

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-A402/24
0612
19.03.2024

Gegenstand <i>Object</i>	Monopole Antenna
Hersteller & Typ <i>Manufacturer & Type</i>	TEKBOX TBMA5
Herstellernummer <i>Serial number</i>	TBMA524001
Auftraggeber <i>Customer</i>	TekBox Digital Solutions Vietnam Co. Ltd. Saigon Hi-Tech Park, Factory 4, 4F Lot I-3B-1, N6 Street Tan Phu Ward Thu Duc City 70000 Ho Chi Minh Vietnam
Auftragsnummer <i>Order Nr.</i>	L.L7.00059.0.0-A-11609_1 Ext. Order No.: P01547
Anzahl der Seiten des Kalibrierscheines <i>Number of pages of the certificate</i>	1 - 5
Datum und Ort der Kalibrierung <i>Date and place of calibration</i>	19.03.2024 Seibersdorf

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 gilt ausschließlich für den kalibrierten Gegenstand und darf nur vollständig und unverändert weiterverarbeitet werden. Auszüge oder Änderungen sind unzulässig. Kalibrierscheine ohne Unterschrift haben keine Gültigkeit.

This calibration certificate is valid only for the calibrated object and may not be reproduced other than in full. Calibration certificates without signature are not valid.

Datum
Date

19.03.2024

Zeichnungsberechtigter
Authorized person

Patrick Preiner

Bearbeiter
Person responsible

Michael Nehyba

Calibration Procedure

Calibration of the **antenna factor** (AF) is carried out according to the Equivalent Capacitance Substitution Method (ECSM) described in internal process guideline LE-EH-VA-A01 (2022-07). The calibration fulfils the requirements given in SAE ARP 958, ANSI C63.5, CISPR 16-1-4 and CISPR 16-1-6. In CISPR 16-1-6 the antenna factor's abbreviation is F_a .

Calibration of the **voltage reflection coefficient** (VRC) is carried out according to the method described in internal process guideline LE-EH-VA-L02 (2022-07) using a network analyser. Results are shown as voltage standing wave ration (VSWR) calculated from the voltage reflection coefficient as following:

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

Test Equipment

Type	Identification
Network Analyzer Keysight E5061B	LE0215
TEKBOX 10pF Cal. Adapter	TBMA5
NWA Calibration Kit	E0116
CalStan 11	E0921

Environmental Conditions

Site Temperature	20°C - 27°C
Site Humidity	30% - 80%

Results

Type	Description	Fig./Table
Antenna Factor	9kHz-30MHz	1
VSWR	9kHz-30MHz	2

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] CISPR 16-1-6:2014+AMD1:2017+AMD2:2022 CSV, Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-6: Radio disturbance and immunity measuring apparatus - EMC antenna calibration
- [2] CISPR 16-1-4:2019/AMD1:2020/AMD2:2023 Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements
- [3] ANSI C63.5-2017/Cor 1-2019 American National Standard for Electromagnetic Compatibility--Radiated Emission Measurements in Electromagnetic Interference (EMI) Control - Calibration and Qualification of Antennas (9 kHz to 40 GHz) – Corrigendum 1
- [4] SAE ARP 958E:2021 Electromagnetic Interference Measurement Antennas; Standard Calibration Method
- [5] EA-4/02 M: 2022 Evaluation of the Uncertainty of Measurement in calibration

