# COMPASS for Pressure

## Introduction, Overview, and Structure

# What is pressure calibration?

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

**<u>Required components</u>:**

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

# What is pressure calibration?

FLUKE® Calibration

**The process includes the following steps:**

- **Connecting the DUT together with the reference**
- **Generating and controlling the applied pressure**
- **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**

# Benefits of calibration automation

FLUKE® Calibration

**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, dwell time, ready/not ready, data collection**
- **Software configurations can be readily duplicated by multiple operators, in multiple locations.**

# Levels of calibration automation

**The level of test automation possible depends on the type of DUT being tested.**

**Visual interface**
analog gauges

**Manual, User-Assisted Data Acquisition**

**Analog output devices**
transmitters
transducers

**Full Data Acquisition through Support Devices**

**Digital output devices**
monitors,
controllers,
digital gauges
digital meters

**Full Data Acquisition**

# Levels of calibration automation

FLUKE® Calibration

## Also depends on the reference…

**Visual interface**
gauges or display only devices

**Manual, User-Assisted Data Acquisition**

**Manual interface devices**
deadweight testers

**Semi-automated through Support Devices**

**Digital interface devices**
controller/calibrators, monitors (molbox)


**Full Automation**

**Automated Primary Standards**
piston gauges with AMH and digital interface

**Full Automation**

# Levels of calibration automation

## Pressure generation and controller options

**Automatic Pressure Controllers**

pressure regulators



**Full Automation**

**Manual Pressure Controllers**

valves (shutoff or needle)

pressure regulators

**Operator sets pressure**

Software manages test - data collection may be automatic

## Control devices may also contain the reference measurement

# COMPASS features

**COMPASS for Pressure calibration software is PC software designed to assist in the pressure calibration process**

- **Various levels of automation are supported for DUTs, references, controllers**
- **Multiple DUTs – Typically limited only by data acquisition hardware**
- **Support of 3rd party (non-Fluke Calibration) references**
- **User-scripted test point definitions**
- **Data saved in unique data files, and in a database**
- **Calibration report generation tool included that is configurable**

# COMPASS versions

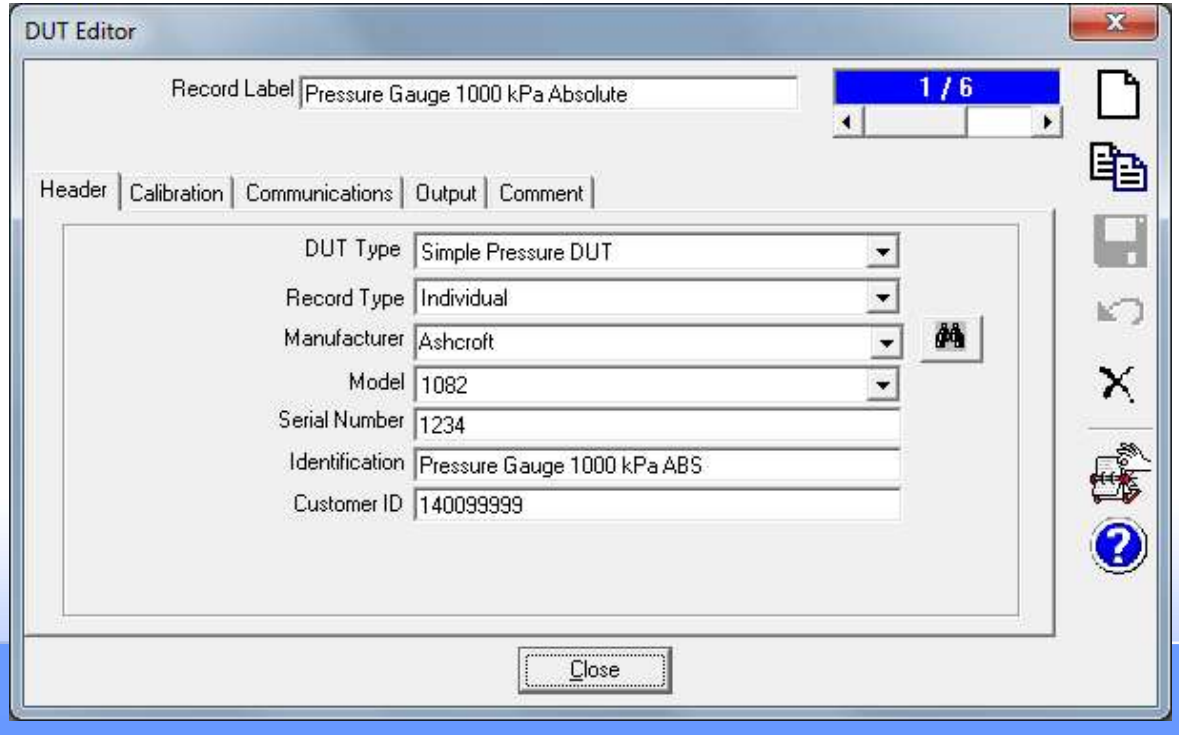
FLUKE® Calibration

**COMPASS for Pressure**

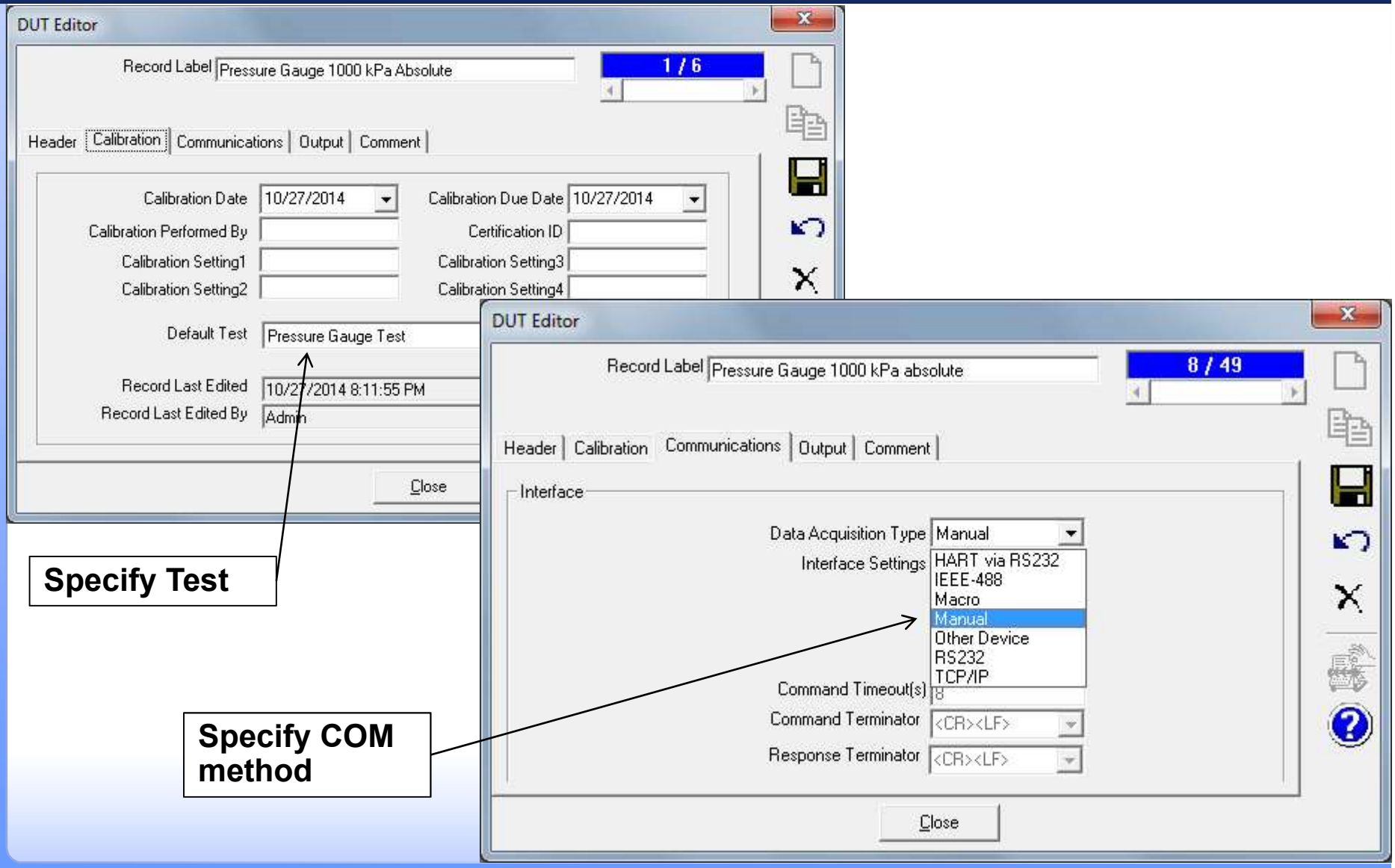
- **Two different levels available:**
  - **Basic:**
    - **Most features available**
  - **Enhanced: All of Basic plus…**
    - **Use of multiple references within a test**
    - **DUTs with multiple outputs or DUTs that also control pressure**
    - **Complex tolerance specifications**
    - **Test event macros**
    - **Line pressure or multiple temperature points**

