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CELERITY

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To: Field Applications and Service Centers

From: Skip Welles, Beverly Barnum and John Raditsas

Subject: MultiFlo Conversion Factor Unit Testing

Date: 08.24.04

Purpose:

To provide best known methods to users who perform flow verification tests on the Celerity MultiFlo product line.

Authorization:

R&D Engineering

System Affected:

This bulletin applies to all 204, 207 and 212 based MultiFlo products.

Date Effective:

8/16/04

Reference Documents:

n/a

Tools:

n/a

Introduction:

We have been experiencing problems in the field when service centers and customers attempt to verify MultiFlo accuracy using the traditional method of running a surrogate gas (typically N2) and correcting the output using C series conversion factors. C-series factors come close but subtle difference between our conventional digital product (203 and 210 based) and the MultiFlo product amount to small perceived errors typically less than 2%.

The MultiFlo product line was developed to replace our conventional digital product line with no affect on process. The physics-based model developed to configure a MultiFlo MFC relies on a series of correction coefficients to make the MultiFlo product replicate our conventional digital product which is calibrated on a number of surrogate gases. Depending on gas and range, these corrections can be linear, like the ubiquitous conversion factors or non-linear. Consequently, the proper method to verify the accuracy of MultiFlo product is to generate a process page for the test gas. For example, if N2 is being used as the test gas, then an active N2 page should be generated.

A new series of conversion factors has been released to help users who do not want to generate a proper surrogate process gas page (N2) when testing with that surrogate gas. Release of this new conversion factor series is not a copy exact issue because we are not changing the MultiFlo product in any way. We are releasing a conversion factor chart that can be utilized to more accurately test MultiFlo product using a surrogate gas(N2) when testing on the active process gas page (NOT N2). This new series is referred to as "Z-series" and should be used for all 204 based, 207 and 212 PCBs, when testing the active process gas page (non-N2) with N2 surrogate gas.

Procedure 1

Recommended Best Known Method: Generate appropriate process gas page to match test gas (typically N2):

This is the preferred test method because conversion factors are not needed and the characterization of the device can be verified directly. For the remainder of these instructions, it is assumed N2 will be used for flow verification. However, this procedure can be used with any surrogate test gas by generating the appropriate process gas page.

1. Insure the active process page matches the test gas used for incoming inspection. Thus, check that the N2 process gas page is active. If the N2 process gas page is not the active page, set the active process gas page to an existing N2 page by using either the MultiFlo Configurator software

of the MFlo V.I. software (see appendices A, B) to change the active gas page in the MFC.

If no N2 process gas page exists, a new N2 page can be generated using the MultiFlo Configurator software. (See appendix C).

Once the MFC is configured to test N2, test the device as follows:

2. Warm up the unit for at least one hour (uninterrupted powered time).

3. Make sure that the MFC is mounted in the correct orientation, as configured (HBD VIU or VID)
   - HBD: Horizontal, with the Base Down
   - VIU: Vertical, with the Inlet facing Up
   - VID: Vertical, with the Inlet facing Down

4. Zero the unit.
   - For instructions refer to User's Manual Analog and Digital Mass Flow Controllers and Meters.
     - Available at:

http://www.celerity.net/4.4.1.manuals.html

5. Perform System checks (leak, etc.)

6. You are now ready to flow the N2 surrogate gas to verify accuracy of the factory N2 characterization.

IMPORTANT:
When incoming inspection is finished, reset the active process gas page to the 'as shipped' process gas page.

Procedure 2

Alternate Conversion Factor Test Method: Run N2 and correct the measured flow using a Z series conversion factor (typically N2):

1. Insure that the process gas page is set to Active.

2. Follow steps 2–5 in the previous section.

3. You are now ready to flow N2 gas and verify the accuracy of the MFC.

4. Record the actual N2 flow rates. Use the flow rates as a fingerprint for the MFC flowing N2.

5. To determine the process gas flow rates use the following formula:

$$N2_{\text{flow rate}} * CF_{\text{process gas}} = \text{Process Gas}_{\text{Flow rate}}$$

6. The relationship between the N2 flow rate and the process gas flow rate is basically linear for bins SC10 through SC15. Consequently, Z series conversion factors will predict the process gas flow rate to better than +/- 2% accuracy. However, deviations between the N2 test flow rate and the process gas page can be as high as +/- 5% for bin SC16 and +/- 15% for bins SC17 and SC18.

Z-series Conversion Factor Chart

Conversion Factors for SC10-15 with process gas pages created by MultiFlo Configurator v3.07 or greater.

