FLUKE®

Pressure Calibration

Application Note

Fluke 718 Pressure Calibrator

Pressure instrumentation is found in virtually every process plant. Periodic calibration of these pressure, level, and flow instruments is required to keep plants operating efficiently and safely. Fluke provides a broad range of pressure calibration tools to help you quickly and reliably calibrate your pressure instrumentation.

These pressure calibrators accurately measure pressure by using:

- Internal sensors, or
- External Pressure Modules

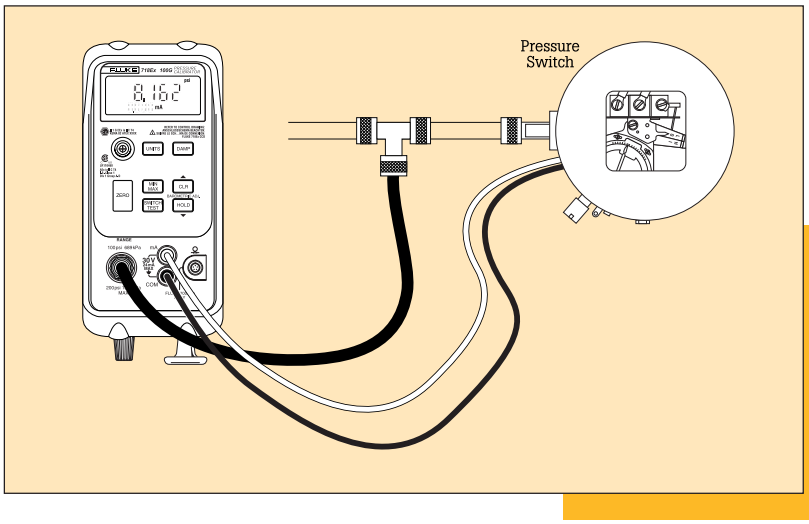
A pressure source may be provided by:

- A self-contained internal pressure pump, or
- An external source such as an accessory pump or a pressure bottle / regulator.

A summary of the pressure calibration capabilities of Fluke Process Tools is shown below.

Pressure Calibration with Fluke Calibrators **Function**	717 30G Pressure Calibrator	717 100G Pressure Calibrator	718 30G Pressure Calibrator	718 100G Pressure Calibrator	725 Multifunction Process Calibrator	741 Documenting Process Calibrator	743 Documenting Process Calibrator	744 Documenting Process Calibrator	5520A Calibrator
Measure Pressure to 30 psi / 2 bar with internal sensor	•		•						
Measure Pressure to 100 psi / 7 bar with internal sensor		•		•					
Measure Pressure to 10,000 psi / 700 bar with Fluke 700Pxx Pressure Modules	•	•	•	•	•	•	•	•	•
New Pressure switch test	•	•	•	•	•	•	•	•	•
Source pressure with accessory pumps	•	•	•	•	•	•	•	•	•
Source pressure with built-in pump			•	•					
Measure mA	•	•	•	•	•	•	•	•	
Loop power supply	•	•	•	•	•	•	•	•	
Multifunction source and measure					•	•	•	•	
Electronic data capture						•	•	•	
Serial communication to PC							•	•	
Integrated HART communication								•	

How to use the 718 to calibrate a pressure switch

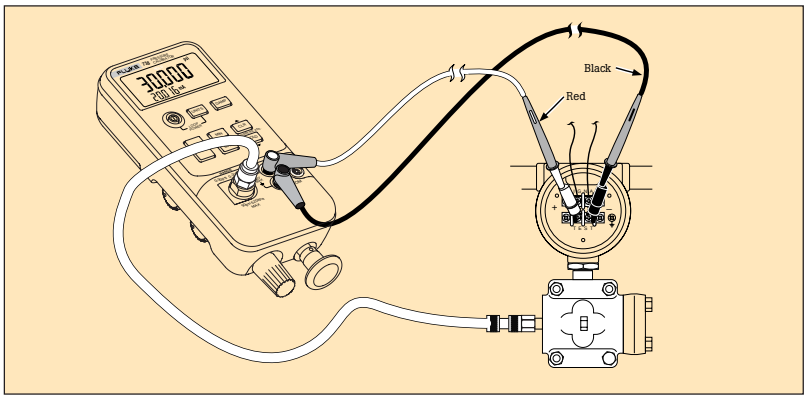


Pressure switch calibration
Verify the setpoint and deadband of pressure switches using the 718 Pressure Calibrators.