# Setup devices

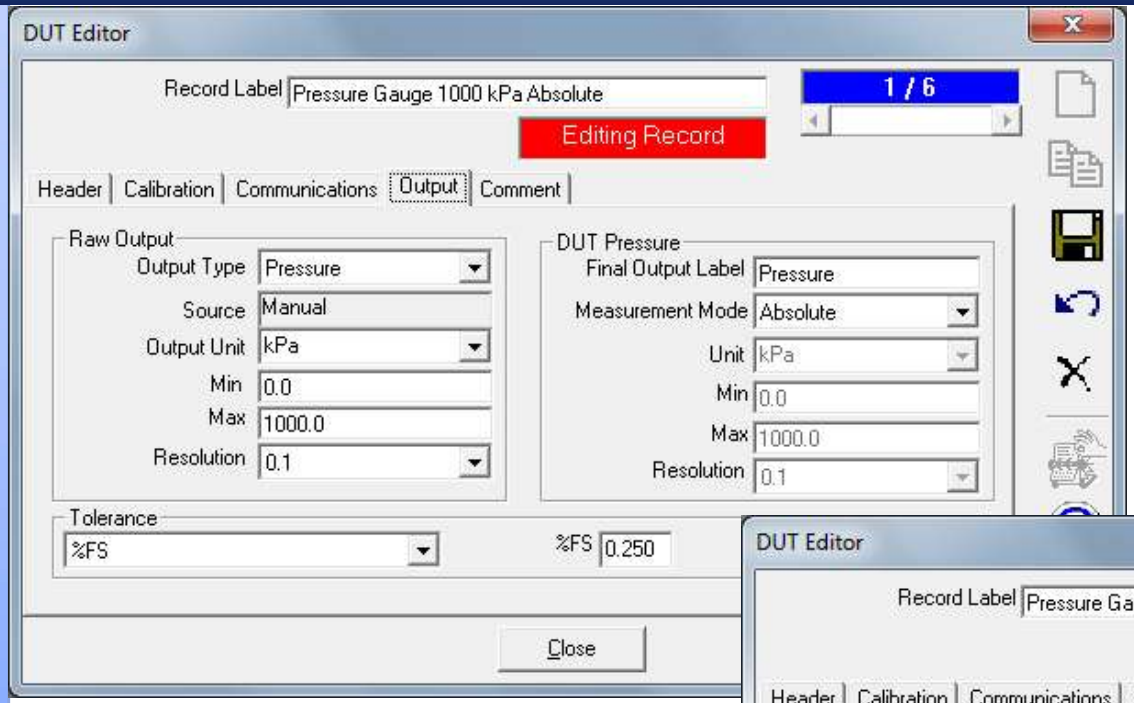
- **Setup DUTs**
  - **Enter for all devices: manufacturer, model, serial number, ID, unit, min/max range, tolerance, raw output(s), final output, remote command(s), etc.**
  - **Entered info can be used during test and/or shown on calibration reports**



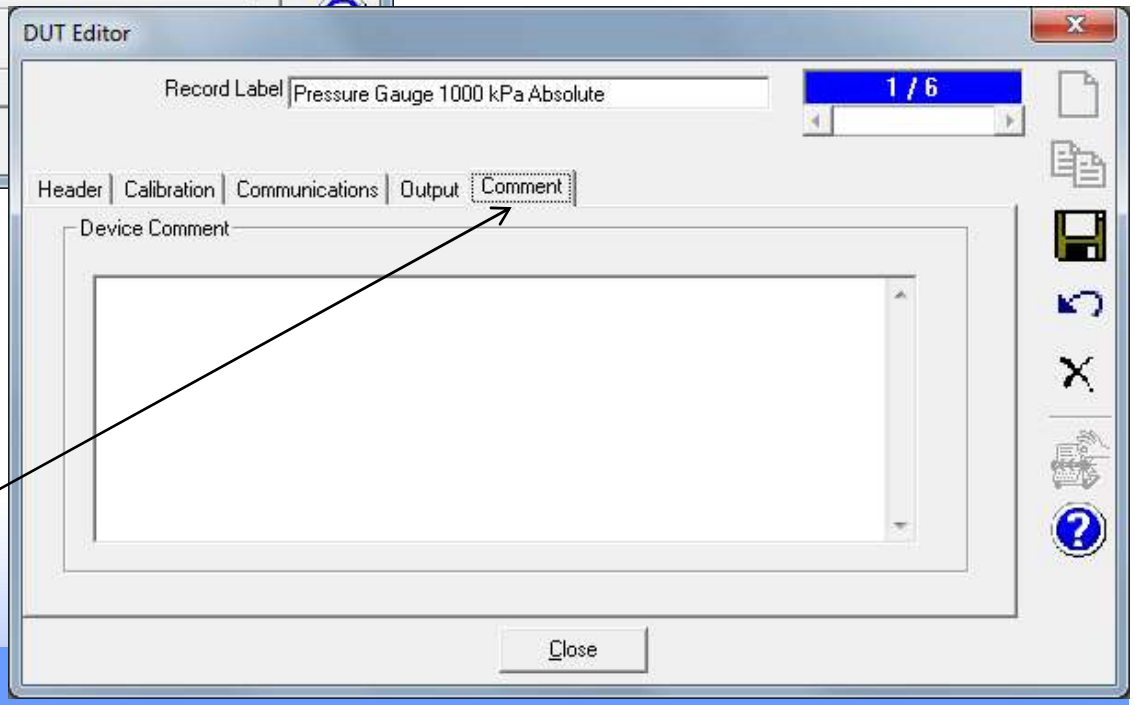
# Setup DUT, cont.



# Setup DUT, cont.



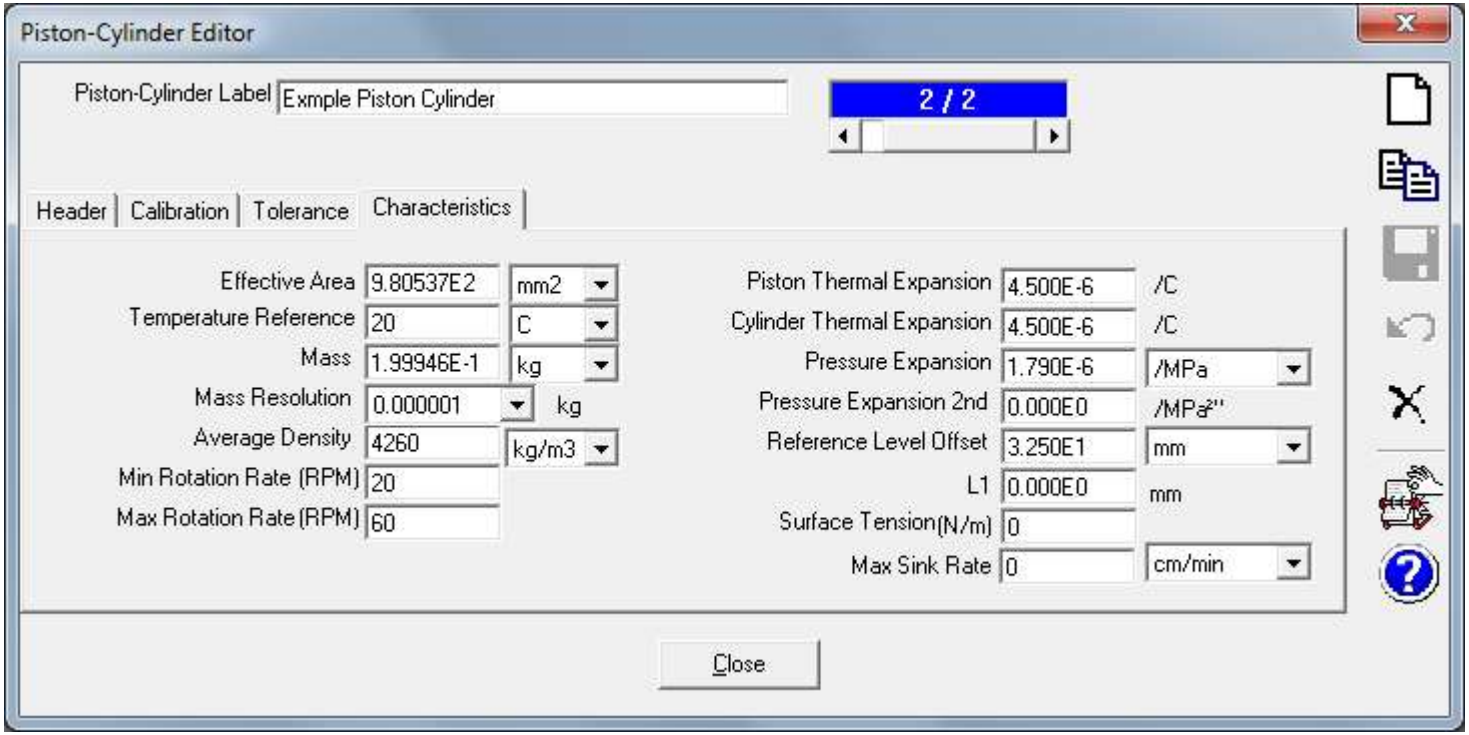

- **Raw output could be volts with final output being pressure. Advanced DUT could have multiple raw outputs (e.g. pressure & temperature)**




**Comments are shown during test initialization and can be saved in data file if desired**

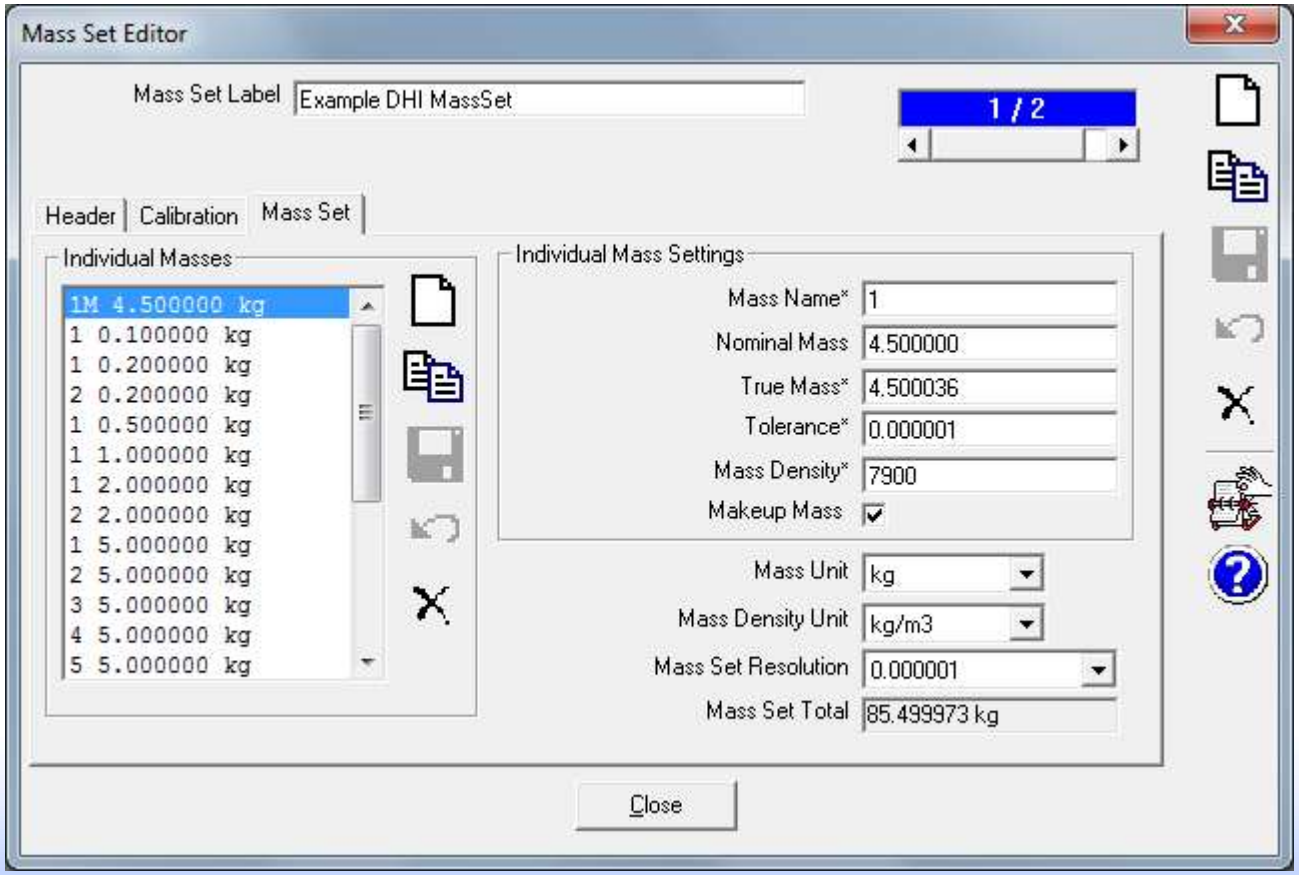
# Setup devices

- **Setup piston gauges and deadweight testers: effective area, true mass, etc.**
  - **Setup piston cylinder**



