	4	None	1	UINT	S-Analog Sensor object instance ID for which this object instance is valid.	Open

**Gas Standard Number**

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

The actual coding of the values are described in the following publication:  
See introduction section for reference to “Practice for Referencing Gases Used in Digital Mass Flow Controllers”.

**Common Services**

The S-Gas Calibration Object provides the following Common Services:

**Table 3-52 Common Services**

Service Code	Service Name	Description of Service
14 (0Ex)	Get_Attribute_Single	Returns the contents of the specified attribute.
16 (10x)	Set_Attribute_Single	Modifies an attribute value.

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

## Object-Specific Services

Table 3-53 Object Specific Services

Service Code	Service Name	Description of Service
4BX	Get All Instances	Return numbers of gas calibration (0) since this is the only one.

Table 3-54 Trip Point Object, Instance 1, Relay 1

Service	Class	Instance	Attribute	Master data	Device data	Data Type	Description	Type
0E <sub>hex</sub>	35 <sub>hex</sub>	1	5	None	00 00 00 00	REAL	Get pressure at which relay 1 activates	Open
10 <sub>hex</sub>	35 <sub>hex</sub>	1	5	00 00 00 00	Success	REAL	Set pressure at which relay 1 activates	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	1	6	None	0	BOOL	Get relay 1 enabled/disabled status 0 = Relay 1 is disabled 1 = Relay 1 is enabled	Open
10 <sub>hex</sub>	35 <sub>hex</sub>	1	6	0	Success	BOOL	Set relay 1 enabled/disabled status	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	1	7	None	0	BOOL	Get relay 1 activation/deactivation status 0 = Relay 1 is deactivated 1 = Relay 1 is activated	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	1	8	None	0	BOOL	Get relay 1 polarity 0 = Activate with decreasing pressure 1 = Activate with increasing pressure	Open
10 <sub>hex</sub>	35 <sub>hex</sub>	1	8	0	Success	BOOL	Set relay 1 polarity	
0E <sub>hex</sub>	35 <sub>hex</sub>	1	9	None	0	USINT	Get override status 0 = Normal 2 = Force false	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	1	0A <sub>hex</sub>	None	00 00 00 00	REAL	Get relay 1 hysteresis as a percentage of pressure.	Open
10 <sub>hex</sub>	35 <sub>hex</sub>	1	0A <sub>hex</sub>	0	Success	REAL	Set relay 1 hysteresis	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	1	0C <sub>hex</sub>	None	24 01	EPATH	Get destination path, 01	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	1	0D <sub>hex</sub>	None	0	BOOL	Get output to output object	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	1	0E <sub>hex</sub>	None	24 00	EPATH	Get source path from analog object	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	1	0F <sub>hex</sub>	None	00 00 24 00	REAL	Get input data from analog sensor object	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	1	11 <sub>hex</sub>	None	CA <sub>hex</sub>	USINT	Get data type, CA <sub>hex</sub>	Open

Table 3-55 Trip Point Object, Instance 2, Relay 2

Service	Class	Instance	Attribute	Master Data	Device Data	Data Type	Description	Type
0E <sub>hex</sub>	35 <sub>hex</sub>	2	5	None	00 00 00 00	REAL	Get pressure at which relay 2 activates	Open
10 <sub>hex</sub>	35 <sub>hex</sub>	2	5	00 00 00 00	Success	REAL	Set pressure at which relay 2 activates	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	2	6	None	0	BOOL	Get relay 2 enabled/disabled status 0 = Relay 2 is disabled 1 = Relay 2 is enabled	Open
10 <sub>hex</sub>	35 <sub>hex</sub>	2	6	0	Success	BOOL	Set relay2 enabled/disabled status	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	2	7	None	0	BOOL	Get relay 2 activation/deactivation status 0 = Relay 2 is deactivated 1 = Relay 2 is activated	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	2	8	None	0	BOOL	Get relay 2 polarity 0 = Activate with decreasing pressure 1 = Activate with increasing pressure	Open
10 <sub>hex</sub>	35 <sub>hex</sub>	2	8	0	Success	BOOL	Set relay 2 polarity	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	2	9	None	0	USINT	Get override status 0 = Normal 2 = Force false	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	2	0A <sub>hex</sub>	None	00 00 00 00	REAL	Get relay 2 hysteresis as a percentage of pressure.	Open
10 <sub>hex</sub>		2	0A <sub>hex</sub>	0	Success	REAL	Set relay 2 hysteresis	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	2	0C <sub>hex</sub>	None	24 02	EPATH	Get destination path, 01	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	2	0D <sub>hex</sub>	None	0	BOOL	Get output to output object	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	2	0E <sub>hex</sub>	None	24 00	EPATH	Get source path from analog object	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	2	0F <sub>hex</sub>	None	00 00 24 00	REAL	Get input data from analog sensor object	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	2	11 <sub>hex</sub>	None	CA <sub>hex</sub>	USINT	Get data type, CA <sub>hex</sub>	Open

