SEIBERSDORF LABORATORIES

Kalibrierstelle für Antennen und Feldsonden
Calibration Body for Antennas and Field Probes

Akkreditiert durch / *accredited by*
AKKREDITIERUNG AUSTRIA

Kalibrierschein nach ISO/IEC 17025
Calibration Certificate according to ISO/IEC 17025

Kalibrierzeichen
Calibration mark

EH-A1564/20
0612
10.11.2020

Gegenstand *Object*	Horn Antenna
Hersteller & Typ *Manufacturer & Type*	TekBox TBMA4
Herstellernummer *Serial number*	N/A
Auftraggeber *Customer*	TekBox Digital Solutions Vietnam Co. Ltd. Saigon Hi-Tech Park, Factory 4, 5F, Lot I-3B-1, N6 Str., Tan Phu Ward, D 9 70000 Ho Chí Minh Vietnam
Auftragsnummer *Order Nr.*	L.L7.00059.0.0-A-8171_1 Ext. Ord. No.: 20201103001
Anzahl der Seiten des Kalibrierscheines *Number of pages of the certificate*	1 - 9
Datum der Kalibrierung *Date of calibration*	10.11.2020

Akkreditierung Austria ist Vollmitglied bei der International Laboratory Accreditation Cooperation ILAC und Unterzeichner der MRAs für die Bereiche „Testing, Calibration and Inspection".

Die Kalibrierung erfolgt auf der gesetzlichen Grundlage des Akkreditierungsgesetzes in gültiger Fassung entsprechend den Anforderungen der ÖVE/ÖNORM EN ISO/IEC 17025.

Dieser Kalibrierschein dokumentiert die Rückführbarkeit auf nationale Normale zur Darstellung der physikalischen Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).

Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

Akkreditierung Austria is a full member of the International Laboratory Accreditation Cooperation ILAC and a signatory of the MRA for "Testing, Calibration and Inspection".

The calibration is performed in accordance with the Akkreditierungsgesetz in the amended version and the requirements of ÖVE/ÖNORM EN ISO/IEC 17025.

This calibration certificate documents the traceability to national standards, which realize the physical units or measurements according to the International System of Units (SI).

The user is obliged to have the object recalibrated at appropriate intervals.

Dieser Kalibrierschein darf nur vollständig und unverändert weiterverarbeitet werden. Auszüge oder Änderungen sind unzulässig. Kalibrierscheine ohne Unterschrift haben keine Gültigkeit.

This calibration certificate may not be reproduced other than in full. Calibration certificates without signature are not valid.

Datum *Date*	Zeichnungsberechtigter *Authorized person*	Bearbeiter *Person responsible*
12.11.2020	Patrick Preiner	Christian Bucco

Calibration Procedure

SAE ARP 958 Calibration, Three-Antenna Method

The SAE ARP 958 standard is extended to a 3-antenna method so that non-identical antennas can be used for the calibration procedure. Calibrations are carried out in a fully absorber lined anechoic test site. At the terminal of each antenna an attenuator is inserted in order to minimise mismatch.

The voltage reflection coefficient (VRC) is measured using a network analyser. Results are shown as voltage standing wave ration (VSWR) calculated from the voltage reflection coefficient as following:

$$\mathrm{VSWR} = \frac{1+\mathrm{VRC}}{1-\mathrm{VRC}}$$

Calibrations are carried out as described in internal working procedures of the ISO 9001 certified quality management system. All relevant additional ports of the device under test are terminated.

Test Equipment

Type	**Identification**
Network Analyzer Agilent Technologies N5244A	E0190
Double Ridged Horn EMCO 3115	E0540
Double Ridged Horn EMCO 3115	E0599
Attenuator 6 dB	E1248
Attenuator 6 dB	E1368
CalStan 10.0	E0920

Environmental Conditions

Test Site Temperature	22°C	± 3 °C
Test Site Humidity	38 %	± 10 %
Control Room Temperature	21°C	± 3 °C
Control Room Humidity	40 %	± 10 %

Results

Type	**Distance**	**Fig./Table**
AF	1 m	1
Gain	1 m	2
VSWR		3

Accuracy of Calibration

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor *k = 2*, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EAL Publication EA 4/02.

