FARS

K6YA FOOTHILLS AMATEUR RADIO SOCIETY

August 2010 Volume 40, Number 8

August Club Meeting

Date: Friday, August 27, 2010
Time: Socializing at 7 pm, Meeting at 7:30
Place: Covington School, 205 Covington Road, Los Altos
Speaker: To Be Announced
Topic: To Be Announced, see the FARS website at http://www.fars.k6ya.org/meeting for more information.

The club offers refreshments (great coffee, great cookies). Bring your questions for Dr. Know-It-All and get great answers.

Pre-Meeting Dinner, 6pm at the Beausejour Restaurant, 170 State St., Los Altos. There are Great Early Bird specials.

July Meeting Report

Mark Byington, President and Founder of Cobalt Power Systems in Mountain View, http://www.cobaltpower.com, spoke about designing and installing photovoltaic (solar electric or PV) systems for homeowners and businesses. Mark showed several installations and talked about the advantages of installing a solar system, including the ability to sell power during the day when rates are highest. Mark is an EE and former Amateur Radio Operator.

Mark Byington, Cobalt Power Systems, July Meeting Speaker

Scott, Rob, Lloyd, Tony July WYWH & Raffle Winners

The first prize, a Diamond SX200 1.8 to 200 MHz SWR and Powermeter, was taken home by Rob Riley, KI6INR. Lloyd De Vaughns, KD6FJI, won the 2nd prize, a Maha MH-C9000 Wizard One Charger Analyzer including four 2700 NiMH Powerex batteries. 3rd prize, a Kill A Watt Electricity Usage Monitor, was won by Tony Kooij, W6AWK. Tony also won an ARRL Repeater Directory. Llloyd also took home two Icom Mugs. The Wish You Were Here (WYWH) number for Scott Overstreet, N6NXI, was chosen. Scott was present to claim the prize of $5.

President's Corner

Membership Meeting. The next regular membership meeting is Friday, August 27th at 7pm).

Am-Tech Day. The next Am-Tech Day is scheduled for August 28th. Don't miss out! There will be food, radios, and hams. Check the web site (k6ya.org/amtechday/) or the email list (k6ya.org/mail/) for the date and program information.

Electronics Flea Market. The next electronics flea market is September 11th. The host and beneficiary of this flea market is Silicon Valley Chapter, American Red Cross. Check out www.electronicsfleamarket.com for all the details.

Homebrew contest, September 24th. It's time to think about an amateur radio project for the Homebrew contest on September 24th. This is your chance to share your experience with the audience. Prizes will be awarded to the best entries.

ARRL VHF QSO Party, September 11-13. We would like to get a group together to work this contest as a FARS activity. Please come to the August meeting to volunteer and help organize this activity.

Email Notices. Subscribe to the FARS Announcement list (k6ya.org/mail/) to receive reminders of FARS activities and other news.

de Mikel, KN6QI

August Raffle Prizes

The prizes for the raffle at the August meeting are: First prize Yaesu FT-1900R 2 meter 55 watt Mobile transceiver with MH48A6J; Second Prize MFJ Cleartone speaker; Third Prize NAARCC 2010 Northern California Repeater Directory. An ARRL repeater directory is the final prize. See later in this newsletter for more information.

Upcoming Events

Aug 27	7:00 pm, Club meeting, Covington School
Aug 28	8 am to 9 pm, Am-Tech Day, SLAC NAL
Sep 2	7:30 PM, Board Mtg at the Los Altos Town Crier
Sep 11	Electronics Flea Market, hosted by Silicon Valley Chapter, American Red Cross
Sep 18	8 am to 9 pm, Am-Tech Day, SLAC NAL
Sep 24	7:00 pm, Club meeting, Covington School
Thursdays	8:00 pm, FARS net, 145.230(-), 100 Hz PL

See more events, FARS Calendar <http://www.fars.k6ya.org/events/calendar>

CLUB INFORMATION

President:	Mikel Lechner, KN6QI
Vice President:	Steve Stearns, K6OIK
Treasurer:	David Cooper K6WA
Secretary:	
Radio Officer:	Phil Hawkins, KA6MZE
Training Officer:	Kevin Weiler, K6XXX
Relay Editor:	Mark Hardy, K6MDH

FARS Board: Dick Baldwinson N6ATD, Peter Chow AF6DS, Robert Flemate KE6TFU, Charlie Morrin KI6FXY, Barbara Neuhauser AE6RM.

