

## **Calibration Protocol**

We would like to inform you about service orders you send to TPF Control. It concerns ISO/IEC 17025:2017 accredited calibrations according to our scope of accreditation (K-149) published by the RvA.

If you send an instrument to us for calibration we will perform the following services;

1. As-Found comparisons
2. Service and repair
3. As-Left (post) comparisons
4. Traceable calibration certificates
5. Apply the latest version of our scope with regard to uncertainty.

### **What it all means;**

#### **1. As-Found and As-Left comparisons**

The comparison of your product to our lab standard.

We perform one series of comparisons when we receive your product, and one series before it is return-shipped.

As a calibration laboratory accredited to ISO/IEC 17025:2017 we follow the ISO Guide to the Expression of Uncertainty in Measurements (GUM). Our calibrations are performed by qualified personnel following controlled test methods and procedures. The results are printed to As-Found (pre) and As-Left (post) calibration certificates.

Though calibration often is interpreted as an adjustment that restores an instrument to its original tolerance, calibration is the comparison of a value indicated by the Device Under Test (DUT) and the corresponding value of a (higher) standard.

For default calibration points, calibration methods as well as manufacturer tolerances and conformity statements see Annex A. Note these are model and make dependent.

TPF will perform adjustment to the DUT when the as-Found calibration results are beyond manufacturer tolerance. If this is not required it must be specified when placing an order.

#### **2. Calibration method (Lab and on-site)**

The calibration methods we use have been proven and accredited by the Dutch council of accreditation (RvA). By default Flow Devices (except for flow calibrators) are calibrated in a serial connection setup with working standards to prevent pollution of reference meters. The use of working standards results in a higher uncertainty. Upon request calibration can be performed with master references. Flow calibrators are calibrated in a parallel connection setup with master references. Temperature, pressure and humidity devices are calibrated with master references by comparison method.

#### **3. Service and repair**

If necessary and applicable, your product is disassembled to its core components. We inspect each component for wear, defect, contaminants and damage and then clean, repair or replace as necessary. At the same time, if applicable, we upgrade hardware that was improved since you last purchased or serviced your product.

Once your product is reassembled, it's ready for its As-Left calibration.

If your product fails any points in this test, it must be disassembled again and the maintenance process continued until your product passes our As-Left calibration.

### Recertification warranty

We warrant our service, labor and parts replacements against failure for a period of 90 days from the last date of recertification, provided your product has been used under normal operating conditions and that the failure is directly related to labor performed or parts installed during the last recertification.

### Terms and conditions

#### 1. Delivery time:

Delivery time of calibration will be one max 14 days unless stated otherwise in the order acknowledgement.

The calibration certificate will be shipped together with the instrument(s).

#### 2. Pricing:

Pricing of calibration is through our standard pricelist which is available on request.

Pricing of non standard items on request.

#### 3. Statement of conformity - Binary decision rule explanation:

On the calibration certificate of MesaLabs dataloggers a statement of conformity is mentioned. It's shown as pass or fail.

We apply a binary decision rule defined as follows;

1. Error (E) (DUT value – Reference value)
2. Tolerance (T) (manufacturer specification)
3. Measurement Uncertainty (MU)
4. Guardband value (GV)  $GV \geq MU$

Decision Rule:  $E + GV < T$ ; Pass. If  $E + GV \geq T$ ; Fail

Explanation of the above

During the calibration process an out of tolerance is determined using a calibration tolerance in combination with a guardband value (GV). The GV is equal to the difference between the calibration tolerance and the tolerance (T). For temperature and pressure calibrations the guardband value is greater than or equal to the maximum MU. The sum of the calibration tolerance and the guardband is less than the instrument tolerance shown on the certificate. So, the guardband eliminates false positives when applying the Binary decision rule.

For humidity (RH) calibrations the guardband value is smaller than MU. So:

$GV < MU$

The decision rule is the same:

$E + GV < T$ ; Pass. If  $E + GV \geq T$ ; Fail

So the definition of the Pass/fail rule is different for RH;  $E + MU$  could be greater than T and still the result could pass

A statement is made on the calibration certificate describing the above.

For gas flow calibration the statement of conformity with tolerance / specification is determined using the decision rule with a non-binary statement. The statement of conformity is based on a 95 % coverage probability for the expanded measurement uncertainty and is only valid for the device under test at the tested points.