References

[1] SAE ARP 958D:2003 Electromagnetic Interference Measurement Antennas; Standard Calibration Method

[2] The Handbook of Antenna Design, Volume 1, A.W.Rudge, K.Milne, A.D.Olver, P.Knight, IEE Electromagnetic Waves Series 15, 1982 Peter Peregrinus Ltd.,London, UK

[3] EA-4/02 M:2013 Evaluation of the Uncertainty of Measurement in Calibration

Figure 1: AF; distance = 1 m

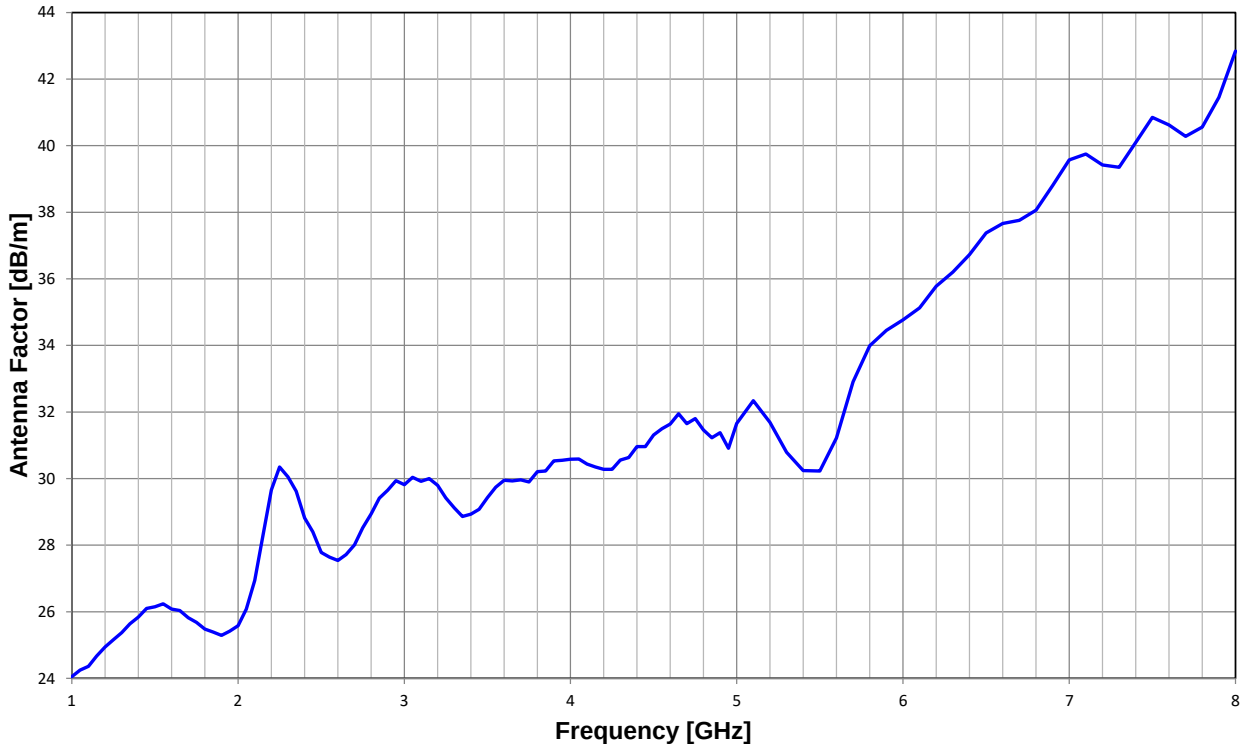

Table 1: AF; distance = 1 m

f [GHz]	AF [dB/m]	U [dB]	f [GHz]	AF [dB/m]	U [dB]
1.000	24.05	1.20	2.300	30.05	1.20
1.050	24.25	1.20	2.350	29.62	1.20
1.100	24.36	1.20	2.400	28.82	1.20
1.150	24.67	1.20	2.450	28.40	1.20
1.200	24.94	1.20	2.500	27.78	1.20
1.250	25.16	1.20	2.550	27.64	1.20
1.300	25.37	1.20	2.600	27.54	1.20
1.350	25.64	1.20	2.650	27.72	1.20
1.400	25.84	1.20	2.700	28.01	1.20
1.450	26.10	1.20	2.750	28.52	1.20
1.500	26.15	1.20	2.800	28.94	1.20
1.550	26.24	1.20	2.850	29.41	1.20
1.600	26.08	1.20	2.900	29.65	1.20
1.650	26.04	1.20	2.950	29.94	1.20
1.700	25.82	1.20	3.000	29.82	1.20
1.750	25.68	1.20	3.050	30.04	1.20
1.800	25.48	1.20	3.100	29.92	1.20
1.850	25.39	1.20	3.150	30.00	1.20
1.900	25.29	1.20	3.200	29.80	1.20
1.950	25.42	1.20	3.250	29.42	1.20
2.000	25.58	1.20	3.300	29.12	1.20
2.050	26.08	1.20	3.350	28.86	1.20
2.100	26.94	1.20	3.400	28.93	1.20
2.150	28.29	1.20	3.450	29.08	1.20
2.200	29.66	1.20	3.500	29.43	1.20
2.250	30.35	1.20	3.550	29.74	1.20

