

The Axon Guide
for
Electrophysiology & Biophysics
Laboratory Techniques



PREFACE

Axon Instruments, Inc. is pleased to present you with *The Axon Guide*, a laboratory guide to electrophysiology and biophysics. The purpose of this *Guide* is to serve as a state-of-the-art information and data resource. It covers a broad scope of topics ranging from the biological basis of bioelectricity and a description of the basic experimental setup to the principles of operation of the most advanced hardware and software equipment currently available.

We planned the *Guide* as a tool benefiting both the novice and the expert electrophysiologist. Newcomers to electrophysiology will gain an appreciation of the intricacies of electrophysiological measurements and the requirements for setting up a complete recording and analysis system. For experienced electrophysiologists, we included in-depth discussions of selected topics of hardware and software design and their applications.

We undertook this endeavor with great enthusiasm. We believe that *The Axon Guide* is a valuable contribution to our customers and to the field of electrophysiology and biophysics. We are planning to update this *Guide* periodically. However, the success of this *Guide* in achieving its goals depends on your input. *We encourage you to contact us with comments on the Guide's content, style and usefulness to you and to your laboratory.* Your comments will assist us in improving the next edition of the *Guide*. If you would like to contribute to a future edition, please contact us.

This *Guide* is a product of a collaborative effort of researchers active in the field of electrophysiology and of Axon Instruments' staff. The names of the authors along with the editorial staff are listed on the following pages. I am deeply grateful to these individuals for sharing their knowledge and devoting significant time and effort to this endeavor. I would also like to thank Dr. Alan Finkel, the founder and CEO of Axon Instruments, and Geoff Powell, President of Axon Instruments, for their support and encouragement. The editorial assistance, layout and graphics done expertly by Jay Kurtz is much appreciated. Many thanks to Axon Instruments' personnel for assisting in numerous ways.

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Editor, *The Axon Guide*
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June 1993

INTRODUCTION

Axon Instruments, Inc., was founded in 1983 to design and manufacture instrumentation and software for electrophysiology and biophysics. Our products are used primarily in cellular neuroscience and cardiovascular research. Most applications are at the cellular and molecular level, such as searching for potent Ca-channel blockers, elucidating the molecular mechanisms involved in learning and memory and investigating the control mechanisms of vasodilation and constriction. However, the applications for our products are not limited to traditional nervous system research. They include general physiology studies at the isolated-organ and whole-animal level (*e.g.*, pulmonary, auditory, and vascular research), and plant electrophysiology.

Axon Instruments products are distinguished by their innovative design, high quality manufacturing standards and expert technical support. Our goal is to respond to the needs of researchers by providing them with the best possible equipment and applications information.

Our growth over the past ten years has been paralleled by a period of rapid growth in neuroscience research. Despite the fact that total research funding has increased significantly, so too have the number of researchers competing for these funds. The maturation of the field and the tight competition for funds has encouraged an ever increasing percentage of researchers to turn to commercial sources for equipment and software, instead of trying to personally develop the required research tools. Axon Instruments has responded to this demand by providing ready-to-use, technologically advanced instrumentation and software, thereby enabling researchers to spend their time in the pursuit of their primary research goals. Based on the feedback that we receive from our customers, we continually enhance our products so that we can keep abreast and ahead of researchers' needs. To help our customers derive maximal advantage from our products, we have, from our inception, given priority to our technical support department, whose staff includes experienced electrophysiologists.

As science is becoming more integrated in the approaches researchers use, and more molecular biologists, biochemists and pharmacologists employ electrophysiological techniques, Axon Instruments is increasingly assuming a significant role in guiding newcomers into the field and disseminating information about technological advancements. In addition to describing the operation of products, our product manuals include relevant background information and related experimental techniques. Our newsletter, **AxoBits**, serves as a forum to disseminate information on our products as well as on the latest experimental techniques employed by our customers. And finally, for the first time, we are publishing a laboratory techniques workbook, *The Axon Guide*.

The 1993 *Axon Guide* is the first publication of this kind that we have produced. The *Axon Guide* would never have been completed without the superb effort of Dr. Rivka Sherman-Gold, the *Guide's* editor. I wish to congratulate Rivka for the skill and dedication that she brought to this task.

Alan S. Finkel, Ph.D.
Chief Executive Officer
Axon Instruments, Inc.

June 1993



Acknowledgment to Axon Consultants and Customers

Axon Instruments employs a talented team of engineers and scientists dedicated to designing instruments and software incorporating the most advanced technology and the highest quality. Nevertheless, it would not be possible for us to enhance our products without close collaborations with members of the scientific community. These collaborations take many forms.

Some scientists assist Axon Instruments on a regular basis, sharing their insights on current needs and future directions of scientific research. Others assist us by virtue of a direct collaboration in the design of certain products. Many scientists help us by reviewing our instrument designs and the development versions of various software products. We are grateful to these scientists for their assistance. We also receive a significant number of excellent suggestions from the customers we meet at scientific conferences. To all of you who have visited us at our booths and shared your thoughts, we extend our sincere thanks. Another source of feedback for us is the information that we receive from the conveners of the many excellent summer courses and workshops that we support with equipment loans. Our gratitude is extended to them for the written assessments they often send us outlining the strengths and weaknesses of the Axon Instruments products.



Company Philosophy

Axon Instruments is a technology-driven company. That is, our sales growth is expected to derive from the introduction of technologically advanced products. These products are expected to embody superb elegance, value and functionality.

We are responsive to the suggestions and criticisms made by our customers. These ideas and comments guide us in the continued enhancement of our existing products and the design of new products.

We recognize our customers' need for prompt and courteous service. This means that we provide the highest-caliber technical support, fast repair service, responsive order processing and sales support, and polite attention on the phone and at conferences.