Code	Symbol	Name	CF_C	SC10-SC15
1	He	Helium	1.399	1.399
2	Ne	Neon	1.395	1.395
4	Ar	Argon	1.414	1.414
5	Kr	Krypton	1.412	1.412
6	Xe	Xenon	1.413	1.413
7	H2	Hydrogen	1.001	1.013
8	Air	Air	0.998	0.998
9	CO	Carbon Monoxide	0.995	0.995
10	HBr	Hydrogen Bromide	1.025	1.025
11	HCl	Hydrogen Chloride	1.016	1.016
13	N2	Nitrogen	1.000	1.000
14	D2	Deuterium	0.997	0.997
15	O2	Oxygen	0.977	0.977
16	NO	Nitric Oxide	0.972	0.972
17	HI	Hydrogen Iodide	1.005	1.005
18	F2	Fluorine	0.903	0.903
19	Cl2	Chlorine	0.851	0.851
22	H2S	Hydrogen Sulfide	0.839	0.839
23	H2Se	Hydrogen Selenide	0.800	0.800
25	CO2	Carbon Dioxide	0.736	0.725
27	N2O	Nitrous Oxide	0.714	0.714
28	CH4	Methane	0.752	0.752
29	NH3	Ammonia	0.790	0.798
31	PH3	Phosphine	0.742	0.742
32	SO2	Sulfur Dioxide	0.694	0.694
33	CH3F	Methyl Fluoride	0.691	0.691
34	COS	Carbonyl Sulfide	0.660	0.660
35	AsH3	Arsine	0.673	0.673
36	CH3Cl	Methyl Chloride	0.637	0.637
37	ClCN	Cyanogen Chloride	0.619	0.619
38	C2H4	Ethylene	0.575	0.575
39	SiH4	Silane	0.603	0.603
41	OF2	Oxygen Difluoride	0.633	0.633
42	C2H2	Acetylene	0.604	0.604
43	GeH4	Germane	0.577	0.577

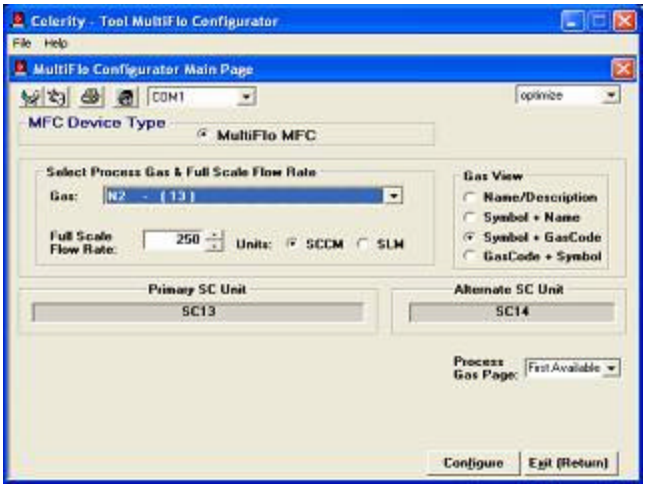
44	CH3Br	Methyl Bromide	0.614	0.614
45	C2H4O	Ethylene Oxide	0.494	0.494
46	COF2	Carbonyl Fluoride	0.578	0.578
47	CH3SH	Methyl Mercaptan	0.518	0.518
48	BF3	Boron Trifluoride	0.528	0.528
49	CHF3	Fluoroform (Freon-23)	0.512	0.505
51	C2H3F	Vinyl Fluoride	0.508	0.508
52	CH5N	Methylamine (Mono)	0.513	0.513
53	NF3	Nitrogen Trifluoride	0.490	0.490
54	C2H6	Ethane	0.475	0.475
57	CHClF2	Chlorodifluoromethane (Freon-22)	0.467	0.467
58	B2H6	Diborane	0.425	0.425
61	C3H6-a)	Cyclopropane	0.417	0.417
62	PF3	Phosphorus Trifluoride	0.459	0.459
63	CF4	Carbon Tetrafluoride (Freon-14)	0.426	0.422
67	SiH2Cl2	Dichlorosilane	0.420	0.420
69	C3H6-b)	Propylene	0.390	0.390
70	BCl3	Boron Trichloride	0.444	0.444
74	CClF3	Chlorotrifluoromethane (Freon-13)	0.397	0.397
80	CBrF3	Bromotrifluoromethane (Freon-13B1)	0.383	0.383
84	CCl2F2	Dichlorodifluoromethane (Freon-12)	0.368	0.368
85	C2H7N	Dimethylamine	0.356	0.356
88	SiF4	Silicon Tetrafluoride	0.365	0.365
89	C3H8	Propane	0.331	0.331
94	C2F4	TETRAFLUOROETHYLENE	0.331	0.331
95	N2O4	NITROGEN TETROXIDE	0.363	0.363
97	Si2H6	DISILANE	0.321	0.321
98	C4H8-j)	TRANSBUTENE	0.286	0.286
99	GeF4	GERMANIUM TETRAFLUORIDE	0.317	0.317
100	C4H6-e)	BUTADIENE	0.302	0.302
104	C4H8-i)	Butene	0.287	0.287
106	C4H8-h)	Isobutylene	0.285	0.285
107	C4H8-g)	Cisbutene	0.308	0.308
108	SiCl4	SILICON TETRACHLORIDE	0.309	0.309
109	C3H9N	TRIMETHYLAMINE	0.279	0.279
110	SF6	SULFUR HEXAFLUORIDE	0.267	0.262
111	C4H10-d)	ISOBUTANE	0.253	0.253
117	C4H10-c)	BUTANE	0.261	0.261
118	C2F6	HEXAFLUOROETHANE (FREON-116)	0.245	0.245
119	C2ClF5	CHLOROPENTAFLUOROETHANE (FREON-115)	0.241	0.241
122	C5H12	Dimethylpropane	0.199	0.199
124	MoF6	Molybdenum hexafluoride	0.213	0.213
128	C3F8	Perfluoropropane	0.176	0.176
129	C4F8	OCTAFLUOROCYCLOBUTANE	0.168	0.168
138	C3F6	Hexafluoropropylene	0.234	0.234
155	C2HF5	PENTAFLUOROETHANE (FREON-125)	0.268	0.268
156	C2H2F4	TETRAFLUOROETHANE (FREON-	0.287	0.287

