WATTS NEWS

The Best of Amateur Radio

OARC e-Magazine

www.OgdenArc.org

NOVEMBER 2021

Next Club Meeting/Activity/Events

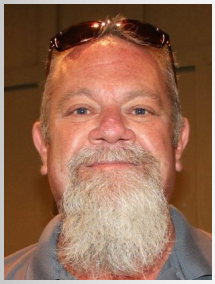
In Person—Club Meeting

Dave Mamanakis KD7GR
President

Justin Hall KB7LAK
Vice President

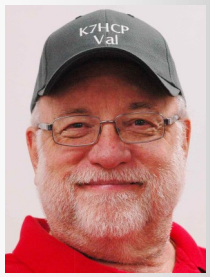
Colleen Pike KJ7EAY
Secretary

J. Siddle KG7CJN
Treasurer



Mike Wilde KJ7HEX
Program Director

Cody Hearell KJ7OHU
Activity Director



Val Campbell K7HCP
Webmaster/NL Editor

OARC Watts News Masthead

www.OgdenArc.org

OARC OFFICERS

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"WATTS NEWS" e-Magazine

NL Editor: Val Campbell K7HCP

"OARC" web site

Webmaster: Val Campbell K7HCP
Postmaster: Val Campbell K7HCP
Membership Clerk: Val Campbell K7HCP

OTHER CLUB APPOINTMENTS

VE Liaisons: Richard Morrison W7RIK
Gil Leonard NG7IL
Jason Miles KE7IET (IT)

Repeater Engineers: Mike Fullmer KZ7O
Scott Willis KD7EKO

Photographer: Kathryn Sutton K8RYN

Asst Photographer: Rick Hansen N7EGA

QSL Manager: Pete Heisig AI7GV

Historian: Kent Gardner WA7AHY

Antenna Manager: Gene Morgan WB7RLX

Club Call Sign Trustee: Larry Griffin AD7GL

Club Elmer: Stan Sjol W0KP

Social Media Manager: Wanted

Equipment Manager: Wanted

Centennial Committee Chair: Gil Leonard NG7IL

Advisors: Mike Fullmer KZ7O
Kent Gardner WA7AHY
Kim Owen KO7U
Larry Griffin AD7GL
Gil Leonard NG7IL
Jason Miles K7IET

PREVIOUS CLUB MEETING/ACTIVITY

OARC

October Activity/Event

In person - Club Meeting

OARC Donation Auction

NEXT CLUB MEETING/ACTIVITY

OARC

November Activity/Event

In person - Club Meeting

Keep clicking...

OARC COMING EVENTS

ARRL Field Day - June
OARC "T"-Hunt - July
OARC Steak Fry - August

Joint (tri-county) Swap Meet - September

Christmas Family Dinner Party - December

Next VE Test Session

1st Wednesday 02 February 2022 @ 6:00 PM

A MESSAGE FROM OUR PRESIDENT

Dave's Rag Chew

Dave Mamanakis KD7GR

Greetings My Friends!

Ah, November! One of my Favorite Months of the Year!

My first most favorite holiday? Halloween.

My second? Thanksgiving!

It is always a good time with Friends and Family!

The past 2 years, with COVID hanging over us, have been especially hard on all of us. I'm glad things are finally getting back to normal, and, unfortunately, that isn't true for everyone!

It is important, I believe, to spend time with Family and Friends because, as many of us have found out, people might not be here with us later on.

This morning, in our Stake, a family lost 2 members to Covid related illnesses, and there is one more that may join them. Yes, all from the same family.

I was also notified that Kelly Vining (AI7J) has gone SK.

https://www.lindquistmortuary.com/obituary/James-Vining

I didn't get to know him, really, but I understand he was an interesting person.

On behalf of the Ogden Amateur Radio Club, we offer our most sincere condolences to the Family.

There have been lots of talk, recently, about setting up a station at a home. Creating a Ham Shack or, at a minimum, just a QTH. I hear questions like, "can I use an FTM-400 for a base station?" or "where can I set up at home?"

I KNOW there are a great many questions, I've asked them myself. Currently, when I set up to operate inside the house, I use the Kitchen Table. My wife rolls her eyes and reminds me that "it can't stay there", but lets me keep it there for a short time to use Digital Modes, or play with NVIS.

Honestly, it doesn't take much to set up a home QTH.

If your question is, "Will a [insert radio here] work for a base station?", the answer is a very emphatic "YES!!!". You can use ANY radio as a base station. Sure, you might need to buy a few things, like, for handheld radios, you may need a power adapter or power supply that can run the radio or charge the battery while you use it. You might need a hand mic, maybe a headset. And you may need an adapter to go from the SMA connector to an SO259 to hook it up to an external antenna…

But what about power? Not to worry, if you are using a repeater, you don't need much. A watt or less will still work, with good line of sight to the repeater, and then you have (up to) 50 watts which covers a very good distance from Mt. Ogden!

For a mobile? You have fewer problems, as those, like any real "base station" run off 12-14 volts which can be easily supplied by a battery with solar panels or ham radio power supply and a nearby power outlet.

How about the antenna? At a minimum you'd want to get a UHF/VHF antenna up off the ground, but you don't have to go up too far… if you have a chimney, attach it there… an old TV antenna mast? Attach it there… a fence post? That'll work… you don't have to go expensive or complicated.

Where do I put it? Well, mine is on the Kitchen Table. Yours could be in a walk-in closet, a basement storage room, or just about any other place you could imagine. You don't really need any more space than a small table or shelf … just big enough to hold the radio (power supply, etc) and some other things, like a logbook and band plan chart. But if you have room, you can opt for the Ultra Plush Reclining Chair, the 75" LED Ultra4K TV, and all the other amenities you can afford.

How do I get the feed line inside from the outside? It might be a little more tricky with options ranging from drilling holes to more simple things, like feeding it through a window or doorway.

Building a small "pass through" for a window would allow you to use bulkhead hardware and you can keep the window closed (to keep from warming up the outdoors with your wallet).

I think the point is: Sometimes we like to make things too complicated. Simple solutions might be just as effective and we can always work on improvements later.

If you have specific questions about how to set up a QTH … or on just about any subject, join us on the Ham-n-Eggs net Tuesday evenings at 6:30. There are lots of good and helpful elmers on the net, and it is why the net exists!

OK!

Please join us at UMA on Saturday the 20th at 9am for our next Club Meeting!
And thank you all for being such great members! This club is AWESOME!

--Dave (KD7GR)

CLUB ANNOUNCEMENTS

CLUB NEWS

HAM and EGGS Net

Tuesday Evenings at 6:30 PM Mountain Time

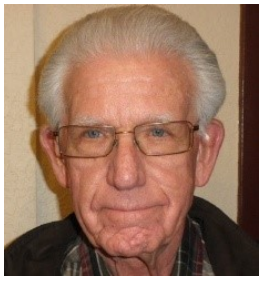
Mt Ogden 70 cm repeater 448.600 MHz (- offset, 123.0 PL Tone)

New, Intermediate & Old Timers. Elmering, Education, General Ham Discussion and Rag Chew.

New hams encouraged to check in. Get connected, learn new things and ask questions.

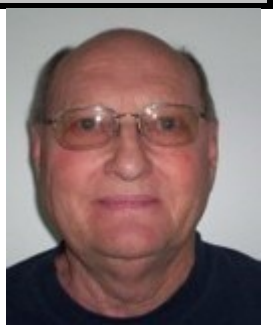
Questions: Larry Griffin AD7GL, ad7gl@arrl.net

Stan Sjol W0KP, stansjol@xmission.com



Larry Griffin AD7GL

Stan Sjol W0KP



CLUB NEWS

10 Meter Net

Thursday Evenings at 0200 UTC (7:00 PM MT)

10 Meters HF - 28.385 MHz SSB (USB)

Purpose is to promote activity on the 10 meter band (especially during low sunspot activity).

To give technician class operators an opportunity to operate phone, and to provide a venue for conversation and experimentation with antenna and ground wave propagation.

NOTICE: "Work toward getting your "10 on 10 Award"

"Work toward getting your "10 meter WAS Award"

Questions and Net Control: Gene WB7RLX, ee_morgan@outlook.com

Gene Morgan WB7RLX

CLUB NEWS

Ham & Eggs Breakfast

Each Wednesday, at a very early 8:00 am, some of the club members meet for an informal breakfast get-to-gather. Everyone is welcome.

Now at a new location:

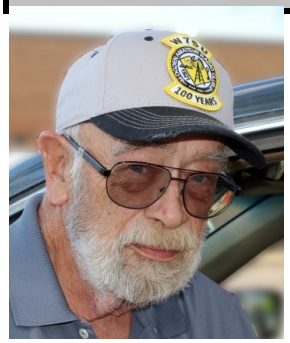
The Rusted Spoon-Ogden (previously The Stagecoach)

1310 Wall Ave, Ogden, UT

NOTE: See you there … if you can get up that early.

A record number attended recently … 17 total.

73, Dave KJ7DAD



Dave DeHeer KJ7DAD

PREVIOUS CLUB MEETING/ACTIVITY

CLUB NEWS

October Activity/Event

In person - Club Meeting

OARC Donation Auction

Photo album available on OARC website homepage.

PREVIOUS MEETING PICTURES

Photos by … club photographers

Kathryn Sutton— K8RYN

Rick Hansen—N7EGA

”Previous Meeting/Activity/Event” …

Photos and links located on the club web site home page.

OARC needs a Social Media Manager

Volunteer today!

Check out the OARC Facebook page

“Ogden Amateur Radio Club”

NEXT CLUB MEETING/ACTIVITY

CLUB NEWS

OARC

November Activity/Event

November In-Person Club Meeting

3rd Saturday 20 November 2021 @ 9:00 AM

Utah Military Academy (5120 S 1050 W, Riverdale)

Meeting Topic :

Station & Tower Grounding for Practical Applications

... by Gene Morgan WB7RLX

Check the club website homepage for the latest information.

CLUB & HOBBY NEWS

CLUB NEWS

AI7J— Kelly Vining (sk)

We lost another good ham….

