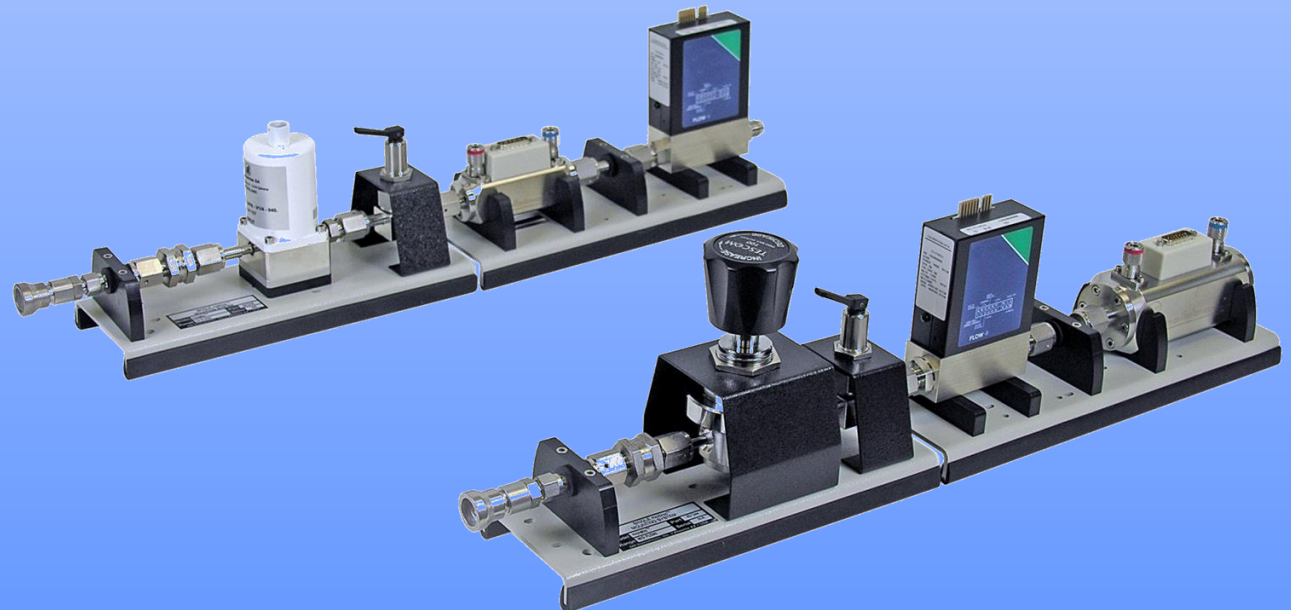


# COMPASS for Flow

## Introduction, Overview, and Structure



**A series of comparisons under specified conditions of applying a known flow to a flow measuring Device Under Test (“D.U.T.”) over its measurement range in order to determine or verify the relationship between flow input and the DUT’s output.**

## **Required components:**

- **DUT(s)**
- **Reference flow device**
- **Flow control hardware**
- **Measurement and/or control hardware for other parameter(s) (e.g. temperature, humidity, etc.)**
- **Data acquisition and interconnection hardware**

The process includes the following steps:

- **Connecting the DUT together with the reference**
- **Generating and controlling the applied flow**
- **Reading the DUT**
- **Reading the reference device**
- **Comparing values**
- **Determining in / out of tolerance**
- **Adjustment of DUT (if necessary)**
- **Verification of adjustment (if necessary)**
- **Reporting results**

## Why should you automate pressure calibration?

### Benefits realized through automation:

- **Reduction of operator error**
- **Electronic records of results**
- **Long and complicated tests can be accomplished unattended or overnight**
- **Improved lab efficiency**
- **Standardization of operational procedures; leak test, exercise, tare, dwell time, ready/not ready, data collection**
- **Software configurations can be readily duplicated by multiple operators, in multiple locations.**

# Levels of calibration automation

FLUKE®

Calibration

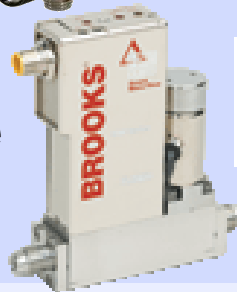
The level of test automation possible depends on the type of **DUT** being tested, the **reference** and the **flow control hardware**

Visual interface  
or  
manual control



Manual, User-Assisted  
Data Acquisition or  
control

Devices that don't  
output in flow units  
(Analog or pressure  
output devices)



Full Data Acquisition  
or control, through  
other Support Devices  
(DMM, pressure  
sensor, etc.)

Digital output devices

digital gauges  
MFC, MFM  
digital meters



Full Data  
Acquisition

**COMPASS for Flow calibration software is PC software designed to assist in the flow calibration process**

- **Manual, semi-automated, or fully automated data entry (or combination of)**
- **Manual (user chosen) or pre-defined test point sequences (test files)**
- **Support of 3rd party (non-Fluke Calibration) references**
- **Data saved in unique data files, and in a database**
- **Calibration report generation tool included that is configurable**

- **Setup Devices**
  - **Setup DUTs**
  - **Setup Support Devices (all non-DUT devices)**
- **Setup Test(s)**
- **Setup options, default hardware**
- **Setup/edit calibration report template(s)**

**Above steps take time but are typically done once, then maybe partially for new devices**

- **Run Test**
- **Create calibration report**

# Setup devices (10 sccm MFC example)

FLUKE®

Calibration

- **Setup DUTs**
  - Enter for all devices: manufacturer, model, serial number, ID, unit, min/max range, tolerance, raw output(s), final output, remote command(s), etc.
  - Entered info can be used during test and/or shown on calibration reports

DUT Editor

Record Label Station 1 MFC 3 / 7

Header Calibration Communications Output Set Comment

DUT Type Advanced DUT (>1 Output)

Record Type Individual

Manufacturer UNIT INSTRUMENTS (A)

Model ufc-1660

Serial Number A4403032800

Identification

Customer ID

Close

## DUT Type:

- Advanced - More than one output (read flow, set flow, pressure, temperature)
- Simple – One output

## Record Type:

- Individual – Unique device with SN, ID, etc.
- Profile – Template, enter unique info when starting test



# Setup DUT, cont.

DUT Editor

Record Label: Station 1 MFC 3 / 7

Header: Calibration | Communications | Output | Set | Comment

Calibration Date: 4 /15/2007 Calibration Due Date: 4 /15/2007

Calibration Performed By: Certification ID:

Calibration Setting1: Calibration Setting3:

Calibration Setting2: Calibration Setting4:

Default Test: Station 1 MFC Test

Record Last Edited: 9/11/2012 9:41:29 PM

Record Last Edited By: Admin

Close

DUT Editor

Record Label: Station 1 MFC 4 / 9

Editing Record

Header: Calibration | Communications | Output | Set | Comment

Interface: Common read and set interface.

