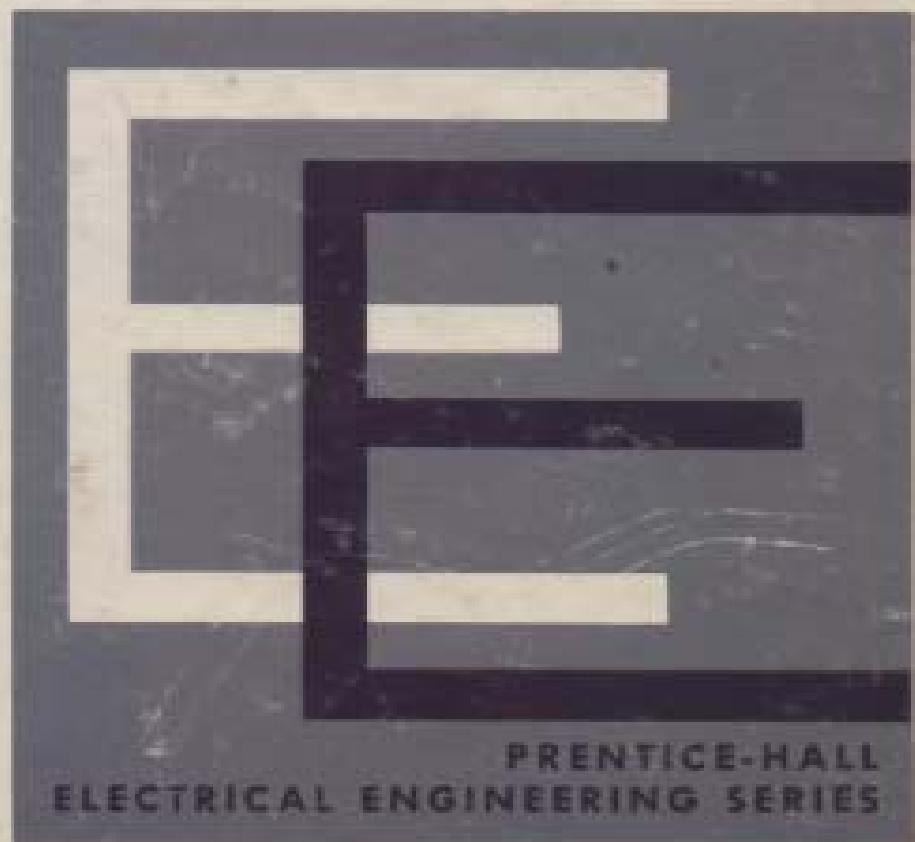




STANLEY WOLF

Guide to Electronic Measurements and Laboratory Practice



Contents

Preface	xii
1 Language of Electrical Measurements	1
Charge, Voltage, and Current	1
Conventions for Describing	
Electrical Quantities	7
Electrical Units	9
Circuit Models and Ideal Circuit Elements	10
Electrical Diagrams	14
Sinewaves, Frequency, and Phase	20
Average and RMS Values	22
Problems	26
References	30
2 Experimental Data and Errors	32
Measurement Recording and Reporting	33
Precision and Accuracy	34
Computational Aids	36
Errors in Measurement	40
Statistical Evaluation of Measurement	
Data and Errors	41

The Decibel	45
Problems	47
References	48
3 Electrical Laboratory Practice	49
Safety	50
Circuit Layout and Assembly	54
Grounds	54
Circuit Protection Devices	60
Input Impedance, Output Impedance, and Loading	63
Interference Signals and Shielding	66
Cables, Connectors, and Switches	82
Power Transfer and Impedance Matching	94
Temperature Effects on Component Operation and Measurements	96
Problems	97
References	99
4 Basic dc and ac Meters	100
Electromechanical Meter Movements	101
dc Ammeters	108
dc Voltmeters	113
ac Ammeters and Voltmeters	116
Features of Meter Construction	125
How to Use Basic Meters	127
Meter Errors	128
Problems	130
References	131
5 Resistors and Resistance Measurements	132
Resistance and Resistors	132
Resistor Types	138
Color Coding of Resistors	145
Environmental Effects on Resistors	146
Measurement of Resistance	150
Problems	158
References	160

6 Capacitors and Capacitance Measurements	161
Capacitance and Capacitors	161
Capacitor Circuit Models and Losses	170
Capacitor Types	173
Color Coding of Capacitors	180
Capacitance Measurement	182
Problems	187
References	188
7 Inductors and Transformers	189
Inductance and Inductors	189
Properties of Magnetic Materials	194
Inductor Structures	200
Measurement of Inductance	205
Transformers	211
Types of Transformers	216
Electromagnets and Relays	222
Problems	225
References	227
8 Batteries, dc Power Supplies, and Standard Cells	228
Batteries	229
Common Battery Types	234
Solar Cell	239
dc Power Supplies	240
Standard Cells and Zener Diodes	244
Problems	247
References	248
9 The Oscilloscope	250
Oscilloscope Subsystems	251
How an Oscilloscope Displays a Signal	262
Oscilloscope Controls	264
How to Operate an Oscilloscope	271
Oscilloscope Limitations	283

Contents

High-Frequency and Other Special Oscilloscopes	290
Oscilloscope Photography	296
Additional Oscilloscope Measurement Applications	297
Problems	298
References	301
10 Low Frequency Power and Energy Measurements	302
Power Measurements in dc Circuits	303
Power in ac Circuits	305
Single-Phase Power Measurements	308
Electric Power Distribution	313
Polyphase Power and Measurements	315
Miscellaneous Meters	320
Electrical Energy Measurements	323
Problems	325
References	326
11 Potentiometers and Recorders	327
Potentiometers	328
Recorders	336
Problems	343
References	344
12 Electronic Voltage and Current Meters	346
Analog Electronic Meters	346
Digital Electronic Meters	357
Special Purpose Electronic Meters	365
Problems	369
References	371
13 AC Signal Sources	372
Oscillators	372
Signal Generators	382

Sweep Frequency Generators	384
Pulse Generators	387
Function Generators	391
Problems	393
References	394
14 Time and Frequency Measurements	396
Time Measurements	397
Frequency Measurements	400
Harmonic Analysis	408
Problems	412
References	413
15 Electrical Transducers	414
Strain Gauges	417
Linear Variable Differential Transformers	421
Fluid-Property Transducers (Pressure and Flow Rate)	425
Temperature Transducers	428
Light and Radiation Transducers	434
Sound Transducers	441
Chemical Property Transducers	444
Magnetic Measurements	446
Thickness Transducers	448
Problems	448
References	449
16 Electrical Amplifiers	451
General Properties of Amplifiers	452
Differential Amplifiers	455
Operational Amplifiers	458
Problems	464
References	465
17 Uses of Electronic Instrumentation in Scientific Measurements	466

Appendix A Electrical Units and Conversion Factors	475
Appendix B Identification of Discrete Solid State Components	478
Appendix C Meter Calibration	480
Index	483