**Purpose:**

 To provide an estimate of:

1. The best uncertainty for the generated pressure to be published in the A2LA scope of accreditation.
2. The expanded measurement uncertainty for the test sensor (SUT) output. This value includes the generated pressure uncertainty and the uncertainty of the SUT readout device. This result is documented on the calibration certificate (with a 95% confidence level) for pressure sensors calibrated using either “Automated DC Pressure Calibration Station.”

**Responsibilities:**

 The Quality Assurance Manager and the Calibration Lab Technical Director have the responsibility for maintaining this procedure.

**Associated Documents:**

 ISO 9001, ISO 10012-1, ISO 17025, ISA-S37.3, EA-4/02, Quality System Manual, Quality Assurance Manual

**Procedure:**

Source Pressure and Test Set-Up Description:

 Each “Automated DC Pressure Calibration Station” utilizes two pressure controllers (one for lower pressure and one for higher pressures) that employ the comparison calibration technique. Pressure values are referenced to a built-in, high-accuracy, high-stability, pressure sensor. There are two systems, one manufactured by DH Instruments, and one manufactured by Fluke.

After the basics (DVM type, controller model, sensor type, serial number, etc…) of the system are configured and the test sensor is mounted to the pressure manifold, the technician uses DH Instrument’s Compass controls software to recall a profile, which includes the required test pressure values. Next, the DH Instruments or Fluke controller automatically pressurizes the manifold to the required pressure and waits for the set-up to stabilize. Then, the system acquires the value on the test sensor DVM (Agilent 34401A for DHI system, and Keysight 34980A for Fluke system) as well as the value for the built-in reference pressure sensor. This process continues until all of the pressure values have been completed. This data is imported into an MS-Excel spreadsheet, where the test sensor output data is plotted against the actual pressure as determined by the reference pressure sensor. Finally, a least-squares, straight-line method is used to calculate a sensitivity for the test sensor.

 DH Instruments defines the calibrator’s measurement uncertainty as the maximum deviation of the reference pressure sensor indication from the true value of the measured pressure including linearity, hysteresis, repeatability, long-term stability, temperature effect and calibration standard uncertainty.

 (The DH Instruments PPC2+ unit has a total of 5 internal reference sensors for both gauge and absolute measurements, the high pressure DH Instruments PPCK+ unit has 3 internal reference sensors. The Fluke 6270A has 4 internal pressure references, and the Fluke 8370A has 1 internal reference. The controller automatically selects the appropriate reference sensor to provide the best accuracy for the current test pressure value.)

**DH Instruments System Uncertainty:**

Appendix A contains a copy of the DH Instruments documentation, while table 1 summarizes this information.

 Table#1: DHI static pressure source error for measurements:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SUT Model Test Ranges (psi) | DHI PPC2+ InternalReference range(psi) | DHI PPCK+ InternalReference range(psi) | DHI Error % ofFull scale | RelativeError % ofFS test range |
| 10 | 30 | n/a | 0.013 | 0.04 |
| 10 | 15 | n/a | 0.013 | 0.02 |
| 15 | 30 | n/a | 0.013 | 0.03 |
| 15 | 15 | n/a | 0.013 | 0.01 |
| 30 | 30 | n/a | 0.013 | 0.01 |
| 30 | 50 | n/a | 0.013 | 0.02 |
| 50 | 60 | n/a | 0.013 | 0.02 |
| 50 | 50 | n/a | 0.013 | 0.01 |
| 100 | 100 | n/a | 0.013 | 0.01 |
| 200 | 300 | n/a | 0.013 | 0.02 |
| 300 | 300 | n/a | 0.013 | 0.01 |
| 500 | 600 | n/a | 0.013 | 0.02 |
| 1000 | 1000 | n/a | 0.013 | 0.01 |
| 2000 | n/a | 3000 | 0.018 | 0.03 |
| 3000 | n/a | 3000 | 0.018 | 0.02 |
| 6000 | n/a | 6000 | 0.018 | 0.02 |
| 10000 | n/a | 10000 | 0.018 | 0.02 |

\* Best uncertainty using a coverage factor of *k*=2, which provides a level of confidence of about 95%.

**NOTE 1:** The internal reference sensor is the same for gauge and absolute measurements in all ranges except for ranges below 100 psi. The shaded cells in tables 1, 7, and 8 indicate the % error for absolute measurements in those ranges only.

Readout Device:

The DVM uncertainty is dependent on the measurement parameter and selected range. Using the published accuracy bounds as the limits, these values are used to calculate the component uncertainty for the DVM. Appendix A contains a copy of the Agilent/HP34401A documentation, while this information is summarized in Table 2.

Table #2: Agilent 34401A meter specification for test ranges used on DHI system:

|  |  |  |
| --- | --- | --- |
| Function | Range | 1 year 23 ºC ±5 ºC± (% of reading + % of range) |
| DC Voltage | 100.000 mV | 0.0050 + 0.0035 |
|  | 1.00000 V | 0.0040 + 0.0007 |
|  | 10.0000 V | 0.0035 + 0.0005 |
| DC Current | 10.0000 mA | 0.050 + 0.020 |
|  | 100.000 mA | 0.050 + 0.005 |

Measurement Error:

 Using the information provided in table 2, the error associated with the selected meter ranges when calibrating both the voltage and current output SUT’s is summarized in tables 3 and 4.