		134A)		
160	CH2F2	Difluoromethane	0.603	0.603
185	CH6Si	Methylsilane (MONO)	0.387	0.387
190	(CH3)3SiH	Trimethylsilane (TMSi)	0.220	0.220
192	C6F6	Hexafluorobenzene	0.158	0.158
193	PCl3	Phosphorus trichloride	0.357	0.357
241	C4F10	Perfluorobutane	0.139	0.139
266	C5F8	Octafluorocyclopentene	0.153	0.153
267	C3H2F6	Hexafluoropropane	0.200	0.200
269	HN3	Hydrazoic acid	0.619	0.619
270	C4F6	Hexafluoro-2-butyne	0.201	0.201
297	C4F6-q)	Hexafluoro Butadiene-1,3	0.195	0.195
351	C4F8O	Perfluoro Oxacyclopentane	0.160	0.160
353	OSG-1	ORGANOSILICONE	0.182	0.182
500	15%PH3/N2	15%PHOSPHINE/NITROGEN	0.950	0.950
501	5%PH3/N2	5%PHOSPHINE/NITROGEN	0.983	0.983
509	10%GeH4/H2	10%GERMANE/HYDROGEN	0.932	0.932
514	1%PH3/N2	1%PHOSPHINE/NITROGEN	0.997	0.997
517	25%PH3/SiH4	25%PHOSPHINE/SILANE	0.633	0.633
527	10%PH3/N2	10%PHOSPHINE/NITROGEN	0.966	0.966
532	10%H2/N2	10%HYDROGEN/NITROGEN	1.000	1.000
535	4%PH3/N2	4%PHOSPHINE/NITROGEN	0.986	0.986
536	20%O2/He	20%OXYGEN/HELIUM	1.288	1.288
538	10%PH3/Ar	10%PHOSPHINE/ARGON	1.297	1.297
542	5%H2/N2	5%HYDROGEN/NITROGEN	1.000	1.000
546	1%PH3/He	1%PHOSPHINE/HELIUM	1.387	1.387
557	1%B2H6/H2	1%DIBORANE/HYDROGEN	0.988	0.988
559	1%BCl3/H2	1%BORON TRICHLORIDE/HYDROGEN	0.989	0.989
563	1%PH3/H2	1%PHOSPHINE/HYDROGEN	0.998	0.998
584	15%PH3/SiH4	15%PHOSPHINE/SILANE	0.620	0.620
595	3%B2H6/N2	3%DIBORANE/NITROGEN	0.961	0.961
597	3%H2/N2	3%HYDROGEN/NITROGEN	1.000	1.000
603	30%He/O2	30%HELIUM/OXYGEN	1.074	1.074
604	30%O2/He	30%OXYGEN/HELIUM	1.239	1.239
605	4%B2H6/N2	4%DIBORANE/NITROGEN	0.949	0.949
606	4%H2/He	4%HYDROGEN/HELIUM	1.377	1.377
607	4%H2/N2	4%HYDROGEN/NITROGEN	1.000	1.000
628	5%SiH2Cl2/Ar	5%DICHLOROSILANE/ARGON	1.264	1.264
632	50%PH3/SiH4	50%PHOSPHINE/SILANE	0.665	0.665
649	10%O2/He	10%OXYGEN/HELIUM	1.341	1.341
654	5%B2H6/N2	5%DIBORANE/NITROGEN	0.937	0.937
656	.5%PH3/H2	.5%PHOSPHINE/HYDROGEN	0.999	0.999
660	.3%PH3/SiH4	.3%PHOSPHINE/SILANE	0.603	0.603
677	20%F2/He	20%FLUORINE/HELIUM	1.261	1.261
695	2%B2H6/N2	2%DIBORANE/NITROGEN	0.974	0.974