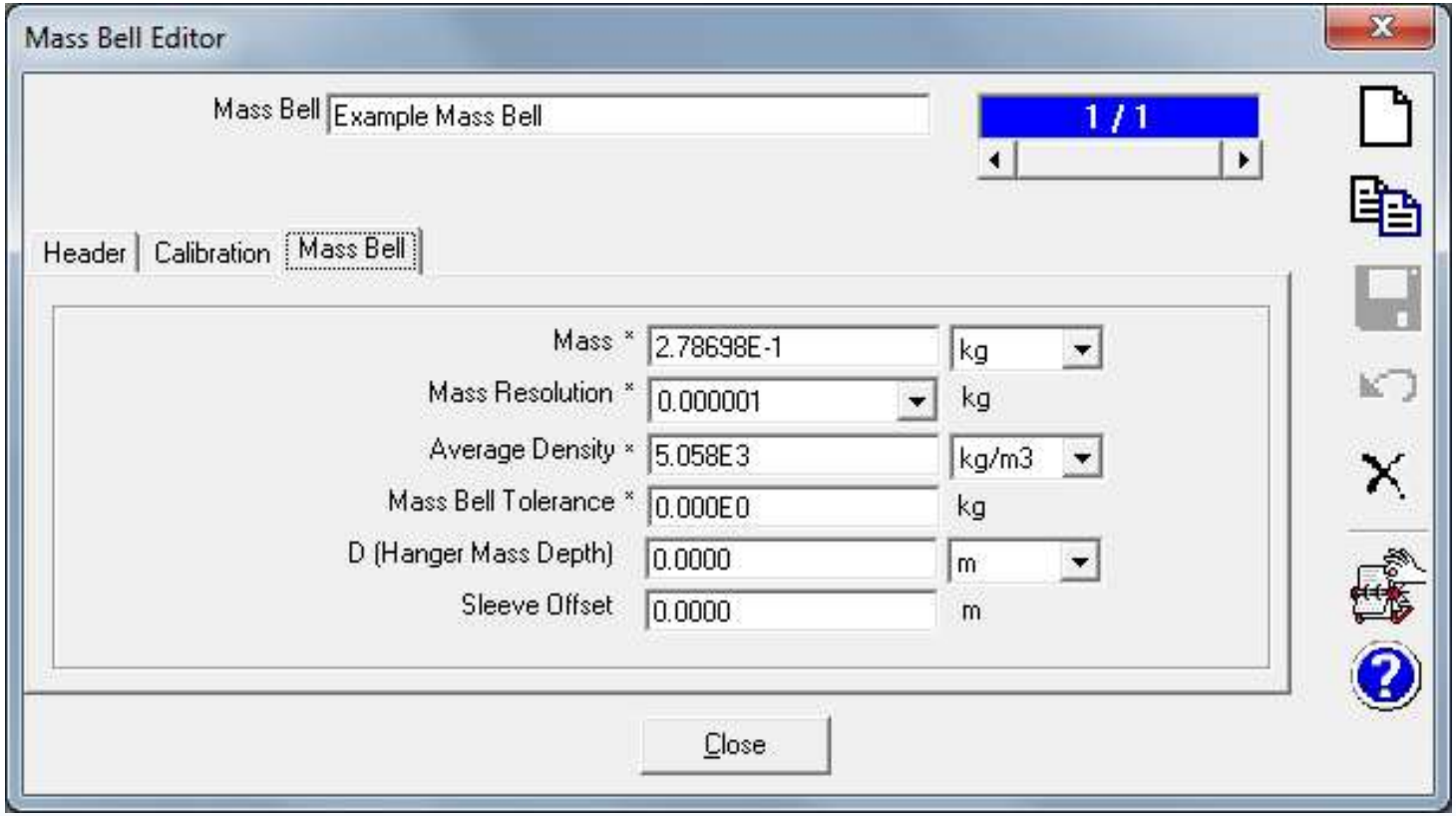
# Setup piston gauge, cont.

- **Setup mass set with true mass values**
  - **Can import WinPrompt mass set (.ms) and piston cylinder (.pc) files**