We sell our products direct around the world in the belief that direct contact with our customers helps us to provide them with the best possible service and support.

We are proud of our reputation as the world's best manufacturer of instruments for electrophysiological research. We continually strive to maintain this reputation through quality of design, manufacture, product testing and technical support.



pCLAMP Users' Group

The pCLAMP Users' Group was launched in April 1990 with the release of the first issue of the group's newsletter, *The Channel*. The newsletter and the users' group was founded by an independent researcher whose aim was to provide a forum for the use of pCLAMP that was independent of Axon Instruments, Inc. Although Axon Instruments, Inc. underwrites the costs of printing and mailing the PUG newsletter, its editorial contents are independent of Axon Instruments. Newsletters are mailed at irregular intervals to all registered users. New users may receive back issue of the newsletter and a pCLAMP Users' Group Director by writing to:

The pCLAMP Users' Group
725 Huckins Road
Cheshire, CT 06410 USA



Customer Feedback

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We would appreciate hearing from you, whether you are the original purchaser, an inheritor, a student user, or if you purchased the product from a distributor.

Many of you have ideas for new products. We are always interested in discussing the possibility of collaboration with our customers. Please contact us if you have an idea for a new product that you think might have commercial significance. It is better to contact us early so that we can evaluate the commercial potential of your ideas before you have expended too much effort and also so that we can participate in the design process as early as possible.



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TABLE OF CONTENTS

Chapter 1 - Bioelectricity	1
Electrical Potentials	1
Electrical Currents	1
Resistors and Conductors.....	3
Ohm's Law	5
The Voltage Divider	6
Perfect and Real Electrical Instruments.....	7
Ions in Solutions and Electrodes	8
Capacitors and Their Electrical Fields.....	10
Currents Through Capacitors.....	11
Current Clamp and Voltage Clamp.....	13
Glass Microelectrodes and Tight Seals.....	14
Further Reading	16
Chapter 2 - The Laboratory Setup	17
The <i>In Vitro</i> Extracellular Recording Setup	17
The Single-Channel Patch Clamping Setup.....	18
Vibration Isolation Methods	18
Electrical Isolation Methods	19
Radiative Electrical Pickup.....	19
Magnetically-Induced Pickup	20
Ground-Loop Noise.....	20
Equipment Placement	20
List of Equipment.....	22
Further Reading	24
Chapter 3 - Instrumentation for Measuring Bioelectric Signals from Cells	25
Extracellular Recording	25
Single-Cell Recording.....	26
Multiple-Cell Recording	27
Intracellular Recording — Current Clamp	27
Voltage Follower.....	27
Bridge Balance	29
Junction Potentials	30
Track	30
Current Monitor	31
Headstage Current Gain	33
Capacitance Compensation.....	33
Transient Balance.....	37
Leakage Current	37
Headstages for Ion-Sensitive Microelectrodes.....	37



Bath Error Potentials	38
Cell Penetration: Mechanical Vibration, Buzz and Clear	42
Command Generation	43
Intracellular Recording — Voltage Clamp	43
The Ideal Voltage Clamp	44
Real Voltage Clamps.....	44
Large Cells — Two-Electrode Voltage Clamp.....	45
Small Cells — Discontinuous Single-Electrode Voltage Clamp.....	48
Discontinuous Current Clamp (DCC).....	54
Continuous Single-Electrode Voltage Clamp	54
Series Resistance Compensation.....	56
Pipette-Capacitance Compensation.....	60
Whole-Cell Capacitance Compensation	62
Rupturing the Patch.....	64
Which One Should You Use: dSEVC or cSEVC?.....	65
Space Clamp Considerations.....	65
Single-Channel Patch Clamp	66
The Importance of a Good Seal	67
Resistor Feedback Technology	67
Capacitor Feedback Technology	70
Special Considerations for Bilayer Experiments	73
How Fast is "Fast"?.....	74
Measurement of Changes in Membrane Capacitance.....	74
Seal and Pipette Resistance Measurement.....	75
Micropipette Holders	75
Current Conventions and Voltage Conventions	76
Definitions.....	76
Whole-Cell Voltage and Current Clamp.....	77
Patch Clamp	78
Summary	79
References.....	80
Chapter 4 - Microelectrodes and Micropipettes	81
Electrodes, Microelectrodes, Pipettes, Micropipettes and Pipette Solutions	81
Fabrication of Patch Pipettes	83
Pipette Properties for Single-Channel vs. Whole-Cell Recording.....	84
Types of Glasses and Their Properties	85
Thermal Properties of Glasses	86
Noise Properties of Glasses	87
Leachable Components.....	89
Further Reading	89



Chapter 5 - Advanced Methods In Electrophysiology	91
Recording from <i>Xenopus</i> Oocytes	91
What is a <i>Xenopus</i> Oocyte?.....	92
Two-Electrode Voltage Clamping of Oocytes	93
Patch Clamping <i>Xenopus</i> Oocytes	95
Further Reading	95
Patch-Clamp Recording in Brain Slices.....	96
The Cleaning Technique	96
The Blind Technique.....	99
Advantages and Disadvantages of the Two Methods of Patch Clamping	
Brain Slices	101
Further Reading	102
Macropatch and Loose-Patch Recording.....	103
Gigaseal-Macropatch Voltage Clamp	103
Loose-Patch Voltage Clamp.....	104
References.....	109
The Giant Excised Membrane Patch Method.....	111
Pre-Treatment of Muscle Cells	111
Pipette Fabrication	112
Seal Formation	113
Further Reading	113
Recording from Perforated Patches and Perforated Vesicles.....	114
Properties of Amphotericin B and Nystatin	114
Stock Solutions and Pipette Filling.....	114
Properties of Antibiotic Partitioning.....	115
The Advantages of the Perforated-Patch Technique.....	115
The Limitations of the Perforated-Patch Technique.....	116
Suggested Ways to Minimize the Access Resistance	117
Other Uses for Perforated Patches	118
Further Reading	121
Enhanced Planar Bilayer Techniques for Single-Channel Recording.....	122
I. Solving the Problems of High Resolution and Voltage Steps	122
Minimizing the Background Current Noise	122
Maximizing the Bandwidth.....	125
Resolving Voltage Steps Across Bilayers.....	125
II. Assembling a Bilayer Setup for High-Resolution Recordings.....	127
Choosing an Amplifier	127
Choosing a Recording Configuration.....	128
Making Small Apertures	128
Viewing with a Microscope	130
Testing the System	130
Making the Recordings	131
Further Reading	132