**Table 3-56 Trip Point Object, Instance 3, Emission Range**

Service	Class	Instance	Attribute	Master Data	Device Data	Data Type	Description	Type
0E <sub>hex</sub>	35 <sub>hex</sub>	3	5	None	38 D1 B7 17 <sub>hex</sub>	REAL	GET trip point value emission ranging (5E <sup>-6</sup> )	Open
10 <sub>hex</sub>	35 <sub>hex</sub>	3	5	38 D1 B7 17 <sub>hex</sub>	Success	REAL	SET trip point value, emission ranging (5E <sup>-6</sup> )	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	43	6	None	0	BOOL	GET trip point enable, emission ranging	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	3	7	None	0	BOOL	GET trip point status, emission ranging	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	3	9	None	0	USINT	GET override status, 0 = normal, 1 = force false	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	3	0C <sub>hex</sub>	None	24 04	EPATH	GET destination path, 01, 02, or 03	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	3	0D <sub>hex</sub>	None	0	BOOL	GET output to output object	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	3	0E <sub>hex</sub>	None	24 02	EPATH	GET source path from analog object	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	3	0F <sub>hex</sub>	None	00 00 00 00	REAL	GET REAL pressure data from analog sensor object (5E <sup>-6</sup> )	Open
0E <sub>hex</sub>	35 <sub>hex</sub>	3	11 <sub>hex</sub>	None	CA <sub>hex</sub>	USINT	GET data type, CA <sub>hex</sub> or C3 <sub>hex</sub>	Open

## Chapter 4 Maintenance

### 4.1 Customer Service

For customer service:

- Phone **1-303-652-4400** or **1-800-776-6543** within the USA.
- Phone **1-800-367-4887** 24 hours per day, 7 days per week within the USA.
- Email [co-csr@brooks.com](mailto:co-csr@brooks.com)
- For Global Customer Support, go to [www.brooks.com](http://www.brooks.com), click on Contact Us, then click on Global Offices to locate the Brooks Automation office nearest you.

### Damage Requiring Service

*Shut off power to the module* and refer servicing to qualified service personnel under the following conditions:

- The product has been exposed to rain or water.
- The product does not operate normally, even if you have followed the operation instructions. Operate only those controls that are covered in the instruction manual.
- The product has been dropped or the module enclosure has been damaged.
- The product exhibits a distinct change in performance.

If the module requires repair:

- See Section 4.5 Returning a Micro-Ion Module for Service on page 64
- Phone **1-303-652-4400** or **1-800-776-6543** within the USA, or
- email [co-csr@brooks.com](mailto:co-csr@brooks.com).

### 4.2 Troubleshooting

If any of the conditions described above have occurred, troubleshooting is required to determine the repairs that are necessary.

**Precautions**

Because the module contains static-sensitive electronic parts, follow these precautions while troubleshooting:

- Use a grounded, conductive work surface. Wear a high impedance ground strap for personal protection.
- Do not operate the module with static sensitive devices or other components removed from the product.
- Do not handle static sensitive devices more than absolutely necessary, and only when wearing a ground strap.
- Rely on voltage measurements for troubleshooting module circuitry. Do not use an ohmmeter.
- Use a grounded, electrostatic discharge safe soldering iron.

**Substitution or modifying parts can result in severe product damage or personal injury due to electrical shock or fire.**

- Install only those replacement parts that are specified by Granville–Phillips.
- Do not install substitute parts or perform any unauthorized modification to the module.
- Do not use the module if unauthorized modifications have been made.