# Setup piston gauge, cont.

- **Setup mass bell (sleeve weight) with true mass value**



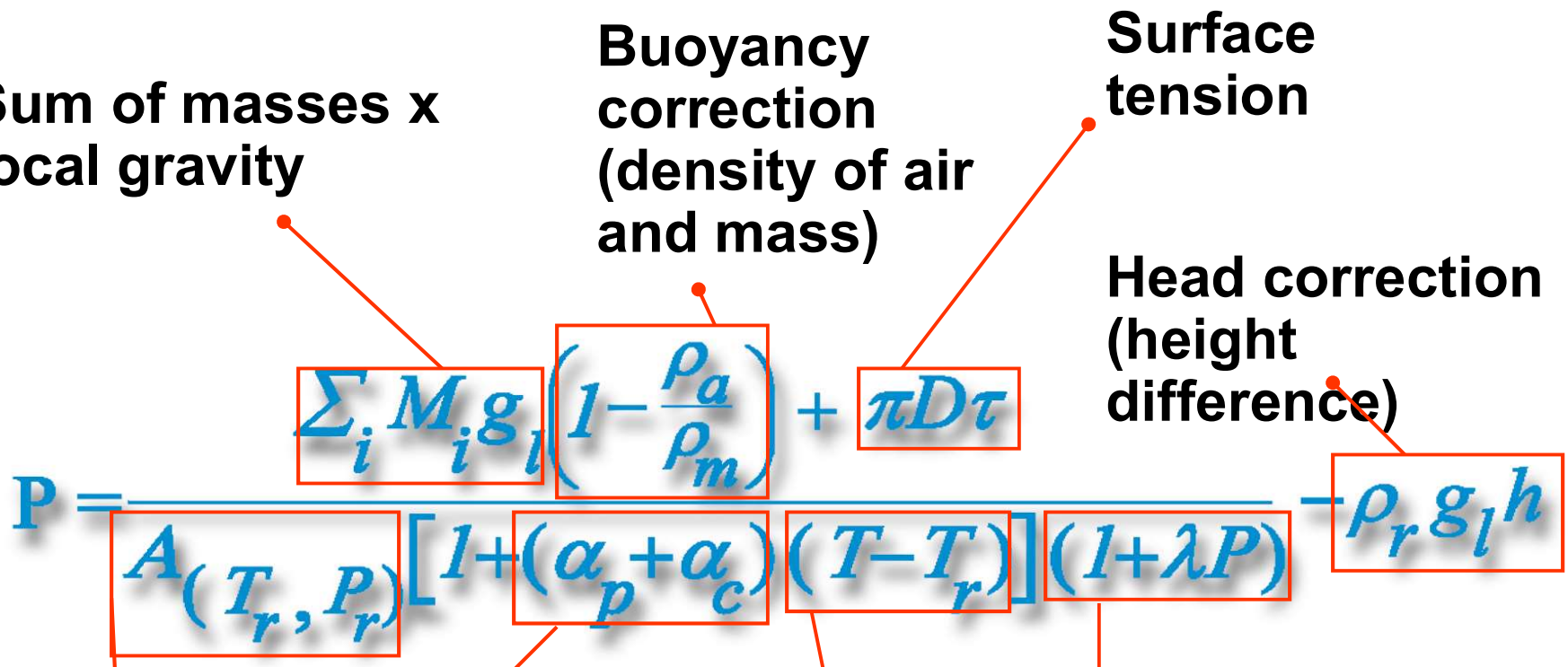
# Setup piston gauges and DWTs

- **COMPASS Piston Gauge Calculator determines resulting pressure**

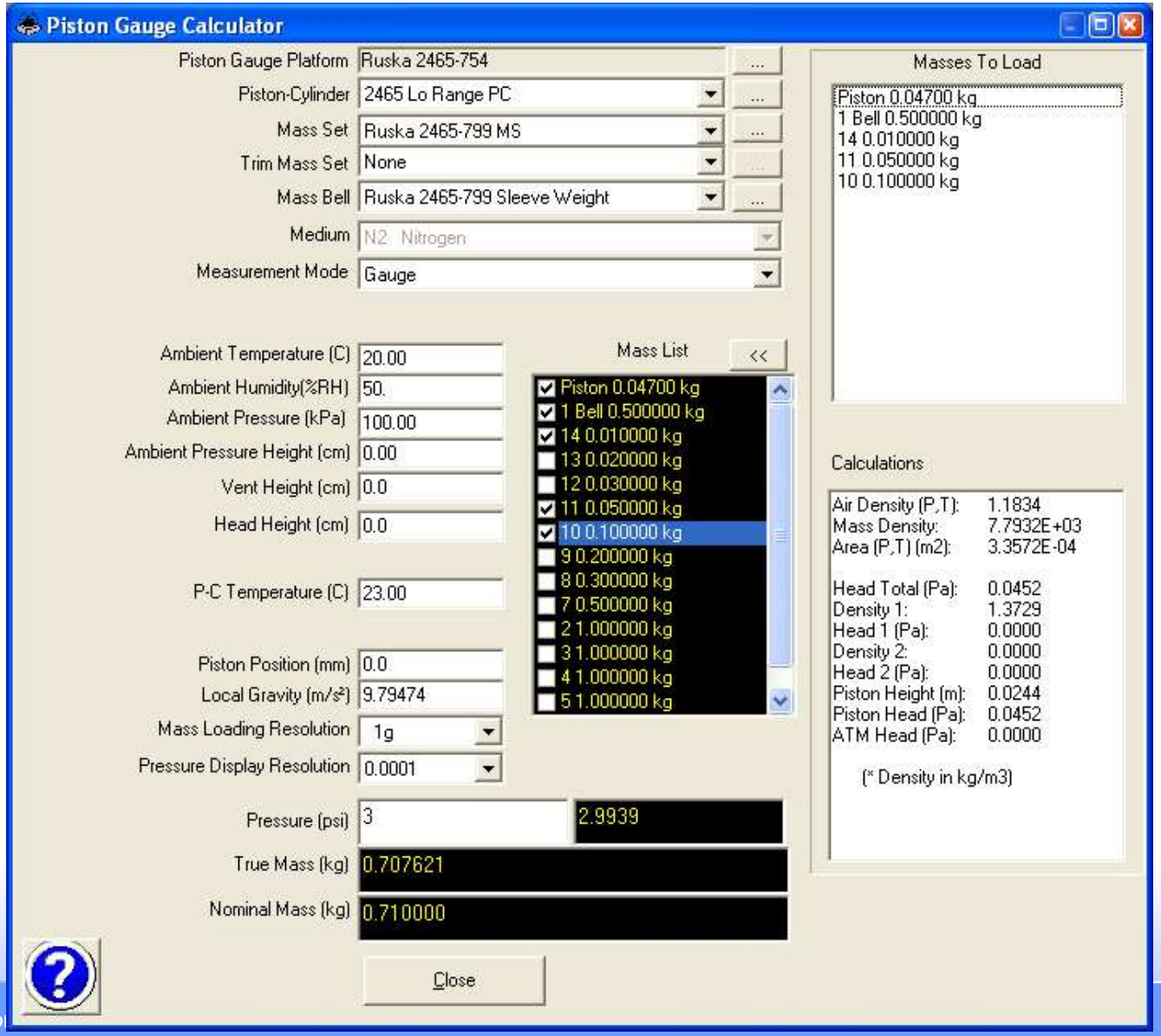
$$pressure = \frac{F}{A} = \frac{M \cdot g}{A_{(t,p)}}$$

$$P = \frac{M g_l \left(1 - \rho_{(air)} / \rho_{(mass)}\right) + \pi D \mathrm{T}}{A_{(20,0)}\left[1 + (\alpha_p + \alpha_c)(\theta - 20)\right](1 + \lambda P)} - \left(\rho_{Fl} - \rho_{air}\right) g_l h$$

# Setup piston gauges and DWTs



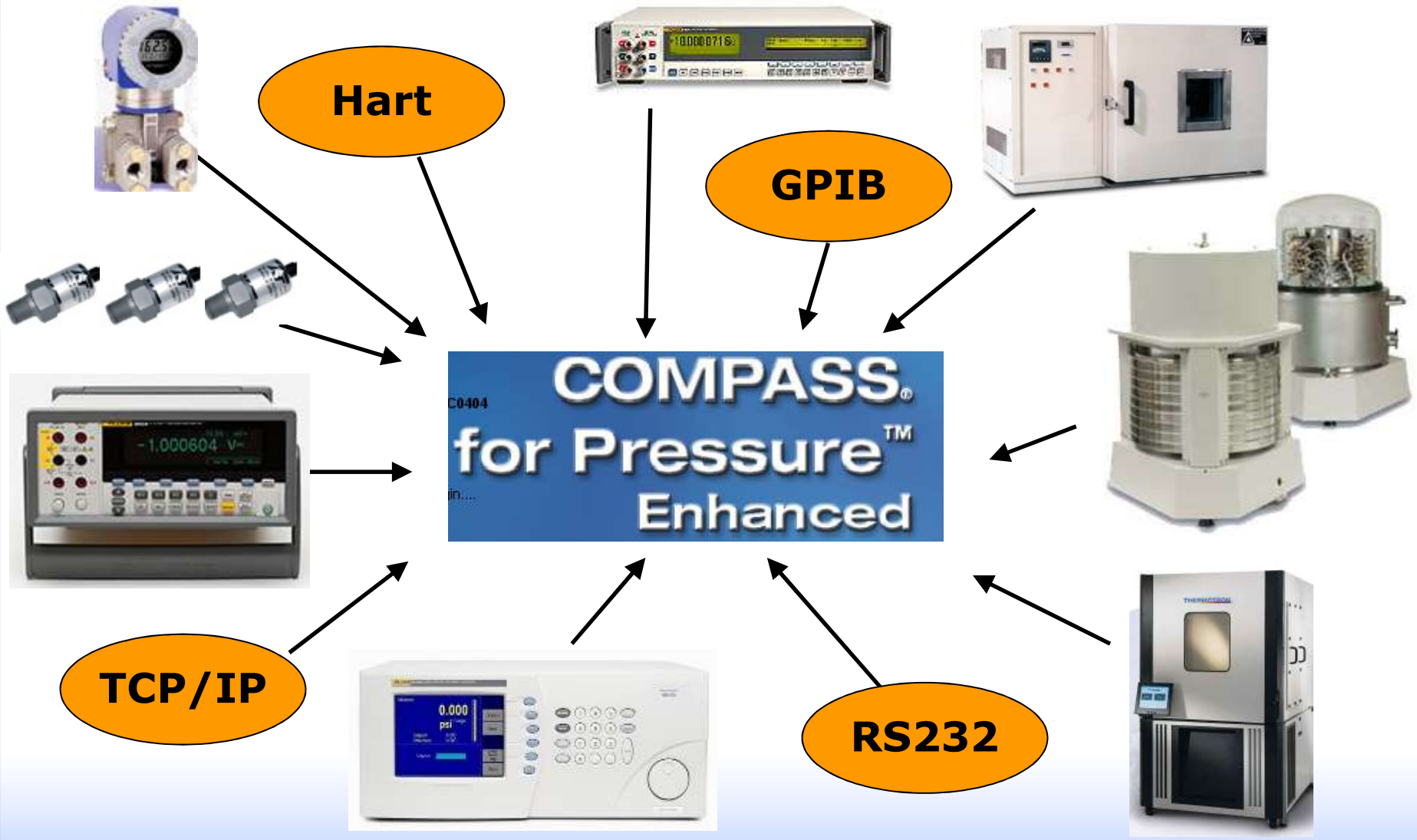
# COMPASS Piston Gauge Calculator



# Setup devices

- Setup Support Devices (anything that is not a DUT, PG or DWT)
  - Reference - Autodetect for Fluke Cal devices
  - Controller - Might be same device as reference
  - Monitors – Ambient conditions, Aux. pressure, etc.
  - Similar to DUT setup tabs but 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), etc.
- When finished with setups, the device definitions are saved and you do not need to do this work again