73 Kelly

James Kelly Vining

September 24, 1963 ~ October 23, 2021 (age 58)

James Kelly Vining, III

September 24, 1963 – October 23, 2021

Kelly left us on October 23, 2021 in the evening after a brief illness. He was born September 24, 1963 in Ogden, Utah and raised in Mountain Green. He was a graduate of Morgan High School and of Weber State University earning an Electronics Engineering degree.

Kelly spent his early years enjoying the outdoors. He loved riding dirt bikes, four wheelers, fishing, camping, and boating. He knew every back road in the state.

He was a member of the Corvette Club of Utah, holding several positions on the board of directors throughout the years. Kelly was an integral part of establishing the CCU website and redesigning the Gazette in recently years winning awards in 2020 and 2021. He took the club on many trips across Utah, Idaho, Montana, Arizona, and into Canada. He had a passion for corvettes and was generous when youths at car shows asked to sit behind the wheel. He loved to travel and was always looking forward to his next adventure and making memories with his sweetheart.

He retired from Hill AFB in June 2021 after 35 years of service supporting the F-16 and F-22 as an electronics engineer.

One of his hobbies was collecting watches. He had a large variety and loved the challenge of looking for something unique. He was a HAM radio enthusiast. He spent many hours talking with people

View full Obit from OARC home page ...

CLUB NEWS

NEW … OARC 10 Meter WAS

OARC 10 Meter WAS Award Rules

Dated: 11/5/2021

Station shall provide confirmation of contact with at least one station in each of the 50 US states.

All Contacts shall be made on 10 meters using any of the following modes:

CW
SSB
FM
Any digital modes such as but not limited to FT8, PSK, JT65, etc.

All contacts must have been made after December 31, 2019 and before the official end of Solar Cycle 25.

Confirmation of contacts shall be provided. Acceptable documentation shall be submitted in either of the following formats:

An electronic Log in ADIF (.adi) format from either **LOTW** or **QRZ**. No other electronic logging formats will be accepted. Instead of an electronic log proof can be submitted by sending photo copies of QSL cards.

Logs can be sent to ee_morgan@outlook.com. Photocopies of QSL cards can be hand delivered or sent to my mailing address. See my WB7RLX QRZ page for mailing address.

For questions or comments contact Eugene Morgan.

CLUB NEWS

Ham Shack Photos

Last month the unidentified Ham Shack Photo was …

Jay (KC7MS) & Janet (KF7NWL) Thomson

CLUB NEWS

Ham Shack Photos

The next in the series of unidentified ham shacks is shown below.

Do you know whose ham shack this is?

CLUB NEWS

(repeat)

Ham Shack Photos

STILL WANTED—STILL NEEDED

We have been doing this for 28 months now.

But now we have run out of new photos.

So … Send me your Ham Shack Photos soon!

Submit to: k7hcp@arrl.net or w7su@arrl.net or 801.389.0690

CLUB NEWS

Congratulations to those that successfully tested at the

06 October 2021 Ogden Weber County VE Test Session:

NAME	CLASS	CALL SIGN
Day, Evan E.	General	KK7BGF (W0GOP)
Gilmore, Timothy D.	General	KK7BGD
Hart, Blake G.	Tech	KK7BGI
Lay, Bryan K.	Tech	KK7BGE
Lewis, Dustin R.	Tech	KK7BGJ
Lyon, Katharine M.	Tech	KK7BGK
Schill, Jason D.	Tech	KK7BGH
Thompson, Michael R.	Tech	KK7BGG

CLUB NEWS

(repeat)

OARC HAM RADIO

EQUIPMENT LOAN PROGRAM

Check OARC website home page for equipment loan inventory chart.

There may some equipment there waiting for you to try out.

And it's FREE!

73, OARC – W7SU

OARC HAM RADIO EQUIPMENT LOAN PROGRAM									
ITEM #	STATUS	ITEM ID	DESCRIPTION	MFG LINK	DONER (if self managed)	BORROWER	CHECK OUT DATE	RETURN DUE DATE	APROX VALUE NEW
		BASE OR MOBILE (Ax)							
A1	On Loan	QYT KT8900 Base/Mobile Dual Band VHF/UHF Transceiver	25 Watt small footprint pre-programmed	https://www.amazon.		K7FDC			$82
		HAND HELD - HT (Bx)							
B1a	Available	Baofeng UV-5R HT w/battery charger and HT Antenna	VHF/UHF dual band HT pre-programmed	https://www.amazon.					$34
B1b	Available	Baofeng UV-5R HT w/battery charger and HT Antenna	VHF/UHF dual band HT pre-programmed	https://www.amazon.					$34
		POWER SUPPLY (Cx)							
C1	On Loan	Wagan EL9903 Power Converter for med power Base Station	12 Volt - 5 Amp Low Wattage PS can be used on KT8900	https://www.amazon.		K7FDC			$23
		ANTENNAS VHF/UHF (Dx)							
D1	Available	Flexible Whip Dual Band 15" HT antenna Nagoya/Btech	Replaces Rubber Duckie	https://www.amazon.					$27
D2	Available	MFJ-1724B Dual Band Mag-Mount Antenna	Mobile/Base VHF/UHF Antenna	https://mfjenterprises					$35
D3	Available	Arrow "J-Pole" Dual Band Base Antenna	Base station VHF/UHF Antenna	http://www.arrowant					$59
D4	Available	Broadband Collinear TRAM Scanner Antenna Resonant 2m & 70 cm	7 Foot Vertical Ant (SO239) w/2 "U" clamps Base Station use	https://www.amazon.					$68
		TEST TOOLS (Ex)							
E1	Available	VOM Volt-Ohm Multi-Meter	Measure Ohms, Volts, Amps	Radio Shack					$30

… and may more items for loan (over 40 items available)

HOBBY NEWS

ARRL Section News

Rocky Mountain - Division: - Utah Section

Section Name: Utah

Contact: Pat Malan, N7PAT

Phone: 801-413-7438

Email: n7pat@arrl.org

The ARRL Board of Directors Honors the Ogden Amateur Radio Club, W7SU, on the occasion of their 100th Anniversary

See http://ogdenarc.org/swapmeet2021.html for photos.

O’bay Swap

(repeat)

SWAP ITEM # 225

FOR SALE: Misc Antenna: equipment, parts, cables, etc. (donated to OARC)

REFER TO CHART: Donation Inventory

ASKING PRICE: $ make offer $ (as a donation to your club)

CONTACT: Gene Morgan WB7RLX, 801-540-4907, ee_morgan@outlook.com

http://OgdenARC.org/swap.html

CLUB NEWS

(repeat)

WANTED…

OARC EQUIPMENT MANAGER

Consider the rewards awaiting you to volunteer for this rewarding and thrilling opportunity. *Hurry because this opening will go fast.* Contact our club president to secure your role in this position. …. .. …. ..

Thank you everyone. 73

CLUB NEWS

(repeat)

WANTED…

OARC SOCIAL MEDIA MANAGER

Consider the rewards awaiting you to volunteer for this rewarding and thrilling opportunity. *Hurry because this opening will go fast.* Contact our club president to secure your role in this position. …. .. …. ..

Thank you everyone. 73

CONTRIBUTING EDITOR SUBMISSIONS

GUEST ARTICLE

by Dan KB6NU

ARRL Clean Signal Initiative on the horizon

In recent message to his Northwest Division membership, Mike Ritz, W7VO, described a program that he's trying to get the ARRL to take on—the Clean Signal Initiative. He writes:

> **ARRL CLEAN SIGNAL INITIATIVE—**
>
> After a few months gathering support from the amateur community for the project, the ARRL Clean Signal Initiative (CSI) is finally getting off the ground. The Board's Programs and Services Committee approved the concept several months ago, and since then I have been canvassing some
> of the best known RF engineers in amateur radio to get their support and input. As a result, the team will be conducting our first Zoom call next week to lay out the next steps for the project. All I can say at this time is that there are some amateur radio "heavy hitters" behind this, and I believe will be a game changer for the ARRL. For those that may be unaware of this project, here is a synopsis (or at least my vision):

1. The CSI gets the ARRL formally in the "technical standards" business. (Other technical organizations already do it: IEEE, UL, ASTM, and SAE, and others.) The ARRL currently tests new products to informal standards, with no real hard benchmarks for manufacturers to meet, other than the minimal standards outlined in FCC Part 97.307.
2. Creates and incorporates documented "best practice" standards and testing methodologies to ensure commercial amateur radio transmitters and amplifiers meet not only minimum FCC requirements for signal cleanliness, but push the envelope.
3. These new standards can be "home grown", or passed through the IEEE, but I think it's important they be also branded as "ARRL Technical Standards."
4. Test new commercial transceivers and amplifiers against these standards.
5. Certify the transmitters and amplifiers that pass the standards: "CSI certified by the ARRL."
6. Work with manufacturers to ensure compliance of those that don't. (Market pressure will drive this.)
7. Market the program to the amateurs through QST .
8. Work with manufacturers and social media experts to create training materials to teach hams how to set up their equipment to ensure the cleanest transmitted signals. (This education part is key!)

Rob Sherwood, NC0B, of Sherwood Engineering, who is most well-known for his ranking of receiver performance, is part of this effort. He has recently been talking a lot about this issue. Below is a talk he gave to the Sutton and Cheam Radio Society.

Based on my knowledge of how IEEE standards committees work, I stressed that the initiative should make every effort to get as many stakeholders—including manufacturers and users—involved as possible. Involving so many people may be cumbersome at times, but standards require consensus for them to be effective, and the only way to do that is to get everyone involved. I'd suggest that if you feel that you have something to contribute that you contact Mike directly.

GUEST ARTICLE

by Kent Gardner WA7AHY

Channel 19 Still Lives

Is the Citizens Band (CB) on its last leg or is it making a comeback?

I was headed toward the Darren Bideaux RV dealership West of the freeway on 21st street and had to turn North off of 21st and pass this truck stop fuel area. I had to look twice at the company name. It just had to be a remnant of the CB of old….**Breaker-Breaker One Nine**.

I am sure that the owners had CB in mind when they came up with the name. It is interesting how one is spelled out and the nine is shown as a numeral.

I still have a CB in my van by my dual-band ham radio, but the CB doesn't get turned on very often. I basically keep it for possible use in an emergency.

