PIVOTAL
SYSTEMS

GFC5L™
GFC20L™
GFC50L™

The Future of Flow Control

|	
Wide Flow Range	*2.0–100% Full Scale*
Flow Accuracy	*±1.0% of Setpoint for 10% -100% Full Scale* *±0.25% of full scale for 2.0–10.0% Full Scale*
Fastest Settling Time for Turn-On and Turndown	*≤300ms 10%-100% F.S.*
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' high flow GFC paves the way for the future of gas flow control. The high flow GFC 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.

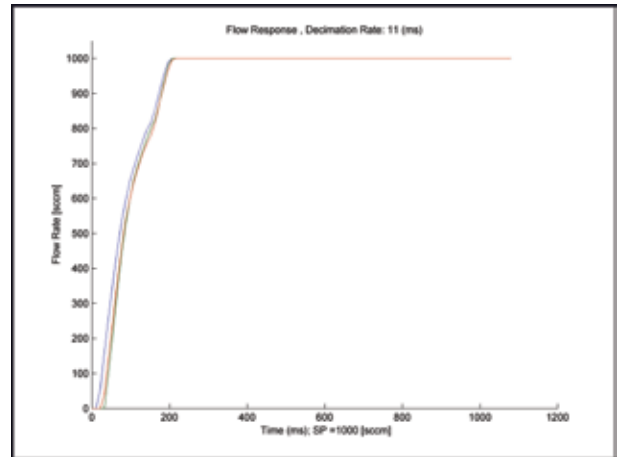## Feature Description

Pressure and Temperature

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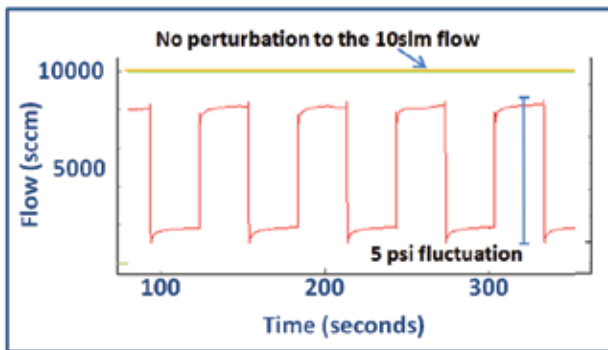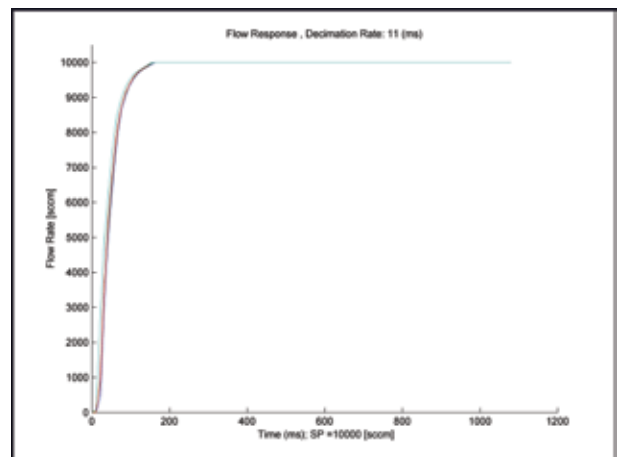

