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Static Check-Calibration of a Dynamic Pressure Measurement System: Serial Numbers DPM1201 and DPM1203

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ABSTRACT

A static check-calibration of a Turbulent Flow Instrumentation (TFI) Dynamic Pressure Measurement System (DPMS), consisting of two modules (serial numbers DPM1201 and DPM1203) with 32 pressure transducers each, is performed and documented in this report. It is estimated that the best-case uncertainty in pressure measurements using the DPMS is ±10.42 Pa at 95% confidence with a coverage factor of 2, occurring on channel 38. The worst-case uncertainty is estimated to be ±13.26 Pa at 95% confidence with a coverage factor of 2, occurring on channel 29. The mean uncertainty over all 64 DPMS transducers is calculated to be ±10.73 Pa at 95% confidence with a coverage factor of 2, with a standard deviation in the mean uncertainty of ±0.414 Pa.

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Executive Summary

A static check-calibration of a Turbulent Flow Instrumentation (TFI) Dynamic Pressure Measurement System (DPMS), consisting of two modules (serial numbers DPM1201 and DPM1203) with 32 pressure transducers each, is performed and documented in this report. A previous static calibration was supplied by TFI in 2012 for a Full Scale (FS) calibration range of 4.5 kPa, but the precise uncertainty associated with this calibration is still unknown.

Here, the check-calibration results show that the best-case expanded uncertainty in pressure measurements using the DPMS is ±10.42 Pa at 95% confidence with a coverage factor of 2, occurring on channel 38. The worst-case expanded uncertainty is estimated to be ±13.26 Pa at 95% confidence with a coverage factor of 2, occurring on channel 29. The mean uncertainty over all 64 DPMS transducers is calculated to be ±10.73 Pa at 95% confidence with a coverage factor of 2, with a standard deviation in the mean uncertainty of ±0.414 Pa.

The worst-case expanded uncertainty estimation in this report is found to be less than the stated accuracy of the DPMS transducers of ±0.3% FS, or ±13.5 Pa at a FS calibration range of 4.5 kPa. Therefore, no adjustments were made to the current DPMS calibration. Also, the standard deviation of the mean uncertainty over all 64 DPMS transducers is sufficiently low, such that the mean uncertainty of ±10.73 Pa could be used to represent the uncertainty in DPMS pressure measurements.

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Glossary

DPMS	Dynamic Pressure Measurement System
DST	Defence Science and Technology
DWT	Dead Weight Tester
FS	Full Scale
RWT	Research Wind Tunnel
TFI	Turbulent Flow Instrumentation
UUT	Unit Under Testing

Notation

a	Semi-range of a rectangular uncertainty distribution
c_i	Sensitivity coefficient, $\frac{\partial y}{\partial x_i}$
$ESDM$	Experimental Standard Deviation of the Mean, $\frac{s}{\sqrt{M}}$
k	Coverage factor
M	Number of measurements
N	Number of measured components
P_{app}	Applied calibration pressure
P_x	DPMS measured pressure
SE	Standard Error, $\sqrt{\frac{\sum_{i=1}^{M}(P_{app_i} - P_{x_i})^2}{M-1}}$
s	Sample standard deviation, $\sqrt{\frac{\sum_{i=1}^{M}[(x_i) - \overline{x}]^2}{M-1}}$
U_{95}	Expanded uncertainty at a 95% confidence limit
$u(x_i)$	The standard uncertainty estimate of the component x_i
$u_c(y)$	The combined standard uncertainty, $\sqrt{\sum_{i=1}^{N}[c_i u(x_i)]^2}$
$u_i(y)$	Uncertainty in y due to component x_i, $u_i(y) = \lvert c_i \rvert u(x_i)$
v_{eff}	Effective degrees of freedom, $\frac{u_c^4(y)}{\sum_{i=1}^{N}\frac{u_i^4(y)}{v_i}}$
v_i	Degrees of freedom, estimated as $M-1$
$\overline{x}$	The mean of M measurements of component x_i, $\sum_{i=1}^{M}\frac{x_i}{M}$
x_i	A measured component
y	A derived result from an N number of components x_i

1. Transducer Details

Measurement of mean and unsteady wind pressure on a wind-tunnel test article at Defence Science and Technology (DST) may be accomplished through the use of a Turbulent Flow Instrumentation (TFI) Dynamic Pressure Measurement System (DPMS). The DPMS as the Unit Under Testing (UUT) in this report has two modules containing multiple pressure transducers. The details of these modules are summarised in Table 1.

A static calibration[1], including linearity corrections, for both DPMS modules was previously supplied by TFI in January of 2012 [2], but the precise uncertainties associated with this calibration are unknown. Therefore, a static check-calibration of the DPMS transducers was performed at DST, and documented in this report.

Table 1: Details of the DPMS pressure transducers.

Manufacturer	**Module Serial Number**	**Number of Pressure Transducers**	**Full Scale Calibration Range (All transducers)**
TFI	DPM1201	32	4.5 kPa
	DPM1203	32	4.5 kPa

2. Check-Calibration Equipment

A Beamex MC6 Calibrator (serial number M602054), using the P6C pressure module, was used as the calibration working standard with a certified maximum uncertainty of ±10 Pa (gauge) at 95% confidence with a coverage factor of 2. The measurement results obtained from this equipment are traceable to Australian primary standards [3]. Though DST has access to a Dead Weight Tester (DWT), there were an insufficient number of calibration masses within the required DPMS check-calibration range, and thus the DWT could not be used for this check-calibration.

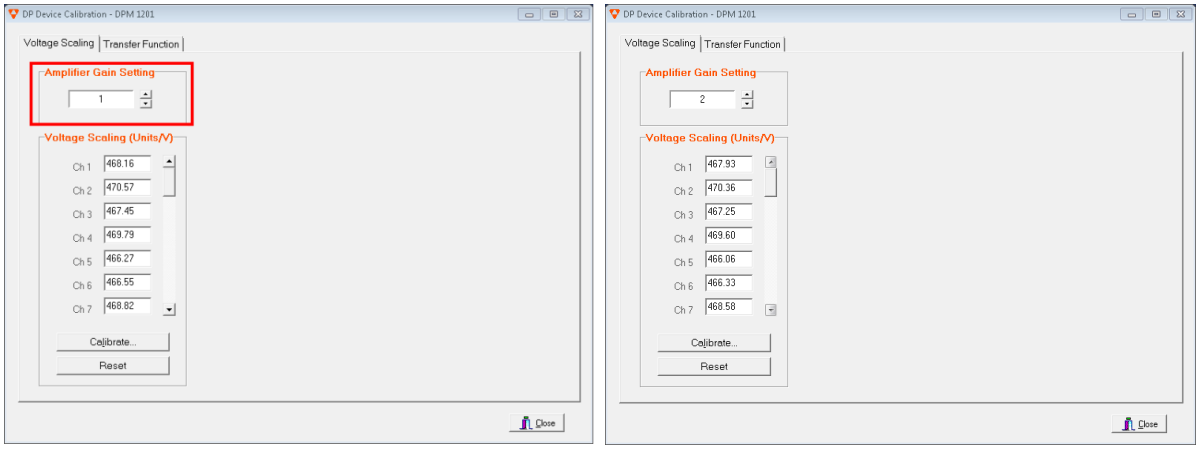
Positive and negative gauge pressure was supplied by a Beamex calibration pressure and vacuum pump (serial numbers 31907 and 15374) respectively.

The ambient temperature measurement during the calibration was provided by a Labjack EI-1034 temperature probe. This probe is factory calibrated to provide temperature measurements with an estimated uncertainty of ±0.44 °C at 95% confidence [4].

3. Check-Calibration Methodology

The check-calibration was conducted in the DST Research Wind Tunnel (RWT) Laboratory in Fishermans Bend, Victoria. Prior to the check-calibration, the DPMS, Beamex MC6 and calibration pumps were placed inside the Laboratory for at least 12 hours to allow for thermal

[1] In this context, a "static calibration" refers to calibration of the mean pressure component; quantifying uncertainty in unsteady pressure requires additional considerations, e.g. see [1].



