

4

Four common PRESSURE CALIBRATION PAIN POINTS

Introduction:

FLUKE®

Host:

TEquipment

Presenter:

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Fluke Corporation



- Fluke has 20+ years serving professionals in the process pressure test market.
- Instrumentation professional are vocal power users of professional test tools
- Years of listening helps us better understand where work stream pain points are
- Correlating user's feedback and enabling technology, it is our job to find better ways to perform difficult tasks



1. Pressure calibration and leaks
 - Causes and how to mitigate the effects
2. Documenting pressure calibrations
 - How to document when your hands are already full of tools to do the job
3. Generating accurate pressures for a multi-point transmitter test
 - Generating 5 pressure points up and down takes time and tool skills
4. Testing pressure switches and achieving repeatability
 - Without repeatability which test result would you trust?



1) Pressure calibration and leaks

- Leaking pressure test set ups in the field lead to failure
- The mythical “perfect seal” is very difficult to achieve
 - Residual leakage likely to remain
 - Mitigation and minimizing to reasonable levels a typical compromise
- Holding pressure stable for a period of time is needed to allow transmitter outputs to settle
 - Damping settings in transmitters can multiply this problem
- Specifying, selecting hoses and fittings can be confusing
- Pressure sources critical in achieving the correct result and outcome but which one is best for my application?



“Debugging” your pressure test setup

The mission: No leaks and the ideal test setup

- Start with quality hoses and connectors
 - No wrenches or PTFE tape required
- Some hose and connector kits offer tool free connectivity
 - No wrenches or PTFE tape required
- If installation requires tools, particularly with NPT fittings PTFE tape is required
 - 3-4 full wraps of PTFE tape usually will do the job
 - Clean off any old tape before wrapping new
 - Wrap in the correct direction or it will unravel as you install the fitting
 - Liquid thread sealant with PTFE an alternative to tape



“Debugging” your pressure test setup

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The mission: No leaks and the ideal test setup

- Connect up the test setup on the bench and pressure up a pressure transmitter or gauge.
- Pressurized value should hold steady or count down slowly
 - If pressure does not hold, start troubleshooting
 - Soapy water using dish soap will bubble easily when rubbed over a leaky fitting
 - Commercial version called “Snoop” available
 - If no obvious leaks substitution tests may be needed to find the problem



“Debugging” your pressure test setup

The mission: No leaks and the ideal test setup

– Other methods for mitigating leaks in test setups include:

- Using a nitrogen bottle and regulator to hold the pressure steady
 - Works until the tank pressure is depleted
 - Careful, can be dangerous if dropped
- Use a modern portable pressure calibrator that automatically regulates pressure



2) Documenting pressure calibrations

- Know what the test requires before leaving the shop, have the right tools
 - Multifunction calibrators give technicians more flexibility and functionality like a “Swiss Army Knife”
 - Dedicated pressure calibration tools can make pressure testing easier
 - Built in pump, manual, electric or automatic
 - Make sure the pressure measurement tool is accurate enough and matched for the task
 - If the test tool is being used at 50% of its specified range it is probably $\frac{1}{2}$ as accurate.



- Have your method sheet started before leaving the shop
- With your hands full holding a calibrator and a pump and gauge how do you document the test results?
 - Magnetic or strap hanging tools for the calibrator can help
- Documenting calibrators can capture your results in the field without pen and paper



Modern documenting pressure calibrators

- Documenting calibrators can capture your test results in the field
 - Automatic testing and calculate pass/fail
 - Pre-adjustment As Found test documentation
 - Required by many regulations
 - Do not perform any adjustment before this test
 - Post adjustment As Left test documentation
 - Required to prove adjustment was successful if performed
 - Proof of the condition of the device when put back into service.



Recording the test, pre-adjust

Test Point	Source	Measure	Error
	psi	mA	%
0.000	0.004	4.198	1.23
50.000	50.000	12.304	1.50
100.000	100.001	20.410	2.56
50.000	50.002	12.303	1.89
0.000	-0.003	4.197	1.23

As Found documented test



Recording the test, post-adjust

Test Point	Source	Measure	Error
	psi	mA	%
0.000	0.000	3.999	-0.01
50.000	50.002	12.006	0.03
100.000	99.999	20.011	0.07
50.000	49.998	12.004	0.03
0.000	-0.014	3.996	-0.01

