Installation & Operation Manual

GF40 Series
Mass Flow Controllers & Meters

BROOKS® INSTRUMENT

Beyond Measure

Essential Instructions
Read before proceeding!

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

- To ensure proper performance, use qualified personnel to install, operate, update, program and maintain the product.
- Read all instructions prior to installing, operating and servicing the product. If this instruction manual is not the correct manual, please see back cover for local sales office contact information. Save this instruction manual for future reference.

⚠ WARNING: Do not operate this instrument in excess of the specifications listed in the Instruction and Operation Manual. Failure to heed this warning can result in serious personal injury and / or damage to the equipment.

- If you do not understand any of the instructions, contact your Brooks Instrument representative for clarification.
- Follow all warnings, cautions and instructions marked on and supplied with the product.

⚠ WARNING: Prior to installation ensure this instrument has the required approval ratings to meet local and national codes. Failure to heed this warning can result in serious injury and / or damage to the equipment.

- Install your equipment as specified in the installation instructions of the appropriate instruction manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- Operation: (1) Slowly initiate flow into the system. Open process valves slowly to avoid low surges. (2) Check for leaks around the flow meter inlet and outlet connections. If no leaks are present, bring the system up to the operating pressure.
- Please make sure that the process line pressure is removed prior to service. When replacement parts are required, ensure that qualified people use replacement parts specified by Brooks Instrument. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look-alike substitutions may result in fire, electrical hazards or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place to prevent electrical shock and personal injury, except when maintenance is being performed by qualified persons.

⚠ WARNING: For liquid flow devices, if the inlet and outlet valves adjacent to the devices are to be closed for any reason, the devices must be completely drained. Failure to do so may result in thermal expansion of the liquid that can rupture the device and may cause personal injury.

European Pressure Equipment Directive (PED)

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

- The Specifications Section of this manual contains instructions related to the PED directive.
- Products described in this manual are in compliance with EN directive 2014/34/EU.
- All Brooks Instrument Flowmeters fall under fluid group 1.
- Products larger than 25mm or 1" (inch) are in compliance with EN directive 2014/34/EU.
- Products of 25mm or 1" (inch) or smaller are Sound Engineering Practice (SEP).

European Electromagnetic Compatibility (EMC)

The Brooks Instrument (electric/electronic) equipment bearing the CE mark has been successfully tested to the regulations of the Electro Magnetic Compatibility (EMC directive 2014/30/EU).

Special attention however is required when selecting the signal cable to be used with CE marked equipment.

Quality of the signal cable, cable glands and connectors:

Brooks Instrument supplies a limited selection of high quality cable(s) which meets the specifications for CE certification.

If you provide your own signal cable you should use a cable which is overall completely screened with a 100% shield.

"D" or "Circular" type connectors used should be shielded with a metal shield. If applicable, metal cable glands must be used providing cable screens clamping. The cable screen should be connected to the metal shell or gland and shielded at both ends over 360 Degrees.

The shield should be terminated to an earth ground. Card Edge Connectors are standard non-metallic. The cables used must be screened with 100% shield to comply with CE certification. The shield should be terminated to an earth ground. For additional instruction regarding Protective Earth (PE) Connections please refer to Section 2, **Electrical Interface** page 29.

For pin configuration: Please refer to the enclosed Instruction Manual.

ESD (Electrostatic Discharge)

⚠ CAUTION: This instrument contains electronic components that are susceptible to damage by static electricity. Proper handling procedures must be observed during the removal, installation or other handling of internal circuit boards or devices.

Handling Procedure:

1. Power to unit must be removed.
2. Personnel must be grounded, via a wrist strap or other safe, suitable means before any printed circuit card or other internal device is installed, removed or adjusted.
3. Printed circuit boards must be transported in a conductive container. Boards must not be removed from protective enclosure until immediately before installation. Removed boards must immediately be placed in protective container for transport, storage or return to factory.

Comments

This instrument is not unique in its content of ESD (electrostatic discharge) sensitive components. Most modern electronic designs contain components that utilize metal oxide technology (NMOS, SMOS, etc.) Experience has proven that even small amounts of static electricity can damage or destroy these devices. Damaged components, even though they appear to function properly, exhibit early failure.

Section 1 Introduction

Section 2 Installation

Section 3 Operation

Section 4 Maintenance & Troubleshooting

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Introduction

Based upon Brooks award-winning GF100 Series, the GF40 Series is a performance/value MFC platform designed for OEM applications, delivering the following class leading features:

- MultiFlo™ process gas and flow range programmability, enabling customers to re-configure the MFC for new gases and full scale flow rates for unparalleled process flexibility.
- A high-performance, corrosion-resistant flow measurement sensor delivers improved reproducibility and stability.
- A variety of elastomer options enable customers to select the optimum and most cost effective mix of products for their application.
- Full range of industrial communication protocols (DeviceNet, Profibus DP-V1, and EtherCAT).

Figure 1-1 GF40 Series Digital Thermal Mass Flow Devices

- An independent service/diagnostic port enables on-tool reconfiguration/optimization, data logging, and troubleshooting without having to remove the MFC from the gas line.

How to Use This Manual

This manual is intended to provide the user with all the information necessary to install, operate, troubleshoot and maintain these thermal mass flow devices. The manual is organized in the following sections:

Section 1 Introduction
Section 2 Installation
Section 3 Operation
Section 4 Maintenance and Troubleshooting
Section 5 Product Description Code
Appendix A GF40 Series Gas Table
Appendix B GF40 Series Patents

Product Support References

Refer to www.BrooksInstrument.com for Brooks sales and service locations and to obtain other documents that support the GF40 Series. Those documents include:

- Brooks MultiFloTM Configurator Quick Start Manual (X-SW-MultiFlo-Config-QS-eng; part number 541B167AAG)
- Brooks GF40 Series data sheet (DS-TMF-GF40-Series-MFC-eng)
- DeviceNetTM Supplemental Manual for GF40/GF80/GF81 Series Mass Flow Controllers and Meters (X-DPT-DeviceNet-GF40-GF80-MFC-eng; part number 541B168AAG)
- Profibus® Supplemental Manual for Brooks® GF40/GF80/GF81 Series Mass Flow Controllers and Meters (X-DPT-Profibus-GF40-GF80-MFC-eng; part number 541B162AAG)
- RS485 Supplemental Manual for GF40/GF80/GF81 Series Mass Flow Controllers and Meters (X-DPT-RS485-GF40-GF80-MFC-eng; part number 541B169AAG)
- EtherCAT Supplemental Manual for Brooks® GF40/GF80 Series Mass Flow Controllers and Meters (X-DPT-EtherCAT-GF40-GF80-MFC-eng; part number 541B170AAG)

Warning, Caution and Notice Statements

Warning, caution and notice statements are located throughout this manual in the ANSI format. A WARNING statement indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury. A CAUTION statement indicates a potentially hazardous situation which, if not avoided, MAY result in minor or moderate injury. It may also be used to alert against unsafe practices. A NOTICE statement describes specific information that requires special attention.

Product Warranty

Product warranty information can be found on the Back Cover of this Manual and on the Brooks website at www.BrooksInstrument.com. This information provides general warranty information, limitations, disclaimers, and applicable warranty periods according to product group.

How to Order a GF40 Series Device

Refer to Section 5.

Industry Standard References

Refer to Table 1-1.

GF40 Devices Gas Table

Refer to Appendix A.

Table 1-1 Industry Standard References

Reference Number	Reference Description
MIL-STD-810	Method 514.4, Category 1, Transportation Requirement Method 516.4, Procedure 1, Functional Shock Test Requirement
SEMI E12	Standard temperature and pressure
SEMI E16	Guideline for determining and describing MFC leak rates
SEMI E17	Guideline for MFC transient characteristics tests
SEMI E18	Guideline for temperature specifications of the MFC
SEMI E27	Standard for MFC and MFM linearity
SEMI E28	Guideline for pressure specifications for the MFC
SEMI E52	Practice for referencing gases used in digital MFCs
SEMI E54	Sensor actuator network connections for DeviceNet
SEMI E56	Test method for detemining accuracy, linearity, repeatability, short-term reproducibility, hystereses of thermal MFCs
SEMI E66	Test method for determining particle contribution by MFCs
SEMI E67	Test method for determining reliabilty of MFCs
SEMI E68	Test method for determining warm-up time of MFCs
SEMI E69	Test method for reproducibilty and zero drift for thermal MFCs
SEMI E80	Test method for determining attitude sensitivity of MFCs
SEMI E16-90	Guidelines for determining and describing mass flow controllers leak rates
SEMI F36	Guide for dimensions and connections of gas distribution components
SEMI F44	Guideline for standardization of machined stainless steel weld fittings
SEMI F45	Guideline for standardization of machined stainless steel reducing fittings
SEMI F47	Specifications for semiconductor processing equipment voltage sag immunity
SEMI S2	Environmental, Health and Safety Guidelines
SEMI S9	Dielectric testing
SEMI S10	Risk assessment
SEMI S12	Decontamination of fielded products

Table 1-2 Terms and Acronyms

Term or Acronym	Definition
CSR	Customer Special Requirement
CVD	Chemical Vapor Deposition
DSP	Digital Signal Processor
EPI Epitaxy (EPI)	A process technology where a pure silicon crystalline structure is deposited or “grown” on a bare wafer, enabling a high-purity starting point for building the semiconductor device
HBD	Horizontal Base Down
HLD	Horizontal Label Down
HLU	Horizontal Label Up
HUD	Horizontal Upside Down
GF40 Series	MultiFlo capable digital device
F.S.	Full Scale
LED	Light Emitting Diode
MFC	Mass Flow Controller
MultiFlo Configurator	I/O communication software package that configures gas and flow ranges
MultiFlo Technology	A physics-based calibration methodology that enables gas and flow range configuration within a defined standard configuration
PID	Proportional Integral Derivative Controller
PSIA	Pounds per Square Inch Absolute
PSID	Pounds per Square Inch Differential
PSIG	Pounds per Square Inch Gauge
ROR	As pressure increases, flow increases at a pressure rate of rise, or ROR
HC	Standard Configuration w/ Hastelloy® sensors (to reduce reaction to corrosive gases)
S.P.	Setpoint
Step Technology	Enables fast set point control through a high speed DSP
VID	Vertical mounting attitude with inlet side facing down
VIU	Vertical mounting attitude with inlet side facing up

Glossary of Terms and Acronyms

Refer to Table 1-2

778Z013ZZZ GF0xx EtherCAT® MultiFlo Configurator Kit w/Power Supply 24 Vdc
124Y211AAA BEST/Multiflo-USB-RS485
641Z117AAA Power Supply 24 Vdc with DB-15 female
124Z170AAA Cable, Power, EtherCAT to DB-15 male

778Z014ZZZ GF0xx DeviceNetTM MultiFlo Configurator Kit w/Power Supply 24 Vdc
124Y211AAA BEST/Multiflo-USB-RS485
641Z117AAA Power Supply 24 Vdc with DB-15 female
124Z171AAA Cable, Power, DeviceNet to DB-15 male

* MultiFlo Configurator Software is available on the Brooks Instrument website at:
www.BrooksInstrument.com/MultiFlo

www.BrooksInstrument.com/Documentation

Advanced Thermal Measurement Sensor

Brooks high-performance thermal flow sensor brings together key design elements to deliver the accurate, repeatable measurement under challenging process conditions:

- Improved accuracy at elevated temperatures through isothermal packaging and ambient temperature sensing and compensation
- Enhanced signal-to-noise performance enables improved low setpoint accuracy
- A large bore, corrosion resistant, Hastelloy® C-22 sensor tube ensures long life and reliability
- Optimized temperature profile for gases prone to thermal decomposition
- Onboard electronics store sensor calibration data for ease of service

Extensive Mechanical Configurations

GF40
1/4" VCR
9/16" - 18 UNF
1/8" tube compression
1/4" tube compression
3/8" tube compression
1/2" tube compression
6-mm tube compression
10-mm tube compression
1/4" RC
1/4" VCO
1/4" NPT

Enhanced Diagnostics and User Interface

The mass flow controller is typically the most complex and critical component in a gas delivery system, When dealing with toxic or reactive gases, removing the MFC to access its functionality should be the last resort. To address this, Brooks GF Series devices include self-diagnostics and an independent service port for in-situ device evaluation and troubleshooting:

- Embedded self-test routines at power-up
- Independent RS485 service port that can be accessed while the MFC is in operation for data logging and troubleshooting
- A convenient Zero button to enable easy re-zeroing during scheduled maintenance

Communication Interfaces

The GF40 Series supports 0-5 Vdc, 0-10 V, 4-20 mA, 0-20 mA, RS485, DeviceNet, EtherCAT, and Profibus communication protocols. DeviceNet, Profibus, EtherCAT and RS485 are multi-drop connections that allow a maximum of 64 devices for DeviceNet, 128 devices for Profibus, 32 devices for RS485, and 65,535 devices for EtherCAT to be connected on the same network.

Brooks Instruments' DeviceNet profile has been certified by the ODVA (Open DeviceNet Vendor's Association).

Brooks Instrument Profibus interface has been certified by the PNO (Profibus User Organization).

The Brooks Instrument EtherCAT interface has been successfully tested by the EtherCAT Conformance Test application version 1.20.30.0.

Description

Control

The GF40 Series brings together Brooks high-performance, patented ultra-fast T-rise flow sensor, high-speed ARM based digital architecture, and a fast-acting diaphragm-free solenoid valve to deliver:

- Fast reproducible transitions between setpoints without overshoot or ringing
- User-programmable ramp functions for processes requiring a slow-ramp in flow or time critical transitions
- Optional bubble tight shut down (elastomer valve seat)

MultiFlo™ Gas and Range Configurability

The Brooks MultiFlo technology delivers exceptional improvement in process gas accuracy for linear and non-linear gases. This is achieved through advanced gas modeling and optimized through actual gas testing. Brooks MultiFloTM allows the device to be quickly and easily configured for another gas and/or flow range without sacrificing accuracy or rangability. Selecting a new gas automatically creates a new calibration curve, establishes optimized PID settings for dynamic control, automatically compensates for gas density effects, and ensures smooth overshoot-free transitions between flow rates with excellent steady-state stability. Brooks MultiFlo technology offers unparalleled flexibility. An extensive gas database is provided and a single device can be quickly programmed for thousands of different gas and flow range combinations. Process benefits achieved include:

- Mass flow controller full scale full range can be rescaled down typically by a factor of 3:1 with no impact on accuracy, turndown or leak by specifications
- Optimum process and inventory flexibility resulting in dramatically reduced inventory costs
- Fewer configurations/bin sizes required to support many different processes
- Less down-time with rapid process recovery

MultiFlo™ Support References: Brooks MultiFlow Configurator Quick Start Guide (X-SW-MultiFlo-Config-QS-eng [Part Number: 541B167AAG])

MultiFlo™ Configurator Accessory Kits:

MultiFlo kits are available in the following configurations:

778Z010ZZZ **Basic MultiFlo Configurator Kit**
124Y211AAA BEST/Multiflo-USB-RS485

778Z012ZZZ **GF0xx RS485 Analog/Profibus® MultiFlo Configurator Kit w/Power Supply 24 Vdc**
124Y211AAA BEST/Multiflo-USB-RS485
641Z117AAA Power Supply 24 Vdc with DB-15 female

Specifications for GF40 Series Devices

⚠ WARNING

Do not operate this instrument in excess of the specifications listed below. Failure to heed this warning can result in serious personal injury and/or damage to the equipment.

⚠ CAUTION

It is the user's responsibility to select and approve all materials of construction. Careful attention to metallurgy, engineered materials and elastomeric materials is critical to safe operation.

See Table 1-3 for specifications for the GF40 Series.

See Figure 1-2 for dimensions for the GF40 Series.