1. Depressurize and isolate the pressure switch from the process.
2. Plumb the 718 and make connections as per the illustration.
3. Turn on the 718 and open the vent valve. Press the Zero button to clear the zero offset. Close the vent.
4. Press the Switch Test button to enter the switch test mode.
5. Apply pressure slowly with the hand pump until you approach the setpoint. Using the fine adjust vernier adjust the pressure until the switch opens and OPEN is displayed on the 718.
6. Release the pressure slowly using the fine adjust vernier until RCL is displayed.
7. Press the Switch Test button once to read the pressure values for switch opening and again to see the pressure at switch closing.
8. Press and hold the Switch Test button for 3 seconds to clear the test results and start over.
9. Adjust the pressure switch setpoint until the switch contacts open and close at the desired pressure.

Typical Pressure Applications

How to calibrate a P / I Transmitter



With a built-in hand pump, precision measurement of both pressure and current, and a 24 volt loop supply, the Fluke 718 Pressure Calibrator is a complete, self-contained tool for the calibration of P/I transmitters. To calibrate a 3-15 psi / 4-20 mA transmitter using a Fluke 718 30G Pressure Calibrator:

1. Depressurize the transmitter, and then plumb the transmitter to the 1/8 inch NPT pressure port of the 718. Connect the test leads per the figure above.
2. Turn the calibrator on. (If you need to power the transmitter, hold down the UNITS key while turning on the calibrator.)
3. Press the UNITS key until PSI shows in the display.
4. With the 718's bleed valve open to atmosphere, press the ZERO key. Close the bleed valve. Set the pressure / vacuum valve to +, for positive pressure.
5. Use the hand pump to apply roughly 3 psi to the transmitter. Partial pump strokes will apply small increments of pressure. Use the fine-adjust knob to get reasonably close to 3.00 psi.
6. Press the HOLD key, and record the psi and mA readings. Press the HOLD key to resume reading.
7. Calculate and record the error, using: **Error = ([(i-4)/16] – [(P-3)/12]) * 100** where Error is in % of span, i is your measured current in mA and P is your measured pressure in psi.
8. Repeat steps 5 through 7 at mid-range, around 9 psi, to check linearity at mid-span.
9. Repeat steps 5 through 7, now at 15 psi, for a check at 100 % of span.

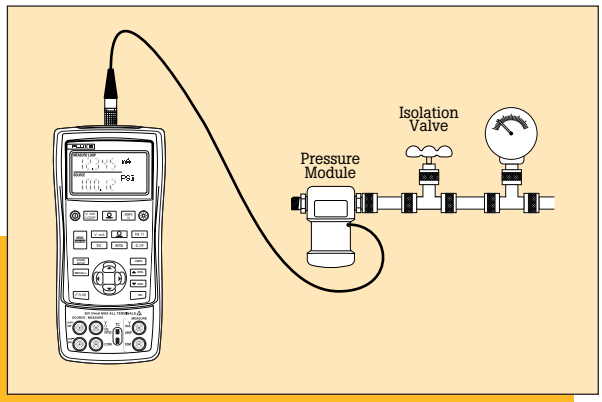
If your calculated errors are within tolerance, the transmitter has passed your As-found test, and you are done. If necessary, perform your zero and span adjustments, then repeat steps 5 through 9 for an As-left test. Depressurize the line, and disconnect the 718.

NEW Intrinsically Safe Version Available

Measuring less than 9 inches in length and weighing just over two pounds, the rugged 718 is easy to carry into the field. The 718 is offered in both 30 psi and 100 psi models. Media compatibility is dry air and non-corrosive gasses. A built-in pump generates pressure or vacuum. Min, Max, and Hold functions are available.