K6YA Trustee:	Phil Hawkins, KA6MZE
FARS Web Page:	http://www.fars.k6ya.org
Download Relay:	http://www.fars.k6ya.org/relay

Club members and non-members are encouraged to subscribe to the FARS Announcement list by browsing www.fars.k6ya.org/mail, clicking on Subscribe/Unsubscribe and following the instructions under "Subscribing to fars-announce.

You may submit announcements to the FARS Announcement at fars-announce@svpal.org. The list is moderated and messages will be posted as approved by the list moderator.

Contact the FARS board of directors at fars-board@svpal.org

Club meetings are held at 7 PM on the fourth Friday of each month except January (Winter Banquet); and sometimes there are changes for June (for field day) and Nov. & Dec (for holidays).

Annual club membership is $20. Club badges are $9. Visitors are always welcome! Directions in this newsletter. Talk-in: N6NFI (145.23-, 100 Hz) or W6ASH repeater (145.27-, 100 Hz).

FARS *Relay* is the official monthly newsletter of the Foothills Amateur Radio Society. Contributions to the newsletter from members, family, and guests are earnestly solicited! Contributions are subject to editing and/or compression. All readable forms welcome.

Here is how to reach the editor:
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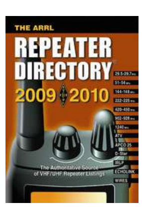
Santa Clara, CA 95055
Voice: 408-243-0701 (Before 9 PM, preferred)
Email: mark.k6mdh@gmail.com, At FARS meetings.

August Raffle Prizes

First prize for the August 27th meeting is a Yaesu FT-1900R 2 meter 55 watt Mobile transceiver with an MH-48A6J, illuminated DTMF microphone. The FT-1900R has a large LCD display with excellent visibility, an internal speaker with superior sound, extended receive range, 200 memory channels alphanumeric labeling and a dedicated, 10-channel wether broadcast channel bank. It also has a security password to prevent unauthorized use. See www.yausu.com for more information. Second Prize is an MFJ Cleartone speaker. See http://www.mfjenterprises.com for more information about the MFJ speaker. Third Prize is a NAARCC 2010 Northern California Repeater Directory. An ARRL repeater directory is also being offered.



FARS in the News

The Los Altos Town Crier, www.lostaltosonline.com, has presented articles about FARS and its recent participation in Field Day. An article telling of the plans for FARS field day can be viewed at the following site:

http://www.losaltosonline.com/index.php?option=com_content&task=view&id=17988&Itemid=47

A report on the FARS field day is also in the Crier. It shows Phil Hawkins, KA6MZE, at the FARS field day site and has quotes from Phil and Paul Zander, AA6PZ. Also mentioned are Peter Chow, AF6DS, and Jeff Shimbo (name misspelled in article), AK6TG. The article is given at the following link:

http://www.losaltosonline.com/index.php?option=com_content&task=view&id=21664&Itemid=109

Pictures from FARS field day may be seen at the following:

http://towncrier.photoshelter.com/gallery/Foothill-Amateur-Radio-Society-Field-Day/G0000KaKjCdfoRsI/

FARS thanks the Los Altos Town Crier for the coverage of the field day events and HAM radio in general. FARS also appreciates the use of the Los Altos Town Crier office meeting space for the monthly board meetings.

