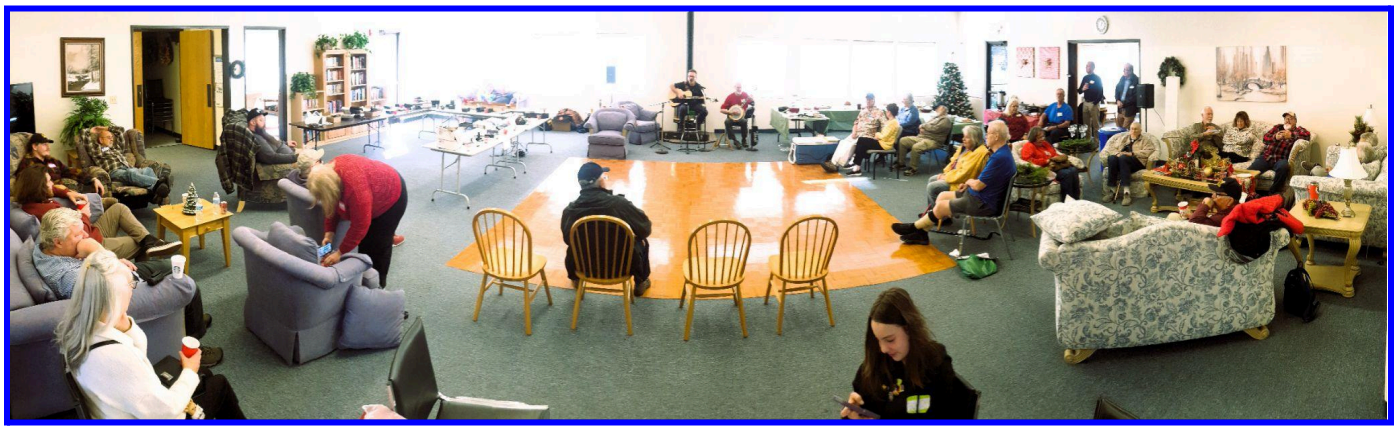
TCARES - Tuolumne County Amateur Radio & Electronics Society

Amateur Radio Club Winter 2025 Newsletter

December 21, 2025



TCARES Christmas Party, December 6, 2025

Greetings - Winter Season has Arrived!

Hello TCARES members and Happy Winter Solstice! As always, this quarter's newsletter articles are meant to *teach*, *inform*, and *inspire*! The TCARES club newsletter helps to keep us abreast of the news of interest, along with promoting connection with one another in different ways. Our article authors have put effort into their pieces and we hope you enjoy their contributions, keeping you aware and actively engaged in our club.

We continue to have breakfast meetings at **My Garden Cafe**, in east Sonora - come join us and connect with other Hams! We hope to see you all at the next **TCARES Club Breakfast** meeting on **January 17th**. Many other events are listed on the TCARES club **Events Calendar** (upcoming events are listed on the right side of the webpage). So, please, come join in on the fun and get connected with other hams!

Coming Up:

Inside This Issue:

Dates to Remember:

December 21	Winter Solstice
January 17	TCARES Breakfast Mtng
January 18-24	Quartzfest!
January 24	TCARES Board Meeting
January 24	Winter Field Day
February 21	TCARES Breakfast Mtng
March 20	Vernal Equinox
March 21	TCARES Breakfast Mtng
March 28	TCARES Board Meeting
March 28	Loomis Hamfest

2025 TCARES Education Classes & Training Events

	Event	Date	Location
1	Beginner Radio Class	Saturday, January 4, 2025	Country Cowboy Church, East Sonora
2	Intermediate Radio Class	Saturday, March 8, 2025	Country Cowboy Church, East Sonora
3	Beginner Radio Class	Saturday, March 29, 2025	Mill Villa Clubhouse, Jamestown
4	Beginner Radio Class	Saturday, May 3, 2025	Country Cowboy Church, East Sonora
5	Intermediate Radio Class	Saturday, June 28, 2025	MeWuk Village (coincides with ARRL Field Day)
6	Beginner Radio Class	Saturday, September 27, 2025	Introduction to Radio (FRS, GMRS, & Amateur)
7	Intermediate Radio Class	Saturday, October 4, 2025	How to Use an HT Radio During an Emergency
8	Intermediate to Advanced	Thursday, October 16, 2025	Net Control Training at the Great ShakeOut

This is the schedule of training sessions for 2025. The schedule for *2026 will be out at the beginning of the year*. Look for it to be posted on ***www.tcares.net***.

Editor's Note

By Jeff Tolhurst
N6JWT/WRDP326

Winter is Here - Happy Winter Solstice!

TCARES has had an active fall quarter, with multiple club events including: 1) the Great Shakeout emergency and net control operator training session; 2) three monthly breakfast meetings; 3) three club breakfast presentations; 4) two Board meetings; 5) one VE session; and 6) three radio training classes (whew!). We continue to be an active club, with lots to participate in each quarter. Thanks to all, who have enjoyed the fun! I would also like to send a *HUGE* thank you to all of the contributors to the TCARES newsletter - I'm so grateful for all of the effort each of you puts into this work to keep our members informed!!

With winter weather upon us, we're experiencing shorter, colder days, with more to come. Last year we had several intense winter storm events with snow, wind, and power outages, so *keep those batteries charged*, with radios, and *Go Bags ready*! We have upcoming training sessions for beginners, as well as anyone wanting to know how to use a handheld radio during an emergency. See our calendar of events at www.tcares.net for more information.

While staying prepared for emergencies, there are also some wonderful opportunities for radio contesting, including the January VHF Contest. Check our website Events Calendar for more information, as well as the ARRL's Contest Calendar page: (https://www.arrl.org/contest-calendar/).

Additionally, club elections were held this quarter and I will be serving as your President for this next term. Ginger, KM6RFT, was re-elected as Secretary, and George, N6GEO, was elected to fill the Director C board position. I would like to thank Mike, W6MVM, Ron, KK6QPP, and Dave, K6DCL, for their tremendous service, volunteer spirit, and leadership in guiding & directing the club this past term. I hope I can speak for the whole club, when expressing our gratitude and thankfulness for your dedication and support to TCARES! My plan is to keep the good things going - we do a lot for our community, and serve well, in my opinion. There are also some things that we'll continue to tinker with, making the club a bit more efficient and effective. Stay tuned!

Finally, we have some upcoming radio-related events, including: Winter Field Day, monthly TCARES Breakfast Meetings, weekly radio nets, VE sessions, ARRL Contests, TCARES sponsored education & training classes, runs & rides, and more. Enjoy the change of the season, stay safe, and we hope to see you at some of these events soon!

73, jeff

President's Message

by Mike McGinty
W6MVM

President's Message

Hi, this will be my last Presidents Column. I have really enjoyed being president of TCARES for these two years. I have had the pleasure of a great Board of Directors that made my job much easier.

In my first column as president, I emphasized that I wanted TCARES to be the members' club, being what the members wanted it to be. I later summarized this as, "TCARES is a social club centered around amateur radio". It traditionally has several service activities: we support multiple run activities; social activities such as Winter & Summer Field Days; the interclub picnic; the Christmas party; and monthly breakfast meetings. The nets are both service, and social, and great fun.

As president, I wanted to continue and improve these traditional activities, where we could. The only activity that we dropped is the collection of funds for ATTCA at breakfast meetings, but we continued to contribute as a club, from our treasury.

Several of our traditional club activities have been greatly improved. ARRL Summer Field Day, this past June, was at a great new location, the Pinecrest Academy School. We also used battery and solar power to power all stations. No more noisy generators. We had an internet connection by StarLink. I have purchased a StarLink Mini so we will have it for the next Winter and Summer Field Days. The Pinecrest Academy is a great location. I hope we will use it for many years to come. Our Christmas Party was held at a new location, the Rambling Hills Estates clubhouse. This was a great location, and Ginger, KM6RFT, our club secretary, did a great job organizing it. Our monthly meetings were greatly improved by the programs provided by Vice President, Jeff, N6JWT.

Our runs and other activities were greatly improved by our new Communications Trailer. This has added greatly to our presence at these events and activities. It also made it better for the net controllers.

Thank you for electing me as club president for these last two years. It has been great fun. I have served on the board as treasurer, secretary, and president, for many years, and have enjoyed every minute of it. I'm not going away. I will still do the Thursday night CW net, and help with activities, especially Field Day and club contesting.

Thank you all for letting me do all of this.

73, Mike, W6MVM (w6mvm@arrl.net or mvmcginty@gmail.com)

Introductory & Intermediate Radio Training Classes on "How to Use a Handheld Radio During an Emergency" held on September 27, 2025 & October 4, 2025 at the Mill Villa Estates Clubhouse

Antenna of the Month

By Gary W. Johnson
NA6O

Antenna of the Month: Portable All-Band Vertical

Having an all-band antenna that's lightweight, easy to set up and easy to use is handy for all kinds of portable operations such as POTA and Field Day. After a request from my blind ham friend Earl, KG7UKW, I put together something that he can take to the field with minimal hassle. It's based on a non-resonant vertical wire and a modest number of ground radials with a matching transformer to improve the average SWR. This one uses one of the "*magic*" vertical lengths of 25 feet which actually resonates around 9 MHz. Avoiding resonance on any ham band is an old trick that helps avoid extreme feed point impedances which are hard to match.