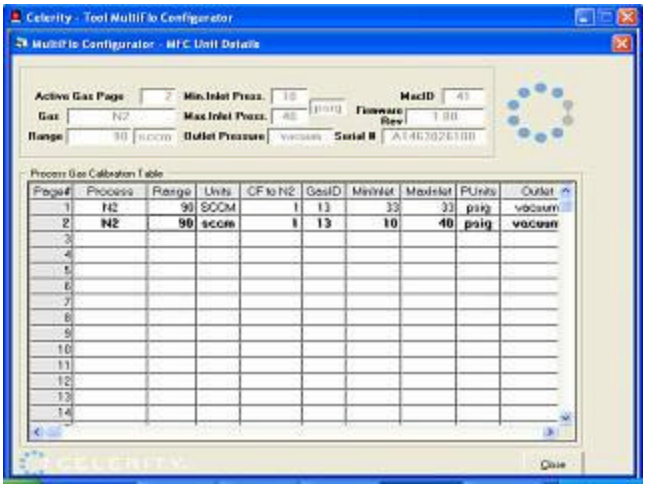
698	10%GeH4/Ar	10%GERMANE/ARGON	1.235	1.235
724	1%AsH3/H2	1%ARSINE/HYDROGEN	0.996	0.996
731	10%Si2H6/H2	10%DISILANE/HYDROGEN	0.826	0.826
762	5%H2/He	5%Hydrogen/Helium	1.372	1.372
775	1.5%GeH4/H2	1.5%Germane/Hydrogen	0.990	0.990
784	.02%CO/N2	.02%CARBON MONOXIDE/NITROGEN	1.000	1.000
786	.1%CO/N2	.1%CARBON MONOXIDE/NITROGEN	1.000	1.000
823	2%SiH4/Ar	2%Silane/Argon	1.377	1.377
837	30%GeH4/Ar	30%GERMANE/ARGON	0.985	0.985
850	50%H2/N2	50%Hydrogen/Nitrogen	1.000	1.000
865	5%CO2/5%O2/N2	5%CARBON DIOXIDE/5%OXYGEN/NITROGEN	0.981	0.981
866	2.5%O2/5%CO2/N2	2.5%OXYGEN/5%CARBON DIOXIDE/NITROGEN	0.981	0.981
867	5%CO2/10%O2/N2	5%CARBON DIOXIDE/10%OXYGEN/NITROGEN	0.980	0.980
874	30%(CH3)3SiH/H2	30%TRIMETHYLSILANE/Hydrogen	0.480	0.480
877	30%SiHCl3/H2	30%Trichlorosilane/Hydrogen	0.632	0.632
878	3%C2H4/He	3%Ethylene/Helium	1.341	1.341
881	10%B2H6/Ar	10%DIBORANE/ARGON	1.147	1.147
886	.01%PH3/Ar	.01%Phosphine/Argon	1.414	1.414
887	.1%PH3/Ar	.1%Phosphine/Argon	1.413	1.413
888	.1%B2H6/Ar	.1%Diborane/Argon	1.411	1.411
895	40%GeH4/N2	40%Germane/Nitrogen	0.773	0.773
896	30%PH3/SiH4	30%Phosphine/Silane	0.639	0.639
897	2.7%C2H4/He	2.7%Ethylene/Helium	1.347	1.347
898	1%GeH4/H2	1%Germane/Hydrogen	0.994	0.994
899	1%CH6Si/H2	1%METHYLSILANE (MONO)/Hydrogen	0.985	0.985
900	.48%NF3/N2	.48%Nitrogen Trifluoride/Nitrogen	0.995	0.995
908	20%B2H6/He	20%DIBORANE/HELIUM	0.959	0.959
919	20%H2/20%C0/N2	20%Hydrogen/20%Carbon monoxide/Nitrogen	0.999	0.999
920	20%H2/20%C0/Ar	20%Hydrogen/20%Carbon monoxide/Argon	1.212	1.212
921	4%O2/N2	4%Oxygen/Nitrogen	0.999	0.999
922	10%CF4/Ar	10%Carbon Tetrafluoride/Argon	1.148	1.148
923	10%NF3/Ar	10%Nitrogen Trifluoride/Argon	1.190	1.190
926	3%H2S/H2	3%Hydrogen Sulfide/Hydrogen	0.995	0.995
927	6%B2H6/N2	6%DIBORANE/NITROGEN	0.925	0.925

Appendix A
Setting the active gas page to N2 using the MultiFlo Configurator.