Table 1-3 Specifications for Standard GF40 Series

	GF40
Performance	
Full-Scale Flow Range (N_2 Eq.)	3 sccm to 50 slm
Flow Accuracy	±1% S.P. 35-100%, ±0.35% F.S. 2-35%
Repeatibility & Reproducibility	<±0.2% S.P.
Linearity	±0.5% F.S. (included in accuracy)
Response Time (Settling Time)	Normally Closed Valve <1 sec (within 2% for steps 0-10 through 0-100%) Normally Open Valve <3 sec (within 2% for steps 0-10 through 0-100%)
Control Range	2 - 100%
MultiFlo™	Standard
Number of Bins	10 bins
Valve Shut Down	<1% of F.S.
Zero Stability	<±0.5% F.S. per year
Pressure Coefficient	0.03% per psi (0-50psi N_2)
Attitude Sensitivity	<0.25% span change @ 90° after rezeroing (N_2 @ 50 psi)
Auto Shut-off	The Auto Shut-off feature closes the GF0xx valve when the set point drops below 0.5% of full scale
Ratings	
Operating Temperature Range	5-50°C (41-122°F)
Maximum Operating Pressure	150 psig (10 bar)
Design Proof Pressure	4000 psig (275 bar)
Differential Pressure Range	3-860 sccm = 7-45 psid 861-7200 sccm = 15-45 psid 7201-50000 sccm = 25-45 psid Typical pressure drop, high density gases like Argon gas applications require an additional 10 psid differential pressure
Leak Integrity (External)	$1x10^{-9}$ atm. cc/sec He
Mechanical	
Valve Type	Normally Closed, Normally Open, No Valve (Meter)
Primary Wetted Materials	316 Stainless Steel, Hastelloy C-22, 17-7 PH, 430SS
External Seals	Viton, Buna, Kalrez or EPDM
Internal Seals/Valve Seat	Viton, Buna, Kalrez or EPDM
Surface Finish	32µ inch Ra
Compliance	
Environmental Compliance	CE: EN61326: 2006 (FCC Part 15 & Canada IC-subset of CE testing)
	Safe Area: Designed to EN61010-1
	RoHS
	General, Leak-Test Traceability, Oxygen Cleaning, Calibration Traceability, Material Certification

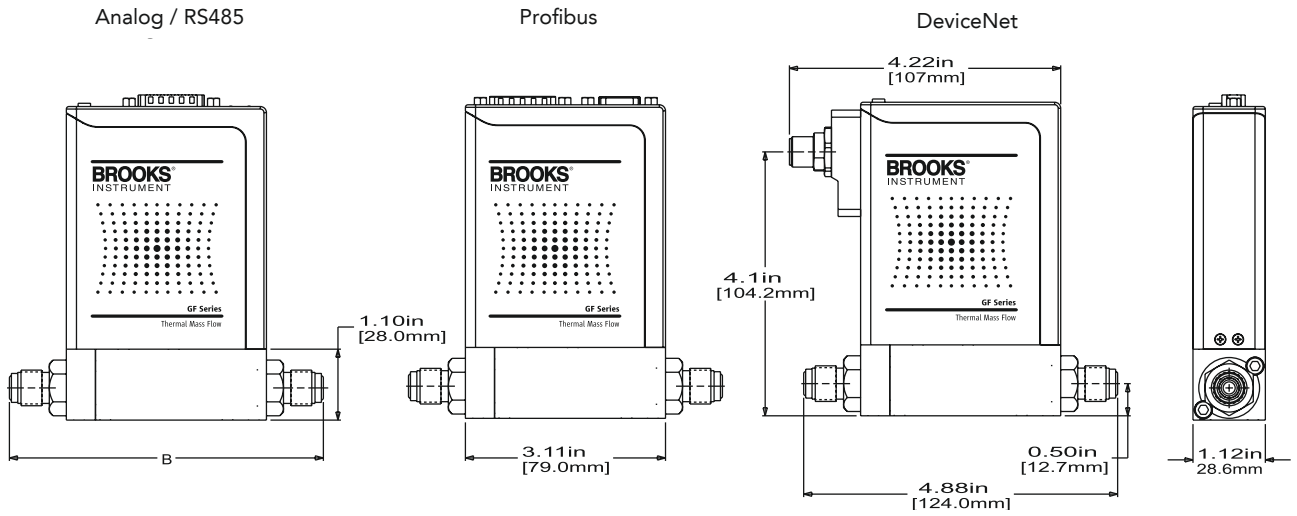
Table 1-4 GF40 Series Electrical Specifications

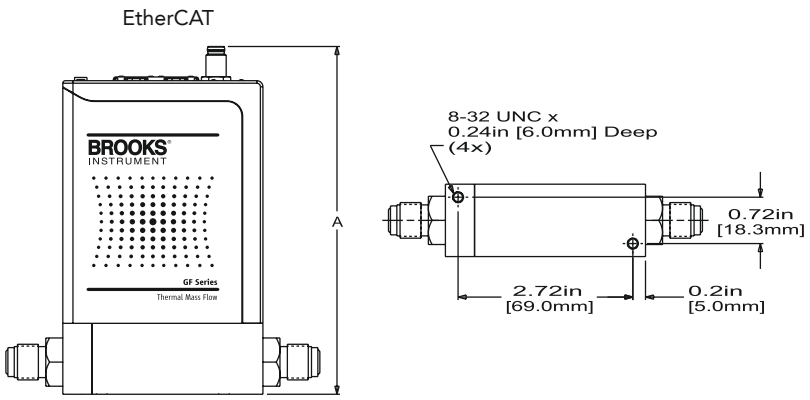
	RS485	Profibus®	DeviceNet™	EtherCAT®
Communication Protocol				
Electrical Connection	1x15-pin Male Sub-D, (A)	1x15-pin Male Sub-D / 1x9-pin Female Sub-D	1xM12 with threaded coupling nut (B)	5-pin M8 with threaded coupling nut / 2xRJ45
Analog I/O	0-5 V, 0-10 V, 0-20 mA, 4-20 mA	0-5 V, 0-20 mA, 4-20 mA	0-5 V (Output Only)	0-5 V (Output Only)
GF40 Power Max./Purge	From +12 Vdc to +24 Vdc: 7 Watt/8 Watt	From +13.5 Vdc to +27 Vdc 7 Watt/8 Watt	From +11 Vdc to +25 Vdc: 7 Watt/8 Watt	From +13.5 Vdc to +27 Vdc 7 Watt/8 Watt
Voltage Set Point Input Specification				
Nominal Range	0-5 Vdc or 0-10 Vdc	0-5 Vdc	N/A	N/A
Full Range	0-11 Vdc	0-5.5 Vdc	N/A	N/A
Absolute Max.	25 V (without damage)		N/A	N/A
Input Impedence	192 kOhms		N/A	N/A
Required Max. Sink Current	0.002 mA		N/A	N/A
Current Set Point				
Nominal Range	4-20 mA or 0-20 mA		N/A	N/A
Full Range	0-22 mA		N/A	N/A
Absolute Max.	25 mA (without damage)		N/A	N/A
Input Impedence	250 Ohms	125 Ohms	N/A	N/A
Flow Output (Voltage) Specifications				
Nominal Range	0-5 Vdc or 0-10 Vdc	0-5 Vdc		
Full Range	(-0.5)-11 Vdc	0-5.5 Vdc	(-0.5)-5.5 Vdc	
Min Load Resistance	1 kOhms	1 kOhms	0.5 kOhms	
Flow Output (Current) Specifications				
Nominal Range	0-20 mA or 4-20 mA		N/A	N/A
Full Range	0-22 mA (@ 0-20 mA); 3.8-22 mA (@ 4-20 mA)		N/A	N/A
Max. Load	400 Ohms for supply voltage: 12-24 Vdc		N/A	N/A
Analog I/O Alarm Output[1]				
Type	Open Collector		N/A	N/A
Max. Closed (On) Current	25 mA		N/A	N/A
Max. Open (Off) Leakage	1µA		N/A	N/A
Max. Open (Off) Voltage	30 Vdc		N/A	N/A
Analog I/O Valve Override Signal Specifications[2]				
Floating/Unconnected	Instrument controls valve to command set point		N/A	N/A
VOR < 1.40 Vdc	Valve Closed		N/A	N/A
1.70 Vdc < VOR < 2.90 Vdc	Valve Normal		N/A	N/A
VOR > 3.20 Vdc	Valve Open		N/A	N/A
Input Impedence	800 kOhms		N/A	N/A
Absolute Max. Input	(-25 Vdc) < VOR < 25 Vdc (without damage)		N/A	N/A

[1] The Alarm Output is an open collector or "contact type" that is CLOSED (on) whenever an alarm is active. The Alarm Output may be set to indicate any one of various alarm conditions.

[2] The Valve Override Signal (VOR) is implemented as an analog input which measures the voltage at the input and controls the valve based upon the measured reading as shown in this section.

GF40 Analog, DeviceNet, EtherCAT, and Profibus Configurations





Configuration	Dim A
Analog/RS485	5.06in [128.5mm]
Profibus	5.00in [127mm]
DeviceNet	4.92in [125.1mm]
EtherCAT	5.41in [137.4mm]

Connection Type	Dim B
9/16 - 18 UNF	3.00in [76.2mm]
1/2 in TC	5.22in [133mm]
3/8 in TC	4.84in [131mm]
1/4 in TC	4.94in [125.5mm]
1/8 in TC	4.84in [123mm]
1/4 in VCR	4.88in [124mm]
1/4 in VCO	4.61in [117mm]
1/4 in NPT	4.58in [116.4mm]
1/4 in RC	4.58in [116.4mm]
6mm TC	5.02in [127.6mm]
10mm TC	5.16in [131mm]

Figure 1-2 Dimensions - GF40 Series

General

This section provides installation instructions for the Brooks GF40 Series Thermal Mass Flow Devices. The installation process consists of purging the gas supply line prior to installation, unpacking and inspecting the device, connecting the device to the gas supply line and testing for leaks.

Receipt of Equipment

When the equipment is received, the outside packing case should be checked for damage incurred during shipment. If the packing case is damaged, the local carrier should be notified at once regarding his liability. A report should be submitted to the nearest Brooks Instrument location listed on the Global Service Network page on our website:
BrooksInstrument.com/GlobalSupportCenters

Carefully remove the equipment from the packing case. Make sure spare parts are not discarded with the packing material. Inspect the contents for damaged or missing parts.

Recommended Storage Practice

If intermediate or long-term storage of the device is required, it is recommended that it be stored in accordance with the following conditions:

- Within the original shipping container.
- Ambient temperature 21°C (70°F) nominal, 32°C (90°F) maximum, 7°C (45°F) minimum.
- Relative humidity 45% nominal, 60% maximum, 25% minimum.

Return Shipment

Prior to returning any instrument to the factory for any reason, visit our website for instructions on how to obtain a Return Materials Authorization Number (RMA #) and complete a Decontamination Statement to accompany it: BrooksInstrument.com/Service. All instruments returned to Brooks also require a Material Safety Data Sheet (MSDS) for the fluid(s) used in the instrument. Failure to provide this information will delay processing of the instrument.

Instrument must have been purged in accordance with the following:

⚠ WARNING

Before returning the device, purge thoroughly with a dry inert gas such as Nitrogen before disconnecting process connections. Failure to correctly purge the instrument could result in fire, explosion or death. Corrosion or contamination may occur upon exposure to air.

Transit Precautions

To safeguard against damage during transit, transport the device to the installation site in the same container used for transportation from the factory, if circumstances permit.

Removal from Storage

Upon removal of the device from storage, a visual inspection should be conducted to verify its "as-received" condition. If the device has been subject to storage conditions in excess of those recommended (refer to "2-3 Recommended Storage Practice"), it should be subjected to a pneumatic pressure test in accordance with applicable vessel codes. To maintain a device's clean integrity, this service should be performed by the factory or one of the certified service centers.

Gas Connections

Prior to installation, ensure that all piping is clean and free from obstructions. Install piping in such a manner that permits easy access to the device if removal becomes necessary.

In-Line Filter

It is recommended that an in-line filter be installed upstream from the device to prevent the possibility of any foreign material entering the flow sensor or control valve. The filtering element should be replaced periodically or ultrasonically cleaned.

Mechanical Installation

⚠ CAUTION

When installing the Mass Flow Controller or Meter, care should be taken that no foreign materials enter the inlet or outlet of the instrument. Do not remove the protective end caps until the time of installation.

The recommended installation procedure guidelines are as follows:

- The device should be located in a clean, dry atmosphere relatively free from shock and vibration.
- Leave sufficient room for access to the user interface and MAC ID and baud rate switches (if equipped) at the top of the device.
- Install the device in such a manner that permits easy purge and removal if the device requires servicing.

⚠ CAUTION

When used with a reactive (sometimes toxic) gas, contamination or corrosion may occur as a result of plumbing leaks or improper purging. Plumbing should be checked carefully for leaks and the instrument purged with clean, dry N_2 before use.

The GF40 Series also utilizes MultiFlo® technology that allows the user to configure standard configurations ("SAs") or "blanks" for a variety of pure gases and mixtures. As a result, MultiFlo® technology enables the user to reduce unique inventory requirements.

Flow Controller Installation Arrangement

Typical gas supply arrangements are shown in Figure 2-1. GF40s are often arranged inside a gas panel. Configure standard configurations ("SAs") or "blanks" for a variety of pure gases and mixtures. As a result, MultiFlo technology enables the user to reduce unique inventory requirements.

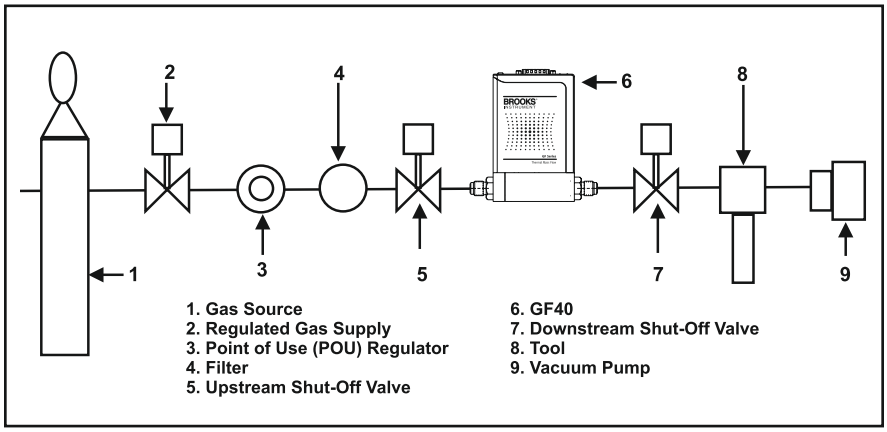


Figure 2-1 Typical Gas Supply Arrangement

Purge the Gas Supply Line Before GF40 Series Installation

⚠ CAUTION

For additional safety, it is recommended to close the two valves between the charged gas line and the GF40 Series to be installed. See Figure 2-1 for more details.

⚠ NOTICE

It is recommended to archive service and calibration documentation for the GF40 Series in order to determine the contamination state of each gas line and to assist service personnel.

⚠ CAUTION

DO NOT remove the shipping caps covering the inlet/outlet for VCR fittings before the GF40 Series is actually being installed. Failure to comply will introduce contaminants into the GF40 Series.

Before operating the GF40 Series, the gas supply line must be completely purged with nitrogen or argon to ensure the line is free from toxic or flammable gases, contaminants, moisture, and oxygen. The purge gas must be free of moisture and oxygen to less than 100 ppb. Purge the gas lines as follows or in accordance with prescribed company and safety procedures.

1. Shut off the process gas supply valve(s) upstream of the GF40 Series. If such a valve is not available, shut the valve on the gas panel. Tag the valve at this point to prevent accidental re-exposure of the process gas to the gas line.

2. Cycle purge the gas line with dry nitrogen or argon to fully flush out the process gas. Cycle purging consists of evacuating to a low pressure adequate to induce out-gassing and then purging to remove adhered moisture and oxygen. If a toxic or reactive gas is present and a clogged GF40 Series is suspected, then proceed with caution. Pump down and purge the GF40 Series from both downstream and upstream lines. If check valves are present in the gas line, both pumping down and purging are required. Pumping down without purging is inadequate. If a good vacuum source is not available, the GF40 Series can be de-contaminated by purge only.

3. Repeat the purge cycle several times within 2-4 hours to complete the cleaning. For toxic and corrosive gasses, it is recommended to use 100-120 cycles.

Position and Mount the GF40 Series

It is recommended that the MFC is re-zeroed with process gas following the recommended Brooks procedure (see zeroing bulletin FSB-001-0015 for futher information).

If your GF40 Series is configured with in-line fittings, secure the GF40 Series block to the gas panel with two, 8-32-UNC-2B" screws. Then connect the inlet/ outlet fittings to the gas supply line using two wrenches. Tighten the fittings to manufacturer recommendations.

Perform a Leak Test

⚠ WARNING

Before operating the flowmeter, ensure all fluid connections have been properly tightened and, where applicable, all electrical connections have been properly terminated.

It is critical to leak test the gas supply lines and GF40 Series connections before turning on the process gas supply after any new installation. Check for leaks using a helium leak detector or any other appropriate leak test method. Follow leak test specifications as defined by integrator.

Performance Checks

This section describes how to zero and sequence the GF40 Series devices for proper operation.

⚠ NOTICE

If the GF40 Series has been in the purge mode for a long period of time, wait until the GF40 Series has cooled down before zeroing. The cool down period should be ~30 minutes for purges up to five minutes and at least 60 minutes after purging overnight.

- The GF40 Series must be warmed up for at least 45 minutes.
- The active gas page must be correct.

Zeroing Setup Process

The following steps are required before the GF40 Series is zeroed.

1. Place the GF40 under normal inlet operating pressure.

2. Make sure that the GF40 Series has been installed inside the equipment (panel) for at least four hours and powered up at least one hour prior to zeroing. This insures that the GF40 Series is in its "use attitude" and is operating at normal temperature. If the GF40 Series is subjected to a vacuum purge for more than one minute, turn off the GF40 Series (i.e., provide a zero setpoint) for a time period of twice the vacuum purge time.
3. Refer to Figure 2-1. Open the upstream shut-off valve (5) and close the downstream shut-off valve (7). This eliminates a pressure drop across the GF40 Series and subsequent leakage from the PID control valve inside the GF40 Series.
4. Provide a 100% setpoint to the GF40 Series for no longer than 30 seconds. This equalizes the pressure across the PID control valve.
5. Refer to Figure 2-1. Close the upstream shut-off valve (5) to prevent any pressure effects from the regulator (3).
6. Close the GF40 Series and wait two minutes.
7. Read the output signal of the GF Series in percent of full scale. This output signal is the initial flow. The output signal should be 0.0 (± 0.1%). If the output signal is too high, re-zero the GF40 Series as described in Section 2-16.

Zeroing the GF40 Series

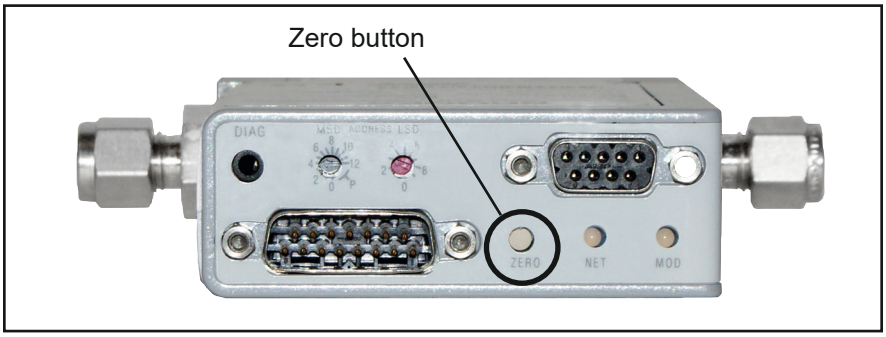


Figure 2-2 Zero Button Accessible at Top of Device

⚠ NOTICE

Make sure you perform the zeroing set-up process outlined in Section 2-15 before zeroing the GF40 Series.

1. Allow time for gas pressure to equalize across the MFC's internal control valve to ensure gas movement.
2. Press and hold down the Zero button, shown in Figure 2-2, for a minimum of 5 seconds.

Auto Shut-Off

The Auto Shut-off feature closes the GF40 valve when the set point drops below 1.5% of full scale. When the Auto Shut-off feature is NOT chosen, then the GF40 valve will shut off when the set point drops below 0.5% of full scale.

Using the MultiFlo™ Configurator

The MutliFlo Configurator application is used to configure the gas and range of the GF40 Series devices.

The MultiFlo Configurator application allows communication to GF40 Series devices through personal computer with serial COM Port and a Windows XP or Windows 7 operating system. It's primary function is to configure gas and flow ranges within defined standard configurations. Flow ranges are configured to the Nitrogen equivalent.