Construction

To keep things simple and lightweight, I used 20 gauge insulated wire for both the vertical and radials,

and a 32-foot telescoping fiberglass pole from *Sotabeams* [Ref. 1], which we extend to about 25 feet. Other types will also work such as the ones made by *Jacktite*. The pole can be supported at the base by almost anything. In an open area, a 3-foot construction stake works great. Heavy Velcro straps tie the mast in place. Radials are connected together via screws and wingnuts at a copper ring at the base but almost any connection method will do. I chose to use eight radials 25 feet long as a compromise. More is better of course but it becomes a matter of convenience and diminishing returns after a point. The radials simply lie on the ground. Finally, the matchbox is strapped to the base and connected between the vertical and radials (Fig. 1).

Figure 1: Base of the antenna showing the mast, radial connections, and matchbox.

Matchbox Design

Feed point impedance of this antenna is literally all over the map as you sweep through the HF bands. The map I'm referring to is the *Smith Chart*, a handy way of displaying complex impedance and much more. It's about the only way to make sense of what's happening and to determine if your matching technique is likely to be successful. In general, we find that the impedance is higher than 50 ohms and also wildly reactive. Also, it's bad enough that the built-in tuner in most transceivers will not succeed. A 4-to-1 impedance stepdown transformer is a reasonable choice, bringing things into range of most tuners on most bands. This same solution was applied in last month's antenna, the off-center fed dipole, which had many of the same issues.

Since this antenna is only intended for use up to 100 W, small ferrite cores were used in the matchbox. A 4:1 transformer is bifilar wound with magnet wire on a 1.4 inch type 61 core which exhibits low loss. A common-mode choke is also required to avoid having the outside of the coax become another radial. I used a 1.2 inch type 31 core wrapped with 12 turns of RG316 Teflon coax. This yields at least 4000 ohms of choking impedance from 7 to 30 MHz, an excellent result. Binding posts provide wire connections. A weatherproof plastic box gives us some peace of mind when it rains. Figures 2 and 3 show the schematic and a photo of the innards. I ran 100 W continuous through this matchbox into the actual antenna on all bands and there was no significant heating.

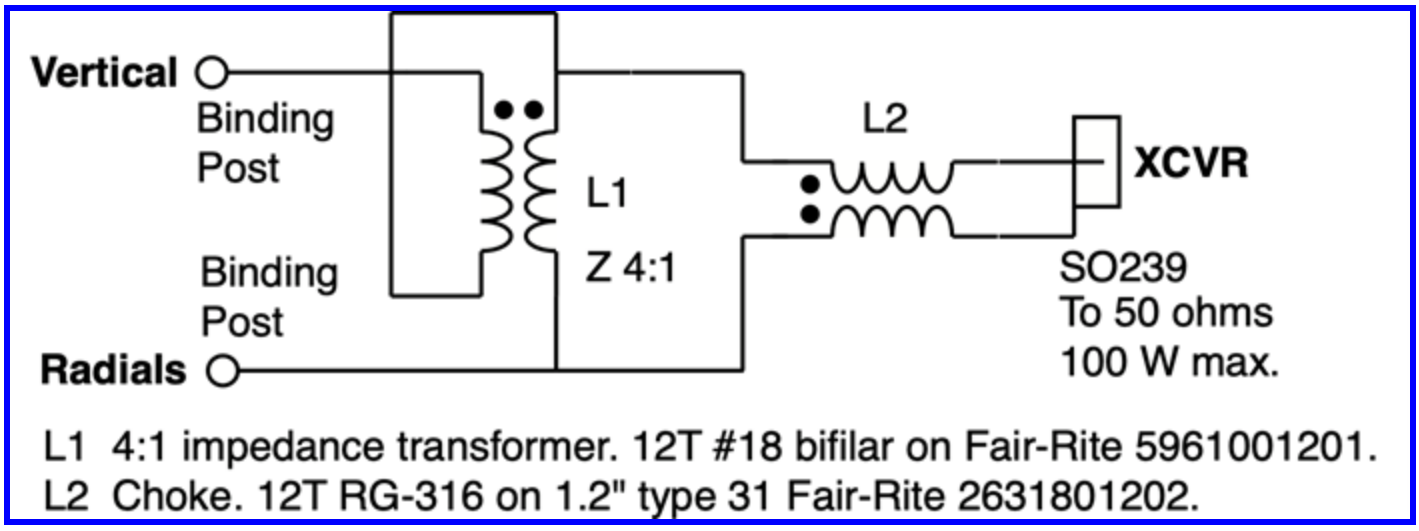


Figure 2: Matchbox schematic.

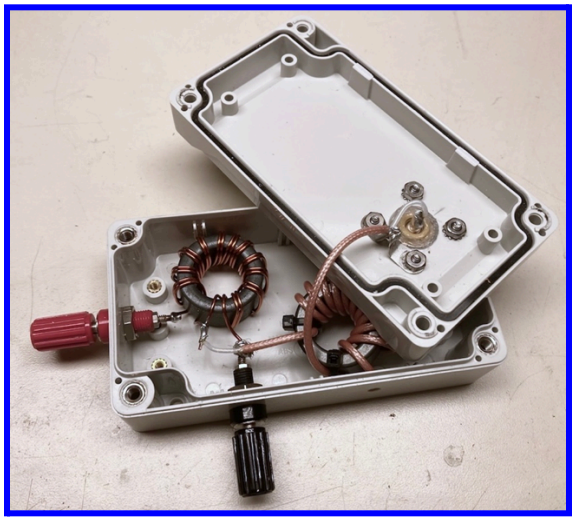


Figure 3: Matchbox internal construction. The box is 5 x 2.5 x 1.6 inches.

Performance

Everybody wants to know if the SWR is perfect everywhere because they mistakenly think that's what makes an antenna "*good*." But a dummy load has perfect SWR and radiates nothing! What matters most are *radiation pattern* and *efficiency*. SWR only has to be within range for your antenna tuner.

One way to estimate efficiency of a vertical is to measure the feedpoint resistance at its fundamental resonance. I did that with my VNA, and found that it was 38.1 ohms at 8.67 MHz. An ideal 1/4-wave vertical over perfect ground would be about 35 ohms, and that represents ideal *radiation resistance*—the place your input power goes to do the work of turning RF current into radiated fields. Since mine measured higher than that, we have some loss, in this case 0.7 dB, and it's mainly due to an imperfect radial system, which allows some current to flow in the lossy Earth. It turns out that's because this antenna exhibits relatively high impedance at its feedpoint, its dependence upon the ground system is relaxed compared to a resonant vertical.

There is also quite a bit of loss in the coax due to the high SWR. I used 40 feet of RG58 and *SimNEC* [Ref. 2] tells me that the worst-case loss between 7 and 50 MHz is about 2.4 dB. Using RG8 reduces that to about 1 dB. Actually, this loss can work somewhat in our favor since it masks the most extreme SWR excursions that might cause our antenna tuner to fail in finding a match. Still, do not be surprised if your tuner fails to match on one, or more, bands. I found that 17 m was the worst. Table 1 lists the SWR at the matchbox connector and at the end of the coax.

Table 1: SWR at matchbox and at the end of 40 ft of RG58.

Band	At Matchbox	At End of Coax
40 m	7.2	5.2
30 m	4.6	3.7
20 m	7.7	4.5
17 m	13.4	5.5
15 m	9.8	4.7
12 m	3.9	2.7
10 m	2.8	2.1
6 m	3.5	2.2

Radiation pattern is of course omnidirectional and mostly at a low takeoff angle. Figure 4 shows the elevation patterns which gain higher-angle lobes on the higher frequencies. This is typical of a vertical that is too long for those bands.

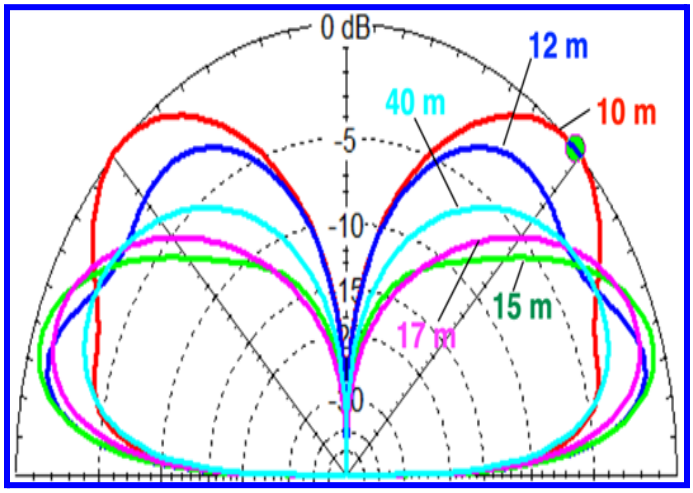


Figure 4: Elevation patterns. 40 through 15 m are typical single-lobe, low-angle. Higher bands start to have lobes at higher angles. Outer ring is 1.7 dBi.

