



GFC-X | Gas Flow Controller

PRECISE CONTROL. UNPARALLELED PERFORMANCE.

The GFC-X paves the way for the future of gas flow control by offering an order of magnitude improvement on key flow metrics and enabling advanced wafer-manufacturing processes. The GFC-X, the latest generation in Pivotal's high-flow product line, offers high accuracy across flows ranging from 5% - 100% of full scale and features a pressure-based flow controller with a position control valve. The GFC-X is ideal for various applications requiring precise flow control, including ALD, EPI and other deposition processes.

Benefits of GFC-X

- Significantly reduces downtime
- Wide flow range up to 50 slm
- Industry's best flow accuracy for entire flow range
- Advanced flow monitoring/self-diagnosis

Key Features

- Self-calibrating
- Innovative control technology
- Unaffected by variations in the upstream or downstream pressure or temperature
- No fixed orifice

PIVOTAL
SYSTEMS

Pivotal Systems & GFC-X Introduction

About Pivotal Systems

Pivotal Systems Corporation provides best-in-class monitoring and process control technology for the semiconductor manufacturing and high-tech industries. Pivotal's vision is to enable an order of magnitude increase in fab productivity and capital efficiency for current and future technology nodes. This vision is achieved through its real time in-situ process monitoring and control solutions. Founded in 2004 and based in Fremont, California, the company is led by veterans from the semiconductor and high-tech industries. For more information about Pivotal Systems, visit www.pivotalsys.com or send an email to info@pivotalsys.com.

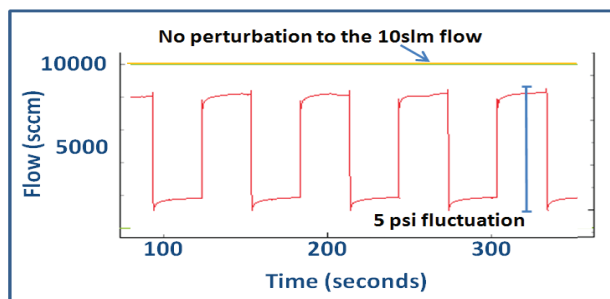
Introduction

As process geometries within the semiconductor industry continue to shrink to 2 nm and beyond, the need for highly accurate, responsive, and repeatable gas flow control during wafer processing is essential. Pivotal Systems' GFC-X paves the way for the future of gas flow control. The GFC-X combines a differential pressure with patented control valve technology. As such, it leapfrogs the current MFC technology by offering an order of magnitude improvement on key flow metrics, thereby enabling advanced wafer-manufacturing processes.

Feature Description

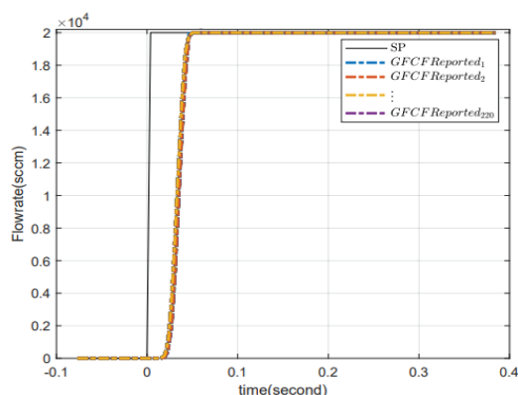
Pressure and Temperature

The unique design of the Pivotal valve results in the GFC-X being unaffected by variations in the upstream or downstream pressure or temperature. The GFC-X does not need a temperature coefficient. High-precision sensors monitor the gas pressure and temperature every millisecond and the control scheme accounts for any variations.

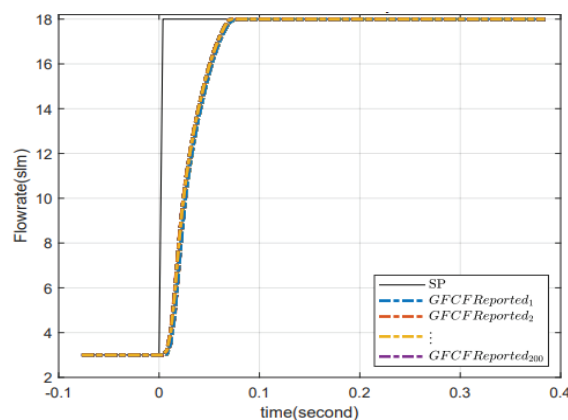


Settling Time

The GFC-X offers best-in-class settling times for flow controllers by providing settling times below 100 ms for both the gas turn-on and gas turndown. Refer to the following graphics.