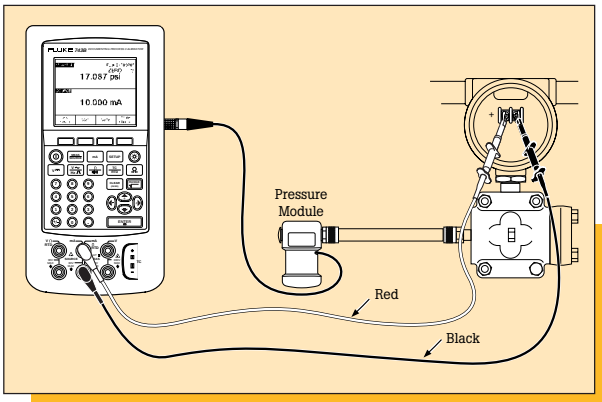
The 718 can also measure pressure using any of the 29 Fluke 700Pxx Pressure Modules, to cover applications up to 10,000 psi. The 718 comes complete with protective holster, test leads, test clips, Users Manual, and two 9-volt batteries (installed).

	Pressure			mA		
Model	**Range**	**Resolution**	**Accuracy**	**Range**	**Resolution**	**Accuracy**
Fluke 718 30G	-12 to 30 psi	0.001 psi	0.05 % FS	0 - 24 mA	0.001 mA	0.025 % + 1 count
Fluke 718 100G	-12 to 100 psi	0.01 psi	0.05 % FS	0 - 24 mA	0.001 mA	0.025 % + 1 count



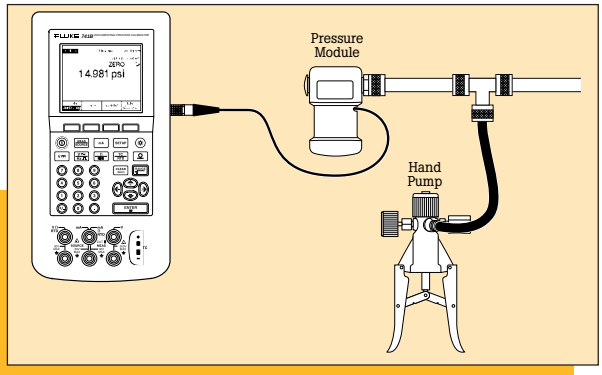
Measuring pressure

To measure pressure, the appropriate pressure module for the pressure to be tested is attached to the calibrator. The measured pressure can be displayed in a variety of engineering units. Here, a Fluke 725 Multifunction Calibrator is shown.



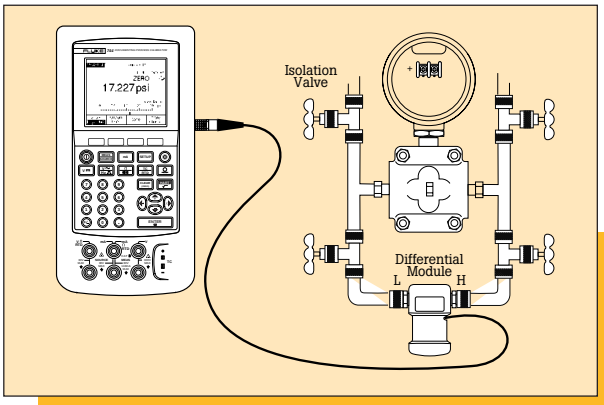
I to P device calibration

The I to P device is used to convert 4 mA to 20 mA electrical analog loop control to pneumatic analog loop control, generally 3 psi to 15 psi. Here, a typical configuration for using a pressure module with a 740 Series DPC is demonstrated.



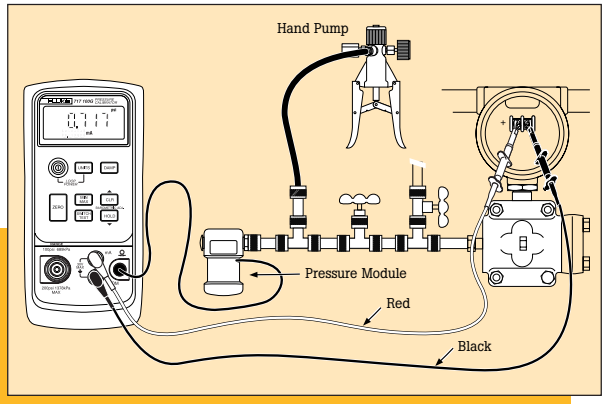
Sourcing pressure

To calibrate an instrument with pressure input, pressure from an external source (such as a hand-held pump) is applied. Prompts on the 740 Series Calibrator display indicate when to increase or decrease the input pressure, and when the specified test points are achieved. Here, a Fluke 741B Documenting Process Calibrator is shown.