Conclusion

Every antenna is a compromise and those that try to cover a vast range of frequencies are often doomed to poor performance over at least part of their range. In this case, we did ok for such a simple, lightweight kit with no fiddly adjustments. It offers decent efficiency and probably will yield a usable match on all bands from 40 through 6 m. I gave it a try mid-morning running 100 W on CW for all bands and the reverse beacon [Ref. 3] detected me from Hawaii to central America and into Europe, as well as all over North America. Also I got a report from Earl: He managed to set his up for the first time in 10 minutes, and that's without eyes! Not bad. And it fits in your backpack.

References

1. **Sotabeams** compact 32-foot travel mast.
https://www.sotabeams.co.uk/compact-light-weight-10-m-32-ft-travel-mast/

2. **SimNEC** is a free Smith Chart simulator, very useful for all kinds of RF circuit analysis. https://www.ae6ty.com/smith_charts/

3. Reverse Beacon Network. https://reversebeacon.net/main.php

73, Gary

Formerly WB9JPS, I have been licensed since 1972, and am originally from Illinois. I no longer have a home station due to RFI and other issues. But thank heavens I now have a fabulous remote station, W6SRR, which I share with Ian, W6TCP. I enjoy operating CW especially and have achieved 9BDXCC (total 318, working on 6m) and 10BWAS. I'm a fairly competent contester, member of NCCC, and station engineer at N6RO. Chasing SOTA activations is also in my fun category--I'm a certified Shack Sloth. My website is: https://na6o.com/.

More Images from the Radio Training Class on "How to Use a Handheld Radio During an Emergency", October 4, 2025

TCARES Great ShakeOut Earthquake Drill October 16, 2025

Meet Our Members

By Ginger Rohlen
KM6RFT/WSAP468

TCARES Club member, Harald Kelley, K06HEA, was born in Bonn, Germany. His dad was in the military and was stationed in Germany, where he met Harald's mother. She was a nurse who grew up in East Germany and had escaped during the war. When Harald was 4 years old, his family moved to the United States to reside in Fort Ord, CA., where his Dad was stationed. Harald had to learn English to attend Ione Olson Elementary School in Marina, CA. Due to his dad being in the military, Harald went on to attend many different elementary schools.

"Being a military brat, I attended several schools including one in Fort Dix, New Jersey, another in Monterey, California, and then one in Fort Benning, Georgia. I graduated high school from Stuttgart American High School in Ludwigsburg, Germany." Harald's dad's last tour of duty was in Connecticut where he taught Reserve Officer's Training Corps (ROTC) at the local college. "While living in Connecticut, I worked as a clerk at a grocery store and as a pin jammer in a bowling alley."

It was around this time when Harald became interested in Citizen Band (CB) Radio. At this time CB was very active and Harald became a member of the Radio Emergency Action Citizen Team (REACT). Harald had several single sideband-capable radios and he enjoyed working DX stations. Additionally he enjoyed helping others during the harsh Connecticut winters via REACT and weather spotting.

"After Connecticut, my dad retired from the military and decided to relocate back to California. I decided to go with them, and we ended up in Pacific Grove, CA, in 1977. I worked several jobs at the time and became an avid surfer. CB radio was not that active there like on the East coast, and I ultimately put it aside. I began taking courses at Monterey Peninsula College to become a police officer."

In 1981 the City of Marina was recruiting for volunteer firefighters. Harald applied and was hired, along with several other applicants. He attended numerous training sessions and classes and found the fire service to be very interesting. After responding to his very first working structure fire, he was hooked. "It was the teamwork and comradery that I liked." Consequently, Harald redirected all his efforts away from law enforcement toward the fire service. "I began the quest of chasing a career in the fire service. I changed my major from Administration of Justice to Fire Protection Technology and began to take CA State Fire Marshal Courses. I began testing at local fire departments. During this time, I also worked at Safeway. I started as a bagger and moved up to a grocery clerk."

In 1984, Harald was hired by the Fort Ord Fire Department (FOFD). The military fire department was staffed by civilian personnel hired by the Department of Defense (DOD). For Harald, having grown up around the military all his life, this was a good fit. Fort Ord was a large installation, and the fire department was very busy, which provided a wide variety of calls for service with lots of challenges. While working at the fire department, the schedule allowed him to have every other day off, which amounted to several days off every week. Harald surfed, and flew remote control planes and gliders. This schedule also allowed for parttime work. Before Harald was hired by the FOFD, he had been working at Safeway. The Safeway management team allowed Harald to stay on and work part time. He did this for about 6 years. In addition, Harald also worked as part time security at Del Monte Shopping Center, in Monterey. As his career progressed, he was promoted up through the ranks and moved from Firefighter, to Engineer, and then Captain. As Harald was living in the city and working with the FOFD, he also remained a volunteer with the Marina Department of Public Safety Fire Division. “Life was good.”

In the late 1980s, it was announced that Fort Ord was one of several military bases that would be closing permanently. The closing was to begin in 1994. Although fire and police were essential services, staffing reductions began. At the time Harald was assisting the Marina Department of Public Safety with part time training of their public safety officers in fire service-related training. The officers would work 9 months on patrol and one officer would be assigned to the fire house for 3 months. It always required refresher training.

In 1996, Harald was offered a fulltime job with the Marina Department of Public Safety as a Training Manager and provided training to those officers assigned to the fire house. Shortly after being hired, Harald became the Fire Marshal. After several years, the Director of Public Safety and the Fire Division Commander retired. With the base closure, and all of the development planned for the city on former Fort Ord property, Harald did a presentation to the, then, city council, outlining how fire protection was being done in the city under the public safety model and how the fire service is done in a dedicated fire department. “In a nut shell, the city could not continue to have only one person in the fire house and the 3 patrol officers on the street and rely just on volunteers.” The city council ultimately approved the presentation and directed staff to work on separating the public safety department into two separate departments. In 1997 the Marina Police Department and the Marina Fire Department were established. Harald became the Acting Fire Chief and about a year later was appointed the permanent Fire Chief. He retired after 32 years in the fire service, which was almost 11 years ago. Since 2002, Harald has been part of the instructor cadre for the Monterey Peninsula College Fire Academy, which he continues to do, to this day.

According to Harald, his interest in radio had been laying idle for too long. So when his family’s vacation home in Don Pedro became more of a permanent residence, and Harold and his wife Glenda moved there, Harald decided to get a GMRS license. “I thought if we get a big fire up here and we lose everything, as far as communication goes, how can I receive information about the fire, and how can I

get information out?" This led to his decision to get his GMRS license. Upon speaking with other local GMRS operators, Harald learned about the Livermore-Altamont repeater and joined their net. Currently, on the Saturday night net, Harald does the General Trivia questions. When he heard about the GMRS repeaters in Sonora, he researched those, and asked the owners for permission to use their repeaters. After being approved, Harald started to participate in several nets. These experiences re-sparked Harald's interest to become a Ham radio operator. "For probably 40 years, I have always wanted to get a Ham license." He studied, and for Harald, "...my amateur radio journey began when I finally decided to test in December 2024 (KO6HEA). This December it will be one year since I got my Technician license."

Since that time, Harald has been learning a lot. He has set up a 2 meter station, with a 70 cm VHF/UHF base. Then, about 6 months ago, Harald bought a Radioditty 10-meter HF radio and set up an Antron 99 antenna for 10 and 11 meters. This simple, but functional, setup has again gotten him even more interested in HF. " I recently bought a Yaesu FT 710 which has been a blast. I'm hooked and learning! I have worked stations in the Canary Islands, South Korea, Japan, Canada, and more. In addition, I have made many U.S. contacts." The other thing that is really kind of cool, is that I have never really been into Geography until now. When I find myself making a new contact, I look at my great big Yaesu map with all the different prefixes so I can locate the call sign. Whether it's the Canary Islands, on the west side of Africa, or Paraguay, down in South America, it's been fun to locate new stations. So it's really kind of interesting to start learning more about the world this way. It's fun to see where everything is!"

Some other things of interest to Harald, as a licensed amateur radio operator, include weather, and ARES (Amateur Radio Emergency Service)." I have always liked weather-related stuff." Currently Harald is getting ready to participate in the Northern California Skywarn online training, after which he will be able to report weather related observations to the National Oceanic and Atmospheric Administration (NOAA). Skywarn is a national network of volunteer severe weather spotters, who are trained by local National Weather Services forecast offices. Two thirds of its volunteers are amateur radio operators. Harald's first class begins on the 19th of this month. Harold's interest in ARES has led him to download the ARRL task book for ARES and begin studying on his own. "Some of the tasks I have already completed are all the ICS (Incident Command System) trainings - ICS 100 through ICS 800, and all that. It's all about radio emergency stuff that I thought would be valuable up here." Harald volunteered to participate as one of

three net control operators for the 2025 Great ShakeOut earthquake drill, with TCARES, on October 18th, and he thoroughly enjoyed himself.

Harald has been married to his lovely wife, Glenda, for 37 years. Together they have enjoyed the summers up here, doing a lot of boating, and waterskiing. Vacationers for many years, they are up here much more now, and Harald is "having a ball with the radio stuff!" At this time he is studying for his General license and hopes to test some time in 2026, before the change in the 2027 ARRL test questions. In addition, he is currently in the process of setting up a 6-meter antenna. Up to this point, "All of my contacts have been SSB voice. I have not tried digital yet. I am not too sure about that mode yet."