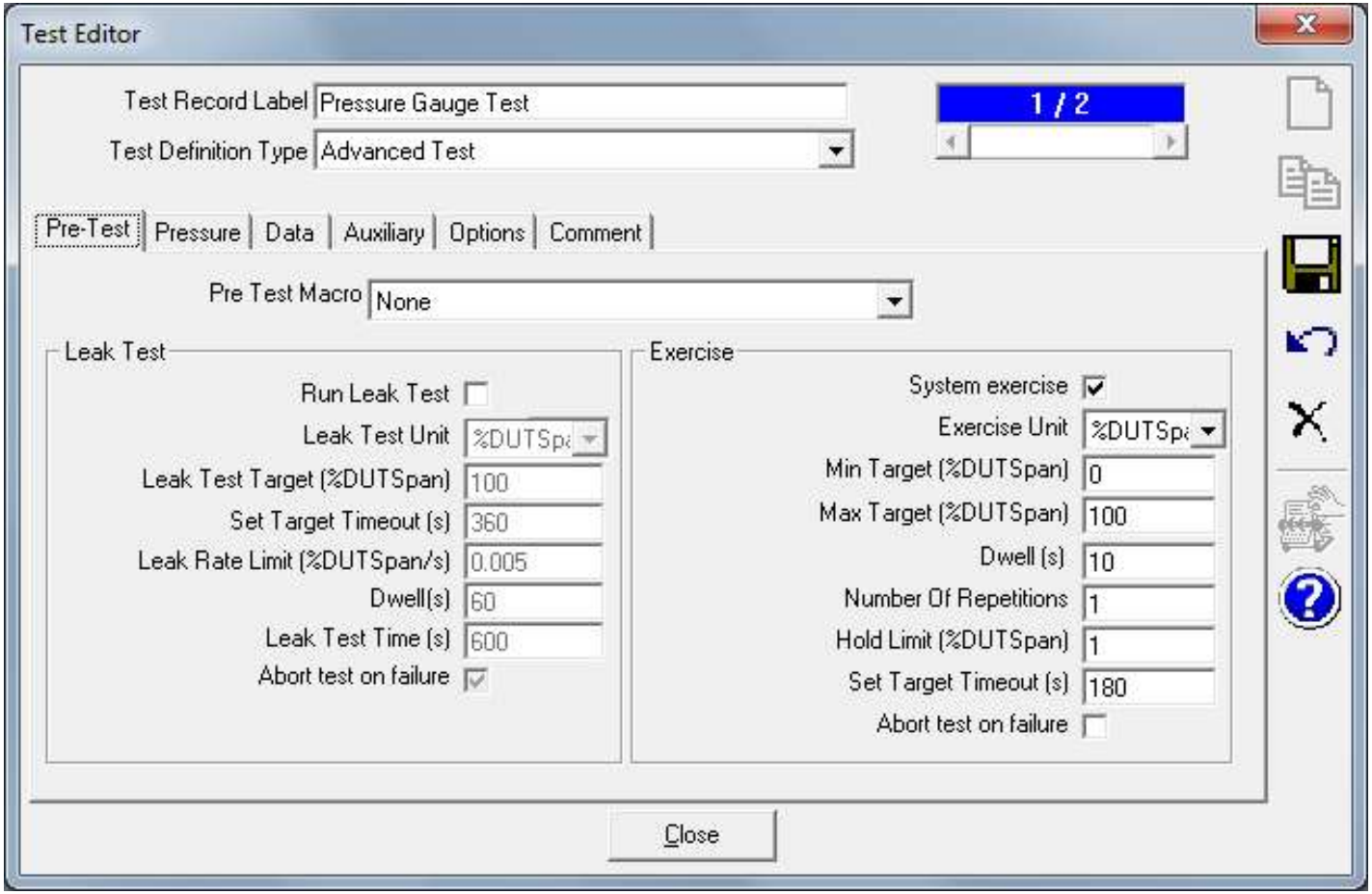
# Data Acquisition Capabilities



# Setup test definitions

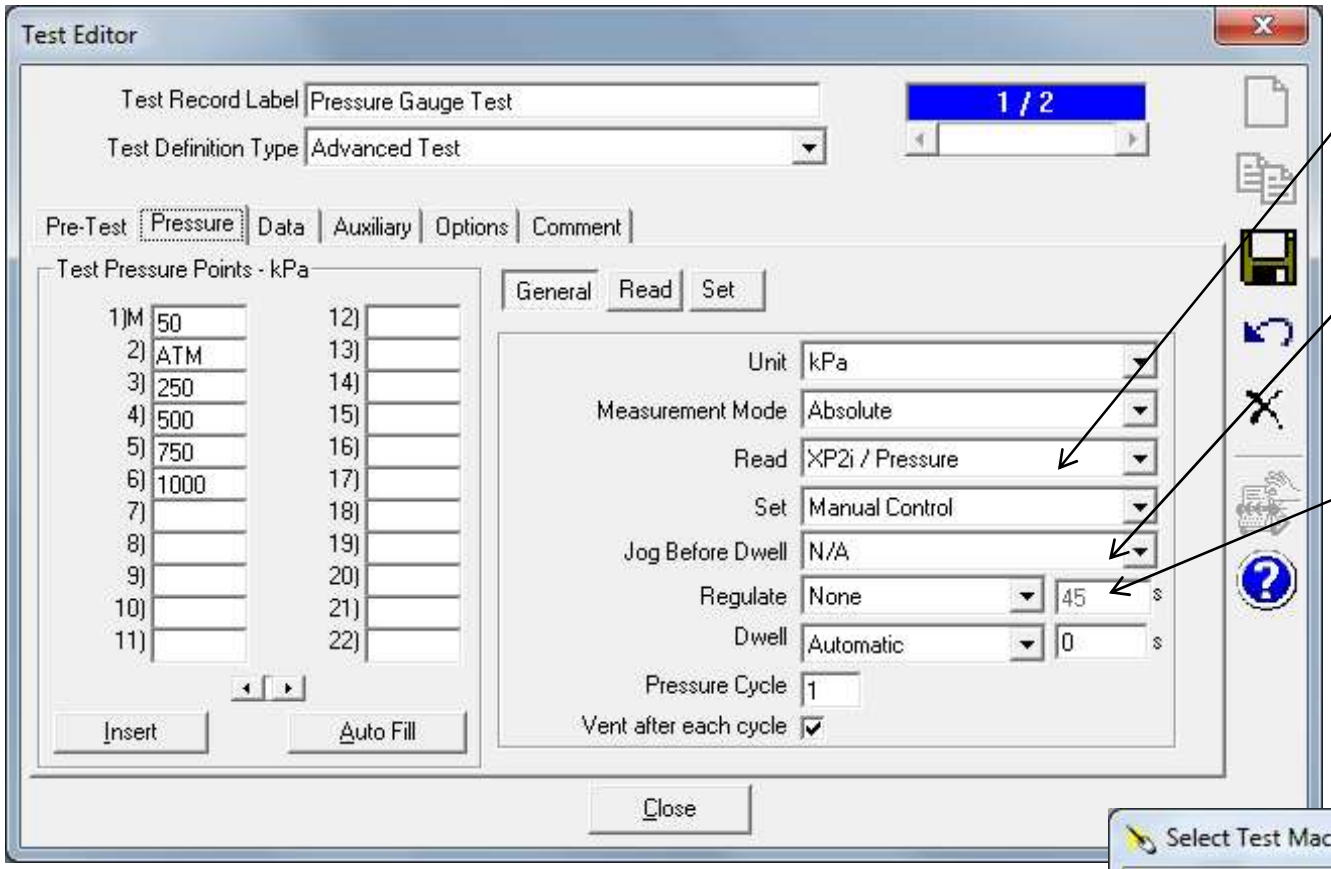
- Setup Test Definitions - specifies how the test will be performed.
  - Leak check and/or exercise the DUT (optional)
  - Define setpoints
  - Specify Reference(s), any other Support Devices
    - Need Enhanced version for multiple references
  - Ready/not ready criteria (stability, how close to setpoint, for how long)
  - Dwell time (wait time before taking data)
  - Data collection method, (manual or averaging)
  - Calibration report template to use (Advanced test with COMPASS for Pressure enhanced)
- 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**

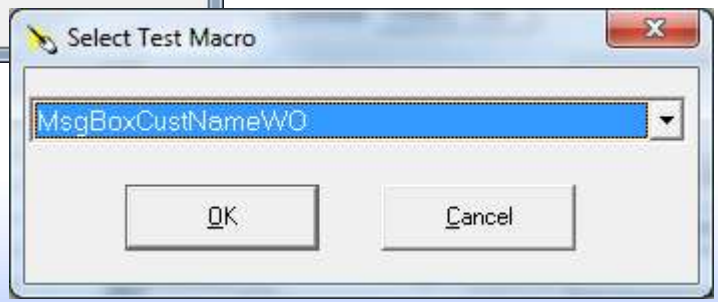
# Setup test definitions, Pressure tab




**Specify Reference**

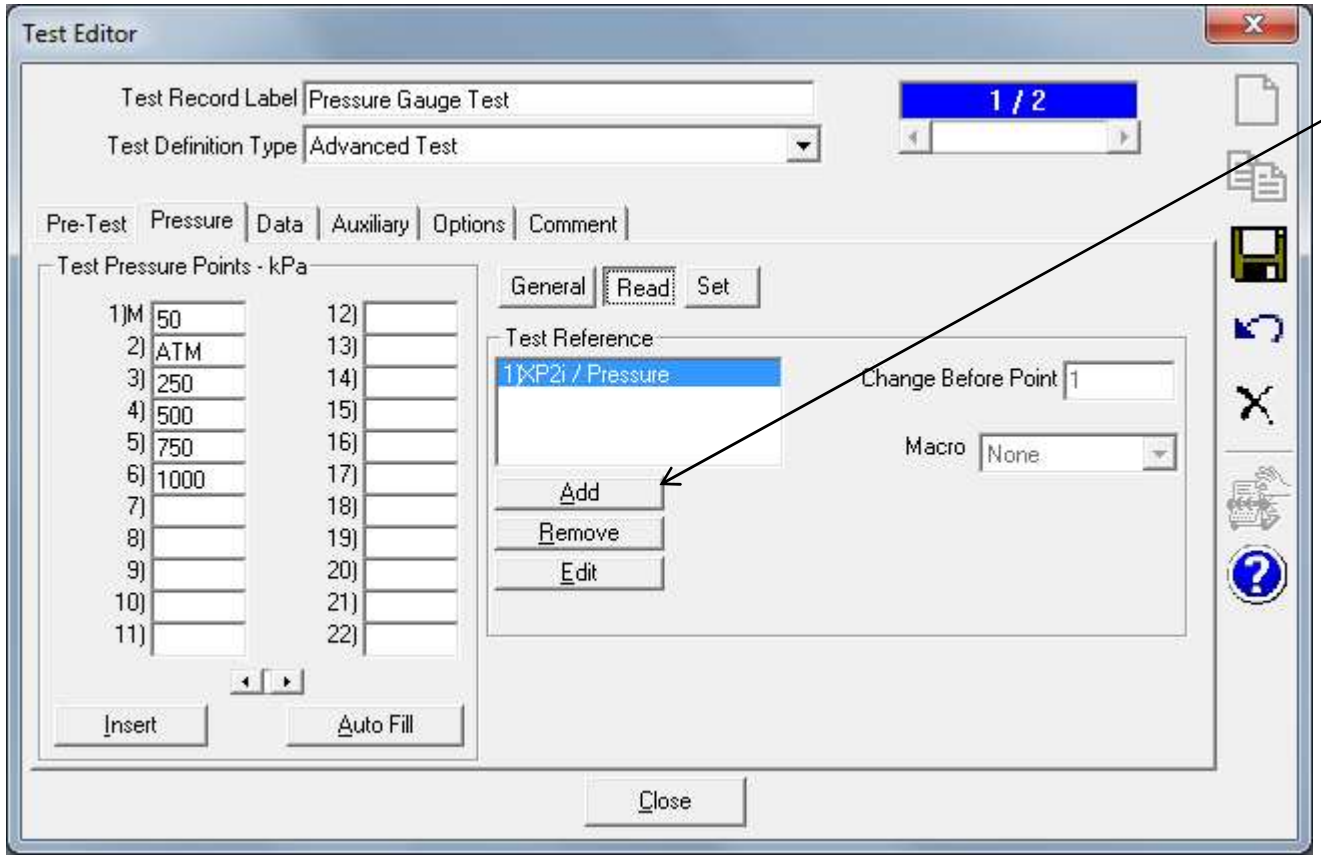
**Jog is usually used with analog gauges and automated pressure controllers**

**Regulate is usually used with digital gauges/meters and you use automated controller to control to a cardinal point on the DUT**