Chapter 6 - Signal Conditioning and Signal Conditioners	133
Why Should Signals Be Filtered?	133
Fundamentals of Filtering	134
-3 dB Frequency	134
Type: High-pass, Low-pass, Band-pass or Band-reject (notch).....	134
Order	134
Implementation: Active, Passive or Digital	134
Filter Function.....	134
Filter Terminology	135
- 3 dB Frequency	135
Attenuation.....	135
Pass Band	136
Stop Band.....	136
Phase Shift.....	136
Overshoot	136
Octave	136
Decade.....	136
Decibels (dB)	137
Order	137
10-90% Rise Time.....	138
Filtering for Time-Domain Analysis.....	138
Filtering for Frequency-Domain Analysis	140
Sampling Rate	141
Filtering Patch-Clamp Data.....	141
Digital Filters	142
Correcting for Filter Delay.....	143
Preparing Signals for A/D Conversion	143
Where to Amplify	143
Pre-Filter vs. Post-Filter Gain	145
Offset Control	146
AC Coupling and Autozeroing.....	146
Time Constant	148
Saturation	148
Overload Detection	148
Averaging.....	149
Line-Frequency Pick-Up (Hum)	149
Peak-to-Peak and rms Noise Measurements	149
Blanking.....	150
Audio Monitor — Friend or Foe?.....	151
Electrode Test	151
Common-Mode Rejection Ratio	152
References.....	153
Further Reading	153



Chapter 7 - Transducers	155
Temperature Transducers for Physiological Temperature Measurement.....	155
Thermistors	155
IC Temperature Transducers that Produce an Output Current Proportional to Absolute Temperature.....	156
IC Temperature Transducers that Produce an Output Voltage Proportional to Absolute Temperature.....	157
Temperature Transducers for Extended Temperature Ranges	157
Thermocouples.....	157
Resistance Temperature Detectors.....	158
Electrode Resistance and Cabling Affect Noise and Bandwidth.....	158
High Electrode Impedance Can Produce Signal Attenuation.....	159
Unmatched Electrode Impedances Increase Background Noise and Crosstalk....	160
High Electrode Impedance Contributes to the Thermal Noise of the System....	161
Cable Capacitance Filters Out the High-Frequency Component of the Signal..	162
EMG, EEG, EKG and Neural Recording	162
EMG.....	162
EKG.....	163
EEG.....	163
Nerve Cuffs	163
Metal Microelectrodes.....	163
Bridge Design for Pressure and Force Measurements.....	163
Pressure Measurements.....	164
Force Measurements	165
Acceleration Measurements.....	165
Length Measurements	166
Self-Heating Measurements.....	166
Isolation Measurements	166
Insulation Techniques	167
Suggested Manufacturers and Suppliers of Transducers.....	168
Further Reading	169
Chapter 8 - Laboratory Computer Issues and Considerations	171
Select the Software First.....	171
How Much Computer Do You Need?.....	172
The Machine Spectrum: Capability vs. Price.....	172
Memory	177
Operating Systems and Environments	180
Peripherals and Options.....	182
Coprocessors	182
Magnetic Disk Storage	182
Optical Disk Storage	183
Video Display Systems	183
Graphic Output: Pen Plotters vs. Laser Printers	184
Data Backup.....	184
I/O Interfaces.....	185
Parallel Centronics	185
Serial Port.....	185
Compatibility Problems	185
Past Problems	186



How to Avoid Problems	186
Recommended Computer Configurations.....	187
IBM PC Compatible.....	187
MACINTOSH.....	188
Glossary	189
Chapter 9 - Acquisition Hardware.....	195
Fundamentals of Data Conversion.....	195
Quantization Error	197
Choosing the Sampling Rate.....	198
Converter Buzzwords.....	199
Gain Accuracy.....	199
Linearity Error.....	199
Differential Nonlinearity.....	199
Least Significant Bit (LSB).....	199
Monotonicity.....	199
Data Formats	199
Offset Binary.....	200
2's Complement	200
Big Endian vs. Little Endian	200
Deglitched DAC Outputs.....	200
DMA, Memory Buffered, I/O Driven.....	201
Interrupts	202
Timers	202
Digital I/O	203
Optical Isolation.....	203
Operating Under Multi-Tasking Operating Systems	204
Software Support	205
PC, Macintosh and PS/2 Considerations	205
Archival Storage (Backup).....	206
Chapter 10 - Data Analysis	209
Choosing Appropriate Acquisition Parameters	209
Gain and Offset	209
Sampling Rate	209
Filtering.....	211
Filtering at Analysis Time	211
Integrals and Derivatives	212
Single-Channel Analysis.....	212
Goals and Methods.....	212
Sampling at Acquisition Time	213
Filtering at Acquisition Time.....	213
Analysis-Time Filtering	213
Generating the Events List.....	213
Setting the Threshold for a Transition	214
Baseline Definition	214
Missed Events	214
False Events	214
Multiple Channels.....	214
Analyzing the Events List	215