Table #3: SUT Voltage output error for DHI system:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Measured output (volts) | Meter auto range setting (volts) | Error (volts) | Error % of 100 millivolt FS | Error % of 5 volt FS | Error % of 10 volt FS |
| 0.02 | 0.1 | 0.000005 | 0.0045 | n/a | n/a |
| 0.04 | 0.1 | 0.000006 | 0.0055 | n/a | n/a |
| 0.06 | 0.1 | 0.000007 | 0.0065 | n/a | n/a |
| 0.08 | 0.1 | 0.000008 | 0.0075 | n/a | n/a |
| 0.1 | 0.1 | 0.000009 | 0.0085 | n/a | n/a |
| 1.0 | 1.0 | 0.000047 | n/a | 0.00094 | 0.00047 |
| 2.0 | 10.0 | 0.000120 | n/a | 0.00240 | 0.00120 |
| 3.0 | 10.0 | 0.000155 | n/a | 0.00310 | 0.00155 |
| 4.0 | 10.0 | 0.000190 | n/a | 0.00380 | 0.00190 |
| 5.0 | 10.0 | 0.000225 | n/a | 0.00450 | 0.00225 |
| 6.0 | 10.0 | 0.000260 | n/a | n/a | 0.00260 |
| 8.0 | 10.0 | 0.000330 | n/a | n/a | 0.00330 |
| 10.0 | 10.0 | 0.000400 | n/a | n/a | 0.00400 |

 Table #4: SUT Current output error for DHI system:

|  |  |  |  |
| --- | --- | --- | --- |
| Measured output (mA) | Meter auto range setting (mA) | Error (mA) | Error % of 16 mA Span |
| 4.0 | 10.0 | 0.004 | 0.02500 |
| 8.0 | 10.0 | 0.006 | 0.03750 |
| 12.0 | 100.0 | 0.011 | 0.06875 |
| 16.0 | 100.0 | 0.013 | 0.08125 |
| 20.0 | 100.0 | 0.015 | 0.09375 |

Uncertainty Calculation:

 The expanded uncertainty for this system is simply based on the uncertainty of the DVM as well as the published uncertainty of the controller/reference pressure sensor. The definition for the combination of source and measurement error is summarized in table 5.

Table #5: DHI static pressure sources of error:

|  |  |  |  |
| --- | --- | --- | --- |
| Source of uncertainty | Probability Distribution | Sens. Coef.*ci* | Comments |
| DHI PPK2+DHI PPCK+ | Rectangular |  | 1 | Assumes nominal values, standard operating procedure |
| Digital Volt MeterHP34401A | Rectangular |  | 1 | Meter specification for active voltage and current ranges relative to SUT. |
| \*Regulated DC Power Supply | Rectangular |  | 1 | Power supply specification for active excitation voltage required for 100mV SUT |

Expanded Uncertainty

The total expanded uncertainty is determined by combining the factors identified in table 5 and calculating the square root of the sum of the squares. While table 6 explains the error budget, the expanded uncertainties for the various configurations of voltage and current output SUT’s is summarized in tables 7 and 8.

 Table #6: DHI static pressure calibration error budget

|  |  |  |  |
| --- | --- | --- | --- |
| Source of uncertainty | Component uncertaintyxi | Probability coefficientpi | Relative standard uncertaintyui |
| DHI PPC2+DHI PPCK+ | See table 7 (column 1) |  | See table 7 (Column 2) |
| Digital Volt MeterHP34401A(Reading) | 0.0085 voltage0.0938 current Maximum value from tables 3 and 4 |  | 0.00490.0541 |
| \*Regulated DC Power Supply | 0.02 |  | 0.0115 |
|  |  | Combined standard uncertaintyuc | See table 7 (Column 3)For voltageSee table 7 (Column 4)For currentSee table 8 (Column 3)For 100 mV w/excitation |
|  |  | Expanded uncertainty (± % FS)U (k=2) | See table 7 (Column 5)For voltageSee table 7 (Column 6)For currentSee table 8 (Column 4)For 100 mV w/excitation |

**\*NOTE:** The power supply contribution of error only applies to the SUT’s operating with 100 mV full-scale output that require an excitation voltage. These values are summarized in table 8.

Table #7: Summary of expanded uncertainty for static pressure SUT’s for DHI system:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Column | 1 | 2 | 3 | 4 | 5 | 6 |
| Test range | RelativeError % ofFS test range xi | Relative standard uncertainty from sourceui | Combined standard uncertainty for Voltageuc | Combined standard uncertainty for Currentuc | Expanded uncertainty for **Voltage**(± % FS)U (k=2) | Expanded uncertainty for **Current**(± % FS)U (k=2) |
| 10 | 0.04 | 0.02 | 0.02 | 0.06 | **0.05** | **0.12** |
| 10 | 0.02 | 0.01 | 0.01 | 0.06 | **0.02** | **0.11** |
| 15 | 0.03 | 0.02 | 0.02 | 0.06 | **0.03** | **0.11** |
| 15 | 0.01 | 0.01 | 0.01 | 0.05 | **0.02** | **0.11** |
| 30 | 0.01 | 0.01 | 0.01 | 0.05 | **0.02** | **0.11** |
| 30 | 0.02 | 0.01 | 0.01 | 0.06 | **0.03** | **0.11** |
| 50 | 0.02 | 0.01 | 0.01 | 0.05 | **0.02** | **0.11** |
| 50 | 0.01 | 0.01 | 0.01 | 0.05 | **0.02** | **0.11** |
| 100 | 0.01 | 0.01 | 0.01 | 0.05 | **0.02** | **0.11** |
| 200 | 0.02 | 0.01 | 0.01 | 0.06 | **0.02** | **0.11** |
| 300 | 0.01 | 0.01 | 0.01 | 0.05 | **0.02** | **0.11** |
| 500 | 0.02 | 0.01 | 0.01 | 0.05 | **0.02** | **0.11** |
| 1000 | 0.01 | 0.01 | 0.01 | 0.05 | **0.02** | **0.11** |
| 2000 | 0.03 | 0.02 | 0.02 | 0.06 | **0.03** | **0.11** |
| 3000 | 0.02 | 0.01 | 0.01 | 0.06 | **0.02** | **0.11** |
| 6000 | 0.02 | 0.01 | 0.01 | 0.06 | **0.02** | **0.11** |

