

PIVOTAL

S Y S T E M S

GFC5™
GFC20™
GFC200™
GFC1000™
GFC2000™

The Future of
Flow Control



Widest Flow Range with Accuracy (Actual Gas) *0.5–100% Full Scale*

Best Flow Accuracy *±0.5% of Setpoint for 0.5–100% Full Scale*

Fastest Settling Time for Turn-On and Turndown *10%-100% FS ≤ 100 ms
0.5%-10% FS ≤ 300 ms*

Effect of Pressure and Temperature *Invariant*

Automated In Situ Calibration *NIST Traceable*

Innovative Control Technology *Robust Design, No Orifice*

Introduction

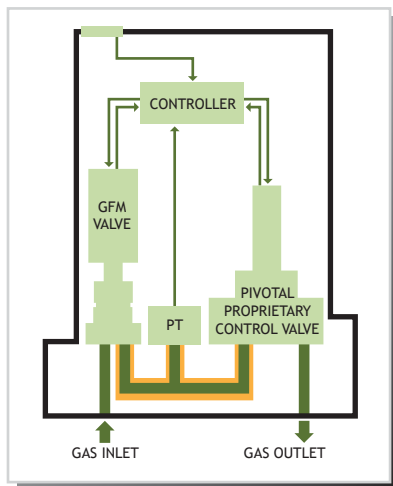
As process geometries within the semiconductor industry continue to shrink to 10 nm and beyond, the need for highly accurate, responsive and repeatable gas flow control during wafer processing is essential. With the emergence of low gas flow rates, short processing times and continuous plasma processing, best-in-class MFCs are struggling to meet the accuracy, settling time and repeatability requirements demanded to ensure high yield and matched chambers.

Pivotal Systems' GFC paves the way for the future of gas flow control. The GFC combines Pivotal's patented, high accuracy GFM™ system 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

Automated Calibration and In Situ Diagnostics

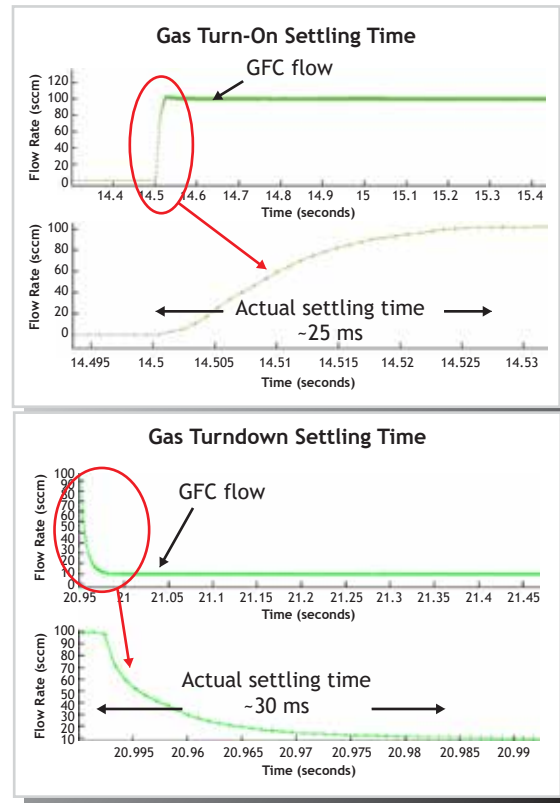
The GFC executes a robust calibration sequence on every run. This feature, unique to the Pivotal GFC, results in highly accurate NIST traceable measurements run-to-run and reduces downtime significantly.



PT PRESSURE TRANSDUCER
 NIST TRACEABLE CALIBRATED VOLUME

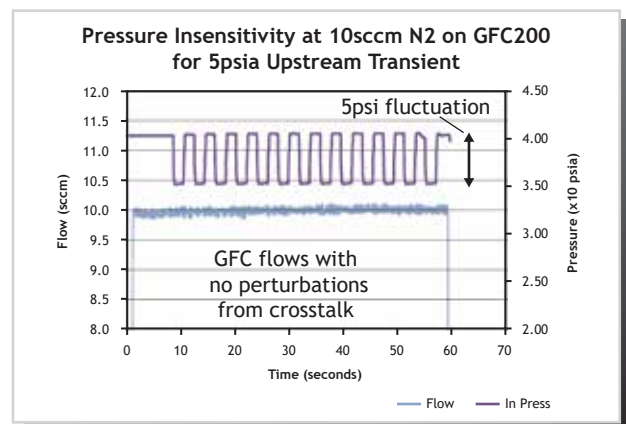
Settling Time

The GFC 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.



