Engineering Report
EB-16242-24

Title: Stress-Strain Test of a sample of conductor AAC Pansy

At the request of: EMTA KABLO SANAYI VE TİCARET A.Ş.
İstasyon Mahallesi İbişağa Caddesi No:4 34940 Tuzla – İstanbul, Turkey

Test standard: EN 50182:2001

Place of test: RIBE Test Laboratory
Werk 2
Industriestr. 5
91126 Schwabach, Germany

Internal request for test: VA 16242 File: 1.2 Contents: 13 pages

Summary:

A Stress-Strain Test was carried out with a sample of conductor AAC Pansy provided by the purchaser. The results are documented in this report.

Mario Dansachmüller
RIBE Engineering

Hans-Jörg Krispin
RIBE Engineering

Schwabach, 15 July 2016

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1. Test set-up

The length of the conductor sample was 21,91 m (between eyes of dead-end clamps). The gauge length was 15,007 m. The conductor sample was prepared in line with instructions given in EN 50182. Epoxy type end fittings were used.

Measuring devices (calibration protocol see Appendices 2 to 5):

Tensile load	Load cell 50 kN HBM U2, S.No. 89022
Displacement	Inductive sensor HBM W100 S.No. 113.04 Data Acquisition Delphin AMDT CH5
Displacement	Inductive sensor HBM W50 S.No. 92410224 Data Acquisition Delphin AMDT CH6

2. Test loads for composite conductor

EN 50182 requires a preload of 2 % RTS (0,1 kN) to straighten the conductor. Subsequently, the conductor shall be unloaded to 0 kN and the strain gauges set to zero. However, the conductor could not be straightened with a load of 0,1 kN. Instead, a preload of 0,5 kN was applied, at which the conductor was straight, and the strain gauges were set to zero. The stress-strain curve was adjusted for the prestrain at 0,5 kN after the stress-strain test. This prestrain was determined to be 0,019 %.

Loading conditions chosen for stress-strain test for conductor AAC Pansy with a rated tensile strength (RTS) of 7,3 kN as specified by the purchaser:

Tensile load (% RTS)	Tensile load (kN)	Hold time (h)	Remark
6,8	0,5	-	Initial load to straighten the conductor, set the strain gauges to zero
30	2,2	0,5	Readings after 5, 10, 15 and 30 minutes, release to initial load
6,8	0,5	-	
50	3,7	1	Readings after 5, 10, 15, 30, 45 and 60 minutes, release to initial load
6,8	0,5	-	
70	5,1	1	Readings after 5, 10, 15, 30, 45 and 60 minutes, release to initial load
6,8	0,5	-	
85	6,2	1	Readings after 5, 10, 15, 30, 45 and 60 minutes, release to initial load
6,8	0,5	-	
85	6,2	-	Remove strain gauges and increase tension until breakage of conductor

3. Results

A screw-type tension device was used (constant rate of displacement per time). The rate of increase of load was such that 30 % RTS were reached after 48 seconds. The respective rate of loading was approximately 2,2 kN/min. Stress was calculated on the basis of tensile load and total cross-sectional area of conductor (42,49 mm²).

