



Český metrologický institut

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Calibration laboratory No. 2202 accredited by the Czech Accreditation Institute according to ISO/IEC 17025:2005

Laboratory: Regional Inspectorate Brno, Okružní 31, 638 00 Brno
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CERTIFICATE OF CALIBRATION

6011-KL-L0643-19

Date of issue: 28th August 2019

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Customer:

Measuring instrument: Impedance calibrator

Manufacturer: Meatest

Type: M-550

Serial number: 599381

The results of the calibration have been obtained following the procedures reported in this Certificate and are related only to the date, place and conditions of the calibration.

Date of calibration: 20th to 22nd August 2019

Calibrated by:

Stanislav Mašlán



**Director of CMI
Regional Inspectorate Brno:**

Radovan Wiecek

Calibration procedure: Impedance of the calibrator was compared to reference standards using bridge Keysight E4980A. Low capacitance ranges were measured by direct reading on capacitance bridge AH2700A. Calibration was carried out according internal procedures 611-MP-C030 Calibration of capacitance, 611-MP-C040 Calibration of ac resistance and 611-MP-C099 Calibration of the inductance.

Measurement standards used: RLC bridge Keysight E4980A, s.n. MY46312534, cal. cert. 6011-KL-E0012-19
 Andeen Hagerling Ultra-precision capacitance bridge AH2700A, s.n. 00700392, certificate of calibration 6011-KL-E0049-19
 Multimeter Fluke 8508A, s.n. 228066304, cal. cert. 6011-KL-E0040-19
 Digital thermometer COMET T3511, s.n. 12960376, cal. cert. 6036-KL-V0299-18
 Set of capacitors HP16380A, s.n. 1840J00995, cal. cert. 6011-KL-E0067-16
 Set of capacitors HP16380C, s.n. 2519J00296, cal. cert. 6011-KL-E0062-16
 Capacitance standard Meatest CP-10M, 10 μ F, s.n. 1/51, cal. cert. 6011-KL-E0064-16
 Capacitance standard Meatest CP-100M, 100 μ F, s.n. 1/52, cal. cert. 6011-KL-E0072-17
 Set of AC resistors HP 42030A, s.n. 3143J90xxx, cal. cert. 6011-KL-E0010-19
 Použité etalony mají metrologickou návaznost na (mezi)národní etalony.

Other equipment: OPEN termination Agilent 42090A-FG, s.n. MY43100286
 SHORT termination Agilent 42091A-FG, s.n. MY43100311

Ambient conditions: Air temperature: (23.0 \pm 0.5) °C
 Relative humidity: (54 \pm 12) %

Measurement uncertainty: The standard uncertainty of measurement has been determined in accordance with EA-4/02 M:2013 document. The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k corresponding to a coverage probability of approximately 95 %, which for normal distribution corresponds to a coverage factor $k = 2$.

Notes:

Values marked * are outside accreditation.

Display: Value shown at display

Rs, Xs, Cp, D, Cs, Rp: Measured impedance and absolute uncertainty (hodnota \pm nejistota)

$\Delta R_s, \Delta X_s, \Delta C_p, \Delta D, \Delta C_s, \Delta R_p$: Deviation (measured - displayed)

Spec: Absolute specification of instrument

% spec: Percent-of-specification $100 * |\text{deviation} / \text{specification}|$

Results of the measurement:

See tables of values.

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Measured resistance in series equivalent connection Rs-Xs (4W, corr on):

Nominal	f	Level	Display	Rs	ΔRs	Spec	%spec
SHORT	1 kHz	10 mA	-	0.185 ± 0.070	-	-	-
			Ω				
100 mΩ	1 kHz	10 mA	0.100133	0.100138 ± 0.000020	0.000005	0.000501	1
1 Ω	1 kHz	10 mA	1.009260	1.009214 ± 0.000051	-0.000046	0.001009	5
10 Ω	1 kHz	10 mA	10.09820	10.09793 ± 0.000051	-0.000027	0.00505	5
100 Ω	1 kHz	5 mA	101.0000	100.9995 ± 0.00051	-0.0005	0.0505	1
			kΩ				
1 kΩ	1 kHz	1 V	0.999958	0.999933 ± 0.000050	-0.000025	0.000200	13
10 kΩ	1 kHz	1 V	9.99786	9.99745 ± 0.000050	-0.00041	0.00200	21
100 kΩ	1 kHz	1 V	99.9995	99.9930 ± 0.00070	-0.0065	0.0500	13
			MΩ				
1 MΩ	1 kHz	1 V	0.990032	0.989954 ± 0.000099	-0.000078	0.001980	4
10 MΩ	1 kHz	1 V	9.9516	9.9516 ± 0.00050	0.0000	-	-
100 MΩ	1 kHz	1 V	99.93	112.04 ± 0.78	12.11	-	-