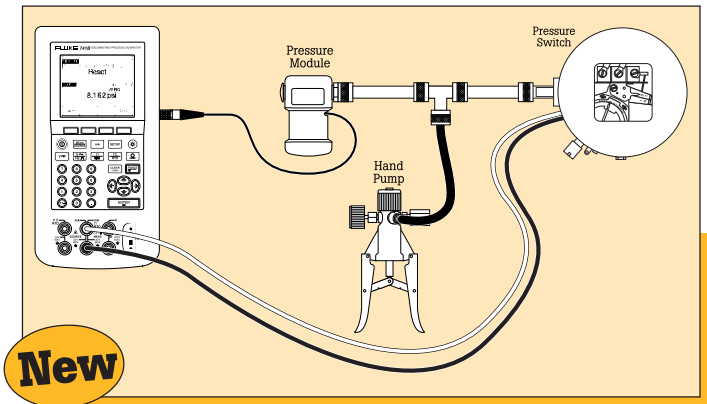
Differential measurements

Differential pressure modules are useful in a wide variety of applications, e.g., measuring the fluid level in a tank or calibrating a differential pressure transmitter. A Fluke 744 Documenting Process Calibrator is shown.



P to I device calibration

The P to I device is used to convert pneumatic analog loop control signals of 3 psi to 15 psi to electrical loop analog control signals of 4 mA to 20 mA. Here, a Fluke 717 Pressure Calibrator is used.



New

Pressure switch calibration

Verify and document the setpoint and deadband of pressure switches using the 740 Series Documenting Process Calibrators.

Pressure Modules

A complete family of pressure modules

A family of 29 pressure modules covers the most common pressure calibrations from 0–1″ H_2O (0–.25 kPa) to 0–10,000 psi (0–70,000 kPa).

Gage pressure modules have one pressure fitting and measure the process pressure with respect to atmospheric pressure. Differential pressure modules have two pressure fittings and measure the difference between the applied pressure on the high fitting versus the low fitting. Each module is clearly labeled for range, overpressure specification, and media compatibility. A metric adapter is included with all but the P29 through P31 high pressure modules.

Quick and easy measurements

Fluke 700 Series pressure modules are easy to operate. To measure pressure, the technician plumbs the pressure module to a pressure source, and connects the pressure module cable to the calibrator. Pressure is applied, measured by the pressure module, and displayed digitally on the calibrator. At the touch of a button, the pressure may be displayed in up to 11 different engineering units. When used with the 741, 743 or 744 Documenting Process Calibrators, pressure readings can be date/time stamped and stored electronically for later retrieval. This saves time, eliminates errors, and supports compliance with quality standards and regulations.

Pressure module performance

Fluke 700 Series pressure modules are highly accurate, with total specifications that apply from 0 % to 100 % of full span and from 0 °C to 50 °C (32 °F to 122 °F)—a feature that sets them apart from other pressure calibrators. Many ranges have total uncertainties of 0.05 % of full scale and reference uncertainties of 0.025 % of scale (see Table, page 5).

This performance is possible through the innovative application of mathematics and microprocessor power. Fluke pressure modules have silicon piezoresistor sensors which consist of a resistive bridge fabricated in a silicon diaphragm. Pressure applied to the diaphragm causes a change in the balance of the bridge which is proportional to the applied pressure. The bridge balance change is not linear and is very sensitive to temperature. However, since these effects are quite stable with time and through repetitive changes of condition, the sensors can be very accurate in measuring pressure provided they are carefully characterized.

During manufacture, Fluke pressure modules are characterized by reading temperature and pressure at more than 100 points. A least-squares regression is used to calculate the coefficients of a polynomial expression for pressure. The coefficients, unique to that pressure module, are stored in the module's memory.

