

DESIGNING PHOTODIODE AMPLIFIER CIRCUITS WITH OPA128

The OPA128 ultra-low bias current operational amplifier achieves its 750A maximum bias current without compromise. Using standard design techniques, serious performance trade-offs were required which sacrificed overall amplifier performance in order to reach femtoamp ($I_A = 10^{-15}$ A) bias currents.

UNIQUE DESIGN MINIMIZES PERFORMANCE TRADE-OFFS

Small-geometry FETs have low bias current, of course, but FET size reduction reduces transconductance and increases noise dramatically, placing a serious restriction on performance when low bias current is achieved simply by making input FETs extremely small. Unfortunately, larger geometries suffer from high gate-to-substrate isolation diode leakage (which is the major contribution to BIFET® amplifier input bias current).

Replacing the reverse-biased gate-to-substrate isolation diode structure of BIFETs with dielectric isolation removes this large leakage current component which, together with a noise-free cascode circuit, special FET geometry, and advanced wafer processing, allows far higher *Difet*® performance compared to BIFETs.

HOW TO IMPROVE PHOTODIODE AMPLIFIER PERFORMANCE

An important electro-optical application of FET op amps is for photodiode amplifiers. The unequalled performance of the OPA128 is well-suited for very high sensitivity detector designs. A few design tips for photodiode amplifiers may be helpful:

- *Photodiode capacitance should be as low as possible.* See Figure 1: C_j affects not only bandwidth but noise as well. This is because C_j and the op amp's feedback resistor form a noise-gain zero (feedback pole).
- *Photodiode active area should be as small as possible so that C_j is small and R_j is high.* This will allow a higher signal-to-noise ratio. If a large area is needed, consider using optical "gain" (lens, mirror, etc.) rather than a large area diode. Optical "gain" is essentially noise-free.
- *Use as large a feedback resistor as possible (consistent with bandwidth requirements) to minimize noise.* This seems paradoxical, but remember, resistor thermal noise increases as:

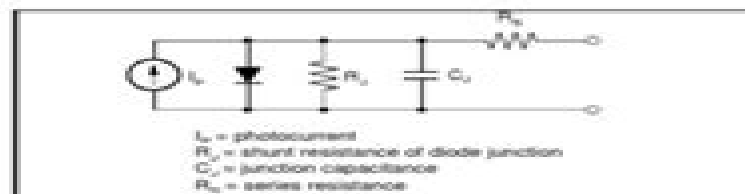


FIGURE 1. Photodiode Equivalent Circuit.

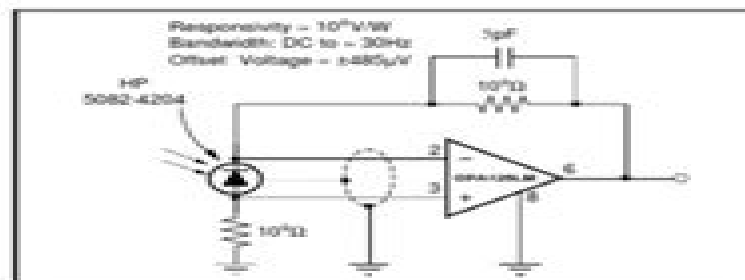


FIGURE 2. High-Sensitivity Photodiode Amplifier.

$$e_{\text{noise}} = \sqrt{4kTBR}$$

k : Boltzman's constant = 1.38×10^{-23} J/K
 T : temperature ($^{\circ}$ K)
 B : noise bandwidth (Hz)
 R : feedback resistor (Ω)
 e_{noise} : noise voltage (Vrms)

while transimpedance gain (signal) increases as:

$$e_{\text{noise}} = i(\text{signal}) R$$

Signal-to-noise improves by $\sqrt{R}$.

- *A low bias current op amp is needed to achieve highest sensitivity.* Bias current causes voltage offset errors with large-feedback resistors. Wide bandwidth circuits with smaller feedback resistors are less subject to bias current errors, but even in these circuits, bias current must be

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Designing Photodiode Amplifier Circuits With Opa128:

Analog Electronics with Op-amps A. J. Peyton, Vincent Walsh, 1993-08-12 A reference volume of analog electronic circuits based on the op amp containing practical detail and technical advice **Design of Pulse Oximeters** John G. Webster, 1997-10-23 Design of Pulse Oximeters describes the hardware and software needed to make a pulse oximeter and includes the equations methods and software required for them to function effectively The book begins with a brief description of how oxygen is delivered to the tissue historical methods for measuring oxygenation and the invention of the pulse oximeter in the early 1980s Subsequent chapters explain oxygen saturation display and how to use an LED provide a survey of light sensors and review probes and cables The book closes with an assessment of techniques that may be used to analyze pulse oximeter performance and a brief overview of pulse oximetry applications The book contains useful worked examples several worked equations flow charts and examples of algorithms used to calculate oxygen saturation It also includes a glossary of terms instructional objectives by chapter and references to further reading **Smart Mems And Sensor Systems** Elena Gaura, Robert Newman, 2006-08-10 In recent years MEMS have revolutionized the semiconductor industry with sensors being a particularly buoyant sector Smart MEMS and Sensor Systems presents readers with the means to understand evaluate appreciate and participate in the development of the field from a unique systems perspective The combination of MEMS and integrated intelligence has been put forward as a disruptive technology The full potential of this technology is only evident when it is used to construct very large pervasive sensing systems The book explores the many different technologies needed to build such systems and integrates knowledge from three different domains MEMS technology sensor system electronics and pervasive computing science Throughout the book a top down design perspective is taken be it for the development of a single smart sensor or that of adaptive ad hoc networks of millions of sensors For experts in any of the domains named above the book provides the context for their MEMS based design work and an understanding of the role the other domains play For the generalist either in engineering or computing or the technology manager the underpinning knowledge is provided which can inform specialist decision making a **Advances in Electrical and Computer Technologies** Thangaprakash Sengodan, M. Murugappan, Sanjay Misra, 2022-06-25 This book comprises select proceedings of the International Conference on Advances in Electrical and Computer Technologies 2021 ICAECT 2021 The papers presented in this book are peer reviewed and cover the latest research in electrical electronics communication and computer engineering Topics covered include smart grids soft computing techniques in power systems smart energy management systems power electronics feedback control systems biomedical engineering geographic information systems grid computing data mining image and signal processing video processing computer vision pattern recognition cloud computing pervasive computing intelligent systems artificial intelligence neural network and fuzzy logic broadband communication mobile and optical communication network security VLSI embedded systems optical networks and wireless