Table #8: Summary of expanded uncertainty for 100 mV SUT’s with required excitation voltage:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Column | 1 | 2 | 3 | 4 |
| Test range | Component uncertainty from sourcexi | Relative standard uncertainty from sourceui | Combined standard uncertainty for 100 mV Voltage SUT’s using power supplyuc | Expanded uncertainty for 100 mV Voltage SUT’s using power supply(± % FS)U (k=2) |
| 10 | 0.04 | 0.02 | 0.03 | **0.05** |
| 10 | 0.02 | 0.01 | 0.02 | **0.03** |
| 15 | 0.03 | 0.02 | 0.02 | **0.04** |
| 15 | 0.01 | 0.01 | 0.01 | **0.03** |
| 30 | 0.01 | 0.01 | 0.01 | **0.03** |
| 30 | 0.02 | 0.01 | 0.02 | **0.04** |
| 50 | 0.02 | 0.01 | 0.02 | **0.03** |
| 50 | 0.01 | 0.01 | 0.01 | **0.03** |
| 100 | 0.01 | 0.01 | 0.01 | **0.03** |
| 200 | 0.02 | 0.01 | 0.02 | **0.03** |
| 300 | 0.01 | 0.01 | 0.01 | **0.03** |
| 500 | 0.02 | 0.01 | 0.02 | **0.03** |
| 1000 | 0.01 | 0.01 | 0.01 | **0.03** |
| 2000 | 0.03 | 0.02 | 0.02 | **0.04** |
| 3000 | 0.02 | 0.01 | 0.02 | **0.03** |
| 6000 | 0.02 | 0.01 | 0.02 | **0.03** |

Table 5, 6, 7and 8 explanation:

Probability coefficient  normal distribution;  rectangular distribution

Sensitivity coefficient  = linear dependency;  = quadratic dependency

Component uncertainty = individual contributions of error identified in the total error budget

Relative uncertainty 

Combined uncertainty 

Expanded uncertainty  (where; )

**Fluke System Uncertainty:**

Limits of uncertainty calculations:

* Will only be applicable to mV/V models with an excitation voltage of 3V or greater.
* Models that have a full scale output of 100 mV or greater.

Pressure Reference Uncertainty:

The 1 year Instrument uncertainty and the Precision uncertainty are provided on fluke specification sheets in the appendix and are summarized below in (columns 4 and 5).

Table #9: Fluke static pressure source error for measurements

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Model Test Ranges (psi)** | **Internal Reference (psi)** | **Fluke Reference P/N** | **1 year Instrumental Uncertainty** | **Precision Uncertainty** | **1 year Instrumental Uncertainty** | **Precision Uncertainty** | **Worst Case Uncertainty - Gauge %FS URefG** | **Worst Case Uncertainty- Atmospheric Measurement %FS\*\*****URefAtm** |
| **% Reading** | **%FS** | **% Reading** | **%FS** | **Reading (psi)** | **FS (psi)** | **Max value (psi)** | **Reading (psi)** | **FS (psi)** | **Max value (psi)** |
| **Barometeric Reference modules (BRM)** |
| 15 | 17.4 | PM500-A120K | 0.01 | 0.05 | 0.007 | 0.0035 | 0.0015 | 0.0087 | 0.0087 | 0.0011 | 0.0006 | 0.0011 | **N/A\*** | **0.0584** |
| 17.4 | 17.4 | PM500-A120K | 0.01 | 0.05 | 0.007 | 0.0035 | 0.0017 | 0.0087 | 0.0087 | 0.0012 | 0.0006 | 0.0012 | **N/A\*** | **0.0505** |
| Bi-Directional Gauges |
| 15 | 100 | PM500-BG700K |  N/A | 0.01 |  N/A | 0.005 | 0.0000 | 0.0100 | 0.0100 | 0.0000 | 0.0050 | 0.0050 | **0.0745** | **0.0947** |
| 100 | 100 | PM500-BG700K | N/A  | 0.01 |  N/A | 0.005 | 0.0000 | 0.0100 | 0.0100 | 0.0000 | 0.0050 | 0.0050 | **0.0112** | **0.0595** |
| 100 | 1000 | PM500-BG7M | 0.01 | 0.005 | 0.007 | 0.0035 | 0.0100 | 0.0500 | 0.0500 | 0.0070 | 0.0350 | 0.0350 | **0.0610** | **0.0845** |
| 1000 | 1000 | PM500-BG7M | 0.01 | 0.005 | 0.007 | 0.0035 | 0.1000 | 0.0500 | 0.1000 | 0.0700 | 0.0350 | 0.0700 | **0.0122** | **0.0597** |
| 1000 | 3000 | PM500-BG20M | 0.01 | 0.005 | 0.007 | 0.0035 | 0.1000 | 0.1500 | 0.1500 | 0.0700 | 0.1050 | 0.1050 | **0.0183** | **0.0612** |
| 3000 | 3000 | PM500-BG20M | 0.01 | 0.005 | 0.007 | 0.0035 | 0.3000 | 0.1500 | 0.3000 | 0.2100 | 0.1050 | 0.2100 | **0.0122** | **0.0597** |
| 3000 | 10000 | PM630-A70M | 0.01 | 0.003 | 0.008 | 0.0024 | 0.3000 | 0.3000 | 0.3000 | 0.2400 | 0.2400 | 0.2400 | **0.0128** | **N/A\*\*** |
| 10000 | 10000 | PM630-A70M | 0.1 | 0.003 | 0.008 | 0.0024 | 10.0000 | 0.3000 | 10.000 | 0.8000 | 0.2400 | 0.8000 | **0.1003** | **N/A\*\*** |

\* This reference not capable of gauge measurements

\*\*This reference not capable of atmospheric measurements

The conversion from percent error to pressure error is calculated for each instance (results in columns 6 and 7) per the following equations,

 *Reading(psi) = (%Reading/100) \* Model test range*

 *FS(psi) = (%FS/100) \* Internal reference*

Then the greater value of pressure error for 1 year instrumental uncertainty is selected and listed in table #9. The Worst case uncertainty for gauge measurement (URefG) is calculated as follows and is listed in column 8,

 *URefG =* $√[$*(1 year instrumental uncertainty max)2 + (Precision Uncertainty max)2]*

Fluke bi-directional mode modules support absolute mode measurement when used with a barometric reference module(BRM). In this system the PM500-A120K is the BRM used. Fluke specifies the uncertainty of an atmospheric measurement using a bi-directional gaue, is the root sum square of the bi-directional gauge and the BRM. The uncertainty for the BRM in this system is calculated as follows and listed in column 9,

 *URefAtm =* $√[$*(1 year instrumental uncertainty max)2 + (Precision Uncertainty max)2]*

And the uncertainty for bi-direction gauges is calculated as follows and is listed in column 9,

 *URefAtm =* $√[$*(URefG)2 + (.0584)2]*

Readout Device:

The DVM uncertainty is dependent on the measurement parameter and selected range. Using the published accuracy bounds as the limits, these values are used to calculate the component uncertainty for the DVM. Keysight 34980A documentation located in appendix A and is summarized in Table 10.

