FLUKE®

Precision Measurement Solutions

Temperature Calibration

Electrical Calibration

Pressure and Flow Calibration

Temperature calibration

FLUKE®

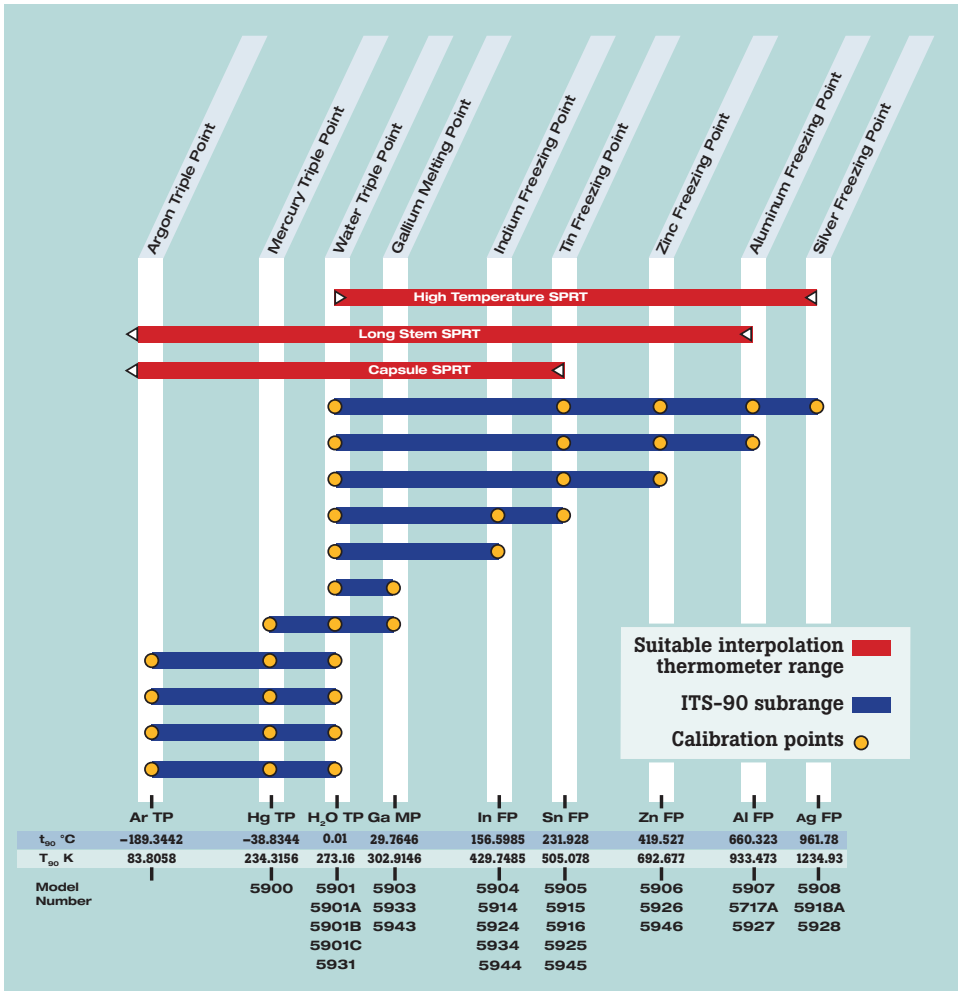
Hart Scientific®

Primary calibration laboratories

Is there a sign on your desk that says the Kelvin starts here? When a world of measurements can be traced back to your lab, come to Fluke Corporation's Hart Scientific division for primary standards with a proven track record of performance. Tested and proven by national labs worldwide, Hart products offer unparalleled accuracy. As good as Hart's products are, the only thing better is Hart Scientific's service. Hart associates provide personalized support to help customers get up and running effectively and will even personally deliver delicate standards when necessary.

- High-stability quartz- and metal-sheath SPRTs covering temperatures from -260 °C to 1070 °C.
- ITS-90 fixed-point and triple point of water cells in traditional and mini sizes.
- Ultrastable metrology furnaces, fluid baths, and automated mini furnaces for maintaining fixed points from mercury to copper.
- Super-Thermometers, recognized in metrology laboratories worldwide for their ease of use and reliable accuracy, are perfectly suited for SPRT calibrations.

Fixed points and ranges of the ITS-90



Tech tip

Maximize your SPRT's performance

Ever wonder how some laboratories achieve temperature uncertainties as low as a few tenths of a millikelvin? Here are a few tips:

- Avoid physical shock or vibration to your SPRT. An SPRT is a delicate instrument, highly susceptible to mishandling.
- Make a measurement at the triple point of water after each measurement. Use the resistance ratio W(t) rather than the absolute resistance to calculate the temperature.
- Measure at two different input currents and extrapolate the results to determine the value at zero power. This will eliminate the often-ignored effects of self-heating.
- Begin with the right equipment. All primary standards are not created equal.

Visit Fluke's Hart Scientific Division on the web at **www.fluke.com/fpmcat** for details about temperature calibration products and services, articles and tips, papers and presentations, and much more.