Date of test: 15 July 2016

Tensile load % RTS	Tensile load kN	Stress MPa	Elongation mm	Strain %	Temperature beginning/end of hold period °C	Remark
6,8	0,5	11,8	0	0	23,6	Set the strain gauges to zero
30	2,2	51,5	10,3	0,069	23,6	Reading after 0 minutes
			11,0	0,073	-	Reading after 5 minutes
			11,2	0,075	-	Reading after 10 minutes
			11,2	0,075	-	Reading after 15 minutes
			11,3	0,076	23,7	Reading after 30 minutes
50	3,7	85,9	21,7	0,144	23,7	Reading after 0 minutes
			23,0	0,153	-	Reading after 5 minutes
			23,3	0,156	-	Reading after 10 minutes
			23,5	0,157	-	Reading after 15 minutes
			23,8	0,159	-	Reading after 30 minutes
			24,1	0,160	-	Reading after 45 minutes
			24,2	0,161	23,8	Reading after 60 minutes
70	5,1	120,3	36,2	0,242	23,8	Reading after 0 minutes
			38,8	0,259	-	Reading after 5 minutes
			39,4	0,262	-	Reading after 10 minutes
			39,7	0,265	-	Reading after 15 minutes
			40,4	0,270	-	Reading after 30 minutes
			40,9	0,273	-	Reading after 45 minutes
			41,3	0,275	23,8	Reading after 60 minutes
85	6,2	146,0	52,7	0,351	23,8	Reading after 0 minutes
			58,2	0,388		Reading after 5 minutes
			59,4	0,396	-	Reading after 10 minutes
			60,1	0,400	-	Reading after 15 minutes
			61,5	0,410	-	Reading after 30 minutes
			62,4	0,416	-	Reading after 45 minutes
			63,2	0,421	23,8	Reading after 60 minutes
30	2,2	51,5	40,4	0,269	-	Readings during 5th application of load
50	3,7	85,9	48,6	0,324	-	
70	5,1	120,3	56,3	0,375	-	
85	6,2	146,0	63,1	0,421	-	

The conductor broke at a load of 7,9 kN (108,2 % RTS based on an RTS value of 7,3 kN) in the free span in the fifth application of load.