1. Error (E) (DUT value – Reference value)
2. Tolerance (T) (manufacturer specification)
3. Measurement Uncertainty (MU)

The statement of conformity with tolerance / specification is reported as:

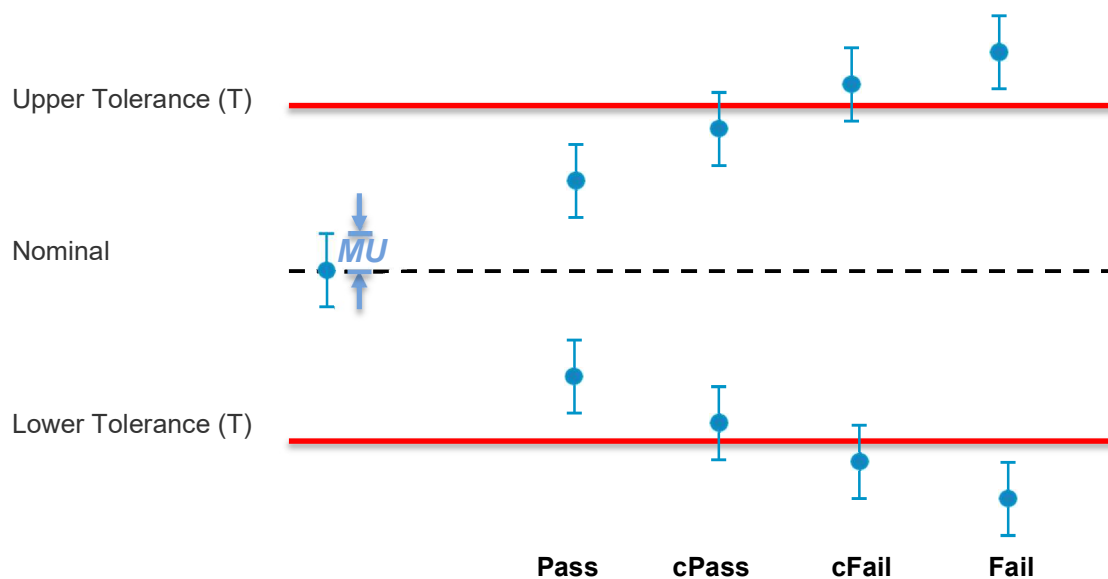
**Pass** The Error (E) and measurement uncertainty (MU) are below tolerance (T).

**cPass** The Error (E) is inside the tolerance (T), MU partly outside the tolerance (T)

**cFail** The Error (E) is outside the tolerance (T), MU partly inside the tolerance (T)

**Fail** The Error (E) and measurement uncertainty (MU) is outside the (T).

**N/A** Not Evaluated: Test Uncertainty Ratio is not sufficient ( $MU > T$ ) to evaluate compliance with tolerances.



#### 4. Due date on certificate or calibration label

In the event an expiration date is indicated on the certificate or calibration label, it should not be inferred that the calibration results are valid over the stated period.

## Annex A

1. Manufacturer tolerance, see datasheet of model on website of manufacturer .
2. Default calibration points and calibration method for:

### Gas flow devices

Model	Calibration points by default Gas flow	Calibration method
VA meters	6 points to scale values	Serial / parallel
All other gas flow devices	<b>As found:</b> 50%, 100% of full scale flow and indication of 0% <b>As left:</b> 5%, 10%, 25%, 50%, 75%, 100% of full scale flow and indication of 0%	Serial

### MesaLabs DryCal Gas Flow calibrators

Flow units are specified as ccm and sccm whereas sccm refers to standardized flow at 21.1 °C and 101325 Pa.

Ambient refers to laboratory temperature and pressure conditions at time of calibration.

The gas flow calibration is performed in a parallel gas flow setup. The pressure and temperature calibration method is by comparison of the DUT to a reference standard.

For calibration points see next page.