Histograms	215
Histogram Abscissa Scaling.....	215
Histogram Ordinate Scaling.....	215
Errors Resulting from Histogramming Events Data	217
Amplitude Histogram.....	218
Fitting to Histograms.....	218
Fitting.....	218
Reasons for Fitting	218
Statistical Aspects of Fitting	219
Methods of Optimization	222
References.....	223
Chapter 11 - Development Environments	225
AxoBASIC	226
A Programming Example.....	229
Turning the Computer into a Digital Oscilloscope	229
Comparison Between AxoBASIC and BASIC-23.....	232
Future Directions	233
Chapter 12 - Noise in Electrophysiological Measurements	235
Thermal Noise.....	236
Shot Noise.....	237
Dielectric Noise	238
Excess Noise	239
Amplifier Noise	240
Electrode Noise.....	242
Electrode Noise in Single-Channel Patch Voltage Clamping.....	242
Seal Noise	250
Noise in Whole-Cell Voltage Clamping.....	252
External Noise Sources.....	254
Digitization Noise	254
Aliasing.....	255
Filtering.....	258
Summary of Patch-Clamp Noise.....	261
Headstage	261
Holder.....	261
Electrode	261
Seal.....	262
Limits of Patch-Clamp Noise Performance	262
Further Reading	263



Appendix I - Guide to Interpreting Specifications	265
General	265
Thermal Noise	265
rms Versus Peak-to-Peak Noise	266
Bandwidth — Time Constant — Rise Time	266
Filters	266
Microelectrode Amplifiers.....	267
Voltage-Clamp Noise.....	267
10-90% Rise Time (t ₁₀₋₉₀).....	267
1% Settling Time (t ₁).....	267
Input Capacitance.....	267
Input Leakage Current.....	268
Patch-Clamp Amplifiers	268
Bandwidth	268
Noise	268
 Appendix II - Telecommunications and the Personal Computer.....	 269
Bulletin Board Systems.....	269
Networks	270
Shareware, Viruses and Other Terms	272
Modems and Communication Software.....	272
Addresses of Producers of Network Programs	273



LIST OF FIGURES

Figure 1-1. Conservation of Current.....	2
Figure 1-2. A Typical Electrical Circuit.....	2
Figure 1-3. Summation of Conductance.....	3
Figure 1-4. Equivalent Circuit for a Single-Membrane Channel	4
Figure 1-5. Ohm's Law	5
Figure 1-6. IR Drop	5
Figure 1-7. A Voltage Divider.....	6
Figure 1-8. Representative Voltmeter with Infinite Resistance	7
Figure 1-9. The Silver/Silver Chloride Electrode.....	9
Figure 1-10. The Platinum Electrode	9
Figure 1-11. Capacitance.....	10
Figure 1-12. Capacitors in Parallel Add Their Values	11
Figure 1-13. Membrane Behavior Compared with an Electrical Current	12
Figure 1-14. RC Parallel Circuit Response	12
Figure 1-15. Typical Voltage-Clamp Experiment	13
Figure 1-16. Intracellular Electrode Measurement.....	14
Figure 1-17. Good and Bad Seals.....	15
Figure 3-1. Blanking Circuit.....	26
Figure 3-2. An Ideal Micropipette Buffer Amplifier.....	28
Figure 3-3. A High-Quality Current Source	28
Figure 3-4. The Bridge Balance Technique.....	29
Figure 3-5. Illustration of Bridge Balancing While Micropipette is Extracellular	30



Figure 3-6. Series Current Measurement.....	31
Figure 3-7. Virtual-Ground Current Measurement.....	32
Figure 3-8. Bootstrapped Power Supplies.....	35
Figure 3-9. Capacitance Neutralization Circuit.....	36
Figure 3-10. Two-Electrode Virtual-Ground Circuit.....	41
Figure 3-11. The Ideal Voltage Clamp.....	44
Figure 3-12. Conventional Two-Electrode Voltage Clamp.....	45
Figure 3-13. Block Diagram and Timing Waveforms.....	49
Figure 3-14. Biphasic Voltage Response of a High-Resistance Micropipette.....	52
Figure 3-15. Voltage and Temporal Errors Caused by the Presence of R_a	56
Figure 3-16. Series Resistance Correction.....	57
Figure 3-17. Prediction Implemented Empirically by the Computer.....	58
Figure 3-18. Implementation of Prediction Based on the Knowledge of the Cell Parameters.....	59
Figure 3-19. Pipette Capacitance Compensation Circuit.....	61
Figure 3-20. Whole-Cell Capacitance Compensation Circuit.....	63
Figure 3-21. Using the Injection Capacitor to Charge the Membrane.....	64
Figure 3-22. Resistive Headstage.....	68
Figure 3-23. Capacitive Feedback Headstage.....	70
Figure 3-24. Signal Handling During Resets in the Capacitor-Feedback Headstage.....	72
Figure 3-25. Typical Current Noise in Bilayer Experiments.....	74
Figure 5-1. Stage V or VI Oocytes as Found in an Ovarian Lobe.....	92
Figure 5-2. The Cleaning Technique.....	98
Figure 5-3. The Blind Technique.....	100
Figure 5-4. Combining Whole-Cell Voltage Clamping with Loose-Patch Current Recording..	105
Figure 5-5. Pipette Fabrication for Giant Excised Patch Method.....	112
Figure 5-6. Forming a Cell-Attached Perforated Patch and a Perforated Vesicle.....	120
Figure 5-7. Aperture Formation in a Plastic Cup.....	129