Turn-on response to 20 slm. Figure shows overlay of 220 runs.



Turn-up response from non-zero to non-zero setpoint. Figure shows overlay of 220 runs.

GFC-X Specifications (GFC-X 5L, GFC-X 20L, GFC-X 50L)

Performance	Flow Range (N2 Equivalent)	100 sccm – 50,000 sccm (50 slm) (3 bin sizes to cover this range)
	Flow Accuracy	±1% of setpoint for flows 5% to 100% full scale: 250 sccm – 5 slm (GFC-X 5L), 1,000 sccm – 20 slm (GFC-X 20L), 2.5 slm – 50 slm (GFC-X 50L)
	Repeatability	±0.25% of setpoint for 10% – 100% full scale
	Settling Time	≤100 ms 5% – 100% full scale
	Leak Integrity	≤ 1E-9 atm cc/sec (He)
	Leak by Rate	≤ 0.05% full scale
Operating Conditions	Supply Pressure	Standard: 276 – 448 kPaG (40 – 65 psig)
	Downstream Pressure	Vacuum to 101 kPa (0 – 760 Torr)
	Design Pressure (Burst Pressure)	2.07 MPaG (300 psig)
	Operating Temperature	15°C – 50°C
	Valve Type	Normally Open (N/O), Normally Closed (N/C)
Materials	Wetted Surface Finish	5 µin Ra, Semi F19 compliant
	Wetted Surface Material	SUS 316L UHP, Semi F20 compliant
	Fittings	1.125" VCR, C-Seal, W-Seal
	Seals	Metal
Electrical	ECAT	+24 VDC
	DeviceNet	11 – 24 VDC, 5 W; In-rush current <200mA
	Analog* and RS-485	±15 VDC, 150 mA

* There is a setpoint hold-time of 60 milliseconds during Analog control. This time is in addition to the reported settling time of this device. When running using Analog control, the GFC has a minimum setpoint sensitivity of ±50mV. The flow accuracy is unaffected. The measured setpoint and corresponding flow feedback may be different from the commanded setpoint by up to that amount. Analog calibration is recommended to align device input to the controller output.

GFC-X Gas Table

Title Gas	Gas #	Bin 07: 1L*			Bin 10: 5L			Bin 20: 20L			Bin 30: 50 L			Input Pressure Range (psig)	Max Downstream Pressure (Torr)
		Min Flow	FS Setting		Min Flow	FS Setting		Min Flow	FS Setting		Min Flow	FS Setting			
			Min	Max		Min	Max		Min	Max		Min	Max		
N2	13				100	2001	5000	400	5001	20000	1000	20001	50000	40 – 65	760
Ar*	4				100	2001	5000	400	5001	20000	1000	20001	40000	40 – 65	760
CO2*	25				100	2001	5000	400	5001	20000	1000	10001	35000	40 – 65	760
H2	7				400	5001	20000	1000	20001	50000	-	-	-	40 – 65	760
He*	1				400	5001	20000	1000	20001	50000	2000	50001	100000	40 – 65	760
O2	15				100	2001	5000	400	5001	20000	1000	20001	45000	40 – 65	760
N2O*	27				100	2001	5000	400	5001	20000	1000	10001	35000	40 – 65	760
NF3*	53				100	2001	2500	400	2501	10000	1000	10001	25000	40 – 65	760
NH3*	29				120	2001	6000	500	6001	25000	-	-	-	40 – 65	760
WF6*	121														
SiH4*	39														
4% H2 in N2*	607				100	2001	5000	400	5001	20000	1000	20001	50000	40 – 65	760
5% B2H6 in N2*	654				100	2001	5000	400	5001	20000	1000	20001	50000	40 – 65	760

Note all flow sizes are in sccm

*GFC-X 1L is under development. Please contact your Pivotal sales representative for flow information.