Skilled at reading up on things he doesn't know about, interested in challenging himself and experimenting, Harald is enjoying learning more about radio each day. His inquisitive, and positive attitude, and his willingness to jump in and apply himself to club events, learning as he goes, is admirable and a true asset to TCARES. We are so thankful to have Harald as one of our new club members. His interest and enthusiasm are contagious and we look forward to growing and learning together.

73, Ginger

Ginger is a mom, a teacher, a student, a devoted partner, and a life-long learner. Her interests are many and center around service, communication, leadership, and integrity. She recently completed a Masters of Science in Counseling. She is open to challenging herself to learn and grow and in facilitating that in others. Ginger shares a love of Geology and the natural world around her with her partner, Jeff, N6JWT, and enjoys hiking and exploring the outdoors. Her interest in Ham radio stems from a desire to join others in learning, to be of service, and to continue to improve her communication skills on the air.

TCARES Breakfast Meeting October 18, 2025

Community Corner

By Paul Bailey
KN6CWT/WRWS835

[Editor's Note: Paul injured his arm and wasn't able to submit an article for this issue. If you hear him on the air, wish him a speedy recovery!]

73, Paul

Hello, my name is Paul Bailey and I have been in love with radios for as long as I can remember. I have been a Ham since 2019. My callsign is KN6CWT. During that time I have gotten involved with TCARES quite a bit. I have been lucky to have been elected to the board of the club as a director and now the Treasurer. I have helped with programing and operating radios for both fun and in emergencies, I've also been fortunate enough to help put in a new repeater. I have also learned so much from APRS to WIN System. I have had the opportunity to participate in club events like field day, races, National Night Out and Fly-in's.

Mike's (W6MVM) last TCARES Board Meeting, November 22, 2025

(Thank you, SO MUCH, Mike, for your leadership, service, and dedication, to TCARES! The club is very thankful, and grateful, for all of your efforts! "*Meeting Adjourned!*")

Mike's CW Column

By Michael McGinty
W6MVM

CW News

Hi, the CW column will be a bit short. The contest season is over, but we did well in the California QSO Party this year, as K6TUO. We made the top ten list for our class. We were in the California station, high power, multi-operator class. This is the hottest class in the CQP. We got number nine. Not bad. We operated both CW, and phone, 320 CW contacts and 230 phone contacts mostly on the 10-, 15-, and 20-meter bands, but I did get some contacts on 40 meters, late in the evening. We had some visitors, too. Grayson, KE6KYI, came by and tried to make some contacts in the afternoon, but the bands were bad. Jeff, N6JWT, and Ginger, KM6RFT, came by to chat, and took pictures for the newsletter. We will continue this effort, and we hope to get some more operators who want to experience contest operating at this station. We have the best contest equipment, and the best contest software available. We would love to show more of our members how to do contesting. It's fun, but sometimes long and hard, but you don't have to push it to have fun. In the CQ WW DX Contest, you can work 100 different countries in about ***two hours*** on phone, or CW, and have fun doing it. We have a few more good years before the sunspot cycle goes bad.

The next big CW event is the ARRL Straight Key Night. That's what it's called, but it's an all day, January 1st event, of operating CW with a straight key, or bug, though that's only suggested. All keys are welcome. The object is to make *conversational CW contacts* with other CW operators. Have a good contact and a good conversation and enjoy CW. The ARRL would like to have log submissions and nominations for best fist, and best QSOs, that they will publish in QST Magazine. The event runs all day, January 1st, UTC. That's 4 PM, December 31st, PST to 4PM January 1st, PST, on all bands. This event started the Straight Key Century Club, which is a great CW organization that supports many great conversational CW events. I'm a member. You can sign up for free on skccgroup.com. I recommend it for anyone interested in CW operating.

I hope to continue this column, even though my tenure as president of TCARES, and on the board is coming to an end. It's been great fun. I plan to do more operating, and contesting, and DX hunting, next year. I'm also getting more of my vacuum tube gear up and running, and even better antennas up here at the ranch.

Thanks for allowing me to be president of TCARES for the last two years. It's been great fun.

73, Mike

I started in Ham Radio in 1957 as KN5UHU and K5UHU in Kingsville, TX. I was very active in the early 60's as KH6DOX in Honolulu. Then I received my EE degree from San Jose State in 1969 and focused on working as a consulting engineer. Ham radio took a back seat to what were very exciting times in electronics and software. After retirement in about 2010, I went back to enjoying ham radio and have been active with TCARES in Sonora. I've collected a lot (too much) of Collins equipment and used them on the air exclusively until recently. I purchased several modern rigs including my favorite Flex 6300. I use the Flex at home.

Repeater Coordinator Notebook

By Greg Triplett
WA6HNA/WRZS966

TCARES Repeater System Status Q3 2025

[Editor's Note: *Greg is on vacation and the TCARES VHF 2 meter repeater system is currently functioning well! Both he and Marc are continuing to work on the "succession plan" mentioned in the last newsletter (September 2025), formalizing TCARES' relationships with owners on the Moccasin Peak and Duckwall Mountain repeater sites.*]

Greg is the TCARES Repeater Coordinator & K6TUO FCC Trustee. He was a senior hardware engineer at Google (now retired), who specialized in FPGA (Field Programmable Gate Array) design for high-speed digital circuits and systems in the networking, data communications, storage area networking, wireless, and RF industries. Additional industry experience was in test & measurement, telecommunications, satellite TV, security, military, and aviation.

TCARES Annual Christmas Party, December 6, 2025

ARES/RACES Emergency Communications Report

By Ned Sudduth

K6NED/WRPM781

Changes at the OES EOC & the New Comms Trailer

It's hard to think clearly during an emergency, and the last thing you want to do is leave something important behind. Use this ARES guideline checklist to gather essential items and prepare today for what might happen tomorrow.

Emergency Prep Kit Checklist

IN CASE OF EMERGENCY, HAVE THESE ITEMS READY

- **Food and Water** — A 3-day supply of water and food. Include 1 gallon of water per person per day and non-perishable food items like energy bars, cereal, dried fruit, nuts, peanut butter, and canned meats.
- **Utensils** — Eating utensils, plates, cups, bowls, a can opener, and paper towels.
- **Clothing** — A change of clothes for each person, rain gear, extra shoes, and waterproof boots.
- **Day-to-Day Living Items** — Garbage bags, toilet paper, matches in a waterproof container, a multipurpose tool, dust masks, duct tape, plastic sheeting, Mylar® blankets, a whistle, local maps, and bleach.
- **Personal Items** — Toiletries, an extra pair of glasses/contact lenses, tweezers, and nail clippers.
- **First Aid Kit** — Sterile gloves and dressings, bandages, soap, antibacterial towels, hand sanitizer, burn ointment, antibiotic ointment, eye wash, and a thermometer.
- **Medications** — A 3-day supply of prescription medications, pain relievers, cold and sinus relief, anti-diarrhea medicine, antacids, and laxatives.
- **Devices** — A cell phone, a charging cord, a portable charger or battery pack, a hand-crank radio, an LED flashlight with extra batteries, and a headlamp.
- **Important Documents** — Copies of birth certificates, driver's licenses, insurance cards, medication lists, medical records, proofs of address, passports, wills, bank records, marriage licenses, adoption papers, and emergency contact lists.
- **Cash** — Small denominations and change.

ADDITIONAL ITEMS

- **For Babies** — Diapers, baby wipes, baby powder, diaper rash cream, baby wash and lotion, formula, baby food, bottles, bibs, burp rags, pacifiers, teething tablets or gel, and blankets.
- **For Seniors** — Medications, hearing aids and batteries, extra eyeglasses, syringes, portable oxygen, mobility supplies, and contact information for doctors and caregivers.
- **For Children** — Books, toys, puzzles, crayons, and comfort items.
- **Ham Radio Gear** — A handheld, a mobile radio, chargers, extra batteries, antennas, power cords, and a laptop.

ARRL The National Association for Amateur Radio®

ARES® Checklist

IDEAS FOR A HEALTHY ARES GROUP

- **Attend Test Sessions** — Many new hams get their license for an opportunity to participate in emergency communications.
- **Public Safety** — There are many volunteers in public safety around the country. Many of those individuals would make great ARES volunteers as well. You should always look for opportunities to assist your partners in public safety.
- **Professionalism** — Maintaining a professional look, including the ARES logo or other appropriate attire at official events, shows that you are part of a professional volunteer organization. Mannerisms and actions should also be consistent with a business environment.
- **Mentoring** — Take time to coach new or potential members. Mistakes can happen — use them as a teaching moment. Remember what it was like to be the "new person."
- **Hamfests** — Take this opportunity to encourage your fellow hams to be active.
- **Training** — Train regularly and realistically. An active group will typically have a better volunteer response. Use a combination of classroom and practical training.
- **CERT** — If you have a Community Emergency Response Team in your area, have conversations with them. Many of these teams are looking for volunteers and ways for their members to communicate.
- **Field Day** — Use events such as ARRL Field Day or Winter Field Day as opportunities for an exercise or drill. Pick one or two areas of the event that you are going to evaluate and work on improving those areas. Treat the event as a real emergency with the opportunity to fix problems.
- **Planned Events** — Parades, bike and running races, and other types of planned events make excellent opportunities to train and are a great service to the community.
- **Nets** — On-the-air activity provides more opportunity for training and operating practice.