Settling Time

The high flow GFC offers best-in-class settling times for flow controllers by providing settling times below 300 ms for both the gas turn-on and gas turn-down. Refer to the following graphics.
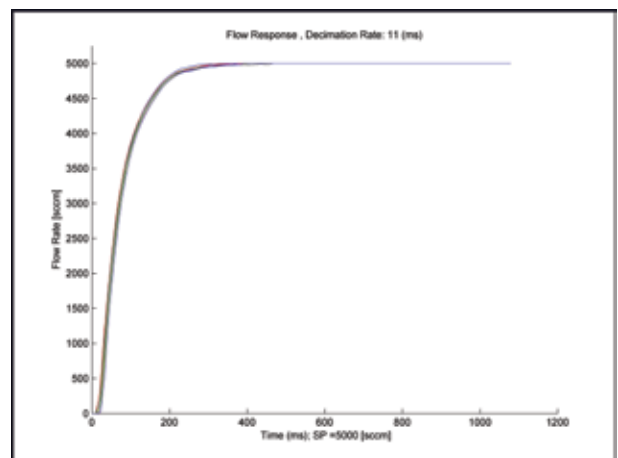
0 to 20 slm Turn on Time

0 to 10 slm Turn on Time

0 to 5 slm Turn on Time

GFC Specifications

Performance	**Flow range**	100 sccm - 50000 sccm (3 part numbers cover this range)
	Flow Accuracy	±1% of setpoint for 10%-100% full scale: 0.5 slm - 5 slm (GFC-5L), 2.0 slm - 20 slm (GFC-20L), 5.0 slm to 50 slm (GFC-50L) ±0.25% of full scale for flows 2% to 10% full scale: 0.1 slm - 0.5 slm (GFC-5L), 0.4 slm - 2.0 slm (GFC-20L), 1.0 slm - 5.0 slm (GFC-50L)
	Repeatability	±0.25% of setpoint for 10% - 100% full scale
	Settling Time	≤300 ms 10% - 100% full scale, ≤ 500 ms 2% - 10% full scale*
	Leak Integrity	≤ 5E^{-12} Pa*m^3 /sec (He)
	Leak By Rate	2.5 sccm (GFC-5L), 10.0 sccm (GFC-20L), 25.0 sccm (GFC-50L)
Operation 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
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

* 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.

Gas Bin Table

Gas \ Title	Gas #	Bin 10: 5L Min Flow	FS Setting Min	FS Setting Max	Bin 20: 20L Min Flow	FS Setting Min	FS Setting Max	Bin 30: 50 L Min Flow	FS Setting Min	FS Setting Max	Input Pressure Range (psig)	Max Downstream Pressure (Torr)
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	20001	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	20001	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
Mixed 4% H2 in N2	607	100	2001	5000	400	5001	20000	1000	20001	50000	40 - 65	760
Mixed 5% B2H6 in N2	654	100	2001	5000	400	5001	20000	1000	20001	50000	40 - 65	760

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

Product Description Code

Code	Description	Option	Option Description
I	Base Model	HFC	Gas Flow Controller
II	Application	XX	Standard Application
III	Configurability	C	Multi-gas Standard Bins
		X	Gas Configured
IV	Gas or Standard Bins	XXXX XXXX	Specific Semi Gas Code and Range
		PS10 005L	Pivotal Systems Standard Bin 10 2001-5000 sccm N2 **
		PS20 020L	Pivotal Systems Standard Bin 20 5001-20000 sccm N2 **
		PS30 050L	Pivotal Systems Standard Bin 30 20001-50000 sccm N2 **
V	Fitting & Body Width	01	VCR 1.125"
		02	C-Seal 1.125"
		03	W-Seal 1.125"
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	0
		RA	RS-485	9-Pin D	NA	NA	NA	NA	NA	NA	NA	NA	115200	63
		RB	RS-485	9-Pin D	NA	NA	NA	NA	NA	NA	NA	NA	115200	63
		RC	RS-485	9-Pin D	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
AK	Analog	20-pin Honda	1	2	3	4	5	6	7, 8	NA	NA	NA

IX	Special Request	XXXX	Customer Special Request Number

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

Sample Standard Application Model Code								
I	II	III	IV	V	VI	VII	VIII	IX
GFC	XX	X	0004-005L	01	C	A	DA	XXXX