Table #10: Keysight 34980A meter specification for test ranges used on Fluke system

|  |  |  |
| --- | --- | --- |
| **Function** | **Range** | **1 year Tcal ± 5°C (± % of reading + % Range)** |
| **% Reading** | **% Range** |
| **DC Voltage** | 100.00 mV | 0.005 | 0.004 |
| 1.0000V | 0.004 | 0.0007 |
| 10.0000V | 0.0035 | 0.0005 |
| **DC Current** | 10.0000 mA | 0.05 | 0.02 |
| 100.0000 mA | 0.05 | 0.005 |

Measurement Error:

 Using the information provided in table 11, the error associated with the selected meter ranges when calibrating both the voltage and current output SUT’s is summarized in tables 11 and 12.

Table#11: Voltage measurement and data acquisition system error for Fluke system

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **1** | **2** | **3** | **4** | **5** | **6** |
| **Measured Output (V)** | **Meter Auto Range Setting (V)** | **Error (V)** | **Error % of 100mV FS** | **Error % of 5V FS** | **Error % of 10V FS** |
| 0.02 | 0.1 | 0.000005 | 0.0050 | N/A | N/A |
| 0.04 | 0.1 | 0.000006 | 0.0060 | N/A | N/A |
| 0.06 | 0.1 | 0.000007 | 0.0070 | N/A | N/A |
| 0.08 | 0.1 | 0.000008 | 0.0080 | N/A | N/A |
| 0.1 | 0.1 | 0.000009 | 0.0090 | N/A | N/A |
| 5 | 10.0 | 0.000225 | N/A | 0.00450 | N/A |
| 10 | 10.0 | 0.0004 | N/A | N/A | 0.004 |

The voltage error (column 3) is calculated using values from tables 10 and 11 as,

 $Error\left(V\right)=MeasuredOutput\*\frac{\%Reading}{100}+Meter Auto range\*\frac{\%Range}{100}$

Columns 4, 5, and 6 are calculated by dividing by the applicable full scale voltage and multiplying by 100.

 *Error % of FS = [Error(V) / FS]\*100*

Table#12: Current measurement and data acquisition system error for Fluke system

|  |  |  |  |
| --- | --- | --- | --- |
| **1** | **2** | **3** | **4** |
| **Measured Output (mA)** | **Meter Auto Range Setting (mA)** | **Error (mA)** | **Error % of 16 mA Span** |
| 4.0 | 10.0 | 0.004 | 0.02500 |
| 8.0 | 10.0 | 0.006 | 0.03750 |
| 12.0 | 100.0 | 0.011 | 0.06875 |
| 16.0 | 100.0 | 0.013 | 0.08125 |
| 20.0 | 100.0 | 0.015 | 0.09375 |

The voltage error is calculated using values from tables 10 and 12 as,

 $Error\left(mA\right)=MeasuredOutput\*\frac{\%Reading}{100}+Meter Auto range\*\frac{\%Range}{100}$

 $Error\left(\%16 mA Span\right)=\frac{Error\left(mA\right)}{16}\*100$

Power Supply Uncertainty:

The documentation of uncertainty of the power supply is listed in the appendix, and summarized below in table 13.

This uncertainty is only for mV/V models that require an excitation voltage. This uncertainty is only applicable for models with excitation voltages as low as 3V, so the scope of this chart is limited to this range

Table#13: Power supply uncertainty

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Voltage** | **% of output** | **Shift (mV)** | **Total error (mV)** | **%FS** |
| 3 | 0.01 | 3 | 3.3 | 0.11 |
| 10 | 0.01 | 3 | 4 | 0.04 |
| 20 | 0.01 | 3 | 5 | 0.025 |

Total voltage error is calculated as,

 *Total error (mV) = [(% of output)\*(Voltage)]*

Uncertainty Calculation:

The expanded uncertainty for this system is simply based on the uncertainty of the DVM as well as the published uncertainty of the controller/reference pressure sensor and power supply when applicable. The definition for the combination of source and measurement error is summarized in table 14.

Table#14: Static pressure sources of error:

|  |  |  |  |
| --- | --- | --- | --- |
| Source of uncertainty | Probability Distribution | Sens. Coef.*ci* | Comments |
| Fluke reference pressure transducers | Rectangular |  | 2 | Assumes nominal values, standard operating procedure |
| Digital Volt MeterKeysight 34980A | Rectangular |  | 2 | Meter specification for active voltage and current ranges relative to SUT. |
|  DC Power Supply | Rectangular |  | 2 | Power supply specification for mV/V models only |

Expanded Uncertainty:

Using the uncertainties for each component of the system and combining them with the probability distribution and sensitivity coefficient listed in table 14. The calculations are completed for mV/V excitation models (in table 15), voltage ouput models (table 16), and current output models (table 17).

Table #15: Summary of expanded uncertainty mV/V SUT’s that require excitation voltage

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test Mode | Test Range | Reference Range (psi) | Worst Case Uncertainty - Reference transducer(URefAtm and URefG) | UREF\*1/$√3$ | Worst case Uncertainty Measurement(UVOLT) | UVOLT\* 1/$√3$ | Worst case Uncertainty - Power Supply(UPS) | UPS\*1/$√3$ | Total Combined uncertainty (%FS) | **Total Expanded Uncertainty (%FS)** |
| Atmosphere | 15 | 17.4 | 0.0122 | 0.0070 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.06411 | **0.128** |
| 17.4 | 17.4 | 0.0122 | 0.0070 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.06411 | **0.128** |
| 100 | 100 | 0.0166 | 0.0096 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.06443 | **0.129** |
| 100 | 1000 | 0.0622 | 0.0359 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.07316 | **0.146** |
| 1000 | 1000 | 0.0173 | 0.0100 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.06450 | **0.129** |
| 1000 | 3000 | 0.0220 | 0.0127 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.06497 | **0.130** |
| 3000 | 3000 | 0.0173 | 0.0100 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.06450 | **0.129** |
| Gauge | 15 | 100 | 0.0745 | 0.0430 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.07689 | **0.154** |
| 100 | 100 | 0.0112 | 0.0065 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.06405 | **0.128** |
| 100 | 1000 | 0.0610 | 0.0352 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.07281 | **0.146** |
| 1000 | 1000 | 0.0122 | 0.0070 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.06411 | **0.128** |
| 1000 | 3000 | 0.0183 | 0.0106 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.06459 | **0.129** |
| 3000 | 3000 | 0.0122 | 0.0070 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.06411 | **0.128** |
| 3000 | 10000 | 0.0128 | 0.0074 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.06415 | **0.128** |
| 10000 | 10000 | 0.1003 | 0.0579 | 0.0090 | 0.0052 | 0.11 | 0.0635 | 0.08611 | **0.172** |