WANT TO GET INVOLVED IN ARES?

- Ask local hams about involvement
- Contact your Section Manager or Section Emergency Coordinator, **www.arrl.org/sections**
- Join local radio clubs, **www.arrl.org/clubs**
- Be "radio active" — Get on the air as often as possible
- Attend SKYWARN® training, **www.weather.gov/SKYWARN**
- Learn more about the Amateur Radio Emergency Service®, **www.arrl.org/ares**
- Reach out to ARRL for assistance, email **ares@arrl.org**

[Note: Use the Zoom (+) tool to zoom in on these useful images.]

73, Ned

Ned is the TCARES Webmaster (http://www.tcares.net), as well as the club's ARES/RACES Coordinator. He was previously KM6EAC, then N4NED, and is now K6NED. He has achieved the following awards: Grid Squared; United States Counties; World Counties; and World Radio Friendship. He served in the U.S. Navy (PlankOwner USS Essex LHD 2) and he and his wife, Toni, K6TNI, live in Sonora.

Sparkie's Corner

By Rich Combs

KN6HSR/WRMM317

Twain Harte Winter Wonderland Parade!

What do you get when you combine 13 radios on a commercial UHF frequency, 10 radios on another UHF frequency, a smattering of GMRS radios, a couple of VHF radios, and the Tuolumne County Community Services Unit (CSU) operating on their frequencies? You get a *very successful Christmas Parade in Twain Harte*!

Thanks to Ron Trout, KK6QPP/WRYV681, who organized a mini radio training course on the night before the parade, a group of volunteers, with basically *no prior radio training*, were brought up to speed on basic radio operation and etiquette.

Thirteen UHF radios with two commercial channels were provided by Columbia Communications. These were provided to the largest group of volunteers covering traffic for the event. One of the channels was for inter-group traffic comms, while the second channel was only for communication from the traffic control captain to the Primary Parade Captain. Another group covering the deployment of the floats and other parade participants, were given another set of radios, that were provided by the Twain Harte School, with a similar channel arrangement. The parade announcers were using GMRS radios and maintained crucial comms with the float deployment captain through the event Primary Captain. Tuolumne County CSU also had radios operating on yet another frequency, somewhat independent from the main parade communications.

How could this all work? It really relied on a central communications clearing house in the person of John Buster, KN6RLM/WROX508, who performed the role of a switchboard operator. With an array of each of the types of radios deployed in the field, and looking like a terrorist bomber with the radios arrayed across his chest, he handled comms from each of the group captains in the field, relayed this to the Primary Parade Captain, and relayed instructions back to the captain of the groups in the field. The field groups each had a captain, or net control, for their sub group, and this individual was the only one that would contact John, keeping the traffic minimized. Having the multiple sets of radios with unique frequencies meant that there was little or no intergroup chatter.

It was amazing how quickly those in the field with little or no prior experience of radio operation, and minimal training the night before, picked up the protocol and etiquette of effective comms. In a different situation, VHF operated by licensed Hams, might be the way to go, but for this community event, with significant planning, and great volunteers, the result was a stellar event. Congratulations to all for a successful Twain Harte Winter Wonderland Parade!

73, Sparkie

I passed my Technician and General licenses in February, 2020 and Extra in September 2021. (I'm good at taking tests; I need to work on working a radio!) Main QTH = Livermore, CA, USA, (CM97). I'm relatively new to the radio world! Member of LARK (Livermore Amateur Radio Klub), and TCARES (Tuolumne County Amateur Radio Electronics Society). My alternate QTH = Strawberry, CA (CM98). As of 10/2021, I'm now working on CW via CW Academy. I passed the Beginner level in October, 2020, and I passed the Basic level in March 2022. I got interested in HAM radio to improve emergency communications for the Strawberry Volunteer Fire Department in 2019. I have gotten in way over my head since then! I have enjoyed building a few kits from QRPme and QQRPguys. I have been developing a Neighborhood Radio Watch (NRW) program in Tuolumne County, modeled on one in El Dorado County, CA, USA.

Tuolumne County GMRS

By Marc Colton
N6NEZ/WRME405

Tuolumne County GMRS Community Update

The Tuolumne County GMRS community would greatly appreciate any TCARES members joining in on our weekly radio nets. These nets help strengthen coordination, improve operating skills, and ensure we are ready to respond effectively when needed.

We are also pleased to report ***100% system uptime since the last newsletter***, a testament to the reliability and resilience of the Tuolumne County GMRS system.

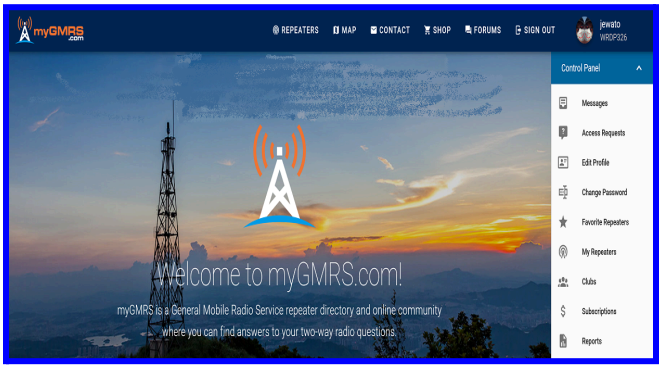
We encourage all members to invite family, friends, and neighbors to join the Tuolumne County GMRS system so that we can all be better prepared should an emergency unfold in our communities. The system is very robust and provides excellent coverage throughout much of Tuolumne County. Now, let's work together to be as well trained and proficient as possible in using this radio system

Community Neighborhood Radio Watch (NRW) GMRS Nets
Net Schedules & Information (in alphabetical order)

Cedar Ridge/Scenic Brook NRW GMRS Net
When: First & Third Mondays at 7:00 PM
Simplex Channel: Cedar Ridge (FRS/GMRS Channel 7)
Net Control: Larry Martin, WSHC534

Columbia NRW GMRS Net
When: Tuesdays at 7:30 PM
Repeater: Hobby Hill (462.700 MHz)
Net Control: Jeff Tolhurst, N6JWT/WRDP326

Duckwall Women's GMRS NRW Net
When: Thursdays at 7:00 PM
Repeater: Duckwall Mountain (462.725 MHz)
Net Control: Ginger Rohlen, KM6RFT/WSAP468



Groveland NRW GMRS Net
When: Saturdays at 7:00 PM
Repeater: Vernal Ridge (462.550 MHz)
Net Control: Chris Passeau, K6CDP/WRPX768

Moccasin Peak NRW GMRS Net
When: Tuesdays at 6:30 PM
Repeater: Moccasin Peak (462.600 MHz)
Net Control: Dave Lichtenhan, K6DCL/WSEL220

Strawberry NRW GMRS Net
When: Saturdays at 8:00 AM
Repeater: Strawberry Peak (462.625 MHz)
Simplex Channel: Strawberry (FRS/GMRS Channel 17)
Net Control: Richard Combs, KN6HSR/WRMM317

Twain Harte NRW GMRS Nets
When: Wednesdays at 6:30 PM & 7:00 PM
Repeater: Cedar Ridge (462.575 MHz) (@ 6:30 PM)
Simplex Channel: FRS/GMRS Channel 18 (@ 7:00 PM)
Net Control: Lee Smith, WRXM552

Note: For all PL tones for repeaters, go to myGMRS.com and request permission for the repeater you would like to use. Unless there's an issue, you'll be granted permission and added to the list of allowed users.

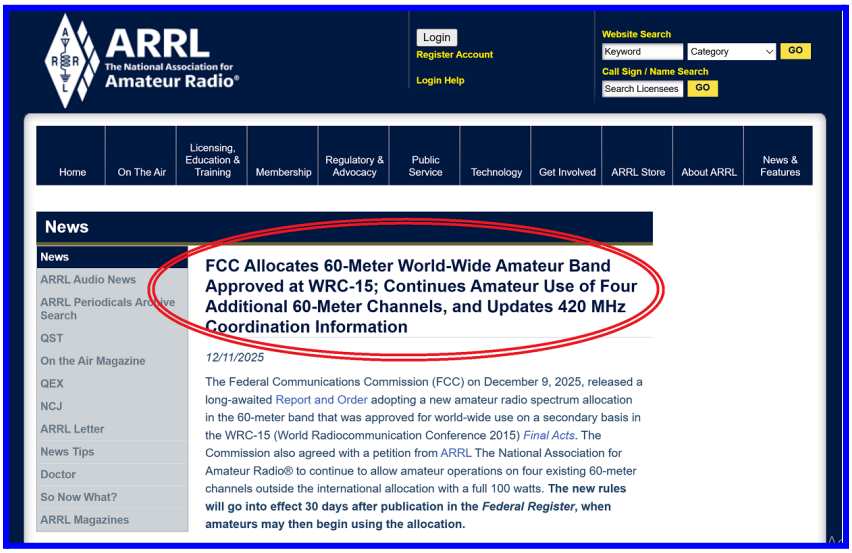
73, Marc

Marc has been interested in two-way radio since college when he earned his Amateur Radio License. He worked in the two-way radio field for most of his career and has seen many advancements in radio technology. He's currently enjoying helping Tuolumne County volunteers put together a robust GMRS radio system. Through the informal Neighborhood Radio Watch (NRW) program, citizens should be better prepared to help each other in the event of a natural disaster, loss of power, or loss of cell phone service, which can happen to residents in our County.