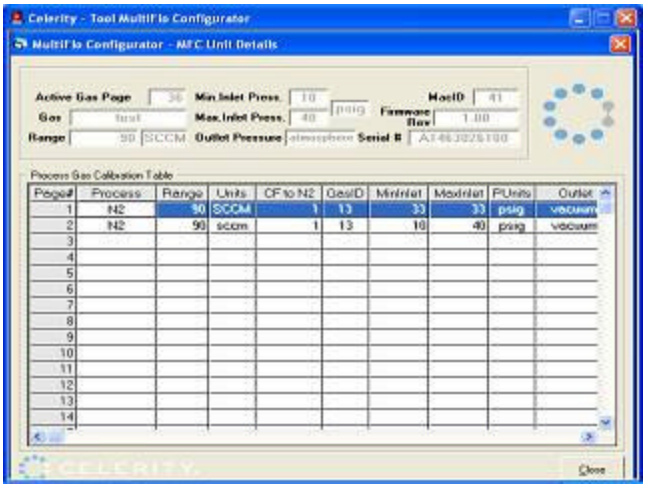
From the Main Page (go on line, select desired port. Select MACid of desired MFC, click Go To MultiFlo Configurator)



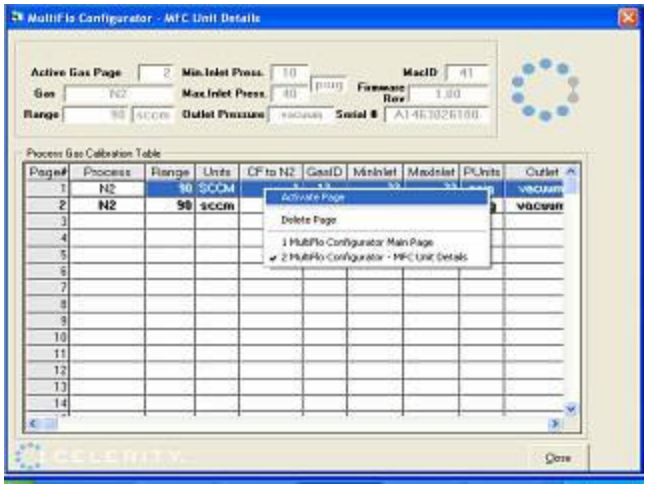
Select File > View Details. The top box displays the current active gas page (In this example page 2, gas 02, 90 sccm)



Left-Click on desired process gas page (#1, in this example).

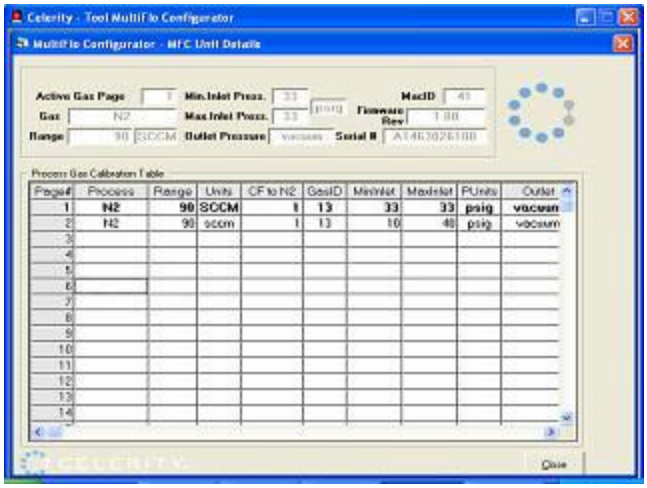


Next, Right-Click to show pull-down menu.
Highlight “Activate”...
… then Left-click to send the command.



The Top Box will display the updated active gas page. In this example, it is now page 1, gas N2, 90 sccm)

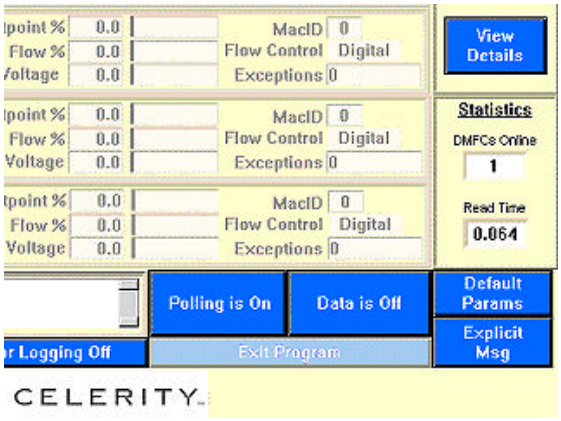
When you are finished with the incoming inspection you will select page 2, and select Activate, to return to original state.