Most stories and articles I have seen tell of the demise of CB, but a YouTube video the other day says that they are going to try FM. We will just have to see if that makes any difference. I made a visit to the Radio Shack Store in Layton the other day and they are adding 10 meters to CB radios, both AM and SSB. The internet seems to have come alive with ads for combo ham and CB units.

The following picture shows the large sign that can be seen from the freeway.

Happy CB-ing good buddy.

TNX

Kent Gardner, WA7AHY

GUEST ARTICLE

My Attic OCF Dipole

By Neil Klagge, w0yse

October 2021

Moving into a condo in a 55+ community with HOA restrictions is something that I resisted for a long time until my age caught up with me. My first antenna at the new place was an Off-Center-Fed-Dipole (OCFD) stapled as high as possible on my garage wall. It was 54 feet of wire bent to fit my 30 foot deep garage. It resonated nicely on 40 and 20 meters but was only 8 feet above the floor. [I have discovered that wire antennas attached to walls or roof shingles resonate at 20% shorter lengths than a dipole out in the open air]

Seeking a better antenna for this place led me to try an indoor vertical. I was able to put up a pole from the corner of the shack 18 feet into the attic area above the shack. I tried that for a few months, feeding it in different ways for each band from 160 to 10 meters. It did not perform well as an inside antenna. Verticals need a decent amount of open space in the near field to perform well.

Next I decided to put a horizontal dipole in the attic for the 10 meter band. The dipole was about 13 feet above the floor of the shack and did a much better job than the 8 foot OCFD on that band. Height made big difference, but it did not tune well on other bands.

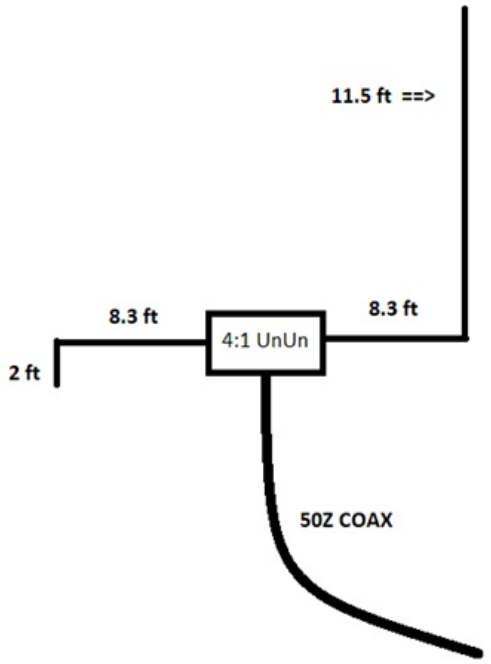
I decided to turn that dipole into an OCFD by extending the length of one side by 11.5 feet, which is all I could reach safely. I extended the other side by only a couple of feet. I had to bend the shape into this pattern to try and keep the bulk of the antenna away from some of the house wiring. I used a 4:1 UnUn at the feed point.

The antenna resonated at 15.6, 21.3, and 30.5 MHz but was very usable with my LDG Z-11 Pro auto tuner. I then reasoned that if I extended the long end by about another 2 feet, and the short end by 1 foot it should resonate better on 10 and 20 meters. To my chagrin those extensions to the antenna gave me problems with RFI on several bands. The LED lighting was affected, but even worse was the RFI to our new Maytag washing machine. Regretfully I had to remove the extensions and use the antenna in the original OCFD dimensions. So, as long as my tuner could keep the radio happy, the antenna can work effectively on all bands from 160 to 6 meters even tho' the SWR on a couple of bands is between 7:1 and 10:1.

I recommend putting up the longest OCFD that you can and see how it performs on various bands of interest. Then adjust the shorter end first if you want to get the SWR improved. Next, adjust the longer end to get it closer to the frequency you want on your favorite HF band. Try to keep the extensions in a 2:1 ratio to preserve the impedance requirements.

Good luck experimenting.

73, Neil, w0yse



GUEST ARTICLE

by Gene Morgan WB7RLX

Setting the Record Straight: SWR

SWR – does your antenna perform better with a 1:1 SWR than with a 2:1 SWR? Is there a relationship between antenna performance and SWR?

By Eugene Morgan (WB7RLX)

I have thought about writing this article for a very long time. The reason is due to all of the misinformation and misunderstanding about SWR and what it actually means in terms of antenna performance. How many times have we all heard conversations about antennas that seem to always start with SWR and that seem to suggest there is a relationship between SWR and performance. I hope in this article to explain the fallacy in this idea but more importantly help the reader to better understand SWR and what it's actually telling you about your antenna system.

A lot of what I'm going to write about has already been written by many other authors. Consequently it will be hard for me to not appear to be plagiarizing some of them. I will at the end of this article give credit to those whose work I have studied and have helped me to understand the true meaning of SWR. Of course I will not go to the level of detail they have and instead encourage those that want to go deeper into the topic to go directly to the sources I have reference at the end of this article.

Throughout this article you will see paragraphs that start with **Key Takeaway:** If you didn't understand what the ideas being expressed was, focus on the key takeaways. The key takeaways attempt to summarize the points or key ideas of the sections they follow. So with that let's jump in and see if we can get a better understanding of this whole SWR thing and what it all means.

How many of us have heard some of the following ideas expressed in our conversations with other hams:

- "I can't operate on the 80-meter band because I don't have room for an antenna."
- "My SWR is 2.5:1 but if I can get it down to 1:1 my antenna will work much better."
- "My SWR was 3.5:1 but my antenna tuner brings it down to 1.1:1."
- "My antenna works best on this frequency because it is resonant here."
- "My SWR is 2:1, so I lose half of my power by being reflected"
- "I had to put up four dipoles so I can operate on 80, 40, 20 and 17 meters."
- "If my SWR is more than 1.5:1, it's bad."
- "I spent all afternoon trying to get my SWR down to 1.5:1."

These statements and others like them demonstrate the general lack of understanding regarding SWR in spite of all the articles and information that has been published on the topic. Of course I'll be the first to admit that some of these articles are hard to understand as they often include so many formulas and with funny characters in them few of us non-math majors understand. Here's a perfect example from the ARRL Antenna Handbook:

	Equation	Valid for:
ARRL Antenna Book, 24th ed. p. 23.13, eq. (16)	$\frac{1}{\eta} = e^{2\alpha l}\frac{1-e^{-4\alpha l}\left\|\Gamma_L\right\|^2}{1-\left\|\Gamma_L\right\|^2} = \frac{a^2-\left\|\Gamma_L\right\|^2}{a\left(1-\left\|\Gamma_L\right\|^2\right)}$	Z_0 real $X_0 = 0$ $a = e^{2\alpha l}$ $\Gamma = \frac{Z-Z_0}{Z+Z_0}$

Figure 1: Transmission Line Loss Formula that includes SWR

There's not many hams that can look at the formula in Figure 1 and know what it's actually saying. What it's expressing is the total loss in a transmission line including the loss due to SWR. So it's no wonder why so many misunderstand what SWR actually means. It also doesn't help that over the years the ARRL antenna handbook inconsistently referred to this formula as both the "*Additional Loss"* in one section and "*Total Loss"* in another section of the same handbook. They also used different notation for some of the Greek characters in the formula in several different editions of the handbook[1]. Fortunately this was for the most part corrected by the 18th edition of the Antenna Handbook.

True or False – Test your knowledge

In this next section I'm going to borrow a test that I took a long time ago about SWR. This test is from the book "*Reflection III*" by Walter Maxwell, W2DU[2]. I'm not going to reproduce the entire test here and I've shortened many of the questions and tried to avoid going to the same level of detail he does. However the test I've summarized here will be a good measure of your current understanding of SWR. Hopefully by the end of this article you will have improved your knowledge.

1. Reflected power does not represent lost power. True or False: __
2. Reflected power does not flow back into the transmitter and cause dissipation and other damage. Damage blamed on high SWR is really caused by improper output-coupling adjustment, not by SWR. True or False: __
3. Any effort to reduce an SWR of 2:1 on any coaxial line will be completely wasted from the standpoint of increasing power transfer significantly. True or False: __
4. Low SWR is not proof of a good-quality antenna system or that it is working efficiently. True or False: __
5. The radiator of an antenna system need not be of self-resonant length for maximum resonant current flow and the feed line need not be of any particular length. True or False: __
6. SWR on the line between the antenna and ATU is determined only by the matching conditions at the load and is not changed or "brought down" by the matching device. True or False: __
7. High SWR in a coaxial transmission line caused by a severe mismatch will not produce antenna currents on the line, nor cause the line to radiate. True or False: __
8. SWR in a feed line cannot be adjusted or controlled in any practical manner by varying the line length. True or False: __

In Dr. Maxwell's test there are a total of 27 questions. I picked only nine because they seem to be the kinds of misunderstanding I hear most often voiced. As has already been stated this is a much shorter list and the nine questions I used were summarized. If you really want to be surprised refer to his book. For the record the answer to all the questions is True.

What is SWR

What is SWR? As simply as can be stated it is the ratio of power being sent to the antenna versus the amount of power being reflected by the antenna. Note that in most articles on SWR the antenna is often referred to as the "load" and the radio or transmitter is often referred to as the "generator." It's also at this point the traditional SWR formula is presented. I'm not going to do that here. Instead we are going to focus on the concepts rather than the math.

By using a specific example we can better understand what SWR actually is. There are usually four things present in any radio station: a transmitter, a tuner (aka: an ATU), a transmission line, and an antenna. We will discuss what happens when there is no ATU in a moment, let me just say at this point it's not good.

When I press down on my CW key my radio sends energy of a certain strength (power) and frequency to the ATU. The ATU is adjusted so the transmitter sees a 50 ohm load. Because of that near perfect match all 100 watts is passed through the ATU and to the transmission line and finally to the antenna at the other end of the transmission line. In cases where the antenna is mismatched to the transmission line a portion of that power is sent back toward the transmitter. The power that is sent back toward the radio is called reflected power. The term we use to express what is happening is SWR. SWR is the measure of what is happening to the forward and reverse voltage and how they compare in size. SWR is the "ratio" of forward to reflected energy and is expressed as a ratio such as 1:1 or 2:1 or 4.5:1 and so on. Note that SWR is not expressed in dB, or watts, or volts or anything else for that matter. But if we know what the units are: volts, watts, or even dB we can use the SWR ratio to convert to whatever units we choose to express loss in. This is of course where things get really messy with lots of math and it's usually at this point we stop reading, so we won't go there in this article. Let's skip all that and see if we can work out what this all means and leave the math to the egg head set. My apologies to the egg head set.