FCC Approves New 60-Meter Amateur Band Allocation

FCC Report and Order Released December 9, 2025

[Editor's Note: This article was also submitted by Marc, N6NEZ/WRME405]



Good News for Amateur Radio Operators

The Federal Communications Commission (FCC) has released a long-awaited Report and Order creating a new amateur radio allocation in the 60-meter band. This allocation was approved for worldwide amateur use on a secondary basis at the World Radiocommunication Conference 2015 (WRC-15).

The FCC also agreed with a request from ARRL – The National Association for Amateur Radio® to continue allowing amateur operation on four existing 60-meter channels outside the international allocation, with up to 100 watts ERP.

The new rules will take effect 30 days after publication in the Federal Register. Once effective, amateurs may begin operating under the new allocation.

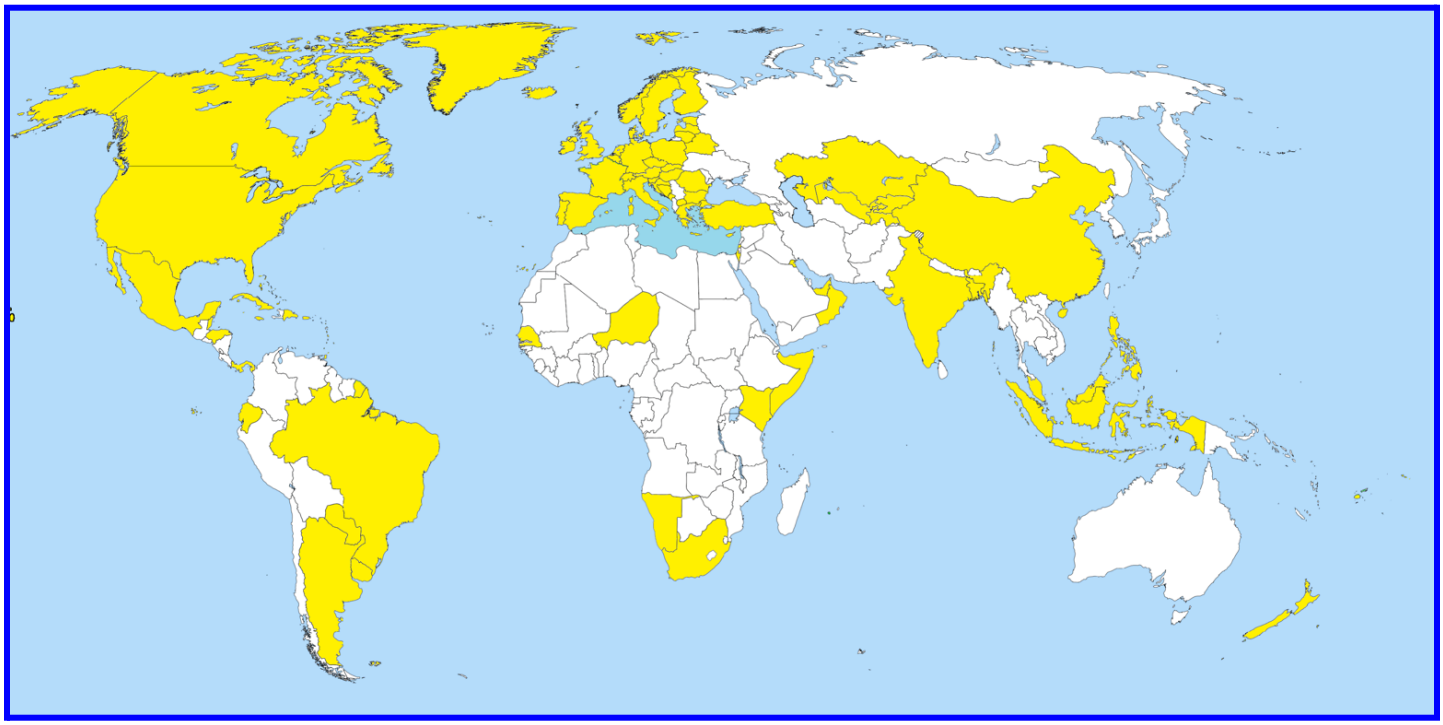


Figure 1: This map shows all the countries that currently have an official Amateur Radio presence on 5 MHz / 60 m, whether it be by WRC-15, Article 4.4, Special Individual Permits, Trial and/or Emergency Basis, or any combination of these.

New 60-Meter Band Allocation

- **Frequency Range**: 5351.5 – 5366.5 kHz
- **Band**: 60 meters
- **Allocation Type**: Secondary
- **Maximum Power**: 9.15 watts ERP
- **Maximum Signal Bandwidth**: 2.8 kHz
- **License Required**: General Class or higher

There are ***no antenna restrictions***, but antenna gain must be included when calculating ERP.

Existing 60-Meter Channels Remain Available

Amateurs may continue to operate on four existing channels outside the new international allocation:

- 5332 kHz
- 5348 kHz
- 5373 kHz
- 5405 kHz

Operating Limits: Secondary basis - Up to 100 watts ERP

Operating Carefully on a Secondary Band

The 60-meter band is shared with primary (non-amateur) users. As a result, amateurs must:

- Avoid causing interference at all times
- Monitor the band carefully using appropriate receiver bandwidths
- Immediately adjust or stop transmitting if primary users are present

The FCC stressed that protecting primary Federal users is critical, noting that even brief interference could impact important operations.

Looking Ahead

The FCC left open **ARRL's 2017 Petition for Rulemaking (RM-11785)**, which may later address possible power adjustments for the new 15 kHz international allocation.

ARRL will continue to observe activity in the new band and evaluate how well the 9.15-watt ERP limit works in real-world operating conditions, including experiences from amateurs in other countries.

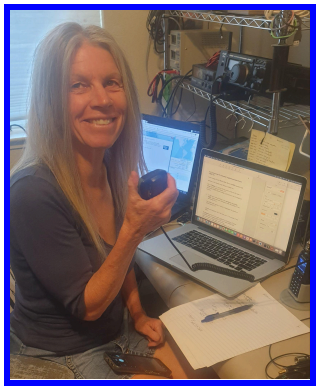
420–450 MHz Coordination Update

In the same Report and Order, the FCC also updated coordination and contact information for the **420–450 MHz band**, particularly in geographic areas where amateur station **peak envelope power (PEP) is generally limited to 50 watts**.

Please share this information with fellow club members and operate responsibly as these new 60-meter privileges take effect.

73, Marc

FCC Adopts Final Rules Implementing WRC-15



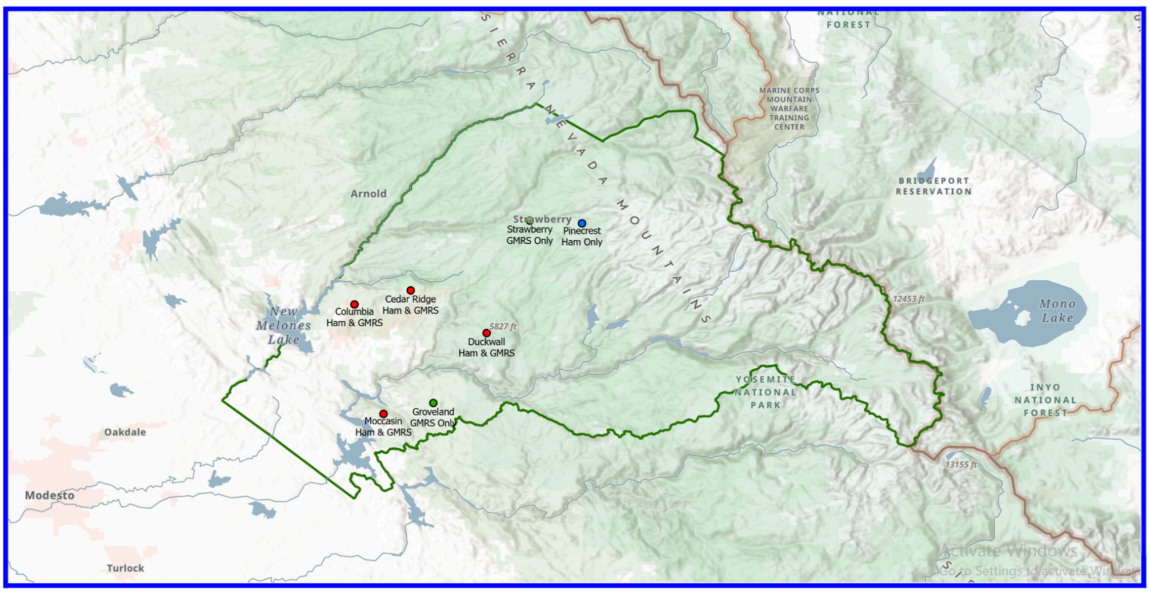
GMRS Women's Net!