*These gas maps are under development for the GFC-X and both the gas availability and flow rates are subject to change. Please contact your Pivotal sales representative with any questions or requests

GFC-X Product Description Codes

Code	Description	Option	Option Description												
I	Base Model	GFX	GFC-X Gas Flow Controller Model												
II	Application	XX	Standard Application												
III	Configurability	C	Multi-gas Standard Bins												
		X	Gas Configured												
IV	Gas or Standard Bins ¹	XXXX XXXX	Specific Semi Gas Code and Range												
V	Fitting & Body Width	O1	1/4" VCR male fitting, 1125" Base Block												
		O2	1125" C-Seal												
		O3	1125" W-Seal												
VI	Valve Configuration	C	Normally Closed (N/C)												
		O	Normally Open (N/O)												
VII	Downstream Condition	V	Vacuum												
		A	Atmospheric - This option can be used for all gases except low pressure gases. Inlet pressure must be ≥60 psia												
VIII	Communication Options	Option	I/O	Connector	Power on State	Full Scale Setting	Full Scale Setting	Full Scale Setting	Poll I/O Instance Producer	Poll I/O Instance Consumer	Poll I/O State Transition	SP Delay in ms	External Baud Rate	Mac ID	
		DA	DeviceNet	5 Pin Micro	Idle	Count	Integer	6000h	2	7	Executing	0	500KB	63	
		DB	DeviceNet	5 Pin Micro	Idle	Count	Integer	6000h	21	7	Executing	0	500KB	63	
		DC	DeviceNet	5 Pin Micro	Idle	Count	Integer	6000h	2	8	Executing	0	500KB	63	
		DD	DeviceNet	5 Pin Micro	Idle	Count	Integer	6000h	21	8	Executing	0	500KB	63	
		DE	DeviceNet	5 Pin Micro	Idle	Count	Integer	6000h	6	8	Executing	0	500KB	63	
		DF	DeviceNet	5 Pin Micro	Idle	Count	Integer	6000h	22	7	Executing	0	500KB	63	
		DG	DeviceNet	5 Pin Micro	Idle	Count	Integer	6000h	3	7	Executing	0	500KB	63	
		DH	DeviceNet	5 Pin Micro	Idle	Count	Integer	7FFFh	3	7	Executing	0	500KB	63	
		DI	DeviceNet	5 Pin Micro	Idle	SCCM	Float	6000h	14	19	Executing	0	500KB	63	
		DJ	DeviceNet	5 Pin Micro	Idle	SCCM	Float	6000h	23	20	Executing	0	500KB	63	
		DK	DeviceNet	5 Pin Micro	Idle	SCCM	Float	7FFFh	13	19	Executing	0	500KB	63	
		DL	DeviceNet	5 Pin Micro	Idle	Count	Integer	7FFFh	6	8	Executing	0	500KB	63	
		DM	DeviceNet	5 Pin Micro	Idle	Count	Integer	6000h	2	7	Executing	0	500KB	63	
		DN	DeviceNet	5 Pin Micro	Idle	Count	Integer	7FFFh	22	7	Executing	0	500KB	63	
		DO	DeviceNet	5 Pin Micro	Idle	Count	Integer	6000h	22	8	Executing	0	500KB	63	
		DP	DeviceNet	5 Pin Micro	Idle	Count	Integer	7FFFh	3	7	Executing	500 ms	500KB	63	
		DQ	DeviceNet	5 Pin Micro	Idle	Count	Integer	7FFFh	1	8	Executing	0	500KB	63	
		DR	DeviceNet	5 Pin Micro	Idle	Count	Integer	603d	22	8	Executing	0	500KB	63	
		EA	Ethercat	Comm: RJ45 Pwr: 5 pin Nano	INIT	NA	NA	NA	NA	NA	NA	NA	NA	NA	0
		Analog DB9 Pin-Out													
		Option	I/O	Connector	Valve Override	Flow Feedback	Power Supply +	Power Supply Common	Power Supply -	Flow Setpoint	Signal Ground	RS 485 +	RS 485 -	Test Point	
		AA	Analog	9-pin D	1	2	3	4	5	6	7	8	9	NA	
		AB	Analog	9-pin D	1	2	3	4	5	6	7, 8	NA	NA	9	
		AC	Analog	20-pin Honda	14	3	4	2	16	11	12	8	9	NA	
		AD	Analog	20-pin Honda	14	3	4	2	16	5	12	8	9	NA	
		AG	Analog	Card Edge-RJ11	J	3	4	2	F	A	B+C+10	3, 4	2, 3	NA	
		AH	Analog	DB9 to DB15	NA	NA	7	5	5	8	NA	NA	NA	NA	
		AK	Analog	20-pin Honda	1	2	3	4	5	6	7, 8	NA	NA	NA	
		AL	Analog	Card Edge	NA	3	4	2	F	A	B+C	NA	NA	NA	
		AM	Analog	Card Edge - Purge Enabled	D	3	4	2	F	A	B+C	NA	NA	NA	
		RA	RS-485	9-Pin D	NA	NA	3	4	5	NA	NA	8	9	NA	
		RB	RS-485	9-Pin D	NA	NA	3	4	5	NA	NA	8	9	NA	
		RC	RS-485	9-Pin D, RJ45	NA	NA	D3	D4	D5	NA	R1,2	R5	R4	NA	
IX	Special Requests	XXXX	Customer Special Request Number												