So what does this forward power, reflected power and so on actually mean? The best way to understand this from a practical standpoint is to work through an example. Let's say my radio supplies 100 watts worth of wiggles via a make believe lossless ATU and the ATU pumps 100 watts into a make believe lossless transmission line. At the end of our perfect transmission line is an antenna. When the power hits the antenna there is an impedance mismatch. Oh no! The mismatch is such that 10% of that precious power gets reflected back down the transmission line. So what happened to that 10 watts that gets reflected? Is it lost, I mean truly lost, does it evaporate, does the IRS collect it, where does it go?

Well, 90 watts is radiated into the ether and 10 watts is sent back down the transmission line where it runs smack dab into the ATU. Guess what happens next? That 10 watts is sent right back to the antenna and this time when that 10 watts hits the antenna 9 watts is sent into the antenna to be radiated and 1 watt is sent back to the ATU. And what happens to that 1 watt when it hits the ATU? You guessed it, it's sent right back to the antenna. Where 90% of the 1 watt is radiated into the ether and the other 10% goes right back to the ATU.

This little back and forth between the ATU and the antenna goes on and on until every microvolt of the radio wave has been radiated. So even with a mismatch there was no loss of power, it all got radiated.

So now let's get back to the real world where there's no such thing as a lossless ATU or lossless transmission line. The world where every time a radio wave passed through something there is a tax that must be paid, paid in the form of energy. Like they say, there is no free lunch in spite of what some would have you believe.

Let's replay the scenario above but this time we recognize the losses as the radio wave passes through each device. In our real world example my radio sends 100 watts to the ATU and the ATU takes a very tiny amount of the power. It varies but as a rule the loss is very small so for now will say it's a tenth of a watt and sort of ignore it for the sake of simplicity. The ATU passes the nearly 100 watts to the transmission line. Now this is where it starts to get expensive.

As we all know transmission lines all have some level of loss. For example for RG58 the loss is pretty big, so that inexpensive 100 feet of RG58 just took a portion of the power, about 2.8 dB worth at 28 MHz, so much for cheap coax. So as they say, you're going to pay for it somewhere. Fortunately RG8X isn't as bad, it will only take 1.4 dB. And the DXE-400 Max coax you paid $1.18 a foot for took only .8 dB.

To get our heads around this let's put these losses into context. Understand that an S-Unit is 6 dB. Stop here and think about that for a moment, an S-unit is equal to 6 dB..... So our signal finally arrives at the antenna a bit poorer than when it started. At the antenna 90% of the power that's left is sent on its way to that DX station in Japan. Guess what happens to the other

10%, it gets sent back to the ATU and it also has to pay a 10% tax on its way back to the ATU. And when it hits the ATU what's left is sent back to the antenna and again it pays another 10% tax on its way back to the antenna. And again 90% of the energy that's left gets radiated and 10% gets sent back to the ATU where it pays another 10% tax and is then sent right back to the antenna losing another 10% as it goes.

This of course goes on and on until not one microvolt of energy is left and with each transit of the transmission line a 10% energy tax is paid. So what happened to all the energy that got lost in the transmission line? Good question, the answer, it was turned into heat. So what can we take away from this? First the higher the SWR the larger is the amount of power that is sent back and forth. So with higher SWR there is a higher loss, but the reflected energy is not totally lost. The other key point that those who like to run a lot of power should be aware of, all that power can create enough heat to melt a hole in the transmission line. So be careful if you're using an amplifier. Running 800 watts into an antenna system with a high SWR on the feed line can damage the feed line by melting little holes in the dielectric and even into the jacket of the coax.

Key Takeaway: In our lossless system all 100 watts of the power was radiated in spite of the mismatch. No power was lost, it was all radiated. In our real world system where there was loss we learned that nothing is wasted. The 100 watts is either converted into RF or into heat. What we also learned is that only a portion of the reflected power is turned into heat but a large majority of the reflected power is actually radiated. Later you will learn just how much power is lost. I think you will be surprised. I'll give you a hint, it's not as bad as you might think.

Now let's take another look at the above scenario and assume there is no ATU in place, however we still have the lossless transmission line in place. What happens in this case? Those of you who don't believe in ATU's pay close attention. The reflected power triggers the mismatch protection circuit of the transmitter, which in turn causes the transmitter to reduce the output power. The power is reduced by the amount of reflection. In this case, the reflected power does not get re-reflected back out the antenna where it could be radiated. The result is that the transmitter throttles back and less power is sent to the antenna. The reflected power does not cause heating in the transmitter but it does result in reducing the amount of available power, which is purposely designed into the radio. Therefore, hams who refuse to use a tuner actually prefer by implication, and perhaps unknowingly, this mode of needless reduced power operation. So it not the reflected power that's lost, it's lost power due to the fold back circuitry being triggered by the reflected power.

Why then is the power reduced when a certain mismatch level exits? The answer is that the reflected impedance (reflected voltage divide by reflected current) going to the transmitter causes the operating voltage or current to increase beyond the design limits established for the final power amplifier transistors and associated components. It is the change in **impedance and NOT the reflected power** that causes the throttle back effect, which is triggered to protect the transistors from being subjected to voltage and/or current values beyond their rated specifications.

The key thing to understand about the ATU, that besides providing the ability to match the transmitter to the transmission line, the ATU provides a gating effect. It's like a one way valve or a better analogy, like a giant diode for radio waves. In the ATU power traveling from the transmitter port of the ATU goes through the ATU and out the antenna port with very little loss. However the reflected power as it comes back to the ATU is totally reflected back to the antenna. So in our lossless transmission line 100% of the power is eventually radiated. With no ATU the transmitter is throttled down to protect the components from operating beyond their design limits which reduces output of the transmitter.

Key Takeaway: Use an ATU whenever the SWR of an antenna is great enough to trigger the mismatch protection circuit (aka: fold-back circuity). For most radios that happens at around 1.5:1 or greater SWR. The rig with an ATU continues to deliver full power to the antenna regardless of the feedline's SWR, assuming the tuner is engaged and properly adjusted. The tuner-less rig does not. So on rigs without tuners one should consider an external tuner be added to the antenna system. An ATU also provides an added benefit, it allows an antenna to be used across a larger portion of the band and even on multiple bands in many cases. This is especially advantageous for the lower HF bands such as 40-160 meters where antennas tend to be a bit narrow banded. It's also critical for the ham who wants to do FT-8 and or CW as well as SSB. CW and FT-8 are always at the lower end of the band and SSB is usually at the higher end of the band. The ATU allows an antenna to be used across a wider frequency range and in some cases allows the antenna to be used across multiple bands.

What's my SWR?

As can be seen in Figure 2, even the best transmission line is not without loss and that loss increases with frequency. What that means is that every time a radio wave transits a transmission line it loses some of its energy to heat regardless of what direction the wave is traveling. This is referred to as attenuation, earlier I referred to it as a kind of a toll tax or energy tax. Each time the radio wave travels traverses the transmission line, either from the ATU toward the antenna or from the antenna toward the ATU, it will be attenuated according to the feedline's attenuation properties, (dB loss in meters or dB loss in feet). These values are found in the spec sheets provided by the cable manufacturer. Before selecting a cable for your station you should take a look at these spec sheets and specifically at the loss numbers for the bands you intend to use the coax for.

This information is essential in determining the initial loss and the extra loss that will be cause by SWR. For example, suppose you are using 100 feet of RG58/A at 7 MHz. The typical total loss for 100 feet of RG58/A at 7 MHz with a perfect 1:1 matched between the antenna and feedline is 1.05 dB. If your SWR happens to be 1:1, then you already know what the feedline loss is. But if the SWR is not 1:1, then there will be additional loss in the line. This additional loss is called the *SWR loss*. To put this another way, ALL the RF energy that is not converted into heat will be radiated by the antenna. That's why even with 10 watts of reflection not all 10 watts will be wasted, only a very small portion will be attenuated. As we saw in our earlier discussion a portion of the energy will be converted into heat as it goes back toward the ATU and then another portion will be converted to heat as it travels back to the antenna and so on until all the energy has been either radiated or converted into heat in the transmission line. The formula I introduced you to at the beginning of this article is one of several formulas used to calculate total loss in a transmission line, some of its key inputs are attenuation and SWR. But not to worry, we are going to try to simplify the calculation by using a couple of tables. Of course our estimates may not be as accurate as might be derived by using a formula only few understand, but our method will be good enough that we can get a rough approximation of the loss in our antenna systems.