Pressure and Temperature

The unique design of the Pivotal valve results in the GFC being unaffected by variations in the upstream or downstream pressure or temperature. The GFC does not need temperature coefficient. Highly sensitive sensors monitor the gas pressure and temperature every milli-second and the control scheme accounts for any variations.



GFC Specifications

Performance	Flow range	0.025 - 2000 sccm (5 part numbers to cover this range)
	Flow Accuracy	±0.5% of Setpoint for actual gas: 0.025 - 5 sccm (GFC5) 0.1 - 20 sccm (GFC20) 1 - 200 sccm (GFC200) 5 - 1000 sccm (GFC1000), 10 - 2000 sccm (GFC2000)
	Settling Time	10% - 100% FS ≤ 100 ms, 0.5% - 10% FS ≤ 300 ms
	Leak Integrity	≤ 5E ⁻¹² Pa*m ³ /sec (He)
	Leak By Rate	0.0025 sccm (GFC5), 0.01 sccm (GFC20), 0.1 sccm (GFC200), 0.5 sccm (GFC1000), 1.0 sccm (GFC2000)
	Repeatability	10-100% FS ±0.2% of setpoint, 0.5-10% of FS ±0.02% of FS
Operating Conditions	Supply Pressure	Standard: 100 - 300kPaG (14.5 - 43.5 psig) Low pressure gases BCl ₃ , C ₄ F ₆ , C ₄ F ₆ -q, C ₄ F ₈ , C ₅ F ₈ , HF, SiCl ₄ and WF ₆ the pressure range has been extended to -81 - 300 kPaG (-11.7- 43.5 psig) Refer to the Gas Bin Table on page 5 for the specific ranges. Standard: 100 - 300 kPaG (14.5 - 43.5 psig)
	Downstream Pressure	Vacuum to 53 kPa (0 - 400 Torr)
	Proof Pressure	2.07 MPaG (300 psig)
	Operating Temperature	15 - 50°C
Materials	Wetted Surface	316 SS per Semi F20
	Surface Finish	5 µin average Ra
	Seals	Metal
Electrical	DeviceNet	11 - 24 VDC, 5 W
	Analog and RS-485	±15 VDC, 150 mA
	In-Rush Current	<200 mA

Communication Protocols

Supported Protocols

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

Analog and RS-485 Interface

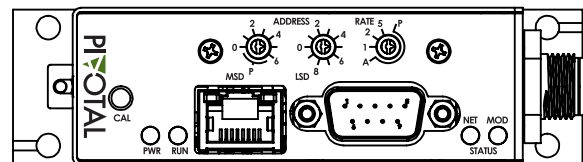
A 9-pin male D-sub connector on top of the GFC enclosure (right) is for operating in the analog and RS-485 modes.

DeviceNet Interface

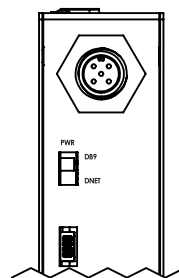
The industry standard, ODVA-compliant DeviceNet *thin* cable with a *micro* connector is located on the side of the GFC enclosure. The table on the right defines this connector's pins.

Ethercat Interface

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

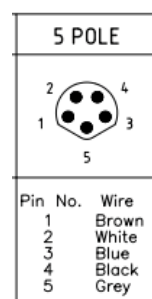


For the analog and RS-485 modes, a suitable mating connector is Tyco PN# 1-747943-6.