Figure 5-8. Voltage-Step Activation of a K-Channel from Squid Giant Axon Axoplasm.....	131
Figure 6-1. Frequency Response Comparison of Fourth-Order Bessel and Butterworth Filters	135
Figure 6-2. Illustration of Filter Terminology	136
Figure 6-3. The Difference Between a Fourth-Order and an Eighth-Order Transfer Function.	138
Figure 6-4. Step Response Comparison Between Bessel and Butterworth Filters.....	139
Figure 6-5. The Use of a Notch Filter: Inappropriately and Appropriately	140
Figure 6-6. Distortion of Signal Caused by High Amplification Prior to Filtering.....	145
Figure 6-7. Distortion of Signal Caused by AC Coupling at High Frequencies	146
Figure 6-8. Comparison of Autozeroing to AC Coupling	147
Figure 7-1. Electrode Resistance and Cabling Can Degrade a Signal.....	159
Figure 7-2. High Electrode Resistance Can Attenuate a Signal and Increase Crosstalk.....	160
Figure 7-3. Wheatstone Bridge Circuit with Amplifier.....	164
Figure 8-1. IBM PC and Apple Macintosh Computers	172
Figure 8-2. Memory Architecture of the PC.....	177
Figure 9-1. Analog-to-Digital Conversion.....	196
Figure 10-1. Histogram Scaling.....	216
Figure 10-2. Sampling Error	217
Figure 10-3. The Likelihood Function	220
Figure 10-4. Confidence Limits.....	222
Figure 12-1. Noise Equivalent Circuits of a Resistor.....	236
Figure 12-2. Operational Amplifier Noise Model	240
Figure 12-3. Noise Model of a Simplifier Current-to-Voltage Converter.....	240
Figure 12-4. Noise in Whole-Cell Voltage Clamping	253
Figure 12-5. Folding of the Frequency Axis	256
Figure 12-6. Squared Transfer Function of a Gaussian Filter	260



LIST OF TABLES

Table 3-1. Correction vs. Prediction.....	60
Table 4-1. Electrical And Thermal Properties of Different Glasses	85
Table 4-2. Chemical Compositions of Different Glasses	86
Table 7-1. Common Thermocouple Materials.....	157
Table 12-1. Thermal Noise of Resistors.....	237
Table 12-2. Shot Noise	238
Table I-1. Noise of a 10 M Resistor in Microvolts rms.....	265
Table I-2. RMS Current in Picoamps	268



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- AC coupling, 146
 - overload detection, 148
 - saturation, 148
 - time constant, 148
- Acceleration measurements, 165
- Accelerometers, 165
- Acquisition hardware, 195
 - 2's complement, 200
 - analog-to-digital conversion, 195
 - analog-to-digital converter, 196
 - archival storage, 206
 - big endian vs. little endian, 200
 - data formats, 199
 - differential nonlinearity, 199
 - digital I/O, 203
 - digital-to-analog converter, 197
 - direct memory access (DMA), 201
 - gain accuracy, 199
 - gap-free acquisition, 201
 - glitch, 200
 - I/O driven, 201
 - interrupts, 202
 - least significant bit, 199
 - linearity error, 199
 - memory buffering, 201
 - monotonicity, 199
 - multi-tasking operating systems, 204
 - offset binary, 200
 - optical isolation, 203
 - personal computers, 205
 - software support, 205
 - timers, 202
- Agar bridge, 81
- Aliasing, 255
 - Bessel filter, 257
 - Folding frequency, 255
 - Gaussian filter, 257
 - Nyquist frequency, 255
- Amphotericin B, 114
 - use in stock solutions, 114
- Amplifier noise, 240
- Amplifiers
 - amplification, 143
 - microelectrode, 267
 - 1% settling time, 267
 - 10-90% rise time, 267
 - input capacitance, 267
 - input leakage current, 268
 - noise, 267
 - patch clamp, 11
 - patch-clamp, 268
 - bandwidth, 268
 - noise, 268
 - voltage clamp, 11
- Analog-to-digital (A/D) conversion, 195
 - optical isolation, 203
 - quantization error, 197
 - sampling rate, 198
- Analog-to-Digital conversion, 143
 - preparing signals, 143
- Analog-to-digital converter (ADC), 196, 255
- Anti-aliasing, 51
- Anti-vibration tables, 19
- Antibiotic partitioning, 115
- Archival storage, 206
- Audio monitor, 151
 - amplitude modulated, 151
 - frequency modulated, 151
- Autozeroing, 146
- Averaging, 149
- AxoBASIC, 226
 - comparison to BASIC-23, 232
- Backup, 184
- Bandwidth, 266
- BASIC-23, 232
 - comparison to AxoBASIC, 232
- Bath error potentials, 38
 - Clamp V_b using a bath clamp, 41
 - clamp V_b using a virtual ground current monitor, 41
 - measure and subtract V_b , 40
 - minimizing R_b , 38
 - series resistance compensation, 40
- Bessel filter, 257, 258
 - aliasing, 257
- Big endian vs. little endian, 200
- Bilayer experiments, 73
- Bilayer techniques, 122
 - maximizing the bandwidth, 125
 - minimizing noise, 122
 - resolving voltage steps, 125
 - setup, 127
- Bioelectricity, 1
- Blanking, 150
 - sample-and-hold, 151
- Blanking circuit, 27