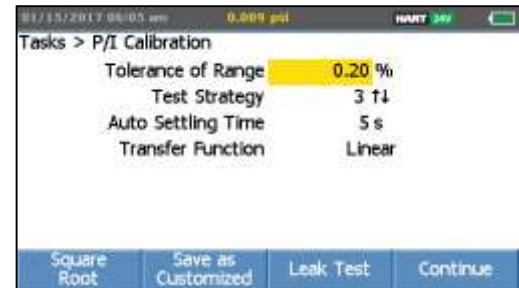
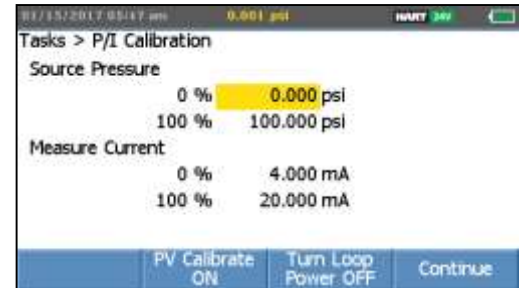
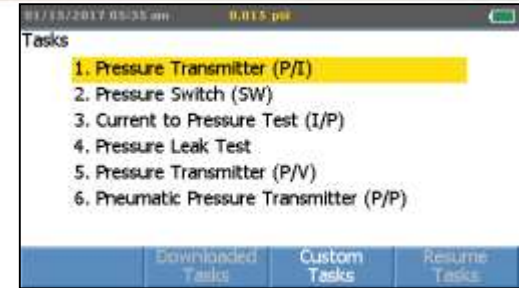
As Left documented test

Tag number, serial number, technician name, date and time recorded



Test templates, setups make documented tests easier

- Can be downloaded from a Calibration Management Software application
 - Templates define pressures applied to the transmitter and measured output parameters (4-20 mA or 1-5 volts)
 - Test tolerance, number of test points
 - Default templates can often be customized and saved to match tag numbers
 - Leak test to verify test setup
 - Square root linearization for transmitters configured for DP flow
- Functionality varies with different manufacturers



- Wireless communication enables remote measurement logging
 - Time series pressure measurements recorded and plotted
 - Enables process pressure recording for documenting loop performance
 - Logged measurement data enables loop tuning
 - Can be used to capture intermittent process anomalies
- Most documenting calibrators can also log to internal memory for recall and review.



Benefits of using documenting calibrators

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- No writing down measurements
- Eliminates transcription errors
- Eliminates errors from manually entering calibration data into a PC
- Pair with calibration management software for data analysis and managing workload
 - Data analysis enables calibration interval adjustments
 - Shorten intervals for repeat failures or marginal devices
 - Lengthen intervals for devices with successive calibrations and errors less than 50% of tolerance
 - Optimizes use of skilled technicians
 - Enables route based maintenance scheme



3) Generating accurate multi-point test pressures

Industry standard pressure calibrations often call for a 5-point ascending and descending test strategy

- **0%, 25%, 50%, 75%, 100%, 75%, 50%, 25%, 0%**
- For this test strategy on a transmitter with a range of 0-200 psi you would apply:
 - **0, 50, 100, 150 and 200 psi ascending** and **150, 100, 50 and 0 psi descending**
- **Ascending** portion test verifies end points (zero and span) and linearity
- **Descending** test will verify hysteresis and zero shift
 - Hysteresis is identified as a shift between the measured values rising and falling at 75%, 50% and 25%.



Test Point	Source	Measure	Error
0.000	0.000	3.999	-0.01
50.000	50.002	12.006	0.03
100.000	99.999	20.011	0.07
50.000	49.998	12.004	0.03
0.000	-0.014	3.996	-0.01

Test result with nearly ideal test pressures, on a transmitter with excellent linearity and minimal hysteresis errors

- Generating the correct values and not overshooting the target pressure is important for the best test
- Minor overshoot, within the fine adjust range of the vernier is the goal
 - Significant overshoot can skew the test results.
 - Gross overshoot can cause damage
 - Over-pressure of the transmitter or test tool
 - Pressure relief valves can be used to limit overpressure conditions
 - Have to be adjusted correctly which requires “calibration”
 - Sometimes leak, adds another device in the loop with the possibility of leaking

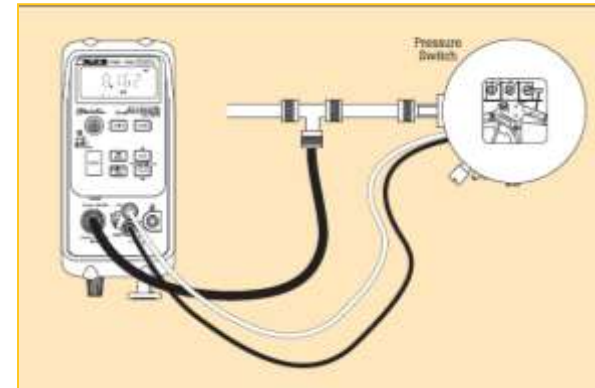


- Start with a debugged, proven test setup.
 - High competence testing is impossible while fighting leaks
- Use a hand pump that matches the test pressure range
- Center the pump vernier before starting the test,
- Remember the position of the pump vernier from one test point to another
- Remove the transmitter from process, test on the bench
 - Bench pressure calibrators can do automatic tests
- Use a new generation portable automatic pressure calibrator; like the Fluke-729