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

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

Product Description Code

Code	Description	Option	Option Description												
I	Base Model	GFC	Gas Flow Controller												
II	Special Application	XX	Standard Application												
		LP	Low Pressure Gases*												
III	Configurability	C	Multi-gas Standard Bins												
		X	Gas Configured												
IV	Gas or Standard Bins	XXXX XXXX	Specific Semi Gas Code and Range												
		PS00-005C	Pivotal Systems Standard Bin 00 0.025-5 sccm N2												
		PS01-020C	Pivotal Systems Standard Bin 01 0.1-20 sccm N2												
		PS02-200C	Pivotal Systems Standard Bin 02 21-200 sccm N2 **												
		PS03-001L	Pivotal Systems Standard Bin 03 201-1000 sccm N2 **												
V	Fitting & Body Width	01	VCR 1.125"												
		02	C-Seal 1.125"												
		03	W-Seal 1.125"												
		04	C-Seal 1.125" with Poke Yoke												
		05	W-Seal 1.5"												
VI	Valve Configuration	C	Normally Closed												
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	Pull I/O Instance Producer	Pull 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	
		EA	Ethercat	Comm: RJ45 Pwr: 5 pin Nano	INIT	NA	NA	NA	NA	NA	NA	NA	NA	NA	0
		RA	RS-485	9-Pin D	NA	NA	NA	NA	NA	NA	NA	NA	NA	115200	63
		RB	RS-485	9-Pin D	NA	NA	NA	NA	NA	NA	NA	NA	NA	115200	63
		RC	RS-485	9-Pin D	NA	NA	NA	NA	NA	NA	NA	NA	NA	115200	63
		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			
AE	Analog	Card Edge	NA	3	4	2	F	A	B+C	NA	NA	NA			
AF	Analog	Card Edge	D	3	4	2	F	A	B+C	NA	NA	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			
IX	Special Request	XXXX	Customer Special Request Number												

Note:

* Required for low pressure gases SiH2Cl2, C3H10Si, C5F8, HF, SiCl4, BCl3, C4F6, C4F8 and WF6.

** Not applicable when selecting Special Application LP (low pressure gases).

***The 1.5" W-seal is not available for 20 sccm GFC (Bin 1)

If other configurations are required, please contact your sale representative.

Sample Standard Application Model Code									
I	II	III	IV	V	VI	VII	VIII	IX	
GFC	XX	X	0004-500C	01	C	V	DA	XXXX	

Sample Pivotal System Blank Model Code									
I	II	III	IV	V	VI	VII	VIII	IX	
GFC	XX	C	PS04-002L	01	C	V	DB	XXXX	

Sample LP Application Model Code									
I	II	III	IV	V	VI	VII	VIII	IX	
GFC	LP	X	0121-500C	01	C	V	AA	XXXX	

Gas Bin Table

Title Gas	Gas #	Bin 0: 5 sccm			Bin 1: 20 sccm			Bin 2: 200 sccm			Bin 3: 1000 sccm			Bin 4: 2000 sccm			Input Pressure Range (psig)	Max Down-stream Pressure (Torr)
		Min Flow	FS Setting		Min Flow	FS Setting		Min Flow	FS Setting		Min Flow	FS Setting		Min Flow	FS Setting			
			Min	Max		Min	Max		Min	Max		Min	Max		Min	Max		
N2	13	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
He	1	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
Ar	4	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
Kr	5	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
Xe	6	0.025	1	5	0.1	6	10	1	11	100	5	101	500	-	-	-	14.5 - 43.5	400
H2	7	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
CO	9	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
HBr	10	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	-	-	-	14.5 - 43.5	400
HF	12	0.025	1	5	0.1	6	10	1	11	100	5	101	1000	-	-	-	6.7 - 43.5	400
O2	15	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
Cl2	19	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	1500	14.5 - 43.5	400
CO2	25	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
N2O	27	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
CH4	28	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
NH3	29	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
SO2	32	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
CH3F	33	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	1500	14.5 - 43.5	400
COS	34	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	1500	14.5 - 43.5	400
SiH4	39	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
CHF3	49	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	1200	14.5 - 43.5	400
NF3	53	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
CF4	63	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	-	-	-	14.5 - 43.5	400
SiH2Cl2	67	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	-	-	-	3.3 - 43.5	400
BCl3	70	0.025	1	5	0.1	6	10	1	11	100	5	101	500	-	-	-	0.3 - 43.5	400
Si2H6	97	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	1500	14.5 - 43.5	400
N2 Cal Atm	0	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	45.3 - 75.3	760

Note: The maximum inlet pressure is 58.2 psia (401.3 kPaa) for all gases flowing into vacuum up to 400T. When the gas is flowing to atmosphere for verification tests the inlet pressure must be greater than 60 psia.