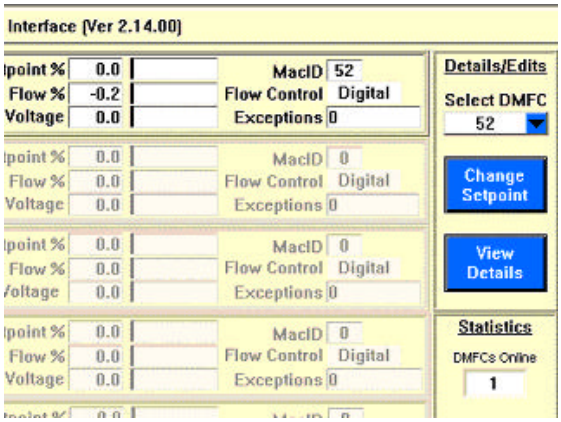
Appendix B
Alternate method for setting the active process gas page for N2 using the MultiFlo VI.

Go online with the MFlo V.I.

- Start the program.
- Click “polling is off” to bring up communications menu.
- Select DeviceNet, 500K baud, and Click Press to Start” to begin.

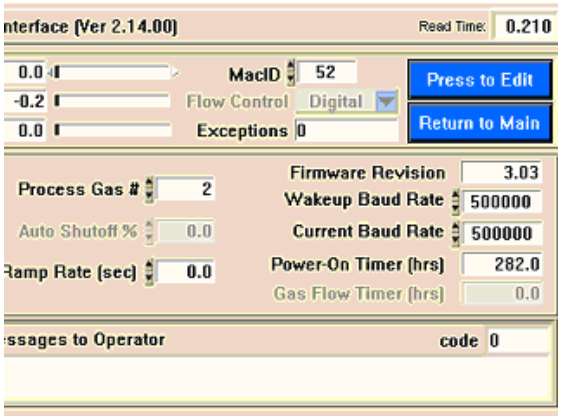


the Main Select the MacId of the desired device [DMFC] and push ‘view details’.

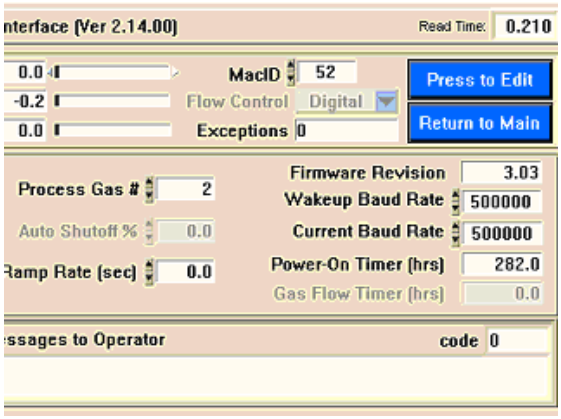


The Active Process Gas is shown in the second box, center column.

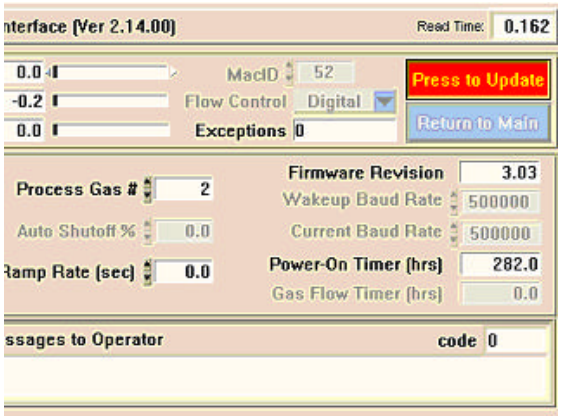
In this example, Process Gas# = 2.



Click the ‘press to edit’ button



This button changes to flashing red ‘press to update’.



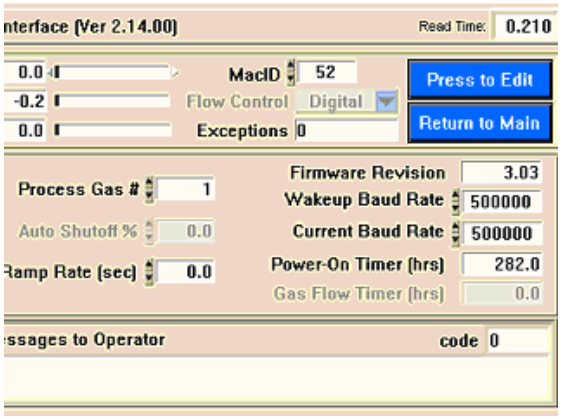
Now change the process gas # to 1.

And click the ‘press to update’ button to set.