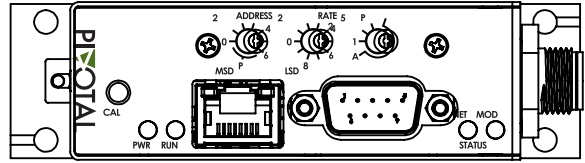| Sample Pivotal System Blank Model Code								
I	II	III	IV	V	VI	VII	VIII	IX
GFC	XX	C	PS07-050L	01	C	A	DB	XXXX

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, 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.
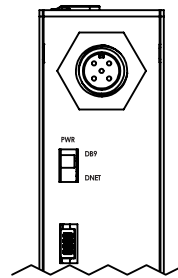
DeviceNet

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.
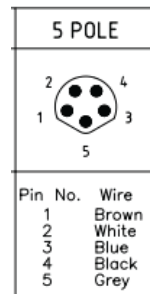
Ethercat

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

GFC VCR Dimensions
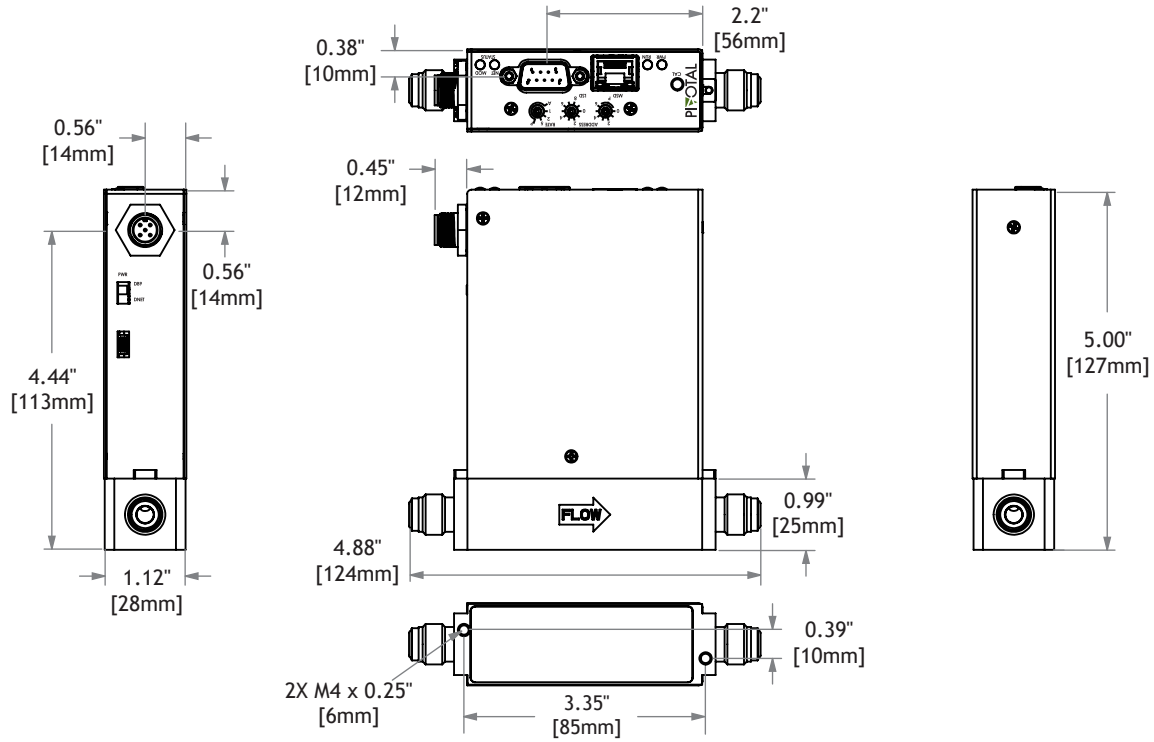
GFC C-Seal and W-Seal Dimensions

W-Seal

C-Seal

GFC Analog Adapter (AB)

