

# CHARACTERIZATION OF A WIDEBAND DIGITIZER FOR POWER MEASUREMENTS UP TO 1 MHz

Gert Rietveld, *Member, IEEE*<sup>(1)</sup>, Dongsbeng Zhao, *Member, IEEE*<sup>(1)</sup>, Charlotte Kramer<sup>(2)</sup>, Ernest Houtzager<sup>(1)</sup>, Orla Kristensen<sup>(2)</sup>, Cyrille de Lefve<sup>(2,3)</sup>, and Torsten Lippert<sup>(2)</sup>

**Abstract**— A two-channel high-speed digitizer has been extensively characterized in the frequency range of 50 Hz to 1 MHz. The measurements involved ac flatness, phase, linearity, input impedance and the effects of dc offsets, temperature, and internal self-calibration routine. The digital anti-aliasing filter inside the digitizer negatively affects the ac flatness in the low-frequency region. An inverse compensation filter has been designed and applied which improves the frequency response with a factor 25 to 60 and makes it flat within 25  $\mu\text{V/V}$  up to 100 kHz and within 100  $\mu\text{V/V}$  up to 1 MHz. The phase difference between the two channels can be modeled by a constant time delay between the two channels, which for the 2  $V_{pp}$  range equals (250  $\pm$  30) ps. The overall results of the characterization indicate that the digitizer can be applied in wideband power measurements under practical circumstances with ( $k=1$ ) uncertainty contributions of not more than 70  $\mu\text{W/WA}$  and 400  $\mu\text{W/WA}$  at 10 kHz and 1 MHz respectively. This uncertainty excludes loading effects which are significant at frequencies above 100 kHz. At low frequencies up to three times lower uncertainties are achieved when the digitizer is calibrated at the signal level and temperature at which it is subsequently used.

**Index Terms**— digitizer, digital-analog conversion, wideband power, frequency response, phase measurement, digital filters, power measurement

## I. INTRODUCTION

THE area of low frequency power measurements is expanding to higher frequencies since in applications as for example lighting and switched power supplies these higher frequencies are used in order to achieve better efficiency and lower losses. The heart of wideband commercial power meters consists of a fast digitizer combined with wideband voltage dividers and current shunts, used to convert the input voltage and current signals to the input voltage levels of the digitizer. For calibration of such power meters, a reference system is

needed where again a digitizer plays an important role.

As part of a European joint research project on "Power and Energy", a commercial wideband digitizer is extensively characterized for possible use in a reference system for power measurements up to 1 MHz. This paper describes the digitizer together with the characterization set-up and the evaluation results.

## II. DIGITIZER

A commercially available digitizer, the National Instruments PXI-5922<sup>1</sup> two-channel high-speed digitizer [1], housed in a PXI-1033 chassis, was selected for evaluation as possible digitizer in wideband power measurements. The digitizer has two ranges, 2  $V_{pp}$  and 10  $V_{pp}$ , and can be operated at sampling rates from 50 kSa/s with 24-bit resolution up to 15 MSa/s with 16-bit resolution. Since the precise properties of the digitizer have been found to depend on the sampling rate, the major part of the characterization is performed at a limited number of sampling rate – frequency combinations. The combinations chosen are 100 kSa/s for frequencies up to 10 kHz, 1 MSa/s for frequencies between 10 kHz and 100 kHz, and 10 MSa/s for frequencies from 100 kHz up to 1 MHz. In this way, an oversampling ratio of at least 5 is reached over the complete measurement frequency range. For all measurements the input impedance is set to 1 M $\Omega$ , since the alternative 50  $\Omega$  setting would result in too high loading errors in the final application.

## III. MEASUREMENT SET-UP

Measurement software has been developed providing simultaneous readout of the two digitizer channels. The software subsequently calculates the rms voltage and, using an FFT, the phase between the two channels. Further features of the software are determination of dc offsets in the current and voltage signals, calculation of the harmonics spectrum, and the possibility of using gain correction factors and phase offset correction. For sampling rates up to 1 MSa/s the sampling and calculations are performed continuously ("streaming mode"); at 10 MSa/s the samples are taken at certain intervals to allow for sufficient computation time of all signal parameters in between these intervals.

Manuscript received June 7, 2010. This work was partially funded by the Dutch Ministry of Economic Affairs and the Danish Ministry of Science, Technology and Innovation. Additional funding was received from the European Community's Seventh Framework Program, ERA-NET Plus, under Grant Agreement No. 237297.

The authors are with:

(1) VSL, the Dutch National Metrology Institute, P.O. Box 654, 2600 AE Delft, The Netherlands. Corresponding author: Gert Rietveld; phone: +31 15 2691 500; fax: +31 15 2612 971; e-mail: gretveld@vsl.nl.