**MesaLabs - DryCal flow calibrators**

Model	Calibration points by default		
	Gas flow	Pressure [ mBar ]	Temperature [ °C ]
DC-2 base		Ambient	Ambient
DC-LC-1	30-100-300 ccm	-	-
DC-MC-1	10-2000-5000 ccm	-	-
DC-HC-1	500-5000-30000 ccm	-	-
DCL-L	30-100-500 ccm	-	-
DCL-ML	50-1000-2000 ccm	-	-
DCL-M	100-2000-7000 ccm	-	-
DCL-MH	200-5000-20000 ccm	-	-
DCL-H	500-5000-30000 ccm	-	-
Defender 510-L	30-100-500 ccm	-	-
Defender 510-M	100-1000-5000 ccm	-	-
Defender 510-H	300-5000-30000 ccm	-	-
Defender 520-L	30-100-500 ccm	Ambient	Ambient
Defender 520-M	100-1000-5000 ccm	Ambient	Ambient
Defender 520-H	300-5000-30000 ccm	Ambient	Ambient
Defender 530-L	30-100-500 ccm	Ambient	Ambient
Defender 530-M	100-1000-5000 ccm	Ambient	Ambient
Defender 530-H	300-5000-30000 ccm	Ambient	Ambient
Definer 220-L	30-100-500 sccm	Ambient	Ambient
Definer 220-M	100-1000-5000 sccm	Ambient	Ambient
Definer 220-H	300-5000-30000 sccm	Ambient	Ambient
Defender 530+ L	30-100-500 sccm	Ambient	Ambient
Defender 530+ M	100-1000-5000 sccm	Ambient	Ambient
Defender 530+ H	300-5000-30000 sccm	Ambient	Ambient
DryCal-500-10	15-90-500 sccm	800-825-850-875-900-925-950-975-1000-1025-1050	16,5-22,5-28,5
DryCal-500-24	50-500-5000 sccm	800-825-850-875-900-925-950-975-1000-1025-1050	16,5-22,5-28,5
DryCal-500-44	500-5000-50000 sccm	800-825-850-875-900-925-950-975-1000-1025-1050	16,5-22,5-28,5
DryCal-800 DCB		800-825-850-875-900-925-950-975-1000-1025-1050	
DryCal-800-3	6-20-40 sccm	0-5-10-20	16,5-22,5-28,5
DryCal-800-10	15-90-500 sccm	0-5-10-20	16,5-22,5-28,5
DryCal-800-24	50-500-5000 sccm	0-5-10-20	16,5-22,5-28,5
DryCal-800-44	500-5000-50000 sccm	0-5-10-20	16,5-22,5-28,5
DryCal-800-75	5000-50000-100000 sccm	0-5-10-20	16,5-22,5-28,5
FlexCal - L	15-90-500 sccm	800-825-850-875-900-925-950-975-1000-1025-1050	16,5-22,5-28,5
FlexCal - M	50-500-5000 sccm	800-825-850-875-900-925-950-975-1000-1025-1050	16,5-22,5-28,5
FlexCal - H	500-5000-50000 sccm	800-825-850-875-900-925-950-975-1000-1025-1050	16,5-22,5-28,5
DryCal 1020	20-50-100-250-375-500 sccm	800-825-850-875-900-925-950-975-1000-1025-1050	16,5-22,5-28,5
DryCal 1500	50-150-375-750-1125-1500 sccm	800-825-850-875-900-925-950-975-1000-1025-1050	16,5-22,5-28,5

### Mesalabs BGI gas flow calibrators.

The gas flow calibration is performed in a serial gas flow setup. The pressure and temperature calibration method is by comparison of the DUT to a reference standard.

Model	Calibration points by default		
	Gas flow	Pressure [ mBar ]	Temperature [ °C ]
Challenger 30	6-15-30 lpm		
Challenger 6	2-4-6 lpm		
DeltaCal 19.5	2-5-10-15-19 lpm	900-930-960-990-1020-1050	5-15-25-35
DeltaCal 20	2.5-5-10-15-20 lpm	900-930-960-990-1020-1050	5-15-25-35
DeltaCal 60	12-20-30-40-50 lpm	900-930-960-990-1020-1050	5-15-25-35
TretaCal 30	6-15-29 lpm		
TetraCal 6	1.2-3-5.5 lpm		
TetraCal 1.2	0.25-0.6-1 lpm		
TetraCal Ultra 6	2-4-6 lpm		
TetraCal Ultra 20	7-12-19.5 lpm		
TetraCal Ultra 60	21-40-58 lpm		
HiVolCal	400-600-900-1100-1500 lpm	900-930-960-990-1020-1050	5-15-25-35
HVC2	400-600-900-1100-1500 lpm	900-930-960-990-1020-1050	5-15-25-35

### MesaLabs DataTrace loggers

The temperature, pressure and humidity calibration methods are by comparison of the DUT to a reference standard.

Conformity statement (Pass/Fail) is mentioned on all DataTrace calibration certificates. Unless otherwise agreed upon with the customer when placing the order, a conformity statement (pass/fail) will be mentioned on the certificate.

Model	Calibration points by default		
	Temperature [ °C ]	Pressure [ psi ]	Humidity [ % ]
M3T	-20,-10,0,10,20,30,40,50,60,70, 80,90,100,110,120,130,140		
M4T	-40,-20,0,20,40,60,80,100,120,140		
M4T with -80	-80,-40,-20,0,20,40,60,80,100,120,140		
M4T ET	-20,0,20,40,60,80,100,120,140,160,180, 200,220,240,260,280,300,320,340,380, 400		
M3P	10,20,30,40,50,60,70,80,90,100,110, 120,130,140	1,10,20,40,60,75 @ 25 °C 20,50 @ 120 °C 20,50 @ 135 °C	
M4P	-20,-10,0,10,20,30,40,50,60, 70,80,90,100,110,120,130,140	1,10,20,40,60,75 @ 25 °C 20,50 @ 120 °C 20,50 @ 135 °C	
M3H	0,10,20,30,40,50,60,70,80,85		0,20,25,30,40,50,60,70,80,90,95 @ 25 °C 25,30,40,60,80,90,95 @ 55 °C
M4H	0,10,20,30,40,50,60,70,80,85		0,20,25,30,40,50,60,70,80,90,95 @ 25 °C 25,30,40,60,80,90,95 @ 55 °C