0.70" [18mm]
0.50" [12mm]
1.20" [31mm]
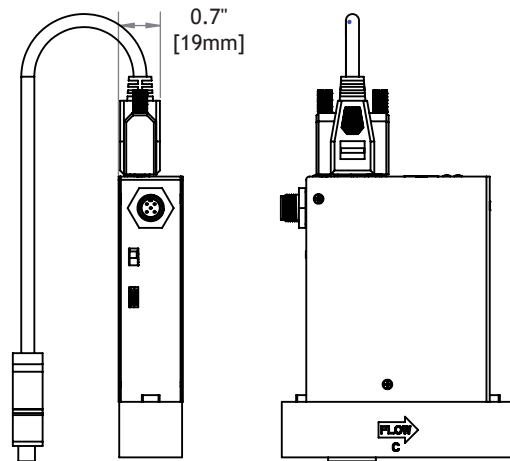
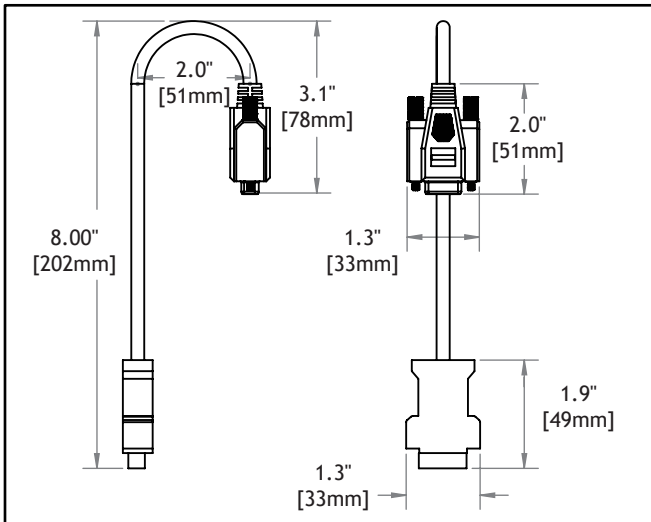0.38" [10mm]
2.2" [56mm]
0.56" [14mm]
0.49" [12mm]
0.52" [13mm]
0.42" [11mm]