Using the MultiFlo Configurator software, configure the gas and flow rate according to Table 2-1.

The MultiFlo Configurator interfaces to the GF40 Series device through RS485. There are various ways to connect the device regardless of device configuration. Devices may be connected through the diagnostic port using cables in one of the following MultiFlo Configurator Kits.

MultiFlo™ Configurator Accessory Kits:

MultiFlo kits are available in the following configurations:

778Z010ZZZ	**Basic MultiFlo Configurator Kit**
A331710003	Cable Assembly 2.5mm
214F027AAA	USB-RS485 converter with DB-9 female

778Z012ZZZ	**GF0xx RS485 Analog/Profibus® MultiFlo Configurator Kit w/Power Supply 24 Vdc**
A331710003	Cable Assembly 2.5mm
214F027AAA	USB-RS485 converter with DB-9 female
641Z117AAA	Power Supply 24 Vdc with DB-15 female

778Z013ZZZ	**GF0xx EtherCAT® MultiFlo Configurator Kit w/Power Supply 24 Vdc**
A331710003	Cable Assembly 2.5mm
214F027AAA	USB-RS485 converter with DB-9 female
641Z117AAA	Power Supply 24 Vdc with DB-15 female
124Z170AAA	Cable, Power, EtherCAT to DB-15 male

778Z014ZZZ	**GF0xx DeviceNet™ MultiFlo Configurator Kit w/Power Supply 24 Vdc**
A331710003	Cable Assembly 2.5mm
214F027AAA	USB-RS485 converter with DB-9 female
641Z117AAA	Power Supply 24 Vdc with DB-15 female
124Z171AAA	Cable, Power, DeviceNet to DB-15 male

Connect the MultiFlo cable adapter 2.5-mm jack to the diagnostic port on the top of the device. See Figure 2-5.

Connect the RS485 end of the converter to the 15-pin RS485 end of the MultiFlo Cable Adapter.

Connect the USB end of the converter to the USB Port of a laptop or PC.

The latest MutliFlo Configurator Software and Databases and MultiFlo Configurator Quick Start Guide are available on the Brooks Instrument website at: www.BrooksInstrument.com/MultiFlo. Please reference the MultiFlo Configurator Quick Start Guide for installation and operation details. Download the MultiFlo Configurator software into your computer from the Brooks Instrument website www.BrooksInstrument.com/MultiFlo. Install the MultiFlo Configurator as described in the MultiFlo Configurator Quick Start Guide and use the guide as a reference for operation details.

⚠ CAUTION

DO NOT make any connections to unlabeled connector pins. Any failure to comply could damage the GF40 Series and/or the mating electrical device. Before connecting the cable, make sure that all pin connections of the mating cable have the same pin out connections. When installing and removing cables to and from your computer, make sure the power is turned off on your computer. This will prevent damage to your computer and associated equipment.

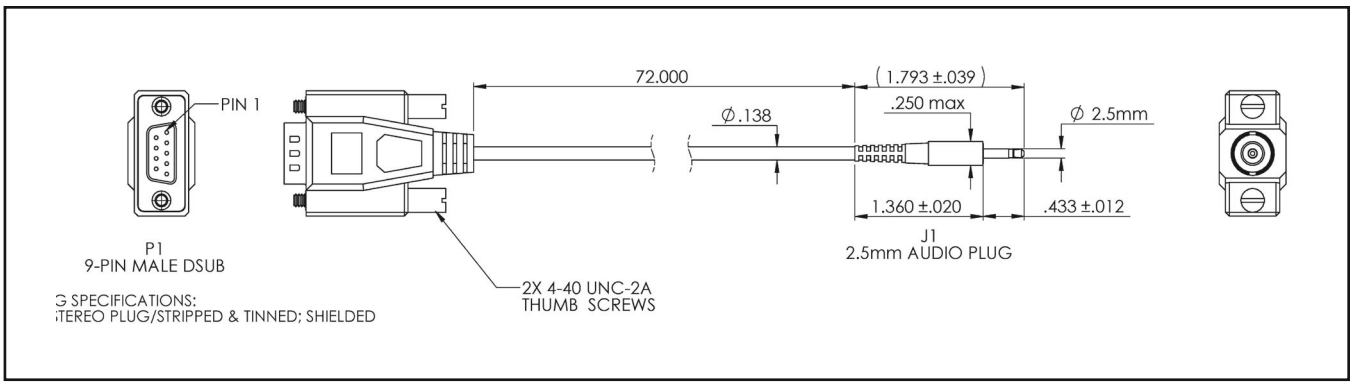


Figure 2-3 MultiFlo Cable Adaptor

Table 2-1 Gas and Flow Ranges - MultiFlo Configurable - N2 Equivalent

Standard MG-MR Bin Configurations	Flow range Code	Gas Flow Range (N2 Equivalent)
SA40	010C	3-10 sccm
SA41	030C	11-30 sccm
SA42	092C	31-92 sccm
SA43	280C	93-280 sccm
SA44	860C	281-860 sccm
SA45	2.6L	861-2600 sccm
SA46	7.2L	2601-7200 sccm
SA47	015L	7201-15000 sccm
SA48	030L	15001-30000 sccm
SA50	050L	30001-50000 sccm

Figure 2-4 USB-RS485 Converter (P/N 214F027AAA)

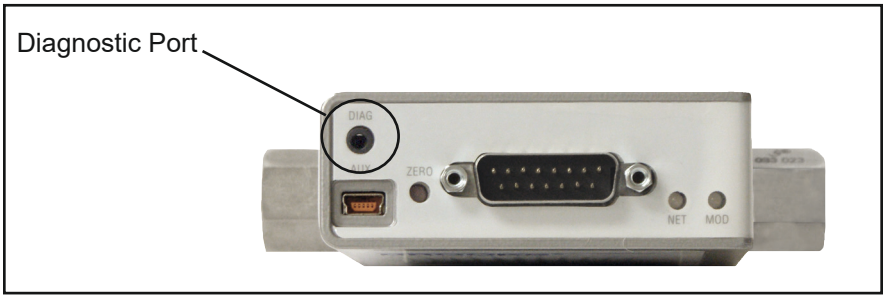


Figure 2-5 Diagnostic Port

Electrical Connections

DeviceNet Connections

DeviceNet is a 5 wire local network connection that employs a command response communication protocol for communicating between a master and slave. Obtain a DeviceNet communication cable (Micro M-12) and fasten it to the 5-pin connector as shown in Figure 2-6.

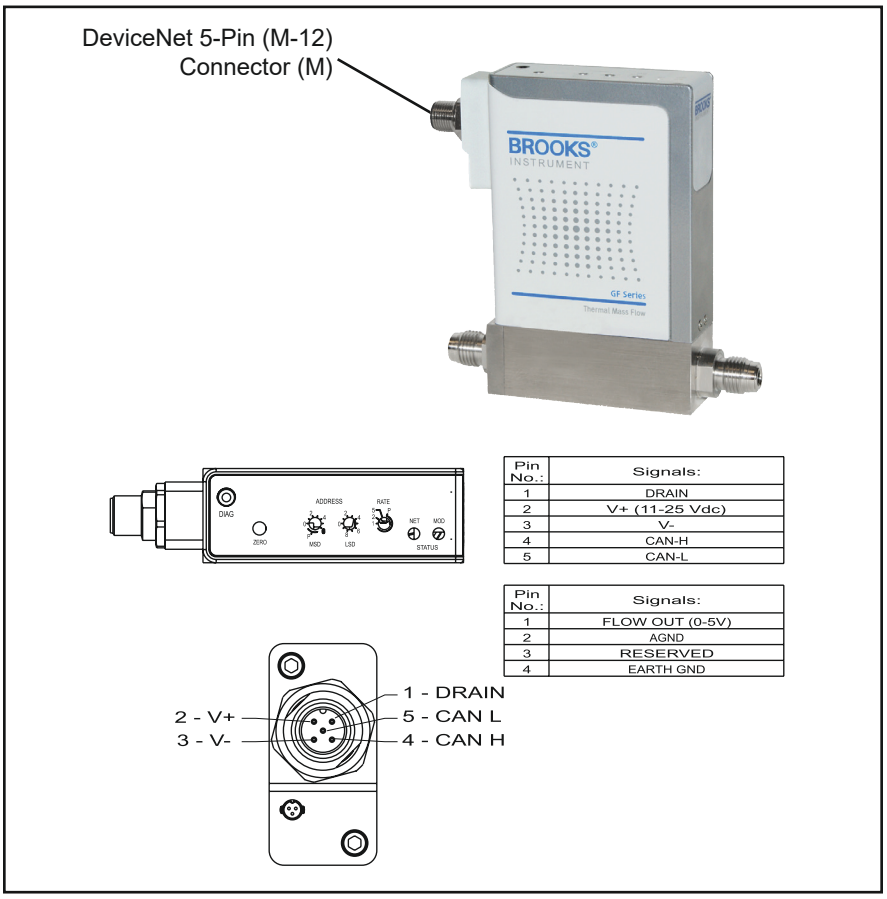


Figure 2-6 GF40 Series DeviceNet Connection and Pinouts

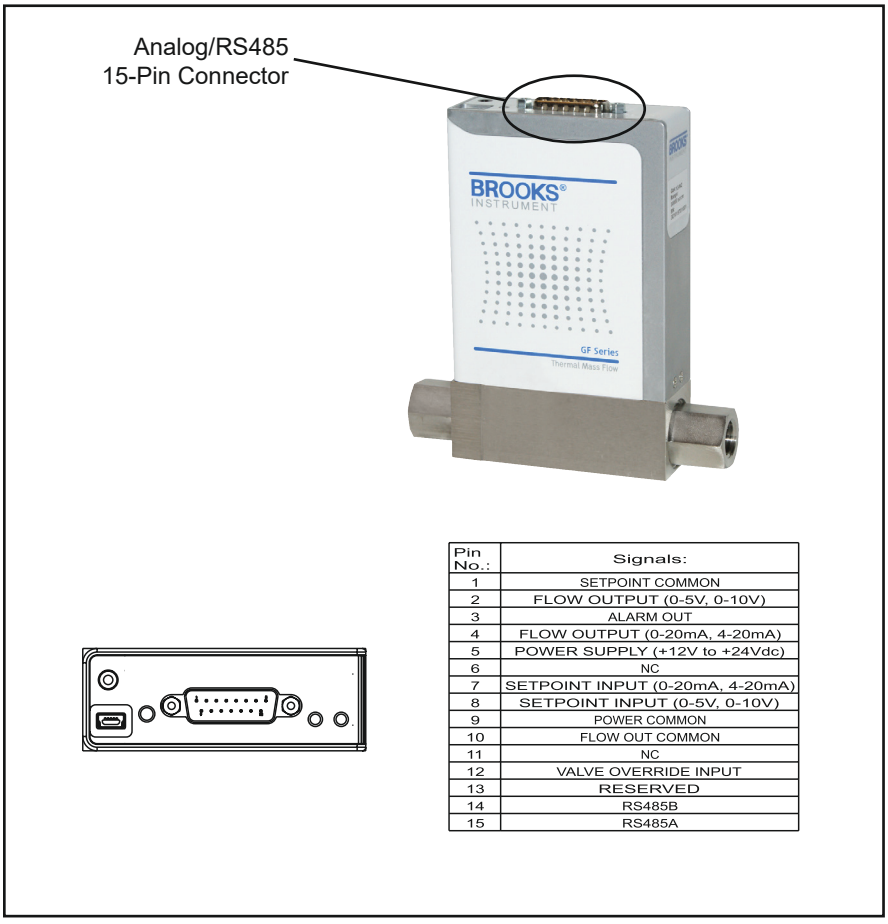
⚠ CAUTION

DO NOT apply more than 10 Inch-Pounds of torque to the cable coupling when connecting the cable to the device or damage may result to the connector.

Analog/RS485 Connections

The GF40 Series devices are available with the Analog/RS485 15-Pin D-Connector shown in Figure 2-7.

It is recommended that when using -15 Vdc & 0, the wiring hook-up should be: -15V is connected to Pin 9 (POWER COMMON) and 0 is connected to Pin 5 (POWER SUPPLY(+12 to +24 VDC)).

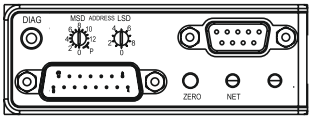


Pin No.:	Signals:
1	SETPOINT COMMON
2	FLOW OUTPUT (0-5V, 0-10V)
3	ALARM OUT
4	FLOW OUTPUT (0-20mA, 4-20mA)
5	POWER SUPPLY (+12V to +24Vdc)
6	NC
7	SETPOINT INPUT (0-20mA, 4-20mA)
8	SETPOINT INPUT (0-5V, 0-10V)
9	POWER COMMON
10	FLOW OUT COMMON
11	NC
12	VALVE OVERRIDE INPUT
13	RESERVED
14	RS485B
15	RS485A

Figure 2-7 GF40 Series with 15-Pin Analog Connector and Pinouts

Profibus Connections

The GF40 Series devices are available with the Profibus connections as shown in Figure 2-8.



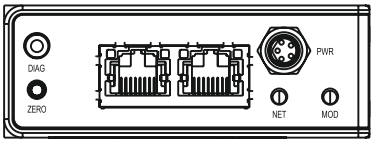
Pin No.:	Signals:
1	SETPOINT COMMON
2	FLOW OUTPUT (0-5V)
3	ALARM OUT
4	FLOW OUTPUT (0-20mA, 4-20mA)
5	POWER SUPPLY (13.5-27V)
6	NC
7	SETPOINT INPUT (0-20mA, 4-20mA)
8	SETPOINT INPUT (0-5V)
9	POWER COMMON
10	FLOW OUT COMMON
11	NC
12	VALVE OVERRIDE INPUT
13	RESERVED
14	NC
15	NC

Pin No.:	Signals:
1	NC
2	NC
3	RXD/TXD - B - red wire
4	NC
5	Ground
6	+5Vdc
7	NC
8	RXD/TXD - A - green wire
9	NC

Figure 2-8 GF40 Series Profibus Connections and Pinouts

EtherCAT Connections

The GF40 Series devices are available with the EtherCAT connections as shown in Figure 2-9.



Pin No.:	Signals:
1	POWER SUPPLY (13,5-27V)
2	FLOW OUT COMMON
3	POWER COMMON
4	FLOW OUTPUT (0-5V)
5	RESERVED

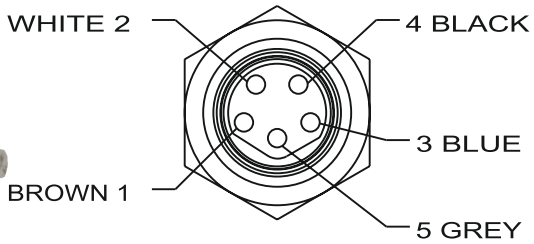


Figure 2-9 GF40 Series EtherCAT Connections and Pinouts

Alarm Output (Analog I/O versions only)

The Alarm Output is an open collector or "contact" type that is CLOSED (on) whenever an alarm is active. The Alarm Output may be set to indicaqte any one of various conditions.

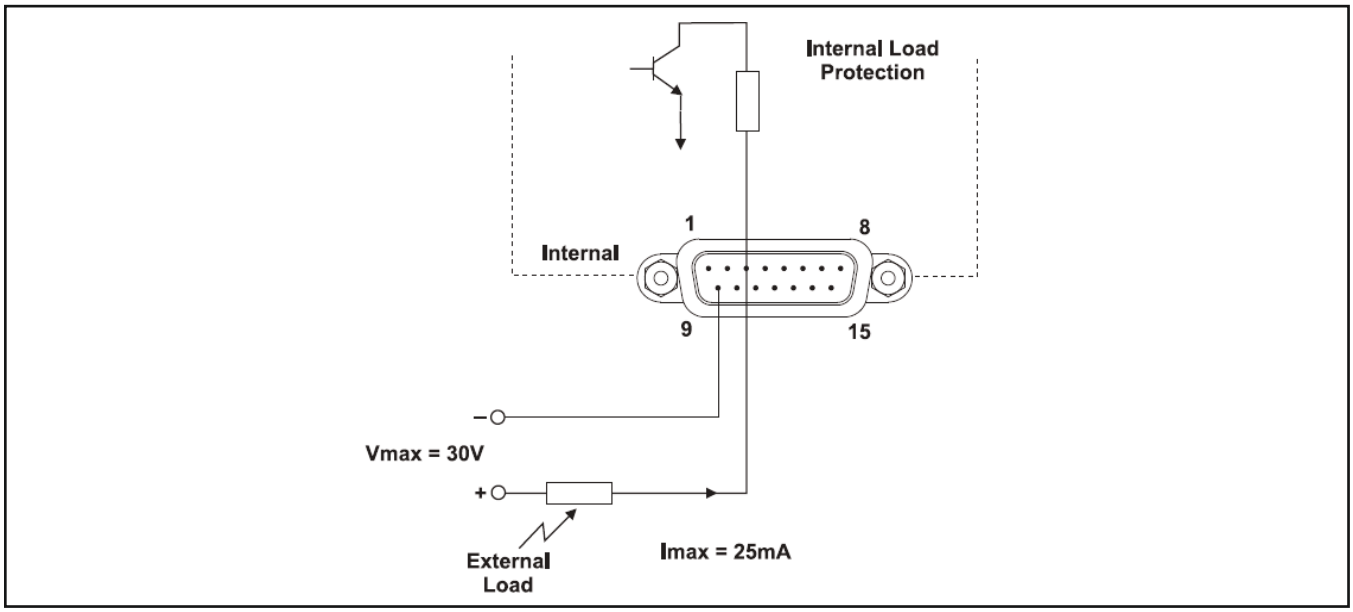


Figure 2-10 Alarm Output Schematic

General

The MutliFlo Configurator application is used to configure the gas and range of the GF40 Series devices.

After the device has been properly installed in the process, it is ready for operation. When initiating flow, slowly open any upstream shutoff valve to avoid a flow surge. A bypass is helpful in bringing the flow on smoothly. Avoid starting a pump to supply the device without the use of a valve upstream of the device.

⚠ CAUTION

Any sudden change in system pressure may cause mechanical damage to elastomer materials. Damage can occur when there is a rapid expansion of fluid that has permeated elastomer materials. The user must take the necessary precautions to avoid such conditions.