Each module has its own microprocessor, allowing it to run the measurement circuitry and to communicate digitally with a calibrator. When connected to the calibrator, the modules coefficients are uploaded from the pressure module to the calibrator. Then, as pressure measurements are made, raw sensor values for pressure and temperature are digitally loaded to the calibrator, where the raw sensor values and coefficients are manipulated to derive and display the pressure reading. This innovative technique provides several benefits:

1. Digital communication eliminates errors due to poor connections and electrical interference.
2. The modules are inherently temperature-compensated from 0 °C to 50 °C (32 °F to 122 °F).
3. The modules are fully interchangeable because all measurements are completed in the pressure module itself and then communicated to the calibrator in digitized form. Modules are calibrated independently of the calibrator, and can be used with any 700 Series calibrator. Each module has its own serial number to facilitate traceability.

Sensor protection in isolated modules

Many of these modules (see Table) incorporate a stainless steel diaphragm to isolate the sensor. With these modules, any medium that is compatible with stainless steel can be used on the high side of the module.

Rugged construction

A urethane overmolding protects against shock if a module is accidentally dropped and also seals against dirt, dust, and moisture. Pressure connections are 1/4″ NPT. A BSP/ISO adapter is also provided on all but the P29, P30 and P31.

Convenient setup

A one-meter cable between the pressure module and calibrator reduces the length of connecting tubing to the pressure source. The remote pressure head also provides an extra margin of safety and convenience by removing the calibrator and operator from the pressure source.

Pressure Performance

Summary calibrator specifications: (one year, 18 °C to 28 °C)

717 30G	717 100G	718 30G	718 100G	725	741B	743B	744	5520A	Function	Range	Resolution	Accuracy	Notes
•		•							**Measure Pressure**[1] *(internal sensor) Over pressure 3xFS*	-12 to 30 psi (-83 to 207 kPa)	0.001 psi	0.05 % full scale	Gasses/liquids[3] (non corrosive) Zero, Min, Max, Hold, Damp
	•		•						**Measure Pressure**[1] *(internal sensor) Over pressure 2xFS*	-12 to 100 psi (-83 to 690 kPa)	0.01 psi (0.1 kPa)	0.05 % full scale	Gasses/liquids[3] (non corrosive) Zero, Min, Max, Hold, Damp
•	•	•	•	•	•	•	•	•	**Measure Pressure**[1] (with Pressure Modules) Over pressure *per pressure module specs*[2]	29 Pressure Modules, 1 in. H_2O / 0.25 kPa to 10,000 psi / 69 MPa	To 0.0001 psi, per Pressure Module specs[2]	To 0.025 % of full span, per Pressure Module specs[2]	Media compatibility per Pressure Module specs[2] Zero, Min, Max, Hold, Damp
		•	•						**Source pressure built-in pump**	-12 psig to full scale	N/A	N/A	Pressure or vacuum, overpressure protected at 180 ± 10 psi
•	•	•	•						**Measure mA**	0 to 24 mA	0.001 mA	0.025 % reading + 1 count	
				•					**Measure mA**	0 to 24 mA	0.001 mA	0.020 % reading + 2 count	
					•	•	•		**Measure mA**	0 to 24 mA	0.001 mA	0.010 % reading + 0.015 % of full scale	
•	•	•	•	•	•	•	•		**Loop power supply**	24 V dc	N/A	± 10 %	

[1] Supported Pressure Units on 701 and 702 include: psi, kPa, bar, inches Hg, mm Hg, inches H_2O (@ 4 °C), and feet H_2O (@4 °C) Supported Pressure Units on 741, 743, and 744 include all of the above, plus kg/cm², inches H_2O (@ 60 °F), mm H_2O (@ 4 °C). Supported Pressure Units on 717, 718, and 725 include psi, kPa, bar, mbar, kg/cm², inches Hg, mm Hg, inches H_2O (@ 4 °C), inches H_2O (@ 20 °C), cm H_2O (@ 4 °C), and cm H_2O (@ 20 °C).

[2] For Pressure Module specifications, see table below.

[3] Gasses only for 718.

Pressure module specifications (all specifications in % of full span. Specifications reflect a confidence interval of 95 %.)