Figure 1: Antenna Factor; 9kHz-30MHz

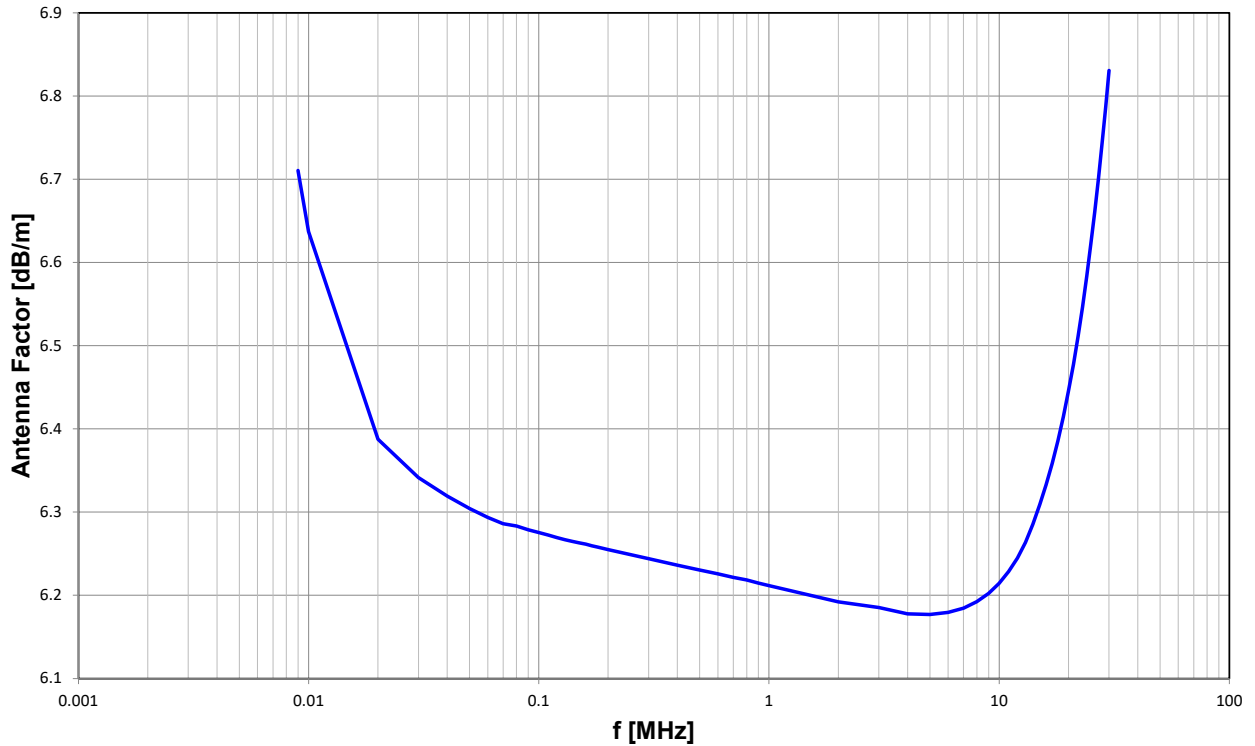


Table 1: Antenna Factor; 9kHz-30MHz

f [MHz]	AF [dB/m]	U [dB]	f [MHz]	AF [dB/m]	U [dB]	f [MHz]	AF [dB/m]	U [dB]
0.009	6.71	±1.00	0.200	6.25	±1.00	13.000	6.26	±1.00
0.010	6.64	±1.00	0.300	6.24	±1.00	14.000	6.29	±1.00
0.020	6.39	±1.00	0.400	6.24	±1.00	15.000	6.31	±1.00
0.030	6.34	±1.00	0.500	6.23	±1.00	16.000	6.33	±1.00
0.040	6.32	±1.00	0.600	6.23	±1.00	17.000	6.36	±1.00
0.050	6.30	±1.00	0.700	6.22	±1.00	18.000	6.39	±1.00
0.060	6.29	±1.00	0.800	6.22	±1.00	19.000	6.41	±1.00
0.070	6.29	±1.00	0.900	6.21	±1.00	20.000	6.45	±1.00
0.080	6.28	±1.00	1.000	6.21	±1.00	21.000	6.48	±1.00
0.090	6.28	±1.00	2.000	6.19	±1.00	22.000	6.51	±1.00
0.100	6.28	±1.00	3.000	6.19	±1.00	23.000	6.55	±1.00
0.110	6.27	±1.00	4.000	6.18	±1.00	24.000	6.58	±1.00
0.120	6.27	±1.00	5.000	6.18	±1.00	25.000	6.62	±1.00
0.130	6.27	±1.00	6.000	6.18	±1.00	26.000	6.66	±1.00
0.140	6.26	±1.00	7.000	6.18	±1.00	27.000	6.70	±1.00
0.150	6.26	±1.00	8.000	6.19	±1.00	28.000	6.74	±1.00
0.160	6.26	±1.00	9.000	6.20	±1.00	29.000	6.79	±1.00
0.170	6.26	±1.00	10.000	6.21	±1.00	30.000	6.83	±1.00
0.180	6.26	±1.00	11.000	6.23	±1.00			
0.190	6.26	±1.00	12.000	6.24	±1.00			