- Bootstrapping, 34
- Brain slices, 17
 - blind technique, 99
 - cleaning technique, 96
 - patch-clamp recording, 96
 - thick slice, 18
 - thin slice, 18
- Bridge balance, 29
- Bridge design
 - pressure and force measurements, 163
- Bulletin board systems, 269
- Bus, 172, 173
- Buzz, 42
 - for cell penetration, 42
- Cable capacitance
 - filtering capabilities, 162
- Cabling
 - affect on noise and bandwidth, 158
- Capacitance
 - input, 267
- Capacitance compensation, 33
 - pipette-capacitance compensation, 60
 - whole-cell, 62
- Capacitance neutralization, 52
- Capacitor feedback headstage, 70
- Capacitors
 - currents through, 11
 - electrical fields, 10
- Cell penetration, 42
- Chebyshev filter, 259
- Chebyshev polynomial fitting, 223
- Chloriding silver wire, 83
- Clear, 42
 - for cell penetration, 42
- Command generation, 43
- Common-mode rejection ratio (CMRR), 152
- Communication software, 272
- Compatibility problems, 185
 - 2's complement, 200
- Computer issues, 171
 - expansion bus (I/O bus), 173
 - microprocessors, 172
 - software selection, 171
- Computers
 - personal computers, 205
- Conductance, 3, 6, 8, 13, 14
- Conductors, 3
- Continuous single-electrode voltage clamp (cSEVC), 54
- Controlled current source, 49
- Coprocessors, 182
- Crosstalk, 160
- Current
 - through capacitors, 11
- Current clamp, 13, 27
- Current conventions, 76
- Current monitor, 31
- Data acquisition parameters, 209
 - D/A update rate, 210
 - data bandwidth, 210
 - filtering, 211, 213
 - gain, 209
 - offset, 209
 - sampling rate, 209, 213
 - multiple channels, 210
 - multiple exponentials, 210
 - single-channel recording, 210
 - time skew, 210
- Data backup, 184
- Data formats, 199
 - 2's complement, 200
 - big endian vs. little endian, 200
 - offset binary, 200
- DESQview, 180, 181
- Development environments, 225
 - AxoBASIC, 226
- Dielectric noise, 238, 243
 - quartz pipettes, 243
 - Sylgard, 243
- Differential nonlinearity, 199
- Digital I/O, 203
- Digital-to-analog converter (DAC), 197
 - feedthrough noise, 201
- Digitization noise, 254
- Direct memory access (DMA), 201
- Discontinuous current clamp, 54



- Discontinuous single-electrode voltage clamp
 - comparison with TEVC, 54
- Disk cache, 179
- Dissipation factor, 243
- Driven shield, 34
- Duty cycle selecting, 52
- Electrical currents, 1
- Electrical instruments
 - perfect and real, 7
- Electrical interference, 19
 - ground-loop noise, 20
 - magnetically-induced pickup, 20
 - radiative electrical pickup, 19
- Electrical isolation methods, 19
- Electrical potentials, 1
- Electrical properties, 85
- Electrocardiogram (EKG), 160, 163
- Electrode impedance
 - affect on noise and bandwidth, 158
 - high, 159
 - contributes to thermal noise, 161
 - unmatched
 - increases noise and crosstalk, 160
- Electrode noise, 242
- Electrode resistance
 - affect on noise and bandwidth, 158
 - see pipette resistance, 75
- Electrode test, 151
- Electrodes, 81
 - chloriding silver wire, 83
 - glasses, 83, 85
 - holders, 83
 - junctional potential, 82
 - liquid junction potential, 82
 - metal microelectrodes, 163
 - microelectrode pullers, 83
 - microelectrodes, 81
 - micropipettes, 81
 - noise, 84
 - patch micropipettes, 82
 - patch pipettes, 83
 - platinum, 9
 - silver, silver-chloride, 81
 - silver/silver chloride, 8
- Electroencephalogram (EEG), 160, 163
- Electromyogram (EMG), 160, 162
- Environments, 182
 - DESQview, 182
 - Microsoft Windows, 181
- Equipment placement, 20
- Excess noise
 - 1/f noise, 239
- Excess noise (1/f noise), 239
- Expansion bus, 173
- Extracellular recording, 25
 - multiple-cell, 27
 - setup, 17
 - single-cell, 26
- Filter
 - anti-aliasing, 51
- Filter terminology
 - 3db frequency, 135
 - 10-90% rise time, 138
 - attenuation, 135
 - decade, 136
 - decibels, 137
 - octave, 136
 - order, 137
 - overshoot, 136
 - pass band, 136
 - phase shift, 136
 - stop band, 136
- Filtering, 258
 - acquisition time, 211, 213
 - analysis time, 211, 213
- Filters, 266
 - 3db frequency, 134
 - band-pass, 134
 - band-reject, 134
 - Bessel, 257, 266
 - Bessel filter, 138, 141
 - Butterworth, 266
 - Butterworth filter, 139, 140, 141
 - Chebyshev, 259
 - correcting for filter delay, 143
 - digital, 142
 - finite impulse response, 142
 - Gaussian, 142
 - nonrecursive, 142
 - recursive, 142
 - frequency domain analysis, 140
 - function, 134
 - high-pass, 133
 - low-pass, 133
 - noise, 265