(i) *(ii)*

Figure 1: The DPMS module calibrations with (i) the module heater deactivated (highlighted in the box) and (ii) the module heater activated. Note that only DPM1201 is shown in these images, and not all calibration coefficients are shown for brevity.

stabilisation of the equipment. Both DPMS modules were placed on a level surface to mitigate gravitational drift effects on measurements. During the check-calibration, the ambient temperature was measured to be nominally 22.9 °C, with a variation of less than the estimated uncertainty in temperature measurements (i.e. $< \pm 0.44$ °C).

Gauge calibration pressure was concurrently applied to the DPM1201 and DPM1203 reference ports, which enabled a check-calibration of all 64 pressure transducers simultaneously. Before the check-calibration, and when switching from positive to negative pressure supply, the DPMS transducers were zeroed to remove offset. Twenty-seven (27) data points were acquired across the Full Scale (FS) calibration range of the pressure transducers (Table 1) for rising and falling pressure, giving 52 check-calibration data points in total.

At each data point, the transducer signals were sampled using TFI software ("TFI Device Control", version 3.8.0) for 5.374 seconds at a rate of 9.8 Hz, resulting in 56 samples[2]. The readings were then averaged over the 56 samples in post-processing.

Both DPMS modules have an internal heater to regulate the transducer temperature, and thus minimise the effects of drift. There are two static calibrations on each module that were supplied by TFI in 2012; one completed with the module heaters deactivated, and one completed with the heaters activated. In the TFI software, these correspond to two different settings in the calibration page of the software, as shown in Fig. 1. It has been confirmed by TFI that the "Amplifier Gain Setting" value does not actually correspond to any changes in amplifier gain, but rather corresponds to these heated and unheated calibrations [2]. As the current check-calibration was conducted with the module heaters activated[3], the heated calibration values were used for measuring pressure (Appendix A).

[2]Note that sample count is not calculated simply as the product of sample period and sample rate; there are other parameters in the DPMS that dictate the number of output samples, not discussed here.

[3]Normally, the DPMS module heaters are activated during usage in test campaigns.

4. Check-Calibration Results

The DPMS as-found measured pressure for each transducer are tabulated in Appendix B. The standard error for each transducer is defined as;

$$SE = \sqrt{\frac{\sum_{i=1}^{M} (P_{app_i} - P_{x_i})^2}{M - 1}}, \tag{1}$$

where $M = 52$ the number of data points in the check-calibration range, P_{app_i} is the applied calibration pressure and P_{x_i} is the measured pressure on the transducer at the ith data point, using the existing heated calibration coefficients (Appendix A). It should be noted that the DPMS channel count is zero-index on the module chassis, but is one-index in the TFI software; in this report, the zero-index channel count is used.

5. Estimation of Uncertainty

The estimation of expanded uncertainty in DPMS pressure measurements is in accordance with the standard in [5]. Since there are 64 transducers, the mean expanded uncertainty over all the transducers is estimated, along with the standard deviation in mean expanded uncertainty. Also, the best- and worst-case expanded uncertainties are estimated, and are found to occur on channels 38 and 29 respectively. The calculations to determine the expanded uncertainty for the best- and worst-case channels are shown in Tables 2 and 3 respectively.

The dominant sources of component uncertainty were assumed to be the standard error in DPMS pressure measurements using the as-found calibration coefficients, and the Beamex MC6 calibration uncertainty. Ambient thermal shift during the check-calibration was disregarded, as the module heaters were activated and the measured ambient temperature variation was considered to be insignificant (Section 3). Also, pressure head correction was assumed to be negligible, as the calibration pumps were operated at approximately the same datum reference level as the DPMS transducers.

The best-case expanded uncertainty at 95% confidence is calculated to be ±10.42 Pa with a coverage factor of 2. The worst-case expanded uncertainty at 95% confidence is calculated to be ±13.26 Pa with a coverage factor of 2. The calculations shown in Tables 2 and 3 are applied to all 64 transducers, resulting in a mean expanded uncertainty of ±10.73 Pa at 95% confidence with a coverage factor of 2. The standard deviation of the mean expanded uncertainty is calculated to be ±0.414 Pa.

Table 2: Estimation of the best-case DPMS expanded uncertainty in pressure measurements.

Component	**Units**	**Distribution**	U_{95} **or** a	**Divisor**	v_i	$u(x_i)$	c_i	$u_i(y)$	$u_i^2(y)$	$u_i^4(y)/v_i$
Beamex calibration pressure	Pa	Normal	10	2	30	5	1	5	25	20.83
DPMS Standard Error (Ch 38)	Pa	Normal	1.4642	1	51	1.4642	1	1.4642	2.1439	0.09012
								Sums	27.1439	20.92
								$u_c(y)$, **Pa**	5.21	
								v_{eff}	35.22	
								k **for** v_{eff} **at 95% Confidence**	$2.03 \approx 2$	
								$U_{95} = ku_c(y)$, **Pa**	10.42	

Table 3: Estimation of the worst-case DPMS expanded uncertainty in pressure measurements.

Component	**Units**	**Distribution**	U_{95} **or** a	**Divisor**	v_i	$u(x_i)$	c_i	$u_i(y)$	$u_i^2(y)$	$u_i^4(y)/v_i$
Beamex calibration pressure	Pa	Normal	10	2	30	5	1	5	25	20.83
DPMS Standard Error (Ch 29)	Pa	Normal	4.3514	1	51	4.3514	1	4.3514	18.9347	7.0298
								Sums	43.9347	27.8598
								$u_c(y)$, **Pa**	6.63	
								v_{eff}	69.35	
								k **for** v_{eff} **at 95% Confidence**	2	
								$U_{95} = ku_c(y)$, **Pa**	13.26	

6. Conclusions

The worst-case expanded uncertainty estimation is still within the TFI specified transducer accuracy of ±0.3% FS, or ±13.5 Pa at a FS of 4.5 kPa [6]. Therefore, no adjustments were made to the as-found heated calibration coefficients. The mean expanded uncertainty over all 64 DPMS transducers, calculated to be ±10.73 Pa, could be used to represent the uncertainty in DPMS pressure measurements, since the standard deviation of the mean uncertainty, ±0.414 Pa, is sufficiently low.

The dominant source of uncertainty in this check-calibration is due to the Beamex MC6 uncertainty in pressure measurements. The DPMS uncertainty in pressure measurements could be lowered if a calibration working standard with a lower uncertainty is used to provide the reference calibration pressure.

7. References

[1] McCarthy, J. & Jones, M. (2018) *The Estimation of Uncertainty in Corrections to Unsteady Pressure Measurements through Tubes*, Technical Report DST-Group-TR-XXXX, Aerospace Division, Defence Science and Technology Group, 506 Lorimer Street, Fishermans Bend, VIC 3207.

[2] Mousley, P. (2018) DPM1201 and DPM1203 static calibration, Personal communication.

[3] Thales (2017) *Beamex MC6 Advanced Field Calibrator and Communicator Calibration Certificate*, Calibration Report 17EL-1921, Thales, 421-449 Gordon Street, Maribyrnong, VIC 3032, Australia.

[4] www.labjack.com (2017) EI-1034 Datasheet, URL.

[5] Cook, R. R. (2002) *Assessment of Uncertainties of Measurement*, 2nd edn, National Association of Testing Authorities.

[6] TFI (2015) *DPMS Catalogue*.

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Appendix A. As-Found Calibration Coefficients

The as-found calibration coefficients for the heated calibrations are documented in Table 4 for modules DPM1201 and DPM1203.

Table 4: DPMS as-found heated calibration coefficients. Note that the channel count is zero-index on the module chassis, but is one-index in TFI Device Control software.

DPM1201 Channel	Calibration Coefficient (Pa/V)	DPM1203 Channel	Calibration Coefficient (Pa/V)
0	467.93	32	466.64
1	470.36	33	467.58
2	467.25	34	469.04
3	469.60	35	467.29
4	466.06	36	467.87
5	466.33	37	467.38
6	468.58	38	469.33
7	468.45	39	467.82
8	470.07	40	471.79
9	470.80	41	467.92
10	467.71	42	468.19
11	467.70	43	468.64
12	471.86	44	472.65
13	467.18	45	468.33
14	467.13	46	468.01
15	467.95	47	468.49
16	466.49	48	468.31
17	467.59	49	466.26
18	468.84	50	470.45
19	470.27	51	470.52
20	468.88	52	469.09
21	469.35	53	466.46
22	469.53	54	467.34
23	468.60	55	467.06
24	466.61	56	465.73
25	467.72	57	469.13
26	468.66	58	469.54
27	468.62	59	466.62
28	467.65	60	469.87
29	469.04	61	468.41
30	470.55	62	468.25
31	466.71	63	469.04

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Appendix B. As-Found DPMS Measured Pressure

Table 5: DPMS as-found measured pressure for channels 0 to 7. All units are in Pascals.