Where,

Total combined uncertainty = $√[$(URefAtm\*1/$√3)$2 + (UVOLT\* 1/$√3$)2 + (UPS\*1/$√3$)2] [For atmospheric models]

 = $√[$(URefG\*1/$√3)$2 + (UVOLT\* 1/$√3$)2 + (UPS\*1/$√3$)2 ] [For gauge models]

Total Expanded uncertainty = Total combined uncertainty \* ci

Table #16: Expanded uncertainty for voltage SUT’s with on Fluke system:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test Mode | Test Range | Reference Range (psi) | Worst Case Uncertainty - Reference transducer | Worst Case Uncertainty - Rectanguar Distribution | Worst case Uncertainty Measurement - Voltage | Worst case Uncertainty Measurement - Rectangular Distribution | Total Combined uncertainty (%FS) | **Total Expanded Uncertainty (%FS)** |
| Atmosphere | 15 | 17.4 | 0.0122 | 0.0070 | 0.0938 | 0.0541 | 0.05458 | **0.109** |
| 17.4 | 17.4 | 0.0122 | 0.0070 | 0.0938 | 0.0541 | 0.05458 | **0.109** |
| 15 | 100 | 0.0755 | 0.0436 | 0.0938 | 0.0541 | 0.06951 | **0.139** |
| 100 | 100 | 0.0166 | 0.0096 | 0.0938 | 0.0541 | 0.05496 | **0.110** |
| 100 | 1000 | 0.0622 | 0.0359 | 0.0938 | 0.0541 | 0.06497 | **0.130** |
| 1000 | 1000 | 0.0173 | 0.0100 | 0.0938 | 0.0541 | 0.05504 | **0.110** |
| 1000 | 3000 | 0.0220 | 0.0127 | 0.0938 | 0.0541 | 0.05560 | **0.111** |
| Gauge | 15 | 100 | 0.0745 | 0.0430 | 0.0938 | 0.0541 | 0.06915 | **0.138** |
| 100 | 100 | 0.0112 | 0.0065 | 0.0938 | 0.0541 | 0.05451 | **0.109** |
| 100 | 1000 | 0.0610 | 0.0352 | 0.0938 | 0.0541 | 0.06459 | **0.129** |
| 1000 | 1000 | 0.0122 | 0.0070 | 0.0938 | 0.0541 | 0.05458 | **0.109** |
| 1000 | 3000 | 0.0183 | 0.0106 | 0.0938 | 0.0541 | 0.05515 | **0.110** |
| 3000 | 3000 | 0.0122 | 0.0070 | 0.0938 | 0.0541 | 0.05458 | **0.109** |
| 3000 | 10000 | 0.0128 | 0.0074 | 0.0938 | 0.0541 | 0.05463 | **0.109** |
| 10000 | 10000 | 0.1003 | 0.0579 | 0.0938 | 0.0541 | 0.07927 | **0.159** |

Where,

Total combined uncertainty = $√[$(URefAtm\*1/$√3)$2 + (UPS\*1/$√3$)2] [For atmospheric models]

 = $√[$(URefG\*1/$√3)$2 + (UPS\*1/$√3$)2 ] [For gauge models]

Total Expanded uncertainty = Total combined uncertainty \* ci

Table #17: Expanded uncertainty for current SUT’s with on Fluke system:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test Mode | Test Range | Reference Range (psi) | Worst Case Uncertainty - Reference transducer | Worst Case Uncertainty - Rectanguar Distribution | Worst case Uncertainty Measurement - Current | Worst case Uncertainty Measurement - Rectangular Distribution | Total Combined uncertainty (%FS) | **Total Expanded Uncertainty (%FS)** |
| Atmosphere | 15 | 17.4 | 0.0122 | 0.0070 | 0.0090 | 0.0052 | 0.00876 | **0.018** |
| 17.4 | 17.4 | 0.0122 | 0.0070 | 0.0090 | 0.0052 | 0.00876 | **0.018** |
| 15 | 100 | 0.0755 | 0.0436 | 0.0090 | 0.0052 | 0.04391 | **0.088** |
| 100 | 100 | 0.0166 | 0.0096 | 0.0090 | 0.0052 | 0.01088 | **0.022** |
| 100 | 1000 | 0.0622 | 0.0359 | 0.0090 | 0.0052 | 0.03631 | **0.073** |
| 1000 | 1000 | 0.0173 | 0.0100 | 0.0090 | 0.0052 | 0.01124 | **0.022** |
| 1000 | 3000 | 0.0220 | 0.0127 | 0.0090 | 0.0052 | 0.01373 | **0.027** |
| Gauge | 15 | 100 | 0.0745 | 0.0430 | 0.0090 | 0.0052 | 0.04335 | **0.087** |
| 100 | 100 | 0.0112 | 0.0065 | 0.0090 | 0.0052 | 0.00829 | **0.017** |
| 100 | 1000 | 0.0610 | 0.0352 | 0.0090 | 0.0052 | 0.03562 | **0.071** |
| 1000 | 1000 | 0.0122 | 0.0070 | 0.0090 | 0.0052 | 0.00876 | **0.018** |
| 1000 | 3000 | 0.0183 | 0.0106 | 0.0090 | 0.0052 | 0.01178 | **0.024** |
| 3000 | 3000 | 0.0122 | 0.0070 | 0.0090 | 0.0052 | 0.00876 | **0.018** |
| 3000 | 10000 | 0.0128 | 0.0074 | 0.0090 | 0.0052 | 0.00904 | **0.018** |
| 10000 | 10000 | 0.1003 | 0.0579 | 0.0090 | 0.0052 | 0.05815 | **0.116** |

