

CONTENTS

PREFACE.....	3
1. INTRODUCTION.....	6
2. INTERNATIONAL SYSTEM OF UNITS (SI) [3]	8
2.1 SI base units	8
2.2 SI derived units.....	9
2.3 SI prefixes.....	9
2.4 Possible future revision of SI	11
3. MEASUREMENT STANDARDS	12
3.1 Primary and intrinsic standards	12
3.1.1 Capacitance standards based on the Thompson-Lampard theorem	12
3.1.2 Voltage standards based on the Josephson effect	15
3.1.3 Resistance standards based on the quantum Hall effect	16
3.4 Secondary, reference and working standards.....	18
3.4.1 Voltage standards	18
3.4.2 Standards of resistance, capacitance and inductance.....	18
3.5 Transfer standards.....	24
4. MEASUREMENT METHODS.....	27
4.1 1:1 comparison of voltage standards.....	27
4.2 Comparison of resistance standard.....	27
4.3 Calibration of capacitance standards by a step-up method.....	33
5. MEASUREMENT ERRORS	35
5.1 Introduction	35
5.2 Errors of direct measurements based on repeated observations.....	38
5.2.1 Possibilities of minimizing random and systematic errors	41
5.2.2 Evaluation of confidence limits of the random error of the measurement result	43
5.2.3 Evaluation of confidence limits of the undisclosed systematic error of the measurement result	43
5.2.4 Evaluation of confidence limits of the total error of the measurement result	44
5.3 Allan variance	45
5.4 Errors of indirect measurements	46
5.4.1 Linear indirect measurements.....	46
5.4.2 Nonlinear indirect measurements	47
6. MEASUREMENT UNCERTAINTIES [26-28].....	50
6.1 Basic terms.....	50

6.2	Uncertainties of direct measurements based on repeated observations	51
6.2.1	<i>Procedure for evaluating the uncertainty of a direct measurement</i>	51
6.2.2	<i>Examples</i>	54
6.3	Uncertainties of indirect measurements	57
6.3.1	<i>Procedure for evaluating the uncertainty of an indirect measurement</i>	57
6.3.2	<i>Examples</i>	58
6.4	Determination of the coverage factor for a specified level of confidence.....	61
6.5	Evaluation of the uncertainty of measurement by a Monte Carlo method	62
7.	FACILITIES AND METHODS FOR PRECISION MEASUREMENTS OF ELECTRICAL QUANTITIES.....	65
7.1	Selected devices for precision measurements of electrical quantities	65
7.1.1	<i>Inductive voltage dividers [29-30]</i>	65
7.1.2	<i>AC comparators</i>	71
7.1.3	<i>DC comparators.....</i>	76
7.1.4	<i>Coaxial chokes</i>	79
7.2	Precision measurement of active electrical quantities.....	82
7.2.1	<i>Measurement of electric current</i>	82
7.2.2	<i>Measurement of voltage</i>	84
7.2.2.1	<i>Measurement of DC voltage.....</i>	84
7.2.2.2	<i>Measurement of AC voltage.....</i>	86
7.2.3	<i>Measurement of power and energy.....</i>	90
7.2.3.1	<i>Application of electrodynamicometers to the measurement of power and energy</i>	90
7.2.3.2	<i>Application of thermal converters to the measurement of power and energy</i>	92
7.2.3.3	<i>Measurement of active power based on systematic sampling of voltage and current [48].....</i>	94
7.3	Precision measurement of passive electrical quantities.....	96
7.3.1	<i>Measurement of DC resistance</i>	96
7.3.1.1	<i>Measurement of low value resistances</i>	96
7.3.1.2	<i>Measurement of high value resistances</i>	98
7.3.2	<i>Measurement of AC resistance</i>	100
7.3.3	<i>Measurement of capacitance</i>	102
7.3.4	<i>Measurement of self-inductance</i>	105
7.3.5	<i>Measurement of mutual inductance</i>	106
7.3.6	<i>Coaxial bridges.....</i>	108
7.3.6.1	<i>C-C bridges.....</i>	109
7.3.6.2	<i>R-R bridges.....</i>	112
7.3.6.3	<i>C-R and L-C bridges [55], [61].....</i>	112
REFERENCES	116	