For any flows higher than the listed values, the upstream and downstream pressure conditions change from the standard, so please contact your sales representative to verify the pressure.

For low pressure gases C4H9F, SiH2Cl2, C3H10Si, C5F8, HF, SiCl4, BCl3, C4F6, C4F8 and WF6 a LP GFC is required.

For SiCl4, the minimum flow is 1 sccm assuming the pressure requirements are met.

Gas Bin Table

Title Gas	Gas #	Bin 0: 5 sccm			Bin 1: 20 sccm			Bin 2: 200 sccm			Bin 3: 1000 sccm			Bin 4: 2000 sccm			Input Pressure Range (psig)	Max Down-stream Pressure (Torr)
		Min Flow	FS Setting		Min Flow	FS Setting		Min Flow	FS Setting		Min Flow	FS Setting		Min Flow	FS Setting			
			Min	Max		Min	Max		Min	Max		Min	Max		Min	Max		
N2	13	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
SiCl4	108	-	-	-	-	-	-	-	-	-	1	10	100	-	-	-	-11.7 - 43.5	Vacuum
SF6	110	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	-	-	-	14.5 - 43.5	400
WF6	121	0.025	1	5	0.1	6	10	1	11	100	5	101	500	-	-	-	-2.7 - 43.5	Vacuum
C4F8	129	0.025	1	5	0.1	6	20	1	21	200	5	201	500	-	-	-	3.3 - 43.5	400
C3F6	138	0.025	1	5	0.1	6	20	1	21	200	5	201	500	-	-	-	3.3 - 43.5	400
CH2F2	160	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	1500	14.5 - 43.5	400
C3H10Si (TMS)	190	0.025	1	5	0.1	6	20	1	21	200	5	201	500	-	-	-	3.3 - 43.5	400
C5F8	266	0.025	1	5	0.1	6	10	1	11	100	5	101	500	-	-	-	-3.7 - 43.5	Vacuum
C4F6	270	0.025	1	5	0.1	6	10	1	11	100	5	101	500	-	-	-	0.3 - 43.5	400
C4F6-q	297	0.025	1	5	0.1	6	10	1	11	100	5	101	500	-	-	-	0.3 - 43.5	400
C4H9F	387	0.025	1	5	0.1	6	20	1	21	200	5	201	500	-	-	-	-3.7 - 43.5	Vacuum
C3H2F4	393	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
20% SiH4 in He	529	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
30% O2 in He	604	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
4% H2 in N2	607	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
5% B2H6 in Ar	615	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
50%PH3 in SiH4	632	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
5% B2H6 in N2	654	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
2.7% C2H4 in He	897	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
6% B2H6 in N2	927	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	14.5 - 43.5	400
COS-Special	5022	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	1500	14.5 - 43.5	400
N2 Cal Atm	0	0.025	1	5	0.1	6	20	1	21	200	5	201	1000	10	1001	2000	45.3 - 75.3	760