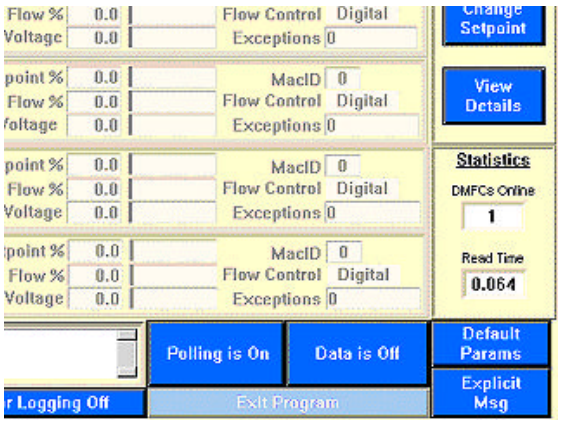
No change will be seen except the Process Gas # in the second box in the middle column.

Click on ‘Return to Main’ button.

The change will be shown in the Main Page and the View Details page upon return to the View Details screen.



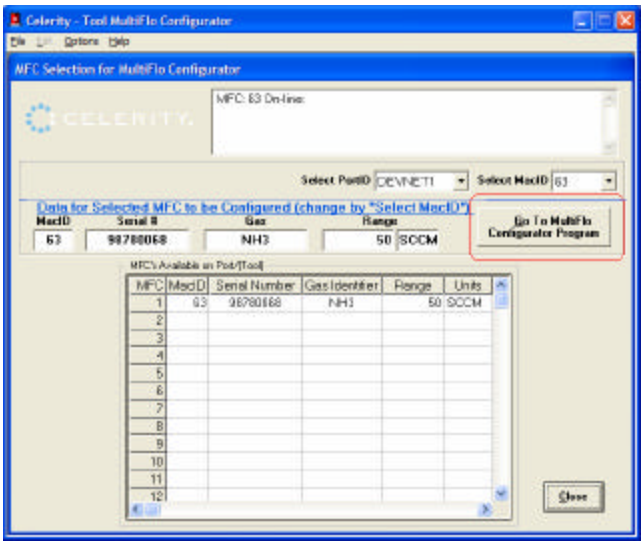
From the Main Screen, click ‘Polling is On’ and then ‘Exit Program.’



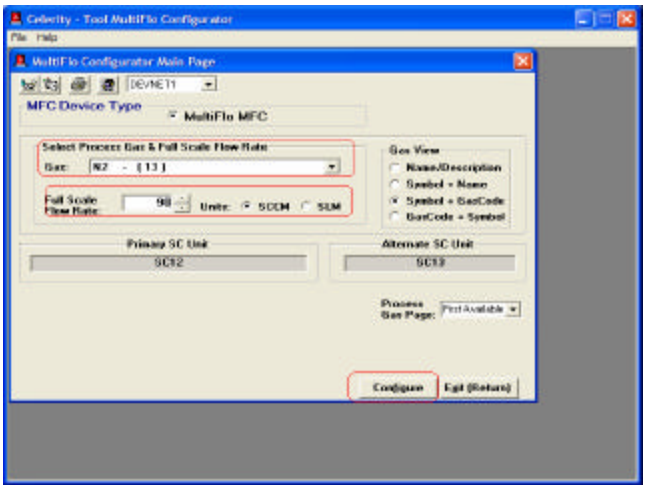
Appendix C
How to create an N2 process gas page using Multiflo Configurator.

At your computer desktop click on the Multiflo Configurator icon.

Click on the “Go To Multiflo Comfigurator Program.



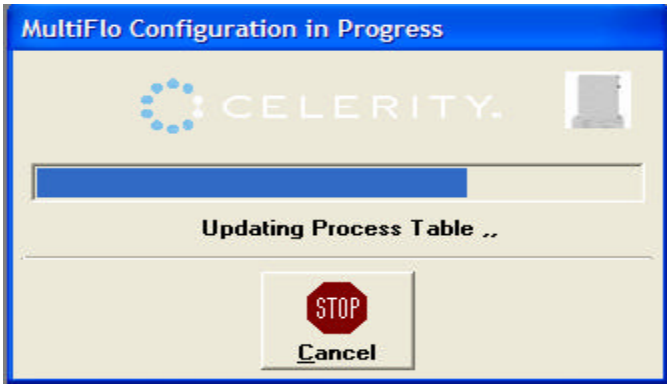
Select the N2 Gas and the Full Scale of the SC Model and click on the “Configure” button.