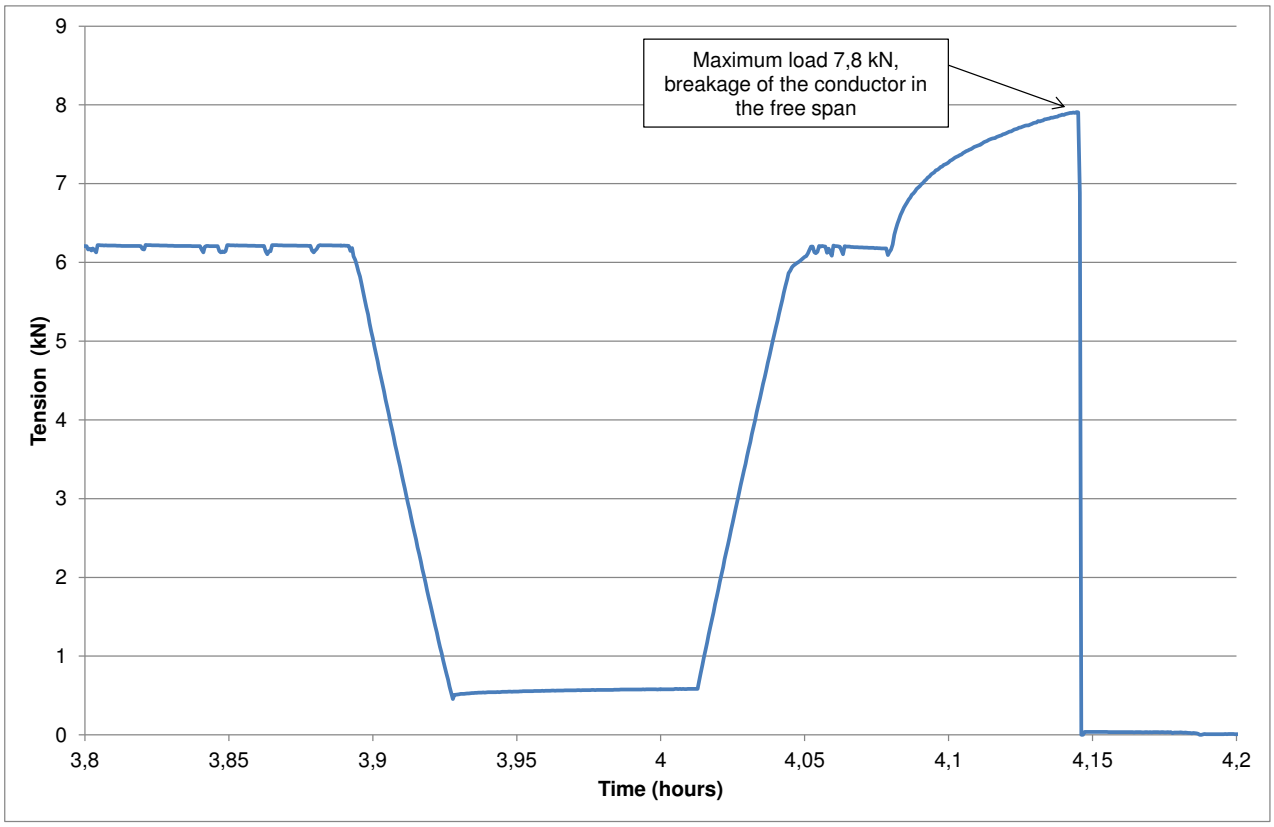

Fig. 1: Diagram load vs. time: Fifth application of load

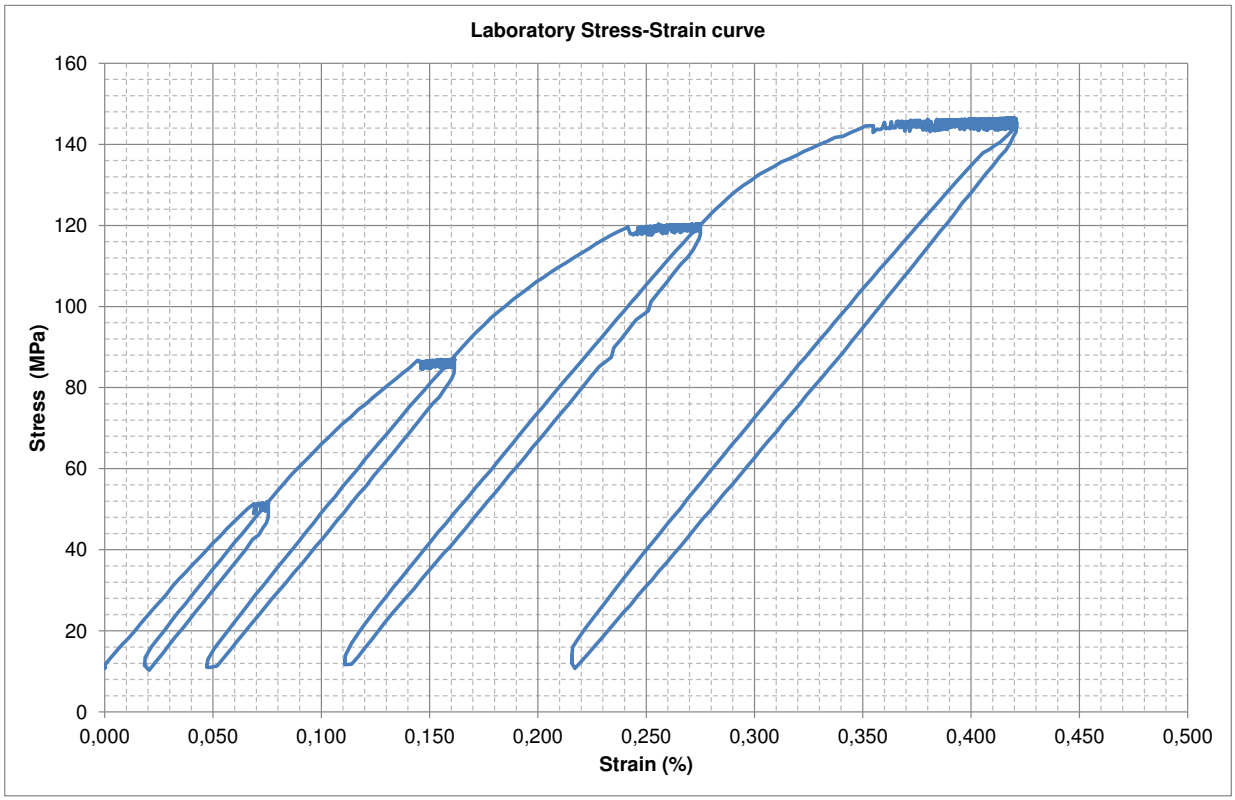

Fig. 3: Laboratory stress-strain curve

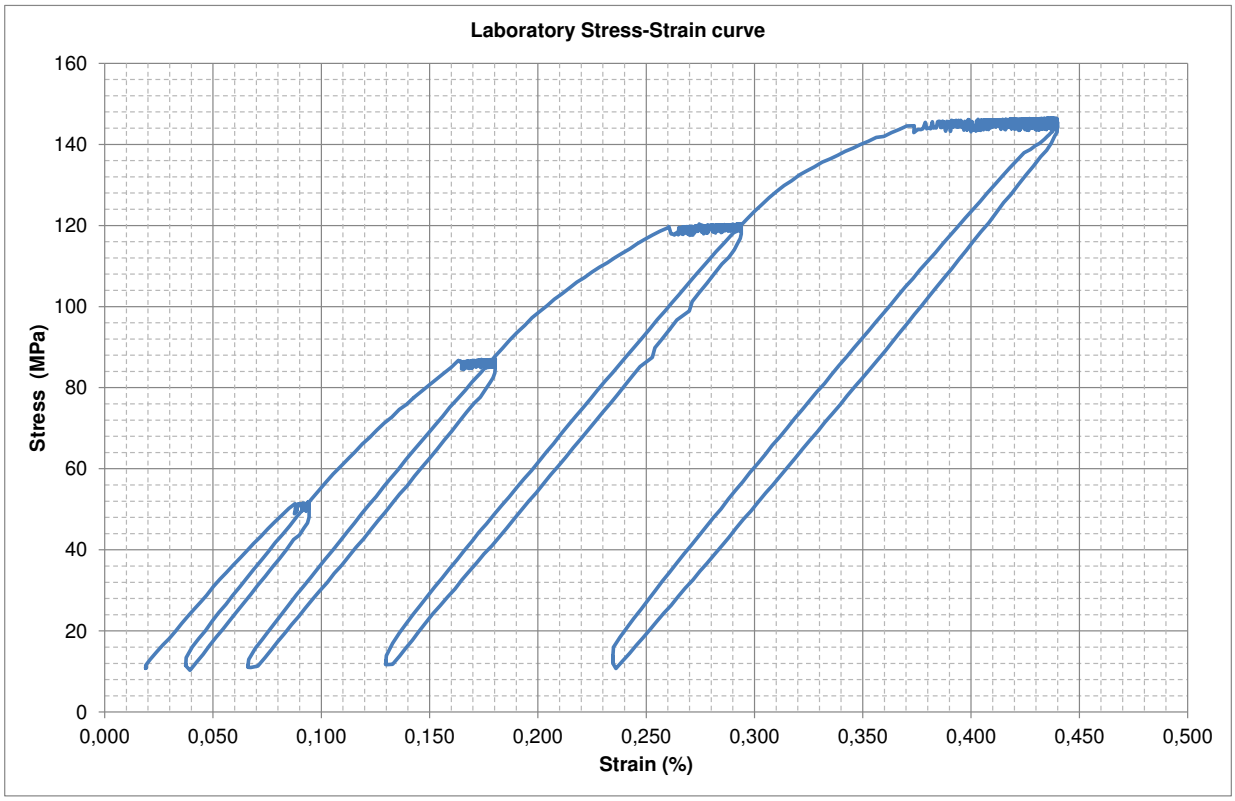

Fig. 4: Laboratory stress-strain curve adjusted for prestrain

4. Evaluation of stress-strain curve

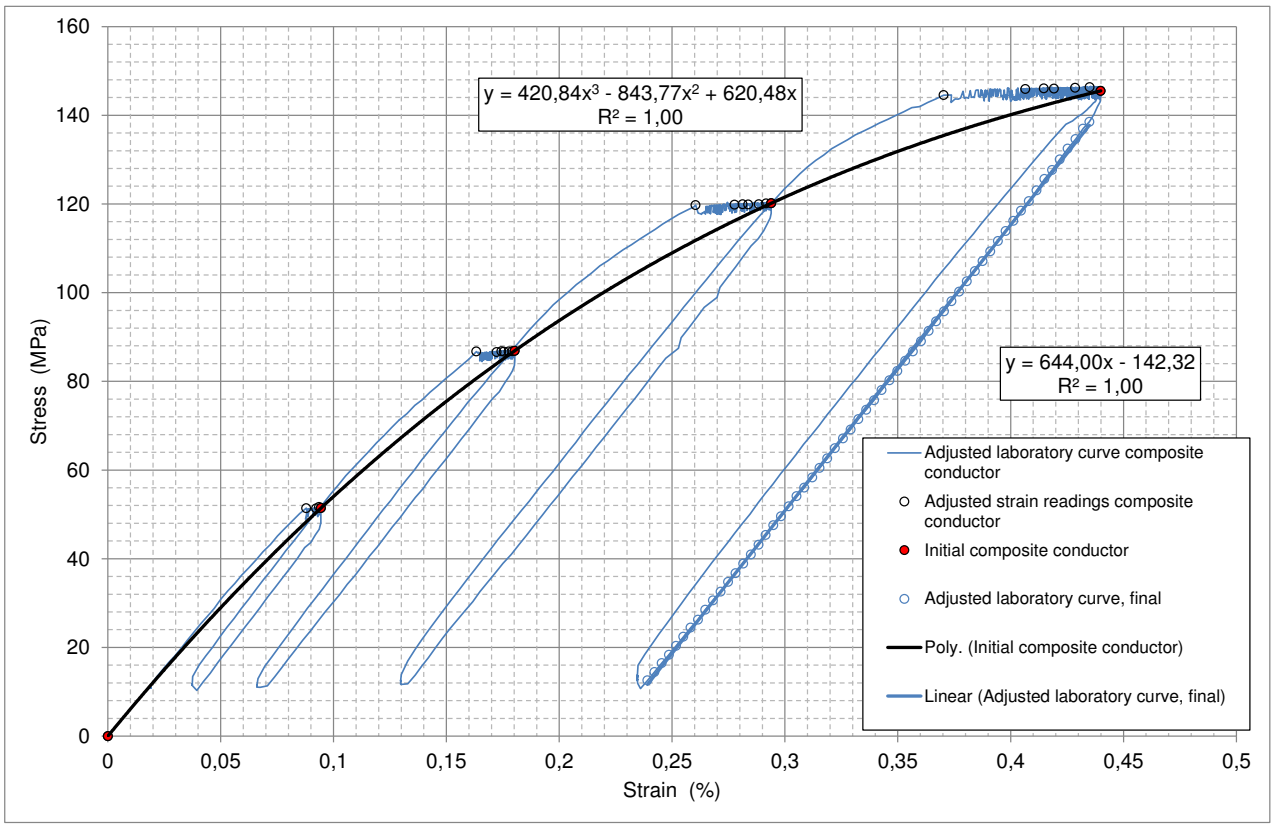

Fig. 5: Initial stress-strain curve and final modulus of conductor

Appendix 1: Conductor data

EMTA
CONDUCTOR & CABLE

CODE NAME			PANSY				
STANDARD			ASTM B 231/B 231M – 04				
All Aluminum Conductor	Size/nominal sectional area	AWG / MCM	1				
	Aluminum strand	Number	7		Diameter	2.78	mm
	Calculated area	mm^2	42.49				
	Minumum breaking strength	kN	7.3				
	Outside diameter	mm	8.34				
	Standard weight	kg/km	116.6				
	Calculated resistance 20°C	D.C.	0.6755	Ohm/km	A.C. 50 Hz		Ohm/km
	Modulus of elasticity	Initial		N/mm^2	Final	60,000	N/mm^2