f [GHz]	AF [dB/m]	U [dB]
3.600	29.95	1.20
3.650	29.93	1.20
3.700	29.96	1.20
3.750	29.90	1.20
3.800	30.21	1.20
3.850	30.23	1.20
3.900	30.53	1.20
3.950	30.55	1.20
4.000	30.58	1.20
4.050	30.59	1.20
4.100	30.44	1.20
4.150	30.35	1.20
4.200	30.28	1.20
4.250	30.28	1.20
4.300	30.56	1.20
4.350	30.63	1.20
4.400	30.96	1.20
4.450	30.96	1.20
4.500	31.31	1.20
4.550	31.50	1.20
4.600	31.64	1.20
4.650	31.95	1.20
4.700	31.65	1.20
4.750	31.80	1.20
4.800	31.46	1.20
4.850	31.23	1.20
4.900	31.38	1.20
4.950	30.91	1.20
5.000	31.66	1.20
5.100	32.34	1.20
5.200	31.69	1.20
5.300	30.79	1.20
5.400	30.24	1.20
5.500	30.23	1.20
5.600	31.22	1.20
5.700	32.91	1.20
5.800	33.99	1.20
5.900	34.45	1.20
6.000	34.77	1.20
6.100	35.13	1.20
6.200	35.78	1.20
6.300	36.20	1.20
6.400	36.73	1.20
6.500	37.38	1.20
6.600	37.66	1.20
6.700	37.76	1.20
6.800	38.06	1.20
6.900	38.80	1.20
7.000	39.57	1.20
7.100	39.75	1.20
7.200	39.42	1.20
7.300	39.35	1.20
7.400	40.10	1.20
7.500	40.85	1.20
7.600	40.62	1.20
7.700	40.28	1.20
7.800	40.56	1.20
7.900	41.45	1.20
8.000	42.84	1.20