Temperature calibration

FLUKE®

Hart Scientific®

Secondary calibration laboratories

Thousands of professionals from all around the world come to Fluke's Hart Scientific division for expert advice, personalized service and temperature calibration products for even the most demanding applications. A broad range of products helps you to balance accuracy and value, and make the choices that work best for your organization and budget. Stable and uniform baths, SPRTs, precision thermometers, thermometer readouts, and more, are all designed to help metrologists work efficiently and productively.

- Proprietary Hart bath controller provides unmatched stabilities (to ± 0.0007 °C) and set-point resolution (to ± 0.00003 °C).
- Multiple options for automation through RS-232 or IEEE-488 interfaces.
- A wide range of baths includes standard baths from -100 °C to 550 °C, compact baths from -80 °C to 300 °C, plus special-purpose baths for standard resistors, sea-water applications, and more—customs available.
- 1560 *Black Stack*, 1529 Chub-E4, and 1502A/1504 Tweener readouts provide unmatched versatility and value as reference thermometers, data acquisition systems, or in integrated automatic calibration systems.
- Precision thermometers with temperature ranges from –200 °C to 1450 °C and accuracies between ±0.001 °C and ±0.2 °C. These include SPRTs, PRTs, thermistors and thermocouples.
- Calibration software provides automation, data collection and analysis.

Tech tip

Readouts and probes should match

Are your temperature readings traceable? Digital thermometer readouts measure resistance, voltage, and sometimes connector temperature (in the case of TCs). The displayed temperature is always a computer result, not a direct measurement. The trouble is that the readout will perform the calculation even if all of the information upon which the calculation is based is wrong or missing. And the error may not always be obvious.

To protect traceability before making a measurement, check the readout and ensure that the coefficients, excitation current, and reference junction settings are correct. Also check the sample timing, statistics, and filtering. You will save yourself a lot of trouble and be much happier with the results.

Bath performance and dimensions

	Temp (°C)		Depth (mm)	Stability (± °C)	Uniformity (± °C)
	Lowest	Highest			
Hot baths	40	300	305 to 464	0.001 to 0.005	0.002 to 0.012
Cold baths	–40	110	305 to 457	0.0007 to 0.003	0.002 to 0.004
Really hot bath	40	550	305	0.002 to 0.008	0.05 to 0.02
Really cold baths	–100	110	305 to 337	0.0015 to 0.003	0.003 to 0.007
Compact baths	–80	300	178 to 234	0.001 to 0.02	0.003 to 0.02
Deep well baths	–5	550	432 to 610	0.001 to 0.01	0.004 to 0.015
Deep well compact baths	–80	300	457 to 496	0.005 to 0.015	0.007 to 0.025
Resistor baths	0	110	203 to 331	0.0007 to 0.002	0.003 to 0.008

Thermometer readout equivalent temperature accuracy (± °C)

Temperature	1521	1522	2562	1502A	1529	1529R	2560	1575	1590
-195	0.0047	0.0047	0.0023	0.0012	0.0012	0.0012	0.0012	0.0002	0.0001
-50	0.0116	0.0116	0.0073	0.0036	0.0036	0.0036	0.0029	0.0006	0.0001
0	0.0198	0.0198	0.0124	0.0062	0.0062	0.0062	0.0050	0.0010	0.0002
200	0.0341	0.0341	0.0213	0.0107	0.0107	0.0107	0.0085	0.0017	0.0004
300	0.0415	0.0415	0.0260	0.0130	0.0130	0.0130	0.0104	0.0021	0.0005
400	0.0488	0.0488	0.0305	0.0152	0.0152	0.0152	0.0122	0.0024	0.0006
500	0.0607	0.0607	0.0379	0.0190	0.0190	0.0190	0.0152	0.0030	0.0008
660	0.0850	0.0850	0.0531	0.0265	0.0265	0.0265	0.0212	0.0042	0.0011

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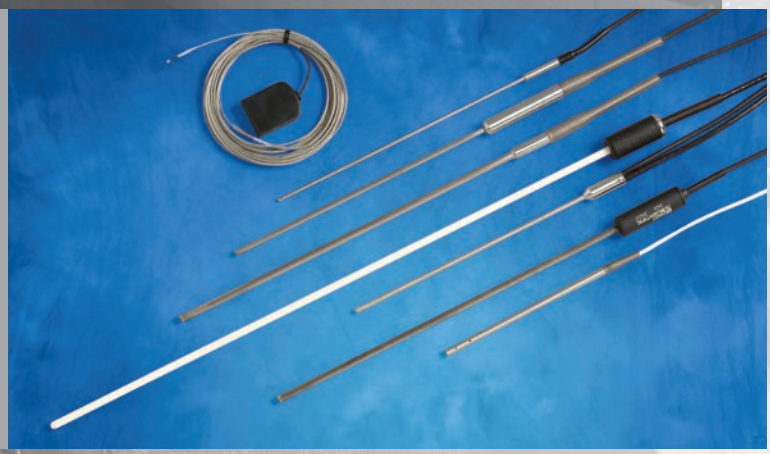
Temperature calibration