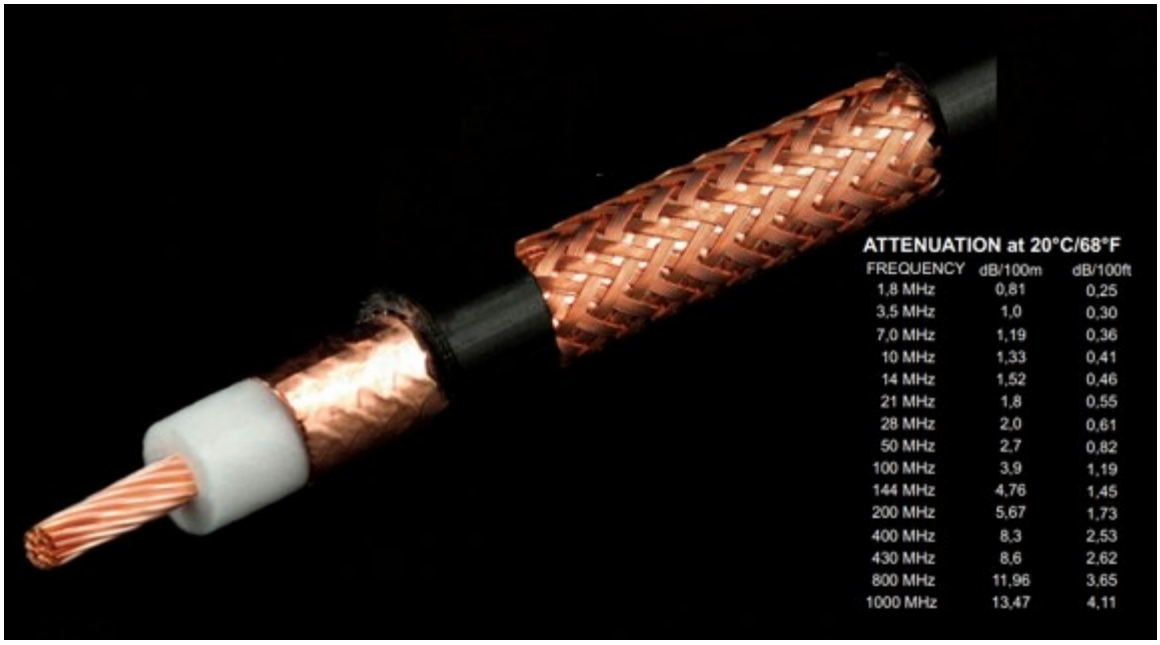


Figure 2: Loss numbers for M&P UltraFlex 10

Now that you understand what happens as your signal travels back and forth across the transmission line, let's try to quantify the real impact of SWR. In short what does it mean, how much power or rather signal do I actually lose to SWR, and should I be worried?

What's My REAL SWR?

The first step to understanding the potential loss in your antenna system is understanding what your real SWR is, here's a hint, it is not what you measured from the comfort of your shack which is generally where the measurement is taken. Measuring it at that point does not give an accurate reading due to the attenuation that is occurring on the feed line. To get the actual SWR, the measurement should be taken at the antenna feed point. The reading you get in your shack is the apparent SWR and is always less than the actual SWR. Sometimes the difference is considerable if the feedline is long and/or has high loss such as in the case of RG58A and RG8X.

However, putting an SWR meter at the antenna feed point is not easily done, especially when it's at the top of your 60' tower or in a tall tree, or suspended in midair by two thin wires. But there are ways to find out what your real SWR is. There is software out there that can make the calculation for you, one I recommend is TLW[4] which is included with the ARRL antenna handbook. There is another way of doing it that I will present here. I should note that the results using the tables will be an estimate and will vary from reality. Actual loss in a given antenna system can truly only be measured using a VNA and while having access to both ends of the transmission line.

SWR at the Transmitter

dB Loss	1.0	1.2	1.4	1.6	1.8	2.0	2.5	3.0	4.0	5.0	6.0	7.0
0.2	1.0	1.2	1.4	1.6	1.9	2.1	2.6	3.1	4.2	5.5	6.8	8.0
0.4	1.0	1.2	1.4	1.7	1.9	2.1	2.7	3.4	4.7	6.3	8.0	9.5
0.6	1.0	1.2	1.5	1.7	2.0	2.2	2.9	3.7	5.2	7.8	10.0	
0.8	1.0	1.2	1.5	1.7	2.0	2.3	3.1	4.0	6.0	9.0		
1.0	1.0	1.2	1.5	1.8	2.1	2.4	3.3	4.3	7.0			
1.2	1.0	1.3	1.5	1.9	2.2	2.6	3.6	4.8	7.0			
1.4	1.0	1.3	1.6	1.9	2.3	2.8	4.0	5.5	9.9			
1.7	1.0	1.3	1.6	2.0	2.5	3.0	4.3	6.5				
2.0	1.0	1.3	1.7	2.1	2.8	3.3	5.3	8.4				
2.5	1.0	1.4	1.8	2.4	3.2	4.0	8.0					
3.0	1.0	1.4	1.9	2.7	3.7	4.9	9.8					
3.5	1.0	1.4	2.1	3.1	4.6	6.9						
4.0	1.0	1.5	2.3	3.7	6.0	6.9						
4.5	1.0	1.6	2.6	4.7	7.9							
5.0	1.0	1.8	3.0	6.0								
5.5	1.0	2.0	3.4	8.5								

Table 1: Actual SWR at the Antenna

The key output of this first exercise is to establish the true SWR, the SWR as if we were to take it at the feed point of the antenna. The true SWR will be one of the numbers from the table above using your cable's attenuation values which is represented by the left most column. The left column is what we call the *Match Loss* and is expressed in dB. Think of it as the toll tax or energy tax that is charged every time a radio wave crosses the coax from one end to the other regardless of direction. The top row of numbers is the measured SWR at your radio and is expressed as the first half of an SWR ratio, the second half is always a 1. Example 1:1 or 2.5:1 and so on. All of the other numbers in the table represent the *Real SWR* values based on measured SWR in the shack (top row) and *Match Loss* in dB (left most column). To better understand let's do an example.

If your transmission line is UltraFlex 10 and is 100 feet long and your target frequency is the 10 meter band (28 MHz) then your match loss would be .61 dB, refer to Figure 2. If the measured SWR in the shack is 2:1 then the actual SWR at the antenna would be around 2.2:1. How did we get that number? Look at the left side of the table and locate the row where you see .6 (row 3). Now look along the top row and locate the column closest to the SWR of 2:1 (column 6). Now find the intersection of column 6 and row 3. There you will find 2.2. 2.2:1 is your *Real SWR*, the SWR we would most likely find at the antenna if we

measured it at 28 MHz. Write that down. We will use it again. Label it *Real SWR*. Also write down the *Match Loss,* which is .61 dB. In case you were wondering where the .61 dB figure came from look at the manufactures spec sheet, see Figure 2.

Just in case you were wondering what if my transmission line were shorter say 50 feet long, then the match loss would be estimated at .3 dB. This would infer that your actual SWR at the antenna would be around 2.1:1.

Now let's estimate what the actual impact of your *Real SWR* is in relation to how much you lose in the signal. I think you may be surprised by the answer so hang in there. We are almost done.

How Much Does *Real SWR* Affect My Signal?

To really understand let's continue on with our example. Okay, we've establish we have a *Real SWR* of 2.2:1. Now we want to know how much our signal is affected in dB. Why dB? Because that's the easiest reference we have that we can relate to. Think about your S-meter. On your S-meter one S-unit is equal to 6 dB. So if we can relate our signal loss to our S-meter we can get a real sense of the impact of that loss. Consider that the difference between an S3 signal and an S4 signal is 6 dB. Between an S4 signal and an S9 the difference is 30 dB. Let's keep going, what you will find by working through this exercise will be beneficial and maybe even surprising. Ready?

Now let's turn our attention to table 2. Table 2 looks a lot like table 1. It's set up the same way. The green column on the left represent the known dB loss for a given transmission line, the *Match loss*. The dark blue row across the top is the *Real SWR* instead of the apparent SWR. All of the values in the table represent SWR loss in dB. We are going to use the intersection of the *Match Loss* column with the *Real SWR* row to calculate our signal loss due to SWR in dB.

Let's now use the numbers we got from the first exercise. Locate the *Real SWR,* which is 2.2 on the top row of table 2 (hint, column 3 is the closest, we will split the difference in a moment.) Now locate the row closest to the *Match Loss* (hint, row 3). Now find the intersection of column 3 and row 3. The number you find there is .1 dB. But because our *Real SWR* was between 2:1 and 2.5:1 let's split the difference and call it .15 dB. Now let's do some real simple addition, you will not need your calculator for this.

The formula for total loss is Match Loss + SWR Loss = Total Loss in dB. So let's plug in some numbers: .61+.15=.76 dB. So our total estimated loss for a 2:1 SWR as measured from the shack is a whopping .76 dB? What! Only .76 dB? Not even one sixth of an S-unit, really? Yes, really. I told you that you would be surprised. Not even a flicker of the needle on the S-meter. So about now you must be asking yourself if it's really worth it to pull the antenna down for the fourth time and snip a bit more off or add a bit more back on in an effort to get the SWR to 1:1 or even 1.2:1. Reflect on that for a minute, pun intended.

Another point I'd like to make. In our example we used 28 MHz. Loss increases as frequency increases. Likewise, loss decreases as frequency decreases. So let's take this same example but instead of 10 meters let's consider 20 meters or 40 meters. The losses we could expect to see on our 40 meter dipole with a 2:1 SWR would be hardly measurable. On our 20 meter vertical the change from a 2:1 to a 1.2:1 SWR wouldn't be noticed by the guy a block away. So killing yourself for the holy grail of a 1:1 SWR is just not productive. Instead, be happy with the 2:1 and get on the air an make some contacts. Or better still read *Reflection III* and find out about low SWR for the right reasons and the wrong reasons. Yes those really are chapters in Dr. Maxwell's book.