September Home Brew Contest

September 2010 will be the annual FARS home brew contest. The home brew contest has been a lot of fun and a real highlight in years past. Last year, Peter Chow, AF6DS, won first prize in the contest with a HF Go-Kit with antenna. It has a HF radio mounted in the case and a quick set-up 20-meter antenna made of two hamsticks.

First Place Winner of the FARS Home Brew 2009

If you have not already begun your home brew, you still have time to prepare for the September meeting on Friday the 24th. Bring your project and present it for an opportunity to win one of the prizes. Even if you do not have a project, come and enjoy seeing the presentations of these resourceful and inventive HAMs.

Dr. Know-It-All

Dear Doctor,

We are all aware that a coaxial cable of a given size has a published loss in dB per hundred feet. We are also aware that the *ARRL Handbook* and similar publications have charts showing the "additional loss" in a coaxial cable due to a SWR other than 1:1. From this information, one can look up the basic cable loss for the band of operation, add the additional cable loss due to SWR and expect that the power level that will be fed into the antenna will be reduced by that many dB.

We also understand that looking into the transmitter end of the coaxial cable with a mismatched antenna one would see a complex impedance, i.e. something other than just 50 ohms resistive. We can match the transmitter to the coax using an antenna tuner to enable maximum power transfer, though the tuner will also introduce some loss.

But none of the above seems to address the mismatch that exists between the coaxial cable and the antenna. What we do at the transmitter end does not change the mismatch between the 50-ohm coax and the antenna, especially as we change the transmitter frequency away from the minimum SWR frequency. The maximum power transfer theorem tells us that for maximum power transfer the antenna should present a conjugate match to the coax. How does one account for this additional power loss?

Rich Stiebel, W6APZ

Answer: The short answer is that the "additional loss due to SWR" accounts for both increased dissipation loss in the cable and mismatch loss at the load. To see why, consider a transmitter, a lossy feedline, and a mismatched load. The SWR on the feedline is greater than unity. Two loss mechanisms are at work, mismatch loss and dissipation loss. These loss mechanisms are not independent. The presence of mismatch loss at the load increases the dissipation loss in the transmission line.

You may have seen Figure 1 in an ARRL publication. It appears in both the *ARRL Handbook* [1] and the *ARRL Antenna Book* [2] and is a graph of the additional loss in a lossy transmission line due to a mismatched load. We will examine the basis of this graph and clarify power transfer from a source to a load through a transmission line. We will keep the discussion simple. By focusing on power and avoiding voltage and current, it is possible to illustrate several key transmission line concepts using only basic algebra, without introducing complications such as complex numbers, trigonometric and hyperbolic functions, or scattering parameters. All mathematical steps will be shown so that the reader who knows algebra can follow easily.

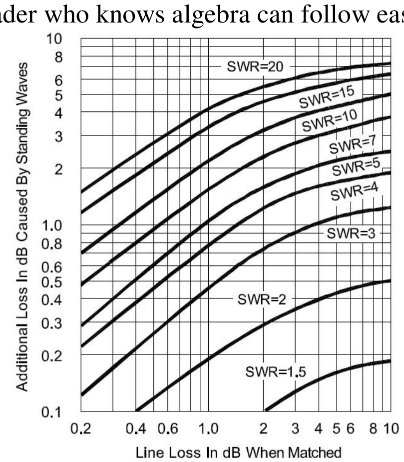


Figure 1. Additional loss in a lossy transmission line due to SWR [ARRL].

Every physical transmission line has loss that is can be described as an attenuation constant α [Greek alpha]. The attenuation constant α depends on frequency and has units of nepers per meter (Np/m) or decibels per 100 feet (dB/100-ft). Since 1 neper is 8.686 dB, and 100 feet is 30.48 meters, it follows that 1 Np/m is 265 dB/100-ft, and conversely 1 dB/100-ft is 0.00378 Np/m. The product αl of a line's attenuation constant times its length is the line's loss assuming only a single wave, either forward or reverse, exists on the line. Because this condition occurs with a matched load, αl is called the "matched" loss of the line and is commonly expressed in dB.