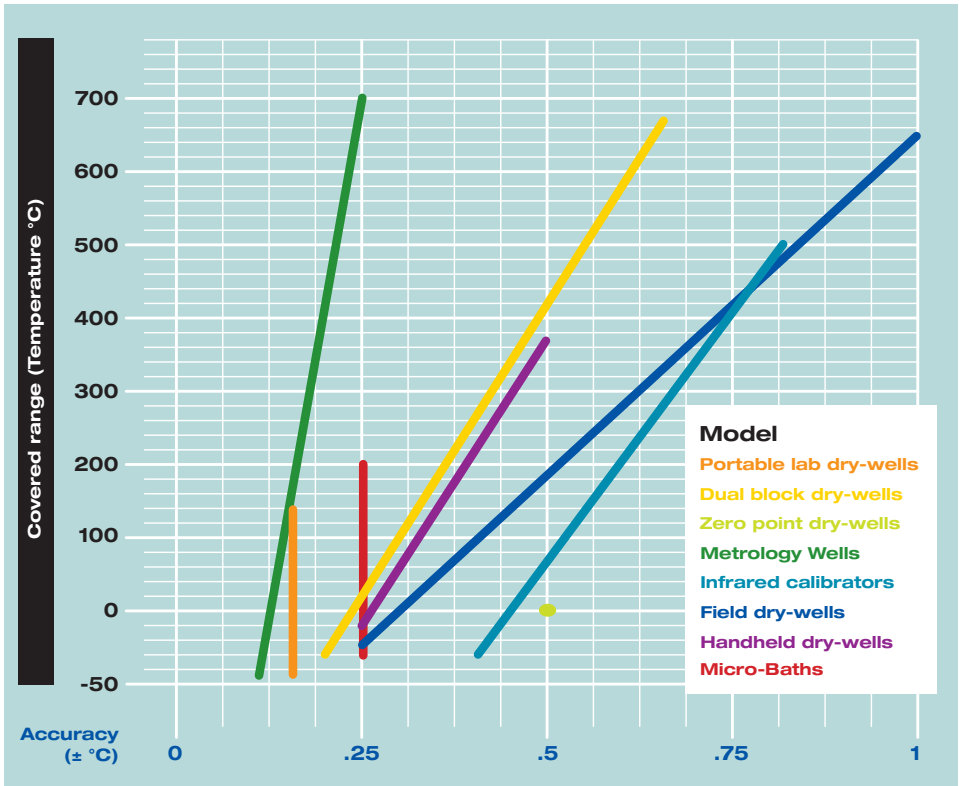
FLUKE®
Hart Scientific®

Industrial temperature calibration

Fluke's Hart Scientific division manufactures a range of practical solutions for calibrating all kinds of industrial temperature sensors. These products are fast, robust and portable, so they can stand up to demanding environments.

- Proprietary controllers provide the most stable and accurate temperatures available over wide temperature ranges.
- Portable dry-wells, including the smallest handheld models available today, designed to be carried to the test site.
- Lab, field, and handheld dry-wells covering temperatures from –45 °C to 1200 °C with world-class stability.
- Portable Micro-Baths for achieving the lowest uncertainties and calibrating even the most oddly shaped industrial thermometers.
- Product range includes blackbody pyrometer calibrators, zero-point dry-wells, horizontal thermocouple furnaces, surface sensor calibrators, and much more.
- Handheld thermometers, Teflon coated thermistors, PRTs for freezers, furnaces and fast-response measurements.

Calibrator relative accuracy



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Tech tip

Increase Metrology Well performance with a reference thermometer

The best way to take advantage of the superior uniformity characteristics of a Metrology Well is to use a reference thermometer. To facilitate using external reference sensors, Metrology Wells have optional built-in readouts with accredited calibrations.

Metrology Wells are the only industrial temperature sources on the market supported by published specifications addressing every performance category in the EA-10/13 document adopted by the European metrology community. These six categories are calibrated display accuracy, stability, axial uniformity (vertical), radial uniformity (well-to-well), impact from loading, and hysteresis.

Electrical calibration

Primary calibration laboratories

Fluke standards are found in primary calibration laboratories across the world. A wide range of electrical and frequency standards are designed to meet the needs of today's laboratories for traceability and quality accreditation while also being portable, simple to use, and easy to support.

- Product range includes dc reference and transfer standards, automated dc measurement standards, ac measurement standards, resistance standards, reference and Kelvin–Varley dividers and current shunts.
- The Fluke 5700A/5720A are the world standards in multifunction calibrators, with uncertainty to within +3.5 ppm/year (V dc).
- Reliable, accurate GPS referenced time and frequency standards address measurement needs for bench and field applications.
- The 8508A Reference Multimeter is designed for metrologists, with 8.5 digit measurement resolution.

Standards instruments

	732A	734B	7001	7004N	742A Series	792A	5790A	A40 / A40A	720A	752A	8508A/01	910/910R
Artifact Calibration Standards	•		•		•							
Direct Voltage Reference Standards	•		•									
Direct Voltage Reference Systems		•		•								
Resistance Standards					•							
Alternating Voltage Standards						•	•					
Current Standards								•				
Ratio Standards									•	•	•	
Reference Multimeter – measures V, Ω & A											•	
Time and Frequency Standards												•

Tech tip

Track performance and reduce uncertainties

With three or more independent voltage references, a lab can use inter-comparison measurement techniques to track performance between certifications and to characterize the outputs and reduce uncertainties.

