



QEX (ISSN: 0886-8093) is published bimonthly in January, March, May, July, September, and November by the American Radio Relay League, 225 Main Street, Newington, CT 06111-1494. Periodicals postage paid at Hartford, CT and at additional mailing offices.

POSTMASTER: Send address changes to: QEX, 225 Main St, Newington, CT 06111-1494 Issue No 276

Harold Kramer, WJ1B
Publisher

Larry Wolfgang, WR1B
Editor

Lori Weinberg, KB1EIB
Assistant Editor

Zack Lau, W1VT
Ray Mack, W5IFS
Contributing Editors

Production Department

Steve Ford, WB8IMY
Publications Manager

Michelle Bloom, WB1ENT
Production Supervisor

Sue Fagan, KB1OKW
Graphic Design Supervisor

David Pingree, N1NAS
Senior Technical Illustrator

Carol Michaud, KB1QAW
Technical Illustrator

Advertising Information Contact:

Janet L. Rocco, W1JLR
Business Services
860-594-0203 – Direct
800-243-7768 – ARRL
860-594-4285 – Fax

Circulation Department

Cathy Stepina, QEX Circulation

Offices

225 Main St, Newington, CT 06111-1494 USA
Telephone: 860-594-0200
Fax: 860-594-0259 (24 hour direct line)
e-mail: qex@arrl.org

Subscription rate for 6 issues:

In the US: ARRL Member \$24,
nonmember \$36;

US by First Class Mail:
ARRL member \$37, nonmember \$49;

International and Canada by Airmail: ARRL member
\$31, nonmember \$43;

Members are asked to include their membership
control number or a label from their QST when
applying.

In order to ensure prompt delivery, we ask that you periodically check the address information on your mailing label. If you find any inaccuracies, please contact the Circulation Department immediately. Thank you for your assistance.



Copyright © 2012 by the American Radio Relay League Inc. For permission to quote or reprint material from QEX or any ARRL publication, send a written request including the issue date (or book title), article, page numbers and a description of where you intend to use the reprinted material. Send the request to the office of the Publications Manager (permission@arrl.org).

January/February 2013

About the Cover

John Franke, WA4WDL, was inspired by an article in the September/October 2009 issue of QEX magazine titled "Atomic Frequency Reference for Your Shack" by Bob Miller, KE6F. The design included a double balanced beat indicator as a means for quickly comparing two oscillators. John determined that while the project used a regular single-polarity meter, a zero-center meter would have been better. John's solution was to build his own using two North Hills baluns, the associated circuitry and a surplus enclosure. Read about it in this issue!



In This Issue

Features

3 Using a Digital Transceiver as a Vector Network Analyzer

James Ahlstrom, N2ADR

7 Buck Converter Basics

Bob Dildine, W6SFH

11 Double Balanced Beat Indicator

John M. Franke, WA4WDL

14 The Drive Level Sensitivity of Quartz Crystals

Richard Harris, G3OTK

22 Multi-Element End-Fire Arrays of K9AY Loops

Richard C. Jaeger, K4IQJ

32 Use Arduino Technology to Create a Clock/10 Minute Timer

Clark Sell, N9APK

40 Octave for T- and Pi-Networks

Maynard A. Wright, W6PAP

43 SDR: Simplified

Ray Mack, W5IFS

48 2012 Annual Index

Index of Advertisers

American Radio Relay League:..... Cover III
Array Solutions: 21
Down East Microwave Inc:..... 10
Kenwood Communications:Cover II
National RF, Inc: 13

Nemal Electronics International, Inc:..... 13
Quicksilver Radio Products..... Cover IV
RF Parts:..... 17, 19
Tucson Amateur Packet Radio: 6