If the load is not matched, then forward waves incident on the load are reflected, giving both forward and reflected waves on the line. The waves carry power in opposite directions. The net power (forward minus reflected) at the transmitter end of the line is the power that the transmitter delivers to the line. Similarly, the net power (forward minus reflected) at the load end of the line is what the line delivers to the load. The difference between the input power to the line and the output power from the line is power lost to the line and is dissipated as heat or radiated.

For a theoretical lossless line, the forward power on the line is the same at both ends. The same is true for reflected power. Hence, the net (forward minus reflected) power is the same at both ends of the line. The power that the transmitter delivers to the line equals the power that the line delivers to the load. No power is lost to heating or radiation.

In the case of a physical line with losses, the forward power varies along the length of the line, being greatest at the transmitter and decreasing as one moves toward the load. If the load is unmatched, a reflected wave exists and the reflected power is greatest at the load and decreases as one moves toward the transmitter. Because the attenuation is the same in both directions, the forward and reflected powers at the transmitter and load ends of the transmission line are related according to

$$P_{F,Load} = \frac{1}{a} \cdot P_{F,Tx}$$

$$P_{R,Load} = a \cdot P_{R,Tx}$$

where $a > 1$ [Latin a distinct from Greek α] is the attenuation, i.e. power ratio, between the line's input and output ends. Clearly a is dimensionless and has no units. It is related to the attenuation constant α according as

$$a = \begin{cases} \exp(2\alpha l) & \alpha \text{ in nepers/meter and } l \text{ in meters} \\ \text{or} & \\ 10^{\alpha l/1000} & \alpha \text{ in dB/100 feet and } l \text{ in feet} \end{cases}$$

where the choice of expression depends on the units used. The first expression is for α in nepers per meter and line length l in meters, while the second expression is for α in dB per 100 feet and l in feet.

The ratio of the reflected power to forward power equals the squared magnitude of the complex reflection coefficient (facing toward the load). Thus, from the equations above, we obtain the magnitude of the reflection coefficient at the line's load end in terms of that at its transmitter end.

$$|\Gamma_{Load}|^2 = \frac{P_{R,Load}}{P_{F,Load}} = a^2 \frac{P_{R,Tx}}{P_{F,Tx}} = a^2 |\Gamma_{in}|^2$$

$|\Gamma_{in}|$ and $|\Gamma_{Load}|$ determine the SWRs at the transmitter and load ends of the line respectively.

$$|\Gamma_{in}|^2 = \left[\frac{SWR_{Tx} - 1}{SWR_{Tx} + 1}\right]^2 \quad \text{and} \quad |\Gamma_{Load}|^2 = \left[\frac{SWR_{Load} - 1}{SWR_{Load} + 1}\right]^2$$

Useful Formulas Involving SWR:

From the above relations and some algebra, the reader can verify that the SWRs at the transmitter and load ends of a transmission line are related as follows.

$$SWR_{Tx} = \frac{(a+1)\,SWR_{Load} + (a-1)}{(a-1)\,SWR_{Load} + (a+1)} = \frac{SWR_{Load} + \left(\frac{a-1}{a+1}\right)}{1 + SWR_{Load}\left(\frac{a-1}{a+1}\right)} \quad \text{for} \quad 1 \le SWR_{Load} < \infty$$

It is easily seen that when the line is lossless, α = 0, $a = 1$, and it follows that $SWR_{Tx} = SWR_{Load}$ for any length l. In fact, the SWR is constant and does not vary along the length of a theoretically lossless line. In other words, if the line is lossless, the SWR equals SWR_{Load} everywhere along the line.