Figure 2: Gain; distance = 1 m

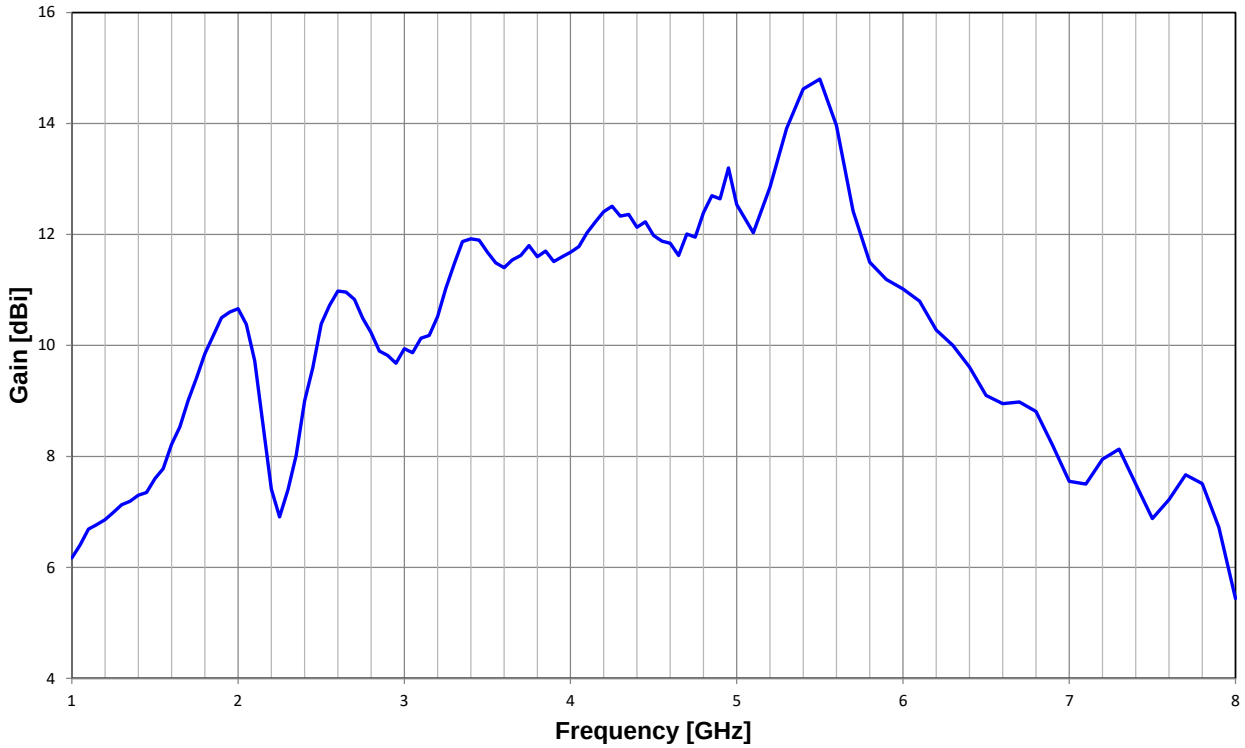

Table 2: Gain; distance = 1 m

f [GHz]	G [dBi]	U [dB]	f [GHz]	G [dBi]	U [dB]
1.000	6.17	1.20	2.300	7.40	1.20
1.050	6.40	1.20	2.350	8.02	1.20
1.100	6.69	1.20	2.400	9.00	1.20
1.150	6.77	1.20	2.450	9.60	1.20
1.200	6.86	1.20	2.500	10.39	1.20
1.250	6.99	1.20	2.550	10.72	1.20
1.300	7.13	1.20	2.600	10.98	1.20
1.350	7.19	1.20	2.650	10.96	1.20
1.400	7.30	1.20	2.700	10.83	1.20
1.450	7.35	1.20	2.750	10.49	1.20
1.500	7.60	1.20	2.800	10.23	1.20
1.550	7.78	1.20	2.850	9.90	1.20
1.600	8.22	1.20	2.900	9.82	1.20
1.650	8.53	1.20	2.950	9.68	1.20
1.700	9.01	1.20	3.000	9.94	1.20
1.750	9.41	1.20	3.050	9.87	1.20
1.800	9.85	1.20	3.100	10.13	1.20
1.850	10.17	1.20	3.150	10.18	1.20
1.900	10.50	1.20	3.200	10.52	1.20
1.950	10.60	1.20	3.250	11.03	1.20
2.000	10.66	1.20	3.300	11.47	1.20
2.050	10.38	1.20	3.350	11.87	1.20
2.100	9.72	1.20	3.400	11.92	1.20
2.150	8.58	1.20	3.450	11.90	1.20
2.200	7.41	1.20	3.500	11.68	1.20
2.250	6.91	1.20	3.550	11.49	1.20

f [GHz]	G [dBi]	U [dB]
3.600	11.40	1.20
3.650	11.54	1.20
3.700	11.62	1.20
3.750	11.80	1.20
3.800	11.60	1.20
3.850	11.70	1.20
3.900	11.51	1.20
3.950	11.60	1.20
4.000	11.68	1.20
4.050	11.78	1.20
4.100	12.03	1.20
4.150	12.23	1.20
4.200	12.41	1.20
4.250	12.51	1.20
4.300	12.33	1.20
4.350	12.36	1.20
4.400	12.13	1.20
4.450	12.23	1.20
4.500	11.98	1.20
4.550	11.88	1.20
4.600	11.84	1.20
4.650	11.62	1.20
4.700	12.01	1.20
4.750	11.95	1.20
4.800	12.39	1.20
4.850	12.70	1.20
4.900	12.64	1.20
4.950	13.20	1.20
5.000	12.54	1.20
5.100	12.03	1.20
5.200	12.85	1.20
5.300	13.91	1.20
5.400	14.62	1.20
5.500	14.80	1.20
5.600	13.96	1.20
5.700	12.42	1.20
5.800	11.50	1.20
5.900	11.19	1.20
6.000	11.02	1.20
6.100	10.80	1.20
6.200	10.28	1.20
6.300	10.00	1.20
6.400	9.61	1.20
6.500	9.10	1.20
6.600	8.95	1.20
6.700	8.98	1.20
6.800	8.81	1.20
6.900	8.20	1.20
7.000	7.55	1.20
7.100	7.50	1.20
7.200	7.95	1.20
7.300	8.13	1.20
7.400	7.50	1.20
7.500	6.88	1.20
7.600	7.22	1.20
7.700	7.67	1.20
7.800	7.51	1.20
7.900	6.72	1.20
8.000	5.44	1.20