P_{app}	Ch 0	Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7
350	349.9	350.1	349.9	349.8	349.9	349.8	349.8	349.9
692	692.6	692.6	692.6	692.5	692.8	692.5	692.6	692.6
1035	1034.3	1034.2	1034.4	1034.3	1034.8	1034.2	1034.2	1034.3
1379	1381.7	1381.5	1381.7	1381.7	1382.3	1381.4	1381.6	1381.6
1736	1738.5	1738.0	1738.6	1738.2	1739.3	1738.2	1738.5	1738.2
2070	2070.1	2069.8	2070.3	2070.0	2071.1	2069.7	2070.0	2069.8
2415	2415.1	2414.9	2415.5	2415.3	2416.5	2415.0	2415.2	2414.9
2760	2762.2	2761.8	2762.7	2762.4	2763.7	2761.8	2762.3	2761.9
3115	3115.3	3115.2	3116.1	3115.7	3117.1	3115.1	3115.5	3115.0
3451	3452.5	3452.3	3453.4	3452.8	3454.5	3452.4	3452.9	3452.3
3804	3803.1	3803.0	3804.2	3803.8	3805.5	3803.3	3803.8	3802.9
4140	4140.9	4140.8	4142.1	4141.5	4143.5	4141.1	4141.6	4140.6
4487	4490.9	4490.8	4492.2	4491.8	4493.8	4491.2	4491.9	4490.6
4150	4152.2	4151.9	4153.6	4152.8	4155.1	4152.5	4153.0	4151.8
3795	3795.4	3795.0	3796.7	3796.1	3798.2	3795.8	3796.0	3794.9
3451	3453.2	3452.9	3454.4	3453.9	3455.9	3453.6	3453.8	3452.7
3105	3104.5	3103.7	3105.3	3105.0	3107.0	3104.8	3104.9	3103.9
2760	2757.9	2757.3	2758.5	2758.2	2760.2	2758.0	2758.2	2757.4
2422	2417.7	2417.3	2418.6	2418.3	2419.8	2418.1	2418.2	2417.4
2070	2070.3	2069.6	2070.6	2070.2	2071.9	2070.3	2070.4	2069.6
1725	1725.2	1724.6	1725.6	1725.3	1726.7	1725.4	1725.3	1724.7
1384	1384.3	1383.8	1384.5	1384.2	1385.3	1384.4	1384.2	1383.9
1039	1037.9	1037.5	1038.0	1038.0	1038.8	1038.0	1037.9	1037.7
691	690.1	689.8	690.0	689.9	690.6	690.1	689.8	689.7
341	341.2	340.7	340.9	340.9	341.4	341.0	340.9	340.8
0	0.1	-0.4	-0.4	-0.4	-0.3	-0.1	-0.3	-0.4
-350	-349.4	-349.4	-349.8	-349.7	-349.9	-349.5	-349.5	-349.5
-694	-693.3	-693.0	-693.6	-693.4	-693.9	-693.3	-693.4	-693.2
-1034	-1033.6	-1033.7	-1034.4	-1034.4	-1034.7	-1034.0	-1034.1	-1034.0
-1378	-1377.1	-1376.3	-1377.3	-1377.0	-1378.1	-1376.7	-1377.1	-1376.8
-1722	-1722.8	-1722.1	-1723.2	-1722.7	-1723.9	-1722.3	-1722.9	-1722.5
-2070	-2068.6	-2067.8	-2068.9	-2068.4	-2069.9	-2067.9	-2068.6	-2068.3
-2410	-2411.1	-2410.9	-2412.2	-2411.8	-2413.2	-2411.2	-2411.9	-2411.5
-2759	-2759.6	-2759.8	-2761.1	-2760.7	-2762.2	-2759.9	-2760.8	-2760.5
-3104	-3104.3	-3104.6	-3106.1	-3105.7	-3107.1	-3104.7	-3105.7	-3105.3
-3446	-3450.2	-3450.5	-3451.9	-3451.6	-3453.3	-3450.5	-3451.7	-3451.2
-3795	-3796.5	-3797.0	-3798.6	-3798.2	-3799.9	-3797.2	-3798.3	-3797.9
-4147	-4146.7	-4147.5	-4149.1	-4148.7	-4150.6	-4147.2	-4148.7	-4148.3
-4490	-4489.8	-4490.3	-4492.0	-4491.6	-4493.6	-4490.0	-4491.8	-4491.3
-4145	-4144.1	-4144.6	-4146.2	-4145.8	-4147.7	-4144.2	-4145.9	-4145.7
-3795	-3796.3	-3796.6	-3798.1	-3797.8	-3799.4	-3796.4	-3798.0	-3797.8
-3450	-3450.4	-3450.6	-3451.9	-3451.6	-3453.1	-3450.4	-3451.6	-3451.8
-3105	-3107.4	-3107.8	-3109.0	-3108.9	-3110.0	-3107.7	-3109.0	-3108.9
-2760	-2760.4	-2760.7	-2761.8	-2761.8	-2762.7	-2760.6	-2761.7	-2761.7
-2410	-2411.1	-2411.5	-2412.2	-2412.2	-2413.0	-2411.2	-2412.1	-2412.1
-2076	-2076.1	-2076.3	-2077.2	-2077.1	-2077.9	-2076.3	-2077.1	-2077.2
-1724	-1726.2	-1726.4	-1727.1	-1727.1	-1727.6	-1726.3	-1726.9	-1727.0
-1380	-1380.6	-1380.8	-1381.6	-1381.4	-1382.0	-1380.8	-1381.3	-1381.5
-1036	-1039.0	-1039.2	-1039.6	-1039.6	-1040.0	-1039.0	-1039.5	-1039.5
-692	-693.8	-693.9	-694.4	-694.4	-694.6	-693.9	-694.2	-694.3
-348	-348.3	-348.6	-348.6	-348.7	-348.7	-348.3	-348.5	-348.7
0	0.1	-0.1	-0.2	-0.4	-0.2	-0.1	-0.3	-0.3

Table 6: DPMS as-found measured pressure for channels 8 to 15. All units are in Pascals.

