

AMPLIFIER APPLICATIONS GUIDE

INTRODUCTION	1
PRECISION TRANSDUCER INTERFACES	2
HIGH IMPEDANCE, LOW CURRENT APPLICATIONS	3
SINGLE-SUPPLY, LOW POWER APPLICATIONS	4
APPLICATIONS FOR AMPLIFIERS IN AUDIO	5
PASSIVE AND ACTIVE ANALOG FILTERING	6
DRIVING ADCs	7
VIDEO AND OTHER HIGH SPEED APPLICATIONS	8
NON-LINEAR CIRCUIT APPLICATIONS	9
UNUSUAL APPLICATIONS FOR OP AMPS	10
OP AMP SUBTLETIES	11
HARDWARE TECHNIQUES	12
ANALOG CIRCUIT SIMULATION	13
INDEX	I

ANALOG DEVICES TECHNICAL REFERENCE BOOKS

PUBLISHED BY PRENTICE HALL

Analog-Digital Conversion Handbook
Digital Signal Processing Applications Using the ADSP-2100 Family
Digital Signal Processing in VLSI
DSP Laboratory Experiments Using the ADSP-2101
ADSP-2100 Family User's Manual

PUBLISHED BY ANALOG DEVICES

Amplifier Applications Guide
Mixed Signal Design Seminar Notes
High-Speed Design Seminar Notes
Nonlinear Circuits Handbook
Transducer Interfacing Handbook
Synchro & Resolver Conversion
THE BEST OF *Analog Dialogue*, 1967-1991

AMPLIFIER APPLICATIONS GUIDE



ACKNOWLEDGEMENTS

Thanks are due the many technical staff members of Analog Devices in Engineering and Marketing who provided invaluable inputs during this project. Particular credit is due the individual authors whose names appear at the beginning of their material in this book.

Linda Grimes Brandon of Brandon's WordService prepared the new illustrations and typeset the text. Ernie Lehtonen of the Analog Devices' art department supplied many camera-ready drawings. Judith Douville compiled the index, and printing was done by R. R. Donnelley and Sons, Inc.

Walt Kester
1992

**Copyright © 1992 by Analog Devices, Inc.
Printed in the United States of America**

All rights reserved. This book, or parts thereof, must not be reproduced in any form without permission of the copyright owner.

Information furnished by Analog Devices, Inc., is believed to be accurate and reliable. However, no responsibility is assumed by Analog Devices, Inc., for its use.

Analog Devices, Inc., makes no representation that the interconnections of its circuits as described herein will not infringe on existing or future patent rights, nor do the descriptions contained herein imply the granting of licenses to make, use, or sell equipment constructed in accordance therewith.

Specifications are subject to change without notice.

ISBN-0-916550-10-9

ANALOG DEVICES

AMPLIFIER APPLICATIONS GUIDE

SECTION I

INTRODUCTION

- Op Amp Evolution / Revolution
- Processes
- Architectures

SECTION II

PRECISION TRANSDUCER INTERFACES

- Bridge Circuit Configurations
- Bridge Amplifiers
- Signal Conditioning for Temperature Measurement:
Thermocouples, Resistance Temperature
Detectors (RTDs), Thermistors, Monolithic
Thermocouple Amplifiers

SECTION III

HIGH IMPEDANCE, LOW CURRENT APPLICATIONS

- Precision Photodiode Preamplifier Design Analysis:
Photodiode Characteristics, DC Analysis, AC
Analysis, Noise Analysis, Circuit Tradeoffs, "T"
Network Analysis
- High Speed Photodiode Preamplifiers:
Characteristics of High Speed Photodiodes,
Determining Circuit Frequency Response,
Selecting the Proper Op Amp, Noise Analysis,
Achieving More Bandwidth by Using Two Stages,
Using a Composite Amplifier to Increase the
Gain Bandwidth Product, High Speed Fiber
Optic Receivers

- Other High Impedance Transducer Applications:
A pH Probe Buffer Amplifier, High Impedance Charge Output Transducers, Accelerometer Amplifiers, Hydrophone Amplifiers, Op Amp Performance: JFET Versus Bipolar, Using Decompensated Op Amps as I/V Converters, A High Performance Audio I/V Converter

SECTION IV SINGLE SUPPLY, LOW POWER APPLICATIONS

- Single Supply Design Considerations:
Reduced SNR, Determining the Ground Reference, Zero-Volt Input Signals, Zero-Volt Output Signals
- Application Example: Designing a True Single Supply Instrumentation Amplifier
- Other Limitations of Zero-Volt Output Amplifiers
- Rail-to Rail Output Swing Op Amp
- Choosing Single Supply Op Amps
- Using Precision Op Amps in Single-Supply, Low Voltage Applications
- Noise Pickup and Logic Supplies

SECTION V APPLICATIONS FOR AMPLIFIERS IN AUDIO

- A Low Noise Microphone Preamplifier with DC Servo Loop
- Line Receivers:
Basic Discrete Audio Line Receiver, Integrated Line Receiver