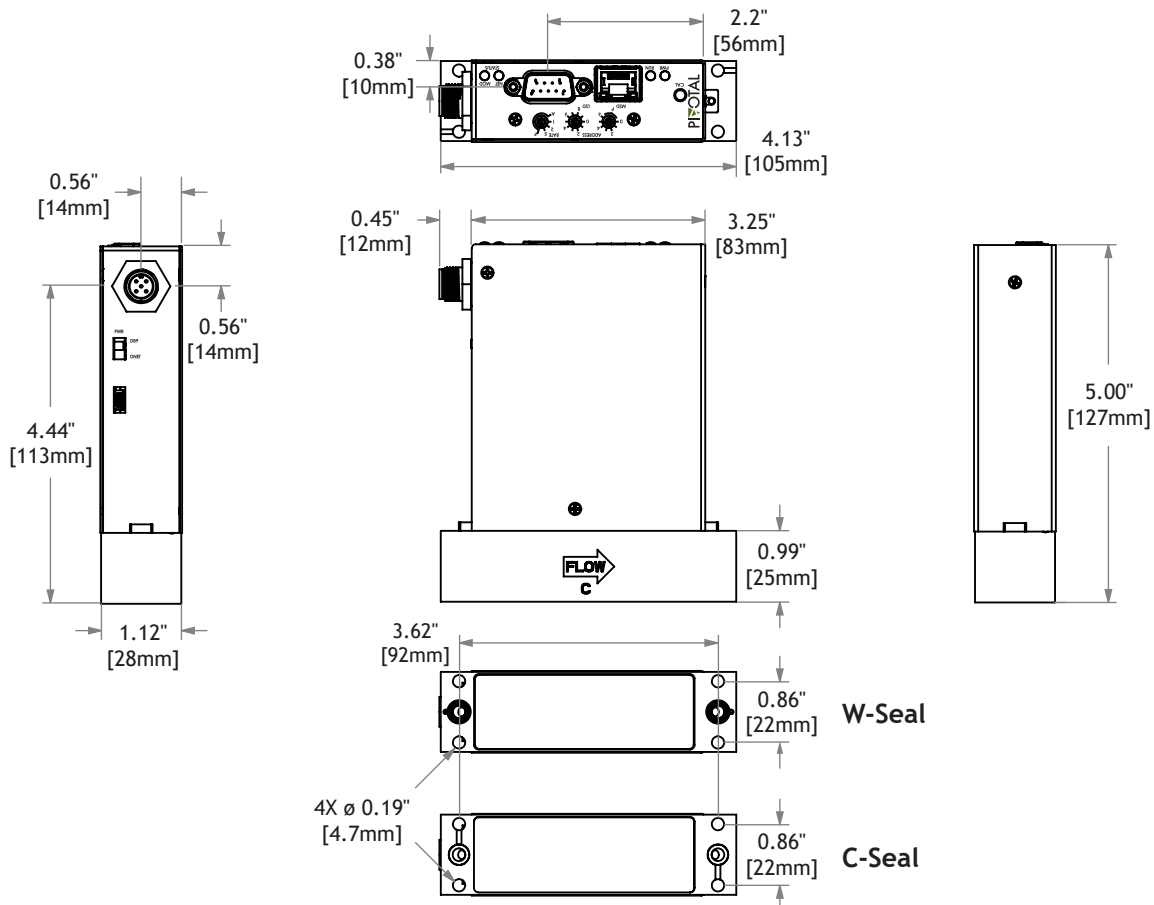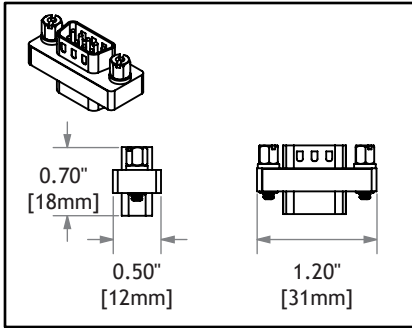
On the right is how the adapter (in green) is attached to the GFC.
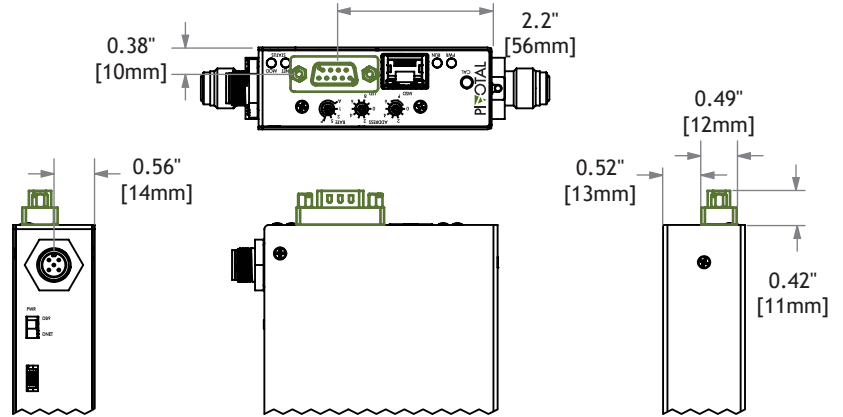
GFC Honda Adapter (AC/AD/AK)