Real SWR - SWR at the Antenna

dB Loss	1.0	1.5	2.0	2.5	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
0.2	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.7
0.4	0.0	0.0	0.1	0.2	0.2	0.4	0.5	0.7	0.8	1.0	1.1	1.3
0.6	0.0	0.0	0.1	0.2	0.3	0.5	0.7	0.9	1.1	1.3	1.5	1.7
0.8	0.0	0.0	0.2	0.3	0.4	0.7	0.9	1.2	1.5	1.7	1.9	2.1
1.0	0.0	0.0	0.2	0.3	0.5	0.8	1.2	1.5	1.7	1.9	2.2	2.5
1.2	0.0	0.0	0.2	0.4	0.6	1.0	1.3	1.7	1.9	2.2	2.5	2.8
1.4	0.0	0.0	0.2	0.4	0.6	1.1	1.5	1.8	2.1	2.4	2.7	3.0
1.7	0.0	0.0	0.3	0.5	0.7	1.3	1.7	2.0	2.3	2.6	3.0	3.3
2.0	0.0	0.1	0.3	0.5	0.8	1.3	1.8	2,1	2.5	2.8	3.2	3.6
2.5	0.0	0.1	0.3	0.6	0.9	1.5	1.9	2.3	2.8	3.1	3.5	3.7
3.0	0.0	0.1	0.3	0.6	1.0	1.5	2.0	2.5	2.9	3.2	3.7	4.0
3.5	0.0	0.1	0.4	0.7	1.1	1.6	2.1	2.6	3.1	3.4	3.8	4.1
4.0	0.0	0.1	0.4	0.7	1.1	1.7	2.2	2.7	3.2	3.5	3.9	4.2
4.5	0.0	0.1	0.4	0.7	1.1	1.7	2.3	2.8	3.2	3.6	4.0	4.3
5.0	0.0	0.1	0.4	0.8	1.2	1.8	2.3	2.9	3.2	3.7	4.1	4.4
5.5	0.0	0.1	0.5	0.8	1.2	1.8	2.4	2.9	3.2	3.8	4.2	4.5

Table 2: Additional Loss Caused by SWR

Following is the 6 step process we followed to arrive at our estimated loss due to SWR. You can use this 6 step process and plug in your own numbers. You might be surprised at the results.

a. We know the cable run is 100' of UltraFlex 10. It has a loss at 28 MHz of around .61 dB when measured across 100' of coax. We know that by looking at the manufacture's spec, see, Figure 2. It happens that our cable run is also 100'

b. We have measured the SWR in the shack for our 10 meter vertical which is 2:1 at 28 MHz

c. Next we estimate the actual SWR at the antenna. Refer to table 1. Look down the left side until you come to .6 then we look across the top row of the table until you come to the apparent SWR of 2.0. Now look at the intersection of the apparent SWR and the Match Line Loss. In our example at that intersection we find an SWR value of 2.2. Our *Real SWR* = 2.2:1 and our Match Loss is .61 dB

d. Now refer to table 2. Again we go down the left side until we find the match loss of .6 dB. Look across the top row until you come closest to our Real SWR of 2.2. That would be column with 2.0 at the top. Now find the intersection of the *Match Loss* row and the *Real SWR* column. At the intersection of those two we see that actual estimated loss is .2 dB. But we are going to fudge it a bit because our actual SWR of 2.2 is between 2,0 and 2.5. So let's assume the loss is somewhere between .1 and .2 dB. Let's estimate it at .15 dB.

e. Now let's make the calculation: Match loss + SWR loss = Total loss.

    a. Match loss = .61 dB

    b. SWR Loss = .15 dB

c. .61 dB + .15 dB = .76 dB.

d. Total loss = .76 dB

In general, when the SWR loss is less than 1 or 2 dB then you are wasting your time by striving for a perfect match. A change in signal strength of 1 dB is recognized as the smallest detectable change. Therefore in practice, anything less amounts to practically nothing. A loss of 1 dB will not be detected by the other station under the best of conditions or for that matter the worst of conditions. Also note that having an SWR loss of less than 1 dB does not mean you have a great antenna or a poor antenna. It simply means there is no point in trying to get a better match with the existing feedline. We will look into that fallacy in a minute.

Key Take Away: At HF frequencies trying to get your SWR down under even 3:1 is often a waste of effort. You are better served to look for other deficiencies in your antenna system in order to minimize loss. For example, do you have a good ATU, are you using a good low loss cable? Can you get your antenna any higher? Do you have enough radials under your vertical? Is there another antenna type that might serve you better? Is my transmission line longer than it needs to be? Consider your options and don't waste time on things that have little return on investment.

Key Take Away: There is another more subtle takeaway from the above example. There is an advantage to lowering the SWR on the antenna if the antenna is one that by its very nature present a high impedance to the feedline. There are several examples: The OCF dipole, the half wave wire, and the long wire, are just three examples. That is one of the reasons these antennas have an impedance transformer at the feed point of the antenna. This is also a case where it might make sense to locate a remote antenna tuner at the feed point of the antenna. By doing so you remove any extra loss due to SWR. If the cable run is short and the cable has good low loss numbers, then there's really no advantage to doing this. But if the cable run is long in terms of wave lengths at the highest frequency used, say 3 or 4 wave lengths or more, and the SWR on the antenna is high, as is often the case with antennas like the G5RV, the OCF dipole, the half wave wire and the long wire antenna, then it might make sense to invest in a remote tuner. But again only when these two conditions are meant: a long transmission line and a high SWR >3:1.

Another antenna that might benefit by having the tuner at its base is the vertical. The vertical, unlike the antennas mentioned above, has the opposite problem, it presents a very low impedance at the feed point, sometimes as low as a few ohms so there can be a significant mismatch at the feed point. In that situation it might make good sense to place a remote tuner at the base of the vertical, especially if the feed line is long in terms of wave lengths for the highest frequency used.

A Note about VHF, UHF and SWR

Throughout this article I have been focused on HF where losses due to SWR are generally so small as to not make a difference in overall signal strength. The same rules do apply to VHF and UHF, however things are much more complicated. First off at VHF and UHF attenuation in the transmission line is going to be considerably greater. Second, at HF UHF fittings like PL-259's, SO-239's, male to male and female to female couplers have very little loss. So little that it has no measurable effect on power measurements. But at VHF and above that's no longer the case. This is one of the key reasons why for UHF and above the use of Type-N fittings is always recommended. With N-Type and BNC fittings loss is minimal and there is no impedance bump as we see in UHF fittings[3].

The other reason is at VHF and above even small losses matter. The loss of a dB can make a difference in modes such as Earth Moon Earth (EME), meteor scatter, and other weak signal communication modes that depend on line of sight propagation. This also includes modes that depend on tropospheric ducting, which usually take place a 50 MHz and above. At HF the loss of a few dB is not critical, at VHF and above, it can be much more impactful. This is why in VHF and UHF systems much more attention is paid to using very low loss transmission lines such as hardline and Heliax and in keeping transmission lines as short as possible or eliminating them altogether.

Does my Tuner (ATU) Change the SWR on the Transmission Line?

Here again the short answer is no. This is another common misconception. The ATU only changes the impedance your transmitter sees. The tuners job is to make sure your radio sees a 50 ohm load. The key reason for that is to stop the transmitter from throttling back the output in order to protect the finals from seeing a high impedance. That's all it does.

You can test this yourself. If you insert an SWR meter between your radio and the ATU and adjust the ATU appropriately the SWR meter will show a good match, usually something very near to a 1:1. But if you change nothing and move the SWR meter between the ATU and the antenna you will see the SWR as it really is. If you move the SWR meter to another place in the transmission line closer to the antenna you may notice the SWR is only slightly higher. This is because there will be less attenuation as you get closer to the antenna.

Key Take Away: The ATU does NOT change the real SWR on the transmission line. If the SWR as measured at the radio is say 2:1 for example without the ATU, it will remain 2:1 with the ATU engaged and adjusted for a low SWR. The 1:1 match would be between the radio and the ATU, not between the ATU and the antenna. Also what you would find if you could move the SWR meter closer to the antenna, is the SWR would increase ever so slightly. Attenuation in the feed line is the reason for the small change in SWR. If the SWR is considerably higher that is a good indication there is something very wrong in the system, possibly a bad length of coax or water has seeped into the coax, or you have a bad fitting somewhere in the system.

In extreme cases of a high SWR coupled with a long transmission line it would make sense to put a tuner at the feed point of the antenna in an effort to lower the SWR on the transmission line. But multiple ATU's should NEVER be put in line. If you still can't get the SWR in range using your ATU you could use an ATU extender like the MFJ-914 tuner extender. However you should never put two ATU's in series. That means if you have both an ATU in your radio and an external ATU, they should never be used together at the same time, use one or the other but not both at the same time.

What Does SWR Have To Do With Antenna Performance

The short answer to the question, nothing. Here again is another often misunderstood concept. SWR is only a measure of the ratio of forward power to reflected power and nothing more. SWR says nothing about how well you're antenna is performing. If SWR really mattered as a performance indicator then we would all put dummy loads on our roofs and be done with it. The dummy load after all has a very low SWR across the entire HF spectrum. But as should be apparent by using this extreme example it should be obvious that SWR has nothing to do with antenna performance. What matters when it comes to antenna performance is height and size, at least that's what the physics tells us and there is no way to cheat the physics as we currently understand it. Maybe someday when we have quantum physics figured out and the nature of dark matter and energy are understood, maybe then we will discover something new, like the quantum gravity dark energy antenna, or the QGDE antenna as I like to call it.

There are many examples of antennas that are good performers that have high feed point impedance by their very nature. I have already mentioned several of them, the cast of characters includes: G5RV (when installed correctly) which uses 450 ohm window line attached to 50 Ohm coax usually through a 1:1 balun. The long wire and the half wave long wire. Both of these antennas have a very high feed point impedance and require a 9:1 unun and a 49:1 unun respectively. Then there is the off center fed dipole (OCFD). This antenna requires a 4:1 balun to achieve a good match to 50 ohm coaxial. And let's not forget the good old loop. Its feed point impedance is anywhere from 75 ohms to 150 ohms and often needs to be tamed with a 2:1 balun. These are all examples of very good antennas that are capable of working a lot of DX. They all operate with a high feed point impedance and usually require some type of a matching transformer at the feed point in order to establish a reasonable match to a 50 ohm feed line.

The key to using any of these antennas is to find a way to transform the high impedance at the feed point to a reasonable level so that SWR can be minimized on the feed line. That is often done using impedance transformers, better known as baluns and

ununs. And in some cases you can actually locate a remote tuner at the base of the antenna. This helps to reduce SWR on the transmission line, which allows all the energy to be radiated in the antenna rather than turned into heat in the transmission line.

Key Takeaway: SWR is not an indicator of antenna performance or efficiency. Don't focus all your energy on trying for the 1:1 SWR. Instead focus on the elements of your antenna system that matters. Use good feed line, waterproof the connectors. Get your antenna as high as possible and clear of obstacles in the near field as best you can. If you are using a ground mounted vertical, ensure you have laid out an adequate radial field. Deploy the best antenna you can for your given set of constraints. Use baluns and/or chokes to minimize common mode current on the feed line. And finally make sure your station and your antennas are well grounded.

There's always kind of a funny irony when I see a station whose owner boasts of his low SWR but has no balun on his dipole and can't figure out why his computer mouse suddenly goes a little crazy or his internet router reboots when he calls CQ.