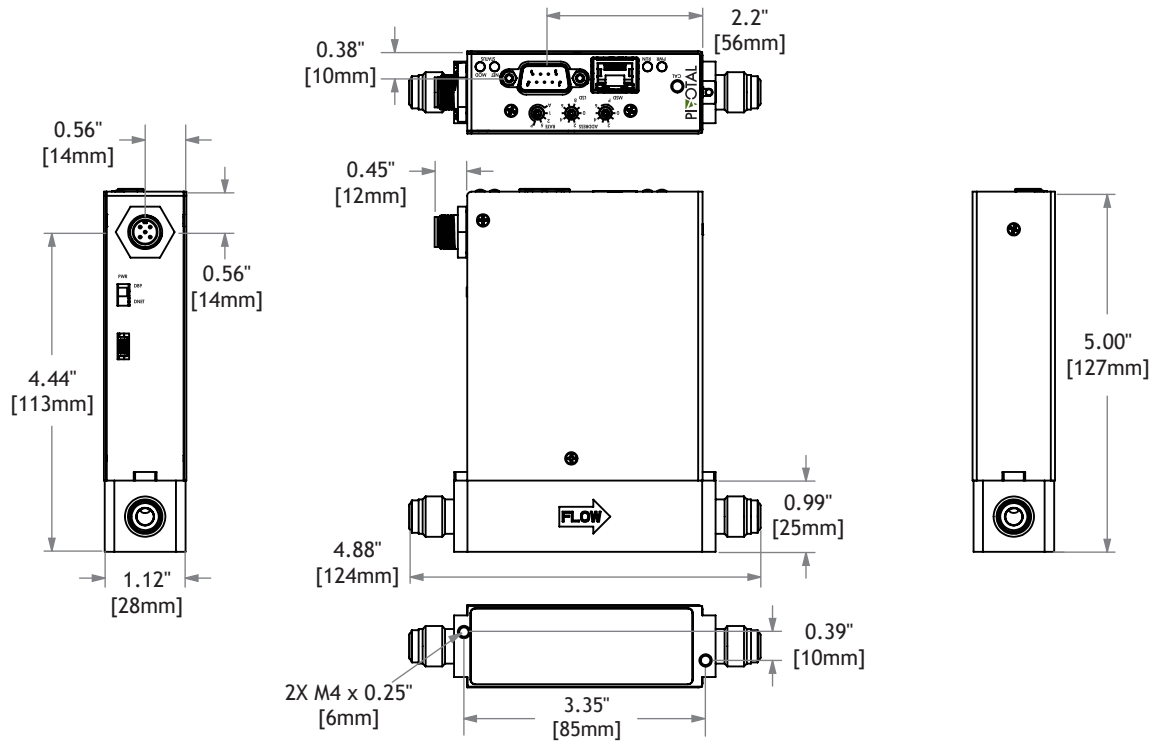
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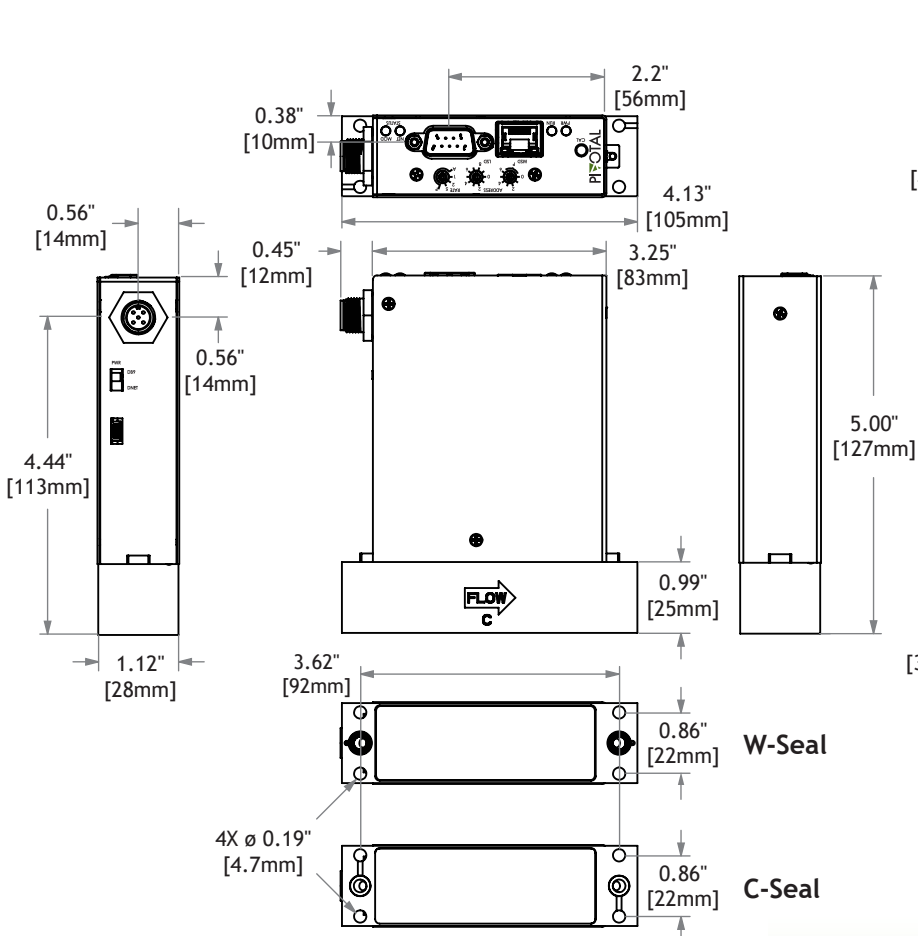