	Coefficient of linear expansion	Per °C	$23 * 10^{-6}$				
	Length of each reel	m (+/- %2)	5,000				
	Reel type	mm*mm*mm	1000 * 500 * 660 (760)				
	Net weight per drum	kg	583				
	Gross weight per drum	kg	663				
	Grease weight	kg/km (+/-%20)					
	Grease type						
ALUMINUM WIRE	Diameter	mm	2.78				
	Ultimate tensile strength (before stranding)	N/mm^2	165				
	Conductivity at 20°C	% IACS	61				

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Appendix 2: Calibration certificate load cell

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EEK Page 1/2 Protocol Cert_50kN_HBM_U2_89022_2016-07-12 12/07/2016

Calibration protocol according to DIN ISO 10012

Calibration protocol code **Cert_50kN_HBM_U2_89022_2016-07-12**

Devices calibrated:

Device 1:		Load Cell HBM U2
	Serial No.:	89022
Device 2:		Measurement Amplifier HBM MGCplus / ML55B
	Serial No.:	801197960/1
Device 3:		none
	Serial No.:	none

Calibration reference device

Device 1:		Load Cell Hegewald&Peschke 1210-AF20kN
	Serial No.:	545012
	Calibration certificate:	1105RB2/2015 dated 05.11.2015

Measurement data: Page 2
Date of calibration: 12/07/2016
Calibration carried out by: H. Jung

H. Jung

CERT_50kN_113-04_2016-07-12.xlsx

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EEK

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Page 2/2 Protocol Cert_50kN_HBM_U2_89022_2016-07-12 12/07/2016

Devices calibrated:

Device 1: Load Cell HBM U2
Serial No.: 89022
Settings: none

Device 2: Measurement Amplifier HBM MGCplus / ML55
Serial No.: 801197960/1
Settings: Channel 2, sensitivity -2,0380 mV/V

Device 3: none
Serial No.: none
Sensitivity none

Calibration reference device:

Device 1: Load Cell Hegewald&Peschke 1210-AF20kN
Serial No.: 545012

1	2	3	4	5
Load reference	Load reading	Relative error (2-1)/1	Load reading	Relative error (4-1)/1
kN	kN	%	kN	%
0	0,000	-	0,000	-