Data Acquisition Type: Other Device

Interface Settings: N/A

Other common:  
Manual  
RS232  
GPIB/IEEE  
macro

Command Timeout(s): 8

Command Terminator: <CR><LF>

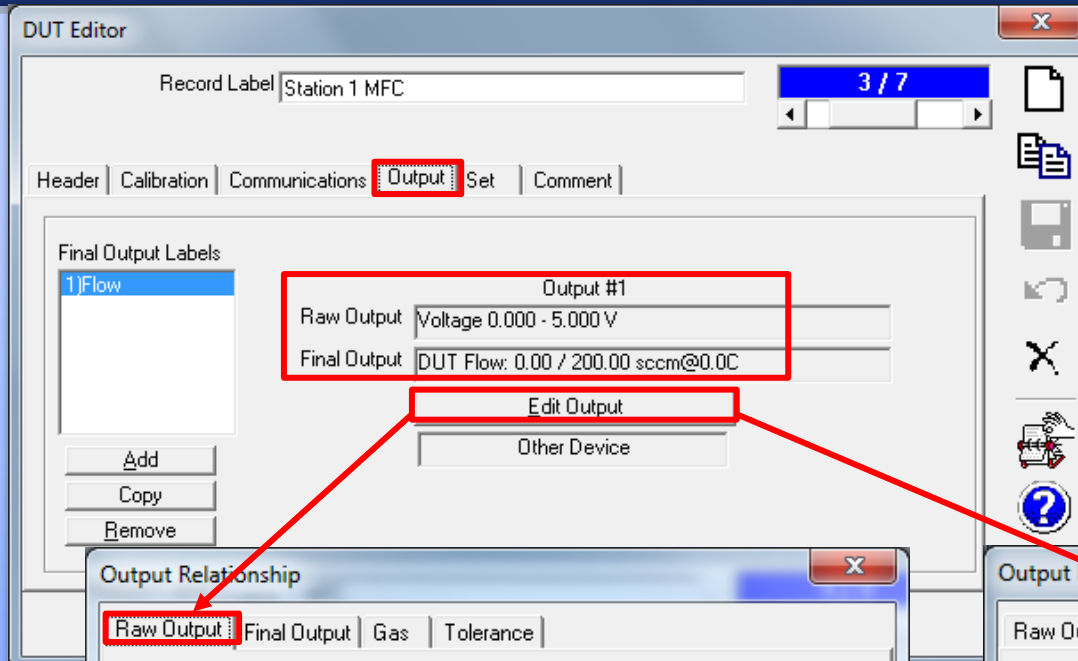
Response Terminator: <CR><LF>

Close

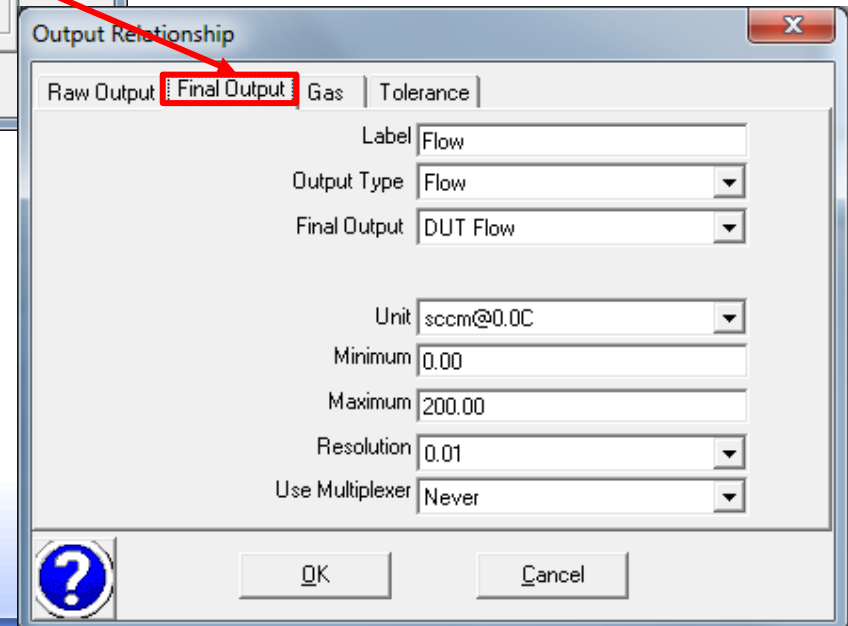
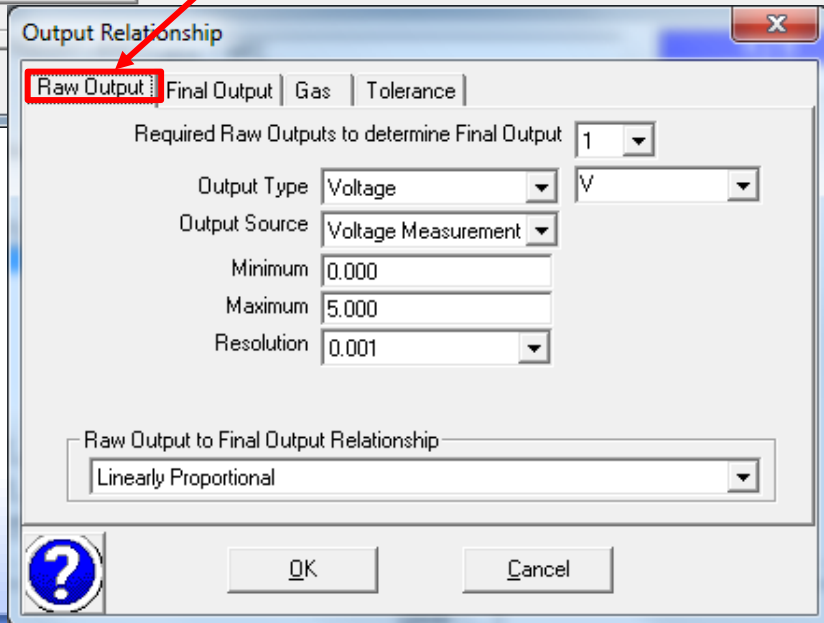
**Specify the Test so the technician doesn't have to when doing the calibration**