P_{app}	Ch 8	Ch 9	Ch 10	Ch 11	Ch 12	Ch 13	Ch 14	Ch 15
350	349.9	349.9	349.8	349.9	349.5	350.0	349.7	349.9
692	692.6	692.7	692.5	692.7	692.0	692.9	692.5	692.9
1035	1034.2	1034.4	1034.2	1034.3	1033.5	1034.6	1034.3	1034.9
1379	1381.3	1381.9	1381.5	1381.5	1380.7	1381.9	1381.3	1382.4
1736	1738.1	1738.6	1738.3	1738.2	1736.9	1738.8	1738.1	1739.3
2070	2069.6	2070.5	2070.1	2069.8	2068.5	2070.6	2069.7	2071.3
2415	2414.7	2415.6	2415.2	2414.8	2413.4	2415.7	2414.8	2416.7
2760	2761.9	2762.8	2762.3	2761.8	2760.2	2762.8	2761.9	2764.1
3115	3114.9	3116.2	3115.5	3115.1	3113.2	3116.3	3115.1	3117.4
3451	3452.1	3453.7	3452.8	3452.3	3450.3	3453.7	3452.3	3455.0
3804	3802.8	3804.6	3803.6	3803.0	3800.7	3804.5	3803.2	3806.1
4140	4140.6	4142.5	4141.4	4140.6	4138.3	4142.4	4141.0	4144.1
4487	4490.4	4492.9	4491.6	4490.6	4488.3	4492.5	4491.1	4494.5
4150	4151.9	4154.0	4152.9	4151.8	4149.9	4153.8	4152.6	4155.8
3795	3795.2	3797.1	3796.1	3794.9	3793.3	3796.9	3795.8	3798.9
3451	3453.2	3454.7	3454.0	3452.7	3451.8	3454.8	3453.7	3456.7
3105	3104.3	3105.7	3105.1	3104.0	3102.9	3105.7	3105.1	3107.5
2760	2757.8	2758.8	2758.4	2757.2	2756.5	2759.0	2758.5	2760.7
2422	2417.9	2418.8	2418.4	2417.2	2416.8	2418.9	2418.4	2420.5
2070	2070.1	2070.8	2070.6	2069.4	2069.2	2070.9	2070.6	2072.4
1725	1725.0	1725.6	1725.7	1724.5	1724.3	1725.8	1725.6	1727.2
1384	1384.0	1384.6	1384.7	1383.7	1383.6	1384.7	1384.6	1385.9
1039	1037.9	1038.2	1038.1	1037.5	1037.4	1038.2	1038.3	1039.3
691	690.0	690.2	690.2	689.8	689.7	690.4	690.4	691.1
341	340.9	341.0	341.1	340.7	340.8	341.0	341.3	341.7
0	-0.2	-0.2	0.0	-0.5	-0.3	-0.4	0.1	0.2
-350	-349.4	-349.5	-349.7	-349.6	-349.4	-349.7	-349.6	-349.7
-694	-693.3	-693.5	-693.5	-693.2	-693.1	-693.7	-693.4	-693.8
-1034	-1034.0	-1034.2	-1034.2	-1034.0	-1033.6	-1034.6	-1034.1	-1034.8
-1378	-1376.8	-1377.1	-1377.0	-1376.7	-1376.3	-1377.4	-1376.9	-1377.9
-1722	-1722.5	-1722.8	-1722.7	-1722.4	-1721.8	-1723.2	-1722.5	-1723.5
-2070	-2068.1	-2068.7	-2068.6	-2068.1	-2067.3	-2069.1	-2068.2	-2069.5
-2410	-2411.2	-2411.9	-2411.8	-2411.3	-2410.3	-2412.3	-2411.3	-2412.9
-2759	-2759.9	-2760.8	-2760.7	-2760.2	-2758.8	-2761.3	-2760.0	-2762.0
-3104	-3104.8	-3105.7	-3105.6	-3105.0	-3103.5	-3106.3	-3104.9	-3106.9
-3446	-3450.5	-3451.6	-3451.4	-3450.8	-3449.2	-3452.1	-3450.8	-3452.9
-3795	-3796.9	-3798.3	-3797.9	-3797.4	-3795.6	-3798.7	-3797.3	-3799.5
-4147	-4147.3	-4148.7	-4148.3	-4147.8	-4145.9	-4149.1	-4147.6	-4149.7
-4490	-4490.1	-4491.7	-4491.0	-4490.6	-4488.5	-4492.0	-4490.4	-4492.6
-4145	-4144.3	-4146.0	-4145.2	-4145.1	-4142.9	-4146.2	-4144.8	-4146.7
-3795	-3796.4	-3797.8	-3797.1	-3797.5	-3795.1	-3798.4	-3796.7	-3798.5
-3450	-3450.5	-3451.6	-3451.1	-3451.3	-3449.2	-3452.2	-3450.6	-3452.3
-3105	-3107.7	-3108.9	-3108.2	-3108.6	-3106.5	-3109.3	-3107.9	-3109.4
-2760	-2760.7	-2761.7	-2761.1	-2761.4	-2759.6	-2762.0	-2760.8	-2762.2
-2410	-2411.3	-2412.0	-2411.6	-2412.1	-2410.3	-2412.6	-2411.3	-2412.6
-2076	-2076.5	-2077.0	-2076.7	-2077.0	-2075.4	-2077.6	-2076.3	-2077.5
-1724	-1726.5	-1726.8	-1726.8	-1726.9	-1725.6	-1727.3	-1726.5	-1727.3
-1380	-1381.1	-1381.4	-1381.2	-1381.4	-1380.3	-1381.7	-1380.8	-1381.5
-1036	-1039.3	-1039.5	-1039.3	-1039.6	-1038.8	-1039.8	-1039.2	-1039.7
-692	-694.2	-694.2	-694.2	-694.4	-693.6	-694.6	-694.0	-694.3
-348	-348.6	-348.4	-348.5	-348.8	-348.2	-348.9	-348.4	-348.5
0	-0.3	0.0	-0.2	-0.4	-0.2	-0.5	-0.2	0.1

Table 7: DPMS as-found measured pressure for channels 16 to 23. All units are in Pascals.

P_{app}	Ch 16	Ch 17	Ch 18	Ch 19	Ch 20	Ch 21	Ch 22	Ch 23
350	349.9	349.9	349.6	349.7	349.7	349.6	349.7	349.9
692	692.6	692.6	692.3	692.3	692.5	692.3	692.4	692.5
1035	1034.4	1034.6	1034.0	1034.2	1034.4	1033.9	1034.2	1034.0
1379	1381.7	1381.8	1381.1	1381.4	1381.6	1381.1	1381.4	1381.3
1736	1738.5	1738.5	1737.9	1738.1	1738.4	1737.8	1738.0	1738.0
2070	2070.2	2070.4	2069.4	2069.7	2070.1	2069.3	2069.4	2069.6
2415	2415.5	2415.5	2414.5	2414.9	2415.3	2414.5	2414.3	2414.8
2760	2762.5	2762.6	2761.5	2761.7	2762.5	2761.2	2761.1	2761.6
3115	3115.8	3115.9	3114.5	3115.4	3115.7	3114.4	3114.1	3114.9
3451	3453.2	3453.2	3451.7	3452.4	3453.1	3451.6	3451.1	3452.5
3804	3804.0	3804.1	3802.3	3803.5	3803.8	3802.3	3801.4	3803.1
4140	4141.8	4141.9	4140.0	4141.5	4141.7	4139.9	4138.6	4140.7
4487	4491.9	4492.1	4489.8	4491.6	4491.9	4489.9	4488.5	4490.8
4150	4153.2	4153.3	4151.4	4153.1	4153.0	4151.3	4149.1	4152.3
3795	3796.5	3796.4	3794.6	3796.3	3796.1	3794.5	3791.9	3795.7
3451	3454.2	3454.1	3452.4	3454.0	3453.9	3452.4	3449.6	3453.6
3105	3105.2	3105.1	3104.0	3105.1	3104.9	3103.7	3100.6	3104.8
2760	2758.5	2758.3	2757.4	2758.6	2758.2	2757.0	2753.9	2758.2
2422	2418.4	2418.2	2417.4	2418.5	2418.1	2417.1	2414.2	2418.3
2070	2070.6	2070.4	2069.8	2070.5	2070.3	2069.4	2066.6	2070.5
1725	1725.4	1725.3	1724.9	1725.7	1725.3	1724.6	1722.2	1725.7
1384	1384.4	1384.3	1384.0	1384.6	1384.4	1383.6	1381.4	1384.5
1039	1038.0	1037.9	1037.6	1038.1	1037.9	1037.4	1035.6	1038.2
691	690.2	690.0	689.9	690.1	690.0	689.6	688.1	690.3
341	340.9	340.9	340.9	341.0	341.0	340.7	339.6	341.1
0	-0.4	-0.4	-0.1	-0.3	-0.2	-0.4	-1.3	0.1
-350	-349.5	-349.8	-349.7	-349.5	-349.9	-349.5	-349.5	-349.5
-694	-693.4	-693.5	-693.4	-693.2	-693.5	-693.2	-693.1	-693.1
-1034	-1034.3	-1034.3	-1034.1	-1034.1	-1034.4	-1033.8	-1033.9	-1034.0
-1378	-1377.3	-1377.1	-1377.0	-1376.9	-1377.5	-1376.4	-1376.6	-1376.7
-1722	-1723.0	-1722.7	-1722.4	-1722.5	-1723.0	-1722.0	-1722.2	-1722.2
-2070	-2068.8	-2068.5	-2068.2	-2068.1	-2068.9	-2067.6	-2067.9	-2067.8
-2410	-2411.8	-2411.9	-2411.4	-2411.5	-2412.0	-2410.9	-2411.3	-2411.2
-2759	-2760.8	-2760.9	-2760.1	-2760.3	-2761.0	-2759.6	-2760.2	-2760.0
-3104	-3105.7	-3105.8	-3105.0	-3105.0	-3105.9	-3104.2	-3105.3	-3104.7
-3446	-3451.7	-3451.7	-3450.9	-3451.1	-3451.9	-3450.0	-3451.5	-3450.3
-3795	-3798.3	-3798.4	-3797.4	-3797.4	-3798.5	-3796.5	-3798.4	-3796.6
-4147	-4148.6	-4148.8	-4147.7	-4147.7	-4148.9	-4146.8	-4149.3	-4146.9
-4490	-4491.4	-4491.7	-4490.6	-4490.4	-4492.0	-4489.4	-4492.9	-4489.6
-4145	-4145.7	-4146.0	-4144.9	-4144.9	-4146.2	-4144.1	-4147.7	-4144.0
-3795	-3797.6	-3798.2	-3797.0	-3796.7	-3798.2	-3796.3	-3800.1	-3796.1
-3450	-3451.5	-3452.1	-3451.2	-3450.7	-3452.0	-3450.3	-3454.0	-3450.1
-3105	-3108.6	-3109.3	-3108.3	-3108.1	-3109.1	-3107.7	-3111.0	-3107.4
-2760	-2761.6	-2762.0	-2761.1	-2760.8	-2762.0	-2760.6	-2763.8	-2760.4
-2410	-2412.0	-2412.6	-2411.8	-2411.5	-2412.4	-2411.2	-2414.1	-2411.1
-2076	-2077.0	-2077.4	-2076.7	-2076.4	-2077.2	-2076.2	-2078.6	-2076.0
-1724	-1727.0	-1727.4	-1726.7	-1726.5	-1727.2	-1726.4	-1728.5	-1726.2
-1380	-1381.3	-1381.6	-1381.1	-1380.9	-1381.6	-1380.9	-1382.7	-1380.7
-1036	-1039.6	-1039.7	-1039.3	-1039.3	-1039.9	-1039.2	-1040.7	-1039.0
-692	-694.3	-694.5	-694.2	-694.1	-694.5	-694.0	-695.2	-693.7
-348	-348.5	-348.7	-348.6	-348.2	-348.9	-348.4	-349.6	-348.3
0	-0.2	-0.2	-0.2	0.2	-0.4	-0.1	-1.1	0.0

