



ARRL Periodicals Archive – Search Results

A membership benefit of ARRL and the ARRL Technical Information Service

ARRL Members: You may print a copy for personal use. Any other use of the information requires permission (see Copyright/Reprint Notice below).

Need a higher quality reprint or scan? Some of the scans contained within the periodical archive were produced with older imaging technology. If you require a higher quality reprint or scan, please contact the ARRL Technical Information Service for assistance. Photocopies are \$3 for ARRL members, \$5 for nonmembers. For members, TIS can send the photocopies immediately and include an invoice. Nonmembers must prepay. Details are available at www.arrl.org/tis or email photocopy@arrl.org.

QST on CD-ROM: Annual CD-ROMs are available for recent publication years. For details and ordering information, visit www.arrl.org/qst.

Non-Members: Get access to the ARRL Periodicals Archive when you join ARRL today at www.arrl.org/join. For a complete list of membership benefits, visit www.arrl.org/benefits.

Copyright/Reprint Notice

In general, all ARRL content is copyrighted. ARRL articles, pages, or documents--printed and online--are not in the public domain. Therefore, they may not be freely distributed or copied. Additionally, no part of this document may be copied, sold to third parties, or otherwise commercially exploited without the explicit prior written consent of ARRL. You cannot post this document to a Web site or otherwise distribute it to others through any electronic medium.

For permission to quote or reprint material from ARRL, send a request including the issue date, a description of the material requested, and a description of where you intend to use the reprinted material to the ARRL Editorial & Production Department: permission@arrl.org.

QST Issue: Jul 1997

Title: The SWR Analyzer and Transmission Lines

Author: Peter J. Schuch, WB2UAQ

[Click Here to Report a Problem with this File](#)



2010 ARRL Periodicals on CD-ROM

ARRL's popular journals are available on a compact, fully-searchable CD-ROM. Every word and photo published throughout 2010 is included!

- **QST** The official membership journal of ARRL
- **NCJ** National Contest Journal
- **QEX** Forum for Communications Experimenters

SEARCH the full text of every article by entering titles, call signs, names—almost any word. **SEE** every word, photo (including color images), drawing and table in technical and general-interest features, columns and product reviews, plus all advertisements. **PRINT** what you see, or copy it into other applications.

System Requirements: Microsoft Windows™ and Macintosh systems, using the industry standard Adobe® Acrobat® Reader® software. The Acrobat Reader is a free download at www.adobe.com.

2010 ARRL Periodicals on CD-ROM

ARRL Order No. 2001

Only \$24.95*

*plus shipping and handling

Additional sets available:

2009 Ed., ARRL Order No. 1486, \$24.95
 2008 Ed., ARRL Order No. 9406, \$24.95
 2007 Ed., ARRL Order No. 1204, \$19.95
 2006 Ed., ARRL Order No. 9841, \$19.95
 2005 Ed., ARRL Order No. 9574, \$19.95
 2004 Ed., ARRL Order No. 9396, \$19.95
 2003 Ed., ARRL Order No. 9124, \$19.95
 2002 Ed., ARRL Order No. 8802, \$19.95
 2001 Ed., ARRL Order No. 8632, \$19.95



ARRL The national association for AMATEUR RADIO™

SHOP DIRECT or call for a dealer near you.
 ONLINE WWW.ARRL.ORG/SHOP
 ORDER TOLL-FREE 888/277-5289 (US)

Technical Correspondence

Edited by **Paul Pagel, N1FB** • Associate Technical Editor

DIODE "PROTECTION"

By Ken Stuart, W3VUN, ARRL Technical Advisor, 1235 Hillcreek Rd, Pasadena, MD 21122-2460, e-mail stuartkl@erols.com

◊ In the early days of diode manufacturing, a high reverse voltage across a diode junction could result in arcing, either internal to the junction, or across the surface of the junction. This arc caused a high-current leakage path, destroying the diode.

To protect diodes in series-connected strings (where unequal leakage resistances between diodes can exist) it was common practice to force equal voltage sharing by swamping these internal leakages with lower-value external-resistor strings. By so doing, each diode sees only its share of the total voltage across the string.¹

For the last couple of decades, however, diode manufacturers commonly add protection against arcing by creating an avalanche reverse mode—similar to that seen in a Zener diode. With this characteristic, the diode conducts with a reverse voltage at a potential that is lower than the arc voltage. Unlike an arc, which, once established, exhibits a high current and low voltage, the avalanche does *not* produce a low-voltage condition. Therefore, avalanche diodes connected in a series string will *not* allow a dangerous internal junction arc to occur. Also, it is common practice for rectifier manufacturers to produce high-voltage rectifiers by combining a number of individual diodes in the rectifier package, and internal shunting resistances are *not* used. With this reverse-avalanche mode, resistors are not needed because each diode self-protects against excessive voltage.

Equipment builders who want to shunt diodes with resistors should be aware that most resistors have only a 300-V maximum rating. If the reverse voltage across each of the "protected" diodes exceeds this level, the resistors can fail and destroy the rectifier string!