Add or Subtracting Coax Changes My SWR

One of the other misconceptions that I often hear is the idea that changing the length of your transmission line will change your SWR. This again is another misunderstood idea. Theoretically, the SWR should not change with line length except for a barely perceptible change because of the corresponding change in line attenuation. If you recall in our previous example, moving the SWR meter from the shack all the way to the antenna resulted in the SWR going from a mere 2:1 to 2.2:1. This is a very small change after moving the SWR meter a hundred feet. If the SWR changes significantly that's an indication there's something else going on. And whatever that something else is, it is generally not good.

If you're reading this and remembering the time when you changed the length of your feed line and your SWR seemed to improve, then I'm sure your wondering why the conflicting perspective. Or the other time your friend related his experience of lowering his SWR by removing a few feet from his transmission line. How come, why did the SWR change? Great question and an important one.

At anywhere along the feedline the SWR should be practically the same value from end to end. If you can cause the SWR to change significantly by changing the length of the transmission line, there is definitely something amiss. There are several possibilities, the SWR meter you bought at the swap meet has a problem. Or it's possible the feedline is bad. Or, and this is the more likely reason, you have current flowing on the outside of the coax shield, yes you have the dreaded "Common Mode Current gremlin" at work.

Here's the reason why the SWR of the antenna changes when there is common mode current present on the outside of the coaxial. Ask yourself what happens when you change the length of an antenna? It changes the resonance of the antenna, which in turn changes the SWR. If you cut the antenna shorter in raises the resonance. If you add length to the antenna it lowers the resonance. When common mode currents are present on the outside of the coax shield the shield becomes a part of the antenna. So much so that it actually radiates like an antenna and picks up RF like an antenna. And what happens when you change the length of an antenna? It changes the SWR. So there's the reason.

When common mode currents are present on your coax your coax becomes a part of your antenna. What's happening is the antenna is attempting to balance the current on the antenna. The unbalanced current attaches itself to the outside of the coax shield, thereby making the shield a part of the antenna. Antennas are funny that way, they need balance and to achieve it they will flow current down the outside of the coax shield. That means that when you're in receive mode the shield of the transmission line is picking up RF, unfortunately a good portion of that RF is bad RF, aka: RFI. During the transmit cycle the shield radiates RF in some of the very places you don't want it to radiate, like the TV, your computer, and maybe even your internet router.

Common Mode Current can be responsible for what I call the poltergeist effect, the TV mysteriously turns on, the washing machine develops a mind of its own, the computer reboots, and so on. The issue with having your coax act as a part of your antenna is it can pick up stuff you don't want it to and it can radiate where you don't want it to. What this also means is you're

wasting precious RF. Common mode current does not add to your signal in a beneficial way. You need to eliminate it or at the very least minimize it and direct it to ground.

How do you do that? Start by using baluns and ununs on your antenna. In the case of the balun it must be of the type that provides some level of choking. In the case of the unun a choke should also be included in the antenna system.

This is the reason I always recommend a choking balun be used on all balanced antennas and an unun on all unbalanced antennas. Balance antennas are usually in the dipole family. This includes: Yagi's, dipoles, G5RV's, OCFD's and so on. I also recommend them for all loop antennas as well. For unbalanced antennas like the end fed wire antennas you should always use an unun in conjunctions with a choke.

Grounding also plays a key role in managing common mode currents. All antennas should be grounded at some point before their respective transmission lines enter the shack. In addition, the equipment in the shack should also be well ground.

Key Takeaway: If changing the feedline length changes the SWR start looking for issues with your antenna and feedline. If the feedline checks out then make sure you're doing all you can to control and minimize common mode current. This infers the use of baluns, ununs, and chokes. It also requires implementing a good grounding solution.

Summary

If you have hung in there to this point then I want to thank you. I know it was a long read so I hope you got something out of it. But more importantly I hope there was something that clicked for you that might help you improved your antenna system. I also hope that this article will help in a small way to slow the SWR myths, although I know they will persist.

SWR is one of the most misunderstood concepts in ham radio. My hope is this article helped you to better understand what SWR is, what it means and what it doesn't mean. I also want to invite you to do two things. First, if you have any questions or if there are any points I have raised that you disagree with please drop me an email. I always enjoy talking about antennas especially if I will learn from the conversation. Second if you want to know more about SWR read Dr. Maxwell's book. When it comes to SWR, in my opinion, his book is the bible on the topic. Unfortunately the book is out of print at this time and may be hard to get and a bit expensive at that. I saw a copy on Amazon that was selling for $147.00. It's also available from CQ Magazine but it has been out of stock for some time.

Dr. Maxwell's book started out as a seven part QST series "*Another Look at Reflections.*" This series appeared in the April 1973, June 1973, August, 1973, October, 1973, April 1974, December 1974, and the August 1976 issues of QST magazine. These earlier articles were written specifically to expose and correct the then prevalent misconceptions concerning the mechanics of transmission lines and in particular the facts regarding SWR. These articles can be download from the ARRL Web site if you're a current subscriber to QST. This series was later completed and published as the book "*Reflections*", by the ARRL in 1990. In 2010 "*Reflections III*" was published by CQ Magazine. The 2010 edition included a lot of new material. I purchased a copy when it came out in 2010 and it has become one of the most referred to books in my antenna book collection.

I have tried to do justice to Dr. Maxwell's book but with limited space and time I only scratched the surface. That is why I encourage any of you who what to know more download what you can from the ARRL web site.

One final item before I close. I would like to extend a big thanks to Neil Klagge, W0YSE. Neil helped with the editing and made several great suggestions. His input made the article better than I could have ever done on my own, however any errors you find are all mine. Thank You Neil!

73,

Gene (WB7RLX)

ee_morgan@outlook.com

End Notes

[1] S Stearns, K6OIK, "*Loss Formulas for General Uniform Transmission Lines and Paradox 5*", QEX, Sept/Oct 2021, page 19.

[2] W Maxwell, W2DUD, "*Reflection III: Transmission Lines and Antennas*", CQ Magazine, Section 2-3.

[3] J Hallas, W1ZR, "*The Care and Feeding of Transmission Lines*", ARRL, Chapter 6.

[4] TLW, **T**ransmission **L**ine Program for **W**indows software is provided with the ARRL *Antenna Hand Book*.

September 2021 Volunteer Monitor Program Report

10/14/2021

The Volunteer Monitor (VM) Program is a joint initiative between the ARRL and FCC to enhance compliance in the Amateur Radio Service. This is the VM Program report for September 2021.

Technician operators in Mansfield, Ohio; Avon Park, Florida, and Pulaski, Tennessee, received *Advisory Notice*s after making numerous FT8 contacts on 20 meters. Technician licensees do not have operating privileges on 20 meters.

A Volunteer Monitor in Mission Viejo, California, received a Department of Homeland Security, United States Coast Guard *Certificate of Appreciation* for his efforts in locating a defective transmitter on Marine Radio Channel 16 that was blocking emergency communications on that channel.

A former licensee in Durham, North Carolina, received an *Advisory Notice* for operating under a call sign and license cancelled by the FCC.

An operator in White Pine, Tennessee, received an *Advisory Notice* regarding operation on 7.137 MHz, a frequency not authorized under his General class licensee.

Operators in Swannanoa, North Carolina, and New Albany, Indiana, received *Good Operator Notice*s for exemplary operation during 2021 and for regularly assisting other operators with transmitter adjustments and amateur radio procedures.

The VM Program made one recommendation to the FCC for case closure.

VM Program statistics for August showed 2,008 hours on HF frequencies and 2,642 hours on VHF frequencies and above, for a total of 4,650 hours. — *Thanks to Riley Hollingsworth, K4ZDH, Administrator, Volunteer Monitor Program*

Job Openings at ARRL Headquarters

10/28/2021

ARRL The National Association for Amateur Radio® is hiring for these positions at its Headquarters in Newington, Connecticut. Qualified candidates are invited to **email** their cover letter and resume to ARRL Human Resources. Visit the ARRL **Employment Opportunities** page for more information.

- Lab Engineer EMC/RFI Specialist
- Administrative Assistant
- Director of Information Technology
- Marketing Communications Associate
- Public Relations & Outreach Manager
- Social Media Strategist

To apply to any of these positions, submit your resume and cover letter by mail, **email**, or fax to ARRL Human Resources, 225 Main St., Newington, CT 06111. Fax: 860-594-0298. ARRL is an equal opportunity employer.

US Government Accepting Applications for FCC Telecommunications Specialist

10/28/2021

The federal government is accepting applications until November 10 for a **telecommunications specialist** to work at the FCC's high-frequency direction finding (HFDF) facility in Columbia, Maryland. This is a full-time position, and no travel is required.

The individual hired would perform watch duty and serve as a technical authority for communication systems users in resolving radio interference complaints and problems, among other responsibilities.

This position requires US citizenship, a security clearance, and education transcripts. Anyone hired to fill this position would be required to be vaccinated against COVID-19 and submit documentation of proof of vaccination. A resumé is considered an integral part of the process to determine if an applicant meets the basic qualifications for the position and if the applicant is among the best qualified.

To learn more and to apply, visit the **USAJobs website**.

CLUB REFERENCE MATERIAL

CLUB REPEATER NEWS

Scott Willis KD7EKO Mike Fullmer KZ7O

Scott Willis KD7EKO and Mike Fullmer KZ7O are the OARC repeater engineers that keep our club repeaters at Mt Ogden and Little Mountain operational.

OARC MEMBERSHIP DRIVE

SUPPORT YOUR RADIO CLUB

Don't forget to signup/renew your OARC membership now ($15) which runs August to August. Consider signing up your spouse as well. Remember … FREE Steak at Steak Fry for ALL members.

Ham + Spouse = $15 + $10 = $25

THANK YOU FOR YOUR SUPPORT

Join OARC

Join or Renew your membership now!

Joining & Renewal is easy. On the club website home page click Join/Renew tab and fill out the membership form. You can pay using your PayPal or mail a Check or Money Order to the club PO Box listed. Or print a hardcopy of the membership form, fill it out and mail it to the PO Box along with your payment. Better yet, Come to a club meeting and bring the completed membership form with you.

DUES: Dues are $15.00 per person and runs August - August. (Ham + spouse = $25.) More than one ham in the family? Consider the OARC Family plan for $25.