communication The book is useful for students and researchers working in the different overlapping areas of electrical electronics and communication engineering *Analog Electronics for Measuring Systems* Davide Bucci, 2017-04-12 Many instrumentation engineers and scientists often deal with analog electronic issues when approaching delicate measurements Even if off the shelf measuring solutions exist comprehension of the analog behavior of the measuring system is often a necessity This book provides a concise introduction to the main elements of a low frequency analog acquisition chain It aims to be sufficiently general to provide an introduction yet specific enough to guide the reader through some classical problems that may be encountered in the subject Topics include sensors conditioning circuits differential and instrumentation amplifiers active filters mainly for anti aliasing purposes and analog to digital converters A chapter is devoted to an introduction to noise and electronic compatibility This work is intended for people with a general background in electronics and signal processing who are looking for an introduction to classical electronic solutions employed in measuring instruments involving low frequency analog signal processing *UV-Visible Reflection Spectroscopy of Liquids* Jukka A. Rätty, Kai-Erik Peiponen, Toshimitsu Asakura, 2013-03-20 An up to date overview of reflectometers used for optical spectroscopy of various kinds of liquids ranging from well known transparent liquids to pathological industrial liquids The book reviews and explains basic materials for anyone wanting to get to know the theory spectral analysis and modern devices needed for the measurement of refractive index and absorption of liquids Moreover the book gives an introduction to reflectivity from optically nonlinear liquids such as liquids containing nanoparticles **Machine Design** ,1987

Handbook of Research on Biomedical Engineering Education and Advanced Bioengineering Learning: Interdisciplinary Concepts Abu-Faraj, Ziad O., 2012-02-29 Description based on v 2 copyrighted in 2012 *EDN* ,1987 SiGe-based Re-engineering of Electronic Warfare Subsystems Wynand Lambrechts, Saurabh Sinha, 2016-10-19 This book provides readers a thorough understanding of the applicability of new generation silicon germanium SiGe electronic subsystems for electronic warfare and defensive countermeasures in military contexts It explains in detail the theoretical and technical background and addresses all aspects of the integration of SiGe as an enabling technology for maritime land and airborne spaceborne electronic warfare including research design development and implementation The coverage is supported by mathematical derivations informative illustrations practical examples and case studies While SiGe technology provides speed performance and price advantages in many markets to date only limited information has been available on its use in electronic warfare systems especially in developing nations Addressing that need this book offers essential engineering guidelines that especially focus on the speed and reliability of current generation SiGe circuits and highlight emerging innovations that help to ensure the sustainable long term integration of SiGe into electronic warfare systems *Electronic Design* ,1988 Photons Plus Ultrasound ,2004 *Electronics World* ,2000 **Annual Research Journal** ,2005 The Dept of Electrical Engineering at the University Park Campus of Penn State University is the host of a National Science

Foundation NSF sponsored Research Experience for Undergraduates REU Site in Electrical Engineering The EE REU Site was created to make available summer research experience in electrical engineering at Penn State for undergraduate students who seek research exposure This publication presents the research papers submitted by program participants each summer

Photodiode Amplifiers: OP AMP Solutions Jerald G. Graeme, 1996 Light photons impinging upon a semiconductor material in the vicinity of a P N junction release conduction carriers to produce current flow through the photodiode effect Photodiode amplifiers convert this current to a voltage in a relationship that remains linear as long as the amplifier eliminates signal voltage swing from the photodiode For this purpose the simple current to voltage converter or transimpedance amplifier presents a virtual ground to the diode However when connected to a photodiode this simple op amp circuit displays surprising multidimensional constraints that defy conventional op amp intuition *Synthesis of Amplifier Circuits Using More Than One Tunnel Design Diode* Richard R. Wong, 1961

Design of OP-AMP Circuits with Experiments Howard M. Berlin, 1988 **Designing Circuits with IC Operational Amplifiers** Robert G. Seippel, Roger Lincoln Nelson, 1975 **A Low-noise Photodiode-amplifier Circuit** Kalevi Hyyppä, 1993 *How to Design Op Amp Circuits, with Projects & Experiments* Delton T. Horn, 1984-01-01

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