Figure 2: VSWR; 9kHz-30MHz

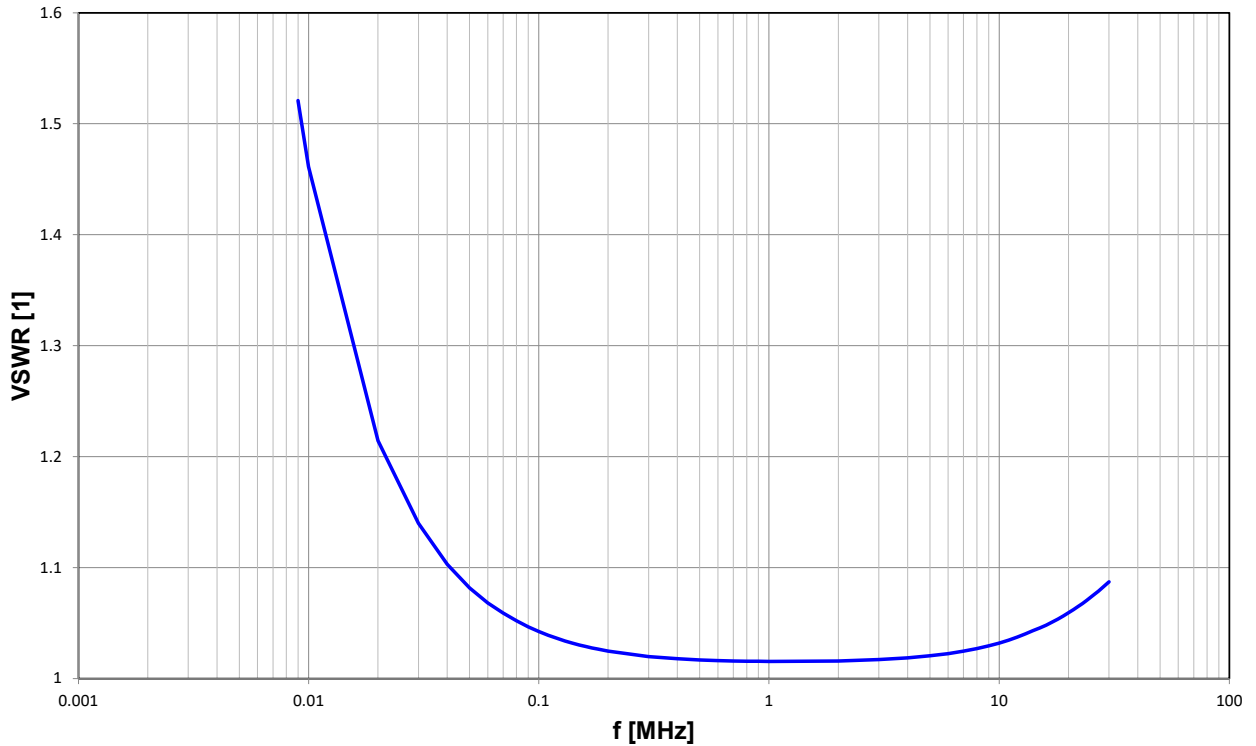


Table 2: VSWR; 9kHz-30MHz

f [MHz]	VSWR [1]	U [1]	f [MHz]	VSWR [1]	U [1]	f [MHz]	VSWR [1]	U [1]
0.009	1.52	±0.08	0.200	1.02	±0.05	13.000	1.04	±0.05
0.010	1.46	±0.08	0.300	1.02	±0.05	14.000	1.04	±0.05
0.020	1.21	±0.06	0.400	1.02	±0.05	15.000	1.05	±0.05
0.030	1.14	±0.06	0.500	1.02	±0.05	16.000	1.05	±0.05
0.040	1.10	±0.06	0.600	1.02	±0.05	17.000	1.05	±0.05
0.050	1.08	±0.06	0.700	1.02	±0.05	18.000	1.05	±0.05
0.060	1.07	±0.05	0.800	1.02	±0.05	19.000	1.06	±0.05
0.070	1.06	±0.05	0.900	1.02	±0.05	20.000	1.06	±0.05
0.080	1.05	±0.05	1.000	1.02	±0.05	21.000	1.06	±0.05
0.090	1.05	±0.05	2.000	1.02	±0.05	22.000	1.06	±0.05
0.100	1.04	±0.05	3.000	1.02	±0.05	23.000	1.07	±0.05
0.110	1.04	±0.05	4.000	1.02	±0.05	24.000	1.07	±0.06
0.120	1.04	±0.05	5.000	1.02	±0.05	25.000	1.07	±0.06
0.130	1.03	±0.05	6.000	1.02	±0.05	26.000	1.08	±0.06
0.140	1.03	±0.05	7.000	1.02	±0.05	27.000	1.08	±0.06
0.150	1.03	±0.05	8.000	1.03	±0.05	28.000	1.08	±0.06
0.160	1.03	±0.05	9.000	1.03	±0.05	29.000	1.08	±0.06
0.170	1.03	±0.05	10.000	1.03	±0.05	30.000	1.09	±0.06
0.180	1.03	±0.05	11.000	1.03	±0.05			
0.190	1.03	±0.05	12.000	1.04	±0.05			