- notch filter, 133, 139
- Nyquist Sampling Theorem, 141
- order, 134
- patch-clamp data, 141
- pole vs. order vs. slopes, 137
- RC, 266
- related terminology, 134, 135
- sampling rate, 141
- time domain analysis, 138
- Fitting, 218
 - Chebyshev polynomials, 223
 - chi-square, 220
 - confidence limits, 221
 - goodness of fit, 221
 - Levenberg-Marquardt, 223
 - likelihood, 219
 - motivation, 218
 - optimization methods, 222
 - Simplex, 223
 - statistical aspects, 219
 - statistical tests, 222
- Folding frequency, 255
- Force measurements, 163, 165
- Gain, 145
 - pre-filter vs. post-filter gain, 145
- Gain accuracy, 199
- Gap-free acquisition, 201
- Gaussian filter, 257, 258
 - aliasing, 257
- Giant excised membrane patch method, 111
 - pipette fabrication, 112
 - seal formation, 113
- Gigaseal-Macropatch voltage clamp, 103
- Gigaseals, 67
- Glass
 - dissipation factor, 243
- Glass compositions, 86
- Glasses, 85
 - electrical properties, 85
 - see electrodes, 83
 - thermal properties, 86
 - types
 - noise properties, 87
- Glitch, 200
- Ground-loop noise, 20
- Hard disks, 182
- Headstage
 - bandwidth, 70
 - capacitor feedback, 70
 - current gain, 33
 - Dynamic range, 70
 - for ion-sensitive microelectrodes, 37
 - Linearity, 70
 - noise, 70
 - resistor feedback, 67
- Headstages
 - for intracellular recording, 36
 - for ion-sensitive microelectrodes, 37
- High electrode impedance
 - can produce attenuation, 159
- HOLDERS, 83
 - for micropipettes, 75
- Hum, 19, 149
 - differential amplification, 149
 - notch filter, 149
- I/O bus, 173
- I/O driven, 201
- I/O interfaces, 185
- IBM compatible, 173
- Implantable length gauges, 166
- Input leakage current, 268
- Insulation measurements, 167
- Interrupts, 202
- Intracellular recording
 - bath error potentials, 38
 - bootstrapping, 34
 - bridge balance, 29
 - capacitance compensation, 33
 - command generation, 43
 - current clamp, 27
 - current monitor, 31
 - headstage current gain, 33
 - junction potentials, 30
 - leakage current, 37
 - track, 30
 - transient balance, 37
 - virtual ground, 32
 - voltage clamp, 43
 - voltage follower, 27
 - Wheatstone bridge, 29
- Ions
 - in electrodes, 8
 - in solutions, 8
- Isolation measurements, 166
- Johnson noise, 236
- Junction potentials, 30, 82



- Laboratory setup, 17
 - list of equipment, 22
- Large cells
 - voltage clamp, 45
- Laser printers
 - vs. pen plotters, 184
- Leachable components, 89
- Leakage current, 37
- Least significant bit, 199
- Least squares, 220
- Length measurements
 - implantable length gauges, 166
 - linear potentiometers, 166
 - linear variable differential transformers, 166
- Levenberg-Marquardt, 223
- Line-frequency pick-up, 149
- Linear potentiometers, 166
- Linear variable differential transformers, 166
- Linearity error, 199
- Liquid junction potential, 82
- Loose-patch recording, 103
- Loose-patch voltage clamp, 104
- Macintosh, 176
- Macropatch recording, 103
- Magnetic disk storage, 182
- Magnetically-induced pickup, 20
- Maximum likelihood, 219
- Mechanical requirements
 - extracellular recording, 17
- Mechanical vibration, 42
 - for cell penetration, 42
- Membrane capacitance
 - per unit area, 64
- Membrane capacitance measurements, 74
- Membrane potential, 51
 - ripple, 51
- Memory, 178
 - conventional, 178
 - disk cache, 179
 - expanded, 178, 179
 - extended, 178, 179
 - managers, 180
 - RAM disk, 180
- Metal microelectrodes, 163
- Microelectrode pullers, 83
- Microelectrodes
 - glass
 - tight seals, 14
- Micromanipulators, 17, 18
 - remote-controlled, 19
- Micropipette holders, 75
- Micropipette selection, 48
- Microprocessors, 172
- Microscope
 - brain slice, 18
 - extracellular recording, 17
 - single-channel recording, 18
- Modem, 269, 272
- Monotonicity, 199
- Multi-tasking operating systems, 204
- Multiple-cell recording, 27
- Muscle
 - measuring
 - implantable length gauges, 166
- Negative capacitance
 - see capacitance compensation, 35
- Nerve cuffs, 163
- Networks, 270
- Noise, 160, 235, 268
 - aliased, in voltage clamp, 51
 - aliasing, 255
 - amplifier, 240
 - capacitance, 245
 - capacitance neutralization, 52
 - dielectric, 235, 238, 243
 - digitization, 254
 - electrode, 242, 261
 - excess (1/f noise), 235, 239
 - external sources, 254
 - headstage, 261
 - high-impedance probes, 158
 - holder, 261
 - in single-channel patch voltage clamping, 242
 - in two-electrode voltage clamp recording, 47
 - Johnson, 161
 - patch capacitance, 250
 - patch clamp, 262
 - peak-to-peak, 149, 235, 266
 - pipette resistance, 245, 250
 - quantizing noise, 255
 - quartz patch pipettes, 248



- recording from bilayers, 122
 - rms, 266
 - rms noise, 149
 - root-mean-square (rms), 235
 - seal, 250, 262
 - shot, 235, 237
 - silicone oil, 247
 - sources, 235
 - thermal, 161, 235, 236, 265
 - power spectral density (PSD), 236
 - thermal (Johnson, Nyquist), 236
 - voltage-clamp, 267
 - whole-cell voltage clamping, 252
- Nyquist frequency, 255
- Nyquist noise, 236
- Nyquist theorem
 - see Sampling theorem, 198
- Nystatin, 114
 - use in stock solutions, 114
- Offset binary, 200
- Offset control, 146
- Offset removal, 48
- Ohm's law, 5
- Oocytes
 - Xenopus*, 91
- Operating systems, 180
 - IBM, 180
 - Macintosh, 180
- Optical disk storage, 183
- Optical isolation, 203
- Optical requirements
 - extracellular recording, 17
 - single-channel recording, 18
- Overload detection, 148
- Parallel centronics, 185
- Patch
 - rupturing, 64
 - zap, 64
- Patch clamp, 14, 141
 - amplifier noise, 240
 - capacitor feedback headstage, 70
 - data, filtering, 141
 - resistor feedback headstage, 67
 - single channel, 66
- Patch clamp noise, 261
 - limits, 262
 - summary, 261
- electrode, 261
 - headstage, 261
 - holder, 261
 - seal, 262
- Patch micropipettes, 82
- Patch pipettes, 83
 - coating, 84
 - concentric, with loose-patch clamp, 108
 - electrical properties, 85
 - fabrication, 83
 - firepolishing, 84
 - from quartz tubing, 248
 - glasses, 85
 - noise, 84
 - noise properties, 87
 - pulling, 83
 - thermal properties, 86
- PC compatible, 173
- Pen plotters
 - vs. laser printers, 184
- Perforated patches
 - cellular voltage measurements, 118
 - other uses, 118
 - recording from, 114
- perforated vesicles
 - recording from, 114
- Perforated-patch technique
 - advantages, 115
 - disadvantages, 116
 - minimizing access resistance, 117
 - single-channel recording in outside-out vesicles, 118
- Peripherals, 182
- Personal computers, 205
- Pipette fabrication, 112
- Pipette resistance measurement, 75
- Pipette solutions, 81
- Pipette-capacitance compensation, 60
- Pipettes, 81
 - glasses, 85
 - micropipettes, 81
 - properties
 - single-channel vs. whole cell recording, 84
- Positive feedback (correction), 56
- Pressure
 - measuring very low, 164
- Pressure measurements, 163