(2) Technical A/S, Mads Clausens Vej 12, 8600 Silkeborg, Denmark.

(3) on temporary leave from Université de Savoie - PolytechSavoie, BP 80439, 74944 Annecy le Vieux Cedex, France.

<sup>1</sup> The manufacturers and types of instrumentation mentioned in this paper do not indicate any preference by the authors, nor does it indicate that these are the best available for the application discussed.

# Characterization Of A Wideband Digitizer For Power

**J Elliott**



## **Characterization Of A Wideband Digitizer For Power:**

## Unveiling the Power of Verbal Beauty: An Emotional Sojourn through **Characterization Of A Wideband Digitizer For Power**

In a world inundated with screens and the cacophony of instant transmission, the profound power and mental resonance of verbal artistry frequently disappear into obscurity, eclipsed by the regular assault of noise and distractions. However, situated within the musical pages of **Characterization Of A Wideband Digitizer For Power**, a charming work of literary elegance that pulses with fresh emotions, lies an memorable journey waiting to be embarked upon. Penned with a virtuoso wordsmith, this enchanting opus courses viewers on a mental odyssey, lightly revealing the latent possible and profound impact stuck within the complex internet of language. Within the heart-wrenching expanse of this evocative analysis, we shall embark upon an introspective exploration of the book is key subjects, dissect their charming writing design, and immerse ourselves in the indelible impact it leaves upon the depths of readers souls.

[https://py.bijouxmedusa.com/files/scholarship/Download\\_PDFS/American%20History%20Alan%20Brinkley%2012th%20Edition%20Quiz.pdf](https://py.bijouxmedusa.com/files/scholarship/Download_PDFS/American%20History%20Alan%20Brinkley%2012th%20Edition%20Quiz.pdf)

### **Table of Contents Characterization Of A Wideband Digitizer For Power**

1. Understanding the eBook Characterization Of A Wideband Digitizer For Power
  - The Rise of Digital Reading Characterization Of A Wideband Digitizer For Power
  - Advantages of eBooks Over Traditional Books
2. Identifying Characterization Of A Wideband Digitizer For Power
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Characterization Of A Wideband Digitizer For Power
  - User-Friendly Interface

4. Exploring eBook Recommendations from Characterization Of A Wideband Digitizer For Power
  - Personalized Recommendations
  - Characterization Of A Wideband Digitizer For Power User Reviews and Ratings
  - Characterization Of A Wideband Digitizer For Power and Bestseller Lists
5. Accessing Characterization Of A Wideband Digitizer For Power Free and Paid eBooks
  - Characterization Of A Wideband Digitizer For Power Public Domain eBooks
  - Characterization Of A Wideband Digitizer For Power eBook Subscription Services
  - Characterization Of A Wideband Digitizer For Power Budget-Friendly Options
6. Navigating Characterization Of A Wideband Digitizer For Power eBook Formats
  - ePub, PDF, MOBI, and More
  - Characterization Of A Wideband Digitizer For Power Compatibility with Devices
  - Characterization Of A Wideband Digitizer For Power Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Characterization Of A Wideband Digitizer For Power
  - Highlighting and Note-Taking Characterization Of A Wideband Digitizer For Power
  - Interactive Elements Characterization Of A Wideband Digitizer For Power
8. Staying Engaged with Characterization Of A Wideband Digitizer For Power
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Characterization Of A Wideband Digitizer For Power
9. Balancing eBooks and Physical Books Characterization Of A Wideband Digitizer For Power
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Characterization Of A Wideband Digitizer For Power
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Characterization Of A Wideband Digitizer For Power
  - Setting Reading Goals Characterization Of A Wideband Digitizer For Power
  - Carving Out Dedicated Reading Time

12. Sourcing Reliable Information of Characterization Of A Wideband Digitizer For Power
  - Fact-Checking eBook Content of Characterization Of A Wideband Digitizer For Power
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