Model		Range (approx)	Resolution uncertanty (23 ± 3°C) (FS)	Reference uncertainty (23 ± 3 °C)	Stability (1 year)	Temperature (0 to 50 °C)	Total[1] uncertainty	High[2] side media	Low[2] side media	Fitting material	Max over-pressure (x nominal)
Differential											
700P00		2.5 mbar	0.001 mbar	0.300	0.025	0.025	0.350	Dry	Dry	316 SS	30x
700P01/700P01Ex	Ex	25 mbar	0.01 mbar	0.200	0.050	0.050	0.300	Dry	Dry	316 SS	3x
700P02		70 mbar	0.007 mbar	0.150	0.070	0.080	0.300	Dry	Dry	316 SS	3x
700P22		70 mbar	0.007 mbar	0.100	0.020	0.030	0.150	316 SS	Dry	316 SS	3x
700P03		340 mbar	0.01 mbar	0.050	0.020	0.030	0.100	Dry	Dry	316 SS	3x
700P23		340 mbar	0.01 mbar	0.025	0.010	0.015	0.050	316 SS	Dry	316 SS	3x
700P04		1000 mbar	0.1 mbar	0.025	0.010	0.015	0.050	Dry	Dry	316 SS	3x
700P24/700P24Ex	Ex	1001 mbar	0.1 mbar	0.025	0.010	0.015	0.050	316 SS	Dry	316 SS	3x
Gage											
700P05/700P05Ex	Ex	2 bar	0.1 mbar	0.025	0.010	0.015	0.050	316 SS	N/A	316 SS	3x
700P06/700P06Ex	Ex	7 bar	0.7 mbar	0.025	0.010	0.015	0.050	316 SS	N/A	316 SS	3x
700P27/700P27Ex	Ex	20 bar	1 mbar	0.025	0.010	0.015	0.050	316 SS	N/A	316 SS	3x
700P07		34 bar	1 mbar	0.025	0.010	0.015	0.050	316 SS	N/A	316 SS	3x
700P08		70 bar	7 mbar	0.025	0.010	0.015	0.050	316 SS	N/A	316 SS	3x
700P09/700P09Ex	Ex	100 bar	10 mbar	0.025	0.010	0.015	0.050	316 SS	N/A	316 SS	2x
Absolute (not compatible with Fluke 701 or 702)											
700PA3		340 mbar	0.01 mbar	0.050	0.010	0.010	0.070	316 SS	N/A	316 SS	3x
700PA4/700PA4Ex	Ex	1000 mbar	0.1 mbar	0.050	0.010	0.010	0.070	316 SS	N/A	316 SS	3x
700PA5		2 bar	0.1 mbar	0.050	0.010	0.010	0.070	316 SS	N/A	316 SS	3x
700PA6		7 bar	0.7 mbar	0.050	0.010	0.010	0.070	316 SS	N/A	316 SS	3x
Vacuum (not compatible with Fluke 701 or 702)											
700PV3		- 340 mbar	0.01 mbar	0.040	0.015	0.015	0.070	316 SS	Dry	316 SS	3x
700PV4		-1000 mbar	0.1 mbar	0.040	0.015	0.015	0.070	316 SS	Dry	316 SS	3x
Dual											
700PD2		± 70 mbar	0.007 mbar	0.150	0.025	0.025	0.200	316 SS	Dry	316 SS	3x
700PD3		± 340 mbar	0.01 mbar	0.040	0.015	0.015	0.070	316 SS	Dry	316 SS	3x
700PD4		± 1000 mbar	0.1 mbar	0.025	0.010	0.015	0.050	316 SS	Dry	316 SS	3x
700PD5		-1000/+2000 mbar	0.1 mbar	0.025	0.010	0.015	0.050	316 SS	N/A	316 SS	3x
700PD6		-1000 mbar/+6.9 bar	1 mbar	0.025	0.010	0.015	0.050	316 SS	N/A	316 SS	3x
700PD7		-1000 mbar/+13.8 bar	1 mbar	0.040	0.015	0.015	0.070	316 SS	N/A	316 SS	3x
High											
700P29/700P29Ex	Ex	200 mbar	0.01 mbar	0.050	0.010	0.020	0.080	C276	N/A	C276	2x
700P30		340 mbar	0.01 mbar	0.050	0.010	0.020	0.080	C276	N/A	C276	2x
700P31		700 mbar	0.07 mbar	0.050	0.010	0.020	0.080	C276	N/A	C276	1.5x

[1] Total uncertainty, one year for temperature range 0 °C to +50 °C. Total uncertainty, 1.0 % of full span for temperature range -10 °C to 0°C. For P00 module only, compensated temperature range is 15 °C to 35 °C.