NOTE: New Hams >>> Membership in OARC is complimentary for remainder of 1st year licensed.

Membership in the Ogden Amateur Radio Club is open to anyone interested in Amateur Radio. You do not need an amateur license to join us. You do not need to join the club to participate with us. Dues are used to operate the club, field day activities, and repeater equipment maintenance.

Club Badges

OARC Club badges are available for all licensed club members.

The cost is $12.00 each. The badge comes with a “MAGNETIC” clip. Badge includes your Call Sign in large letters and your First Name in a somewhat smaller font in white lettering on a pitch black background with the club logo. See example below.

Place your order along with $12.00 prepaid in advance for each badge ordered and specify Call Sign and First Name.

Visit the club website home page Join/Renew tab and select the Badge Order form to order your badge. You can use PayPal or mail your check to the club PO Box.

OARC Facebook Page

Did you know that OARC has a Facebook page ?

Just click on the icon on the bottom of the club website home page to visit OARC's ongoing monthly activities and events. They are posted here for your viewing pleasure.

OARC You Tube Channel

Did you know that OARC has a You Tube Channel ?

A lot of our meeting presentations are recorded and posted to our OARC You Tube channel for you to view at a later date.

It's easy to view missed **meetings…**

Just click on the icon on the bottom of the club website home page to view recorded meetings preserved for your viewing pleasure.

ANNOUNCEMENTS

Next Club Meeting:

3rd Saturday of each Month

The Ogden Amateur Radio Club meetings are usually held on the **3rd Saturday** of each month.

Meeting/Activity:

See monthly notices earlier in this newsletter.

Talk-in: - 448.600 (pl 123.0)

Check OARC web site for details

www.ogdenarc.org

Please invite a friend to join you. You do not have to be a member of the club to participate in our club meetings or activities. We invite all to join us.

If anyone is interested in doing a presentation on something or just have something unique to show at the meetings. - Please get a hold of any of the officers and let us know.

Next Weber Co VE Test Session:

1st Wednesday Feb, Jun & Oct

Exam sessions are held in Ogden every few months, ***usually*** the first Wednesday in February, June, and October.

Time: 06:00 PM *Walk-ins allowed*

Location: Permanent location

Utah Military Academy
5120 S 1050 W
Riverdale UT 84405

Contact: VE Liaison:

Rick Morrison W7RIK (Co-Liaison)

morrisonri@msn.com (801-791-9364)

Gil Leonard N7GIL (Co-Liaison)

Jason Miles KE7IET (IT)

Cost: **$ 14.00**

Two forms of **ID**, one of which must be a **picture ID**.
For "Upgrades" bring current **license** and a **copy** of current license, and any **CSCE**'s

Most **calculators** allowed. Calculator memories must be cleared before use.

Club Web Site

Be sure to visit our club web site.

www.OgdenARC.org

Club membership is open to anyone interested in Amateur Radio. You do not need an amateur license to join us. Dues are used to operate the club, field day activities, and repeater equipment maintenance.

Club Call Sign

Listen to the club repeaters for this very familiar CW ID. You do know Morse Code don't you?

W7SU

OARC is 100 years old

OARC was established in May 1921 and became ARRL affiliated in 1937.

OARC REPEATERS

(*) Yaesu Fusion digital/FM compatible

FREQ	CLUB	TONE	LOCATION
146.900-	OARC (*)	125 DCS	Mt Ogden (w/WiresX)
448.600-	OARC (*) "talk-in"	123.0	Mt Ogden
146.820-	OARC (*)	123.0	Little Mtn
448.575-	OARC	100.0	Little Mtn (w/auto patch)

FREQ/Offset	TONE	LOCATION	OWNER
145.250 -	PL 123.0	Weber State Univ	WSC
145.290 -	PL 123.0	Brigham City	GSARC
145.330 -	PL 100	BYU (Provo)	BYUarc
145.430 -	PL 123.0	Brigham City	GSARC
145.470 -	PL 123	Powder Mountain	Weber Co Sheriff
145.490 -	PL 123.0	Promontory Point	unknown
146.620 -	PL none	Farnsworth Peak	UARC
146.640 -	PL none	Logan	BARC
146.720 -	PL 103.5	Mount Logan	BARC
146.760 -	PL none	Lake Mountain	UARC
146.780 -	PL 100.0	Lake Mountain	UVARC
146.920 -	PL 123.0	Promontory Point	N7TOP
147.040 +	PL 123.0	Antelope Island	DCARC
147.100 +	PL 123.0	Morgan County	KB7ZCL
147.120 +	PL 100.0	Farnsworth Peak	UARC
147.220 +	PL 123.0	Brigham City	GSARC
147.260 +	PL 103.5	Promontory Point	BARC
147.360 +	PL 100.0	Lewis Peak	Summit Co ARC
447.200 -	PL 127.3	Antelope Island	DCARC
447.225 -	PL 100.0	Malad Idaho	Malad Repeater
447.775 -	PL 123	Powder Mountain	Weber Co Sheriff
448.300 -	PL 123.0	Brigham City	GSARC
448.825 -	PL 123.0	Clearfield City	IRLP Node 4654
449.100 -	PL 146.2	Farnsworth Peak	UARC
449.250-	PL 123.0	Weber State Univ	Coming soon
449.425 -	PL 100.0	Nelson Peak	IRLP - Western
449.500 -	PL 100.0	Farnsworth Peak	UARC
449.625 -	PL 103.5	Mount Logan	BARC
449.775 -	PL 123.0	Promontory Point	unknown
449.925 -	PL 100.0	North Salt Lake	DCARC
449.950 -	PL 123.0	Clearfield City	IRLP Node 3876
ATV - wb7fid	TV Ch 58	Farnsworth Peak	UARC - Utah ATV

AREA CLUB MEETINGS & WEB SITES

CLUB	WEB SITE	DATE/TIME	LOCATION
OgdenARC	ogdenarc.org	3rd Saturday 09:00 am	Check OARC web site …
WC Sheriff Comm-O		1st Saturday 10:00 am	Weber Co. Sheriff Complex West 12th Street Ogden Utah
Barc	barconline.org	2nd Saturday 10:00 am	Cache Co. Sheriffs Complex 200 North 1400 West Logan Ut
CSERG	dcarc.net /ares.htm/	Last Wednesday 8:30pm	Clearfield City Hall Clearfield Utah
DCarc	dcarc.net	2nd Saturday 10:00 am	Davis Co. Sheriff Complex Farmington Utah
NU Ares	home.comcast.net/ ~noutares/	3rd Wednesday 7:00 pm	Cache Co. Sheriff Office Logan Utah
Uarc	xmission.com /~uarc/	1st Thursday 7:30 pm	UofU EMC Bldg Room 101 Salt Lake City Utah
UVarc	https://uvarc.club	1st Thursday 6:30 pm	Orem City Council Chamber Room 56 North State St. Orem Utah
GSarc	Ubetarc.org	Check Website	Check Website
Utah DX Association	udxa.org	3rd Wednesday check web page for details	check web page for details Salt Lake City area
UvhfS	ussc.com /~uvhfs/	Each Tuesday 8:00 pm (refer to web site)	Weekly 2 meter net (no eye ball meetings)
WDArc	westdesertarc.org/	1st Tuesday 7:00 pm	Tooele County Courthouse Tooele Utah
WsuArc	https:groups.google.com/forum/#!forum/wsuarc	3rd Thursday 5:30 pm	WSU Blding #4 Room ? Ogden Utah

LOCAL AREA NETS

DATE	CLUB	FREQ
Daily @ 12:30 PM mt	Utah Beehive net HF	7.272 Mhz HF LSB
Daily @ 07:30 PM mt	Utah Code net HF	3.570 Mhz HF CW
Daily @ 02:00 UTC	Utah Farm net HF	3.937 Mhz HF LSB
Sunday @ 8:45 AM	Ogden Old Timers HF net	7.193 Mhz HF LSB
Sunday @ 7:15 PM	Weber/Davis ERC	146.820 - 123.0 (ERC training net)
Sunday @ 7:30 PM	GS ARC	145.430 - 123.0 (training net)
Sunday @ 8:30 PM	SATERN Net	145.900 - 123.0
Sunday @ 9:00 PM	Morgan Co Net	147.100 +123.0
Sunday @ 9:00 PM	UARC Info net	146.620- no PL tone required
Monday @ 9:00 PM	2-meter SSB net	144.250 Mhz 2-meter USB
Tuesday @ 6:30 PM	OARC—Ham & Eggs Net	448.600 -123.0
Tuesday @ 8:00 PM	Weber ARES	448.600 - 123.0
Tuesday @ 8:00 PM	VHF Society Swap	147.120 + 100.0
Tuesday @ 9:00 PM	Bridgerland ARC	147.260 + 103.5
Wednesday @ 7:00 PM	Am-Con Northern Utah	448.600 –123.0
Wednesday @ 8:00 PM	GS ARC	145.290-, 145.430-, 448.300- (all 123.0)
Wednesday @ 8:30 PM	CSERG	145.770 simplex
Wednesday @ 9:00 PM	No. Utah 10m HF net	28.313 Mhz HF USB
Wednesday @ 9:00 PM	6-meter SSB net	50.125 Mhz 6-meter USB
Thursday @ 7:00 PM	OARC - 10 Meter Net	28.385 MHz USB (all hams invited)
Thursday @ 6:30 PM	Davis Co Elmers Net	147.040 + 123.0 New Hams
Thursday @ 8:00 PM	Weber State ARC	146.820 - 123.0 (coming soon)
Thursday @ 8:00PM	State RACES VHF/IRLP	145.490 - 123.0, 146.680 - 123.0 3rd Thursday - even months only
Thursday @ 8:30 PM	Davis ARES	147.420 = simplex
Thursday @ 9:00PM	Wasatch Back Net	147.360 + 100.0
Saturday @ 8:00AM mst	RACES State HF	3.920 Mhz HF LSB 3rd Saturday – odd months only
Saturday @ 11:00AM mst	QCWA net HF	7.272 Mhz HF LSB

73 de W7SU

w7su@arrl.net

www.OgdenARC.org

PO Box 3353 Ogden UT 84409