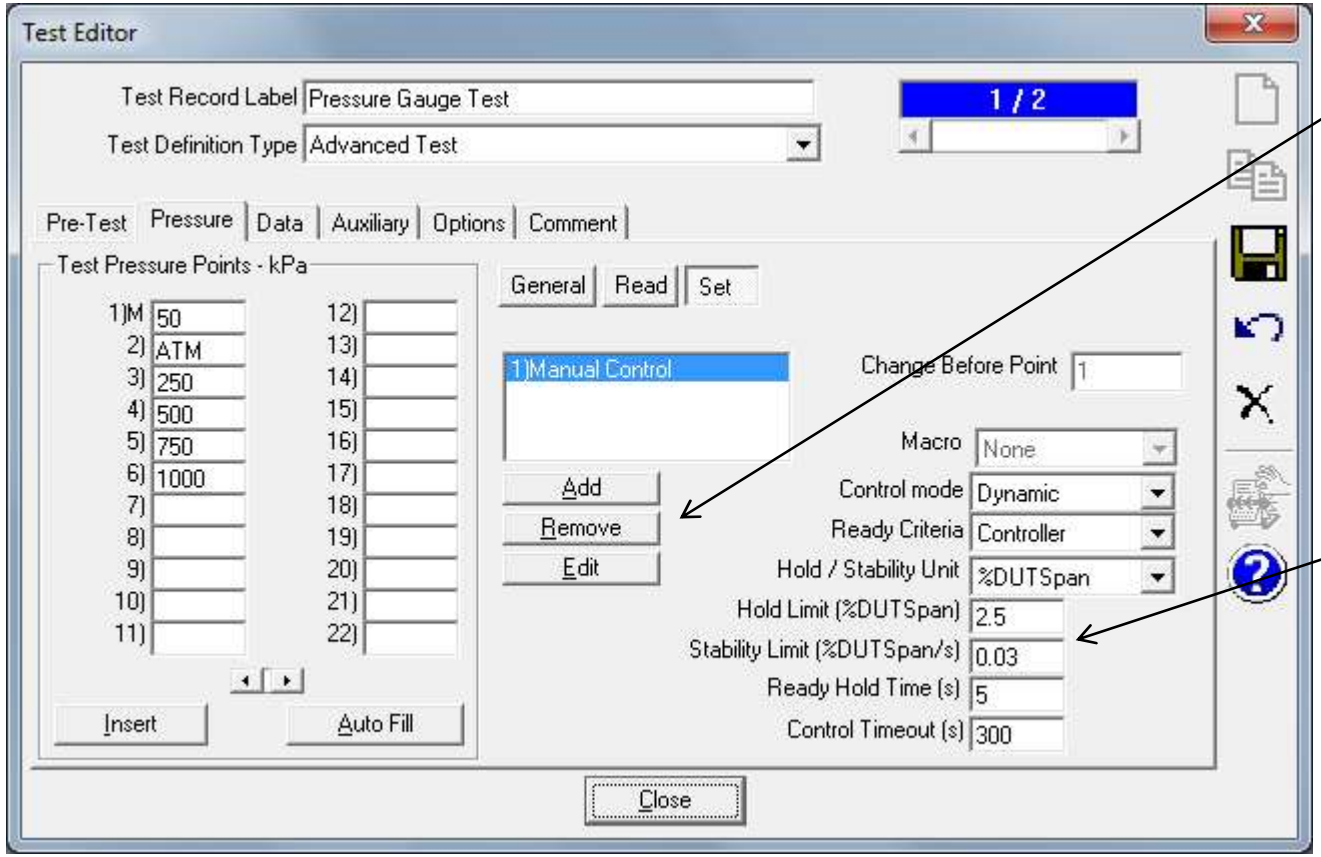

- **Pre-point macro message box in point 1 to prompt user to enter customer name and work order**

# Setup test definitions, Read child tab




**Add or Edit References, specify what points they are used at**

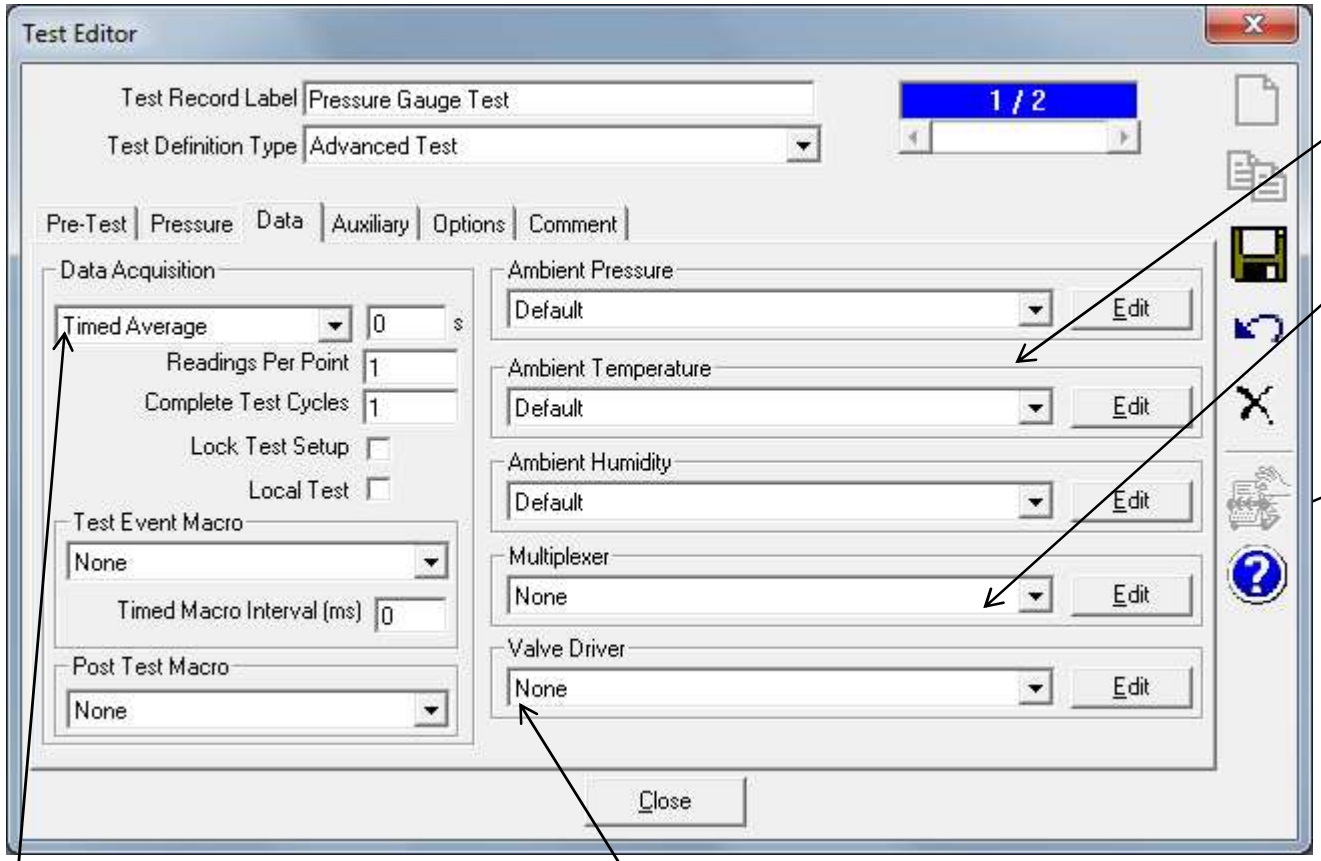
# Setup test definitions, Set child tab




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

**Specify ready/not ready criteria. Typically make stability 10 times better than DUT tolerance to ignore these effects (control noise, environmental effects)**

# Setup test definitions, Data tab




**Specify ambient devices (optional)**

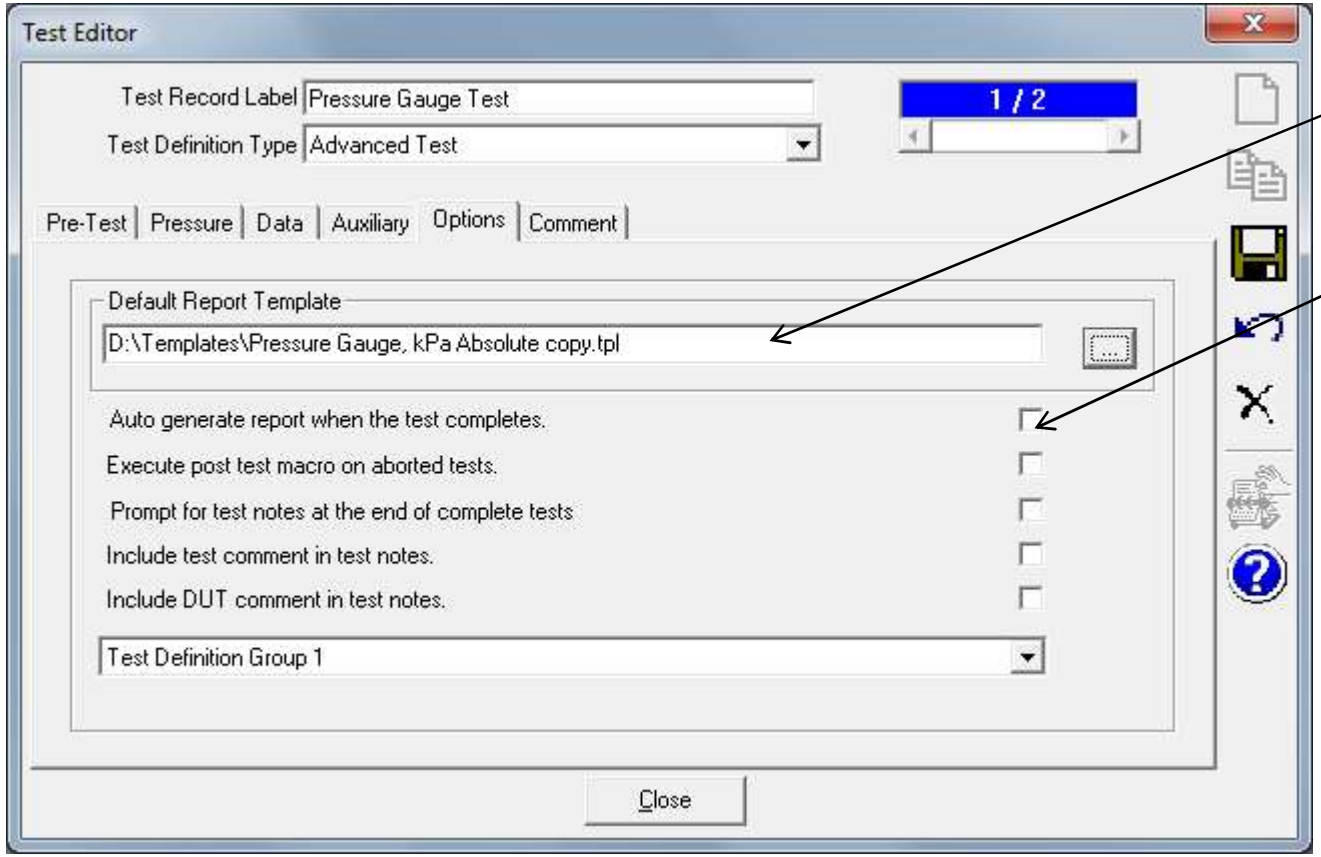
**Specify MUX if always used in test**

**Specify valve driver if always used in test (e.g. turn on vac pump through a relay, open a valve)**

**Zero second timed average is a single point**

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

# Setup test definitions, Options tab




**Specify calibration report template**

**Automatically open calibration report when test is done**

# Run 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/exercise, test points, collecting data – fully automated, or guiding the user through the test**
  - **Upon completion, user has the option of compiling the data into a formatted calibration report using the COMPASS Report Editor (can be setup to automatically open cal report)**
- **Run Manual Test**
  - **Same but don't choose a test. User selects points and saves data**