⚠ WARNING

Before operating the flow controller, ensure all gas connections have been properly tightened and, where applicable, all electrical connections have been properly terminated.

Theory of Operation for Flow Measurement

The thermal mass flow measurement system consists of two components: the restrictor or bypass and the flow sensor. Figure 3-1 is a diagram of the flow stream through the device, with an enlarged view of the flow sensor. Gas flow entering the device is separated into two paths; one straight through the restrictor and the other through the flow sensor.

The separation of the flow streams is caused by the restrictor. During flow conditions, there will be a pressure differential across the restrictor that forces gas to flow in the sensor.

The pressure difference caused by the restrictor varies linearly with total flow rate. The sensor has the same linear pressure difference versus flow relationship. The ratio of sensor flow to the flow through the restrictor remains constant over the range of the device. The full scale flow rate of the device is established by selecting a restrictor with the correct pressure differential for the desired flow.

The flow sensor is a very narrow, thin-walled Hastelloy tube. This tube has upstream and downstream temperature sensing and heating elements. During no-flow conditions, the amount of heat reaching each temperature sensor is equal, so temperatures T1 and T2 (Figure 3-1) are equal. Gas flowing through the tube carries heat away from the upstream temperature sensor and toward the downstream sensor. The temperature difference, T2 – T1, is directly proportional to the gas mass flow.

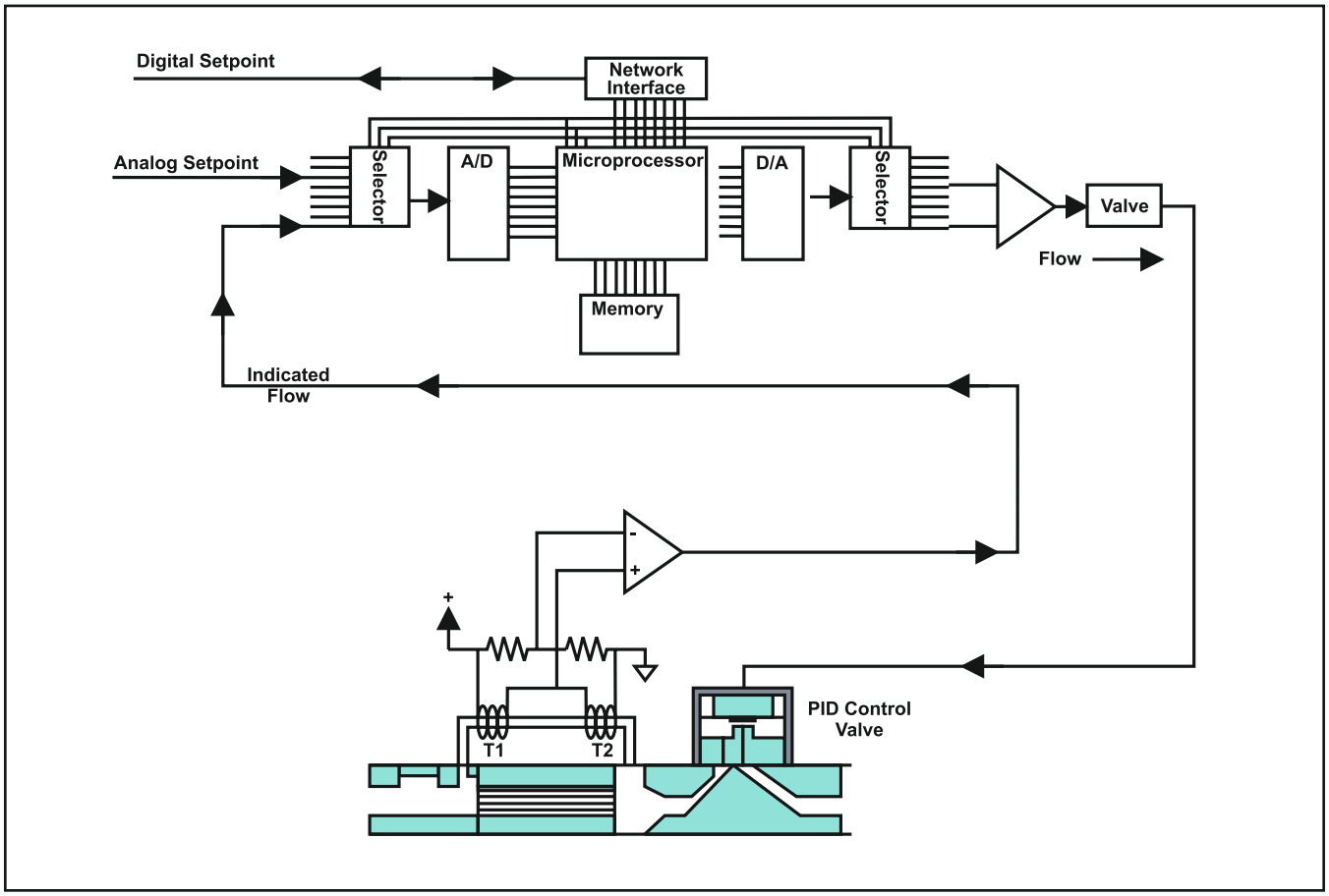
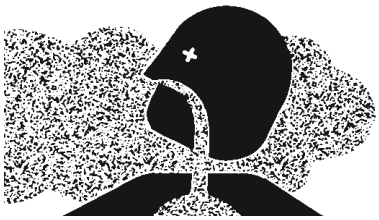


Figure 3-1 GF40 Series Operating Principles

Overview

No routine maintenance is required on the Brooks GF40 Series devices. If an in-line filter is used, the filtering elements should be periodically replaced or cleaned. Any precision unit such as a flow controller requires occasional servicing, especially if it has been operating for an extended period of time. If reactive gases are being used, it is recommended that you send the device to a Brooks Service Center for cleaning and recalibration. Please follow the instructions for removal, product packaging and product return instructions found in Section 2- Installation—Return Shipment. All active process instrumentation and equipment is subject to aging and wear from their environment. This includes temperature, mechanical stress, component tolerance shift, contaminant buildup, oxidation, and other influences. The effects are gradual, but over time the changes can affect the accuracy of even the best equipment. Therefore, it is recommended to re-zero the device at 6 month intervals. Refer to Section 2-14 Performance Checks for re-zeroing instructions.

Maintenance



⚠ WARNING

METER/CONTROLLER SEAL COMPATIBILITY

Products in this manual may contain metal or elastomeric seals, gaskets, O-rings or valve seats. It is the "user's" responsibility to select materials that are compatible with their process and process conditions. Using materials that are not compatible with the process or process conditions could result in the Meter or Controller leaking process fluid outside the pressure boundary of the device, resulting in personnel injury or death.

It is recommended that the user check the Meter or Controller on a regular schedule to ensure that it is leak free as both metal and elastomeric seals, gaskets, O-rings and valve seats may change with age, exposure to process fluid, temperature, and /or pressure.

⚠ WARNING

If it becomes necessary to remove the controller from the system after exposure to toxic, pyrophoric, flammable or corrosive gas, purge the controller thoroughly with a dry inert gas such as Nitrogen before disconnection the gas connections. Failure to correctly purge the controller could result in fire, explosion or death. Corrosion or contamination of the mass flow controller, upon exposure to air, may also occur.

⚠ WARNING

If it becomes necessary to remove the instrument from the system, power to the device must be disconnected.

⚠ CAUTION

It is important that this device only be serviced by properly trained and qualified personnel.

⚠ CAUTION

This instrument contains electronic components that are susceptible to damage by static electricity. Proper handling procedures must be observed during the removal, installation or other handling of internal circuit boards or devices.

Troubleshooting

This section includes a Troubleshooting Checklist and a GF40 Series Troubleshooting Guide that identifies symptoms, possible causes, and corrective actions.

⚠ NOTICE

OEM tool problems are often caused by something other than the GF40 Series. Therefore, Brooks recommends that you review both the Troubleshooting Checklist and the GF40 Series Troubleshooting Guide before removing the GF40 Series from your system. It is also suggested to contact your Brooks Service representative before removing the GF40 Series from your system.

Maintenance, Factory Calibration and Service, and On-Site Service.

Troubleshooting Checklist

1. Check environmental factors that could affect changes to GF40 Series performance. The most common environmental factors are listed in Table 4-1.
2. Check supply voltage and check for a consistent ground.
3. Insure OEM tool setpoint matches the setpoint at the GF40 Series. Observe for consistency.
4. Verify isolations valves are open and the gas supply is turned on. Then verify operating pressures are within operating ranges.
5. Check GF40 Series voltage response by moving the setpoint back and forth. Observe for voltage changes.

Table 4-1 Environmental Factors

GF40 Series Performance	Possible Causes
Inaccurate flow.	• Temperature shift (steady state or transient) • Inlet pressure shift (steady state or transient) • Power supply problem • Electrical interference • Dirty gas chamber • Changes in gas
Control problems. Can not reach setpoint. Oscillation.	• Differential pressure not within operating range • Inlet pressure not stable
Zeroing problems, indicated zero is not stable.	• Temperature shift (steady state or transient). • Inlet pressure shift (steady state or transient). • Power supply problem. • Electrical interference

GF40 Series Troubleshooting Guide

Table 4-2 GF40 Series Troubleshooting Guide

Symptoms & Possible Causes	Corrective Action
1. No gas flow.	
Is the gas supply turned on?	Check shut-off valve and pressure readout. Open the gas supply.
Is the regulator turned on at the correct operating pressure?	Turn off the regulator and reset it to the recommended pressure as described in the Data Sheet.
Are any upstream or downstream shut-off valves closed, either by the system or because of failure?	Verify that the valves are open and operating properly.
Is the MOD LED light on the GF Series lit solid green?	Observe the LED display panel on top of the GF40 device to verify. If the LED light is not lit, cycle power to reboot the device.
Is the commanded setpoint from tool/system at 0.00 Vdc?	Use the tool software to verify.
Has the valve been commanded off by an active “valve closed” input?	Use the tool software to verify. Confirm that pin 12 is not connected to DC common.
2. Flow out of range.	
Is the gas inlet/outlet pressure differential either too high or too low? NOTE: If the differential pressure is too high, voltage to the valve will be zero, which is abnormally low for the setpoint. If the differential is too low, voltage to the valve will be at its maximum value, which is abnormally high for the set-point.	Verify that the pressure is correct for the gas and range. If required, adjust inlet/outlet pressure to achieve proper pressure reading.
Is the MOD LED light on the GF40 Series lit solid green?	Observe the LED at the top of the GF40 device. If the LED light is not lit, cycle power the device to reboot.
Is the setpoint correct for the required gas flow?	Use the tool software to verify the analog signal.
Is the device calibrated for the particular gas?	Check the device side label. Run a flow check to verify.
Is the device zero correct?	Zero the device according to zeroing procedure in Section 2-16. Verify leak check rates are OK.
3. No gas control; flow is at or above maximum.	
Is the gas pressure across the device too high?	Verify that the pressure is correct for the gas and range. If required, adjust inlet/outlet pressure to achieve proper pressure reading.
Are system valves open, or is the purge input activated?	Use tool software to verify. Confirm that pin 12 is not connected to an active voltage source.
Is the setpoint correct for the required flow?	Use tool software to verify.

Table 4-2 GF40 Series Troubleshooting Guide (Continued)

Symptoms & Possible Causes	Corrective Action
4. No gas flow above some setpoint.	
NOTE: When the setpoint is increased beyond this point, the GF40 Series signal remains at some value lower than the set-point.	
Is the gas inlet/outlet differential pressure sufficient? NOTE: If the pressure is too low, the valve voltage to the GF40 Series will be at its maximum output. This condition will cause internal GF valve heating and inability to properly reach desired flow setpoints.	Verify that the pressure is correct for the gas and range. If required, adjust regulator to achieve proper pressure.
Is the GF40 Series calibrated for the gas flow?	Check GF40 Series side label. Run a flow check to verify. If flow is incorrect, replace the GF40 Series with a unit that is calibrated properly.
5. No gas flow below some setpoint.	
NOTE: When the setpoint is decreased below this point, the GF40 Series signal remains at some value higher than the setpoint. Is the gas inlet/outlet differential pressure too high?	Verify that the pressure is correct for regulator to achieve proper pressure.
Is the GF40 Series leaking?	Check for contamination. Test the GF40 Series for leak integrity. Replace the GF40 Series if leakage is detected.
6. Gas flow oscillates.	
Is the GF40 Series calibrated for the gas flowing?	Check the GF40 Series side can label. Run a flow check to verify. If flow is incorrect, replace the GF40 Series.
Is there too much gas pressure across the GF40 Series?	Verify that the pressure is correct for this gas and range. If required, adjust regulator to achieve proper pressure reading.
Are inlet and outlet pressures stable?	If outlet pressure is unstable, check for (no oscillation or hunting) a faulty vacuum pump, or hunting at a downstream valve. Check inlet pressure on tool. A faulty pressure regulator can make the GF40 Series appear to oscillate. Adjust inlet pressure up or down by 2 psig increments until hunting disappears. Verify common gas pressure is within range. NOTE: Hunting or oscillation can be contributed to multiple GF40 Series sharing a common gas manifold. Therefore, inspect gas delivery sources to the gas box (for example; two tools sharing a common gas bottle and calling for gas at the same time). Valve leak. Unregulated gas pressure from Facilities.

Table 4-2 GF40 Series Troubleshooting Guide (Continued)

Symptoms & Possible Causes	Corrective Action
7. OEM tool does not read correct GF40 Series zero reading.	
Is the differential pressure across the GF40 Series really zero? Is the supply voltage within specified range? Is the GF40 Series mounted in the proper attitude? Is the flow output signal of the GF40 Series really zero?	GF40 Series valve leakage. Incorrect MFC zero.
8. Zero Drift.	
Improper zero of the GF40 Series? Excessive Valve leakage?	GF40 Series aging or sensor stabilization. Zero is not correct.
9. Calibration Drift.	
Gas box temperature too high? Is it linear offset?	Zero is not correct.
10. GF40 Series indicates Overshoot.	
If the tool is idle for an extended period of time, high inlet pressure or contamination will cause overshoot on first use.	Purge the line before operating.
11. OEM tool indicates the wrong full scale value for GF40 Series.	
Older version of Multiflo Configurator used to program GF40 Series.	Update Multiflo Configurator. Refer to Section 2-17.
12. GF40 Series dumps large volume of gas into chamber when setpoint is commanded from the tool.	
The tool is commanding a setpoint before the pneumatic valves are opened. GF40 Series and pneumatic timing may be offset. GF40 Series overshoots.	Change the tool sequence.
13. Tool display output doesn't match GF40 Series flow output.	
Cable resistance or read-out impedance causing offset in the tool's display.	Check cables and read out. Eliminate any ground loops.

Table 5-1 GF40 Series Product Description Code Table

Code Description	Code Option	Option Description
I. Base-Model Code	GF040	Elastomer / Range Flow (0-50 slpm)
II. Configurability	C	MultiFlo Capable. Standard Bins or specific gas range may be selected
	X	Not MultiFlo Capable. Specific gas/range required
III. Special Application	XX	Standard
IV. Valve Configuration	C	Normally Closed Valve
	O	Normally Open Valve
	M	Meter (No Valve)
V. MultiFlo Bin & Range or Gas & Range (Standard)	XXXX XXXX	Specific Gas Code & Range, example: "0004" = Argon and "010L" = 10 slpm
	SA40 010C	Standard Configuration #40, 3-10 sccm N_2 Eq. @ 0 deg C Ref Temp.
	SA41 030C	Standard Configuration #41, 11-30 sccm N_2 Eq. @ 0 deg C Ref Temp.
	SA42 092C	Standard Configuration #42, 31-92 sccm N_2 Eq. @ 0 deg C Ref Temp.
	SA43 280C	Standard Configuration #43,93-280 sccm N_2 Eq. @ 0 deg C Ref Temp.
	SA44 860C	Standard Configuration #44, 281-860 sccm N_2 Eq. @ 0 deg C Ref Temp.
	SA45 2.6L	Standard Configuration #45, 861-2600 sccm N_2 Eq. @ 0 deg C Ref Temp.
	SA46 7.2L	Standard Configuration #46, 2601-7200 sccm N_2 Eq. @ 0 deg C Ref Temp.
	SA47 015L	Standard Configuration #47, 7201-15000 sccm N_2 Eq. @ 0 deg C Ref Temp.
	SA48 030L	Standard Configuration #48, 15001-30000 sccm N_2 Eq. @ 0 deg C Ref Temp.
	SA50 050L	Standard Configuration #50, 30001-50000 sccm N_2 Eq. @ 0 deg C Ref Temp.
VI. Fitting	XX	9/16" - 18 UNF
	T1	1/8" tube compression
	T2	1/4" tube compression
	T3	3/8" tube compression
	T4	1/2" tube compression
	T6	6 mm tube compression
	T0	10 mm tube compression
	R2	14" RC (BSP)
	VX	1/4" VCR
	O2	1/4" VCO
	N2	1/4" NPT
VII. Downstream Condition	A	Atmosphere
	V	Vacuum
	P	Positive Pressure
VIII. External Seals, Valve Seat	B	Seal Buna / Seat Buna
	E	Seal EPDM / Seat EPDM
	K	Seal Kalrez / Seat Kalrez
	V	Seal Viton / Seat Viton

Table 5-1 GF40 Series Product Description Code Table (Continued)