Ratio measurements made easier

Ratio measurements are critical to metrology. A Kelvin-Varley Divider provides the best precision measurements which require variable ratios. Alternatively, reference multimeters like the 8508A can make similar ratio measurements, using much simpler operator techniques with only a small increase in uncertainty.

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Electrical calibration

FLUKE®

Secondary dc/lf electrical laboratories

Versatility and value go hand in hand at Fluke. The range of electrical calibration products encompasses many innovative and multi-functional solutions to help laboratories operate efficiently, increase throughput, and comply with today's quality standards. Models and options provide a wide range of possibilities to match a wide variety of workloads and budgets

- 5500A/5520A Multi-Product Calibrators provide solutions for calibrating meters to 6.5 digits, oscilloscopes to 1.1 GHz, insulation and continuity meters, current clamps, process calibrators, power harmonics analyzers, and much, much more.
- 5320A Multifunction Electrical Tester Calibrators calibrate many different types and models of electrical testers efficiently and effectively.
- 9640A Reference Source features a unique combination of level accuracy, dynamic range and frequency capability to calibrate the broadest range of RF measurement workload.
- MET/CAL® *Plus* calibration software automates the calibration process and documents procedures, increasing throughput and making compliance with quality standards easy.
- The 9500B and 5820A are flexible oscilloscope calibrators solutions that give you choice of bandwidths from 600 MHz to 14 GHz, features and automation solutions.
- 6100A Electrical Power Standard delivers measurement validation and calibration for single and multiphase electrical power applications.

	Workload	Calibration Instrument										
		525 Temperature/ Pressure	Multi-Product			Multi-Function		Oscilloscope		9640A Precision RF Source	6100A Electrical Power Standard	5320A Electrical Tester
			9100	5500A	5520A	5700A	5720A	5820A	9500B			
DMMs	< 5 digits		•	•	•	•	•					
	≤ 6½ digits				•	•	•					
	≤ 7½ digits to 8½ digits						•					
Scopes	≤300 MHz		•	•	•			•	•			
	≤600 MHz			•	•			•	•			
	≤1100 MHz				•			•	•			
	≤2100 MHz							•	•			
	≤3200 MHz to 14 GHz								•			
RF	Spectrum analyzers									•		
	Modulation meters									•		
	Power sensors & attenuators									•		
	RF millivoltmeters					•	•		•	•		
Power	Watt meters		•	•	•						•	
	Power quality & harmonic analyzers		•	•	•						•	
	Energy										•	
Electrical	Hipot & leakage current testers											•
	Insulation resistance testers		•									•
	Continuity/earth resistance testers		•									•
	Loop/line impedance & RCD testers											•
	Multifunction installation testers and PATs											•
	Medical electrical safety testers											•
Others	Thermocouple & RTD	•	•	•	•							
	Pressure	•			•							
	Process calibrators	•	•	•	•							
	Chart / strip / XY recorders		•	•	•							

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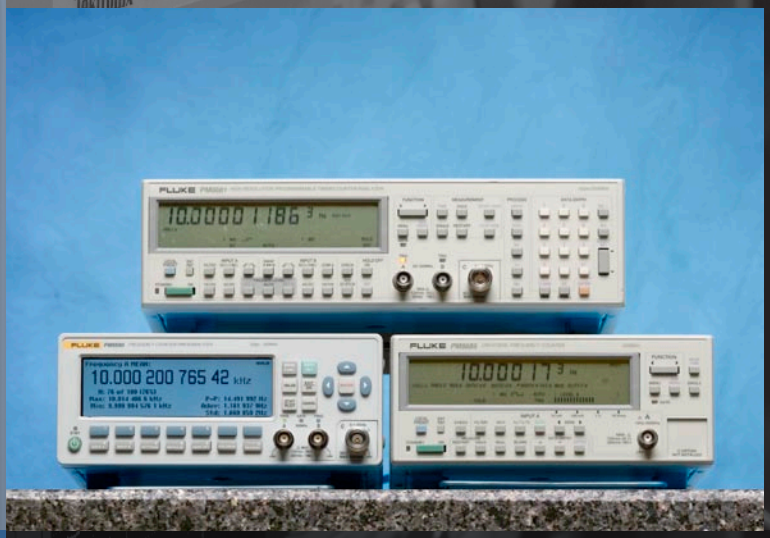
Tech tip

Flexible options help you match capabilities to needs and budgets

Upgrades are available for selected calibrators. Add or increase oscilloscope or power calibration capabilities over time as your needs change

A wide variety of options and accessories also exists for software products, including a "LITE" version of MET/CAL dedicated to specific calibrators, Barcode Magician® software for real-time batch updates to your database, and a support program that provides automate software upgrades and free access to a huge procedures library.