For lossy lines, α > 0 and $a > 1$, the formulas reveal that the SWR at the transmitter has a finite maximum possible value. As SWR_{Load} varies from 1 to ∞, SWR_{Tx} varies from 1 to $(a + 1)/(a - 1)$, which is its maximum possible value. The formula can be reversed to determine the SWR at the antenna from the SWR measured at the transmitter.

$$SWR_{Load} = \frac{(a+1)\,SWR_{Tx} - (a-1)}{-(a-1)\,SWR_{Tx} + (a+1)} = \frac{SWR_{Tx} - \left(\frac{a-1}{a+1}\right)}{1 - SWR_{Tx}\left(\frac{a-1}{a+1}\right)} \quad \text{for} \quad 1 \le SWR_{Tx} \le \frac{a+1}{a-1}$$

We can express the "additional SWR" at the load as either a difference or a ratio relative to the SWR at the transmitter. A little algebra reveals

$$\text{Additional SWR at load} = SWR_{Load} - SWR_{Tx} = \frac{(SWR_{Tx})^2 - 1}{\left(\frac{a+1}{a-1}\right) - SWR_{Tx}} \quad \text{for} \quad 1 \le SWR_{Tx} \le \frac{a+1}{a-1}$$

$$\text{SWR Ratio} = \frac{SWR_{Load}}{SWR_{Tx}} = \frac{1 - \left(\frac{1}{SWR_{Tx}}\right)\left(\frac{a-1}{a+1}\right)}{1 - SWR_{Tx}\left(\frac{a-1}{a+1}\right)} \quad \text{for} \quad 1 \le SWR_{Tx} \le \frac{a+1}{a-1}$$

Figure 2 illustrates these SWR relations.

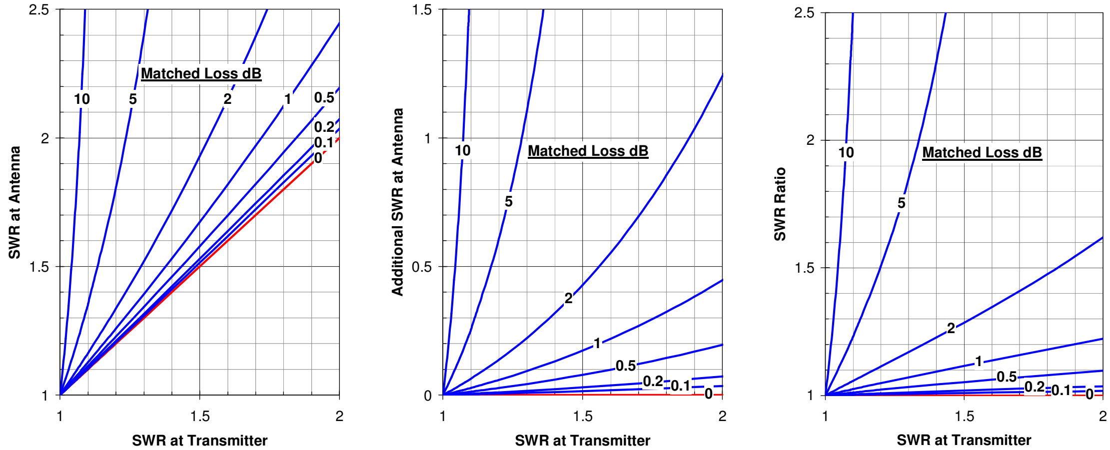


Figure 2. SWR at the antenna in terms of the SWR measured at the transmitter.

The SWR at the load is greater than or equal to the SWR at the transmitter. SWR is always worse at the antenna than what your meter at the transmitter says. These formulas and graphs tell you how much worse.