Code Description	Code Option	Option Description				
IX. Communications / Connector	P5	Profibus / Analog (Input 0-5 V; Output 0-5 V); 9-Pin Female D conn. / 15-Pin Male D conn.				
	P0	Profibus / Analog (Input 0-20 mA; Output 0-20 mA); 9-Pin Female D conn. / 15-Pin Male D conn.				
	P4	Profibus / Analog (Input 4-20 mA; Output 4-20 mA); 9-Pin Female D conn. / 15-Pin Male D conn.				
	E5	EtherCAT™ / (Output 0-5 V); 2xRJ45 signal 2-Pin power				
	S5[4]	RS485: (S-Protocol)/Analog (Input 0-5 V; Output 0-5 V)15-Pin Male D (Brooks Protocol)				
	S1[2]	RS485: (S-Protocol)/Analog (Input 0-10 V; Output 0-10 V); 15-Pin Male D (Brooks Protocol)				
	S0[1]	RS485 (S-Protocol)/Analog (Input 0-20 mA ; Output 0-20 mA); 15-Pin Male D (Brooks Protocol)				
	S4[3]	RS485 (S-Protocol)/Analog (Input 4-20 mA; Output 4-20 mA); 15-Pin Male D (Brooks Protocol)				
	L5	RS485 (L-Protocol)/Analog (Input 0-5 V; Output 0-5 V); 15-Pin Male D (Celerity/Legacy Protocol)				
	L1[2]	RS485 (L-Protocol)/Analog (Input 0-10 V; Output 0-10 V); 15-Pin Male D (Celerity/Legacy Protocol)				
	L0[1]	RS485 (L-Protocol)/Analog (Input 0-20 mA; Output 0-20 mA); 15-Pin Male D (Celerity/Legacy Protocol)				
	L4	RS485 (L-Protocol)/Analog (Input 4-20 mA; Output 4-20 mA); 15-Pin Male D (Celerity/Legacy Protocol)				
	A5	RS485 (A-Protocol)/Analog (Input 0-5 V; Output 0-5 V); 15-Pin Male D (Aera Protocol)				
	A1	RS485 (A-Protocol)/Analog (Input 0-10 V; Output 0-10 V); 15-Pin Male D (Aera Protocol)				
	A0	RS485 (A-Protocol)/Analog (Input 0-20 mA; Output 0-20 mA); 15-Pin Male D (Aera Protocol)				
	A4	RS485 (A-Protocol)/Analog (Input 4-20 mA; Output 4-20 mA); 15-Pin Male D (Aera Protocol)				
	DeviceNet Standard Configuration Parameters					
		Connector	Full Scale Setting	Full Scale Setting	Poll I/O Instance Consumer	External Baud Rate
	D1	5 Pin Micro	Count	6000h	7	500KB
	D3	5 Pin Micro	Count	6000h	7	500KB
	D5	5 Pin Micro	Count	6000h	8	500KB
	D7	5 Pin Micro	Count	7FFFh	8	500KB
	D9	5 Pin Micro	Count	6000h	7	500KB
	DB	5 Pin Micro	Count	6000h	8	500KB
	DD	5 Pin Micro	Count	7FFFh	8	500KB
	DX	5 Pin Micro	To be defined by CSR			
X. Customer Special Request	XXXX	Customer Special Request Number				
XI. Auto Shut Off	A	Auto Shut-Off (Included)				
	X	Auto Shut-Off (Not Included)				
XII. Fixed X Value	X	Fixed X Value				
XIII. Reference Temperature	00C	0°C Reference				
	15C	15°C Reference				
	20C	20°C Reference				
	70F	21.1°C Reference / 70°F Reference				

Sample Model Code

I	II	III	IV		V		VI	VII	VIII	IX		X	XI	XII		XIII
GF040	C	XX	C	-	0013300C	-	T2	A	V	P5	-	XXXX	A	X	-	20C

Table A-1 GF40 Series Gas Table - Codes 1-102, Bins SA40 to SA44

Gas Code	Gas Symbol	Gas Name	Min inlet pressure for vac. exhaust (PSIA)			SA40		SA41		SA42		SA43		SA44	
			SA40-SA47	SA48	SA50	Low	High	Low	High	Low	High	Low	High	Low	High
1	He	Helium	19.7	24.7	29.7	5	14	15	42	43	128	129	400	401	1194
2	Ne	Neon	24.7			5	14	15	42	43	129	130	400	401	1207
4	Ar	Argon	24.7	29.7	29.7	5	14	15	42	43	130	131	400	401	1214
5	Kr	Krypton	29.7			4	11	12	32	33	100	101	302	303	930
6	Xe	Xenon	24.7			3	6	7	19	20	58	59	178	179	546
7	H2	Hydrogen	14.7	14.7	29.7	3	10	11	30	31	92	93	280	281	860
8	Air	Air	24.7	29.7	29.7	3	10	11	30	31	92	93	280	281	860
9	CO	Carbon Monoxide	24.7	29.7		3	10	11	30	31	92	93	280	281	860
10	HBr	Hydrogen Bromide	24.7			3	8	9	25	26	77	78	235	236	723
11	HCl	Hydrogen Chloride	24.7	29.7	32.7	3	10	11	30	31	92	93	280	281	860
12	HF	Hydrogen Fluoride	14.7	17.7		3	10	11	30	31	94	95	281	282	880
13	N2	Nitrogen	24.7	29.7	29.7	3	10	11	30	31	92	93	280	281	860
14	D2	Deuterium	14.7	14.7		3	10	11	30	31	94	95	280	281	880
15	O2	Oxygen	24.7	29.7	29.7	3	10	11	30	31	92	93	280	281	860
16	NO	Nitric Oxide	24.7	29.7	39.7	3	10	11	30	31	92	93	280	281	860
17	HI	Hydrogen Iodide	24.7	29.7		3	5	6	15	16	46	47	141	142	432
18	F2	Fluorine	24.7	29.7		3	9	10	27	28	83	84	254	255	780
19	Cl2	Chlorine	24.7	29.7		3	6	7	19	20	57	58	173	174	531
22	H2S	Hydrogen Sulfide	24.7	29.7		3	8	9	25	26	76	77	232	233	713
23	H2Se	Hydrogen Selenide	24.7	29.7		3	7	8	22	23	66	67	202	203	620
25	CO2	Carbon Dioxide	24.7	29.7	29.7	3	7	8	22	23	69	70	209	210	642
27	N2O	Nitrous Oxide	24.7	29.7	29.7	3	7	8	21	22	65	66	200	201	611
28	CH4	Methane	24.7	24.7	29.7	3	7	8	23	24	71	72	215	216	660
29	NH3	Ammonia	24.7	24.7	29.7	3	8	9	24	25	73	74	223	224	685
30	O3	Ozone	24.7	29.7	29.7	3	8	9	26	27	82	83	250	251	770
31	PH3	Phosphine	19.7	24.7		3	7	8	22	23	67	68	205	206	629
32	SO2	Sulfur Dioxide	19.7	24.7		3	5	6	17	18	52	53	157	158	482
33	CH3F	Methyl Fluoride	24.7	29.7		3	7	8	22	23	67	68	204	205	625
34	COS	Carbonyl Sulfide	24.7	29.7		3	6	7	20	21	60	61	183	184	562
35	AsH3	Arsine	24.7	29.7		3	6	7	18	19	56	57	171	172	524
36	CH3Cl	Methyl Chloride	24.7	29.7	26.7	3	6	7	20	21	60	61	180	181	560
37	ClCN	Cyanogen Chloride	14.7	21.7		3	5	6	15	16	46	47	142	143	435
38	C2H4	Ethylene	24.7	29.7		3	6	7	18	19	56	57	170	171	523
39	SiH4	Silane	24.7	29.7		3	6	7	18	19	56	57	170	171	523
42	C2H2	Acetylene	16.7	19.7		3	6	7	18	19	57	58	170	171	530
43	GeH4	Germane	24.7	29.7		3	5	6	17	18	53	54	161	162	495
44	CH3Br	Methyl Bromide	19.7	24.7		3	3	4	11	12	35	36	108	109	332
45	C2H4O	Ethylene Oxide	14.7	19.7		3	5	6	15	16	46	47	140	141	430
46	COF2	Carbonyl Fluoride	19.7	19.7		3	5	6	17	18	53	54	160	161	500
47	CH3SH	Methyl Mercaptan	24.7	29.7		3	4	5	14	15	44	45	132	133	410
48	BF3	Boron Trifluoride	19.7	24.7		3	5	6	16	17	50	51	150	151	457
49	CHF3	Fluoroform (Freon-23)	24.7	24.7	26.7	3	5	6	15	16	48	49	145	146	445
51	C2H3F	Vinyl Fluoride	24.7	29.7	34.7	3	6	7	18	19	56	57	170	171	520
52	CH5N	Methylamine	24.7	29.7	32.7	3	4	5	14	15	44	45	133	134	410
53	NF3	Nitrogen Trifluoride	24.7	29.7	34.7	3	5	6	15	16	46	47	140	141	430
54	C2H6	Ethane	24.7	29.7	26.7	3	5	6	16	17	50	51	153	154	469
57	CHClF2	Chlorodifluoromethane (Freon-22)	24.7	29.7		3	4	5	12	13	36	37	112	113	345
58	B2H6	Diborane	19.7	19.7		3	4	5	12	13	38	39	116	117	358
60	COCl2	Phosgene	12.7	14.7		3	3	4	11	12	35	36	106	107	325
61	C3H6-a)	Cyclopropane	24.7	29.7		3	4	5	14	15	44	45	133	134	410
62	PF3	Phosphorus Trifluoride	19.7	24.7		3	4	5	14	15	42	43	129	130	400
63	CF4	Carbon Tetrafluoride (Freon-14)	24.7	24.7	29.7	3	4	5	13	14	40	41	121	122	372
67	SiH2Cl2	Dichlorosilane	14.7	19.7		3	3	4	10	11	29	30	89	90	273
69	C3H6-b)	Propylene	19.7	19.7		3	4	5	12	13	36	37	110	111	338
70	BCl3	Boron Trichloride	11.7	14.7		3	3	4	10	11	31	32	94	95	289
72	ClO3F	Perchloryl Fluoride	14.7	20.7		3	4	5	12	13	38	39	114	115	350
73	C2H6O	Dimethylether	14.7	19.7		3	3	4	11	12	36	37	110	111	340
74	CClF3	Chlorotrifluoromethane (Freon-13)	24.7	29.7		3	4	5	12	13	39	40	120	121	360
77	ClF3	Chlorine Trifluoride	14.7	20.7		3	3	4	11	12	35	36	107	108	327
79	BBr3	Boron Tribromide	24.7	29.7	29.7	3	4	5	12	13	37	38	115	116	352
80	CBrF3	Bromotrifluoromethane (Freon-13)	24.7	29.7		3	3	4	10	11	32	33	100	101	300
84	CCl2F2	Dichlorodifluoromethane (Freon-1	24.7	29.7		3	3	4	9	10	30	31	91	92	282
85	C2H7N	Dimethylamine	9.7	14.7		3	3	4	11	12	34	35	101	102	310
88	SiF4	Silicon Tetrafluoride	19.7	24.7		3	3	4	11	12	34	35	103	104	316
89	C3H8	Propane	9.7	11.7		3	3	4	10	11	32	33	100	101	300
94	C2F4	Tetrafluoroethylene	19.7	19.7		3	3	4	10	11	31	32	100	101	300
97	Si2H6	DISILANE	19.7	19.7		3	3	4	10	11	30	31	92	93	282
98	C4H8-j)	Transbutene	19.7	19.7		3	3	4	9	10	27	28	83	84	250
99	GeF4	Germanium Tetrafluoride	20.7	24.7		3	3	4	10	11	30	31	92	93	282
100	C4H6-e)	Butadiene	19.7	19.7		3	3	4	10	11	30	31	92	93	280
102	POCl3	Phosphorus Oxychloride	9.7	9.7	9.7			3	4	5	14	15	45	46	139

Table A-2 GF40 Series Gas Table - Codes 1-102, Bins SA45 to SA50

Gas Code	Gas Symbol	Gas Name	Min inlet pressure for vac. exhaust (PSIA)			SA45		SA46		SA47		SA48		SA50	
			SA40-SA47	SA48	SA50	Low	High	Low	High	Low	High	Low	High	Low	High
1	He	Helium	19.7	24.7	29.7	1195	3609	3610	11200	11201	23000	23001	56000	56001	105000
2	Ne	Neon	24.7			1208	3650	3651	10600	10601	22300				
4	Ar	Argon	24.7	29.7	29.7	1215	3671	3672	10000	10001	20100	20101	38000	38001	60000
5	Kr	Krypton	29.7			931	2809	2810	6940	6941	14500				
6	Xe	Xenon	24.7			547	1651	1652	4070	4071	8490				
7	H2	Hydrogen	14.7	14.7	29.7	861	2600	2601	8000	8001	16000	16001	40000	40001	77000
8	Air	Air	24.7	29.7	29.7	861	2600	2601	7400	7401	15000	15001	30000	30001	51000
9	CO	Carbon Monoxide	24.7	29.7		861	2600	2601	7300	7301	15000	15001	30000		
10	HBr	Hydrogen Bromide	24.7			724	2187	2188	5490	5491	11400				
11	HCl	Hydrogen Chloride	24.7	29.7	32.7	861	2600	2601	6900	6901	14100	14101	26100	26101	42000
12	HF	Hydrogen Fluoride	14.7	17.7		881	2610	2611	7400	7401	15000	15001	30000		
13	N2	Nitrogen	24.7	29.7	29.7	861	2600	2601	7400	7401	15000	15001	30000	30001	51000
14	D2	Deuterium	14.7	14.7		881	2600	2601	8000	8001	17000	17001	39000		
15	O2	Oxygen	24.7	29.7	29.7	861	2600	2601	7200	7201	15000	15001	30000	30001	51000
16	NO	Nitric Oxide	24.7	29.7	39.7	861	2600	2601	7200	7201	15000	15001	30000	30001	50000
17	HI	Hydrogen Iodide	24.7	29.7		433	1305	1306	3250	3251	6780	6781	11900		
18	F2	Fluorine	24.7	29.7		781	2358	2359	6700	6701	14000	14001	28000		
19	Cl2	Chlorine	24.7	29.7		532	1604	1605	4780	4781	9970	9971	17900		
22	H2S	Hydrogen Sulfide	24.7	29.7		714	2155	2156	5900	5901	12000	12001	23000		
23	H2Se	Hydrogen Selenide	24.7	29.7		621	1874	1875	4640	4641	9670	9671	16900		
25	CO2	Carbon Dioxide	24.7	29.7	29.7	643	1942	1943	5300	5301	11000	11001	21000	21001	33000
27	N2O	Nitrous Oxide	24.7	29.7	29.7	612	1849	1850	5100	5101	10400	10401	20000	20001	32000
28	CH4	Methane	24.7	24.7	29.7	661	2000	2001	6000	6001	12000	12001	25000	25001	44000
29	NH3	Ammonia	24.7	24.7	29.7	686	2072	2073	6000	6001	12200	12201	25000	25001	43000
30	O3	Ozone	24.7	29.7	29.7	771	2300	2301	6000	6001	12300	12301	22200	22201	35000
31	PH3	Phosphine	19.7	24.7		630	1901	1902	5200	5201	10700	10701	20200		
32	SO2	Sulfur Dioxide	19.7	24.7		483	1459	1460	3760	3761	7840	7841	14200		
33	CH3F	Methyl Fluoride	24.7	29.7		626	1890	1891	5200	5201	10600	10601	20100		
34	COS	Carbonyl Sulfide	24.7	29.7		563	1700	1701	4400	4401	9200	9201	16000		
35	AsH3	Arsine	24.7	29.7		525	1590	1591	4050	4051	8440	8441	15100		
36	CH3Cl	Methyl Chloride	24.7	29.7	26.7	561	1700	1701	4300	4301	9100	9101	16000	16001	25000
37	ClCN	Cyanogen Chloride	14.7	21.7		436	1320	1321	3340	3341	6960	6961	12400		
38	C2H4	Ethylene	24.7	29.7		524	1582	1583	4400	4401	9300	9301	18100		
39	SiH4	Silane	24.7	29.7		524	1581	1582	4400	4401	9300	9301	18100		
42	C2H2	Acetylene	16.7	19.7		531	1600	1601	4500	4501	9300	9301	18400		
43	GeH4	Germane	24.7	29.7		496	1500	1501	3900	3901	8300	8301	15000		
44	CH3Br	Methyl Bromide	19.7	24.7		333	1000	1001	2600	2601	5400	5401	9830		
45	C2H4O	Ethylene Oxide	14.7	19.7		431	1300	1301	3500	3501	7300	7301	13400		
46	COF2	Carbonyl Fluoride	19.7	19.7		501	1500	1501	4000	4001	8400	8401	16000		
47	CH3SH	Methyl Mercaptan	24.7	29.7		411	1230	1231	3300	3301	7000	7001	12600		
48	BF3	Boron Trifluoride	19.7	24.7		458	1381	1382	3800	3801	7900	7901	15000		
49	CHF3	Fluoroform (Freon-23)	24.7	24.7	26.7	446	1344	1345	3600	3601	7500	7501	14000	14001	22000
51	C2H3F	Vinyl Fluoride	24.7	29.7	34.7	521	1540	1541	4100	4101	8700	8701	16000	16001	25200
52	CH5N	Methylamine	24.7	29.7	32.7	411	1230	1231	3400	3401	7100	7101	13400	13401	22000
53	NF3	Nitrogen Trifluoride	24.7	29.7	34.7	431	1300	1301	3600	3601	7500	7501	14200	14201	23000
54	C2H6	Ethane	24.7	29.7	26.7	470	1418	1419	4000	4001	8300	8301	16000	16001	27000
57	CHClF2	Chlorodifluoromethane (Freon-22)	24.7	29.7		346	1040	1041	2710	2711	5640	5641	10300		
58	B2H6	Diborane	19.7	19.7		359	1082	1083	3010	3011	6400	6401	13000		
60	COCl2	Phosgene	12.7	14.7		326	1000	1001	2480	2481	5160	5161	9140		
61	C3H6-a)	Cyclopropane	24.7	29.7		411	1230	1231	3300	3301	7000	7001	13000		
62	PF3	Phosphorus Trifluoride	19.7	24.7		401	1200	1201	3200	3201	6800	6801	12500		
63	CF4	Carbon Tetrafluoride (Freon-14)	24.7	24.7	29.7	373	1123	1124	3000	3001	6400	6401	12000	12001	19000
67	SiH2Cl2	Dichlorosilane	14.7	19.7		274	824	825	2100	2101	4380	4381	7860		
69	C3H6-b)	Propylene	19.7	19.7		339	1022	1023	2800	2801	6000	6001	11400		
70	BCl3	Boron Trichloride	11.7	14.7		290	874	875	2170	2171	4520	4521	8000		
72	ClO3F	Perchloryl Fluoride	14.7	20.7		351	1060	1061	2720	2721	5800	5801	10300		
73	C2H6O	Dimethylether	14.7	19.7		341	1010	1011	2800	2801	5800	5801	11000		
74	CClF3	Chlorotrifluoromethane (Freon-13)	24.7	29.7		361	1100	1101	2800	2801	5900	5901	10400		
77	ClF3	Chlorine Trifluoride	14.7	20.7		328	1000	1001	2530	2531	5280	5281	9490		
79	BBr3	Boron Tribromide	24.7	29.7	29.7	353	1060	1061	2780	2781	5790	5791	10700	10701	16800
80	CBrF3	Bromotrifluoromethane (Freon-13	24.7	29.7		301	904	905	2270	2271	4730	4731	8350		
84	CCl2F2	Dichlorodifluoromethane (Freon-1	24.7	29.7		283	853	854	2160	2161	4490	4491	7980		
85	C2H7N	Dimethylamine	9.7	14.7		311	960	961	2520	2521	5400	5401	10100		
88	SiF4	Silicon Tetrafluoride	19.7	24.7		317	1000	1001	2600	2601	5400	5401	10000		
89	C3H8	Propane	9.7	11.7		301	910	911	2420	2421	5100	5101	10000		
94	C2F4	Tetrafluoroethylene	19.7	19.7		301	900	901	2300	2301	4900	4901	9100		
97	Si2H6	DISILANE	19.7	19.7		283	853	854	2300	2301	4900	4901	9300		
98	C4H8-j)	Transbutene	19.7	19.7		251	770	771	2030	2031	4300	4301	8300		
99	GeF4	Germanium Tetrafluoride	20.7	24.7		283	860	861	2200	2201	4600	4601	8200		
100	C4H6-e)	Butadiene	19.7	19.7		281	850	851	2300	2301	4800	4801	9200		
102	POCl3	Phosphorus Oxychloride	9.7	9.7	9.7	140	420	421	1060	1061	2200	2201	3900	3901	5990