**MFC is read/set through "Other Device" (DMM)**

# Setup DUT, cont.



- **Advanced DUT could have multiple raw outputs (e.g. pressure & temperature)**



# Setup DUT, cont.

Output Relationship

Raw Output | Final Output | **Gas** | Tolerance

Process gas: H2 Hydrogen

Calibration Gas: N2 Nitrogen

K Factor: 1.024

Normal Operating Conditions

Gas Density Correction Type: None

Absolute Pressure: N/A kPa

Temperature: N/A C

Molecular Mass (g/mol): N/A

Compressibility: N/A

Buttons: ? OK Cancel

Output Relationship

Raw Output | Final Output | Gas | **Tolerance**

Number of Tolerance Segments: 1

Segment Tolerance: %Span

%Span: 1.000

Tolerance Segment Definition: All Final Outputs

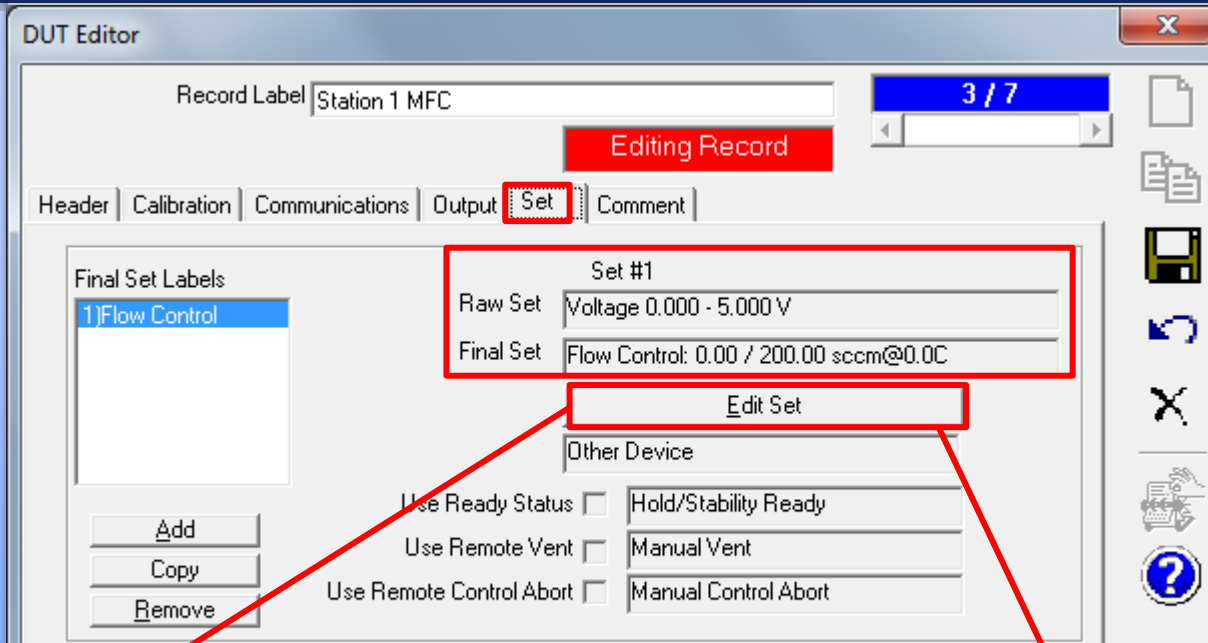
Diagram: Min ——— Tol ——— Max

Buttons: ? OK Cancel

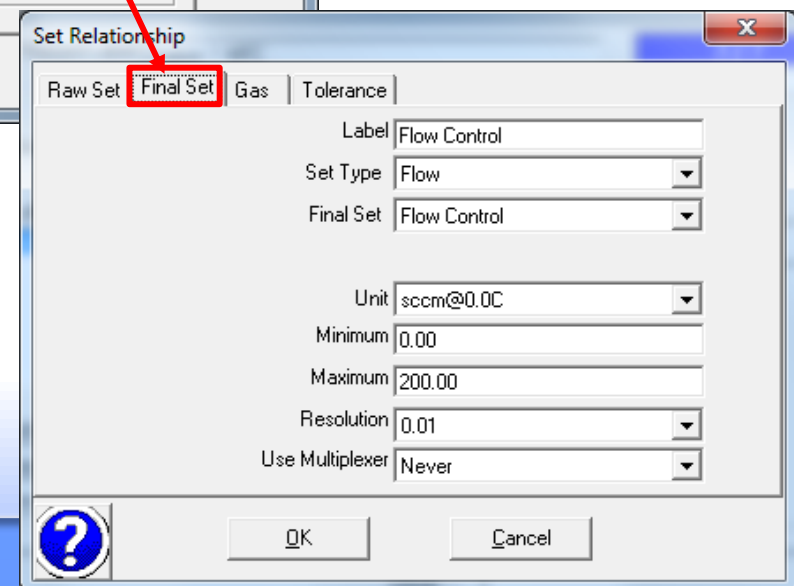
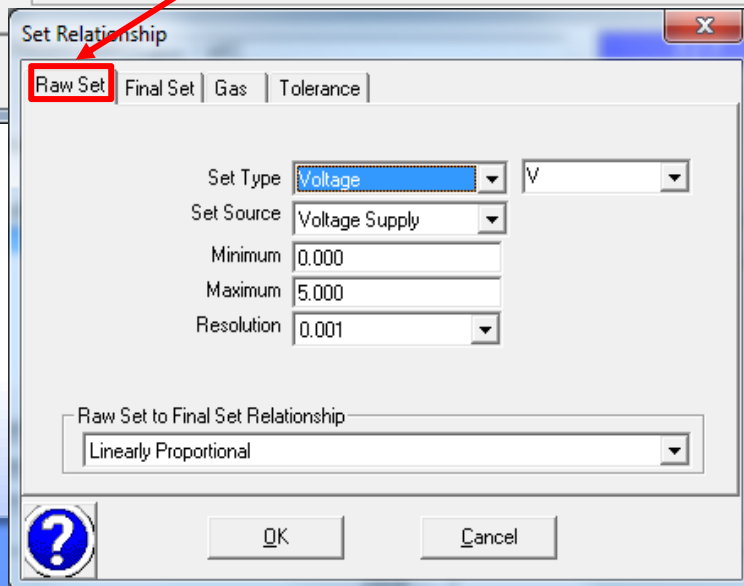
**K Factor for thermal mass flow devices running a different gas**

**Gas density correction used for rotameters and other density dependent DUTs. Proportional or square root density correction. Must specify normal (design) pressure and temperature**

# Setup DUT, cont.



Set (control) tab is very similar to Output (read) tab, but for control. It is also optional as many DUTs don't control.



# Setup DUT, cont.

Set Relationship

Raw Set | Final Set | **Gas** | Tolerance

Process gas: H2 Hydrogen

Calibration Gas: N2 Nitrogen

K Factor: 1.000

Normal Operating Conditions

Gas Density Correction Type: None

Absolute Pressure: N/A kPa

Temperature: N/A C

Molecular Mass (g/mol): N/A

Compressibility: N/A

Buttons: ? OK Cancel

Set Relationship

Raw Set | Final Set | Gas | **Tolerance**

Number of Tolerance Segments: 1

Segment Tolerance: %Span

%Span: 1.000

Tolerance Segment Definition: All Final Outputs

Diagram: Min — Tol — Max

Buttons: ? OK Cancel

DUT Editor

Record Label: Station 1 MFC 1 / 11

Header | Calibration | Communications | Output | Set | **Comment**

Device Comment

Thermal MFC with K factor

Setup Info

Use DUT as the control device

Callout: Comments are shown during test initialization and can be saved in the data file if desired

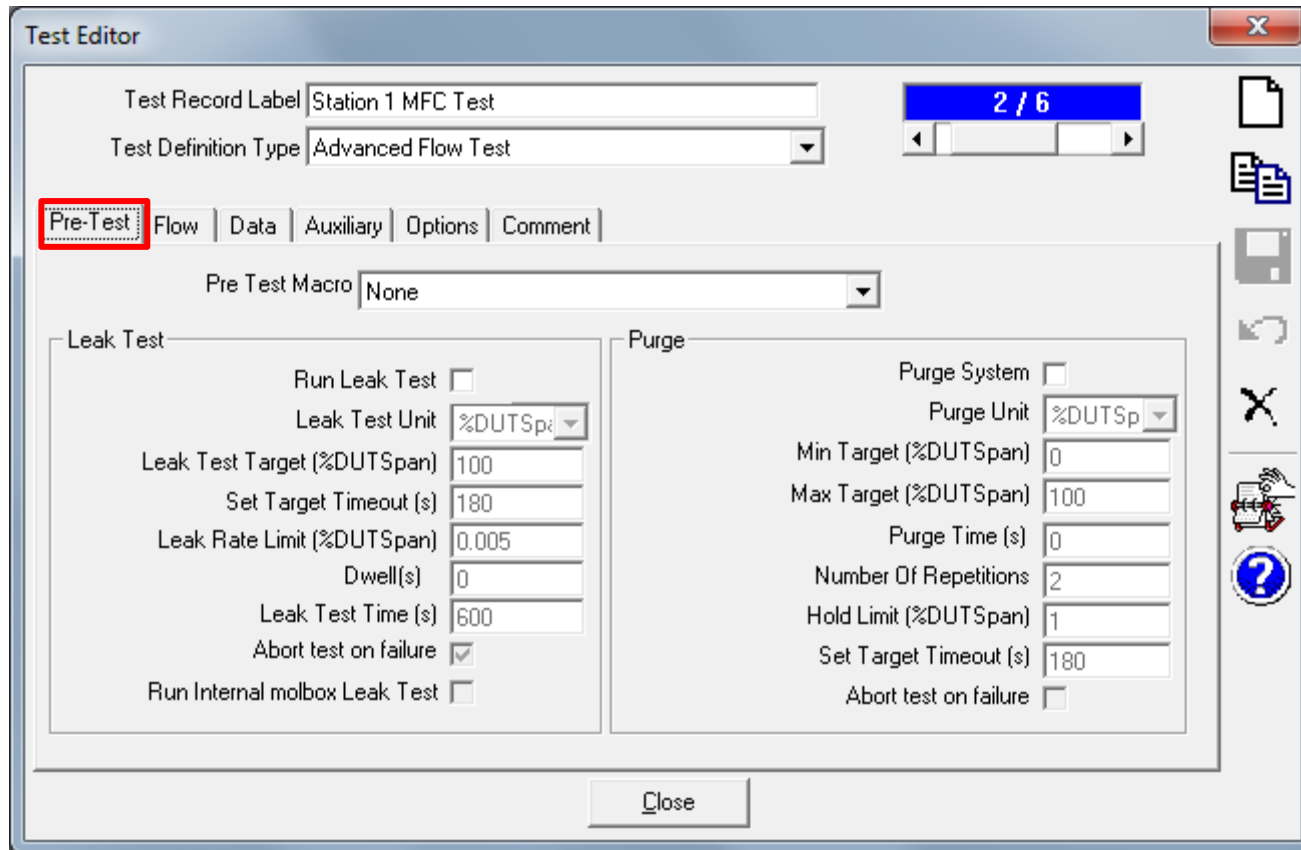
**Set (control) tab is very similar to Output (read) tab, but for control. It is also optional as many DUTs don't control.**