Manufacturing, R&D and service solutions



FLUKE®

Manufacturing test, R&D and service applications

Fluke products have the precision and versatility to handle the most demanding measurements, on the bench or in a system. These instruments are easy to use and offer excellent value that makes them an ideal solution for many applications.

- 8845A/8846A 6.5 digit precision digital multimeters have precision and versatility for bench or system applications, with analog performance up to 24 ppm.
- Function, pulse/function and universal waveform generators meet a broad range of signal source requirements and offer maximum value.
- Portable and stationary data acquisition systems include multiple options for collecting and transferring data.
- Economical counters and timer/counters offer state-of-the-art performance.
- Frequency counters and standards, including the world's first truly traceable GPS-disciplined frequency reference.

Selection guide

		8808A	8845A	8846A	80	81	271	28X	29X	39X	2640	2680
Measure	Basic V dc accuracy	0.01 %	0.0035 %	0.0024 %							0.01 %	0.01 %
	Resolution (digits)	5.5	6.5	6.5							5.5	5.5
	V, A and ohms	•	•	•							•	•
	Frequency/period	•	•	•							•	•
	Capacitance			•								
	Temperature			•							•	•
	TrendPlot™ and statistics		•	•								
	USB memory port			•								
Signal Source	Max sine freq range				50 MHz	50 MHz	16 MHz	16 MHz	40 MHz	50 MHz		
	Sine, square, triangle wave				•	•	•	•	•	•		
	Function generator				•	•	•	•	•	•		
	Multi channel							1, 2, 4	1, 2, 4	1, 2		
	Pulse waveform					Single	Multi Level	Pulse Train	Pulse Train	Pulse		
	Arbitrary waveforms						•	•	•	•		
	Waveform sequencing							•	•	•		
	Waveform looping							•	•	•		
	Modulation						•	•	•	•		
	Triggered, gated				•	•	•	•	•	•		
	Burst, sweep				•	•	•	•	•	•		
	Signal summing							•	•			
	Phase lock				•	•	•	•	•	•		
Data Looging	Math channels										•	•
	Single channel logging		•	•								
	20 to 400 channel logging										•	
	20 to 2000 + channel logging											•

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Pressure calibration

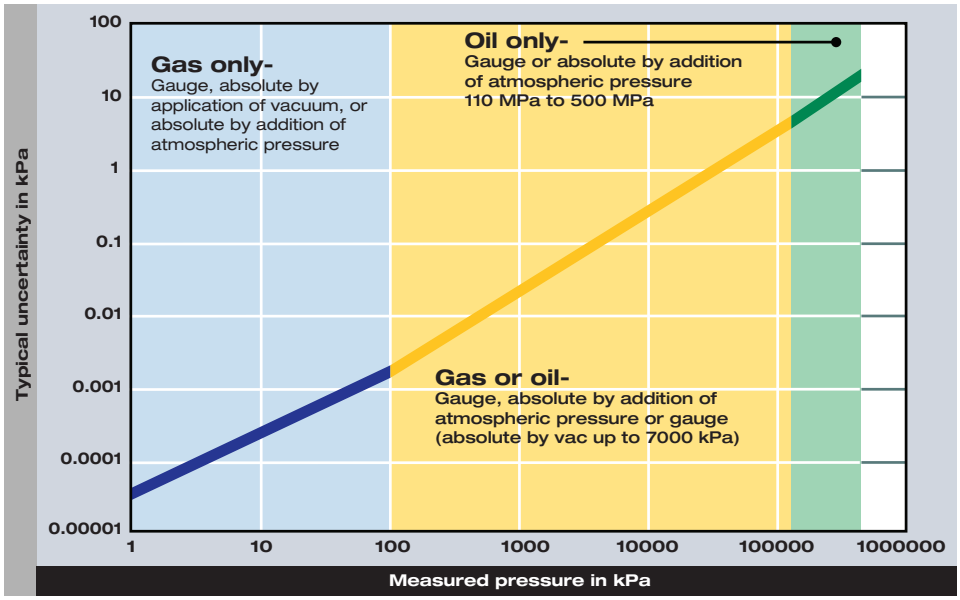
DH Instruments
A Fluke Company

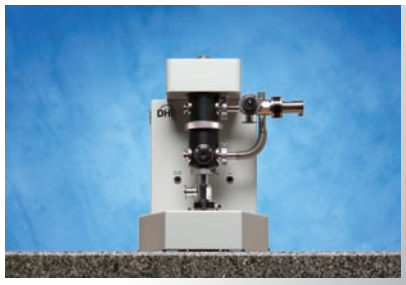
Primary pressure calibration

DH Instruments (DHI), a Fluke company, has a unique focus on very high end primary standard pressure balances for reference laboratories and other applications in which "as good as possible" is the driving specification. DHI pressure balances deliver state-of-the-art metrological performance combined with advanced features that simplify operation and reduce dependence on the operator. More than 30 national measurement institutes rely on DHI pressure standards to establish their pressure references, and the US Air Force recently selected DHI's PG7601™ as its next generation gas pressure standard.