Note: If interested in another gas and/or configuration, please contact your sales representative.

¹ Blank Bins are not yet released, please contact your Pivotal sales representative for more information

Sample Standard Application Model Code								
I	II	III	IV	V	VI	VII	VIII	IX
GFX	XX	X	XXXX XXXX	O2	C	V	EA	XXXX

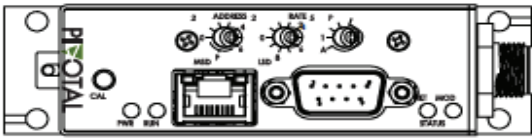
■ GFC-X Communication Protocols

Supported Protocols

The GFC supports analog, DeviceNet, RS-485 and EtherCAT communication protocols.

Analog and RS-485 Interface

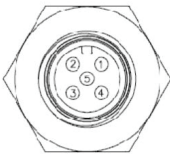
A 9-pin male D-sub connector on top of the GFC enclosure (right) is for operating in the analog and RS-485 modes.



For the analog and RS-485 modes, a suitable mating connector is Tyco PN# 1-747943-6.

DeviceNet Interface

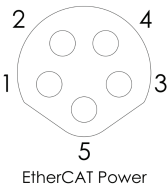
The industry standard DeviceNet thin cable with a micro connector is located on the side of the GFC enclosure. The table on the right defines this connector's pins.



DeviceNet		
Pin	Signal Name	Specification
1	Drain	-
2	V+	+11 VDC to +24 VDC
3	V-	0 VDC
4	CAN_H	-
5	CAN_L	-

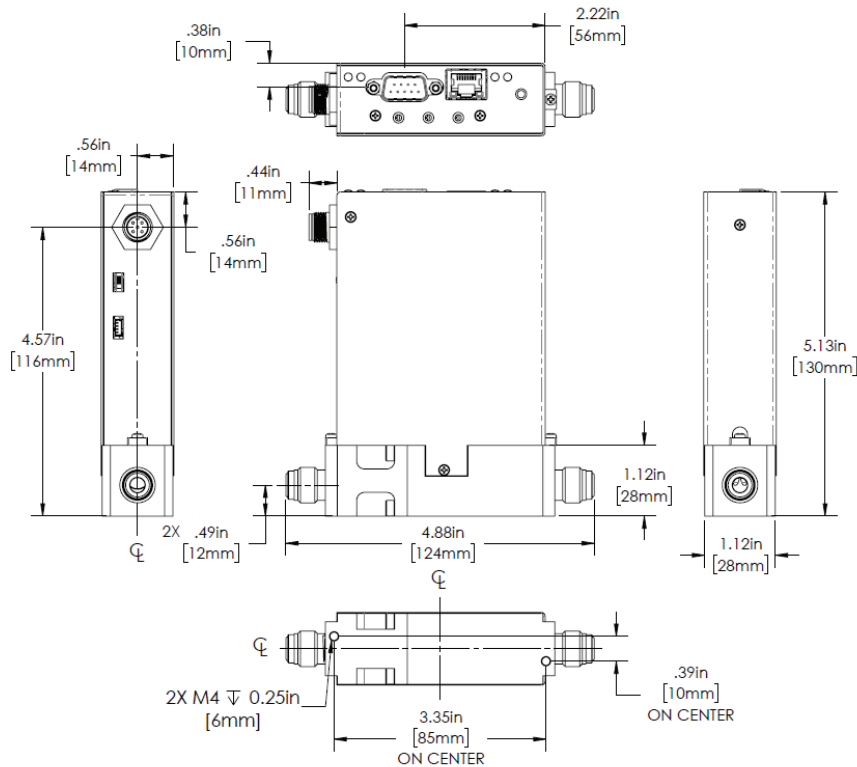
EtherCAT Interface

A 5-pin M8 power connector is located on the side of the GFC enclosure. The table on the right defines this connector's pins.