-
- Line Drivers:
“Inverter / Follower” Line Drivers, Cross-Coupled Differential Line Drivers, Integrated Line Drivers, A High Performance Composite Audio Line Driver Stage

SECTION VI PASSIVE AND ACTIVE ANALOG FILTERING

- Introduction to Filter Design and Implementation
- Antialiasing Filter Design Example
- A Programmable State Variable Filter
- A Seven-Pole FDNR 20kHz Antialiasing Filter
- A 2MHz Biquad Bandpass Filter Using a 30MHz Quad Op Amp
- Practical Problems In Filter Implementation:
Passive Components, Active Components
- A 12MHz Sallen-Key Filter Using a Current Feedback Amplifier

SECTION VII DRIVING ADCs

- ADC Performance Specifications
- Effects of Drive Amplifier on System Performance
- Specifying and Positioning the Antialiasing Filter
- Driving Non-Sampling ADCs
- Driving Sampling ADCs
- Driving Flash Converters

- Driving Precision 16-bit Sampling ADCs
- Driving Sigma-Delta Audio ADCs
- ADC Input Clamping and Protection Circuits

SECTION VIII

VIDEO AND OTHER HIGH SPEED OP AMP APPLICATIONS

- Introduction to Broadcast Video
- Video Applications:
 - Video Cable Driving, A Composite Video Sync Tip DC Restorer, A Video Sync Stripper Circuit, A High Performance Video ADC Differential Input Buffer
- Applying Ultra High Speed Op Amps:
 - A Low Distortion Drive Circuit for Precision Wide Dynamic Range ADCs, Ultra High Speed Buffers, High Speed Differential Line Drivers and Receivers, A High Speed Three Op Amp Instrumentation Amplifier

SECTION IX

NON-LINEAR CIRCUIT APPLICATIONS

- Introduction to Dynamic Range Compression
- Voltage Controlled Amplifiers (VCAs):
 - Exploiting the Bipolar Junction Transistor, VCAs Built Using Analog Multipliers, The X-AMP, X-AMP Applications
- Logarithmic Amplifiers:
 - Classifications, Scaling, Translinear Log Amps, Progressive Compression Log Amps, The AD640 Log Amp, Log Amps Based on Bipolar Differential Stages

-
- Using the AD834 in DC to 500MHz Applications: RMS-to-DC Conversion, Voltage-Controlled Amplifiers, and Video Switches
 - Video VCAs and Keyers Using the AD834 and AD811

SECTION X

UNUSUAL APPLICATIONS FOR OP AMPS

- Where do Op Amps Come From?
- What Really is An Op Amp?
- Basic Assumptions About Op Amps
- Novel Applications:
 - Gain in the Feedback Loop, Composite Amplifiers, Abusing the Null Pins, Op Amps Without Feedback, Maltreatment of the Compensation Pins, Shunt-Mode Operation, Supply Sensing, Computer Simulation
- Op Amps Used as Comparators

SECTION XI

OP AMP SUBTLETIES

- Op Amp Output Voltage Phase Reversal
- Does Op Amp Open Loop Gain Non-Linearity Affect Linearity?
- High Speed Op Amp Settling Time Measurements
- Op Amp Noise and How to Avoid It:
 - Internal Circuit Noise, Circuit Noise from Components, External Noise, Photoelectric Effects, Noise from Switching Supplies, Noise Reduction, Measuring External Noise

- The IC Op Amp User's Guide to Grounding, Decoupling, and Making Things Go Right for a Change

SECTION XII HARDWARE TECHNIQUES

- Leakage In Insulators:
Guard Rings, Electrostatic Damage (ESD)
- Grounding and Signal Routing:
Signal Return Currents, Ground Noise and Ground Loops, Star Grounds, Separate Analog and Digital Grounds, Ground Planes, Transmission Lines, System Grounds, Signal Routing
- Problem Areas:
Limitations of Spice Modelling, Sockets, Prototyping

SECTION XIII ANALOG CIRCUIT SIMULATION

- Macromodel Versus Micromodel
- The ADSpice Model
- The Noise Model
- Current Feedback Amplifier Model
- Voltage Reference Model
- Analog Multiplier Model
- Simulation and Breadboarding
- Using Simulation Wisely

INDEX

AMPLIFIER APPLICATIONS GUIDE

INTRODUCTION	1
PRECISION TRANSDUCER INTERFACES	2
HIGH IMPEDANCE, LOW CURRENT APPLICATIONS	3
SINGLE-SUPPLY, LOW POWER APPLICATIONS	4
APPLICATIONS FOR AMPLIFIERS IN AUDIO	5
PASSIVE AND ACTIVE ANALOG FILTERING	6
DRIVING ADCs	7
VIDEO AND OTHER HIGH SPEED APPLICATIONS	8
NON-LINEAR CIRCUIT APPLICATIONS	9
UNUSUAL APPLICATIONS FOR OP AMPS	10
OP AMP SUBTLETIES	11
HARDWARE TECHNIQUES	12
ANALOG CIRCUIT SIMULATION	13
INDEX	I