**K Factor is 1 on the Set tab. If I set 1 volt to the MFC, I want it set as 1 volt, and don't want to double the K factor**

- **Setup **Support Devices**** (any device that is not a DUT)
  - **Reference – Use Autodetect for Fluke Cal devices (don't have to set them up)**
  - **Controller - Might be same device as DUT (MFC). Very often a “Manual control” device**
  - **Monitors – Ambient conditions, Aux. pressure, etc.**
  - **Similar to the DUT setup tabs, they also have a Set (control) tab that is optional**
  - **Enter for all devices: manufacturer, model, serial number, asset IDs, unit, min/max range, tolerance, raw output(s), final output, remote command(s)**
- **When finished setting up the support devices, they are saved and you do not need to do this work again**

- **Setup Test Definitions** - specifies how the test will be performed
  - Define setpoints, typically add Tare to first setpoint in test
  - Specify **Reference(s)**, any other **Support Devices**
  - Ready/not ready criteria (stability, how close to setpoint, for how long)
  - Data collection method (manual or averaging)
  - Specify calibration report template to use (can't do with a Simple Test)
- When finished, the Test Definitions are saved and you do not need to do this work again

# Setup test definitions, Pre-Test tab



- **Some prefer to do any Leak Checks and Exercise cycles manually before the test. They are optional**



# Setup test definitions, Flow tab

Test Editor

Test Record Label: Station 1 MFC Test

Test Definition Type: Advanced Flow Test

2 / 6

Pre-Test **Flow** Data Auxiliary Options Comment

Test Flow Points - %DUTSpan

1)T	0	12)	
2)	25	13)	
3)	50	14)	
4)	75	15)	
5)	100	16)	
6)	50	17)	
7)	0	18)	
8)		19)	
9)		20)	
10)		21)	
11)		22)	

General Read Set

Unit: %DUTSpan

Read: Station 1 molbox1 + A700K / Flow

Set: DUT Control

Jog Before Dwell: N/A

Regulate: None 45 \$

Dwell: Automatic 10 \$

Flow Cycle: 1

Set 0 flow after each cycle

Insert Auto Fill Close

Specify Reference (Read) and Controller (Set)

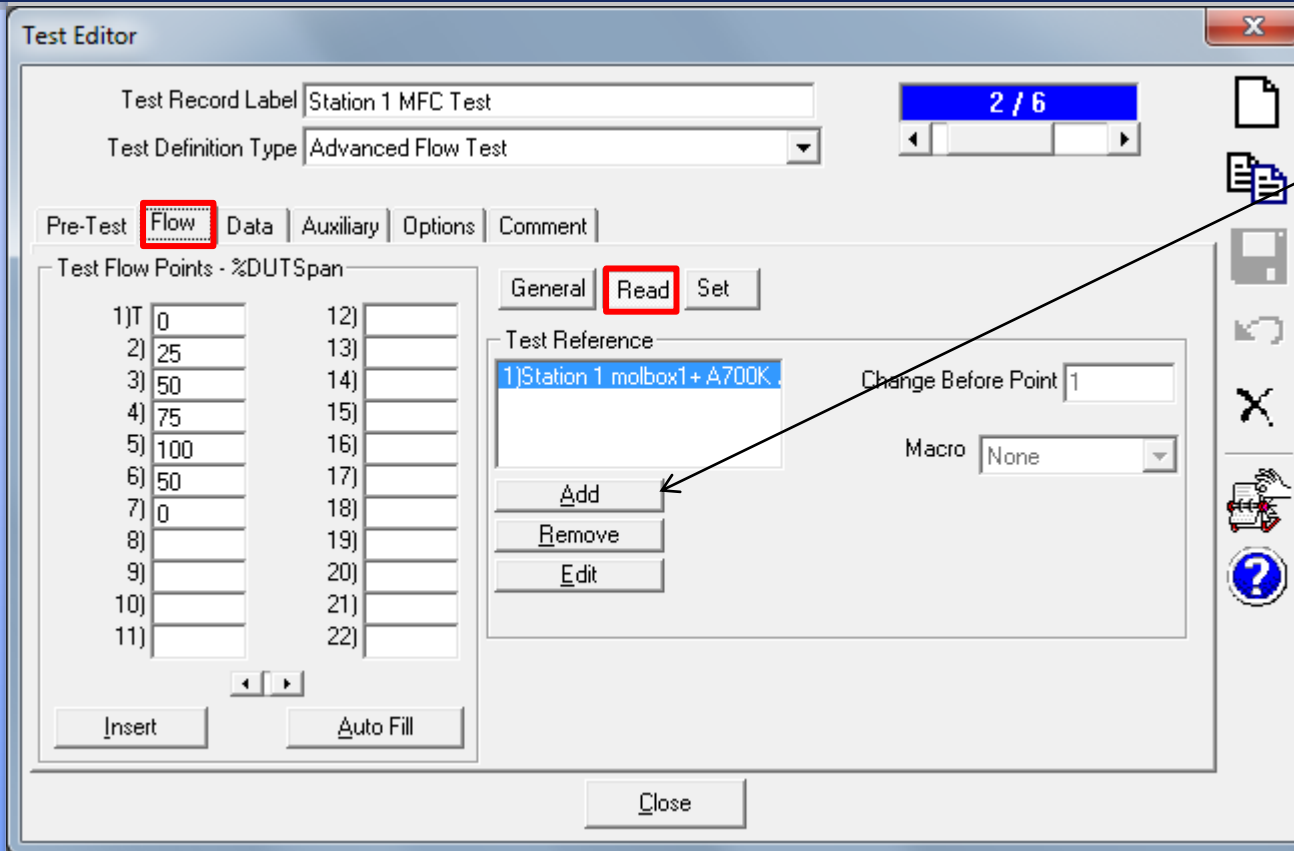
Jog – Adjust flow a little bit before taking data point

Regulate is usually used with digital gauges/meters and you use an automated controller to control to a cardinal point on the DUT. Control is regulated at chosen time intervals