Display	Xs	ΔXs
mΩ	mΩ	mΩ
-	1.785 ± 0.070	-
Ω	Ω	Ω
0.000113	0.000110 ± 0.000010	-0.000003
0.000060	0.000069 ± 0.000050	0.000009
0.00003	0.00006 ± 0.000050	0.00003
-0.0040	-0.0053 ± 0.00050	-0.0013
kΩ	kΩ	kΩ
-0.000421	-0.000484 ± 0.000050	-0.000063
-0.04145	-0.04865 ± 0.00050	-0.00720
-0.0220	-0.0235 ± 0.00050	-0.0015
MΩ	MΩ	MΩ
0.002156	0.001336 ± 0.000099	-0.000820
0.3112	0.1986 ± 0.00050	-0.1126
35.29	8.33 ± 0.34	-26.96

Measured capacitance in parallel equivalent connection Cp-D (4W, corr on):

Nominal	f	Level	Display	Cp	ΔCp	Spec	%spec
OPEN	1 kHz	1 V	-	13.9609 ± 0.0042	-	-	-
100 pF	1 kHz	1 V	100.4050	100.4062 ± 0.0080	0.0012	1.0041	0
			nF				
1 nF	1 kHz	1 V	0.976628	0.976602 ± 0.000049	-0.000026	0.000977	3
10 nF	1 kHz	1 V	10.00690	10.00678 ± 0.000050	-0.00012	0.00500	2
100 nF	1 kHz	1 V	98.8104	98.8127 ± 0.0049	0.0023	0.0494	5
			μF				
1 μF	1 kHz	5 mA	0.991742	0.991709 ± 0.000050	-0.000033	0.000496	7
10 μF	1 kHz	10 mA	9.84821	9.84865 ± 0.00089	0.00044	0.00985	5
100 μF	1 kHz	10 mA	97.766	97.770 ± 0.015	0.004	0.196	2

Display	D	AD
-	-	-
0.000050	0.01727 ± 0.00050	-
-	0.000052 ± 0.000070	0.000002
0.000100	0.000023 ± 0.000010	-0.000077
0.000100	0.000041 ± 0.000050	-0.000059
0.000050	0.000073 ± 0.000050	0.000023
-	-	-
0.002780	0.002721 ± 0.000080	-0.000059
0.004100	0.004058 ± 0.000090	-0.000042
0.014210	0.014172 ± 0.000090	-0.000038

Measured resistance in parallel equivalent connection Rp-Cp (2W):

Nominal	f	Level	Display	Rp	ΔRp	Spec	%spec
			Ω	Ω	Ω	Ω	%
1 Ω	1 kHz	10 mA	1.1513	1.1475 ± 0.0023	-0.0038	0.0057	67
10 Ω	1 kHz	10 mA	10.2313	10.2270 ± 0.0020	-0.0043	0.0511	8
100 Ω	1 kHz	5 mA	101.1300	101.1254 ± 0.0051	-0.0046	0.1011	5
			kΩ	kΩ	kΩ	kΩ	%
1 kΩ	1 kHz	1 V	1.000100	1.000071 ± 0.000050	-0.000029	0.001000	3
10 kΩ	1 kHz	1 V	9.99801	9.99786 ± 0.00050	-0.00015	0.01000	2
100 kΩ	1 kHz	1 V	99.9809	99.9809 ± 0.0070	0.0000	0.1000	0
			MΩ	MΩ	MΩ	MΩ	%
1 MΩ	1 kHz	1 V	0.988479	0.988511 ± 0.000099	0.000032	0.001977	2
10 MΩ	1 kHz	1 V	9.8133	9.8076 ± 0.0034	-0.0057	0.0490	12

Measured capacitance in series equivalent connection Cs-D (2W):

Nominal	f	Level	Display	Cs	ΔCs	Spec	%spec
			pF	pF	pF	pF	%
100 pF	1 kHz	1 V	114.380	114.368 ± 0.023	-0.012	5.718	0
			nF	nF	nF	nF	%
1 nF	1 kHz	1 V	0.990600	0.990563 ± 0.000050	-0.000037	0.009906	0
10 nF	1 kHz	1 V	10.02080	10.02074 ± 0.00050	-0.00006	0.02004	0
100 nF	1 kHz	1 V	98.8249	98.8274 ± 0.0049	0.0025	0.1977	1
			μF	μF	μF	μF	%
1 μF	1 kHz	5 mA	0.99183	0.99178 ± 0.00050	-0.00005	0.00198	3
10 μF	1 kHz	10 mA	9.8542	9.8539 ± 0.0059	-0.0003	0.0493	0
100 μF	1 kHz	10 mA	98.321	98.290 ± 0.069	-0.031	0.983	3