2.0" [51mm]
3.1" [78mm]
2.0" [51mm]
8.00" [202mm]
1.3" [33mm]
1.9" [49mm]
1.3" [33mm]
0.7" [19mm]

GFC Card Edge Analog Adapter (AE/AF)

1.60" [41mm]
0.60" [16mm]
1.20" [31mm]

0.38" [10mm]
2.2" [56mm]
0.6" [14mm]
1.4" [35mm]
0.5" [12mm]
1.20" [30mm]
0.5" [12mm]
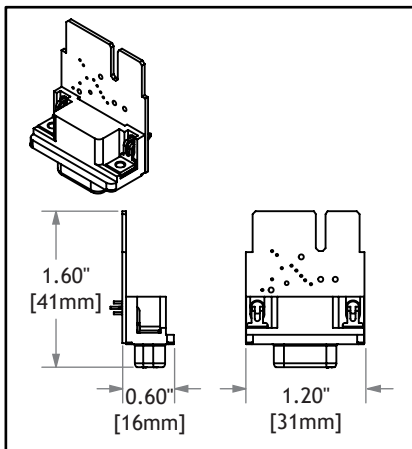
On the right is how the adapter (in green) is attached to the GFC.
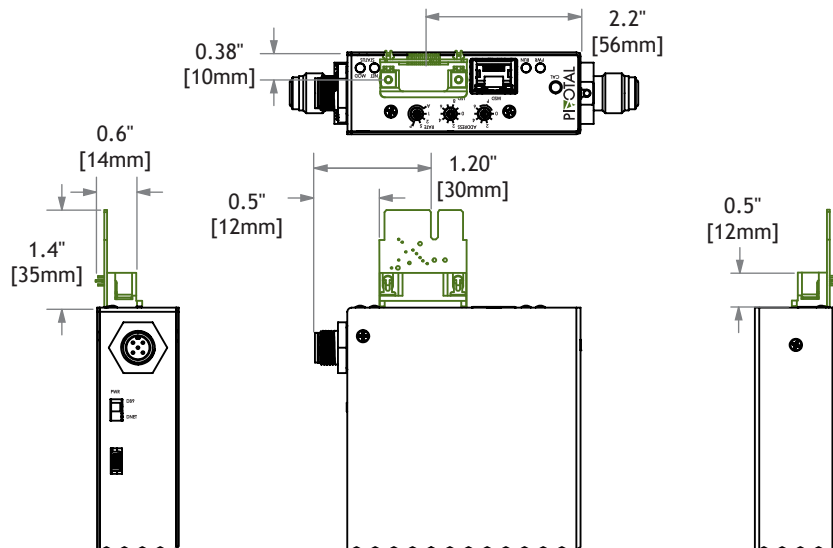
GFC DB9 to Card Edge – RJ11 Cable (AG)

PIN 6
PIN 1   PIN 5   8"
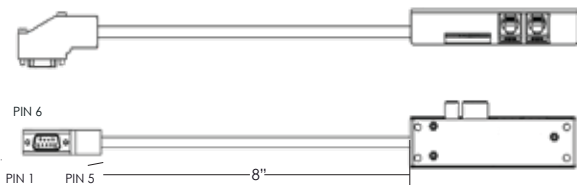
GFC DB9 to DB15 Adapter Cable (AH/AJ)

PIN 15
PIN 9
PIN 1

PIN 6
PIN 1   PIN 5   8"

GFC FNET Cable (RC)

23"

35"
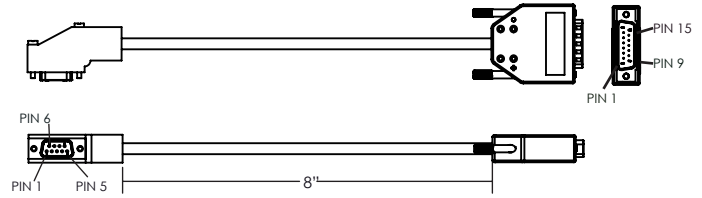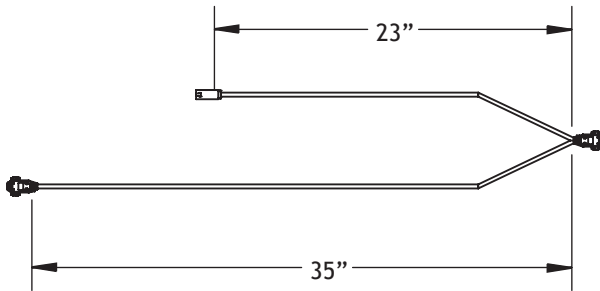
DB9-F	DB9-M	RJ45	Description
1	1	-	Valve Override Signal (Input)
2	2	-	Flow Feedback Signal (Output)
3	3	8	Power Supply +15V
4	4	1, 2	Power Supply 0V
5	5	9	Power Supply -15V
6	6	-	Flow Setpoint Signal (Input)
7	7	-	Signal Common (0V)
8	-	-	RS-485 +
9	-	-	RS-485 -