1	1,000	0,00	0,999	-0,10
2	1,999	-0,05	1,997	-0,15
3	2,999	-0,03	2,996	-0,13
4	4,000	0,00	3,997	-0,08
5	5,000	0,00	4,997	-0,06
6	6,000	0,00	5,997	-0,05
7	7,000	0,00	6,997	-0,04
8	8,000	0,00	7,998	-0,02
9	9,000	0,00	9,001	0,01
10	10,002	0,02	10,002	0,02

CERT_50kN_113-04_2016-07-12.xlsx

Appendix 3: Calibration certificate displacement sensor 1

RIBE **Richard Bergner Elektroarmaturen GmbH + Co. KG**

EEK Page 1/2 Protocol Cert_W50_092410224_2016-06-16 16/06/2016

Calibration protocol according to DIN ISO 10012

Calibration protocol code **Cert_W50_092410224_2016-06-16**

Devices calibrated:

Device 1:	Displacement Sensor HBM W50
Serial No.:	092410224
Device 2:	HBM Measurement Amplifier MGCplus / ML55B
Serial No.:	801197960/1
Device 3:	Delphin Data acquisition system, AMDT CH3
Serial No.:	without

Calibration reference device

Device 1:	Gauge blocks Johansson Type 11
Serial No.:	11, 25463 DKD-K-17301 2010-11