- One coherent line of instruments with a consistent look and feel covers the complete pressure range from a few Pa absolute (less than 100 mTorr) to 500 MPa (72 500 psi) including gas pressure to 100 MPa (15 000 psi).
- FPG86011™ addresses the need for a means of maintaining long term traceability with very low uncertainty in the pressure range under that covered by conventional pressure balances. The measurement range covered is from zero (0.5 Pa in absolute) to 15 kPa (112 Torr, 2.2 psi) in both gauge and absolute modes.
- Calibrations supported by DHI's accredited calibration program and pressure calibration chain feature a 20 year stability history as well as direct traceability to NIST and other national measurement institutes.
- Fully automated operation is available in all ranges, supported by standard personal computer interfaces and off-the-shelf automated calibration software.
- Tungsten carbide piston-cylinders adjusted to sub-micron tolerances provide unmatched sensitivity and drop rates. Patented piston-cylinder modules make piston-cylinder changing a five second, risk free operation.
- Putting together a high-performance pressure calibration system requires more than just the measuring instruments. The pressure generating, controlling and interconnecting accessories must be of the same level as the instruments themselves. Recognizing the importance of providing a complete solution, DHI offers a full line of accessories to complete your system.

Typical pressure measurement uncertainty





Tech tip

Piston drop rate?

The drop rate of a piston is the measure of the rate at which the piston moves vertically while floating. The drop rate is normally negative as the piston moves down to compensate for the loss of pressurized fluid through the piston-cylinder gap.

The natural drop rate is the rate at which the piston descends in a stable system without leaks.

- A drop rate greater than the natural rate suggests a leak in the system.
- A slower drop rate may suggest a dirty piston.
- A positive drop rate suggests a leak across the pressure supply valve on the control, a leak to the outside world if the set pressure is lower than atmosphere or a temperature increase in the test volume.
- Erratic drop rates suggests pressure instability on the test due to external influences such as temperature changes and/or volume changes.

Knowing the natural drop rate of your piston-cylinders is a useful tool in quickly assessing whether conditions are present for a valid measurement.

Visit DH Instruments on the web at **www.fluke.com/fpmcat** for details about pressure and flow calibration products and services, articles and tips, papers and presentations, and much more.

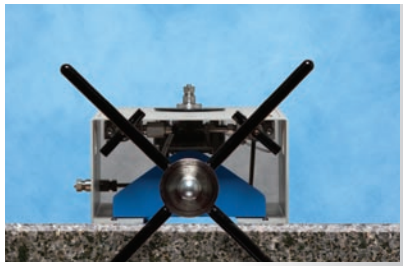
Pressure calibration

DH Instruments
A Fluke Company

Transfer pressure calibration

Pressure transfer standards are used in a wide variety of calibration and testing applications, particularly when maximum speed, simplicity of operation and/or automation are desired. DHI pressure controller/calibrators and monitors are recognized for their advanced design features and functions, extreme rangeability, overall quality and durability, and the realistic specifications that are the hallmark of a true metrology company. All models feature transfer standard quality reference pressure transducers, employing advanced technology to provide unsurpassed pressure measurement specifications.

- PPC pressure controller/calibrators offer fully automated pressure measurement and control in compact and rugged packages, covering the pressure range from low absolute to 70 MPa (10 000 psi) in gas and 200 MPa (30 000 psi) in oil.
- RPM reference pressure monitors are much more than traditional digital pressure indicators. They combine very high accuracy measurement capability and a variety of unique features in compact and easy-to-use packages. Ranges are available from very low pressure to 275 MPa (40 000 psi).

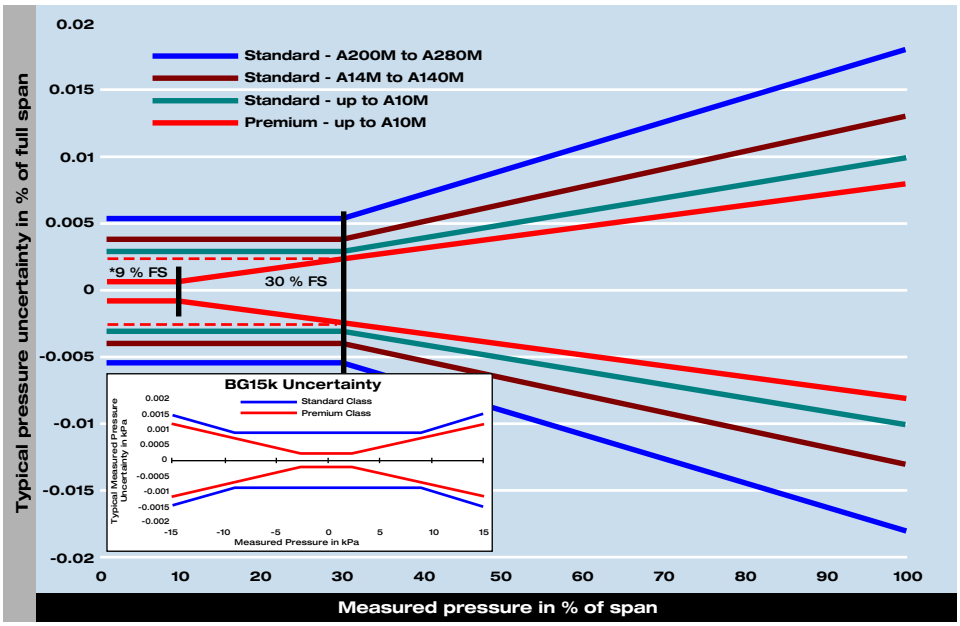


Manufacturing characterization and calibration

DHI's transfer and primary standards are designed to handle applications in production processes that support device characterization and calibration. Automated features and high operational reliability allow intensive tests to be run automatically without interruption for days, weeks or months, with the premium specifications that are DHI's trademark.