Figure 3: VSWR

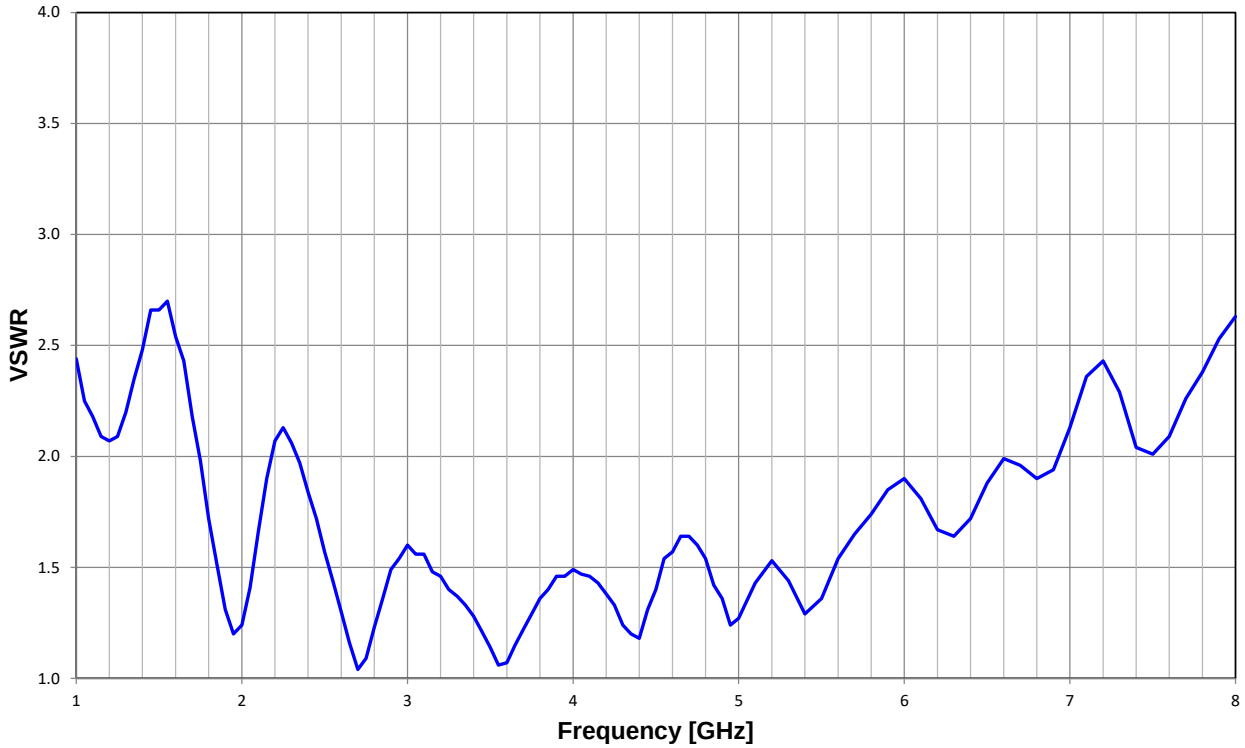

Table 3: VSWR

f [GHz]	VSWR [1]	U [1]	f [GHz]	VSWR [1]	U [1]
1.000	2.44	-0.32/0.40	2.300	2.06	-0.26/0.31
1.050	2.25	-0.29/0.35	2.350	1.97	-0.24/0.29
1.100	2.18	-0.28/0.33	2.400	1.84	-0.22/0.26
1.150	2.09	-0.26/0.32	2.450	1.72	-0.21/0.24
1.200	2.07	-0.26/0.31	2.500	1.57	-0.18/0.22
1.250	2.09	-0.26/0.32	2.550	1.44	-0.17/0.19
1.300	2.20	-0.28/0.34	2.600	1.30	-0.15/0.17
1.350	2.35	-0.31/0.37	2.650	1.16	-0.13/0.15
1.400	2.48	-0.33/0.41	2.700	1.04	-0.04/0.13
1.450	2.66	-0.36/0.45	2.750	1.09	-0.09/0.14
1.500	2.66	-0.36/0.45	2.800	1.23	-0.14/0.16
1.550	2.70	-0.37/0.46	2.850	1.36	-0.16/0.18
1.600	2.54	-0.34/0.42	2.900	1.49	-0.17/0.20
1.650	2.43	-0.32/0.39	2.950	1.54	-0.18/0.21
1.700	2.18	-0.28/0.33	3.000	1.60	-0.19/0.22
1.750	1.98	-0.24/0.29	3.050	1.56	-0.18/0.21
1.800	1.72	-0.20/0.24	3.100	1.56	-0.18/0.21
1.850	1.51	-0.18/0.20	3.150	1.48	-0.17/0.20
1.900	1.31	-0.15/0.17	3.200	1.46	-0.17/0.20
1.950	1.20	-0.14/0.16	3.250	1.40	-0.16/0.19
2.000	1.24	-0.14/0.16	3.300	1.37	-0.16/0.18
2.050	1.41	-0.16/0.19	3.350	1.33	-0.15/0.17
2.100	1.66	-0.20/0.23	3.400	1.28	-0.15/0.17
2.150	1.90	-0.23/0.28	3.450	1.21	-0.14/0.16
2.200	2.07	-0.26/0.31	3.500	1.14	-0.13/0.15
2.250	2.13	-0.27/0.32	3.550	1.06	-0.06/0.14

f [GHz]	VSWR [1]	U [1]