Dwell is wait time before taking data. Automatic 0 is no dwell

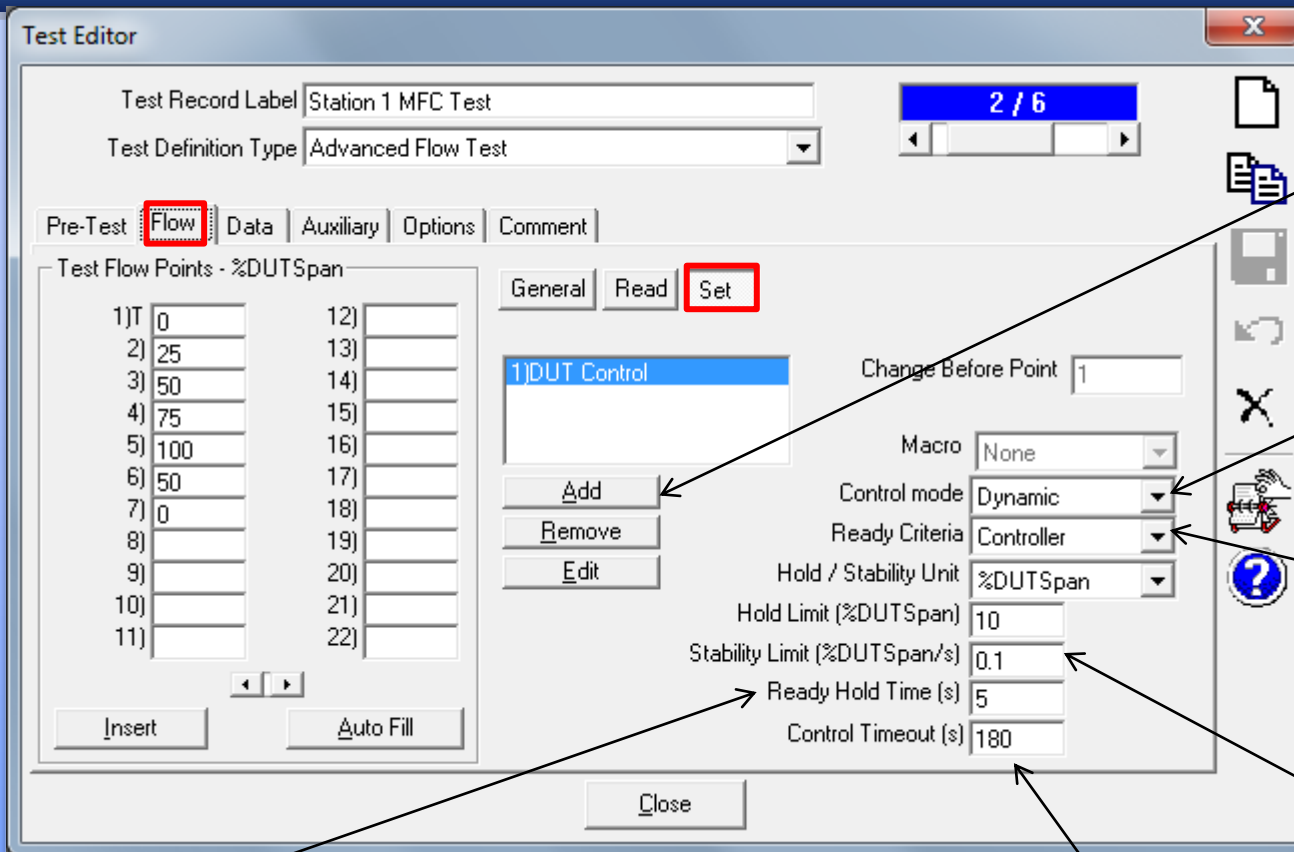
Tare (T) at point 1

# Setup test definitions, Read child tab



**Add or Edit References, specify what points they are used at (optional). If you do this they will already be selected for the technician, and they won't have to choose them when doing the calibration**

# Setup test definitions, Set child tab



Add or Edit Set devices (controllers), specify what points they are used at

Control mode doesn't matter with COMPASS for Flow

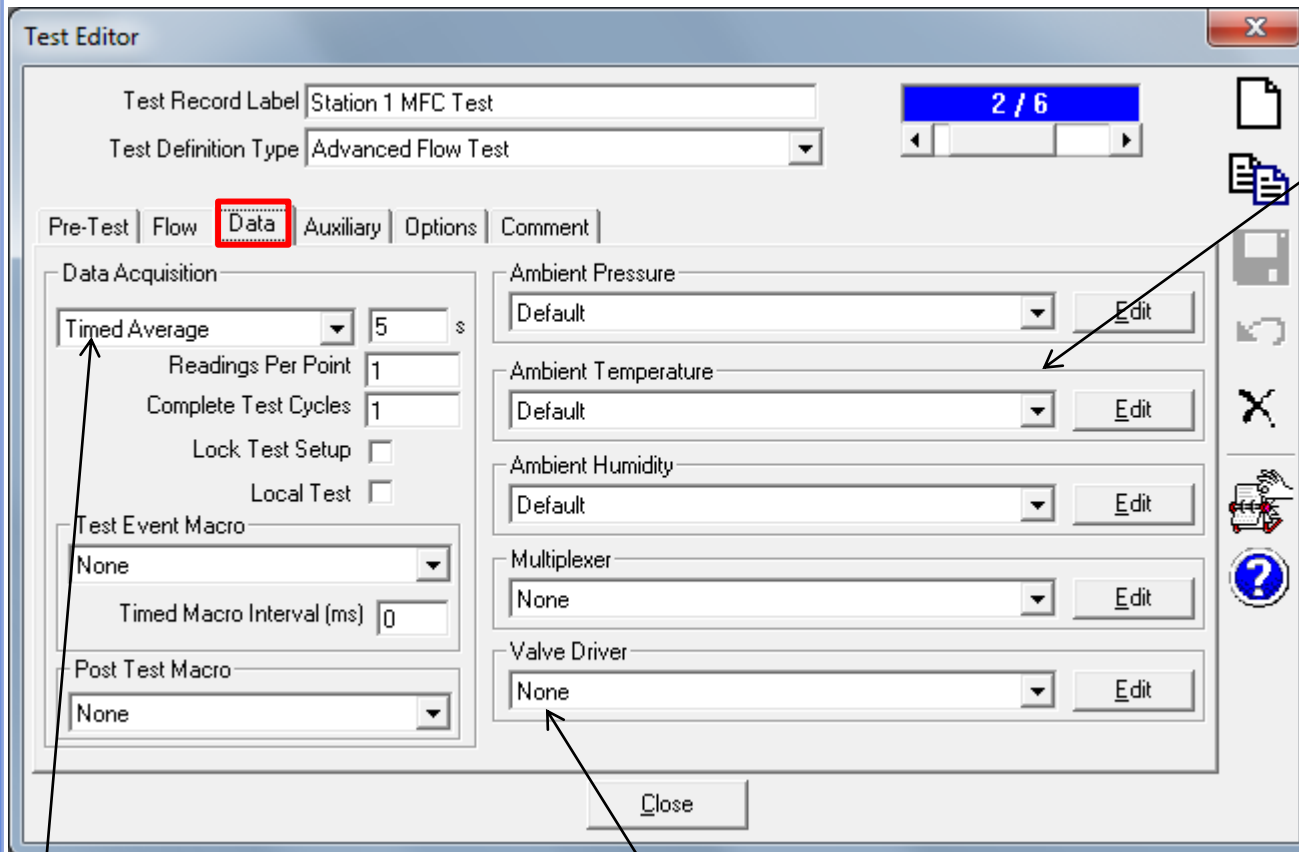
Ready/Not Ready reply from Controller, or COMPASS calculates

Specify ready/not ready criteria. Typically make stability 10 times better than DUT tolerance so control noise and other environmental effects are insignificant

Ready Hold Time – How long to meet ready criteria before continuing on to the dwell time

Control Timeout – How long to get ready. If not, test might be aborted, the point repeated, or a prompt