Table 8: DPMS as-found measured pressure for channels 24 to 31. All units are in Pascals.

P_{app}	Ch 24	Ch 25	Ch 26	Ch 27	Ch 28	Ch 29	Ch 30	Ch 31
350	349.6	349.8	349.8	349.8	349.7	349.7	349.8	349.7
692	692.6	692.5	692.6	692.6	692.6	693.2	692.3	692.4
1035	1034.2	1034.2	1034.3	1034.2	1034.1	1035.4	1034.0	1034.0
1379	1381.5	1381.3	1381.7	1381.3	1381.4	1383.2	1381.2	1381.3
1736	1738.3	1738.1	1738.3	1737.9	1738.0	1740.3	1737.9	1738.0
2070	2070.0	2069.6	2069.9	2069.5	2069.5	2072.4	2069.6	2069.6
2415	2415.0	2414.6	2415.0	2414.6	2414.6	2417.7	2414.5	2414.8
2760	2762.0	2761.6	2762.1	2761.5	2761.7	2764.8	2761.6	2761.6
3115	3115.0	3114.8	3115.2	3114.8	3114.8	3118.1	3114.7	3115.0
3451	3452.3	3452.0	3452.5	3452.0	3451.9	3455.5	3451.8	3452.3
3804	3802.9	3802.7	3803.2	3802.8	3802.7	3806.1	3802.4	3803.1
4140	4140.5	4140.3	4140.9	4140.5	4140.4	4143.6	4140.2	4140.7
4487	4490.4	4490.4	4491.0	4490.5	4490.1	4493.5	4490.2	4490.9
4150	4151.8	4151.5	4152.1	4151.7	4151.6	4155.9	4151.7	4152.2
3795	3795.0	3794.8	3795.1	3794.9	3794.9	3800.1	3795.0	3795.3
3451	3453.0	3452.7	3453.0	3452.7	3453.0	3458.6	3453.0	3453.0
3105	3104.2	3103.8	3104.1	3103.9	3104.3	3110.6	3104.2	3104.3
2760	2757.6	2757.3	2757.5	2757.3	2757.8	2764.8	2757.8	2757.5
2422	2417.5	2417.3	2417.5	2417.5	2417.8	2425.2	2417.9	2417.6
2070	2069.9	2069.6	2069.7	2069.6	2070.1	2077.7	2070.0	2069.8
1725	1724.9	1724.8	1725.0	1724.7	1725.1	1732.8	1725.3	1725.0
1384	1383.7	1383.8	1383.9	1383.8	1384.3	1391.7	1384.3	1384.2
1039	1037.8	1037.6	1037.8	1037.6	1037.9	1044.9	1038.0	1037.9
691	689.7	689.7	689.7	689.9	690.0	696.7	690.1	690.2
341	340.8	340.9	340.7	341.0	340.9	347.1	341.2	341.0
0	-0.5	-0.3	-0.4	-0.3	-0.3	5.4	-0.1	-0.2
-350	-349.6	-349.6	-349.6	-349.5	-349.5	-349.6	-349.6	-349.6
-694	-693.6	-693.2	-693.4	-693.4	-693.4	-693.1	-693.2	-693.1
-1034	-1034.2	-1034.0	-1034.3	-1034.0	-1034.1	-1033.9	-1034.0	-1033.8
-1378	-1377.1	-1376.7	-1377.0	-1376.8	-1377.0	-1376.5	-1376.8	-1376.6
-1722	-1722.9	-1722.4	-1722.8	-1722.4	-1722.8	-1722.0	-1722.4	-1722.2
-2070	-2068.5	-2068.0	-2068.5	-2068.1	-2068.4	-2067.6	-2068.1	-2068.0
-2410	-2411.7	-2411.2	-2411.8	-2411.1	-2411.4	-2411.1	-2411.1	-2411.1
-2759	-2760.6	-2760.1	-2760.6	-2760.2	-2760.2	-2759.9	-2760.0	-2759.9
-3104	-3105.5	-3104.9	-3105.6	-3104.9	-3105.0	-3104.8	-3104.6	-3104.7
-3446	-3451.4	-3450.7	-3451.4	-3451.0	-3450.7	-3451.1	-3450.5	-3450.4
-3795	-3797.8	-3797.3	-3798.2	-3797.2	-3797.2	-3798.3	-3796.8	-3797.2
-4147	-4148.3	-4147.6	-4148.7	-4147.6	-4147.4	-4149.3	-4147.2	-4147.5
-4490	-4491.2	-4490.4	-4491.6	-4490.3	-4490.2	-4492.6	-4489.9	-4490.5
-4145	-4145.6	-4144.8	-4145.9	-4144.9	-4144.5	-4147.3	-4144.2	-4144.5
-3795	-3797.6	-3796.9	-3798.0	-3796.8	-3796.8	-3799.6	-3796.2	-3796.7
-3450	-3451.5	-3450.9	-3451.9	-3450.7	-3450.8	-3453.7	-3450.3	-3450.6
-3105	-3108.6	-3108.3	-3109.0	-3108.0	-3107.9	-3111.1	-3107.5	-3107.9
-2760	-2761.4	-2761.2	-2761.8	-2761.0	-2760.9	-2764.1	-2760.5	-2760.8
-2410	-2412.0	-2411.7	-2412.3	-2411.6	-2411.5	-2414.6	-2411.1	-2411.3
-2076	-2077.0	-2076.7	-2077.4	-2076.6	-2076.5	-2079.7	-2076.2	-2076.3
-1724	-1727.0	-1726.6	-1727.3	-1726.4	-1726.5	-1729.7	-1726.1	-1726.4
-1380	-1381.4	-1381.0	-1381.7	-1381.0	-1381.1	-1384.3	-1380.7	-1380.9
-1036	-1039.5	-1039.4	-1039.8	-1039.2	-1039.4	-1042.3	-1039.0	-1039.2
-692	-694.2	-694.2	-694.4	-693.9	-694.1	-696.5	-693.8	-694.2
-348	-348.6	-348.6	-348.7	-348.5	-348.4	-350.2	-348.4	-348.6
0	-0.2	-0.4	-0.6	-0.2	-0.2	-1.2	0.0	-0.4

Table 9: DPMS as-found measured pressure for channels 32 to 39. All units are in Pascals.