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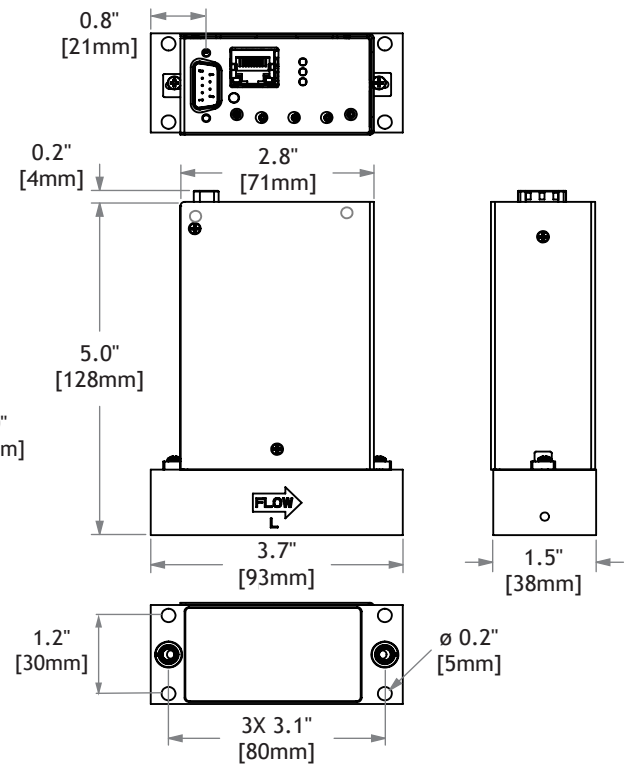
GFC VCR Dimensions