- Quantization error, 197
- Quantizing noise, 255
- Quartz patch pipettes, 248
- Quartz pipettes, 243
- Radiative electrical pickup, 19
- RAM disk, 180
 - recommended computer configurations, 179
- Resistor feedback headstage, 67
- Resistors, 3
 - seal, 14
 - single-channel recording, 3
- Rise time, 266
- Sample-and-hold, 151
- Sampling rate
 - choosing, 198
 - oversampling, 198
 - sampling theorem, 198
- Sampling theorem, 198
- Saturation, 148
- Seal, 67, 75
- Seal formation, 113
- Seals
 - pretreatment of muscle cells for best, 111
- Self-heating measurements, 166
- Serial port, 185
- Series resistance compensation, 56
 - 1% setting time, 267
 - limitations, 60
 - positive feedback (correction), 56
 - supercharging (prediction), 58
- Set-up procedure
 - for voltage clamp, 53
- Shareware, 272
- Shielding, 19, 20
- Shot noise, 237
- Signal conditioners, 133
 - AC coupling, 146
 - amplification, 143
 - audio monitor, 151
 - autozeroing, 146
 - averaging, 149
 - blanking, 150
 - common-mode rejection ratio, 152
 - differential amplification, 149
 - electrode test, 151
 - gain, 145
 - line frequency pick-up (hum), 149
 - noise measurements, 149
 - offset control, 146
 - overload detection, 148
 - peak-to-peak, 149
 - programmable gain amplifier (PGA), 144
 - saturation, 148
 - stimulus coupling, 151
 - time constant, 148
- Signal conditioning, 133
- Silicone oil, 247
- Simplex, 223
- Sinel-cell recording, 26
- Single-channel
 - patch clamp, 66
- Single-channel analysis
 - baseline estimation, 214
 - events
 - false, 214
 - missed, 214
 - multiple channels, 214
 - events list, 213, 215
 - false closings, 213
 - filtering, 213
 - goals, 212
 - histograms, 215
 - errors, 217
 - sampling rate, 213
 - threshold, 214
- Single-channel patch clamp
 - seal, 67
- Single-channel recording
 - bilayer techniques, 122
 - setup, 18
- Small cells
 - voltage clamp, 48
- Software, 171
- Software support, 205
- Space clamp
 - considerations, 65
- Specifications, 265
- Stimulus coupling, 151
- Supercharging (prediction), 58
- Sylgard, 243, 247
- Telecommunications, 269
 - bulletin board systems, 269
 - communication software, 272



- modem, 269, 272
- networks, 270
- shareware, 272
- viruses, 272
- Temperature transducers, 155, 157
 - resistance thermometers, 158
 - thermistors, 155
 - thermocouples, 157
- Thermal noise, 161, 236
- Tickle
 - see Buzz, 42
- Time constant, 148, 266
- Time-domain analysis, 138
- Timers, 202
- Track, 30
- Transducers, 155
 - acceleration measurements, 165
 - accelerometers, 165
 - for extended temp. ranges, 157
 - force measurements, 163, 165
 - IC temperature, current, 156
 - IC temperature, voltage, 157
 - insulation techniques, 167
 - isolation measurements, 166
 - length measurements, 166
 - metal microelectrodes, 163
 - pressure measurements, 163, 164
 - resistance temp. detectors, 158
 - self-heating measurements, 166
 - temperature transducers, 155
 - thermistors, 155
 - thermocouples, 157
- Transient balance, 37
- Vibration isolation methods, 18
- Video display systems, 183
- Virtual ground, 32
- Viruses, 272
- Voltage clamp, 13, 43
 - anti-aliasing filter, 51
 - capacitance neutralization, 52
 - common errors, 51
 - controlled-current source, 49
 - current and voltage measurement, 53
 - error, 46
 - gigaseal-macropatch, 103
 - ideal, 44
 - large cells, 45
 - loose-patch, 104
 - membrane conductance changes, 47
 - micropipette selection, 48
 - noise, 47
 - real, 44
 - setup procedure, 53
 - signal bandwidth, 53
 - small cells, 48
 - stability, 46
 - step response and bandwidth, 46
- Voltage conventions, 76
- Voltage divider, 6
- Voltage follower, 27
- Voltage pulses
 - applied to loose-patch pipette, 107
- Wheatstone bridge, 29, 163
- Whole-cell capacitance compensation, 62
- Whole-Cell clamp
 - combining with focal current recording, 104
- Whole-cell mode
 - dSEVC or cSEVC, 65
 - rupturing the patch, 64
- Whole-cell voltage clamping, 252
 - noise, 252
- Windows, 181, 182
- Xenopus* oocytes
 - definition, 92
 - patch clamping of, 95
 - recording from, 91
 - two-electrode voltage clamping of, 93
- Zap, 64