[2] "Dry" indicates dry air or non-corrosive gas as compatible media. "316 SS" indicates media compatible with Type 316 Stainless Steel. "C276" indicates media compatible with Hastelloy C276.

Use of pressure zero is required prior to measurement or source. Maximum overpressure specification includes common mode pressure. Modules are CE rated. Metric adapter(s): 1/4" NPT female to male BSP/ISO 1/4-19, tapered thread, included with all modules except P29, P30, and P31. Effective October 1996, all modules include a NIST traceable certificate and test data.

* Ex Intrinsically safe version available for use with the 718Ex and 725Ex.

Pressure Accessories

Fluke 700PTP Pneumatic Test Pump

For use with: Fluke 700 Series Pressure Modules and the Fluke 710 Series Pressure Calibrators.

Description: The Fluke 700PTP is a handheld pressure pump designed to generate either vacuum to -13 psi/-0.9 bar or pressure to 600 psi/40 bar.

The Fluke 700PTP has two pressure ports:

- 3/8-BSP (ISO228) female parallel thread fitting for the reference gauge or pressure module
- 1/8-BSP (ISO228) female parallel thread fitting for the unit under test

Application: The Fluke 700PTP features an integral pressure adjustment vernier which varies the pressurized volume by 2.0 cc over approximately eleven turns of the vernier knob. The pressure variation achievable with the vernier will depend on the nominal pressure and total pressurized volume, but with a minimum volume and maximum pressure, the vernier provided 600 ± 20 psi adjustment range. With a minimum volume and no pressure applied, the vernier can also be used to provide a 0 to 70″ H_2O range. Larger volumes will provide a smaller range of adjustment, but greater resolution. The length of the stroke can be adjusted to limit the maximum output pressure. Maximum output pressure is adjustable from 2.5 psi to 600 psi.

Fluke 700HTP Hydraulic Test Pump

For use with: Fluke 700 Series Pressure Modules and the Fluke 710 Series Pressure Calibrators.

Description: The Fluke 700HTP is designed to generate pressures up to 10,000 psi/700 bar. The Fluke 700HTP has two pressure ports:

- 3/8-BSP (ISO228) female parallel thread fitting for the reference gauge or pressure module
- 1/8-BSP (ISO228) female parallel thread fitting for the unit under test

Note: The user must provide a hose with appropriate end fittings from this port to the unit under test.

Application: This pump can provide up to 10,000 psi using distilled water or mineral-based hydraulic oil. The pump is operated by pumping several strokes to prime the system, then switching to high pressure mode when the resistance increases. An integral pressure adjustment vernier knob varies the pressurized volume by 0.6 cc. The pressure variation achievable with the vernier will depend on the nominal pressure and total pressurized volume, but with a minimum volume, the vernier provided 150-3,000 psi (at 150 psi nominal) and 3,000-10,000 psi (at 3,000 psi nominal) adjustment ranges. With a minimum volume and no pressure applied, the vernier can also be used to provide a 0 to 1.7 psi range. Larger volumes will provide a smaller range of adjustment, but greater resolution.

Fluke 700LTP Low-Pressure Test Pump

Description: The Fluke 700LTP is a hand operated pressure pump designed to generate either vacuum to -12 psi / -.85 bar or pressures to 20 psi / 2000 mbar. The Fluke 700LTP has two pressure ports with push fit connectors. These push fit connectors, one for the reference port for connection to a Fluke 700 series pressure module and one to connect to a unit under test, connect to the supplied test hoses. These test hoses are terminated with 1/4-BSP (ISO228) female parallel thread fittings that can be adapted using the fittings included.

Application: The Fluke 700LTP is primarily intended for low pressure applications. It features a fine adjust vernier with .00145 / PSI resolution at low pressures. The pressure variation achievable with the vernier will depend on the nominal pressure and total pressurized volume, but with minimum volume and maximum pressure the vernier provides 30 psi ± 6 psi. The adjustable pressure relief valve features a slow-bleed capability that allows the user to slowly release pressure at a controlled rate to achieve a desired pressure.

Fluke 700HTH Hydraulic Test Hose

Description: The Fluke 700HTH hydraulic test hose is a 10,000 psi, 700 bar working pressure test hose that features stainless steel and nylon construction. The hose uses self-sealing fittings with easy finger tight connections. The hose has very low volumetric expansion and a negligible pressure drop at rated pressures.