Measurement data:	Page 2
Date of calibration:	16/06/2016
Calibration carried out by:	H. Jung

H. Jung

CERT_W50_092410224_2016-06-16.xlsx

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Page 2/2 Protocol Cert_W50_092410224_2016-06-16 16/06/2016

Devices calibrated:

Device 1: Displacement Sensor HBM W50
Serial No.: 092410224
Settings: none

Device 2: HBM Measurement Amplifier MGCplus / ML55B
Settings: Channel 2, sensitivity 80,10 mV/V
Serial No.: 801197960/1

Device 3: Data acquisition system Delphin, AMDT CH4
Serial No.: without
Settings: Sensitivity 10 V / 50 mm

Calibration reference device

Device 1: Gauge blocks Johansson Type 11
Serial No.: 11, 25463 DKD-K-17301 2010-11

Relative displacement reference mm	Displacement reading mm	Relative displacement mm	Deviation relative displacement %
0	0,000	0,00	-
5	4,993	4,99	-0,14
10	9,993	9,99	-0,07
15	14,992	14,99	-0,05
20	19,985	19,99	-0,08
25	24,966	24,97	-0,14
30	29,989	29,99	-0,04
35	35,002	35,00	0,01
40	40,013	40,01	0,03
45	45,025	45,03	0,06
50	50,000	50,00	0,00

CERT_W50_092410224_2016-06-16.xlsx

Appendix 4: Calibration certificate displacement sensor 2

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EEK Page 1/2 Protocol Cert_W100_113-04_2016-06-16 16/06/2016

Calibration protocol according to DIN ISO 10012

Calibration protocol code **Cert_W100_113-04_2016-06-16**

Devices calibrated:

Device 1: Displacement Sensor HBM W100
Serial No.: 113.04 / 3799

Device 2: Measurement Amplifier HBM MGC / MC55
Serial No.: 199144B

Device 3: Data acquisition system Delphin, AMDT CH5
Serial No.: none

Calibration reference device

Device 1: Gauge blocks Johansson Type 11
Serial No.: 11, 25463 DKD-K-17301 2010-11

Measurement data: Page 2
Date of calibration: 16/06/2016
Calibration carried out by: H. Jung

H. Jung

CERT_W100_113-04_2014-10-10.xlsx

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Page 2/2 Protocol Cert_W100_113-04_2016-06-16 16/06/2016

Devices calibrated:

Device 1: Displacement Sensor HBM W100
Serial No.: 113.04 / 3799
Settings: none

Device 2: Measurement Amplifier HBM MGC / MC55
Serial No.: 199144B
Settings: Channel 1, sensitivity 82,08 mV/V, Filter AC

Device 3: Data acquisition system Delphin, AMDT CH5
Serial No.: none
Sensitivity 10 V / 100 mm

Calibration reference device:

Device 1: Gauge blocks Johansson Type 11
Serial No.: 11, 25463 DKD-K-17301 2010-11

Relative displacement reference mm	Displacement reading mm	Relative displacement mm	Deviation relative displacement %
0	-99,75	0,00	
10	-90,29	9,46	-5,43
20	-80,30	19,44	-2,79
30	-70,31	29,44	-1,88
40	-60,39	39,36	-1,60
50	-50,34	49,40	-1,19
60	-40,39	59,36	-1,07
70	-30,42	69,32	-0,97
80	-20,39	79,35	-0,81
90	-10,33	89,41	-0,65
100	-0,44	99,31	-0,69
110	9,62	109,36	-0,58
120	19,80	119,55	-0,38
130	29,96	129,70	-0,23
140	40,50	140,24	0,17
150	50,40	150,14	0,09
160	60,64	160,39	0,24
170	70,72	170,47	0,28
180	80,64	180,39	0,22
190	90,16	189,90	-0,05
200	99,67	199,42	-0,29

CERT_W100_113-04_2014-10-10.xlsx