# Data, end of test

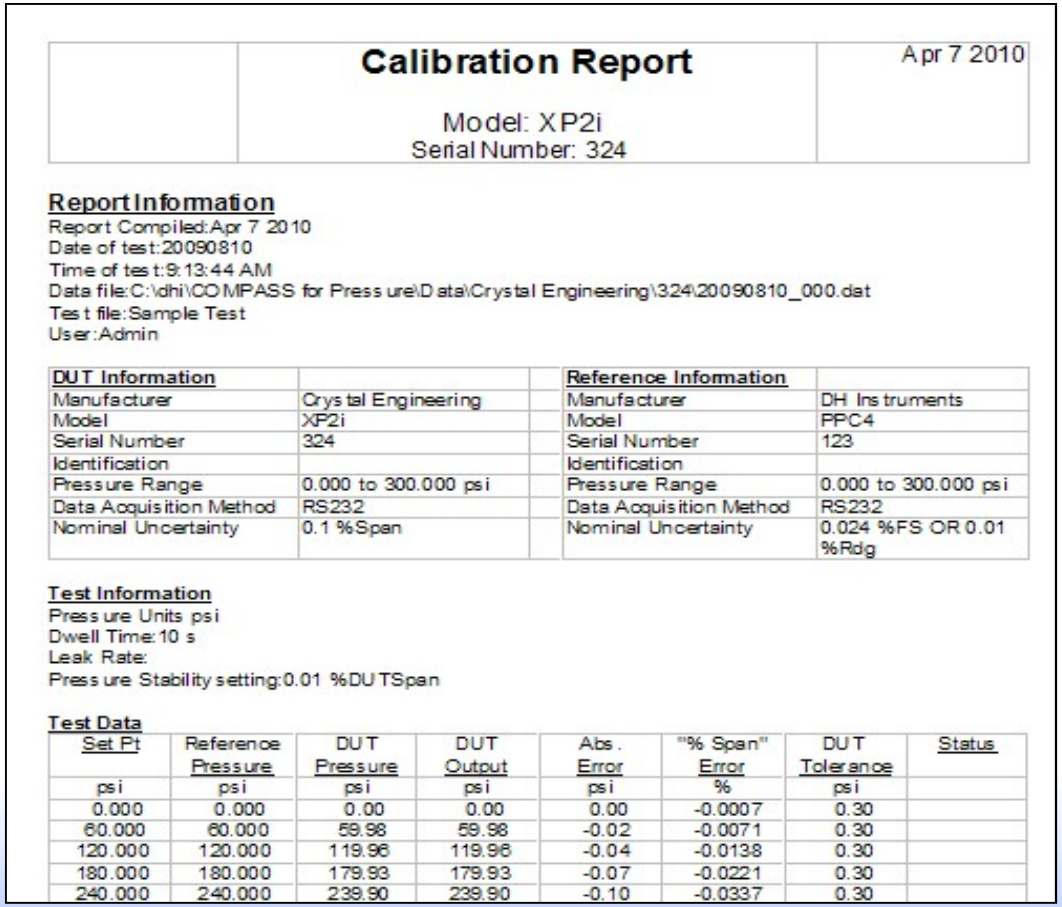
**Test data:**

- 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®, open data file(s) in pre-selected Excel workbook (Enhanced)
- Export to MET/TRACK database
  - Must have licensed MET/CAL version 7.3.39 or version 8
  - Automatic at end of test, or anytime through menu paths with a COMPASS data file

# Calibration report

## COMPASS Report Editor

- **Produces professional quality calibration reports**



**Calibration Report**

Apr 7 2010

Model: XP2i
Serial Number: 324

**Report Information**
Report Compiled:Apr 7 2010
Date of test:20090810
Time of test:9:13:44 AM
Data file:C:\dhi\COMPASS for Pressure\Data\Crystal Engineering\324\20090810_000.dat
Test file:Sample Test
User:Admin

| DUT Information | | Reference Information | |
|---|---|---|---|
| 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 |

**Test Information**
Pressure Units psi
Dwell Time:10 s
Leak Rate:
Pressure Stability setting:0.01 %DUTSpan

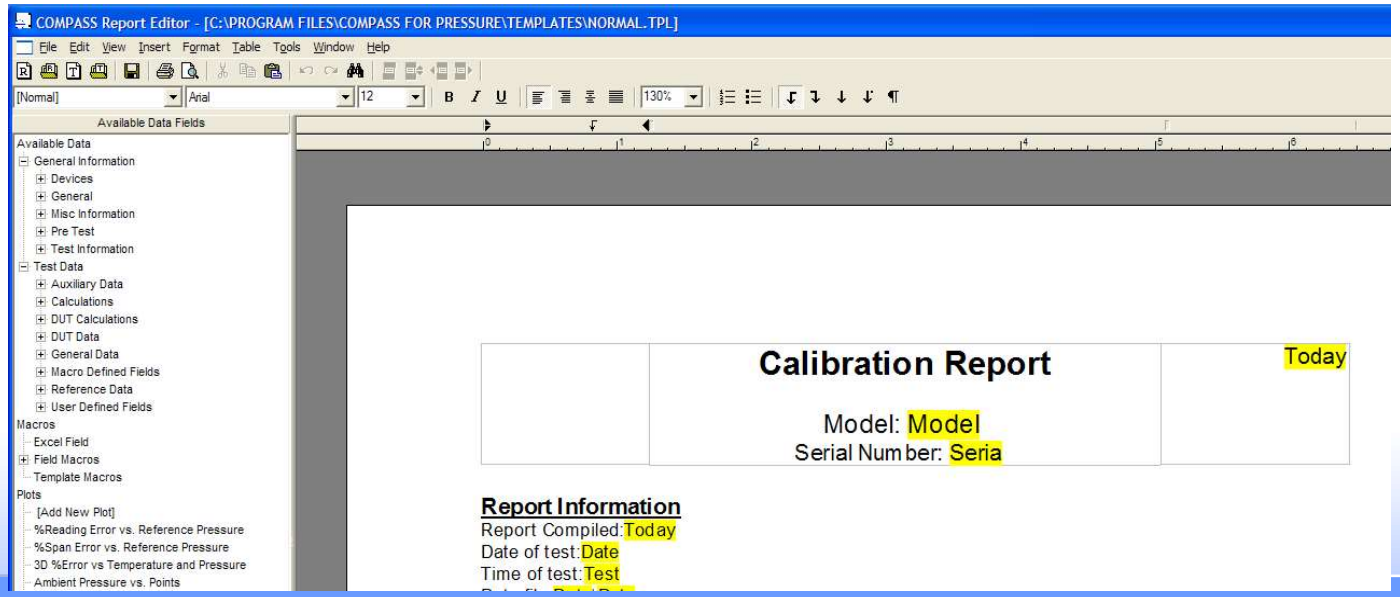
**Test Data**

| 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 | |
| 180.000 | 180.000 | 179.93 | 179.93 | -0.07 | -0.0221 | 0.30 | |
| 240.000 | 240.000 | 239.90 | 239.90 | -0.10 | -0.0337 | 0.30 | |

# Calibration report customization

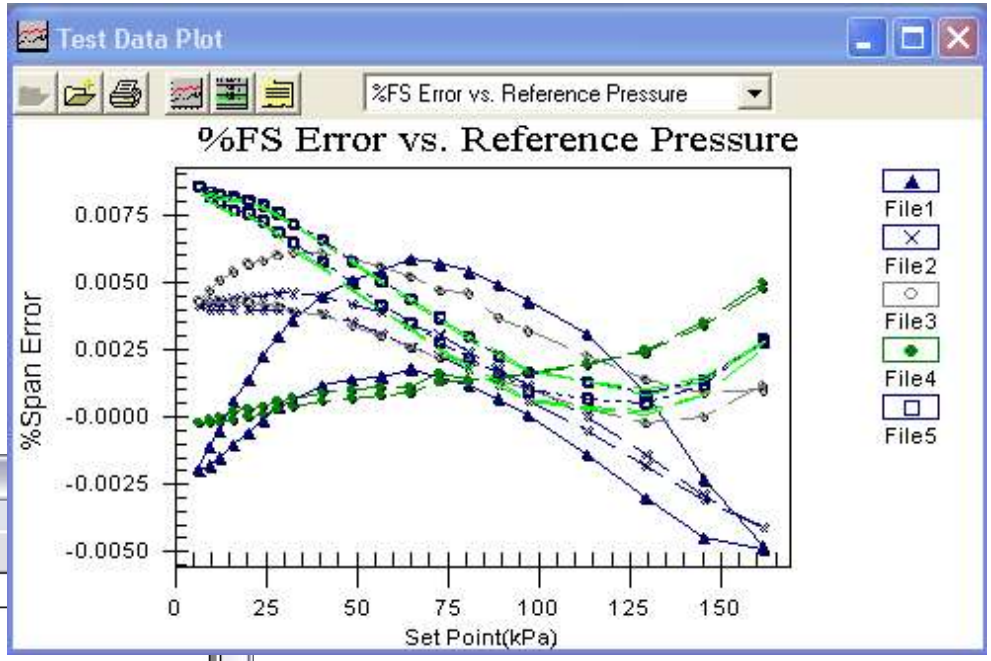
## Calibration reports

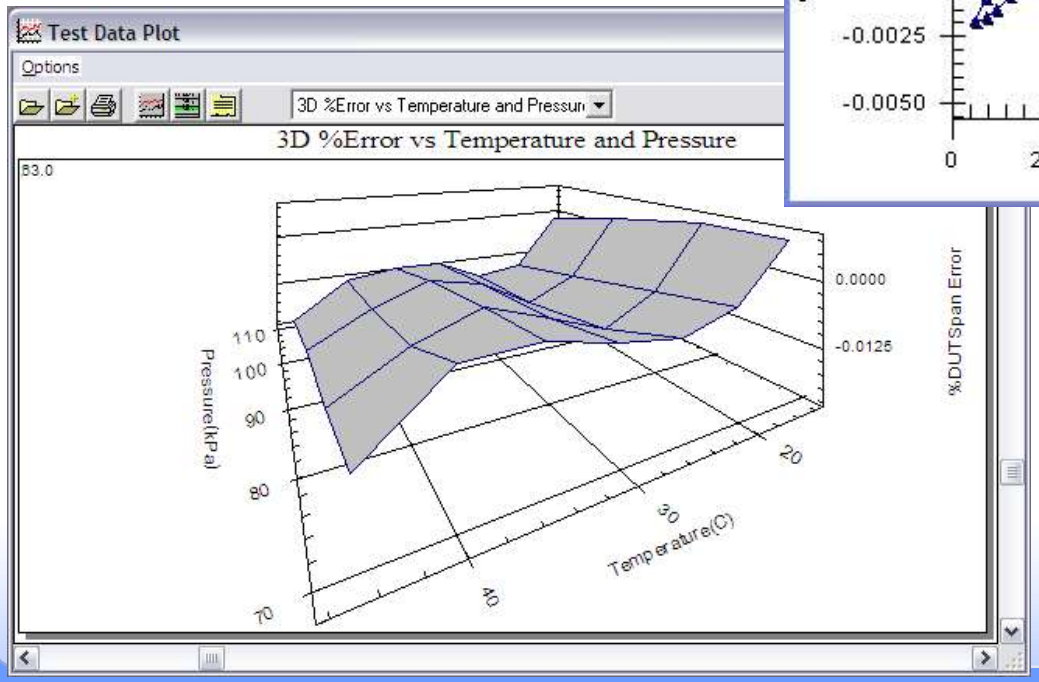
- Generated from data file(s) and template
  - Predefined and customizable templates
    - Black and white is fully editable text
    - Yellow is data fields from data file or built in calculations, or user calculations via a macro