Where,

Total combined uncertainty = $√[$(URefAtm\*1/$√3)$2 + (UPS\*1/$√3$)2] [For atmospheric models]

 = $√[$(URefG\*1/$√3)$2 + (UPS\*1/$√3$)2 ] [For gauge models]

Total Expanded uncertainty = Total combined uncertainty \* ci

**Referenced Documents:**

* Agilent/HP34401A Multi-meter manual
* DHI PPC2+ and PPCK+ Manuals
* Fluke PM500 Pressure measurement modules specification sheet
* Fluke PM600 Pressure measurement modules specification sheet
* Keysight 34980A Data sheet
* Keysight E3640A Data sheet

**Unusual Conditions:**

 NOTE: Additional experimental random uncertainty values were not added into the final total expanded uncertainty for two reasons. First, the measurement uncertainty provided by DH Instruments already includes repeatability and long-term stability characteristics of their system. Second, the reference pressure sensors are of a vibrating quartz-beam construction and are considered state-of-the-art. In other words, additional experimental random uncertainty data would really only be characterizing the repeatability of the test sensor and the not best measurement capabilities of the calibration system.

**Appendix A**

Keysight 34401A Accuracy Specifications: (From data sheet)



DH Instruments PPC2+ Reference Specifications: (from manual)



### Fluke PM500 Summary:

### PM500 Modules measurement specifications

Specifications are valid from 15 °C to 35 °C.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Model** | **Range(SI Units)** | **Range(Imperial Units)** | **MeasurementMode2** | **1-YearInstrumental Uncertainty(% of reading or % FS, whichever is greater) unless otherwise stated** | **1-Year Zero Instrumental Drift% FS, RSS with 1-Year Instrumental Uncertainty1** | **Precision Uncertainty(% of reading or % FS, whichever is greater)** |
| PM500-G100K4 | 0 kPa to 100 kPa | 0 psi to 15 psi | gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-G200K4 | 0 kPa to 200 kPa | 0 psi to 30 psi | gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-G250K4 | 0 kPa to 250 kPa | 0 psi to 36 psi | gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-G350K4 | 0 kPa to 350 kPa | 0 psi to 50 psi | gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-G400K4 | 0 kPa to 400 kPa | 0 psi to 60 psi | gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-G600K4 | 0 kPa to 600 kPa | 0 psi to 90 psi | gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-G700K5 | 0 kPa to 700 kPa | 0 psi to 100 psi | gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-BG1M5 | -0.1 MPa to 1 MPa | -15 psi to 150 psi | bi-directional gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-BG1.4M5 | -0.1 MPa to 1.4 MPa | -15 psi to 200 psi | bi-directional gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-BG2M5 | -0.1 MPa to 2 MPa | -15 psi to 300 psi | bi-directional gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-BG2.5M5 | -0.1 MPa to 2.5 MPa | -15 psi to 400 psi | bi-directional gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-BG3.5M5 | -0.1 MPa to 3.5 MPa | -15 psi to 500 psi | bi-directional gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-BG4M5 | -0.1 MPa to 4 MPa | -15 psi to 600 psi | bi-directional gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-BG7M5 | -0.1 MPa to 7 MPa | -15 psi to 1000 psi | bi-directional gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-BG10M5 | -0.1 MPa to 10 MPa | -15 psi to 1500 psi | bi-directional gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-BG14M5 | -0.1 MPa to 14 MPa | -15 psi to 2000 psi | bi-directional gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-BG20M5 | -0.1 MPa to 20 MPa | -15 psi to 3000 psi | bi-directional gauge | 0.01 or 0.005 | - | 0.007 or 0.0035 |