### **Characterization Of A Wideband Digitizer For Power Introduction**

In this digital age, the convenience of accessing information at our fingertips has become a necessity. Whether its research papers, eBooks, or user manuals, PDF files have become the preferred format for sharing and reading documents. However, the cost associated with purchasing PDF files can sometimes be a barrier for many individuals and organizations. Thankfully, there are numerous websites and platforms that allow users to download free PDF files legally. In this article, we will explore some of the best platforms to download free PDFs. One of the most popular platforms to download free PDF files is Project Gutenberg. This online library offers over 60,000 free eBooks that are in the public domain. From classic literature to historical documents, Project Gutenberg provides a wide range of PDF files that can be downloaded and enjoyed on various devices. The website is user-friendly and allows users to search for specific titles or browse through different categories. Another reliable platform for downloading Characterization Of A Wideband Digitizer For Power free PDF files is Open Library. With its vast collection of over 1 million eBooks, Open Library has something for every reader. The website offers a seamless experience by providing options to borrow or download PDF files. Users simply need to create a free account to access this treasure trove of knowledge. Open Library also allows users to contribute by uploading and sharing their own PDF files, making it a collaborative platform for book enthusiasts. For those interested in academic resources, there are websites dedicated to providing free PDFs of research papers and scientific articles. One such website is Academia.edu, which allows researchers and scholars to share their work with a global audience. Users can download PDF files of research papers, theses, and dissertations covering a wide range of subjects. Academia.edu also provides a platform for discussions and networking within the academic community. When it comes to downloading Characterization Of A Wideband Digitizer For Power free PDF files of magazines, brochures, and catalogs, Issuu is a popular choice. This digital publishing platform hosts a vast collection of publications from around the world. Users can search for specific titles or explore various

categories and genres. Issuu offers a seamless reading experience with its user-friendly interface and allows users to download PDF files for offline reading. Apart from dedicated platforms, search engines also play a crucial role in finding free PDF files. Google, for instance, has an advanced search feature that allows users to filter results by file type. By specifying the file type as "PDF," users can find websites that offer free PDF downloads on a specific topic. While downloading Characterization Of A Wideband Digitizer For Power free PDF files is convenient, it's important to note that copyright laws must be respected. Always ensure that the PDF files you download are legally available for free. Many authors and publishers voluntarily provide free PDF versions of their work, but it's essential to be cautious and verify the authenticity of the source before downloading Characterization Of A Wideband Digitizer For Power. In conclusion, the internet offers numerous platforms and websites that allow users to download free PDF files legally. Whether it's classic literature, research papers, or magazines, there is something for everyone. The platforms mentioned in this article, such as Project Gutenberg, Open Library, Academia.edu, and Issuu, provide access to a vast collection of PDF files. However, users should always be cautious and verify the legality of the source before downloading Characterization Of A Wideband Digitizer For Power any PDF files. With these platforms, the world of PDF downloads is just a click away.

### **FAQs About Characterization Of A Wideband Digitizer For Power Books**

How do I know which eBook platform is the best for me? Finding the best eBook platform depends on your reading preferences and device compatibility. Research different platforms, read user reviews, and explore their features before making a choice. Are free eBooks of good quality? Yes, many reputable platforms offer high-quality free eBooks, including classics and public domain works. However, make sure to verify the source to ensure the eBook's credibility. Can I read eBooks without an eReader? Absolutely! Most eBook platforms offer web-based readers or mobile apps that allow you to read eBooks on your computer, tablet, or smartphone. How do I avoid digital eye strain while reading eBooks? To prevent digital eye strain, take regular breaks, adjust the font size and background color, and ensure proper lighting while reading eBooks. What's the advantage of interactive eBooks? Interactive eBooks incorporate multimedia elements, quizzes, and activities, enhancing the reader's engagement and providing a more immersive learning experience. Characterization Of A Wideband Digitizer For Power is one of the best books in our library for free trial. We provide a copy of Characterization Of A Wideband Digitizer For Power in digital format, so the resources that you find are reliable. There are also many eBooks related to Characterization Of A Wideband Digitizer For Power. Where to download Characterization Of A Wideband Digitizer For Power online for free? Are you looking for Characterization Of A Wideband Digitizer For Power PDF? This is definitely going to save you time and cash in something you should think about.

**Find Characterization Of A Wideband Digitizer For Power :**

*american history alan brinkley 12th edition quiz*

alternative dispute resolution letter

american english file 2 workbook resuelto

~~am general humvee the us armys iconic high mobility multi purpose wheeled vehicle hmmwv enthusiasts manual~~

**algebra structure method book 1 test on chapter 9**

*agricultural science question paper 2 grade 11*

algorithmic foundations of robotics ix selected contributions of the ninth international workshop on the algorithmic