Line Loss and Power Transmission Efficiency:

The line's total loss can be expressed as the reciprocal of its efficiency, or in dB as

$$\begin{aligned}
\text{Total Loss (dB)} &= 10\log_{10}\frac{P_{in}}{P_{out}} \\
&= 10\log_{10}\frac{P_{F,Tx}-P_{R,Tx}}{P_{F,Load}-P_{R,Load}} \\
&= 10\log_{10}\left(\frac{P_{F,Tx}}{P_{F,Load}}\right)\left(\frac{1-\dfrac{P_{R,Tx}}{P_{F,Tx}}}{1-\dfrac{P_{R,Load}}{P_{F,Load}}}\right) \\
&= 10\log_{10} a\,\frac{1-|\Gamma_{in}|^2}{1-|\Gamma_{Load}|^2} \\
&= 10\log_{10} a \quad + \quad 10\log_{10}\left(\frac{1-|\Gamma_{in}|^2}{1-|\Gamma_{Load}|^2}\right) \\
&= \alpha l\ \text{(dB)} \quad + \quad 10\log_{10}\left(\frac{1-|\Gamma_{in}|^2}{1-|\Gamma_{Load}|^2}\right)
\end{aligned}$$

We see that the total loss in dB can be expressed as the sum of two terms. The first term is the matched loss, i.e. the αl product in dB. The second term is the additional loss due to the mismatched load impedance. The loss can be expressed in terms of the reflection coefficient at the line's input or output ends. We will obtain the result for both ends. Using the equation $|\Gamma_{Load}|^2 = a^2 |\Gamma_{in}|^2$ to eliminate $|\Gamma_{in}|^2$ from the numerator, we express the loss in terms of the reflection coefficient at the load.

$$\begin{aligned}
\text{Total Loss (dB)} &= 10\log_{10} a\,\frac{1-\dfrac{1}{a^2}|\Gamma_{Load}|^2}{1-|\Gamma_{Load}|^2} \\
&= 10\log_{10} a \quad + \quad 10\log_{10}\frac{1-\dfrac{1}{a^2}|\Gamma_{Load}|^2}{1-|\Gamma_{Load}|^2} \\
&= 10\log_{10}\frac{a^2-|\Gamma_{Load}|^2}{a\left(1-|\Gamma_{Load}|^2\right)}
\end{aligned}$$

This last equation is published by ARRL as Equation 11 on page 20.5 of the *ARRL Handbook* [1] and Equation 16 on page 24-10 of the *ARRL Antenna Book* [2]. Subtracting the matched loss term gives the additional loss due to mismatch, shown graphed in Figure 3, which duplicates the ARRL graph in Figure 1.

$$\text{Additional Loss (dB)} = 10\log_{10}\frac{1-\frac{1}{a^2}|\Gamma_{Load}|^2}{1-|\Gamma_{Load}|^2}$$

Figure 3. Additional loss in a lossy transmission line due to SWR.

Alternatively, we can eliminate $|\Gamma_{Load}|^2$ to express the loss in terms of the reflection coefficient at the line's input end.

$$\text{Total Loss (dB)} = 10\log_{10} a\,\frac{1-|\Gamma_{in}|^2}{1-a^2|\Gamma_{in}|^2}$$

$$= 10\log_{10} a \quad + \quad 10\log_{10}\frac{1-|\Gamma_{in}|^2}{1-a^2|\Gamma_{in}|^2} \quad \text{if} \quad 0<|\Gamma_{in}|<\frac{1}{a}$$

$$\text{Additional Loss (dB)} = 10\log_{10}\frac{1-|\Gamma_{in}|^2}{1-a^2|\Gamma_{in}|^2} \quad \text{if} \quad 0<|\Gamma_{in}|<\frac{1}{a}$$

These expressions for the loss are more useful than the ARRL equation because amateurs generally have SWR meters at their transmitters and not at their antennas.

What is the nature of the loss? It is clear from the analysis above that the loss represents the deficit between power that enters the transmission line and power that exits. This "disappearing" power is lost to ohmic and dielectric heating. We refer to it simply as dissipation loss without distinction.