Table A-3 GF40 Series Gas Table - Codes 104-636, Bins SA40 to SA44

Gas Code	Gas Symbol	Gas Name	Min inlet pressure for vac. exhaust (PSIA)			SA40		SA41		SA42		SA43		SA44	
			SA40-SA47	SA48	SA50	Low	High	Low	High	Low	High	Low	High	Low	High
104	C4H8-i)	Butene	19.7	19.7				3	5	6	17	18	51	52	159
106	C4H8-h)	Isobutylene	19.7	19.7		3	3	4	9	10	28	29	86	87	260
107	C4H8-g)	Cisbutene	19.7	19.7		3	3	4	9	10	28	29	85	86	260
108	SiCl4	Silicon Tetrachloride	8.7					3	6	7	18	19	56	57	172
109	C3H9N	Trimethylamine	6.7	8.7				3	8	9	25	26	78	79	240
110	SF6	Sulfur Hexafluoride	19.7	19.7	29.7			3	8	9	25	26	77	78	237
111	C4H10-d)	Isobutane	19.7	19.7	29.7			3	7	8	23	24	70	71	216
113	GeCl4	Germanium Tetrachloride	19.7	24.7	24.7	3	3	4	9	10	28	29	87	88	261
117	C4H10-c)	Butane	19.7	19.7	29.7			3	8	9	25	26	76	77	234
118	C2F6	Hexafluoroethane (Freon-116)	19.7	19.7				3	8	9	23	24	71	72	218
119	C2ClF5	Chloropentafluoroethane (Freon-1	24.7	29.7				3	7	8	22	23	69	70	210
121	WF6	Tungsten Hexafluoride	9.7	11.7				3	5	6	16	17	48	49	150
122	C5H12	Dimethylpropane	24.7	29.7				3	6	7	20	21	61	62	184
128	C3F8	Perfluoropropane	19.7	19.7				3	5	6	16	17	50	51	154
129	C4F8	Octafluorocyclobutane	19.7	19.7				3	5	6	16	17	50	51	154
138	C3F6	Hexafluoropropylene	19.7	19.7				3	6	7	20	21	60	61	184
155	C2HF5	PENTAFLUOROETHANE (FREO	19.7	19.7				3	8	9	25	26	77	78	235
156	C2H2F4	Tetrafluoroethane (Freon-134a)	24.7	29.7		3	3	4	9	10	28	29	86	87	260
160	CH2F2	Difluoromethane	24.7	29.7		3	6	7	19	20	57	58	174	175	533
185	CH6Si	Methylsilane (MONO)	9.7	14.7		3	4	5	12	13	37	38	111	112	340
190	(CH3)3SiH	Trimethylsilane (TMSi)	6.7					3	6	7	20	21	62	63	189
193	PCl3	Phosphorus Trichloride													
241	C4F10	Perfluorobutane	14.7	19.7				3	4	5	13	14	40	41	120
249	B2F4	Difluroborane	14.7	19.7	19.7	3	3	4	10	11	32	33	99	100	300
266	C5F8	Octafluorocyclopentene	9.7	14.7				3	4	5	14	15	44	45	134
270	C4F6	Hexafluoro-2-butyne	9.7					3	6	7	19	20	57	58	176
297	C4F6-q)	Hexafluoro Butadiene-1-3	14.7	14.7				3	5	6	17	18	52	53	160
354	C5F8O	Epoxyperfluorocyclopentene	19.7	19.7				3	4	5	13	14	40	41	122
360	CF3I	trifluoroiodo-Methane	14.7	14.7				3	7	8	22	23	66	67	201
368	Si3H9N	Trisilylamine (TSA)	6.0	7.2				3	6	7	20	21	60	61	181
371	C4H11N	Dimethylethylamine	8.7	8.7				3	6	7	20	21	63	64	190
385	C3H2F4	2,3,3,3-tetrafluoro-1-Propene	14.7	14.7				3	7	8	23	24	71	72	217
500	15%PH3/N2	15%Phosphine/Nitrogen	24.7	29.7		3	9	10	29	30	90	91	270	271	840
501	5%PH3/N2	5%Phosphine/Nitrogen	24.7	29.7		3	10	11	30	31	93	94	280	281	870
502	20%SiH4/N2	20%Silane/Nitrogen	20.7	25.7	44.7	3	9	10	27	28	83	84	250	251	780
509	10%GeH4/H2	10%Germane/Hydrogen	20.7	20.7		3	9	10	28	29	86	87	260	261	800
516	10%PH3/H2	10%Phosphine/Hydrogen	14.7	14.7		3	9	10	28	29	87	88	265	266	813
517	25%PH3/SiH4	25%Phosphine/Silane	14.7	29.7		3	6	7	19	20	60	61	180	181	560
527	10%PH3/N2	10%Phosphine/Nitrogen	19.7	24.7		3	9	10	30	31	91	92	271	272	850
528	4.5%PH3/N2	4.5%Phosphine/Nitrogen	20.7	29.7		3	10	11	30	31	94	95	280	281	880
529	20%SiH4/He	20%Silane/Helium	20.7	29.7		4	11	12	34	35	103	104	320	321	1000
532	10%H2/N2	10%Hydrogen/Nitrogen	20.7	29.7		3	10	11	30	31	94	95	281	282	880
535	4%PH3/N2	4%Phosphine/Nitrogen	20.7	29.7		3	10	11	30	31	93	94	280	281	870
536	20%O2/He	20%Oxygen/Helium	19.7	29.7		4	13	14	38	39	120	121	360	361	1102
537	1%PH3/Ar	1%Phosphine/Argon	24.7	29.7		4	14	15	43	44	130	131	400	401	1200
538	10%PH3/Ar	10%Phosphine/Argon	24.7	29.7		4	13	14	40	41	120	121	370	371	1110
542	5%H2/N2	5%Hydrogen/Nitrogen	24.7	29.7		3	10	11	30	31	92	93	280	281	860
544	2%SiH4/H2	2%Silane/Hydrogen	24.7	29.7		3	10	11	30	31	94	95	280	281	870
546	1%PH3/He	1%Phosphine/Helium	24.7	29.7		4	14	15	42	43	130	131	400	401	1200
549	.5%B2H6/Ar	.5%Diborane/Argon	24.7	29.7		4	14	15	42	43	130	131	400	401	1200
550	.5%PH3/N2	.5%Phosphine/Nitrogen	24.7	29.7		3	10	11	30	31	94	95	280	281	880
557	1%B2H6/H2	1%Diborane Hydrogen	24.7	29.7		3	10	11	30	31	91	92	270	271	850
559	1%BCl3/H2	1%Boron Trichloride/Hydrogen	24.7	29.7		3	10	11	30	31	94	95	280	281	870
560	1%BCl3/N2	1%Boron Trichloride/Nitrogen	24.7	29.7		3	10	11	30	31	93	94	280	281	870
563	1%PH3/H2	1%Phosphine/Hydrogen	19.7	19.7		3	10	11	30	31	90	91	273	274	850
565	10%SiH4/Ar	10%Silane/Argon	24.7	29.7		4	12	13	38	39	115	116	350	351	1100
584	15%PH3/SiH4	15%Phosphine/Silane	19.7	19.7		3	6	7	19	20	59	60	175	176	550
589	2%SiH4/He	2%Silane/Helium	19.7	19.7		4	14	15	42	43	126	127	400	401	1200
595	3%B2H6/N2	3%Diborane/Nitrogen	20.7	29.7		3	9	10	29	30	90	91	270	271	850
597	3%H2/N2	3%Hydrogen/Nitrogen	24.7	29.7		3	10	11	30	31	92	93	280	281	860
603	30%He/O2	30%Helium/Oxygen	24.7	29.7		4	11	12	33	34	100	101	301	302	950
604	30%O2/He	30%Oxygen/Helium	19.7	29.7		4	12	13	37	38	113	114	345	346	1060
605	4%B2H6/N2	4%Diborane/Nitrogen	19.7	29.7		3	9	10	29	30	90	91	270	271	830
606	4%H2/He	4%Hydrogen/Helium	19.7	19.7		4	14	15	41	42	126	127	400	401	1200
607	4%H2/N2	4%Hydrogen/Nitrogen	24.7	29.7		3	10	11	30	31	92	93	280	281	860
615	5%B2H6/Ar	5%Diborane/Argon	24.7			4	12	13	38	39	116	117	353	354	1084
626	5%PH3/Ar	5%Phosphine/Argon	27.7	32.7		4	13	14	41	42	125	126	380	381	1170
627	5%PH3/SiH4	5%Phosphine/Silane	14.7	19.7	19.7	3	6	7	18	19	58	59	172	173	540
628	5%SiH2Cl2/Ar	5%Dichlorosilane/Argon	24.7	29.7		4	12	13	38	39	116	117	360	361	1100
632	50%PH3/SiH4	50%Phosphine/Silane	16.7	24.7		3	6	7	20	21	62	63	190	191	580
636	8%PH3/SiH4	8%Phosphine/Silane	16.7	24.7		3	6	7	19	20	58	59	173	174	540

For gases not specified for SA50, contact Brooks Product Marketing.

Table A-4 GF40 Series Gas Table - Codes 104-636, Bins SA45 to SA50

Gas Code	Gas Symbol	Gas Name	Min inlet pressure for vac. exhaust (PSIA)			SA45		SA46		SA47		SA48		SA50	
			SA40-SA47	SA48	SA50	Low	High	Low	High	Low	High	Low	High	Low	High
104	C4H8-i)	Butene	19.7	19.7		160	480	481	1400	1401	2920	2921	6480		
106	C4H8-h)	Isobutylene	19.7	19.7		261	800	801	2110	2111	4500	4501	8600		
107	C4H8-g)	Cisbutene	19.7	19.7		261	790	791	2100	2101	4400	4401	8400		
108	SiCl4	Silicon Tetrachloride	8.7			173	520	521	1280	1281	2660				
109	C3H9N	Trimethylamine	6.7	8.7		241	720	721	1910	1911	4000	4001	7700		
110	SF6	Sulfur Hexafluoride	19.7	19.7	29.7	238	715	716	1900	1901	3900	3901	7300	7301	11200
111	C4H10-d)	Isobutane	19.7	19.7	29.7	217	653	654	1800	1801	3800	3801	7300	7301	11700
113	GeCl4	Germanium Tetrachloride	19.7	24.7	24.7	262	810	811	2200	2201	4700	4701	9500	9501	15600
117	C4H10-c)	Butane	19.7	19.7	29.7	235	706	707	1910	1911	4000	4001	7800	7801	12300
118	C2F6	Hexafluoroethane (Freon-116)	19.7	19.7		219	658	659	1740	1741	3700	3701	7000		
119	C2ClF5	Chloropentafluoroethane (Freon-1	24.7	29.7		211	640	641	1620	1621	3400	3401	6200		
121	WF6	Tungsten Hexafluoride	9.7	11.7		151	452	453	1160	1161	2410	2411	4330		
122	C5H12	Dimethylpropane	24.7	29.7		185	570	571	1500	1501	3110	3111	6000		
128	C3F8	Perfluoropropane	19.7	19.7		155	465	466	1200	1201	2500	2501	4700		
129	C4F8	Octafluorocyclobutane	19.7	19.7		155	465	466	1150	1151	2400	2401	4400		
138	C3F6	Hexafluoropropylene	19.7	19.7		185	556	557	1460	1461	3040	3041	5620		
155	C2HF5	PENTAFLUOROETHANE (FREO	19.7	19.7		236	711	712	1900	1901	4000	4001	7500		
156	C2H2F4	Tetrafluoroethane (Freon-134a)	24.7	29.7		261	800	801	2020	2021	4300	4301	7800		
160	CH2F2	Difluoromethane	24.7	29.7		534	1612	1613	4300	4301	8900	8901	16100		
185	CH6Si	Methylsilane (MONO)	9.7	14.7		341	1050	1051	2800	2801	5900	5901	11000		
190	(CH3)3SiH	Trimethylsilane (TMSi)	6.7			190	572	573	1530	1531	3200				
193	PCl3	Phosphorus Trichloride													
241	C4F10	Perfluorobutane	14.7	19.7		121	370	371	950	951	1930	1931	3500		
249	B2F4	Difluroborane	14.7	19.7	19.7	301	920	921	2600	2601	5500	5501	11600	11601	20300
266	C5F8	Octafluorocyclopentene	9.7	14.7		135	406	407	1040	1041	2200	2201	3900		
270	C4F6	Hexafluoro-2-butyne	9.7			177	533	534	1400	1401	2900				
297	C4F6-q)	Hexafluoro Butadiene-1-3	14.7	14.7		161	500	501	1250	1251	2610	2611	4760		
354	C5F8O	Epoxyperfluorocyclopentene	19.7	19.7		123	369	370	1000	1001	2040	2041	3900		
360	CF3I	trifluoroiodo-Methane	14.7	14.7		202	609	610	1530	1531	3200	3201	5670		
368	Si3H9N	Trisilylamine (TSA)	6.0	7.2		182	560	561	1400	1401	2900	2901	5300		
371	C4H11N	Dimethylethylamine	8.7	8.7		191	580	581	1530	1531	3200	3201	6100		
385	C3H2F4	2,3,3,3-tetrafluoro-1-Propene	14.7	14.7		218	656	657	1720	1721	3600	3601	6700		
500	15%PH3/N2	15%Phosphine/Nitrogen	24.7	29.7		841	2500	2501	6900	6901	14200	14201	28100		
501	5%PH3/N2	5%Phosphine/Nitrogen	24.7	29.7		871	2600	2601	7200	7201	15000	15001	30000		
502	20%SiH4/N2	20%Silane/Nitrogen	20.7	25.7	44.7	781	2310	2311	6500	6501	13300	13301	27000	27001	45000
509	10%GeH4/H2	10%Germane/Hydrogen	20.7	20.7		801	2400	2401	7100	7101	15000	15001	34000		
516	10%PH3/H2	10%Phosphine/Hydrogen	14.7	14.7		814	2500	2501	7500	7501	16000	16001	37000		
517	25%PH3/SiH4	25%Phosphine/Silane	14.7	29.7		561	1700	1701	4600	4601	9600	9601	19000		
527	10%PH3/N2	10%Phosphine/Nitrogen	19.7	24.7		851	2510	2511	7100	7101	14500	14501	29000		
528	4.5%PH3/N2	4.5%Phosphine/Nitrogen	20.7	29.7		881	2600	2601	7200	7201	15000	15001	30000		
529	20%SiH4/He	20%Silane/Helium	20.7	29.7		1001	3000	3001	8700	8701	18000	18001	40000		
532	10%H2/N2	10%Hydrogen/Nitrogen	20.7	29.7		881	2610	2611	7400	7401	15200	15201	31000		
535	4%PH3/N2	4%Phosphine/Nitrogen	20.7	29.7		871	2600	2601	7200	7201	15000	15001	30000		
536	20%O2/He	20%Oxygen/Helium	19.7	29.7		1103	3331	3332	10000	10001	21000	21001	48000		
537	1%PH3/Ar	1%Phosphine/Argon	24.7	29.7		1201	3700	3701	9700	9701	20000	20001	37000		
538	10%PH3/Ar	10%Phosphine/Argon	24.7	29.7		1111	3400	3401	9000	9001	18400	18401	35000		
542	5%H2/N2	5%Hydrogen/Nitrogen	24.7	29.7		861	2600	2601	7400	7401	15100	15101	31000		
544	2%SiH4/H2	2%Silane/Hydrogen	24.7	29.7		871	2600	2601	8000	8001	16200	16201	39000		
546	1%PH3/He	1%Phosphine/Helium	24.7	29.7		1201	3700	3701	11000	11001	23000	23001	55000		
549	.5%B2H6/Ar	.5%Diborane/Argon	24.7	29.7		1201	3700	3701	9700	9701	20000	20001	37000		
550	.5%PH3/N2	.5%Phosphine/Nitrogen	24.7	29.7		881	2600	2601	7500	7501	15000	15001	30000		
557	1%B2H6/H2	1%Diborane Hydrogen	24.7	29.7		851	2510	2511	7900	7901	16000	16001	39000		
559	1%BCl3/H2	1%Boron Trichloride/Hydrogen	24.7	29.7		871	2600	2601	7900	7901	16200	16201	39000		
560	1%BCl3/N2	1%Boron Trichloride/Nitrogen	24.7	29.7		871	2600	2601	7300	7301	15000	15001	30000		
563	1%PH3/H2	1%Phosphine/Hydrogen	19.7	19.7		851	2531	2532	7900	7901	16000	16001	38000		
565	10%SiH4/Ar	10%Silane/Argon	24.7	29.7		1101	3300	3301	8800	8801	18000	18001	34000		
584	15%PH3/SiH4	15%Phosphine/Silane	19.7	19.7		551	1630	1631	4500	4501	9500	9501	18400		
589	2%SiH4/He	2%Silane/Helium	19.7	19.7		1201	3600	3601	10700	10701	22300	22301	54000		
595	3%B2H6/N2	3%Diborane/Nitrogen	20.7	29.7		851	2500	2501	7100	7101	14500	14501	29000		
597	3%H2/N2	3%Hydrogen/Nitrogen	24.7	29.7		861	2600	2601	7400	7401	15100	15101	31000		
603	30%He/O2	30%Helium/Oxygen	24.7	29.7		951	2800	2801	8100	8101	17000	17001	35000		
604	30%O2/He	30%Oxygen/Helium	19.7	29.7		1061	3203	3204	10000	10001	20000	20001	45000		
605	4%B2H6/N2	4%Diborane/Nitrogen	19.7	29.7		831	2500	2501	7000	7001	14300	14301	29000		
606	4%H2/He	4%Hydrogen/Helium	19.7	19.7		1201	3600	3601	11000	11001	22300	22301	55000		
607	4%H2/N2	4%Hydrogen/Nitrogen	24.7	29.7		861	2600	2601	7400	7401	15100	15101	31000		
615	5%B2H6/Ar	5%Diborane/Argon	24.7			1085	3278	3279	8900	8901	18200				
626	5%PH3/Ar	5%Phosphine/Argon	27.7	32.7		1171	3600	3601	9500	9501	19300	19301	36000		
627	5%PH3/SiH4	5%Phosphine/Silane	14.7	19.7	19.7	541	1600	1601	4500	4501	9400	9401	18200	18201	30000
628	5%SiH2Cl2/Ar	5%Dichlorosilane/Argon	24.7	29.7		1101	3300	3301	8800	8801	18000	18001	33000		
632	50%PH3/SiH4	50%Phosphine/Silane	16.7	24.7		581	1730	1731	4800	4801	10000	10001	19100		
636	8%PH3/SiH4	8%Phosphine/Silane	16.7	24.7		541	1610	1611	4500	4501	9400	9401	18200		