foundations of robotics springer tracts in advanced robotics

**amando a pablo odiando escobar virginia vallejo**

*affect in language learning*

*alexander osterwalder business model generation*

**algebra juan antonio cuellar on line**

**aki ola series physics**

**all the things we never knew chasing the chaos of mental illness**

~~algorithms for vlsi physical design automation naveed a sherwani~~

american red cross first aid responding

**Characterization Of A Wideband Digitizer For Power :**

Postal Exam 473 Practice Tests | Postal Service Exam Study for the Postal Service Exam 473 with help from our practice tests! · Address Checking Test · Forms Completion Test · Coding Test · Memory Test. 15 ... Postal Exam 473 Practice Tests [2023] | 10+ Exams Jun 15, 2023 — Take a postal exam 473 practice test. Use our questions and answers to prepare for your upcoming exam. All of our resources are 100% free. USPS Postal Exam 473 Practice Test No information is available for this page. How to Easily Pass Postal Exam 473/473E So where can you find a truly up-to-date and effective study guide? Our bestselling USPS Practice Tests with Actual Postal Exam Questions & Proven Best Answers ... Postal Exam 473 Practice Test - Questions & Answers You should make use of 473 Postal exam study guides, practice exams, and 473 practice tests. Preparation is needed for you to pass the exam. There is a lot of ... Free, Practice Battery 473 Exam 4Tests.com - Your free, practice test site for a Free, Practice Battery 473 Exam. ... Postal Exams. Battery 473 Exam. This site requires JavaScript. To fully use ... USPS Postal Exam 474 - 477: Practice Tests & Examples [2023] This is a complete prep guide for the USPS Postal

Exams 474, 475, 476, and 477. See how to pass the assessments with accurate USPS practice tests. US Postal Exams 473/473c (U.S. Postal Exams Test Prep) REA's all-new fourth edition contains six complete practice exams and review material for the U.S. Postal Exams 473/473c, and includes everything you need to ... Postal Service Test Ace the U.S. Postal Exam 473 using this full-length practice exam with answers fully explained for ideal study. It is applicable for test takers in all 50 ... Real Estate Brokerage Operations This lesson will discuss access time, accumulated delay, action time, conformance, CQI, management by exception, optimum conformity, perception, performance ... Real Estate Training Courses Online - Agent Campus Agent Campus by 360training provides online real estate courses that Real Estate Agents need. Enroll today to get your license and continuing education. Become a Real Estate Agent and Renew Your License at ... About Us 360training is a leader in regulatory-approved online training and certification across a wide range of industries and professions in the United States. 360training 360training is a leading online e-learning provider. Since 1997, the company has delivered best-in-class training content for workforce compliance, ... 360 Training Reviews Texas sales associates can complete TREC approved SAE courses at 360 Training. Topics covered include: TREC Legal Update I and II; Real Estate Brokerage ... 360training Review This online learning center offers virtual real estate pre-licensing courses and training in 14 different states, although course options vary widely. Exam prep ... 360training Privately Held. Founded: 1997. Specialties: Real Estate Pre-Licensing, CE, Broker, OSHA Safety Training, Insurance Licensing, Environmental ... 360training Acquires Van Education Center To Expand Its ... May 3, 2021 — Acquiring VanEd and its team of real estate educators is a great addition to 360training. ... 360training is the most trusted online platform for ... 360 Training Sessions Flashcards Study with Quizlet and memorize flashcards containing terms like National Association of Realtors (NAR), A REALTOR® is a professional in real estate who ... Hawaiian Money Standard Catalog Second Edition Most complete up-to-date "one source" catalog covering Hawaiian numismatic items, profusely illustrated with prices, pertinent historical background and ... Hawaiian Money Standard Catalog, 1991 by Donald ... Hawaiian Money - 2nd Edition by Ronald Russell A copy that has been read, but remains in clean condition. All pages are intact, and the cover is intact. Hawaiian Money Standard Catalog Second Edition | Books Hawaiian Money Standard Catalog Second Edition by Donald Medcalf & Ronald Russell (1991). Hawaiian Money Standard Catalog by Medcalf Donald Hawaiian Money, Standard Catalog; Second Edition by MEDCALF, Donald; and Ronald Russell and a great selection of related books, art and collectibles ... SIGNED HAWAIIAN MONEY STANDARD CATALOG ... Oct 12, 2020 — A collection of ancient prayers, in Hawaiian and English that deal with family life, healing, gods, the Aina (land), Ali'i (Chiefs), and more. Hawaiian Money Standard Catalog, 1991 Here is the most complete, up-to-date catalog covering Hawaiian numismatic items, illustrated, with current prices and pertinent historical backgrounds. Read ... Hawaiian Money Standard Catalog. Edition, 2nd edition. Publisher, Ronald Russell. Publication location, Mill Creek, Washington, United States. Publication year, 1991. ISBN-10 ... About | The Hawaiiana Numismatist™ Hawaiian Money

Standard Catalog Second Edition, by Medcalf and Russell, 1991, ISBN 0-9623263-0-5; So Called Dollars, 2nd Edition, by Hibler and Kappen, 2008 ... Numismatics Reference Book Medcalf HAWAIIAN MONEY ... Numismatics Reference Book Medcalf HAWAIIAN MONEY-STANDARD CATALOGUE 1991 2nd Ed ; Availability: In Stock ; Ex Tax: \$31.68 ; Price in reward points: 124 ...