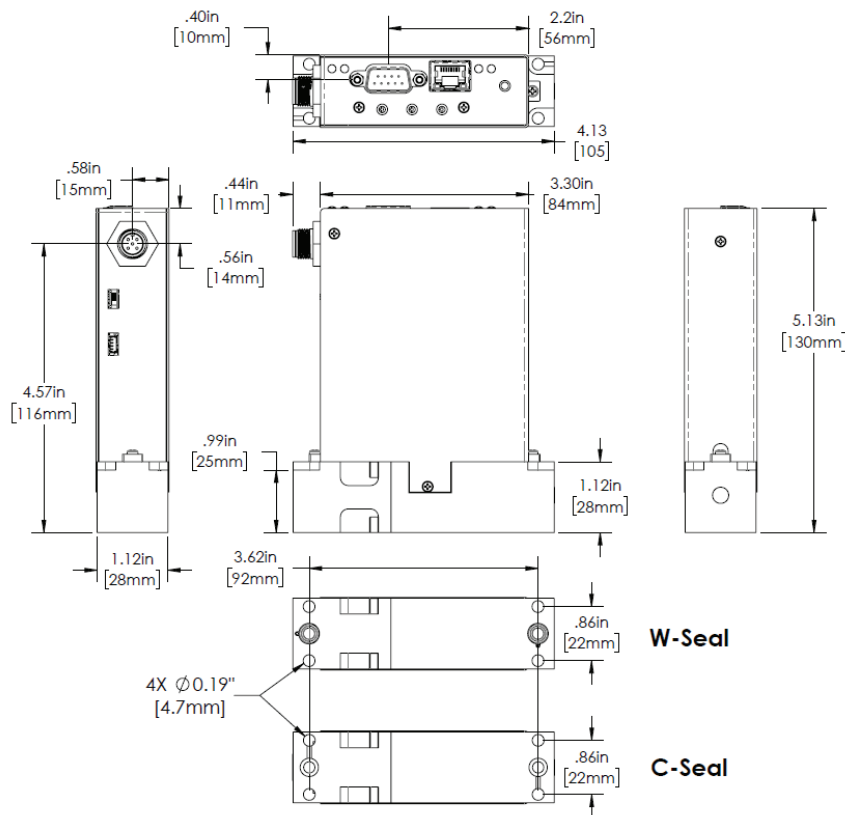


Ethercat		
Pin	Signal Name	Specification
1	V+	+24 VDC
2	Chassis Ground	-
3	Power Common	-
4	Unassigned	-
5	Unassigned	-