# COMPASS Advanced Plot Support

Multiple sensors can be plotted together

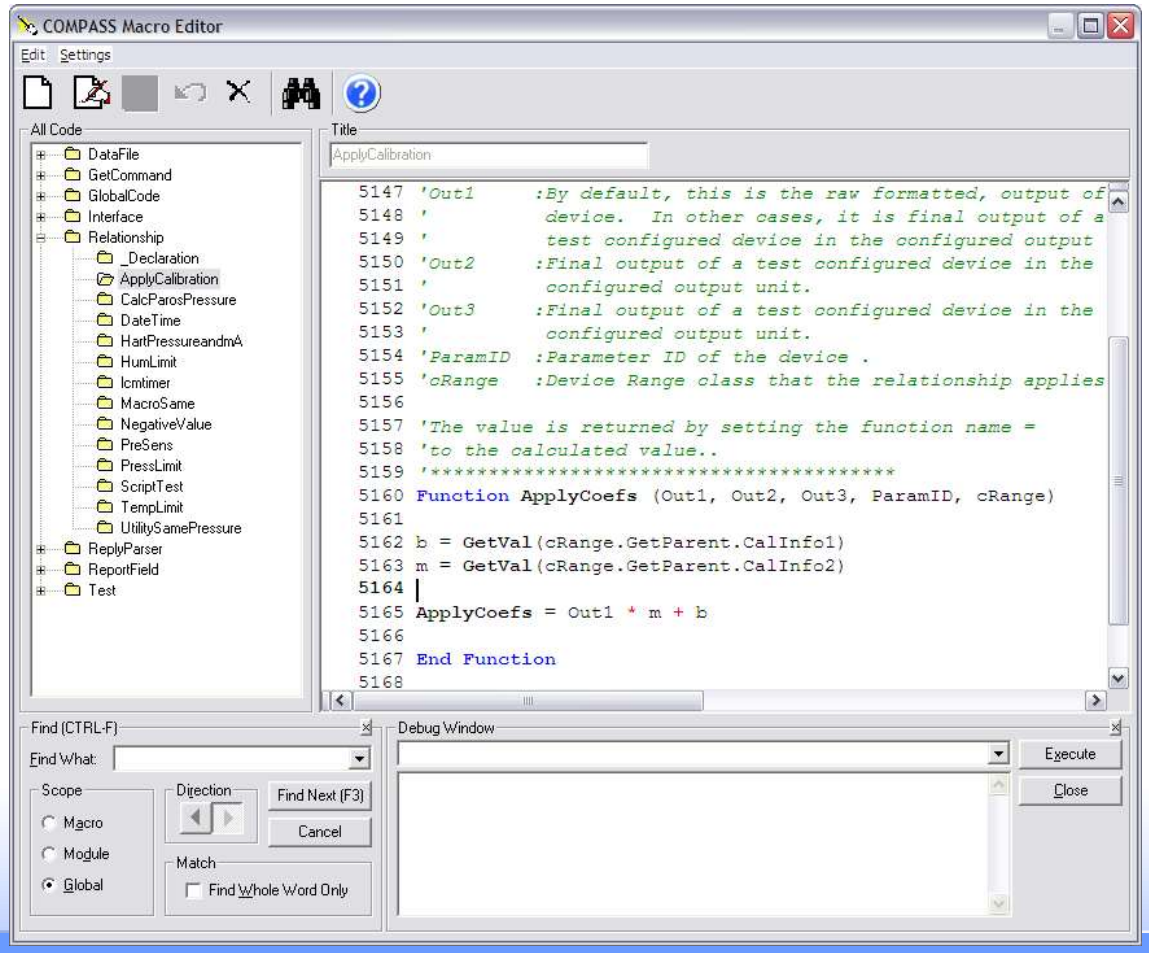



Fully customizable 2D and 3D plots

# Other COMPASS features

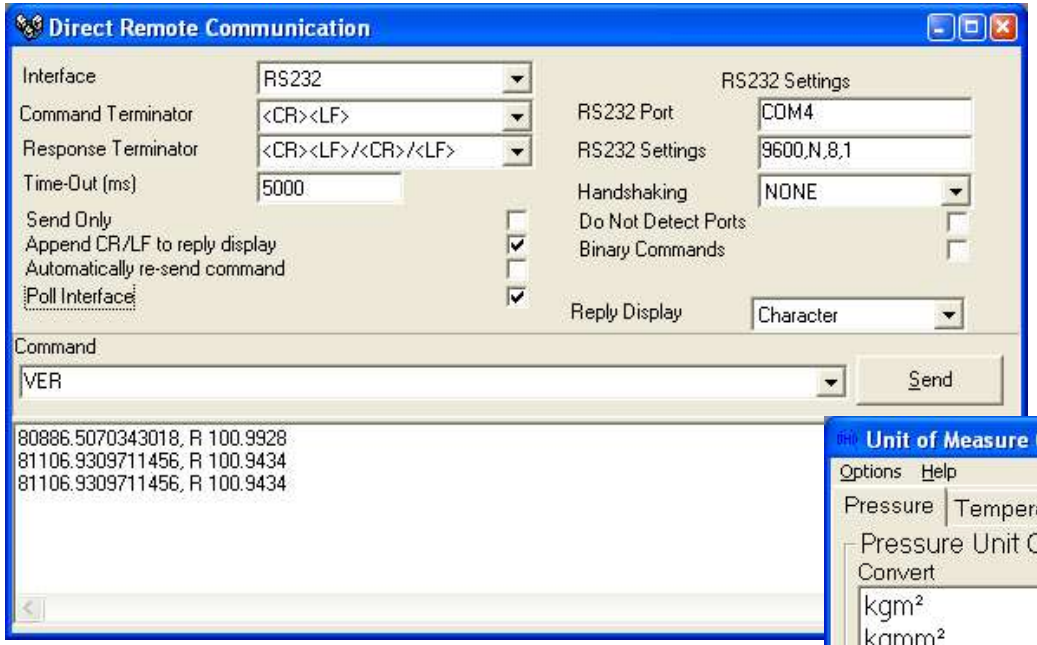
## COMPASS Macro Editor – VB Script editor for specialized interface, calculations, programming needs



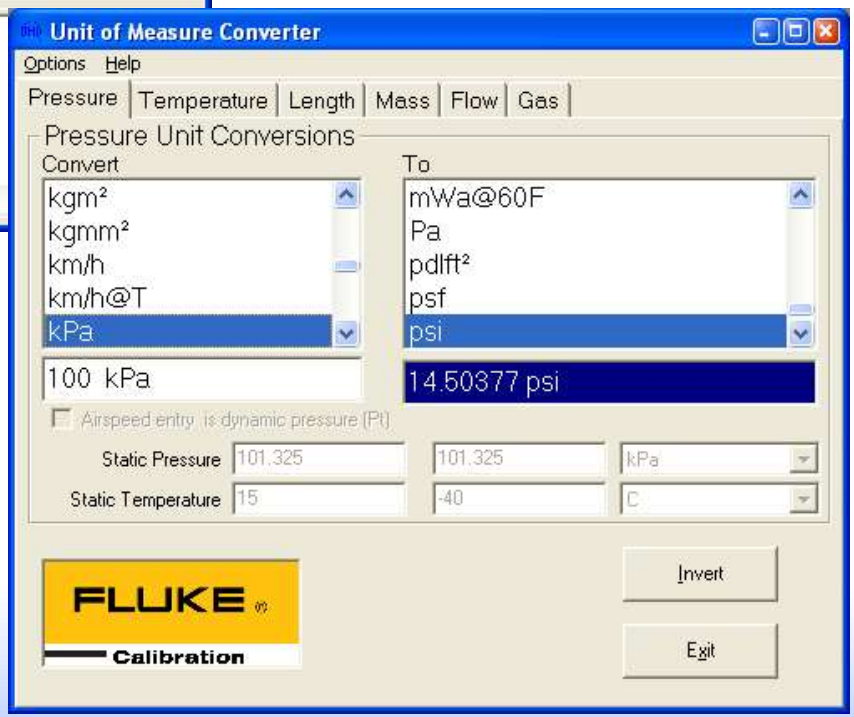
# Other COMPASS features

- Run Manual Test
  - Manual Data Acquisition mode
    - Collect or log data from devices without the need for following a pre-defined test definition
    - Great for logging data and troubleshooting devices (communications, intermittent bad readings)

# 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)**

# Other COMPASS features

- Temperature test (Need Enhanced, has to be with pressure test)
- Differential Pressure Test (Need Enhanced)
  - Pressure test with Line Pressure (e.g. natural gas or steam DP sensors
- 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

# COMPASS test demonstration

**Each device in the demonstration has an RS232 interface.**

- **Test at 25% increments.**
- **PPC4 will apply the pressure,**
- **Wait for a “Ready” condition**
- **Dwell for 5 seconds**
- **Average data for 5 seconds**
- **Log the ‘as received data’**
- **Run a function to calculate new coefficients**
- **Apply the new coefficients**
- **Run a second, ‘as left’ test**
- **Generate test report when finished**


# Thank you.

## Questions?

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

**www.flukecal.com**