**Failure to perform a safety check after the module has been repaired can result in severe property damage or personal injury due to electrical shock or fire.**

**If the module has been repaired, before putting it back into operation, make sure qualified service personnel perform a safety check.**

**Table 4-1 Failure Symptoms, Causes, and Solutions**

Symptom	Possible Causes	Solution
Pressure reading is too high.	Plumbing to module leaks or is contaminated. Chamber pressure is too high due to leak, contamination, or pump failure. Power supply or output cable is improperly connected or faulty.	If plumbing leaks or is contaminated, clean, repair or replace plumbing. If pump failed, repair or replace it. If cable is improperly connected or faulty, repair or replace cable (see page 21).
Pressure reading is inaccurate.	Micro-Ion gauge is contaminated. Micro-Ion gauge is damaged (for example, by reactive gas) or contaminated. Temperature or mechanical vibration is extreme.	If Micro-Ion gauge is contaminated, degas the gauge or replace gauge assembly.  If temperature or vibration is extreme, relocate module or eliminate source of heat or vibration.
Indicated pressure is different than pressure indications from other measurement devices.	Micro-Ion gauge is defective	Replace the gauge assembly.
Module LED status indicator is solid Red.	A fault caused the Module to stop reading pressure.	See the DeviceNet Error Codes in Section 3.16 DeviceNet Error Codes on page 46.
Relay will not activate	The set point not programmed.  A circuit board is faulty.	See Section 3.10 Process Control Relays on page 36. Return module to factory.

**4.3 DeviceNet Error Codes**

You may use DeviceNet explicit messages or polled I/O to find out if an alarm or warning has been reported. To select polled I/O or explicit messages, see pages 32 - 33.

#### 4.4 Ion Gauge Continuity Test and Replacement

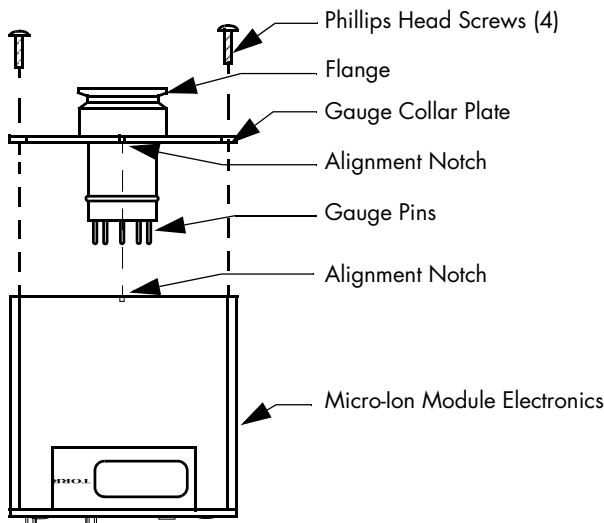
**To prevent electrical shock, turn OFF electrical power before servicing the Micro-Ion Module. Do not touch any gauge pins while the gauge tube is under vacuum or connected to a controller.**

**Be aware that an electrical discharge through a gas may couple dangerous high voltage directly to an ungrounded conductor almost as effectively as would a copper wire connection. A person may be seriously injured or even killed by merely touching an exposed ungrounded conductor at high potential. This hazard is not peculiar to this product.**

This test should only be performed while the ion gauge is exposed to atmospheric pressure and the electronics is removed from the gauge. If a problem with pressure measurement is traced to the Micro-Ion Module, the gauge may be tested with an ohm meter. This test can detect open filaments or shorts between gauge elements. This test may not detect inaccurate pressure measurement due to gauge contamination or vacuum leaks.

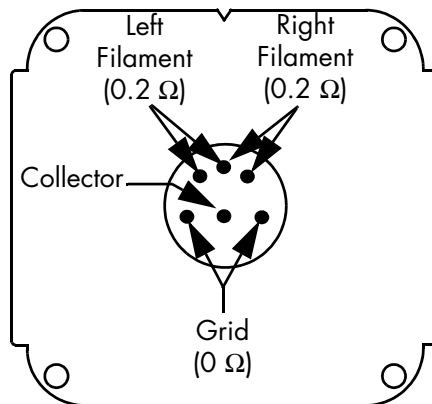
1. Turn OFF power to the module.
2. Disconnect the cables from the module.
3. Remove the Micro-Ion Module from the vacuum system.
4. Remove the four Phillips head screws from the gauge collar plate as shown in Figure 4-1.