| PM500-BA120K3, 6 | 60 kPa to 120 kPa | 8 psi to 17 psi | absolute | 0.01 % of reading | 0.05 | 0.005 % of reading |
| PM500-A120K3, 6 | 0.08 kPa to 120 kPa | 0.01 psi to 16 psi | absolute | 0.01 or 0.005 | 0.05 | 0.007 or 0.0035 |
| PM500-A160K3, 6 | 0.08 kPa to 160 kPa | 0.01 psi to 23 psi | absolute | 0.01 or 0.005 | 0.05 | 0.007 or 0.0035 |
| PM500-A200K3, 4 | 0.08 kPa to 200 kPa | 0.01 psi to 30 psi | absolute | 0.01 or 0.005 | 0.05 | 0.007 or 0.0035 |
| PM500- A350K 4 | 0.08 kPa to 350 kPa | 0.01 psi to 50 psi | absolute | 0.01 or 0.005 | 0.03 | 0.007 or 0.0035 |
| PM500- A700K 4 | 0.08 kPa to 700 kPa | 0.01 psi to 100 psi | absolute | 0.01 or 0.005 | 0.025 | 0.007 or 0.0035 |
| PM500- A1.4M 5 | 0.035 MPa to 1.4 MPa | 5 psi to 200 psi | absolute | 0.01 or 0.005 | 0.015 | 0.007 or 0.0035 |
| PM500-A2M 5 | 0.07 MPa to 2 MPa | 10 psi to 300 psi | absolute | 0.01 or 0.005 | 0.015 | 0.007 or 0.0035 |
|  | **(% FS + % of reading)** |  | **(% FS + % of reading)** |
| PM500- G2.5K 6 | 0 kPa to 2.5 kPa | 0 inH2O to 10 inH2O | gauge | 0.03 + 0.02 | - | 0.015 + 0.01 |
| PM500-G7K 6 | 0 kPa to 7 kPa | 0 inH2O to 30 inH2O | gauge | 0.01 + 0.01 | - | 0.005 + 0.005 |
| PM500-G14K6 | 0 kPa to 14 kPa | 0 inH2O to 50 inH2O | gauge | 0.01 + 0.01 | - | 0.005 + 0.005 |
| PM500-G20K6 | 0 kPa to 20 kPa | 0 inH2O to 80 inH2O | gauge | 0.01 + 0.01 | - | 0.005 + 0.005 |
| PM500-G35K6 | 0 kPa to 35 kPa | 0 psi to 5 psi | gauge | 0.01 + 0.01 | - | 0.005 + 0.005 |
| PM500-G70K6 | 0 kPa to 70 kPa | 0 psi to 10 psi | gauge | 0.01 + 0.01 | - | 0.005 + 0.005 |
| PM500-NG100K6 | -100 kPa to 0 kPa | -15 psi to 0 psi | negative gauge | 0.01 + 0.01 | - | 0.005 + 0.005 |
| PM500-BG1.4K6 | -1.4 kPa to 1.4 kPa | -5 inH2O to 5 inH2O | bi-directional gauge | 0.03 + 0.02 | - | 0.015 + 0.01 |
| PM500-BG2.5K6 | -2.5 kPa to 2.5 kPa | -10 inH2O to 10 inH2O | bi-directional gauge | 0.03 + 0.02 | - | 0.015 + 0.01 |
| PM500-BG3.5K6 | -3.5 kPa to 3.5 kPa | -15 inH2O to 15 inH2O | bi-directional gauge | 0.01 + 0.01 | - | 0.005 + 0.005 |
| PM500-BG7K6 | -7 kPa to 7 kPa | -30 inH2O to 30 inH2O | bi-directional gauge | 0.01 + 0.01 | - | 0.005 + 0.005 |
| PM500-BG14K6 | -14 kPa to 14 kPa | -50 inH2O to 50 inH2O | bi-directional gauge | 0.01 + 0.01 | - | 0.005 + 0.005 |
| PM500-BG25K6 | -25 kPa to 25 kPa | -100 inH2O to 100 inH2O | bi-directional gauge | 0.01 + 0.01 | - | 0.005 + 0.005 |
| PM500-BG40K6 | -40 kPa to 40 kPa | -6 psi to 6 psi | bi-directional gauge | 0.01 + 0.01 | - | 0.005 + 0.005 |
| PM500-BG60K6 | -60 kPa to 60 kPa | -9 psi to 9 psi | bi-directional gauge | 0.01 + 0.01 | - | 0.005 + 0.005 |
|  | **% FS** |  | **% FS** |
| PM500-BG100K4 | -100 kPa to 100 kPa | -15 psi to 15 psi | bi-directional gauge | 0.01 | - | 0.005 |
| PM500-BG200K4 | -100 kPa to 200 kPa | -15 psi to 30 psi | bi-directional gauge | 0.01 | - | 0.005 |
| PM500-BG250K4 | -100 kPa to 250 kPa | -15 psi to 36 psi | bi-directional gauge | 0.01 | - | 0.005 |
| PM500-BG350K4 | -100 kPa to 350 kPa | -15 psi to 50 psi | bi-directional gauge | 0.01 | - | 0.005 |
| PM500-BG400K4 | -100 kPa to 400 kPa | -15 psi to 60 psi | bi-directional gauge | 0.01 | - | 0.005 |
| PM500-BG700K5 | -100 kPa to 700 kPa | -15 psi to 100 psi | bi-directional gauge | 0.01 | - | 0.005 |
| Notes1. The 1 Year Instrumental Uncertainty is specified with a zeroing technique in the Operators Manual.  If not adhered to the 1 Year Instrumental Uncertainty is:

PM500spec_formula 1. PM500 gauge or bi-directional mode modules support absolute mode measurement when used with a Barometric Reference Module. Instrumental uncertainty for gauge mode modules used in absolute mode by addition of a barometric reference module is calculated as the uncertainty of the gauge mode module root sum squared with the uncertainty of the barometric reference module. Uncertainty for gauge mode assumes routine zeroing which is default operation mode when used in a chassis.
2. These modules can be used as barometric reference modules on all chassis.
3. Compatible with [2271A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/pneumatic-pressure-control-0), [6270A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/pneumatic-pressure-control-1) and [8270A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/high-pressure-pneumatic-co-1)
4. Compatible with [2271A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/pneumatic-pressure-control-0), [6270A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/pneumatic-pressure-control-1), [8270A and 8370A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/high-pressure-pneumatic-co-1)
5. Compatible with [2271A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/pneumatic-pressure-control-0) and [6270A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/pneumatic-pressure-control-1)
 |

Fluke PM600 Summary:

### PM600 Modules measurement specifications

Specifications are valid from 15 °C to 35 °C.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Model** | **Absolute Mode Range (SI Units)** | **Absolute Mode Range (Imperial Units)** | **Gauge Mode Range 3 (SI Units)** | **Gauge Mode Range (Imperial Units)** | **1-Year Instrumental Uncertainty (% of reading or % span, whichever is greater)** | **Precision Uncertainty (% of reading or % span, whichever is greater)** |
| BRM600-BA100K4 | 70kPa to 110kPa | 10psi to 16psi | - | - | 0.01% of reading | 0.008 or 0.0024 |
| PM600-BG15K5 | - | - | -15kPa to 15kPa | -60inH2O to 60inH2O | 0.01 or 0.003 | 0.008 or 0.0024 |
| PM600-G100K6 | - | - | 0kPa to 100kPa | 0psi to 15psi | 0.01 or 0.003 | 0.008 or 0.0024 |
| PM600-G200K6 | - | - | 0kPa to 200kPa | 0psi to 30psi | 0.01 or 0.003 | 0.008 or 0.0024 |
| PM600-A100K5 | 6kPa to 100kPa | 0.9psi to 15psi | -94kPa to 0kPa | -13.8psi to 0psi | 0.01 or 0.0031,4 | 0.008 or 0.0024 |
| PM600-A200K6 | 10kPa to 200kPa | 1.5psi to 30psi | -90kPa to 100kPa | -13.2psi to 15psi | 0.01 or 0.0031,4 | 0.008 or 0.0024 |
| PM600-A350K6 | 10kPa to 350kPa | 1.5psi to 50psi | -90kPa to 250kPa | -13.2psi to 35psi | 0.01 or 0.0031 | 0.008 or 0.0024 |
| PM600-A700K7 | 18kPa to 700kPa | 2.6psi to 100psi | -82kPa to 700kPa | -12.1psi to 100psi | 0.01 or 0.0031 | 0.008 or 0.0024 |
| PM600-A1.4M7 | 0.035MPa to 1.4MPa | 5psi to 200psi | -0.065MPa to 1.4MPa | -10psi to 200psi | 0.01 or 0.0031 | 0.008 or 0.0024 |
| PM600-A2M7 | 0.07MPa to 2MPa | 10psi to 300psi | -0.03MPa to 2MPa | -5psi to 300psi | 0.01 or 0.0031 | 0.008 or 0.0024 |
| PM600-A3.5M7 | 0.07MPa to 3.5MPa | 10psi to 500psi | -0.03MPa to 3.5MPa | -5psi to 500psi | 0.01 or 0.0031 | 0.008 or 0.0024 |
| PM600-A7M7 | ATM2 to 7MPa | ATM 2 to 1000psi | 0MPa to 7MPa | 0psi to 1000psi | 0.01 or 0.003 1 | 0.008 or 0.0024 |
| PM600-A10M7 | ATM2 to 10MPa | ATM 2 to 1500psi | 0MPa to 10MPa | 0psi to 1500psi | 0.01 or 0.003 1 | 0.008 or 0.0024 |
| PM600-A14M7 | ATM2 to 14MPa | ATM 2 to 2000psi | 0MPa to 14MPa | 0psi to 2000psi | 0.01 or 0.003 1 | 0.008 or 0.0024 |
| PM600-A20M7 | ATM2 to 20MPa | ATM 2 to 3000psi | 0MPa to 20MPa | 0psi to 3000psi | 0.01 or 0.003 1 | 0.008 or 0.0024 |
| PM600-A28M8 | ATM3to 28 MPa | ATM 3to 4000psi | 0MPa to 28 MPa | 0psi to 4000psi | 0.01 or 0.003 2 | 0.008 or 0.0024 |
| PM600-A35M8 | ATM3to 35 MPa | ATM 2 to 5000psi | 0MPa to 35 MPa | 0psi to 5000psi | 0.01 or 0.003 2 | 0.008 or 0.0024 |
| PM600-A40M8 | ATM3to 40MPa | ATM 3 to 6000psi | 0MPa to 40 MPa | 0psi to 6000psi | 0.01 or 0.003 2 | 0.008 or 0.0024 |
| PM630-A70M9 | ATM3to 70MPa | ATM 3 to 10000psi | 0MPa to 70MPa | 0psi to 10000psi | 0.01 or 0.003 2 | 0.008 or 0.0024 |
| PM630-A100M9 | ATM3 to 104 MPa | ATM 3 to 15000psi | 0MPa to 104 MPa | 0psi to 15000 psi | 0.012 or 0.0042 | 0.01 or 0.003 |
| Notes1. For PM600s absolute mode modules used in absolute mode, root sum square (RSS) with 0.007% of FS (reduced to k=1 by square root of 3).

formula1. PM600 and PM630 modules with full scales of 28 MPa and higher use an internal barometer in the PMM to correct for changes in barometric pressure when they are used in gauge mode and as a zeroing reference when used in absolute mode, hence there is no need to RSS 0.007 %FS. ATM is any atmospheric pressure from 70kPa to 110kPa (10psi to 16psi).
2. For absolute ranges used in gauge mode there is an additional uncertainty of ±14 Pa for dynamic barometric compensation. When combined with uncertainties this changes the PM600-A100K Instrumental Uncertainty to ±0.015 kPa and the PM600-A200K to ±0.016 kPa. The threshold uncertainty for the PM600-A350K is changed to ±0.005 % Span.
3. These modules can be used as a barometric reference module on all chassis.
4. Compatible with [6270A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/pneumatic-pressure-control-1)
5. Compatible with [6270A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/pneumatic-pressure-control-1) and [8270A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/high-pressure-pneumatic-co-1)
6. Compatible with [6270A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/pneumatic-pressure-control-1), [8270A and 8370A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/high-pressure-pneumatic-co-1)
7. Compatible with [8270A and 8370A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/high-pressure-pneumatic-co-1)
8. Compatible with [8370A](https://us.flukecal.com/products/pressure-calibration/automated-pressure-controller-calibrators/high-pressure-pneumatic-co-1)
 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Model** | **Native Reference Mode** | **Minimum Setpoint (SI Units)** | **Maximum Setpoint (SI Units)** | **Minimum Setpoint (Imperial Units)** | **Maximum Setpoint (Imperial Units)** |
| PM600-BG15K | gauge | -15.47 kPa | 15.47 kPa | -2.244 psi | 2.244 psi |
| PM600-G100K | gauge | -2.11 kPa | 105.5 kPa | -0.306 psi | 15.3 psi |
| PM600-G200K | gauge | -4.22 kPa | 211.0 kPa | -0.612 psi | 30.6 psi |
| PM600-A100K | absolute | 0 kPa | 105.5 kPa | 0 psi | 15.3 psi |
| PM600-A200K | absolute | 0 kPa | 211.0 kPa | 0 psi | 30.6 psi |
| PM600-A350K | absolute | 3.45 kPa | 357 kPa | 0.5 psi | 51.8 psi |
| PM600-A700K | absolute | 6.89 kPa | 817 kPa | 1 psi | 118.6 psi |
| PM600-A1.4M | absolute | 6.89 kPa | 1.53 MPa | 1 psi | 222.1 psi |
| PM600-A2M | absolute | 20.7 kPa | 2.21 MPa | 3 psi | 321.0 psi |
| PM600-A3.5M | absolute | 20.7 kPa | 3.67 MPa | 3 psi | 532.8 psi |
| PM600-A7M | absolute | 55.2 kPa | 7.24 MPa | 8 psi | 1051 psi |
| PM600-A10M | absolute | 55.2 kPa | 10.06 MPa | 8 psi | 1545 psi |
| PM600-A14M | absolute | 55.2 kPa | 14.43 MPa | 8 psi | 2086 psi |
| PM600-A20M | absolute | 55.2 kPa | 20.12 MPa | 8 psi | 3075 psi |
| BRM600-BA100K | absolute | 65.5 kPa | 113.8 kPa | 9.5 psi | 16.5 psi |

Keysight 34980A Accuracy Specifications: (From data sheet)



Keysight E3641 Accuracy Specifications: (From data sheet)