# Setup test definitions, Data tab

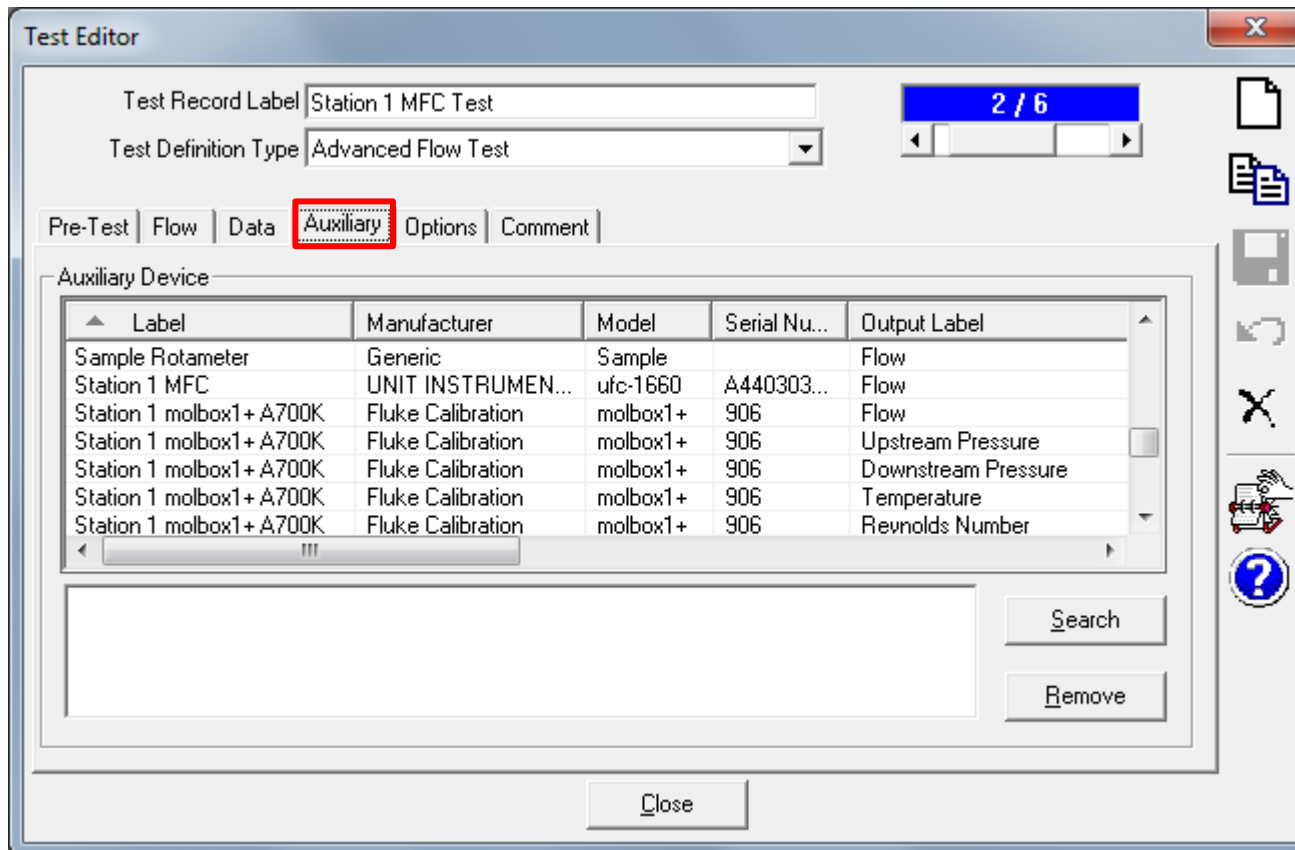


Specify ambient devices (optional)

Timed Average 0 is a single point (no averaging)

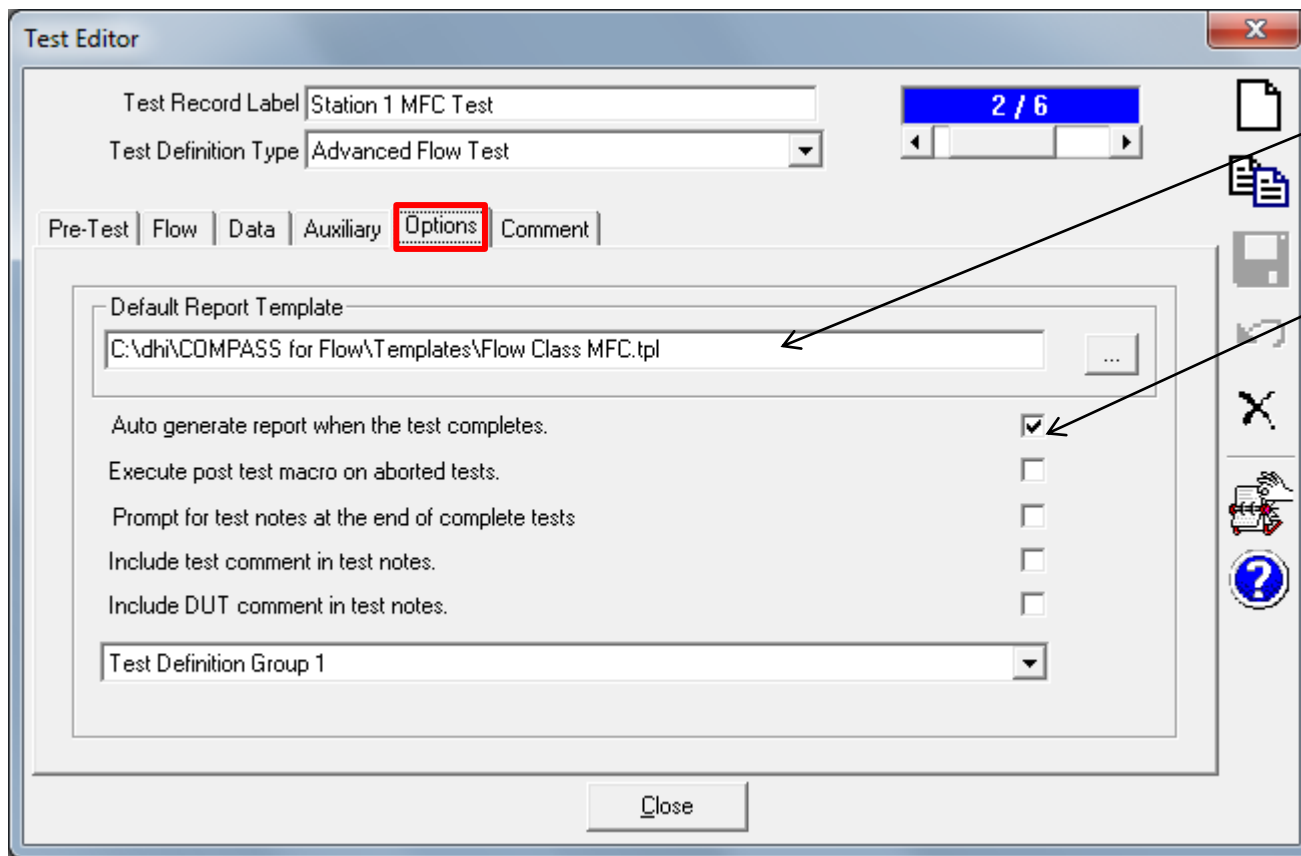
Valve driver(s) might be used to open/close valves, turn on vacuum pump, etc.