Shunting capacitors across diodes is *not* recommended. Momentary dielectric breakdown in capacitors is not uncommon, and this can overstress the other diode/capacitor pairs in the string causing catastrophic failure.

THE SWR ANALYZER AND TRANSMISSION LINES

By Peter J. Schuch, WB2UAQ, 9 Sturr Ln, Florida, NY 10921

◊ The September and October 1996 is-

¹For other comments on this subject, see Steven D. Katz, WB2WIK, "Diode Failure," Technical Correspondence, QST, Apr 1988, pp 46-47.—Ed.

sues of QST contain articles on the application of hand-held SWR and impedance analyzers.^{2,3} I'd like to add to the collection of ideas for use of these handy instruments.

I needed to determine when a given length of transmission line (in this case, coaxial cable) is an electrical $1/4$ or $1/2 \lambda$ long at a given frequency. Using the analyzer, making this determination is easy because it isn't necessary to be concerned with the velocity factor or characteristic impedance (Z_0) of the cable.

You'll need your SWR analyzer, a T adapter and a low-SWR 50 Ω load. Connect the T adapter to the analyzer. To one arm of the T, connect the 50 Ω load; connect the cable under test (CUT) to the other arm. If you are checking for a $1/4 \lambda$ line, short the far end of the line. If you're checking for a $1/2 \lambda$ line, leave the far end *open*. Starting at a low frequency—a frequency too low to create a $1/4 \lambda$ or $1/2 \lambda$ response—slowly tune the analyzer frequency upward until the SWR decreases to a *minimum*, or equals 1:1. (Low-loss cable will show a lower SWR than lossy cable.) At the frequency of minimum SWR, the CUT is an electrical $1/4 \lambda$ or $1/2 \lambda$, depending on whether the far end of the CUT was shorted or open, respectively.

This occurs because a *shorted* $1/4 \lambda$ line—or *open* (unshorted) $1/2 \lambda$ line—presents a very high impedance circuit to the analyzer. This high impedance effectively removes the CUT from the T, allowing the SWR analyzer to see only the 50 Ω dummy load. This occurs regardless of the cable's characteristic impedance (Z_0), even though the reference impedance of your analyzer is 50 Ω . If you are stacking antennas and make a cable harness from lines that are odd multiples of a $1/4 \lambda$ at the frequency of operation, you can use 70 Ω transmission line even in a 50 Ω system.

To determine the velocity factor of a transmission line, find the frequency at which a sample of the line is electrically $1/4 \lambda$ long, then measure the line's physical length. Divide the line's physical length by the line's free-space quarter wavelength. The result is the line's velocity factor.

If your analyzer can measure the magnitude of impedance, the line's Z_0 can be determined by taking advantage of a simple formula: $Z_0 = \sqrt{Z_i + Z_1}$, where Z_i is the input impedance of the line and Z_1 is the

load impedance. Here's how to use this procedure to find the Z_0 of a $1/4 \lambda$ transmission line. After finding the $1/4 \lambda$ line frequency, remove the 50 Ω load from the T. Remove the short at the far end of the CUT and replace it with the 50 Ω load. Without changing the SWR analyzer's frequency, measure the magnitude of the impedance. If the impedance measured is 50 Ω , the cable's Z_0 is 50 Ω . If the magnitude of the impedance is other than 50 Ω , use Equation 1, substituting the impedance just measured for Z_i ; Z_1 is 50 Ω . As an example, if Z_i is 100 Ω , $Z_0 = \sqrt{100 + 50} = 70.7 \Omega$.

The foregoing relationships hold up fairly well at low frequencies where the connectors and T are of negligible length. At VHF and above, the lengths and velocity factors of connectors and adapters become significant and must be considered.

It is also possible to determine the Z_0 of a line if your analyzer can only measure SWR; it just takes a bit of reasoning, as the following example illustrates. When the measured SWR of the line is 2:1, Z_i can be 100 Ω or 25 Ω as both values result in a 2:1 SWR (ie, $100 \div 50 = 2$ and $25 \div 25 = 2$). With Z_1 equal to 50 Ω (the dummy load constant), substituting a value of 100 Ω for Z_i in the formula yields a Z_0 of 70.7 Ω (a likely characteristic impedance), but using 25 Ω for Z_i yields a Z_0 of 35.4 Ω , an unlikely value.

Letters for this column may be sent to Technical Correspondence, ARRL, 225 Main St, Newington, CT 06111, or via e-mail to ppagel@arrl.org. Please include your name, call sign, complete mailing address, daytime telephone number and e-mail address on all correspondence. Whether praising or criticizing a work, please send the author(s) a copy of your comments. The publishers of QST assume no responsibility for statements made herein by correspondents. **QST**

Feedback

◊ Please see "A New(?) Serial Communication Protocol Discovered . . .", Technical Correspondence, QST, Apr 1997, p 70. Although Sam (N4UAU) Ulbing's signature spells 73 in binary, to agree with the protocol mentioned in the item, the correct representation is 1100000011DEN4UAU.

QST