Application: The Fluke 700HTH allows connection to a calibration unit under test from a Fluke 700HTP hydraulic test pump in use with the Fluke 700 series pressure modules. The 700HTH is compatible with water and non-corrosive oil.

Fluke 700ILF In-line Filter

For use with: Fluke 717 and 718 Pressure Calibrators to help isolate the calibrator from liquid contamination.

Description: Use to isolate calibrator from contact with liquids. Input is 1/8″ NPT female. Output is 1/8″ NPT male.

Application: The Fluke 700ILF can be used to isolate the calibrator from incidental contact with fluids present in the gas medium being measured. Particularly useful with the 718 calibrator to help keep moisture or oils from contaminating the on-board pump. The 1/8″ NPT male threaded output threads directly into the 717 and 718 calibrators. Maximum pressure is 100 psi. Burst pressure is 375 psi. Maximum flow is 10 SCFM and filtration to 1 micron.

Fluke 700PRV Pressure Relief Valve Kit

For use with: Fluke 700HTP Hydraulic Test Pump.

Description: The Fluke 700PRV consists of two relief valves (1360 and 5450 psi) to be used with the 700HTP Hydraulic Test Pump. These relief valves will protect the most commonly used Fluke pressure modules from damage due to accidental over-pressurization. 1/4 BSP male parallel thread to fit Fluke 700HTP.

Application: Repeatability ± 10 % of nominal setting. Multi-turn adjustment screw to set preload on internal disc springs.

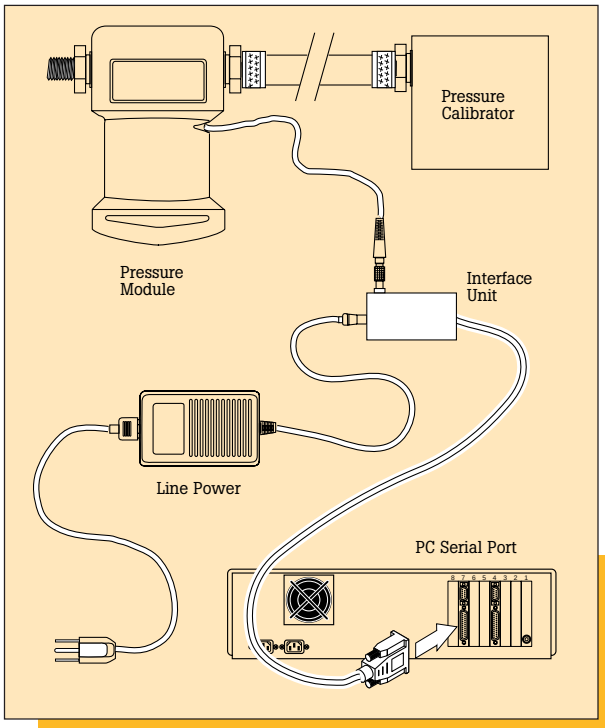
Fluke 700PMP Pressure Pump

For use with: Fluke 700 Series Pressure Modules and the Fluke 710 Series Pressure Calibrators.

Description: The Fluke 700PMP

is a hand-operated pressure pump to provide pressures up to 150 psi/1000 kPa. Output fitting is 1/8 FNPT.

Application: Linear stroke of 1.6″ (4 cm). Multi-turn vernier for fine adjustment of pressure.



Fluke 700 PCK Calibration Kit

The Fluke 700PCK Pressure Calibration Kit makes it possible to calibrate your pressure modules at your facility using your own precision pressure standards. The kit consists of a power supply, an interface adapter, appropriate cables, and Fluke 700PC Pressure Module Calibration software. When installed on your PC, the Windows®-based software easily steps you through an as-found verification, a calibration adjustment, and an as-left verification. Calibration data is captured for import to your database. A 386 or better PC, running Windows 3.1, or later is required, along with a precision pressure standard with an uncertainty of less than 1/4 that of the pressure module being verified.

Note: *With a Fluke 700PCK and any Fluke Pressure Module, a Fluke 5520A Calibrator becomes a precision pressure standard.*

Fluke. *Keeping your world up and running.*

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