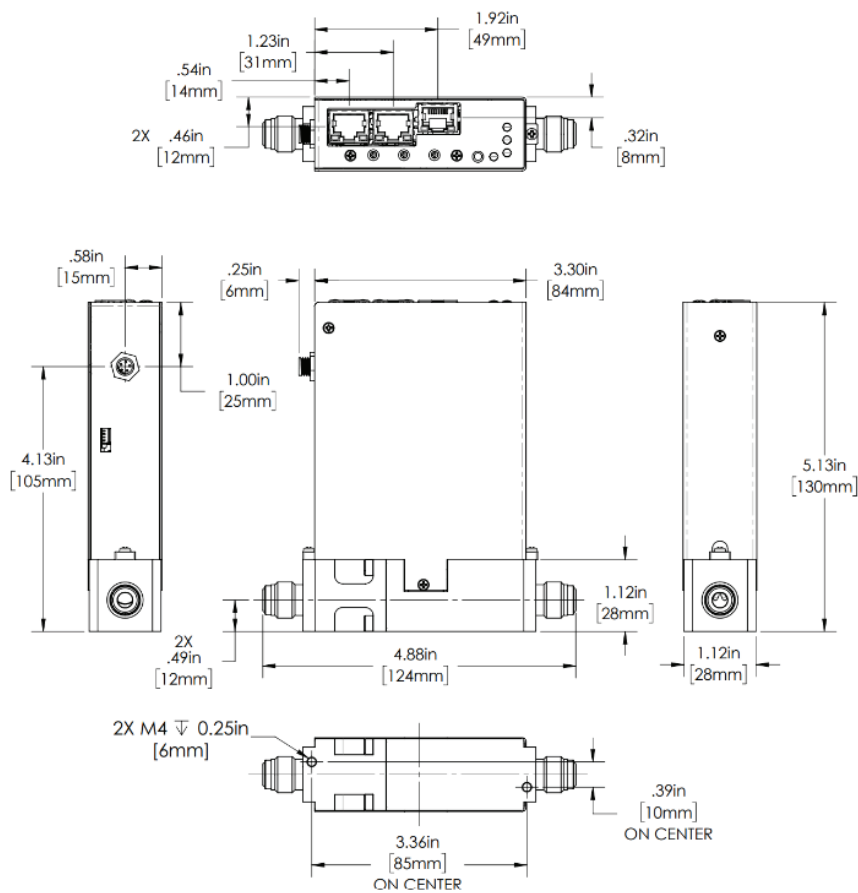
GFC-X DNET VCR Dimensions



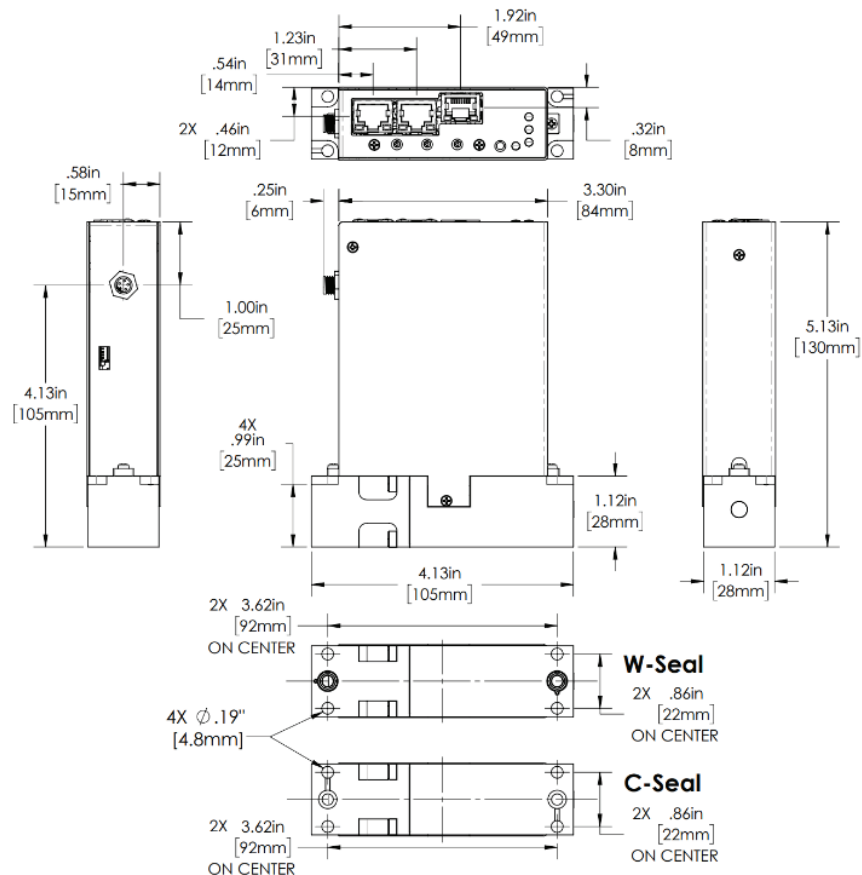
GFC-X DNET C-Seal and W-Seal Dimensions



GFC-X EtherCAT VCR Dimensions



GFC-X EtherCAT C-Seal & W-Seal Dimensions



The Future of Flow Control is Now.

A decorative horizontal line with a wavy, undulating pattern in a burnt orange color, separating the headline from the dark green background below.