Figure 4-1 Micro-Ion Gauge Disassembly/Reassembly



5. While holding the flange, *gently* pull the Micro-Ion Vacuum Gauge Module away from the gauge collar plate as shown in Figure 4-1. The gauge tube and plate will disconnect from the module.
6. Using a digital multimeter, measure the resistance of the left filament and the right filament between filament pins as shown in Figure 4-2. The reading should be approximately 0.2  $\Omega$ .

**Figure 4-2 Micro-Ion Gauge Continuity Check**



7. Measure the resistance of filament pins to any other pin or gauge case as shown in Figure 4-2. The reading should be infinity.
8. Measure the resistance between Grid pins as shown in Figure 4-2. The reading should be approximately 0  $\Omega$ .
9. Measure the resistance of Grid pins to any other pin or gauge case as shown in Figure 4-2. The reading should be infinity.
10. Measure the resistance of Collector pin to any other pin or gauge case as shown in Figure 4-2. The reading should be infinity.

*NOTE: If the readings obtained during this procedure are not within the values specified, the gauge should be replaced. Contact a Brooks Automation, Inc./Granville-Phillips Customer Service Representative to order a replacement gauge. See Section 4.1 Customer Service on page 59 at the beginning of this chapter.*

**To Reassemble the  
Micro-Ion Gauge/Module**

If the continuity check proves that the gauge is good, reassemble the gauge/module as outlined below.

If replacement of the gauge is necessary, install the replacement gauge as outlined below.

*NOTE: The Micro-Ion replacement gauge is double-packaged at the factory for cleanroom compatibility. Handle the gauge carefully to avoid damaging the vacuum port screen after the cap plug is removed. To reduce the chance of contamination, do not remove the replacement gauge from its inner bag until you are ready to install it and connect the module to the vacuum system. Avoid contaminating the replacement gauge. Do not touch the vacuum connection port. Follow good vacuum practice. To minimize the possibility of leaks, do not scratch the vacuum connection seal surfaces.*

1. Align the notches on the replacement gauge collar plate and the Micro-Ion Vacuum Gauge Module as shown in Figure 4-1.
2. Gently insert the replacement gauge and collar plate into the Micro-Ion Vacuum Gauge Module until the tube pins are inserted into the tube socket.
3. Insert and tighten all four Phillips head screws.
4. Install the Micro-Ion Vacuum Gauge Module onto the vacuum system.
5. Connect the cables to the Module.
6. Turn ON power and verify communication to the Micro-Ion Vacuum Gauge Module.

**4.5 Returning a Micro-Ion  
Module for Service**

If the module must be returned for service, request a Return Authorization (RA) from Brooks Automation / Granville-Phillips. Do not return products without first obtaining an RA. In some cases a hazardous materials document may be required. The Brooks Automation / Granville-Phillips Customer Service Representative will advise you if the hazardous materials document is required.

When returning equipment to Brooks Automation / Granville-Phillips, be sure to package the products to prevent shipping damage. Circuit boards and modules separated from the controller chassis must be handled using proper anti-static protection methods and must be packaged in anti-static packaging. Brooks Automation / Granville-Phillips will supply return packaging materials at no charge upon request. Shipping damage on

returned products as a result of inadequate packaging is the Buyer's responsibility. Before *you return the module*, obtain an RA number by contacting Granville-Phillips customer service:

- Phone **1-303-652-4400** or **1-800-776-6543** within the USA.
- Phone **1-800-367-4887** 24 hours per day, seven days per week within the USA.
- Email *co-csr@brooks.com*
- For Global Customer Support, go to [www.brooks.com](http://www.brooks.com), click on Contact Us, then click on Global Offices to locate the Brooks Automation office nearest you.



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## Series 354

# Granville-Phillips® Series 354 Micro-Ion® Vacuum Gauge Module with DeviceNet™



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## Instruction Manual

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