The dissipation loss depends on two variables – the "matched loss" given by the αl product, and the SWR at a specified point along the line. The total loss increases with both variables. The ARRL formula gives the loss in terms of SWR at the load end of the line. However, it is more convenient to express the loss in terms of the SWR at the transmitter, where SWR is likely to be measured. The additional loss due to mismatch (or SWR) is shown graphed in Figure 3, where SWR is taken as SWR_{Tx} at the transmitter.

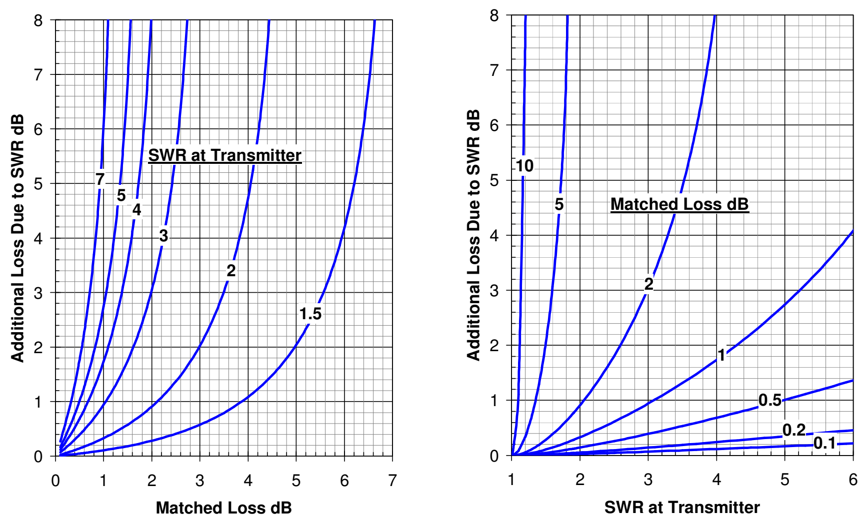


Figure 3. Additional loss versus matched loss and SWR at the transmitter.

The additional loss due to SWR is the penalty for putting a tuner at the transmitter instead of the antenna end of the transmission line. This penalty can be substantial. For example, if a 50-ohm line's matched loss is 1.5 dB and the antenna is 1,000 ohms (SWR = 20), then the total loss is 6.5 dB, so the additional loss is 5 dB. Putting the tuner at the transmitter allows only 22% of the transmitter's power to be radiated. The remaining 78% is wasted as heat in the transmission line. With the tuner at the antenna, however, 71% of the power is radiated, and only 29% is lost as heat. In other words, more than three times as much power is radiated instead of wasted as heat in the transmission line.

Maximum Power Transfer:

Finally, I will comment on the statement "the maximum power transfer theorem tells us that for maximum power transfer the antenna should present a conjugate match to the coax." This statement must be qualified to state that a conjugate match between the line and load gives only maximum power transfer from the line to the load. It does not result in maximum power transfer from the transmitter to the load. It's true that for a theoretically lossless line, if a conjugate match exists anywhere along the line, then a conjugate match exists everywhere along the line. Yet, the fact remains that for a general lossy line, a conjugate match at one end does not imply a conjugate match at the other end. Conjugate matching a transmitter to a line does not imply that maximum available power is delivered from the line to the load. Likewise, conjugate matching a load to a line does not imply that maximum available power is delivered from the transmitter to the line. Moreover, conjugate matching at the load generally permits a reflected wave; so additional loss due to SWR occurs. The idea of conjugate matching for maximum power transfer as presented in amateur publications [3] is naive in the case of physical transmission lines such as coax that have significant matched loss.

The formulas derived here apply to more than just transmission lines. They apply to any 2-port network whose scattering parameters satisfy $s_{11} = s_{22} = 0$ and $s_{12} = s_{21}$. We have quantified the power transfer efficiency of such 2-port networks. In a future installment, I will show how to get maximum power transfer from a source through a general lossy transmission line to a load. The solution to this general problem is more involved than conjugate matching and is a story for another day.