P_{app}	Ch 32	Ch 33	Ch 34	Ch 35	Ch 36	Ch 37	Ch 38	Ch 39
350	349.8	349.8	349.7	349.8	349.6	349.5	349.4	349.6
692	692.5	692.7	692.5	692.5	692.5	692.3	692.0	692.4
1035	1034.1	1034.4	1034.1	1034.2	1034.2	1034.2	1033.7	1034.5
1379	1381.4	1381.9	1381.5	1381.4	1381.6	1381.5	1380.9	1381.6
1736	1738.0	1738.7	1738.2	1738.1	1738.1	1738.2	1737.4	1738.4
2070	2069.7	2070.2	2069.9	2069.7	2069.7	2069.7	2069.0	2070.0
2415	2414.7	2415.5	2415.1	2415.0	2414.8	2414.9	2413.9	2415.2
2760	2761.7	2762.5	2762.2	2761.9	2761.9	2761.9	2760.9	2762.3
3115	3114.9	3115.8	3115.5	3115.1	3115.0	3114.9	3113.9	3115.6
3451	3451.9	3452.9	3452.6	3452.3	3452.1	3452.2	3451.2	3453.0
3804	3802.6	3803.9	3803.6	3802.9	3802.8	3802.6	3801.9	3803.7
4140	4140.3	4141.6	4141.5	4140.7	4140.6	4140.5	4139.7	4141.6
4487	4490.4	4491.6	4491.6	4490.8	4490.4	4490.3	4489.7	4491.5
4150	4151.6	4153.1	4152.9	4152.2	4151.9	4151.8	4151.5	4152.9
3795	3794.8	3796.1	3796.2	3795.4	3795.0	3795.0	3794.7	3796.2
3451	3452.7	3454.1	3454.1	3453.3	3453.0	3453.0	3452.8	3454.1
3105	3103.9	3105.0	3105.1	3104.5	3104.2	3104.2	3104.1	3105.1
2760	2757.3	2758.3	2758.4	2758.1	2757.7	2757.9	2757.7	2758.6
2422	2417.3	2418.3	2418.2	2418.1	2417.8	2417.8	2417.7	2418.4
2070	2069.8	2070.5	2070.5	2070.4	2070.1	2070.0	2070.1	2070.7
1725	1724.9	1725.5	1725.4	1725.4	1725.1	1725.0	1725.3	1725.6
1384	1384.0	1384.3	1384.5	1384.4	1384.1	1384.1	1384.4	1384.5
1039	1037.7	1038.0	1038.1	1038.2	1037.9	1037.9	1037.9	1038.1
691	690.0	689.9	690.1	690.3	689.9	690.0	690.1	690.3
341	341.1	340.9	341.1	341.2	340.9	341.0	341.2	341.1
0	-0.1	-0.4	-0.1	-0.1	-0.3	-0.3	0.1	-0.1
-350	-349.5	-349.7	-349.9	-349.6	-349.5	-349.4	-349.3	-349.6
-694	-693.4	-693.4	-693.6	-693.3	-693.4	-693.5	-693.1	-693.4
-1034	-1033.8	-1034.3	-1034.0	-1034.1	-1033.9	-1034.1	-1033.6	-1034.0
-1378	-1377.0	-1377.3	-1377.1	-1376.9	-1377.0	-1377.0	-1376.4	-1377.1
-1722	-1722.5	-1722.9	-1722.8	-1722.5	-1722.7	-1722.7	-1721.7	-1722.7
-2070	-2068.2	-2068.7	-2068.5	-2068.2	-2068.3	-2068.2	-2067.3	-2068.4
-2410	-2411.0	-2412.0	-2411.5	-2411.3	-2411.4	-2411.2	-2410.2	-2411.5
-2759	-2759.9	-2760.8	-2760.4	-2760.2	-2760.1	-2760.0	-2758.9	-2760.2
-3104	-3104.6	-3105.7	-3104.8	-3104.7	-3105.0	-3104.9	-3103.4	-3105.0
-3446	-3450.5	-3451.7	-3450.7	-3450.7	-3450.9	-3450.5	-3448.9	-3450.7
-3795	-3796.9	-3798.4	-3797.4	-3797.3	-3797.4	-3796.9	-3795.3	-3797.3
-4147	-4147.3	-4148.8	-4147.6	-4147.5	-4147.8	-4147.2	-4145.2	-4147.6
-4490	-4490.2	-4491.6	-4490.0	-4490.1	-4490.5	-4489.7	-4487.6	-4490.2
-4145	-4144.6	-4146.0	-4144.4	-4144.5	-4145.0	-4144.2	-4142.0	-4144.6
-3795	-3796.8	-3797.9	-3796.6	-3796.6	-3797.2	-3796.5	-3794.4	-3796.7
-3450	-3450.8	-3451.7	-3450.7	-3450.6	-3451.2	-3450.6	-3448.4	-3450.7
-3105	-3108.0	-3109.0	-3107.8	-3107.9	-3108.4	-3108.0	-3105.8	-3107.9
-2760	-2761.1	-2761.8	-2760.7	-2760.8	-2761.3	-2761.0	-2759.0	-2760.8
-2410	-2411.5	-2412.2	-2411.2	-2411.2	-2411.7	-2411.6	-2409.7	-2411.4
-2076	-2076.7	-2077.2	-2076.4	-2076.3	-2076.8	-2076.6	-2075.0	-2076.5
-1724	-1726.7	-1727.1	-1726.4	-1726.5	-1726.7	-1726.7	-1725.3	-1726.5
-1380	-1381.1	-1381.5	-1380.9	-1380.8	-1381.0	-1381.0	-1379.9	-1381.0
-1036	-1039.5	-1039.7	-1039.2	-1039.1	-1039.4	-1039.2	-1038.5	-1039.2
-692	-694.2	-694.3	-694.0	-694.1	-694.1	-694.2	-693.5	-694.1
-348	-348.7	-348.5	-348.5	-348.3	-348.4	-348.3	-347.9	-348.4
0	-0.4	-0.4	0.1	0.0	0.1	0.1	0.3	0.0

Table 10: DPMS as-found measured pressure for channels 40 to 47. All units are in Pascals.