4) Testing pressure switches and achieving repeatability

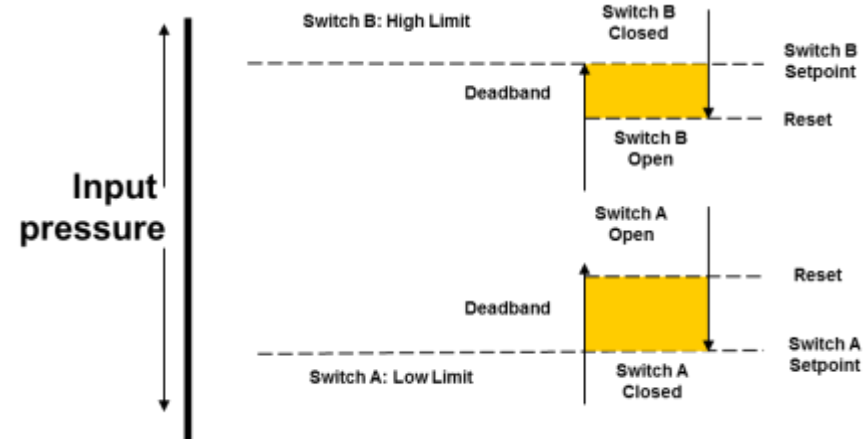
- Without test repeatability which test result would you trust?
- Pressure switch testing requires significant tribal knowledge
 - Good knowledge of the test hand pump
 - Ability to get the test pressure within the range of the fine adjust vernier
 - When the applied pressure is close to a switch state the pressure change rate must be slowed down
 - Slow pressure change rate + high speed pressure measurement rate is ideal
 - Run the test multiple times to and verify for test result repeatability



- Pressure Switches usually have three connections
 - Common usually a black wire
 - Normally open, usually a red wire
 - Normally closed, usually a green wire
 - One or both contact states might be used for pressure sensing
 - Connect one test lead to common and the other to the green or red wire depending on which state is being tested
 - Make pressure connections from the output of the pump or calibrator to the switch

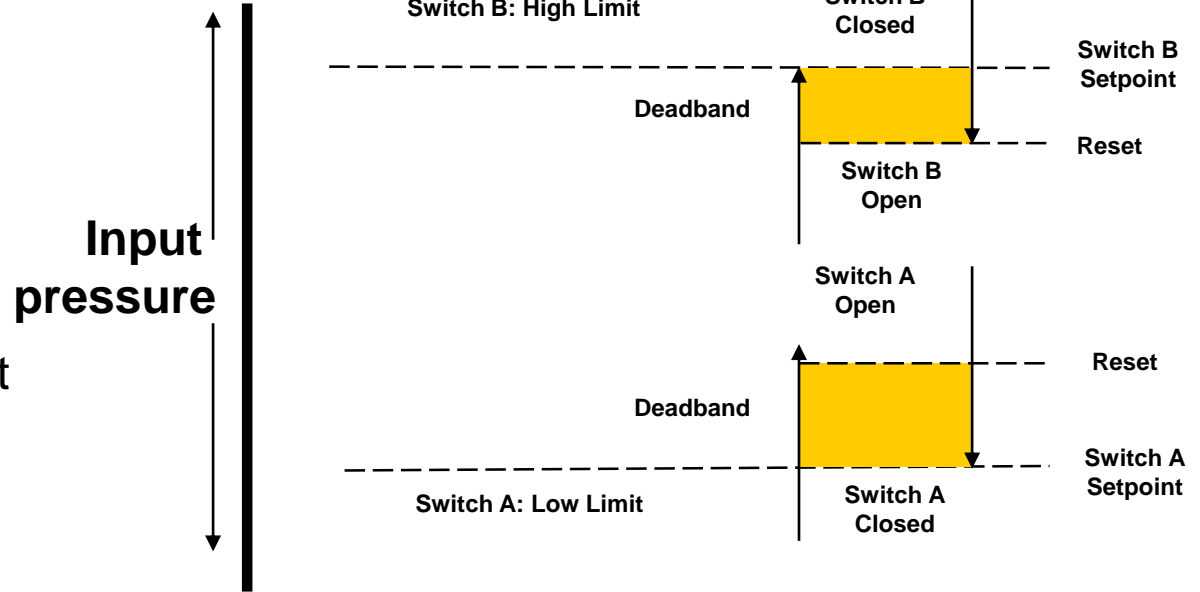


- **Reset state:** the relaxed state of a switch
 - For normally closed contacts the reset state is shorted dry contacts
 - For normally open contacts the reset state is open dry contacts
 - The pressure applied to the switch for reset typically “follows” the setting for the set state or set point
 - Occasionally adjustable on premium switches
- **Set State:** The state of the switch when it changes responding to an applied pressure (adjustable)