GFC Ethercat C-Seal and W-Seal Dimensions

45°
PIN 1

1.66" [42mm]
0.97" [25mm]
0.45" [12mm]

4.13" [105mm]

0.56" [14mm]
0.25" [6mm]
3.25" [83mm]

5.00" [127mm]

3.97" [101mm]

FLOW
C
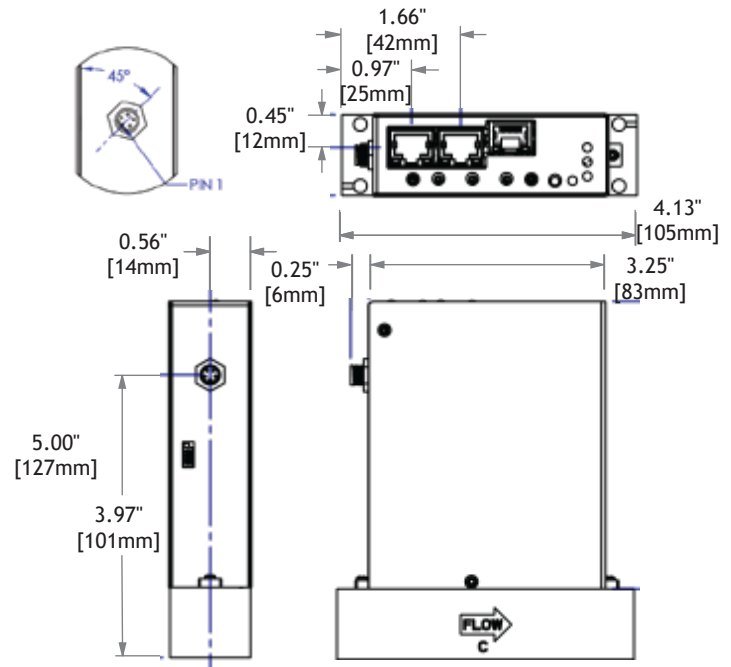
GFC C-Seal Poke Yoke Dimensions

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

A
FLOW
C

0.06±0.01" [1.8mm]

B   B

ø 0.095±0.001" [2.4mm]

Detail A

0.155" [4mm]   PIN
0.950" [24mm]
ø 0.110" [3mm] (HOLE)
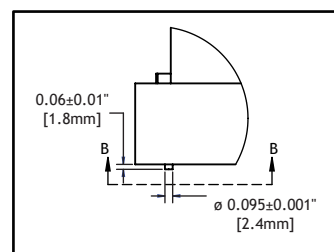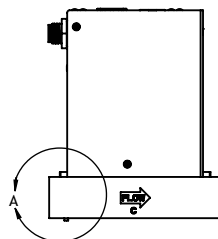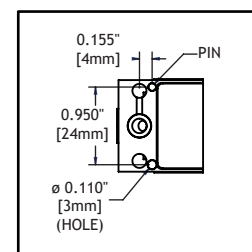
Section B-B

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.pivotalsys.com or send an email to support@pivotalsys.com.

PIVOTAL
SYSTEMS

10-141-109-7 (Updated February 2019)