

Barry J. Shelley, N1VXY
Interim Publisher

Steve Ford, WB8IMY
Editor

Becky R. Schoenfeld, W1BXY
Managing Editor

Jen Glifort, KC1KNL
Senior Editor

Caroline Kenney
Leanna Zwiebel
Assistant Editors

Bart Jahnke, W9JJ
Radiosport & Field Services
Manager

Rick Lindquist, WW1ME
Happenings

Bob Allison, WB1GCM
Product Review Lab Testing

Mark J. Wilson, K1RO
Al Brogdon, W1AB
Bernie McClenny, W3UR
H. Ward Silver, N0AX
Paul Wade, W1GHZ
Jon Jones, N0JK
Rick Palm, K1CE
Joel R. Hallas, W1ZR
Barry Shackelford, W6YE
Kai Siwiak, KE4PT
Bruce Draper, AA5B
Contributing Editors

Michelle Bloom, WB1ENT
Production Supervisor

Jodi Morin, KA1JPA
Assistant Production Supervisor

Maty Weinberg, KB1EIB
Production Coordinator

David Pingree, N1NAS
Senior Technical Illustrator

Janet Rocco, W1JLR
Advertising Sales Manager

Bob Inderbitzen, NQ1R
Product Development Manager

Yvette Vinci, KC1AIM
Marketing and Sales Manager

Steve Ewald, WV1X
Field Organization Supervisor

Eric Casey, KC2ERC
Convention and Event Coordinator

30 Build Your Own Open-Wire Line

Robert J. Zavrel, Jr., W7SX

34 Using Integrated Circuits to Add Propagation Delays

Klaus Spies, WB9YBM

36 "Leaky" Antenna Switches

Ellwood (Woody) Brem, K3YV

38 Batteries for the Elecraft KX3 and Other Low-Power Radios

Eliot Mayer, W1MJ

42 Product Review

Mark Wilson, K1RO
Xiegu G90 HF Transceiver;
SOTABEAMS Wolfwave Audio
Processor; Inexpensive Antenna
System Tuning Indicators



42

60 A Grid DXpedition in the Upper Peninsula

Dan Brandner, N9DJB

64 How the Ionosphere Was Confirmed

Robert H. Welsh, N3RW

67 Eclectic Tech: A New Technical Podcast for Amateur Radio!

68 The Saga of Clipperton Island

Allison McLellan

72 Nominations Now Being Accepted for 2020 McGan Silver Antenna Award for Excellence in Public Relations

80 The 2019 IARU HF World Championship Results

Bob Raymond, WA1Z

87 The April 2020 ARRL Rookie Roundup — Phone

93 A Look Back: May 1970



67

Columns

Celebrating Our Legacy.....	99
Classic Radio.....	100
Close Up.....	41
Contest Corral	79
Correspondence.....	24
The Doctor is In.....	55
Edictic Technology	59
Happenings	73
Hints & Hacks.....	57
How's DX?.....	86
Member Spotlight	13
Public Service.....	77
Up Front.....	20
The World Above 50 MHz.....	84
100, 50, and 25 Years Ago.....	102

Digital and Mobile Editions

ARRL members can access the digital edition via a link at www.arrrl.org/qst, download our iOS app from the iTunes Store, and download our Android app from the Google Play Store.

Departments

Amateur Radio Band Chart	9
ARRL Section Managers.....	16
Certificate of Code	
Proficiency Recipients.....	88
Convention and Hamfest Calendar.....	89
Feedback.....	90
Field Organization Reports.....	78
Guide to ARRL Member Benefits.....	14
Ham Ads.....	140
Index of Advertisers.....	142, 143
New Books	90
New Products	54
Officers, Division Directors, and Staff.....	15
QST Cover Plaque Award.....	71
Silent Keys.....	103
Special Event Stations.....	83
Strays.....	101, 103
VEC Honor Roll	92
WIAW Qualifying Runs	88
WIAW Schedule.....	91
WIAW's QSL File.....	28

Write for QST

www.arrrl.org/qst-author-guide
email: qst@arrrl.org



Our Cover

The open-wire feed line on our cover is based on Robert Zavrel's, W7SX, step-by-step construction. His rugged open-wire line holds up in difficult weather and works great even under high SWR conditions. For Robert's full instructions — which can be adapted to suit your specifications and the tools you have available — see his article, "Build Your Own Open-Wire Line," on page 30 of this issue.



QST (ISSN:0033-4812) is published monthly as its official journal by the American Radio Relay League, Inc., 225 Main St., Newington, CT 06111-1400, USA. Periodicals postage paid at Hartford, CT, USA and at additional mailing offices.

POSTMASTER: Send address changes to: QST, 225 Main St., Newington, CT 06111-1400, USA. Canada Post: Publications Mail Agreement #90-0901437. Canada returns to be sent to IMEX Global Solutions, 1501 Morse Ave., Elk Grove Village, IL 60007.

US & Possessions: Membership in the ARRL, including a 1-year subscription to QST, is available to individuals at \$49. Licensed radio amateurs age 21 and under and the eldest licensee in the household may qualify for the rate of \$25. Life Membership, including a subscription to QST is available at \$1,225.* Membership includes \$21 per year for subscription to QST. Membership and QST cannot be separated. Libraries and institutions, \$49 per year. Single copies \$6.95.

International

To compensate for additional postage for mailing outside the US, the following rates apply:

Canada: Membership in the ARRL, including a 1-year subscription to QST, \$62, payable in US funds. Life Membership, including a subscription to QST is available at \$1,550.* Libraries and institutions, \$62 per year.

All Other Countries: Membership in the ARRL, including a 1-year subscription to QST, \$76, payable in US funds. Life Membership, including a subscription to QST, is available at \$1,900.* Libraries and institutions, \$76 per year.

Membership without QST is available to the immediate family of a member living at the same address, and to anyone who is legally blind, for \$10 per year.

Foreign remittances should be by international postal or express money order or bank draft negotiable in the US and for an equivalent amount in US funds.

Membership in the ARRL, including a 1-year subscription to Digital QST only, is available to Canadian and International members at \$49.

Copyright © 2020 by the American Radio Relay League Inc. Title registered at the US Patent Office. International copyright secured. All rights reserved. Quedan reservados todos los derechos. Printed in the USA.

QST® DXCC® VUCC® DX Century Club®, ARES®, Amateur Radio Emergency Service®, Logbook of The World®, LoTW®, and ARRL, the national association for Amateur Radio® are registered trademarks of the American Radio Relay League, Inc.

The ARRL and QST in no way warrant the products described or reviewed herein.

QST is available to blind and physically handicapped individuals from the Library of Congress, National Library Service for the Blind and Physically Handicapped. Call 1-800-424-8567 or go to www.loc.gov/nls/.

Indexed by Applied Science and Technology Index, Library of Congress Catalog Card No. 21-9421.

*Payment arrangements available. Please write for details.

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 at circulation@arrrl.org or 860-594-0200 immediately. Thank you for your assistance.

Reprints and permissions: permission@arrrl.org

Details of our Online Privacy Policy can be found at www.arrrl.org/online-privacy-policy.

Telephone: 860-594-0200
Fax: 860-594-0259