Measured resistance in series equivalent connection Rs-Xs (4TP, corr on):

Nominal	f	Level	Display	Rs	ΔRs	Spec	%spec
SHORT	1 kHz	10 mA	-	112 ± 25	-	-	-
			Ω	Ω	Ω	Ω	%
100 mΩ	1 kHz	10 mA	0.099482	0.099493 ± 0.000020	0.000011	0.000199	6
1 Ω	1 kHz	10 mA	0.999559	0.999535 ± 0.000050	-0.000024	0.001000	2
10 Ω	1 kHz	10 mA	10.00130	10.00109 ± 0.00050	-0.00021	0.00500	4
100 Ω	1 kHz	5 mA	99.9944	99.9927 ± 0.0050	-0.0017	0.0200	8
			kΩ	kΩ	kΩ	kΩ	%
1 kΩ	1 kHz	1 V	0.999964	0.999940 ± 0.000050	-0.000024	0.000200	12
10 kΩ	1 kHz	1 V	9.99928	9.99915 ± 0.00050	-0.00013	0.00200	6
100 kΩ	1 kHz	1 V	100.0000	99.9976 ± 0.0070	-0.0024	0.0200	12
			MΩ	MΩ	MΩ	MΩ	%
1 MΩ	1 kHz	1 V	0.99993	0.99990 ± 0.00010	-0.00003	0.00030	9
10 MΩ	1 kHz	1 V	9.9999	9.9999 ± 0.0020	0.0000	0.0050	0
100 MΩ	1 kHz	1 V	100.17	100.16 ± 0.10	-0.01	0.50	1

Measured capacitance in parallel equivalent connection Cp-D (4TP, corr on):

Nominal	f	Level	Display	Cp	ΔCp	Spec	%spec
OPEN	1 kHz	1 V	-	0.45035 ± 0.00090	-	-	-
10 pF	1 kHz	1 V	10.0830	10.0911 ± 0.0070	0.0081	0.0505	16
100 pF	1 kHz	1 V	99.4300	99.4384 ± 0.0050	0.0084	0.0994	8
			nF	nF	nF	nF	%
1 nF	1 kHz	1 V	1.010290	1.010255 ± 0.000051	-0.000035	0.000505	7
10 nF	1 kHz	1 V	9.95592	9.95584 ± 0.00050	-0.00008	0.00498	2
100 nF	1 kHz	1 V	99.2650	99.2675 ± 0.0050	0.0025	0.0496	5
			μF	μF	μF	μF	%
1 μF	1 kHz	5 mA	0.987616	0.987638 ± 0.000049	0.000022	0.000494	4
10 μF	1 kHz	10 mA	9.84860	9.84871 ± 0.00089	0.00011	0.00492	2
100 μF	1 kHz	10 mA	97.757	97.762 ± 0.015	0.005	0.098	6

Measured inductance in series equivalent connection Ls-Rs (4TP, corr on):

Nominal	f	Level	Display	Ls	ΔLs	Spec	%spec	Rs	ARs
			μH	μH	μH	μH	%	Ω	Ω
10 μH	50 kHz	5 mA	10.911	10.911 ± 0.011	0.000	0.033	0	66.030 ± 0.033	0.000
100 μH	50 kHz	5 mA	99.045	99.022 ± 0.050	-0.023	0.198	11	199.98 ± 0.10	-0.02
-	-	-	mH	mH	mH	mH	%	kΩ	kΩ
1 mH	50 kHz	1 V	1.08309	1.08307 ± 0.00054	-0.00002	0.0108	2	0.66060 ± 0.00033	0.00001
10 mH	10 kHz	1 V	10.8903	10.8909 ± 0.0033	0.0006	0.0109	6	0.66052 ± 0.00033	0.00000
100 mH	10 kHz	1 V	99.659	99.655 ± 0.020	-0.004	0.100	4	1.9999 ± 0.0014	-0.0001
-	-	-	H	H	H	H	%	kΩ	kΩ
1 H	1 kHz	1 V	0.99394	0.99378 ± 0.00020	-0.00016	0.00099	16	19.994 ± 0.010	0.001
10 H	100 Hz	1 V	9.9579	9.9584 ± 0.0020	0.0005	0.0100	4	19.997 ± 0.010	-0.003

End of calibration certificate.

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