P_{app}	Ch 40	Ch 41	Ch 42	Ch 43	Ch 44	Ch 45	Ch 46	Ch 47
350	349.8	349.8	350.0	349.8	349.4	349.8	349.7	349.9
692	692.5	692.2	692.6	692.6	692.0	692.6	692.7	692.6
1035	1034.3	1034.0	1034.4	1034.4	1033.6	1034.3	1034.5	1034.2
1379	1381.6	1381.2	1381.7	1381.8	1380.7	1381.4	1381.8	1381.5
1736	1738.3	1738.0	1738.5	1738.6	1737.3	1738.2	1738.6	1738.4
2070	2070.0	2069.7	2070.3	2070.2	2068.8	2069.7	2070.3	2070.0
2415	2415.2	2414.9	2415.4	2415.5	2413.7	2415.0	2415.4	2415.1
2760	2762.3	2762.2	2762.4	2762.7	2760.6	2762.0	2762.5	2762.3
3115	3115.5	3115.6	3115.8	3116.0	3113.8	3115.1	3115.9	3115.5
3451	3452.8	3453.2	3453.0	3453.5	3451.0	3452.4	3453.1	3452.8
3804	3803.5	3804.2	3803.8	3804.5	3801.6	3803.1	3804.0	3803.6
4140	4141.3	4142.2	4141.6	4142.4	4139.3	4140.8	4141.9	4141.5
4487	4491.4	4492.8	4491.9	4492.6	4489.3	4490.8	4492.2	4491.5
4150	4152.8	4154.6	4153.4	4154.0	4151.1	4152.1	4153.3	4152.9
3795	3795.9	3798.3	3796.3	3797.1	3794.8	3795.4	3796.5	3796.1
3451	3453.8	3456.3	3454.2	3455.0	3452.9	3453.2	3454.3	3453.8
3105	3104.8	3107.4	3105.3	3106.0	3104.3	3104.4	3105.3	3105.1
2760	2758.0	2760.9	2758.6	2759.2	2757.9	2757.8	2758.8	2758.5
2422	2418.1	2420.8	2418.5	2419.1	2417.9	2417.7	2418.6	2418.4
2070	2070.2	2072.7	2070.6	2071.3	2070.3	2070.1	2070.8	2070.7
1725	1725.1	1727.4	1725.6	1726.2	1725.4	1725.2	1725.8	1725.8
1384	1384.3	1386.2	1384.7	1385.1	1384.4	1384.2	1384.7	1384.6
1039	1037.9	1039.5	1038.2	1038.6	1038.0	1037.8	1038.3	1038.3
691	690.1	691.4	690.6	690.5	690.1	689.9	690.3	690.3
341	341.0	342.0	341.4	341.4	341.2	341.0	341.2	341.3
0	-0.2	0.6	-0.2	-0.1	0.1	-0.2	-0.3	0.1
-350	-349.6	-349.6	-349.6	-349.6	-349.4	-349.4	-349.7	-349.5
-694	-693.6	-693.5	-693.5	-693.6	-693.1	-693.4	-693.5	-693.1
-1034	-1034.2	-1034.2	-1034.2	-1034.3	-1033.6	-1034.0	-1034.3	-1033.8
-1378	-1377.3	-1377.2	-1377.2	-1377.4	-1376.5	-1377.0	-1377.4	-1376.9
-1722	-1722.9	-1722.8	-1722.9	-1723.1	-1721.9	-1722.6	-1722.9	-1722.4
-2070	-2068.6	-2068.6	-2068.8	-2068.9	-2067.5	-2068.2	-2068.6	-2067.9
-2410	-2411.8	-2411.6	-2411.9	-2411.8	-2410.2	-2411.5	-2411.8	-2411.2
-2759	-2760.5	-2760.3	-2760.9	-2760.8	-2758.8	-2760.1	-2760.5	-2759.8
-3104	-3105.3	-3104.9	-3106.0	-3105.6	-3103.2	-3104.9	-3105.2	-3104.5
-3446	-3451.3	-3450.6	-3451.9	-3451.6	-3448.8	-3450.6	-3451.0	-3450.3
-3795	-3797.9	-3796.8	-3798.5	-3798.2	-3795.1	-3797.1	-3797.7	-3796.8
-4147	-4148.3	-4146.7	-4148.9	-4148.5	-4144.8	-4147.3	-4147.9	-4146.8
-4490	-4491.1	-4489.1	-4491.9	-4491.2	-4487.1	-4490.0	-4490.8	-4489.5
-4145	-4145.4	-4143.1	-4145.9	-4145.4	-4141.7	-4144.6	-4145.2	-4143.8
-3795	-3797.4	-3794.7	-3797.9	-3797.5	-3793.9	-3796.8	-3797.3	-3796.0
-3450	-3451.4	-3448.7	-3451.7	-3451.2	-3448.1	-3450.8	-3451.2	-3450.0
-3105	-3108.7	-3106.1	-3108.9	-3108.6	-3105.6	-3108.1	-3108.4	-3107.5
-2760	-2761.5	-2759.1	-2761.6	-2761.4	-2758.6	-2761.0	-2761.2	-2760.3
-2410	-2411.9	-2409.6	-2412.2	-2411.9	-2409.5	-2411.6	-2411.8	-2410.9
-2076	-2077.0	-2075.0	-2077.1	-2076.7	-2074.8	-2076.8	-2076.8	-2076.1
-1724	-1726.9	-1725.4	-1727.0	-1726.7	-1725.1	-1726.8	-1726.6	-1726.2
-1380	-1381.3	-1379.7	-1381.2	-1381.2	-1379.6	-1381.2	-1381.2	-1380.7
-1036	-1039.6	-1038.4	-1039.6	-1039.4	-1038.2	-1039.5	-1039.3	-1038.8
-692	-694.5	-693.3	-694.4	-694.1	-693.1	-694.2	-694.1	-693.8
-348	-348.7	-347.7	-348.7	-348.4	-347.9	-348.4	-348.3	-348.2
0	-0.4	0.5	-0.3	-0.1	0.3	-0.2	-0.1	0.0

Table 11: DPMS as-found measured pressure for channels 48 to 55. All units are in Pascals.

P_{app}	Ch 48	Ch 49	Ch 50	Ch 51	Ch 52	Ch 53	Ch 54	Ch 55
350	349.7	349.8	349.8	349.9	349.8	350.1	349.8	349.7
692	692.6	692.6	692.6	692.6	692.6	692.7	692.5	692.5
1035	1033.9	1034.3	1034.3	1034.1	1034.1	1034.6	1034.2	1034.1
1379	1381.5	1381.5	1381.4	1381.4	1381.6	1381.9	1381.4	1381.4
1736	1738.1	1738.2	1738.3	1738.0	1738.2	1738.8	1738.0	1738.0
2070	2069.9	2069.9	2069.9	2069.6	2070.0	2070.7	2069.6	2069.5
2415	2415.0	2415.0	2415.0	2414.7	2415.3	2415.9	2414.7	2414.6
2760	2761.4	2762.0	2761.9	2761.7	2762.3	2762.9	2761.6	2761.7
3115	3115.1	3115.0	3115.1	3115.0	3115.7	3116.3	3114.8	3114.8
3451	3451.7	3452.5	3452.3	3452.2	3453.1	3453.7	3452.0	3452.0
3804	3802.7	3803.1	3803.2	3803.0	3804.0	3804.7	3802.9	3802.7
4140	4140.4	4141.0	4141.1	4140.7	4141.9	4142.5	4140.5	4140.3
4487	4490.3	4491.0	4491.1	4490.8	4492.2	4492.8	4490.5	4490.5
4150	4151.5	4152.2	4152.7	4152.2	4153.4	4154.0	4151.8	4151.6
3795	3794.0	3795.3	3795.9	3795.5	3796.8	3797.1	3795.2	3794.8
3451	3452.4	3453.1	3453.9	3453.4	3454.5	3454.9	3453.0	3452.8
3105	3103.2	3104.2	3104.9	3104.6	3105.6	3105.9	3104.0	3103.9
2760	2756.7	2757.5	2758.4	2758.1	2759.0	2759.2	2757.6	2757.3
2422	2416.8	2417.6	2418.3	2418.0	2418.8	2419.0	2417.5	2417.4
2070	2069.5	2069.8	2070.5	2070.4	2071.0	2071.2	2070.0	2069.6
1725	1724.2	1725.0	1725.7	1725.4	1725.8	1726.1	1725.1	1724.8
1384	1383.2	1384.0	1384.5	1384.5	1384.9	1384.9	1384.1	1383.8
1039	1036.9	1037.6	1038.1	1037.9	1038.4	1038.6	1037.7	1037.6
691	689.1	689.8	690.2	690.2	690.4	690.5	690.0	689.8
341	340.2	340.8	340.9	341.1	341.2	341.2	341.1	340.8
0	-1.0	-0.3	-0.3	-0.1	-0.1	0.0	-0.3	-0.4
-350	-350.1	-349.6	-349.5	-349.5	-349.6	-349.6	-349.5	-349.5
-694	-693.5	-693.3	-693.4	-693.3	-693.5	-693.6	-693.4	-693.3
-1034	-1034.7	-1033.9	-1034.0	-1034.0	-1034.2	-1034.4	-1033.9	-1033.9
-1378	-1377.3	-1377.0	-1377.0	-1376.9	-1377.3	-1377.4	-1376.9	-1376.9
-1722	-1723.3	-1722.5	-1722.7	-1722.5	-1722.9	-1723.3	-1722.6	-1722.5
-2070	-2069.0	-2068.3	-2068.4	-2068.2	-2068.7	-2069.0	-2068.2	-2068.2
-2410	-2411.4	-2411.4	-2411.3	-2411.3	-2411.7	-2412.2	-2411.3	-2411.2
-2759	-2760.2	-2760.3	-2760.0	-2760.1	-2760.6	-2761.0	-2760.0	-2760.1
-3104	-3105.6	-3105.2	-3104.8	-3104.8	-3105.2	-3105.8	-3104.6	-3104.8
-3446	-3450.9	-3451.0	-3450.4	-3450.6	-3451.2	-3451.8	-3450.5	-3450.6
-3795	-3797.7	-3797.8	-3796.9	-3797.1	-3797.6	-3798.4	-3797.0	-3797.3
-4147	-4148.0	-4148.1	-4147.1	-4147.1	-4147.8	-4148.8	-4147.2	-4147.6
-4490	-4490.8	-4491.0	-4489.7	-4489.8	-4490.4	-4491.8	-4490.0	-4490.3
-4145	-4145.0	-4145.5	-4144.0	-4144.2	-4144.8	-4145.9	-4144.6	-4144.6
-3795	-3797.5	-3797.6	-3796.0	-3796.3	-3796.9	-3797.8	-3796.5	-3796.7
-3450	-3451.4	-3451.5	-3450.1	-3450.4	-3450.7	-3451.7	-3450.5	-3450.6
-3105	-3108.9	-3108.7	-3107.5	-3107.7	-3108.2	-3109.0	-3107.8	-3108.1
-2760	-2761.6	-2761.6	-2760.6	-2760.6	-2760.9	-2761.7	-2760.7	-2761.0
-2410	-2412.1	-2412.1	-2411.1	-2411.1	-2411.4	-2412.0	-2411.2	-2411.5
-2076	-2077.1	-2077.1	-2076.3	-2076.2	-2076.5	-2077.0	-2076.3	-2076.7
-1724	-1726.8	-1726.9	-1726.2	-1726.3	-1726.5	-1726.9	-1726.4	-1726.6
-1380	-1381.5	-1381.5	-1380.7	-1380.8	-1381.0	-1381.4	-1380.7	-1380.9
-1036	-1039.5	-1039.5	-1039.1	-1039.1	-1039.3	-1039.4	-1039.1	-1039.2
-692	-694.4	-694.3	-693.9	-693.9	-694.1	-694.1	-694.0	-694.0
-348	-348.7	-348.7	-348.3	-348.3	-348.4	-348.5	-348.4	-348.5
0	-0.3	-0.2	0.0	0.0	0.0	-0.1	-0.1	-0.1