# Setup test definitions, Auxiliary tab



**Choose none or as many Auxiliary devices as you want. For example - extra temperature or pressure sensor, etc.**

# Setup test definitions, Options tab

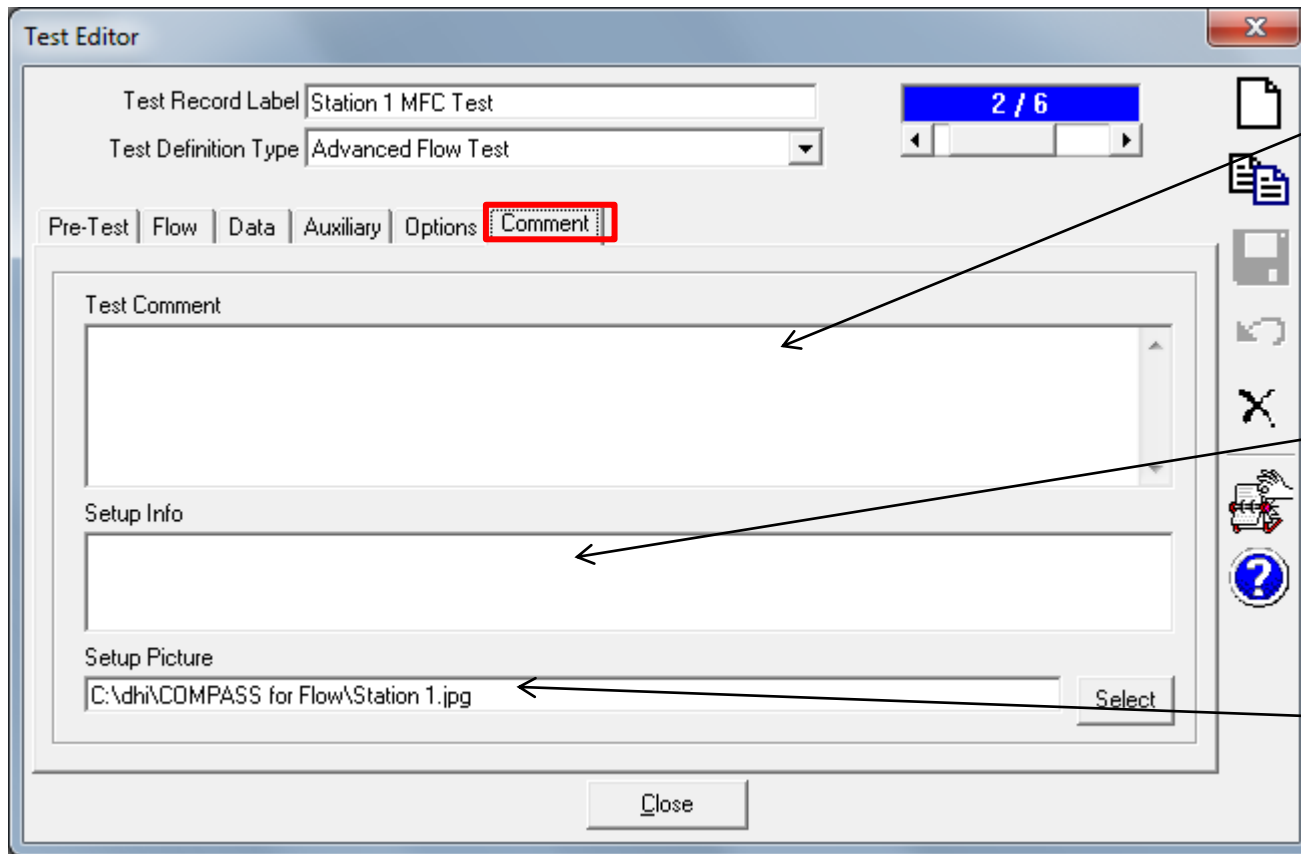


Specify calibration report template

Automatically open calibration report when test is done

**Options tab is only in Advanced Tests**

# Setup test definitions, Comment tab



Comments can be included in data file and calibration report if you want

Setup Info can be read during test initialization

Specify picture that can be shown when initializing test

## Run Test:

- **Run Test Definition**
  - Follow the on-screen prompts for selection of DUT(s), Support Devices, and Test Definition
  - Proceed through the leak test/purge, test points, collecting data – fully automated, or guiding the user through the test
  - Upon completion, the calibration report typically automatically opens in the **COMPASS Report Editor**
- **Run Manual Test**
  - Same but don't choose a test. User selects points and saves data at specified times or intervals. **Very good for logging data.**



# Run test

Run Test (Hardware Setup)

Configure DUT (1 / 1) Station 1 MFC

Manufacturer UNIT INSTRUMENTS (A) Customer ID

Model ufc-1660 Interface Other

Serial Number A4403032800 Parameter ID

Identification

DUT Flow Output Label:Flow

Customize Output

Min (sccm@0.0C) 0 DUT Temperature None

Max (sccm@0.0C) 200

Raw Output Type Voltage Calibration Gas N2 Nitrogen

Voltage (V) K Factor 1.024

Use Multiplexer

8846, 10 VDC range / Voltage, 6-digit res

Manual Entry

MFC-CB / Chn1

MFC-CB / Chn2

molbox1 IEEE / Voltage Measurement

molbox1 IEEE / Voltage Supply Measurement

molbox1 RS232 / Voltage Measurement

molbox1 RS232 / Voltage Supply Measurement

? Cancel Back Next Finish

Choose molbox1 / Voltage Measurement to read the flow rate from the MFC

# Run test

Run Test (Hardware Setup)

**Test Hardware Configuration**

Ambient Pressure None

Ambient Temperature None

Ambient Humidity None

Reference Flow molbox1 RS232 / Flow

Flow Control DUT Control

Multiplexer None

Valve Driver None

Default Hardware Setup

Setup Picture

Cancel Back Next Finish

Choose DUT Control to have the MFC control the flow rates

Click [Setup Picture] if you saved a picture in the Test's comments tab.

# Run test

Run Test (Hardware Setup)

Configure Device (1 / 2) Station 1 MFC

Manufacturer UNIT INSTRUMENTS (A) Customer ID

Model ufc-1660 Interface Other

Serial Number A4403032800 Parameter ID

Identification

Output (2 / 2) Flow Control Output Label: Flow\_Control

Customize Output Change Display

Min (sccm@0.0C) 0

Max (sccm@0.0C) 200

Raw Set Type Voltage Calibration Gas N2 Nitrogen

Voltage (V) K Factor 1.024

Manual Control

MFC-CB / Chn1

MFC-CB / Chn2

molbox1 IEEE / Voltage Supply

molbox1 RS232 / Voltage Supply

? Cancel Back Next Finish

Choose molbox1 / Voltage Supply to control the flow rate of the MFC (set the setpoint)

# Run test, "Run Window"

The screenshot shows the COMPASS for Flow Enhanced software interface. The main window displays various flow measurement parameters for a molbox1+ device (SN: 612). The parameters include Rate, Flow, Reynolds Number, Upstream Pressure, Downstream Pressure, Differential Pressure, Temperature, Set, and Output. The flow rate is 0.138130 pph@70.0F. The DUT/Reference Comparison window is also visible, showing a table of device outputs and errors.

Device	Output	%Span Er:	%Rdg Err:
molbox1+/SN: 612	0.138130pph@70.0F		
1093007/SN: 7860	-----	N/A	N/A

molbox window

DUT/Ref comparison window

Tare  
change molbloc  
change gas  
activate driver(s)

## Test data:

- **As COMPASS runs, data is written to a storage location, saved as an ASCII delimited text file**
  - **Storage location is local drive or network location**
  - **Optional, can also save in \*.mdb database file**
- **Export to Excel® option, open data file(s) in pre-selected Excel workbook**

## COMPASS Report Editor

- Produces professional quality calibration reports from the data file and a specified template

Calibration Report				Apr 7 2010			
Model: XP2i				Serial Number: 324			
<b>Report Information</b>							
Report Compiled: Apr 7 2010							
Date of test: 20090810							
Time of test: 9:13:44 AM							
Data file: C:\dh\COMPASS for Pressure\Data\Crystal Engineering\324\20090810_000.dat							
Test file: Sample Test							
User: Admin							
<b>DUT Information</b>				<b>Reference Information</b>			
Manufacturer	Crystal Engineering			Manufacturer	DH Instruments		
Model	XP2i			Model	PPC4		
Serial Number	324			Serial Number	123		
Identification				Identification			
Pressure Range	0.000 to 300.000 psi			Pressure Range	0.000 to 300.000 psi		
Data Acquisition Method	RS232			Data Acquisition Method	RS232		
Nominal Uncertainty	0.1 %Span			Nominal Uncertainty	0.024 %FS OR 0.01 %Rdg		
<b>Test Information</b>							
Pressure Units: psi							
Dwell Time: 10 s							
Leak Rate:							
Pressure Stability setting: 0.01 %DU Tspan							
<b>Test Data</b>							
Set Pt	Reference Pressure	DUT Pressure	DUT Output	Abs. Error	"% Span" Error	DUT Tolerance	Status
psi	psi	psi	psi	psi	%	psi	
0.000	0.000	0.00	0.00	0.00	-0.0007	0.30	
60.000	60.000	59.98	59.98	-0.02	-0.0071	0.30	
120.000	120.000	119.96	119.96	-0.04	-0.0138	0.30	

## Predefined and customizable templates

- **Black and white is fully editable text**
- **Data parameters, or calculations, are in yellow and are chosen from field chooser list at left**

The screenshot shows the COMPASS Report Editor interface. On the left is a tree view of 'Available Data Fields' including categories like General Information, Test Data, Macros, and Plots. The main area displays a report template with the following content:

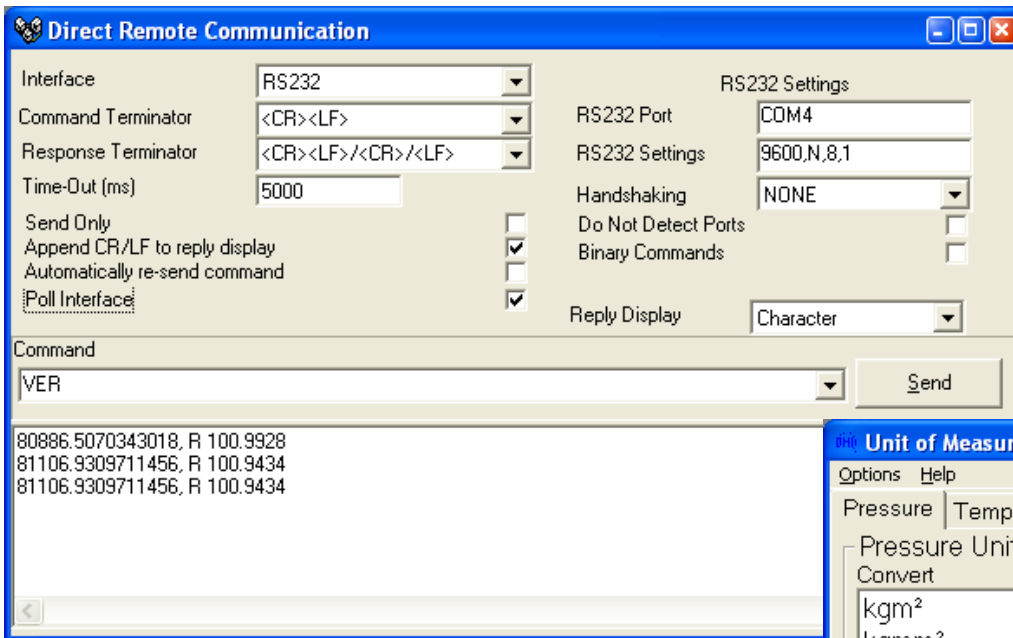
**Calibration Report** Today

Model: Model  
Serial Number: Serial

**Report Information**  
Report Compiled: Today  
Date of test: Date  
Time of test: Test  
Data file: Data Data  
Test file: Test  
User: Opera

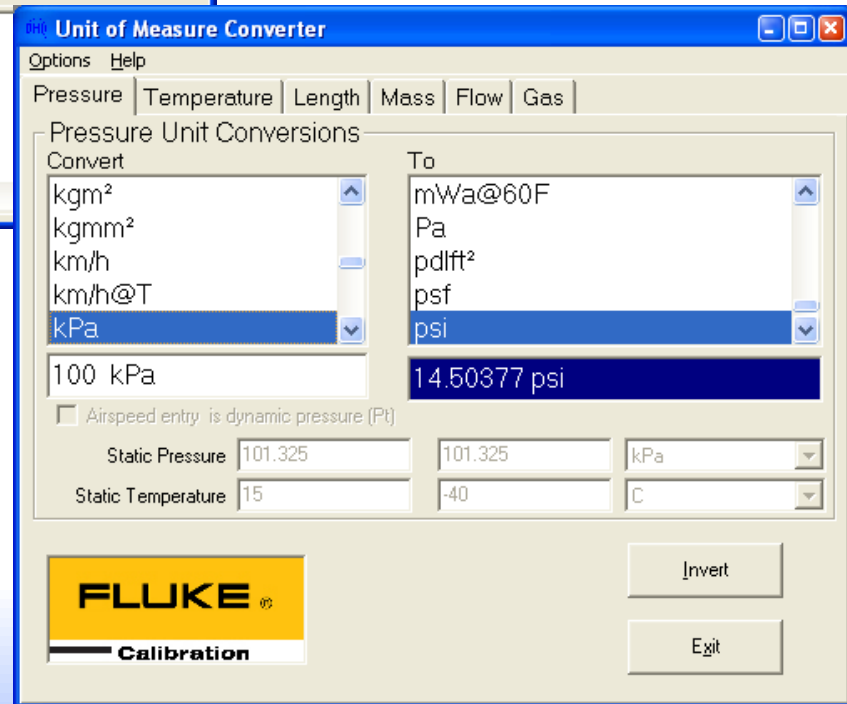
<b>DUT Information</b>		<b>Reference Information</b>	
Manufacturer	Manuf	Manufacturer	Manuf
Model	Model	Model	Model
Serial Number	Seria	Serial Number	Seria
Identification	Ident	Identification	Ident

# Remote Comm. / Unit of Measure



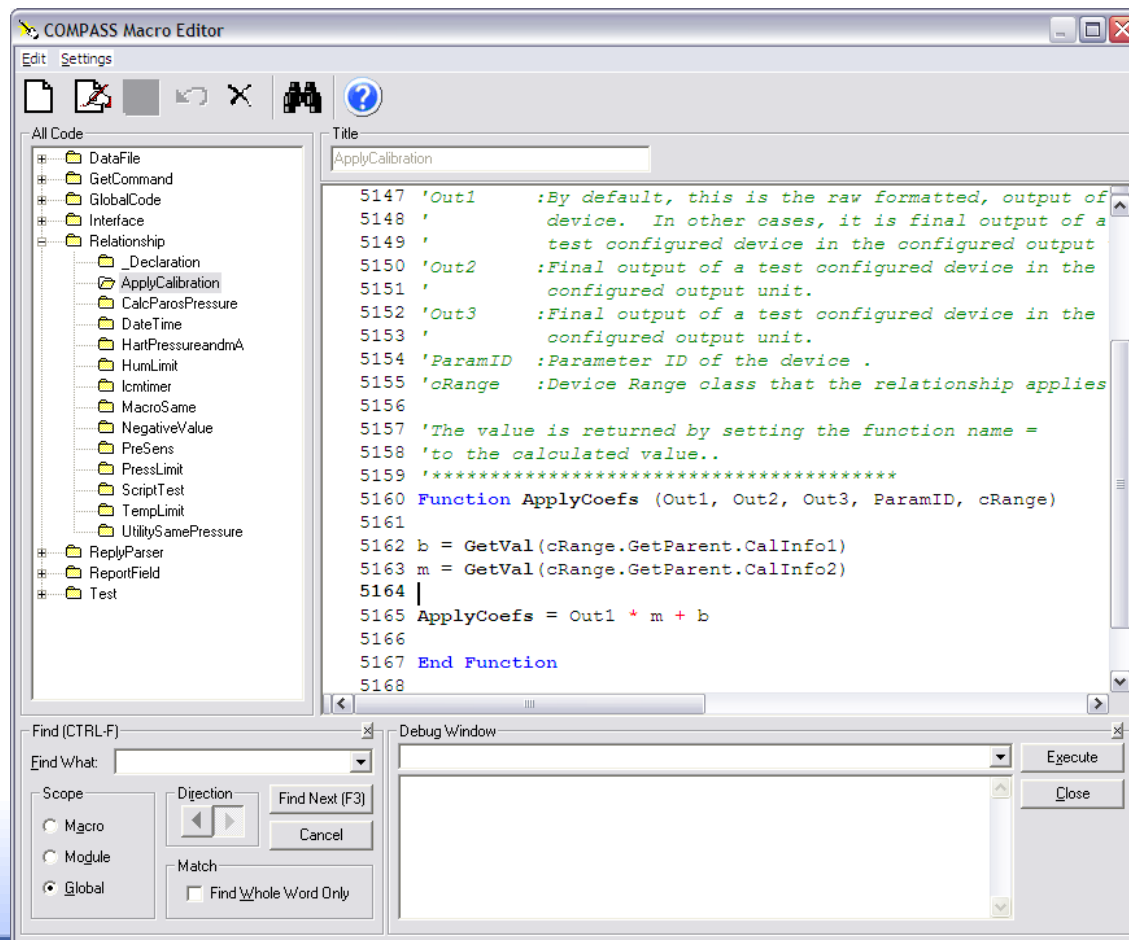
**Remote Communications Tool - Convenient tool for testing of command syntax and response without running a test. RS232, IEEE, TCP/IP, Hart, etc.**

**Unit of Measure Converter - Pressure, Temperature, Length, Distance Flow, Gas (with density, viscosity, compressibility)**





## COMPASS Macro Editor – VB Script editor for specialized interface, calculations, programming needs



- **User and feature display options**
  - **Hide test initialization windows and options that are not necessary for simple tests. Simplifies the user interface when advanced functions are not required**
  - **Specify default hardware (power supply, DMM, ambient conditions monitors, etc.)**
  - **User levels with passwords**
  - **Network options**
  - **Seat-based licensing**
- **Temperature test (has to be with a Flow test)**
- **Flow test with Line Pressure (e.g. Run at a specified line pressure)**

# Thank you.

## Questions?

Visit the Fluke Calibration website for COMPASS demos, upgrades, and updated example set up database

[www.flukecal.com](http://www.flukecal.com)