Table A-5 GF40 Series Gas Table - Codes 640-948, Bins SA40 to SA44

Gas Code	Gas Symbol	Gas Name	Min inlet pressure for vac. exhaust (PSIA)			SA40		SA41		SA42		SA43		SA44	
			SA40-SA47	SA48	SA50	Low	High	Low	High	Low	High	Low	High	Low	High
640	2%PH3/N2	2%Phosphine/Nitrogen	22.7	27.7	49.7	3	10	11	30	31	94	95	280	281	870
649	10%O2/He	10%Oxygen/Helium	19.7	24.7		4	13	14	41	42	123	124	380	381	1150
653	2%SiH4/N2	2%SILANE/NITROGEN	19.7	24.7		3	10	11	30	31	93	94	280	281	870
654	5%B2H6/N2	5%Diborane/Nitrogen	24.7	29.7		3	9	10	28	29	86	87	262	263	804
656	.5%PH3/H2	.5%Phosphine/Hydrogen	24.7	29.7		3	10	11	31	32	95	96	282	283	880
660	.3%PH3/SiH4	.3%Phosphine/Silane	24.7	29.7		3	6	7	18	19	57	58	171	172	530
662	.8%B2H6/N2	.8%Diborane/Nitrogen	24.7	29.7		3	10	11	30	31	93	94	280	281	870
664	8%GeH4/H2	8%Germane/Hydrogen	24.7	29.7		3	9	10	29	30	89	90	270	271	840
674	10%PH3/He	10%Phosphine/Helium	14.7	19.7		4	13	14	40	41	120	121	370	371	1110
676	7.5%PH3/SiH4	7.5%Phosphine/Silane	14.7	14.7		3	6	7	19	20	58	59	175	176	540
677	20%F2/He	20%Fluorine/Helium	14.7	19.7		4	13	14	39	40	117	118	360	361	1100
693	5%PH3/He	5%Phosphine/Helium	12.7	14.7		4	13	14	41	42	125	126	380	381	1150
695	2%B2H6/N2	2%Diborane/Nitrogen	24.7	29.7		3	10	11	30	31	93	94	280	281	870
698	10%GeH4/Ar	10%Germane/Argon	24.7	29.7		4	12	13	38	39	114	115	350	351	1070
700	4%H2/Ar	4%Hydrogen/Argon	24.7	29.7		5	14	15	42	43	130	131	390	391	1200
701	10%B2H6/H2	10%Diborane/Hydrogen	14.7	14.7		3	8	9	26	27	81	82	241	242	760
710	10%CH4/Ar	10%Methane/Argon	34.7	39.7	44.7	4	13	14	40	41	120	121	370	371	1120
724	1%AsH3/H2	1%Arsine/Hydrogen	14.7	19.7		3	10	11	30	31	94	95	281	282	880
731	10%Si2H6/H2	10%Disilane/Hydrogen	19.7	19.7		3	8	9	25	26	79	80	240	241	730
762	5%H2/He	5%Hydrogen/Helium	19.7	19.7		5	13	14	41	42	125	126	400	401	1200
766	5%B2H6/He	5%Diborane/Helium	14.7	16.7		4	12	13	38	39	115	116	350	351	1100
771	.7%GeH4/H2	.7%Germane/Hydrogen	14.7	16.7		3	10	11	30	31	94	95	281	282	880
773	5%SiH4/N2	5%Silane/Nitrigen	24.7	29.7		3	10	11	30	31	90	91	280	281	860
775	1.5%GeH4/H2	1.5%Germane/Hydrogen	14.7	16.7		3	10	11	30	31	94	95	280	281	880
780	5%SiH4/He	5%Silane/Helium	14.7	16.7		4	13	14	40	41	122	123	380	381	1140
784	.02%CO/N2	.02%Carbon Monoxide/Nitrogen	24.7	29.7		3	10	11	30	31	94	95	280	281	880
786	.1%CO/N2	.1%Carbon Monoxide/Nitrogen	24.7	29.7		3	10	11	30	31	94	95	280	281	880
805	1%B2H6/Ar	1%Diborane/Argon	14.7	16.7		4	14	15	42	43	130	131	390	391	1200
820	15%B2H6/H2	15%Diborane/Hydrogen	14.7	14.7		3	8	9	25	26	76	77	230	231	710
821	15%SiH4/Ar	15%Silane/Argon	24.7	29.7		4	12	13	36	37	110	111	330	331	1010
823	2%SiH4/Ar	2%Silane/Argon	24.7	29.7		4	14	15	42	43	126	127	390	391	1200
824	2%SO2/N2	2%Sulfur Dioxide/Nitrogen	19.7	24.7		3	10	11	30	31	93	94	280	281	870
833	3%H2/Ar	3%Hydrogen/Argon	24.7	29.7		5	14	15	42	43	130	131	400	401	1200
837	30%GeH4/Ar	30%Germane/Argon	19.7	24.7		3	10	11	30	31	93	94	280	281	860
850	50%H2/N2	50%Hydrogen/Nitrogen	19.7	24.7		3	10	11	30	31	95	96	281	282	880
863	2%O2/Ar	2%Oxygen/Argon	24.7	29.7		4	14	15	43	44	130	131	400	401	1200
865	5%CO2/5%O2/N2	5%Carbon Dioxide/5%Oxygen/Nit	24.7	29.7		3	10	11	30	31	92	93	280	281	860
866	2.5%O2/5%CO2/N2	2.5%Oxygen/5%Carbon Dioxide/N	24.7	29.7		3	10	11	30	31	93	94	280	281	860
867	.5%CO2/10%O2/N2	.5%Carbon Dioxide/10%Oxygen/N	24.7	29.7		3	10	11	30	31	92	93	280	281	860
875	20%O2/Ar	20%Oxygen/Argon	24.7	29.7		4	13	14	39	40	120	121	370	371	1120
877	30%SiHCl3/H2	30%Trichlorosilane/Hydrogen	19.7	24.7	34.7	3	6	7	19	20	59	60	180	181	550
878	3%C2H4/He	3%Ethylene/Helium	19.7	19.7		5	13	14	40	41	123	124	374	375	1149
881	10%B2H6/Ar	5%Diborane/Argon	24.7	29.7		4	11	12	35	36	105	106	320	321	1000
886	.01%PH3/Ar	.01%Phosphine/Argon	24.7	29.7		5	14	15	43	44	130	131	400	401	1210
887	.1%PH3/Ar	.1%Phosphine/Argon	24.7	29.7		5	14	15	43	44	130	131	400	401	1210
888	.1%B2H6/Ar	.1%Diborane/Argon	24.7	29.7		4	14	15	43	44	130	131	400	401	1210
895	40%GeH4/N2	40%Germane/Nitrogen	19.7	19.7		3	7	8	23	24	73	74	220	221	680
896	30%PH3/SiH4	30%Phosphine/Silane	20.7	20.7		3	6	7	20	21	60	61	180	181	560
897	2.7%C2H4/He	2.7%Ethylene/Helium	19.7	19.7		5	13	14	40	41	123	124	375	376	1153
898	1%GeH4/H2	1%Germane/Hydrogen	20.7	20.7		3	10	11	30	31	91	92	275	276	850
900	.48%NF3/N2	.48%Nitrogen Fluoride/Nitrogen	24.7	29.7		3	10	11	30	31	94	95	280	281	880
907	10%AsH3/N2	10%Arsine/Nitrogen	24.7	29.7		3	9	10	29	30	88	89	269	270	825
908	20%B2H6/He	20%Diborane/Helium	24.7	29.7		3	10	11	30	31	90	91	275	276	840
910	.5%GeH4/H2	0.5%Germane/Hydrogen	20.7	20.7		3	10	11	30	31	92	93	280	281	860
916	2%PH3/H2	2%Phosphine/Hydrogen	21.7	21.7		3	10	11	30	31	91	92	275	276	850
917	50%C3H6-b)/N2	50%Propylene/Nitrogen	21.7	21.7		3	5	6	17	18	53	54	160	161	500
919	20%H2/20%CO/N2	20%Hydrogen/20%Carbon Monox	24.7	29.7		3	10	11	30	31	94	95	281	282	880
920	20%H2/20%CO/Ar	20%Hydrogen/20%Carbon Monox	24.7	29.7		4	12	13	37	38	112	113	340	341	1050
921	4%O2/N2	4%Oxygen/Nitrogen	24.7	29.7		3	10	11	30	31	94	95	280	281	880
925	10%C3H6-b)/N2	10%Propylene/Nitrogen	21.7	21.7		3	8	9	26	27	82	83	243	244	760
926	3%H2S/H2	3%Hydrogen Sulfide/Hydrogen	24.7	29.7		3	10	11	30	31	94	95	280	281	880
927	6%B2H6/N2	6%Diborane/Nitrogen	24.7	29.7		3	9	10	28	29	87	88	260	261	810
929	10%CH4/N2	10%Methane/Nitrogen	21.7	21.7		3	10	11	29	30	91	92	272	273	850
930	3.9%H2/N2	3.9%Hydrogen/Nitrogen	24.7	29.7		3	10	11	30	31	92	93	280	281	860
932	5%GeH4/H2	5%Germane/Hydrogen	19.7	19.7		3	10	11	30	31	91	92	272	273	850
936	10%He/N2	10%Helium/Nitrogen	19.7	19.7		3	10	11	31	32	100	101	290	291	910
939	10%B2H6/He	10%Diborane/Helium	19.7	19.7		4	11	12	34	35	103	104	314	315	965
941	1%O2/Ar	1%Oxygen/Atgon	19.7	24.7		4	14	15	43	44	130	131	400	401	1210
946	30%C2H4/He	30%Ethylene/Helium	19.7	24.7		3	10	11	30	31	92	93	281	282	862
947	10%HCl/Ar	10%Hydrogen Chloride/Argon	19.7	24.7		4	13	14	41	42	125	126	380	381	1160
948	20%PH3/Ar	20%Phosphine/Argon	19.7	19.7		4	12	13	36	37	110	111	340	341	1030

Table A-6 GF40 Series Gas Table - Codes 640-948, Bins SA45 to SA50

Gas Code	Gas Symbol	Gas Name	Min inlet pressure for vac. exhaust (PSIA)			SA45		SA46		SA47		SA48		SA50	
			SA40-SA47	SA48	SA50	Low	High	Low	High	Low	High	Low	High	Low	High
640	2%PH3/N2	2%Phosphine/Nitrogen	22.7	27.7	49.7	871	2600	2601	7300	7301	15000	15001	30000	30001	50000
649	10%O2/He	10%Oxygen/Helium	19.7	24.7		1151	3500	3501	10400	10401	22000	22001	52000		
653	2%SiH4/N2	2%SILANE/NITROGEN	19.7	24.7		871	2600	2601	7300	7301	15000	15001	30000		
654	5%B2H6/N2	5%Diborane/Nitrogen	24.7	29.7		805	2500	2501	6900	6901	14100	14101	29000		
656	.5%PH3/H2	.5%Phosphine/Hydrogen	24.7	29.7		881	2620	2621	8100	8101	16500	16501	40000		
660	.3%PH3/SiH4	.3%Phosphine/Silane	24.7	29.7		531	1600	1601	4400	4401	9300	9301	18100		
662	.8%B2H6/N2	.8%Diborane/Nitrogen	24.7	29.7		871	2600	2601	7300	7301	15000	15001	30000		
664	8%GeH4/H2	8%Germane/Hydrogen	24.7	29.7		841	2500	2501	7500	7501	15200	15201	35000		
674	10%PH3/He	10%Phosphine/Helium	14.7	19.7		1111	3400	3401	10200	10201	21100	21101	50000		
676	7.5%PH3/SiH4	7.5%Phosphine/Silane	14.7	14.7		541	1610	1611	4500	4501	9400	9401	18200		
677	20%F2/He	20%Fluorine/Helium	14.7	19.7		1101	3300	3301	10000	10001	20300	20301	47000		
693	5%PH3/He	5%Phosphine/Helium	12.7	14.7		1151	3500	3501	10400	10401	22000	22001	52000		
695	2%B2H6/N2	2%Diborane/Nitrogen	24.7	29.7		871	2600	2601	7200	7201	15000	15001	30000		
698	10%GeH4/Ar	10%Germane/Argon	24.7	29.7		1071	3300	3301	8600	8601	18000	18001	33000		
700	4%H2/Ar	4%Hydrogen/Argon	24.7	29.7		1201	3700	3701	9700	9701	20000	20001	38000		
701	10%B2H6/H2	10%Diborane/Hydrogen	14.7	14.7		761	2300	2301	7000	7001	14000	14001	33000		
710	10%CH4/Ar	10%Methane/Argon	34.7	39.7	44.7	1121	3400	3401	9200	9201	19000	19001	36000	36001	58000
724	1%AsH3/H2	1%Arsine/Hydrogen	14.7	19.7		881	2610	2611	8000	8001	16400	16401	40000		
731	10%Si2H6/H2	10%Disilane/Hydrogen	19.7	19.7		731	2200	2201	6500	6501	13300	13301	30000		
762	5%H2/He	5%Hydrogen/Helium	19.7	19.7		1201	3600	3601	11000	11001	23000	23001	55000		
766	5%B2H6/He	5%Diborane/Helium	14.7	16.7		1101	3300	3301	10000	10001	21000	21001	50000		
771	.7%GeH4/H2	.7%Germane/Hydrogen	14.7	16.7		881	2610	2611	8000	8001	16400	16401	40000		
773	5%SiH4/N2	5%Silane/Nitrigen	24.7	29.7		861	2600	2601	7100	7101	14600	14601	29100		
775	1.5%GeH4/H2	1.5%Germane/Hydrogen	14.7	16.7		881	2600	2601	7900	7901	16200	16201	40000		
780	5%SiH4/He	5%Silane/Helium	14.7	16.7		1141	3500	3501	10300	10301	21400	21401	51000		
784	.02%CO/N2	.02%Carbon Monoxide/Nitrogen	24.7	29.7		881	2600	2601	7400	7401	15000	15001	30000		
786	.1%CO/N2	.1%Carbon Monoxide/Nitrogen	24.7	29.7		881	2600	2601	7400	7401	15000	15001	30000		
805	1%B2H6/Ar	1%Diborane/Argon	14.7	16.7		1201	3600	3601	9600	9601	20000	20001	37000		
820	15%B2H6/H2	15%Diborane/Hydrogen	14.7	14.7		711	2120	2121	6500	6501	13100	13101	31000		
821	15%SiH4/Ar	15%Silane/Argon	24.7	29.7		1011	3100	3101	8300	8301	17000	17001	33000		
823	2%SiH4/Ar	2%Silane/Argon	24.7	29.7		1201	3600	3601	9600	9601	20000	20001	37000		
824	2%SO2/N2	2%Sulfur Dioxide/Nitrogen	19.7	24.7		871	2600	2601	7300	7301	15000	15001	30000		
833	3%H2/Ar	3%Hydrogen/Argon	24.7	29.7		1201	3700	3701	10000	10001	20000	20001	38000		
837	30%GeH4/Ar	30%Germane/Argon	19.7	24.7		861	2600	2601	6800	6801	14000	14001	26000		
850	50%H2/N2	50%Hydrogen/Nitrogen	19.7	24.7		881	2610	2611	7700	7701	16000	16001	35000		
863	2%O2/Ar	2%Oxygen/Argon	24.7	29.7		1201	3700	3701	10000	10001	20000	20001	37000		
865	5%CO2/5%O2/N2	5%Carbon Dioxide/5%Oxygen/Nit	24.7	29.7		861	2600	2601	7200	7201	15000	15001	30000		
866	2.5%O2/5%CO2/N2	2.5%Oxygen/5%Carbon Dioxide/N	24.7	29.7		861	2600	2601	7200	7201	15000	15001	30000		
867	.5%CO2/10%O2/N2	.5%Carbon Dioxide/10%Oxygen/N	24.7	29.7		861	2600	2601	7200	7201	15000	15001	30000		
875	20%O2/Ar	20%Oxygen/Argon	24.7	29.7		1121	3400	3401	9200	9201	19000	19001	36000		
877	30%SiHCl3/H2	30%Trichlorosilane/Hydrogen	19.7	24.7	34.7	551	1640	1641	4400	4401	9200	9201	17000	17001	27100
878	3%C2H4/He	3%Ethylene/Helium	19.7	19.7		1150	3474	3475	10700	10701	22300	22301	53000		
881	10%B2H6/Ar	5%Diborane/Argon	24.7	29.7		1001	3000	3001	8100	8101	17000	17001	32000		
886	.01%PH3/Ar	.01%Phosphine/Argon	24.7	29.7		1211	3700	3701	10000	10001	20000	20001	38000		
887	.1%PH3/Ar	.1%Phosphine/Argon	24.7	29.7		1211	3700	3701	10000	10001	20000	20001	38000		
888	.1%B2H6/Ar	.1%Diborane/Argon	24.7	29.7		1211	3700	3701	10000	10001	20000	20001	38000		
895	40%GeH4/N2	40%Germane/Nitrogen	19.7	19.7		681	2010	2011	5500	5501	11300	11301	21400		
896	30%PH3/SiH4	30%Phosphine/Silane	20.7	20.7		561	1700	1701	4600	4601	9700	9701	19000		
897	2.7%C2H4/He	2.7%Ethylene/Helium	19.7	19.7		1154	3487	3488	11000	11001	22300	22301	54000		
898	1%GeH4/H2	1%Germane/Hydrogen	20.7	20.7		851	2530	2531	8000	8001	16000	16001	39000		
900	.48%NF3/N2	.48%Nitrogen Fluoride/Nitrogen	24.7	29.7		881	2600	2601	7300	7301	15000	15001	30000		
907	10%AsH3/N2	10%Arsine/Nitrogen	24.7	29.7		826	2495	2496	7000	7001	14300	14301	28000		
908	20%B2H6/He	20%Diborane/Helium	24.7	29.7		841	2500	2501	7500	7501	15200	15201	35000		
910	.5%GeH4/H2	0.5%Germane/Hydrogen	20.7	20.7		861	2600	2601	8000	8001	16000	16001	40000		
916	2%PH3/H2	2%Phosphine/Hydrogen	21.7	21.7		851	2530	2531	8000	8001	16000	16001	39000		
917	50%C3H6-b)/N2	50%Propylene/Nitrogen	21.7	21.7		501	1500	1501	4100	4101	8600	8601	17000		
919	20%H2/20%CO/N2	20%Hydrogen/20%Carbon Monox	24.7	29.7		881	2610	2611	7500	7501	15300	15301	32000		
920	20%H2/20%CO/Ar	20%Hydrogen/20%Carbon Monox	24.7	29.7		1051	3200	3201	9000	9001	18100	18101	36000		
921	4%O2/N2	4%Oxygen/Nitrogen	24.7	29.7		881	2600	2601	7500	7501	15000	15001	30000		
925	10%C3H6-b)/N2	10%Propylene/Nitrogen	21.7	21.7		761	2300	2301	6400	6401	13100	13101	26100		
926	3%H2S/H2	3%Hydrogen Sulfide/Hydrogen	24.7	29.7		881	2600	2601	8000	8001	16300	16301	39000		
927	6%B2H6/N2	6%Diborane/Nitrogen	24.7	29.7		811	2400	2401	6800	6801	14000	14001	28000		
929	10%CH4/N2	10%Methane/Nitrogen	21.7	21.7		851	2520	2521	7200	7201	15000	15001	30000		
930	3.9%H2/N2	3.9%Hydrogen/Nitrogen	24.7	29.7		861	2600	2601	7400	7401	15100	15101	31000		
932	5%GeH4/H2	5%Germane/Hydrogen	19.7	19.7		851	2530	2531	7700	7701	16000	16001	37000		
936	10%He/N2	10%Helium/Nitrogen	19.7	19.7		911	2700	2701	7600	7601	16000	16001	32000		
939	10%B2H6/He	10%Diborane/Helium	19.7	19.7		966	2918	2919	9100	9101	19000	19001	43000		
941	1%O2/Ar	1%Oxygen/Atgon	19.7	24.7		1211	3700	3701	10000	10001	20000	20001	38000		
946	30%C2H4/He	30%Ethylene/Helium	19.7	24.7		863	2605	2606	8000	8001	16000	16001	36000		
947	10%HCl/Ar	10%Hydrogen Chloride/Argon	19.7	24.7		1161	3600	3601	9400	9401	19200	19201	36000		
948	20%PH3/Ar	20%Phosphine/Argon	19.7	19.7		1031	3100	3101	8400	8401	17100	17101	32000		