That's it for this month. You can send your comments or questions about any aspect of Amateur Radio to Dr. Know-It-All. Written comments and questions are accepted at the monthly meetings of the Foothills Amateur Radio Society, by email to FARS officers and board members, or through the FARS web site at http://www.fars.k6ya.org.

References

1. *ARRL 2010 Handbook for Radio Communications*, 87th ed., pp. 20.1 to 20.5, American Radio Relay League, 2009, ISBN 0872591409.
2. *ARRL Antenna Book*, 21st ed., pp. 24-7 to 24-11 and 24-15, American Radio Relay League, 2007, ISBN 0872599876.
3. W. Maxwell, W2DU, *Reflections III*, 3rd ed., CQ Communications, 2010, ISBN 0943016436. First edition American Radio Relay League, 1990, ISBN 0872592995; 2nd edition WorldRadio Books, 2001, ISBN 0970520603.

Amateur Radio Technology Day Teams

Morning Set-up Team Members,
Amateur Radio - Technology Day # 67, 24 July 2010

Back Row: Dave Cooper, K6WA; Christopher Poda, AF6KI; Jacob Whiting, N6EWS; Robert Flemate, KE6TFU

Front Row: Rich Stiebel, W6APZ; Arv Hamer, WA6UUT; Phil Hawkins, KA6MZE; Joanna Dilley, K6YRU; Rik Kasuga, KF6COZ

Photos thanks to Dave Cooper, K6WA.

Evening Recovery Team Members,
Amateur Radio - Technology Day # 67, 24 July 2010

Back Row: Dave Cooper, K6WA; Robert Johnson, KG6UWZ; Christopher Poda, AF6KI; Name and Call Unknown; Doug Teter, KG6LWE; Robert Flemate, KE6TFU

Front Row: Phil Hawkins, KA6MZE; Robert "Texx" Woodworth, KG6ATH; Barbara Neuhauser, AE6RM; Joanna Dilley, K6YRU; Michael Taber, KJ6CHX

FARS 2010 MEMBERSHIP RENEWAL FORM Date: ______________________________

PLEASE fill out the form for all new/renewal memberships.

Name(s) & Callsign(s) & Class (E-A-G-T-N-None): ______________________________

____

Mailing Address: ____

____

Home phone: _________________________ Work phone: _______________________________

Fax (H or W?) ______________________ Packet BBS Address: _________________________

E-mail: ______________________________ ARRL Exp Date(s): ________________________

Preferred modes: (e.g. HF-SSB/VHF/QRP/Other): _________________________________

I'm willing to Elmer new hams with: ____

____

Special topics of interest / suggestions for club meeting speakers:

____

Dues: $20 per year, new members add $9 for badge fee. **Please note:** Membership runs from January 1 to December 31.

Send your check payable to FARS, to:

David A. Cooper
PMB 41
270 Redwood Shores Parkway
Redwood City, CA 94065-1173

How to get to FARS Club meetings (Visitors always welcome)

Meetings are held at the Covington Elementary School (directions below) on the fourth Friday. Socializing at 7 PM with the regular meeting at 7:30 PM. There may be changes in the meeting dates for January, June, November, and December.

DIRECTIONS:

From Interstate 280. take the El Monte exit Northeast. Cross Foothill Expressway. (A) At the first traffic light turn right on Covington. (B) Immediately at the fork take the left street (Covington). Go about 1/10th of a mile. Turn left into the parking lot. The gym is the tall building to your right with red and white stripes.

From Foothill Expwy., take the El Monte exit and go Northeast; then follow directions as above at point (A).

From US101 or El Camino: take San Antonio Road west (to Foothill Expressway). Then follow directions above at point (A).

TALK-IN via the N6NFI (145.230-; 100Hz PL) repeater or the W6ASH 145.27- (100Hz PL) repeater.