- PPC pressure controllers to operate into multi-instrument manifolds over the complete temperature range.
- PPC pressure controllers excel in the most extreme and difficult, very low and very high pressures.
- PG7000-AMH™ fully automated pressure balances deliver specifications at least 10 times better than the best pressure controllers in the automated testing environment.

Transfer measurement uncertainty



*For premium only – downrangeable to 30 % full span

Pressure tip

Predicting the pressure?

Static pressure calibration assumes that the pressure at the device under test can be predicted from the reference pressure measurement at another point in the test system. Changing pressure rapidly causes instability in the test system due to adiabatic temperature changes and creep of pressure vessels. The time required for the effects to dissipate limits the speed at which low uncertainty calibrations can be performed.

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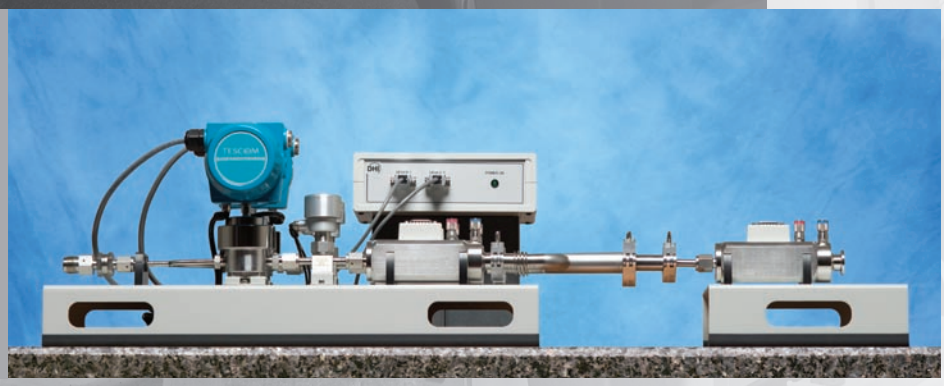
Flow calibration



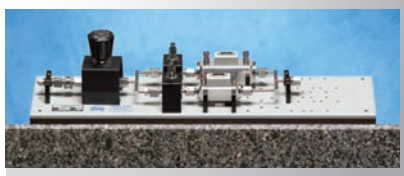
DH Instruments
A Fluke Company

Gas flow calibration

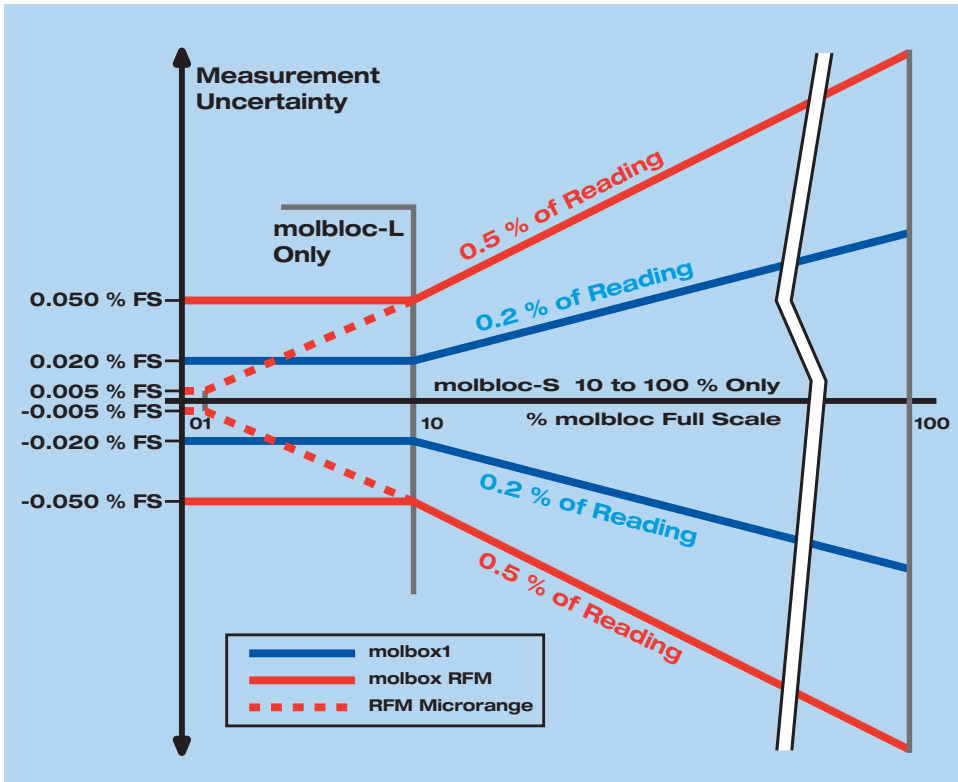
DHI supports gas flow calibration needs from the primary standard laboratory at the apex of the measurement system to secondary laboratories and production calibration and testing.