Switch test terminology, Deadband

- The diagram depicts two Normally open switches that set (close contacts) when the pressure gets either too high (switch B) or too low (switch A)
- For a given setpoint, the difference in pressure between the set and reset states is the **deadband**.
- Allows process pressure to cycle within acceptable limits before changing state triggering a control device and causing control action

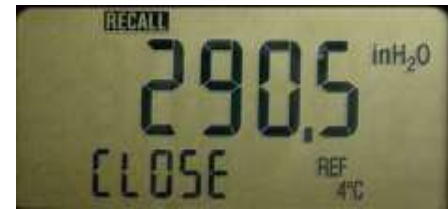


Running the test with a manual pump

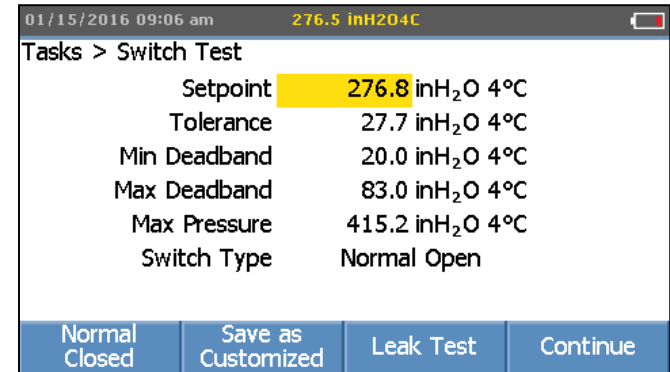
- Exploration: Pump up to the expected setpoint value
 - Note the pressure reading where the switch sets (closes)
 - Slowly release pressure and note the pressure where the switch resets (opens)
- After the first pass repeat the test increasing the pressure very slowly as you approach the expected setpoint and releasing slowly as you approach the expected reset point
 - Approach these target pressures using the fine adjust vernier of the pump to enable slow pressure change rate



- Two test results that correlate are required for a known repeatable test conclusion
 - Requires multiple tests beginning with exploration and repeating with slow changing pressures based on expected set and reset values
 - Repeatability can be achieved with practice and good pump operation skills
- The example test results captured with a 718 pressure calibrator (built in manual pump)
- This normally closed switch Set (opened) at 184.1 inH₂O, reset at 290.5 inH₂O.
- Deadband: $290.5 \text{ inH}_2\text{O} - 184.1 \text{ inH}_2\text{O} = 106.4 \text{ inH}_2\text{O}$



- Automatic pressure calibrators with special purpose test procedures automatically perform this test
 - Define the expected pressure for the set point and deadband size
 - Define the maximum pressure
 - Helps avoid overpressure damage
 - Describe the switch type (normally open or closed)



Tasks > Switch Test	
Setpoint	276.8 inH ₂ O 4°C
Tolerance	27.7 inH ₂ O 4°C
Min Deadband	20.0 inH ₂ O 4°C
Max Deadband	83.0 inH ₂ O 4°C
Max Pressure	415.2 inH ₂ O 4°C
Switch Type	Normal Open

Normal Closed Save as Customized Leak Test Continue

Switch test definition

Performing a switch test with an automatic pressure calibrator

- Once configured, the test runs and displays results automatically
 - Explores and retests, achieves repeatability



Start the Automatic Test



Setpoint pressure found



Documented test result



Switch Reset pressure found

1. Pressure leaks

- Debug your test setup, use a nitrogen bottle and regulator or use an automatic regulating pressure calibrator

2. Documenting pressure calibrations

- Automatic documenting pressure calibrator makes documenting easy and paperless

3. Generating accurate pressures for a multi-point transmitter test

- A debugged test set and/or an automatic pressure calibrator makes this easier

4. Testing pressure switches and achieving repeatability

- Skill and experience with a hand pump or leverage the test routine built into an automatic pressure calibrator.



Thank-you to our host

- Thank-you TEquipment for hosting the webinar today
- If you have pressure testing pain points they have experts in the field to suggest:
 - Premium hose kits to reduce leaks in test setups
 - A wide variety of test pumps supporting pressure ranges low inH2O to > 10,000 psi
 - Industry best selection of pressure calibrators
 - Premium automatic pressure calibrators like the new Fluke-729 that help eliminate pressure testing pain points



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Thank you!