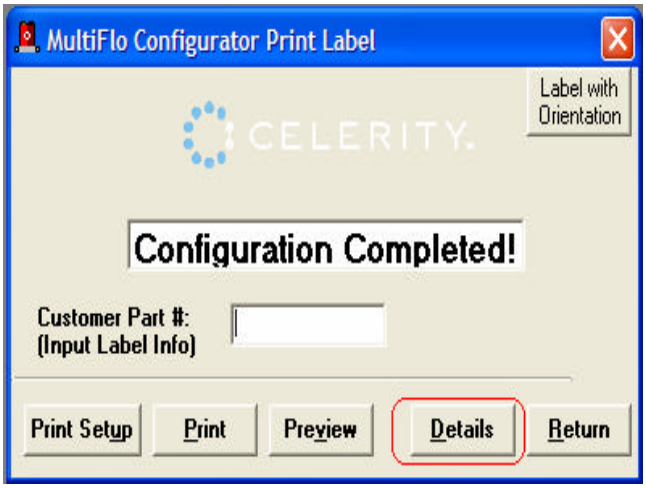
Note: The SC bin number is identified on the side can label of the MultiFlo MFC. The full scale range for a given bin is shown in the table below.

UFC SC Range

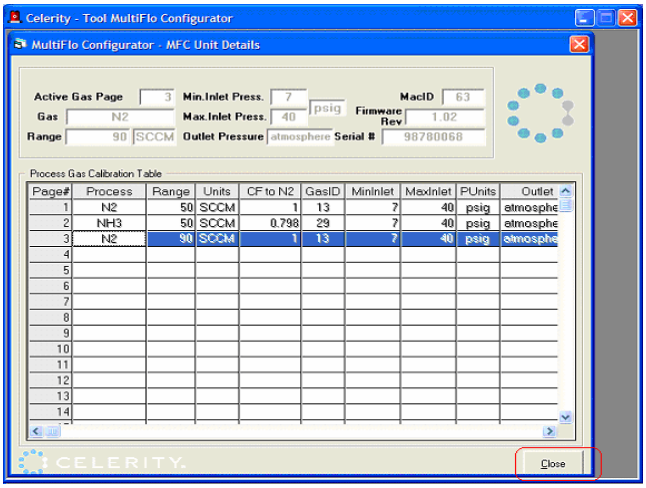
SC10	10 sccm N_2
SC11	30 sccm N_2
SC12	90 sccm N_2
SC13	250 sccm N_2
SC14	750 sccm N_2
SC15	2,000 sccm N_2
SC16	6,000 sccm N_2
SC17	15,000 sccm N_2
SC18	30,000 sccm N_2



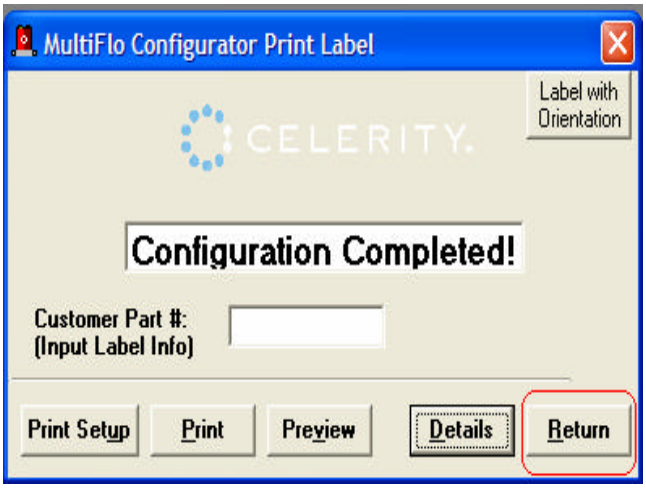
Click on the “Details” button.



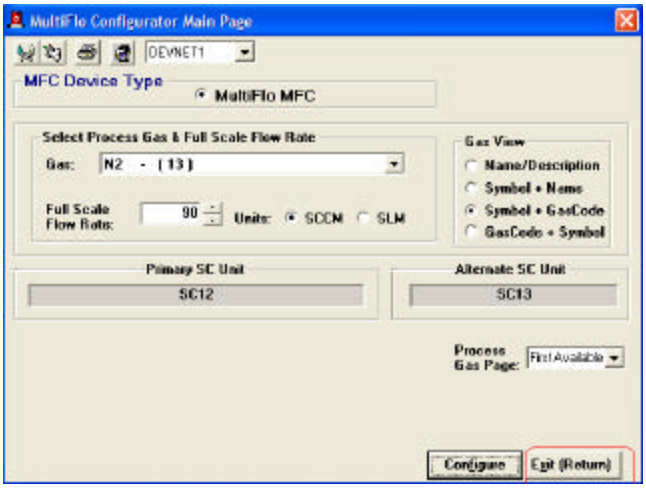
Verify N2 Gas process page has been configured and click “Close” button.



Click on the “Return” button.



Click on the “Exit (Return)” button.



Click on the “Close” button.