3.600	1.07	-0.07/0.14
3.650	1.15	-0.13/0.15
3.700	1.22	-0.14/0.16
3.750	1.29	-0.15/0.17
3.800	1.36	-0.16/0.18
3.850	1.40	-0.16/0.19
3.900	1.46	-0.17/0.20
3.950	1.46	-0.17/0.20
4.000	1.49	-0.17/0.20
4.050	1.47	-0.17/0.20
4.100	1.46	-0.17/0.20
4.150	1.43	-0.17/0.19
4.200	1.38	-0.16/0.18
4.250	1.33	-0.15/0.17
4.300	1.24	-0.14/0.16
4.350	1.20	-0.14/0.16
4.400	1.18	-0.13/0.15
4.450	1.31	-0.15/0.17
4.500	1.40	-0.16/0.19
4.550	1.54	-0.18/0.21
4.600	1.57	-0.18/0.21
4.650	1.64	-0.19/0.23
4.700	1.64	-0.19/0.23
4.750	1.60	-0.19/0.22
4.800	1.54	-0.18/0.21
4.850	1.42	-0.16/0.19
4.900	1.36	-0.16/0.18
4.950	1.24	-0.14/0.16
5.000	1.27	-0.14/0.17
5.100	1.43	-0.17/0.19
5.200	1.53	-0.18/0.21
5.300	1.44	-0.17/0.19
5.400	1.29	-0.15/0.17
5.500	1.36	-0.16/0.18
5.600	1.54	-0.18/0.21
5.700	1.65	-0.20/0.23
5.800	1.74	-0.21/0.25
5.900	1.85	-0.22/0.27
6.000	1.90	-0.23/0.28
6.100	1.81	-0.22/0.26
6.200	1.67	-0.20/0.23
6.300	1.64	-0.19/0.23
6.400	1.72	-0.20/0.24
6.500	1.88	-0.23/0.27
6.600	1.99	-0.25/0.30
6.700	1.96	-0.24/0.29
6.800	1.90	-0.23/0.28
6.900	1.94	-0.24/0.28
7.000	2.13	-0.27/0.33
7.100	2.36	-0.31/0.38
7.200	2.43	-0.32/0.39
7.300	2.29	-0.30/0.36
7.400	2.04	-0.25/0.31
7.500	2.01	-0.25/0.30
7.600	2.09	-0.26/0.32
7.700	2.26	-0.29/0.35
7.800	2.38	-0.31/0.38
7.900	2.53	-0.34/0.42
8.000	2.63	-0.36/0.44