The molbloc/molbox™ mass flow calibration system is based on patented laminar and sonic nozzle flow element designs that apply today's modern sensor, mathematical modeling, data processing and manufacturing techniques to reach new levels of precision and stability over time. Following its introduction, molbloc/molbox was rapidly and widely adopted by organizations requiring reliable low gas flow measurements, particularly mass flow controller (MFC) manufacturers and users. Today, hundreds of molbloc/molbox systems are in use throughout the world, and molbloc/molbox is truly considered an industry standard for low gas flow calibration.

- molbloc/molbox transfer standard covers the flow range from less than 1 sccm to more than 5000 slm with measurement uncertainty of ± 0.2 % of reading in a compact, easy-to-use, bench top system.
- molbloc/molbox and its accessories are designed to optimize the setup of a complete, automated gas flow calibration system. The system performs a wide variety of flow calibration functions with the greatest convenience and the highest level of automation possible.
- The GFS dynamic gravimetric mass flow calibration system is the only commercially available primary flow standard based on the direct measurement of the fundamental units of mass and time.



molbloc® flow measurement uncertainty



Tech tip

Accurate gas flow calibrations require attention to detail.

- For standard or normal flow units (e.g.; slm, nccm), assure you are using the same reference pressure and temperature for the flow standard and device under test.
- Are you calibrating the device under test under its correct operating conditions, or making proper corrections if not?
- Flow standards and instrumentation can be susceptible to contamination. Are you using a clean, dry gas source and appropriate filtration?
- Reduce stabilization time for low flow calibrations by minimizing the gas volume between the flow reference and device under test.

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Calibration software

Software

MET/CAL® *Plus* calibration software

- Perform manual and automated calibration.
- Improve calibration consistency and efficiency.
- Track calibration and maintenance asset history, traceability, customers and location.
- Support plan includes free software upgrades and updates plus free access to Warranted Procedures.

Data acquisition software

- Data loggers include Windows®–based software, making instrument configuration and data analysis as easy as a few mouse clicks.
- A wide variety of optional software and development tools to support almost any research or industrial application.

FlukeView® Forms software

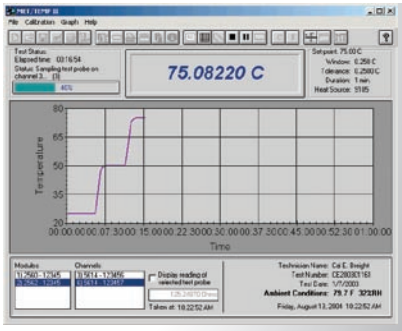
- Available for the 8845A/8846A digital multimeters.
- Document, store and analyze individual readings or series of measurements, then convert them into professional-looking documents.

Hart temperature calibration software

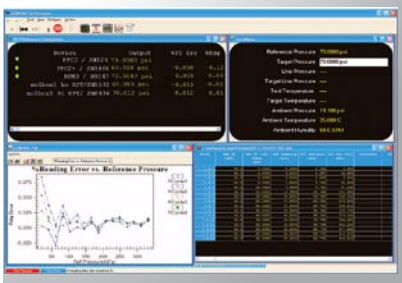
- Communicate with thermometer readouts and control multiple heat sources so calibrations can run unattended.
- Log and analyze data in real time.
- Get plug-and-play compatibility with all Hart temperature products.
- Automate calibrations of PRTs, thermistors, and Hart manufactured dry well heatsources.
- Generate ITS-90 thermometer coefficients and calibration reports.

COMPASS® software

- COMPASS® for molbox™ software configures an integrated, fully automated system for the calibration and testing of MFCs and other gas flow controlling and measuring devices.
- COMPASS® for Pressure calibration software automates pressure calibrations to the level supported by the available hardware.
- Expert software configuration, installation and training services get your hardware and software investments up and running.
- Run complete, automated calibration sequences on single or multiple units under test, unattended.
- Advanced on-board report editor with simple template editing to produce customized calibration reports.
- Creates standard test data files that are easily imported into Microsoft® Excel and other software tools. Also outputs to an external database.



MET/TEMP II Automated Calibration Software



COMPASS® main run screen

Tech Tips

MET/CAL *Plus* software tips

- Use MET/CAL guardbanded procedures when TURs drop below adequate TURs.
- Always use the MET/CAL dual GPIB configuration to eliminate potential problems with UUT GPIB interface.

PC based data acquisition

- Always use a remote interface tool to communicate with an instrument in IEEE-488 or RS232 prior to using it for the first time in a PC based data acquisition program. This guarantees that the PC and instrument interface are properly set up.
- Double check all power and communications cabling and interface settings before any automated test. Power and communications settings are frequently the reason why an automated test does not run.
- Always log min, max, standard deviation and the number of samples when averaging reference and device under test outputs in an automated test.

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