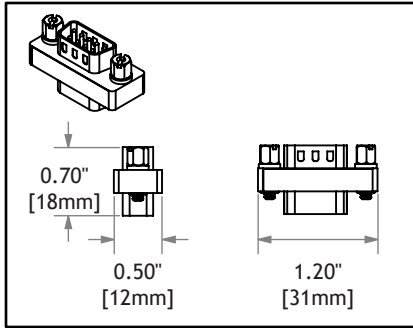
GFC C-Seal and W-Seal Dimensions



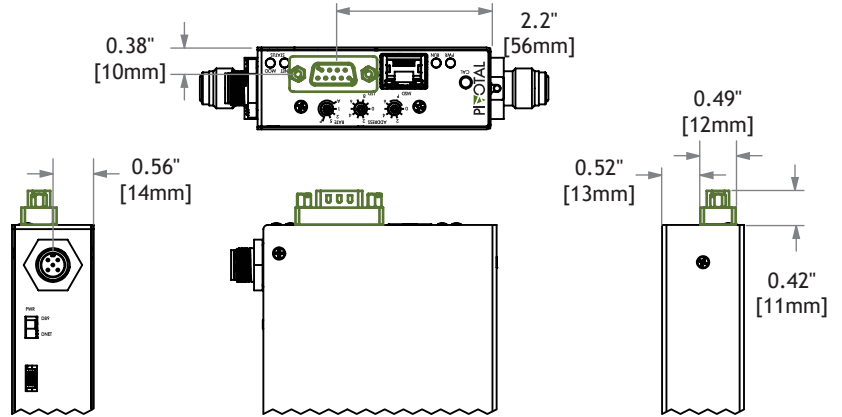
GFC 80mm W-Seal Dimensions



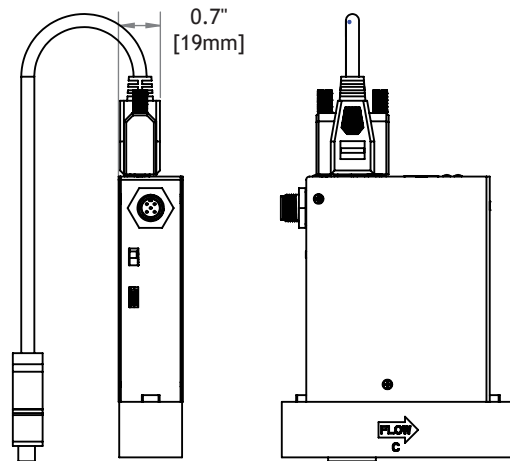
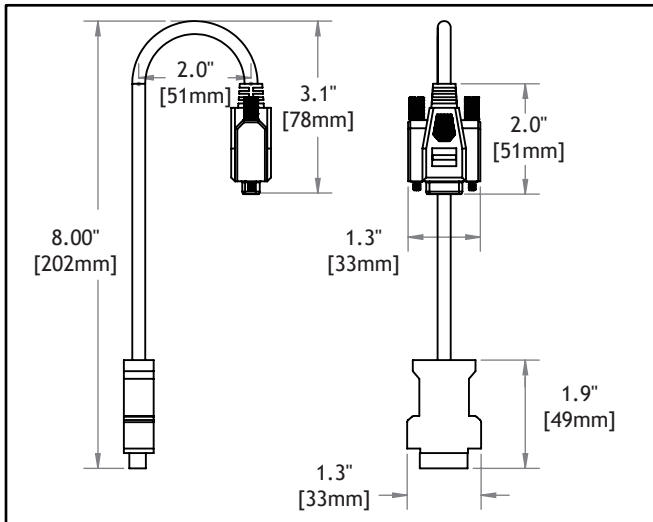
GFC Analog Adapter (AB)



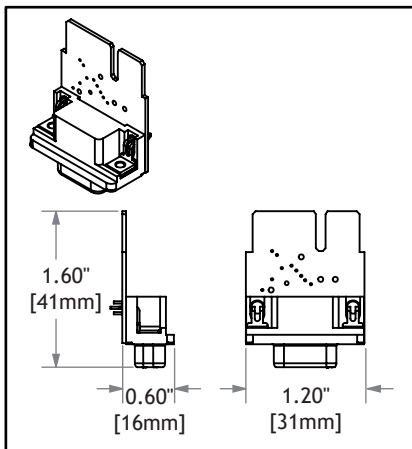
On the right is how the adapter (in green) is attached to the GFC.



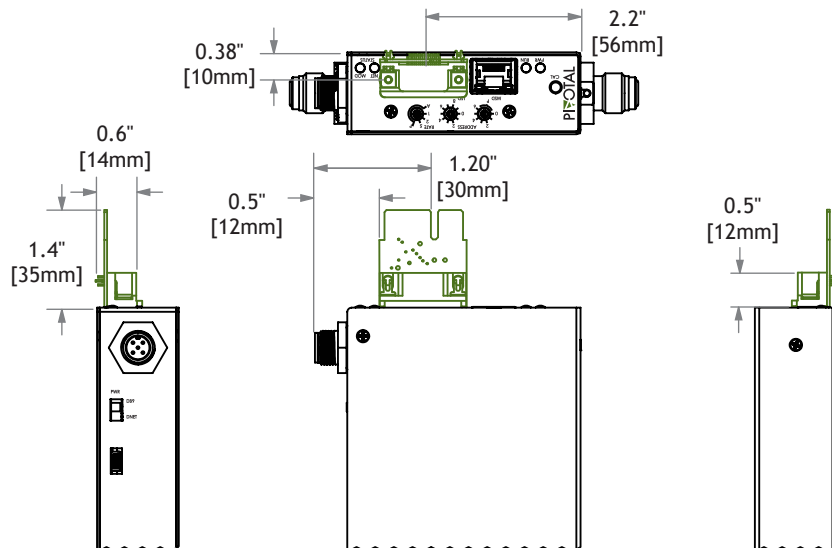
GFC Honda Adapter (AC and AD)



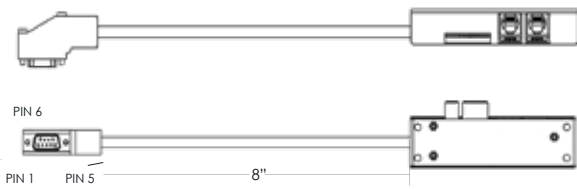
GFC Card Edge Analog Adapter (AE and AF)



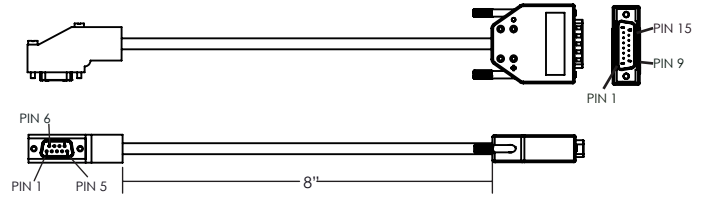
On the right is how the adapter (in green) is attached to the GFC.