Table A-7 GF40 Series Gas Table - Codes 949-5022, Bins SA40 to SA44

Gas Code	Gas Symbol	Gas Name	Min inlet pressure for vac. exhaust (PSIA)			SA40		SA41		SA42		SA43		SA44	
			SA40-SA47	SA48	SA50	Low	High	Low	High	Low	High	Low	High	Low	High
949	2%F2/Ne	2%Fluorine/Neon	19.7	19.7		4	14	15	42	43	130	131	400	401	1200
950	10%H2/He	10%Hydrogen/Helium	19.7	19.7		4	13	14	40	41	125	126	373	374	1145
951	7%AsH3/H2	7%Arsine/Hydrogen	19.7	19.7		3	10	11	30	31	92	93	280	281	860
953	15%H2/B2H6	15%Hydrogen/Diborane	19.7	19.7		3	4	5	14	15	42	43	130	131	400
954	14%SiH2Cl2/20%SiH4/33%HCl/N	14%Dichlorosilane/20%Silane/33%	14.7	19.7		3	7	8	23	24	71	72	212	213	670
958	17%CH4/CO2	17%Methane/Carbon Dioxide	24.7	29.7		3	7	8	23	24	70	71	210	211	650
962	20%CH6Si/H2	20%Methylsilane (MONO)/Hydrog	14.7	19.7		3	7	8	23	24	71	72	212	213	660
963	20%F2/N2	20%Fluorine/Nitrogen	24.7	29.7		3	10	11	30	31	92	93	280	281	860
965	50%CH3SiHCl2/H2	50%Dichloromethylsilane/Hydroge	11.7	13.7		3	4	5	14	15	42	43	130	131	400
976	4%CH4/Ar	4%Methane/Argon	19.7	24.7		4	13	14	41	42	125	126	390	391	1200
977	4%He/H2	4%helium/Hydrogen	14.7	19.7		3	10	11	30	31	94	95	280	281	880
978	20%GeH4/H2	20%Germane/Hydrogen	19.7	24.7		3	8	9	26	27	81	82	241	242	750
979	0.5%B2H6/He	0.5%Diborane/Helium	14.7	19.7		5	14	15	42	43	130	131	400	401	1200
980	20%F2/Ar	20%Fluorine/Argon	24.7	29.7		4	13	14	39	40	120	121	360	361	1100
982	5%HF/N2	5%Hydrogen Fluoride/Nitrogen	24.7	29.7		3	10	11	30	31	92	93	280	281	860
983	3%H2S/CO	3%Hydrogen Sulfide/Carbon Mon	24.7	29.7		3	10	11	30	31	92	93	280	281	860
984	1.4%C2H2/Ar	1.4%Acetylene/Argon	24.7	29.7		5	14	15	42	43	130	131	390	391	1200
985	2%Ge2H6/H2	2%Digermane/Hydrogen	24.7	29.7		3	10	11	30	31	92	93	280	281	860
986	38%SiCl4/O2	38%Silicon Tetrachloride/Oxygen	24.7	29.7		3	5	6	16	17	50	51	150	151	460
987	20%H2S/20%CO2/N2	20%Hydrogen Sulfide/20%Carbon	24.7	29.7		3	9	10	27	28	85	86	252	253	790
988	20%SiH2Cl2/H2	20%Dichlorosilane/Hydrogen	24.7	29.7		3	8	9	24	25	74	75	222	223	700
989	0.1%Cl2/N2	0.1%Chlorine/Nitrogen	24.7	29.7		3	10	11	30	31	94	95	280	281	880
990	1%HCl/N2	1%Hydrogen Chloride/Nitrogen	24.7	29.7		3	10	11	30	31	94	95	280	281	880
991	3%BCl3/N2	3%Boron Trichloride/Nitrogen	24.7	29.7		3	9	10	29	30	91	92	270	271	850
992	18%NO/N2	18%Nitric Oxide/Nitrogen	24.7	29.7		3	10	11	30	31	94	95	280	281	880
993	9%NO/41%N2/H2	9%Nitric Oxide/41%Nitrogen/H2	24.7	29.7		3	10	11	30	31	94	95	281	282	880
994	20%H2/Ar	20%Hydrogen/Argon	24.7	29.7		4	13	14	40	41	120	121	370	371	1120
996	25%H2S/Ar	25%Hydrogen Sulfide/Argon	31.7	37.7	59.7	4	12	13	37	38	111	112	340	341	1040
997	25%H2Se/Ar	25%Hydrogen Selenide/Argon	34.7	39.7	64.7	4	12	13	36	37	110	111	340	341	1030
998	50%NH3/He	50%Ammonia/Helium	14.7	24.7	34.7	3	10	11	30	31	94	95	280	281	880
999	40%CO/45%C2H4/Ar	40%Carbon Monoxide/45%Ethyle	24.7	29.7	39.7	3	8	9	24	25	75	76	230	231	700
1000	0.9%SiH4/N2	0.9%Silane/Nitrogen	19.7	24.7	24.7	3	10	11	30	31	94	95	280	281	880
1001	5%Ar/N2	5%Argon/Nitrogen	19.7	24.7	24.7	4	10	11	31	32	96	97	290	291	890
1002	25%PH3/N2	25%Phosphine/Nirtogen	19.7	24.7	24.7	3	9	10	28	29	86	87	260	261	810
1003	5%C4H6-e)/He	5%Butadiene/Helium	14.7	19.7		4	12	13	36	37	110	111	336	337	1032
1004	10%Cl2/N2	10%Chlorine/Nitrogen	24.7	29.7		3	10	11	29	30	90	91	275	276	844
1005	15%Xe/H2	15%Xenon/Hydrogen	24.7	29.7		4	10	11	32	33	97	98	294	295	903
5022	COS-Special	Carbonyl Sulfide (Special)	24.7	29.7		3	6	7	20	21	60	61	183	184	562

Table A-8 GF40 Series Gas Table - Codes 949-5022, Bins SA45 to SA50

Gas Code	Gas Symbol	Gas Name	Min inlet pressure for vac. exhaust (PSIA)			SA45		SA46		SA47		SA48		SA50	
			SA40-SA47	SA48	SA50	Low	High	Low	High	Low	High	Low	High	Low	High
949	2%F2/Ne	2%Fluorine/Neon	19.7	19.7		1201	3700	3701	10500	10501	22000	22001	48000		
950	10%H2/He	10%Hydrogen/Helium	19.7	19.7		1146	3500	3501	11000	11001	22300	22301	54000		
951	7%AsH3/H2	7%Arsine/Hydrogen	19.7	19.7		861	2600	2601	7700	7701	16000	16001	36000		
953	15%H2/B2H6	15%Hydrogen/Diborane	19.7	19.7		401	1200	1201	3400	3401	7100	7101	14200		
954	14%SiH2Cl2/20%SiH4/33%HCl/N2	14%Dichlorosilane/20%Silane/33%	14.7	19.7		671	2000	2001	5300	5301	11000	11001	21000		
958	17%CH4/CO2	17%Methane/Carbon Dioxide	24.7	29.7		651	2000	2001	5400	5401	11000	11001	21100		
962	20%CH6Si/H2	20%Methylsilane (MONO)/Hydrog	14.7	19.7		661	2000	2001	5800	5801	12100	12101	27000		
963	20%F2/N2	20%Fluorine/Nitrogen	24.7	29.7		861	2600	2601	7200	7201	15000	15001	30000		
965	50%CH3SiHCl2/H2	50%Dichloromethylsilane/Hydroge	11.7	13.7		401	1200	1201	3100	3101	6600	6601	12000		
976	4%CH4/Ar	4%Methane/Argon	19.7	24.7		1201	3600	3601	9600	9601	20000	20001	37000		
977	4%He/H2	4%helium/Hydrogen	14.7	19.7		881	2600	2601	7900	7901	16200	16201	39000		
978	20%GeH4/H2	20%Germane/Hydrogen	19.7	24.7		751	2240	2241	6600	6601	13400	13401	30000		
979	0.5%B2H6/He	0.5%Diborane/Helium	14.7	19.7		1201	3700	3701	11200	11201	23000	23001	56000		
980	20%F2/Ar	20%Fluorine/Argon	24.7	29.7		1101	3400	3401	9000	9001	18400	18401	35000		
982	5%HF/N2	5%Hydrogen Fluoride/Nitrogen	24.7	29.7		861	2600	2601	7200	7201	15000	15001	30000		
983	3%H2S/CO	3%Hydrogen Sulfide/Carbon Mono	24.7	29.7		861	2600	2601	7200	7201	15000	15001	30000		
984	1.4%C2H2/Ar	1.4%Acetylene/Argon	24.7	29.7		1201	3600	3601	9700	9701	20000	20001	37000		
985	2%Ge2H6/H2	2%Digermane/Hydrogen	24.7	29.7		861	2600	2601	7200	7201	15000	15001	30000		
986	38%SiCl4/O2	38%Silicon Tetrachloride/Oxygen	24.7	29.7		461	1400	1401	3500	3501	7300	7301	12500		
987	20%H2S/20%CO2/N2	20%Hydrogen Sulfide/20%Carbon	24.7	29.7		791	2400	2401	6500	6501	13300	13301	26000		
988	20%SiH2Cl2/H2	20%Dichlorosilane/Hydrogen	24.7	29.7		701	2100	2101	5900	5901	12000	12001	25000		
989	0.1%Cl2/N2	0.1%Chlorine/Nitrogen	24.7	29.7		881	2600	2601	7400	7401	15000	15001	30000		
990	1%HCl/N2	1%Hydrogen Chloride/Nitrogen	24.7	29.7		881	2600	2601	7400	7401	15000	15001	30000		
991	3%BCl3/N2	3%Boron Trichloride/Nitrogen	24.7	29.7		851	2510	2511	7000	7001	14400	14401	29000		
992	18%NO/N2	18%Nitric Oxide/Nitrogen	24.7	29.7		881	2600	2601	7300	7301	15000	15001	30000		
993	9%NO/41%N2/H2	9%Nitric Oxide/41%Nitrogen/H2	24.7	29.7		881	2610	2611	7700	7701	16000	16001	34000		
994	20%H2/Ar	20%Hydrogen/Argon	24.7	29.7		1121	3400	3401	9400	9401	19200	19201	38000		
996	25%H2S/Ar	25%Hydrogen Sulfide/Argon	31.7	37.7	59.7	1041	3200	3201	8500	8501	17300	17301	33000	33001	52000
997	25%H2Se/Ar	25%Hydrogen Selenide/Argon	34.7	39.7	64.7	1031	3110	3111	8100	8101	17000	17001	30000	30001	47000
998	50%NH3/He	50%Ammonia/Helium	14.7	24.7	34.7	881	2600	2601	7700	7701	16000	16001	35000	35001	63000
999	40%CO/45%C2H4/Ar	40%Carbon Monoxide/45%Ethyle	24.7	29.7	39.7	701	2100	2101	5900	5901	12000	12001	24000	24001	44000
1000	0.9%SiH4/N2	0.9%Silane/Nitrogen	19.7	24.7	24.7	881	2600	2601	7300	7301	15000	15001	30000	30001	51000
1001	5%Ar/N2	5%Argon/Nitrogen	19.7	24.7	24.7	891	2700	2701	7500	7501	15200	15201	31000	31001	51000
1002	25%PH3/N2	25%Phosphine/Nirtogen	19.7	24.7	24.7	811	2400	2401	6700	6701	14000	14001	27000	27001	45000
1003	5%C4H6-e)/He	5%Butadiene/Helium	14.7	19.7		1033	3121	3122	9500	9501	19400	19401	46000		
1004	10%Cl2/N2	10%Chlorine/Nitrogen	24.7	29.7		845	2551	2552	7100	7101	14600	14601	29000		
1005	15%Xe/H2	15%Xenon/Hydrogen	24.7	29.7		904	2731	2732	8000	8001	16300	16301	35000		
5022	COS-Special	Carbonyl Sulfide (Special)	24.7	29.7		563	1700	1701	4400	4401	9300	9301	16100		

The GF40 Series may be protected by the following US patents and their international filings.

Table B-1 GF40 Series Patents

Patent/Pub. No.	Title
6343617	System and method of operation of a digital mass flow controller
6389364	System and method for a digital mass flow controller
6425281	Pressure insensitive gas control system
6445980	System and method for a variable gain proportional-integral (PI) controller
6539792	Method and apparatus for balancing resistance
6640822	System and method of operation of a digital mass flow controller
6681787	System and method of operation of a digital mass flow controller
6714878	System and method for a digital mass flow controller
6752166	Method and apparatus for providing a determined ratio of process fluids
6826953	Flow sensor
6845659	Variable resistance sensor with common reference leg
6910381	System and method of operation of an embedded system for a digital capacitance diaphragm gauge
6941965	Method and apparatus for providing a determined ratio of process fluids
6962164	System and method for a mass flow controller
7043374	Flow sensor signal conversion
7073392	Methods and apparatus for pressure compensation in a mass flow controller
7082824	Variable resistance sensor with common reference leg
7113895	System and method for filtering output in mass flow controllers and mass flow meters
7114511	System and method for a mass flow controller
7133785	Valve control system and method
7143774	Method and apparatus for providing a determined ratio of process fluids
7150201	System and method for measuring flow
7216019	Method and system for a mass flow controller with reduced pressure sensitivity
7231931	System and method for a mass flow controller
7243035	System and method for mass flow detection device calibration
7272512	Flow sensor signal conversion
7273063	Methods and apparatus for pressure compensation in a mass flow controller
7287434	System and method for measuring flow
7360551	Method and apparatus for providing a determined ratio of process fluids
7363182	System and method for mass flow detection device calibration
7380564	System and method for a mass flow controller
7409871	Mass flow meter or controller with inclination sensor
7412986	Method and system for flow measurement and validation of a mass flow controller
7424894	Method and apparatus for providing a determined ratio of process fluids
7434477	Methods and apparatus for pressure compensation in a mass flow controller

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