Table 12: DPMS as-found measured pressure for channels 56 to 63. All units are in Pascals.

P_{app}	Ch 56	Ch 57	Ch 58	Ch 59	Ch 60	Ch 61	Ch 62	Ch 63
350	349.8	349.6	349.9	349.6	349.8	349.5	349.6	349.8
692	692.7	692.3	692.6	692.5	692.5	692.3	692.3	692.5
1035	1034.4	1034.0	1034.3	1034.2	1034.1	1034.1	1033.9	1034.2
1379	1381.9	1381.3	1381.6	1381.6	1381.4	1381.2	1381.1	1381.6
1736	1738.7	1738.0	1738.2	1738.3	1737.9	1737.9	1737.7	1738.1
2070	2070.3	2069.5	2069.8	2069.9	2069.5	2069.5	2069.3	2069.8
2415	2415.4	2414.8	2414.8	2415.0	2414.5	2414.5	2414.4	2414.9
2760	2762.7	2761.6	2761.8	2762.0	2761.3	2761.4	2761.3	2762.0
3115	3115.9	3114.8	3115.0	3115.3	3114.4	3114.6	3114.4	3115.5
3451	3453.2	3452.1	3452.3	3452.6	3451.4	3451.9	3451.6	3452.6
3804	3804.0	3802.8	3803.1	3803.4	3801.8	3802.5	3802.4	3803.3
4140	4141.9	4140.6	4140.7	4141.2	4139.3	4140.2	4140.1	4140.9
4487	4492.0	4490.6	4490.8	4491.3	4489.1	4490.3	4490.0	4491.1
4150	4153.2	4151.8	4152.2	4152.4	4150.3	4151.4	4151.4	4152.4
3795	3796.1	3795.1	3795.5	3795.6	3793.5	3794.5	3794.7	3795.6
3451	3453.9	3452.9	3453.3	3453.3	3451.3	3452.2	3452.4	3453.2
3105	3104.9	3104.2	3104.5	3104.5	3102.6	3103.3	3103.6	3104.4
2760	2758.2	2757.5	2758.1	2757.9	2756.2	2756.8	2756.9	2757.8
2422	2418.0	2417.6	2418.2	2417.9	2416.3	2416.9	2417.1	2417.8
2070	2070.2	2069.8	2070.4	2070.1	2068.7	2069.2	2069.5	2070.0
1725	1725.2	1724.9	1725.3	1725.1	1724.0	1724.4	1724.6	1725.1
1384	1384.2	1384.0	1384.5	1384.3	1383.2	1383.6	1383.6	1384.1
1039	1037.7	1037.7	1038.0	1037.7	1036.9	1037.3	1037.4	1037.7
691	690.0	689.9	690.3	689.9	689.4	689.6	689.6	689.9
341	340.8	340.9	341.4	341.0	340.5	340.7	340.8	340.9
0	-0.3	-0.4	0.1	-0.3	-0.5	-0.4	-0.3	-0.2
-350	-349.6	-349.5	-349.4	-349.7	-349.5	-349.4	-349.5	-349.6
-694	-693.6	-693.3	-693.3	-693.4	-693.3	-693.2	-693.3	-693.3
-1034	-1034.2	-1033.9	-1033.9	-1034.1	-1033.8	-1033.9	-1033.7	-1034.0
-1378	-1377.4	-1376.7	-1376.9	-1377.2	-1376.9	-1376.9	-1376.8	-1376.9
-1722	-1723.0	-1722.4	-1722.5	-1722.8	-1722.3	-1722.4	-1722.3	-1722.5
-2070	-2068.8	-2068.0	-2068.0	-2068.4	-2067.8	-2068.0	-2067.9	-2068.2
-2410	-2411.8	-2411.2	-2411.1	-2411.6	-2410.8	-2411.2	-2410.9	-2411.3
-2759	-2760.6	-2760.0	-2759.7	-2760.4	-2759.5	-2760.2	-2759.6	-2760.0
-3104	-3105.5	-3104.8	-3104.8	-3105.3	-3104.3	-3104.9	-3104.4	-3104.9
-3446	-3451.5	-3450.6	-3450.3	-3451.2	-3450.0	-3450.8	-3450.2	-3450.7
-3795	-3798.3	-3797.2	-3796.7	-3797.7	-3796.7	-3797.4	-3796.6	-3797.2
-4147	-4148.6	-4147.4	-4146.7	-4148.1	-4147.0	-4147.8	-4146.9	-4147.4
-4490	-4491.8	-4490.3	-4489.6	-4491.1	-4489.8	-4490.7	-4489.6	-4490.1
-4145	-4145.9	-4144.5	-4143.8	-4145.4	-4144.6	-4145.2	-4144.0	-4144.5
-3795	-3797.9	-3796.7	-3796.2	-3797.4	-3797.0	-3797.2	-3796.3	-3796.7
-3450	-3451.7	-3450.6	-3450.2	-3451.3	-3451.0	-3451.2	-3450.2	-3450.6
-3105	-3108.9	-3107.9	-3107.4	-3108.5	-3108.5	-3108.4	-3107.7	-3108.0
-2760	-2761.9	-2760.9	-2760.5	-2761.3	-2761.3	-2761.1	-2760.5	-2760.9
-2410	-2412.2	-2411.4	-2411.1	-2412.0	-2412.0	-2411.7	-2411.2	-2411.5
-2076	-2077.1	-2076.4	-2076.2	-2076.8	-2076.9	-2076.7	-2076.2	-2076.5
-1724	-1727.0	-1726.4	-1726.3	-1726.8	-1726.9	-1726.7	-1726.3	-1726.6
-1380	-1381.4	-1380.8	-1380.8	-1381.3	-1381.3	-1381.0	-1380.8	-1381.0
-1036	-1039.6	-1039.2	-1039.1	-1039.6	-1039.5	-1039.3	-1039.2	-1039.4
-692	-694.4	-694.2	-694.0	-694.3	-694.3	-694.1	-694.1	-694.1
-348	-348.6	-348.4	-348.5	-348.7	-348.7	-348.5	-348.5	-348.5
0	-0.2	-0.1	-0.1	0.0	-0.3	-0.1	-0.2	-0.2

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19. ABSTRACT A static check-calibration of a Turbulent Flow Instrumentation (TFI) Dynamic Pressure Measurement System (DPMS), consisting of two modules (serial numbers DPM1201 and DPM1203) with 32 pressure transducers each, is performed and documented in this report. It is estimated that the best-case uncertainty in pressure measurements using the DPMS is ±10.42 Pa at 95% confidence with a coverage factor of 2, occurring on channel 38. The worst-case uncertainty is estimated to be ±13.26 Pa at 95% confidence with a coverage factor of 2, occurring on channel 29. The mean uncertainty over all 64 DPMS transducers is calculated to be ±10.73 Pa at 95% confidence with a coverage factor of 2, with a standard deviation in the mean uncertainty of ±0.414 Pa.			