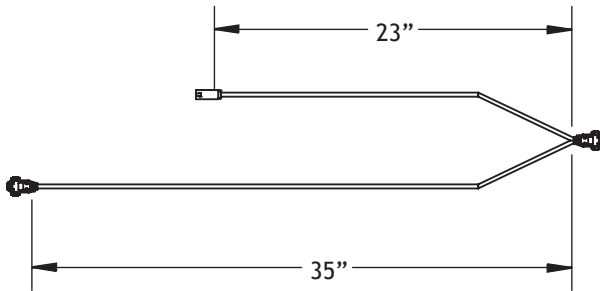
GFC DB9 to Card Edge - RJ11 Cable (AG)



GFC DB9 to DB15 Adapter Cable (AH)



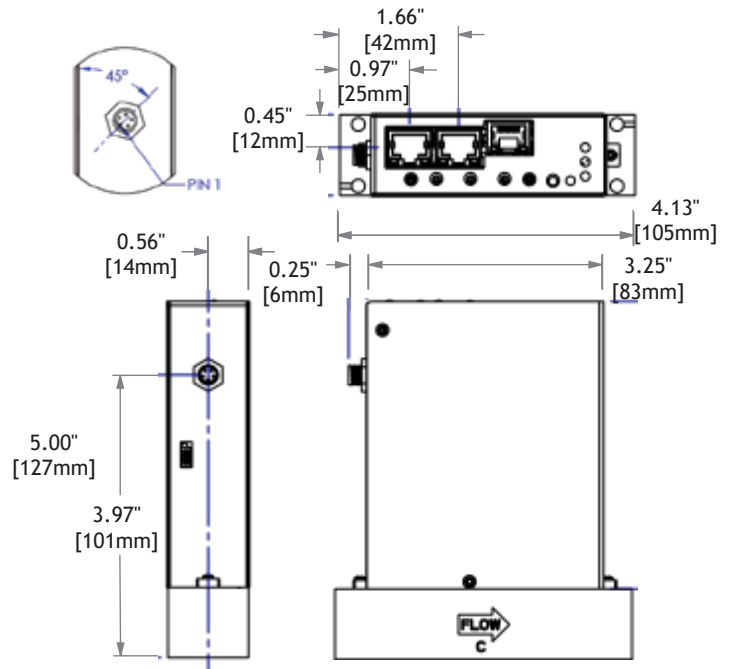
GFC FNET Cable (RC)



PIN OUTS

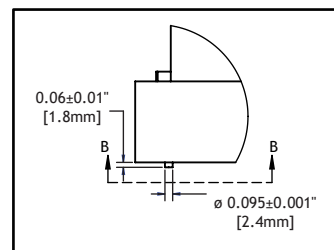
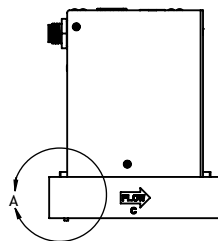
DB9-F	DB9-M	RJ45	Description
1	1	-	Valve Override Signal (Input)
2	2	-	Flow Feedback Signal (Output)
3	3	8	Power Supply +15V
4	4	1, 2	Power Supply 0V
5	5	9	Power Supply -15V
6	6	-	Flow Setpoint Signal (Input)
7	7	-	Signal Common (0V)
8	-	-	RS-485 +
9	-	-	RS-485 -

GFC Ethercat C-Seal and W-Seal Dimensions

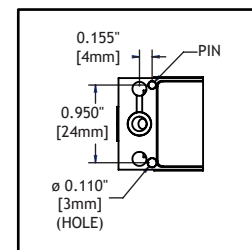


GFC C-Seal Poke Yoke Dimensions

Refer to the GFC C-seal drawing for more detail.



Detail A



Section B-B

About Pivotal

Pivotal Systems Corporation provides best-in-class monitoring and process control technology for the semiconductor manufacturing industry. 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, visit www.pivotal.com or send an email to support@pivotal.com.

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