Who: Any women with an FCC GMRS license
What: Weekly GMRS net
When: Thursday evenings @ 7 pm
Why: To practice radio skills, increase knowledge, make connections, and more
How: Tune in to the Duckwall GMRS repeater (Channel 22R; RX: 462.725 MHz; TX: 467.725 MHz; PL: 192.8 Hz)
Where: Anyone within line-of-sight, who can hit the Duckwall GMRS repeater

"*The **purpose** of this net is to create a supportive community of women to practice skills in handling radio traffic and to share GMRS radio news, information, current status, and activities.*"

TCARES Comms Trailer being used for Net Control Training During the Great ShakeOut Earthquake Training Event, October 16, 2025

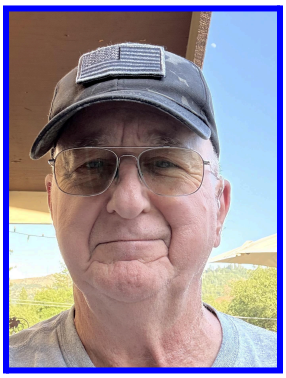
TCARES Comms Trailer being used for Net Control Operator Training During the Great ShakeOut Earthquake Training Event, October 16, 2025



Map Showing the Location of the Tuolumne County Ham & GMRS Repeater Sites

Tech Talk: Beyond the Basics

By Dave Arrich
AD6AE



Measuring Antenna Gain
Using the Friis 3-Antenna Method and a NanoVNA

"There are many methods of measuring the gain of an antenna; most of them call for a reference antenna of known gain.[1] *This method requires three antennas but does not require knowledge of any of them, but will find the gain of each of them. Since the method depends on the Friis transmission equation, all the conditions for its validity must apply." -Owen Duffy, VK2OMD* [2]

The Friis transmission equation was developed by Harald Friis *(pronounced Frisch)* in 1946. This article describes its application as related to the 3-antenna method of measuring antenna gain in a concise, straightforward manner.[3][16][20] However, careful attention to detail is critical for accuracy. The Gauss-Jordan Elimination equations used to calculate individual antenna gains were recomposed to enhance operability and comprehension then rigorously tested against standard calculators written by VK2OMD et al.[1][3][9]

Antenna range testing for the amateur is practical only for VHF/UHF. The ubiquitous *NanoVNA* has made it possible to measure antenna gain with relative ease and acceptable accuracy; measurement data, including compensation for distance and cable losses, are then plugged into a simplified elimination equation where the gain for each antenna is easily solved.

Range measurements are neither trivial nor exact but have several factors that improve accuracy include: properly calibrated equipment, range setup, correct antenna spacing and height; selecting a location that is unobstructed and free of adjacent buildings or metal structures that can cause multipathing; no overhead or close by power lines, and having enough open space to accommodate antenna heights of 3-4 meters and separations of 15 to 25 meters or more. When met, tests should yield results with acceptable levels of accuracy.[3][8][9][10]

In addition to gain, three other simple tests that should be concurrently performed on the *Antenna Being Evaluated* are: Beamwidth, Front to Back ratio, and Front to Side ratio.[4][5][6]

~~~~ Definition of Terms ~~~~

- **VNA Ports:** s11 is Rx on Port 1/Tx on Port 1 *(s11 REFL)*; s21 is Rx on Port 2/Tx on Port 1 *(s21 THRU)*.
- **AUT(s):** Antenna(s) Under Test.
- ***PL:*** Free Space Path Loss (FSPL) is signal level decrease as a function of distance and frequency.
- ***d:*** Distance between Rx & Tx antennas in km (scaled to allow entry in meters)[11][12] **(Notes 1.4)**.
- ***Lc*:** Cable loss of the coax that connects the distant Rx AUT to VNA port s21.[6]
- ***32.44:*** A constant as a function of field intensity dispersion per unit of distance and used in computing PL.[13]
- f_0***:*** Frequency of operation: center of span, sweep range or a stationary CW frequency.
- ***dBi*:** Gain as referenced to an isotropic antenna having a spherical radiation pattern in free space.
- ***dBd:*** Gain as referenced to a dipole in free space.[17][19]
- **Conversions: Gain dBi** = dBd **+** 2.15 & **Gain dBd** = dBi **-** 2.15 [17]

~~~~ NanoVNA Calibration and Test Setup ~~~~

1. *Calibrate s11 REFL and s21 THRU* (**do not skip this step!**). Refresher: W2AEW video.[15]

Open Menu, Tap Calibrate, Reset; Stimulus Start/Stop: 142MHz/150MHz; Perform O.S.L. cal. on port s11.

2. *Perform Isolation and Thru calibration* Move Load to port s21**;** Tap ISOLN; Remove Load; Connect a very short 4-6" coax cable from s11 to s21. Tap THRU, Done, Save (to a Channel).
3. *Assign a Trace to Display s21 as Logmag* Open Menu. Tap Display, tap "Channel s11 REFL" to toggle it to "s21 THRU". Tap Trace; Tap any trace tile to assign and display s21. Tap Format, Logmag, Back, Display, Trace; tap unused traces to toggle them to off; Save. This displays a single line showing the Rx signal in (-dB).
4. *Measure the Long Rx Cable for THRU Loss (Lc) and Calibrate s11 to an Extended Reference Plane (Tx)*

Put Common Mode chokes on ***both*** Tx and Rx cables used for the test close to the connector at the antenna end. Connect the long cable that will be connected to the distant Rx antenna between ports 1 and 2 and measure *s21 THRU* loss; record as an unsigned number on the ***Lc*** line of the worksheet on **Page 4**.

5. *Extend s11 Reference Plane* Attach the Tx cable to *s11*; Open Menu; Tap Calibrate, Reset; Stimulus, Start/Stop freq. to 142MHz/150MHz; Perform O.S.L. calibration with standards placed at the far *end of the Tx cable* where the CM choke is attached, tap Save. The VNA's reference plane is now "extended" out to the antenna connector.

Equipment Used for Testing

- NanoVNA-H4 calibrated for s11 Extended and s21 THRU.
- 20-foot long (RG-316) cable, calibrated as the extended reference plane.
- 75-foot long (RG-316) cable, measured for THRU loss**.**
- The *Antenna Being Evaluated** plus two others (dipoles, Yagis or a mix); all tuned for a 1:1 VSWR at 146 MHz**.**
- Two stands with masts 3-4 meters high, having a 1-1.5 meter long PVC or fiberglass upper section.
- AUTs were chosen for being conceptually unique, and typical of old-school, ham radio "make do" spirit!

➔ **Ant (1):** ½ wave Tape Measure Dipole
➔ **Ant (2):** 2-element Tape Measure Yagi
➔ **Ant (3):** 3-element Tape Measure Yagi *(antenna being evaluated)*

~~~~ Test Implementation ~~~~

1. To ensure far-field measurements,space AUTs 15-20 meters (≈ 50 to 66 feet) apart.[8]
2. For P_L Use **Table 1** or, if using a different separation and/or frequency, recalculate P_L **(Notes 1.e)**.
3. Horizontally orient, then elevate and boresight AUTs at a height of 3 to 4m (≈ 9 to 12 feet) **Fig. 1**.[7]
4. Connect the Tx AUT to s11 and the Rx AUT to s21. Test using the pairing order shown on the worksheet.
5. When finished testing *Pair 3-to-1*, leave undisturbedAUTs; test remaining parameters below.
6. **Beamwidth:** Record boresight heading of Ant 3; slowly turn it each side of the boresight until the Rx signal strength changes by *(-3 dB)*; record the compass headings; the difference should be 50° to 70° (**Fig 2)**.[4]
7. The VNA displays s21 levels in *(-dB)*. When measuring F/S levels, slightly swing the antenna L/R ≈30° stopping on the lobe with the least negative dB level. There may be several side lobes. Record only the least negative one. ***Note:*** *The highest Rx level attainable for antenna gain readings is (0 dB).*
8. **F/B Ratio:** Turn ant. 180°; boresight, record; Ratio=difference of F/B levels in dB.[5]
9. **F/S Ratio:** Turn back to 90°; jog L/R, record; Ratio=difference of F/S levels in dB.[6]
10. **Vertically Polarized Parameters**: Optional**.** Repeat all tests with the antennas vertically orientated.[7]

Notes 1:

1. s21 Rx readings on the VNA will display in *(-dB)*; record them as unsigned numbers on the worksheet.When calculating gains, plug in values and use the signs shown in the equations.
2. For convenience and further study, create a spreadsheet similar to that of **Fig. 3**.
3. FSPL *(P_L)* calc. is scaled so that distance *d* may be entered in meters *(d_m)* instead of kilometers (d_{km}).
4. Excel equation for P_L: =20*LOG**(***d_m** x 0.001**)** + 20*LOG**(***f_{MHz}**)** + 32.44 [11][12][13] or use **Table 1**.

~ Precalculated Path Loss for Distance and Frequency ~

dm (ft)	(144 MHz)	(146 MHz)	(148 MHz)
10m (33')	35.6 dB	35.7 dB	35.9 dB
15m (50')	39.1 dB	39.3 dB	39.4 dB
20m (66')	41.6 dB	41.8 dB	41.9 dB
25m (82')	43.6 dB	43.7 dB	43.8 dB

~~~~~ Table 1 ~~~~~

References:

1. Inside Wireless: Gain Measurement - YouTube
2. *O. Duffy, VK2OMD*
3. 3 Point Antenna Measurements - Friis Method
4. Inside Wireless: Antenna Beam Width
5. Inside Wireless: Front to Back ratio
6. Inside Wireless: Side Lobes
7. Wave Polarization and Antenna Polarization
8. Near and far field - Wikipedia
9. How to Measure Antenna Gain in 5 Simple Steps
10. Antenna Theory - Reciprocity
11. Free Space Path Loss Calculator
12. Free Space Path Loss: Details & Calculator
13. fspl constant of 32.44
14. Measurement of Antenna Radiation Pattern
15. #379: How to measure coax loss using a NanoVNA.
16. Friis Equation - (aka Friis Transmission Formula)
17. dBi vs. dBd summary | Digi International
18. VHF/UHF Yagi Antenna Quick Designer - K7MEM
19. dBi vs. dBd (G9C04)
20. Friis transmission equation - Wikipedia

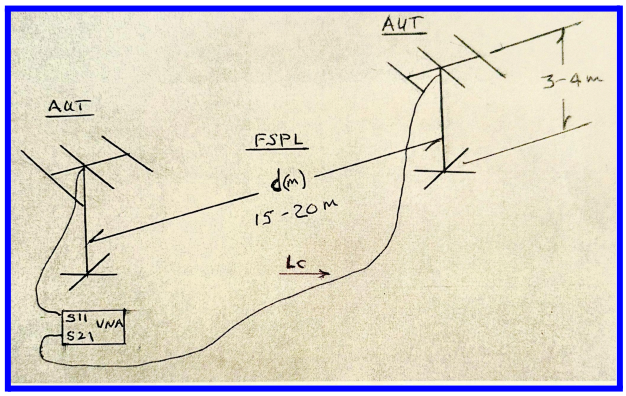


Fig. 1
Sketch of Range Setup

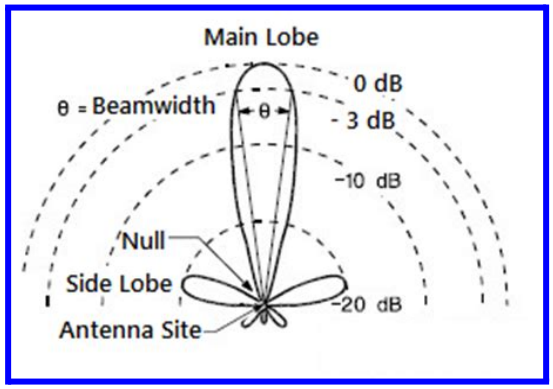


Fig. 2
Typical Yagi Antenna Radiation Pattern[14]
Beamwidth is the half-power or -3dB points

Notes 2:

1. Signs and computational order of the original elimination equations have been recomposed so that values can be entered as unsigned numbers. The revised format gives the equations a more "conventional look and feel" when manually performing calculations. The spreadsheet was similarly reformatted. **Fig. 3**.[3][20]
2. When utilizing the NanoVNA as shown in **Fig. 1**, s21 must be connected to the distant Rx AUT by a relatively long cable. Considering that cable loss (***Lc)*** is a function of both length and frequency, it must therefore be considered additional path loss. If not included, calculated gain results will be grossly in error.[12][15]
3. For convenience, *PL* is precalculated (**Table 1)** and illustrates the relationships between ***f*** and ***d***.

	A	B	C	D	E	F	G	H	I	J	K
1	**3-Antenna Gain Calculator**										
2		**Freq (MHz)**	146.0	Make entries in yellow boxes only			Cell:	Calculation			
3		***d*** **(meters)**	20.0	**Results**			E4	=(-C4-C6+C5+E7+C7)/2			
4		**s21 dB12 (Ant 1)**	46.7	**Antenna 1**	**0.92**	**(dBi)**	E5	=(-C5-C4+C6+E7+C7)/2			
5		**s21 dB23 (Ant 2)**	39.3	**Antenna 2**	**3.82**	**(dBi)**	E6	=(-C6-C5+C4+E7+C7)/2			
6		**s21 dB31 (Ant 3)**	42.2	**Antenna 3**	**8.32**	**(dBi)**	E7	=20*LOG(C2)+20*LOG(C3*0.001)+32.44			
7		**Lc** ***(cable loss)***	9.7	**PL** ***(path loss)***	**41.75**	**(dB)**	OR	=20*LOG(4*3.14159*C2*C3/299.792458)			
8											

Figure 3: Screenshot of an Excel Path Loss and 3-Antenna Gain Calculator

Example of a Friis 3-Antenna Method Gain Worksheet

Record all dB values as unsigned
1-2 means Ant 1 is Tx and Ant 2 is Rx, etc.
Ant. 1-to-2 or $s21_{12}$ (A_1) **:** *46.7 dB*
Ant. 2-to-3 or $s21_{23}$ (A_2) **:** *39.3 dB*
Ant. 3-to-1 or $s21_{31}$ (A_3) **:** *42.2 dB*
Distance *(d)*: *20 m*
P_L (from Table 1): *41.8 dB*

Conventional Elimination Gain Equation Order
Antenna 1: $(A_1) = (A_1 + A_3 - A_2 + PL + Lc) \div 2$
Antenna 2: $(A_2) = (A_2 + A_1 - A_3 + PL + Lc) \div 2$
Antenna 3: $(A_3) = (A_3 + A_2 - A_1 + PL + Lc) \div 2$
Frequency: *146 MHz*
Height: *3 m*
Lc: *9.7 dB*

Recomposed Elimination Gain Equation Order — Measured Levels

Ant (1) Gain $= (A_2 + P_L + L_C - A_1 - A_3) \div 2$ is $(39.3 + 41.8 + 9.7 - 46.7 - 42.2) \div 2$ = **Ant 1: 0.95 dBi**
Ant (2) Gain $= (A_3 + P_L + L_C - A_2 - A_1) \div 2$ is $(42.2 + 41.8 + 9.7 - 39.3 - 46.7) \div 2$ = **Ant 2: 3.85 dBi**
Ant (3) Gain $= (A_1 + P_L + L_C - A_3 - A_2) \div 2$ is $(46.7 + 41.8 + 9.7 - 42.2 - 39.3) \div 2$ = **Ant 3: 8.35 dBi***

Other Parameters: Beamwidth: 58° F/B Ratio: 13 dB F/S Ratio: 35 dB

**Antenna Being Evaluated* (Gain closely agrees with a modeled K7MEM antenna made with standard materials.)
For results in dBd, subtract 2.15 from dBi

Example (continued)
Beamwidth: *Boresight* = 120° *Left* -3dB = 91° *Right* -3dB = 149° 149°- 91° = **58°**
F/B Ratio: F: 42.2 dB, **B:** 55 dB 55 - 42 = **13 dB**
F/S Ratio: F: 42.2 dB, **S:** 77 dB 77 - 42 = **35 dB**

Summary: As of this writing, I have found no mention of the Friis or Three Antenna Gain Method in any literature relating to Amateur Radio other than a white paper written by VK2OMD that he shared with me where he derived the method from Friis' original transmission equation into three easily solved, simultaneous equations. The few online professional sites that mention the Friis method, use either a tightly controlled engineered range or a scaled model in an anechoic chamber using a calibrated reference antenna and laboratory-grade equipment.*{1}{3}*

Applying the "3-Antenna Method" and using a NanoVNA to measure gain parameters is easy and perfectly suited for range testing VHF and UHF antennas by the amateur. It's fun, educational and a great opportunity to learn more about the nanoVNA's capabilities and increase technical skills.

Building off his white paper, this article explains an otherwise complex undertaking in concise, easy to understand terms with examples of actual field tests performed on three unknown antennas made of scrap material to demonstrate a process that's unique, and not widely known outside of professional circles. Using new and inexpensive technology like the nanoVNA, puts this proven method within easy reach of the amateur experimenter.

If you're building a new antenna using design calculators like those posted by K7MEM and DL6WU or have purchased an antenna with no enclosed data sheet or snapped up a bargain at a hamfest or swap-meet, then correctly using this method will provide acceptably accurate performance data.

Note: High gain antennas are of limited use in extending the range in a non-Line-of-Sight (non-LOS) environment. In a non-LOS environment the obstructions contribute more losses to the system than the antennas are able to overcome. Also, the obstructions cause the signals to bounce and arrive at the antenna from different angles so it is desirable to have an antenna with a wide beam width and a lower gain.*{17}*

Amateurs are encouraged to learn to use a NanoVNA alongside their antenna analyzer and ***quantify*** the phrase, ***"It works real good."*** The nanoVNA's low cost, versatility and accuracy makes it an amazing piece of test gear that will serve you well. *Lastly, I owe a debt of gratitude to VK2OMD for introducing this method to me and providing expert advice along the way. This was an educational experience and a challenging writeup.*

73, Dave

Friis 3-Antenna Method Gain Worksheet

Date: ___ /___ /20___ Site Location: _____

Test Frequency: _____ MHz Height: _____ m
Ant. 1-to-2: (A_1) _____ dB Distance *d* : _____ m
Ant. 2-to-3: (A_2) _____ dB *PL* : _____ dB
Ant. 3-to-1: (A_3) _____ dB* *Lc*: _____ dB
Ant (1) Gain = (A_2 + PL + LC - A_1 - A_3) ÷ 2 = **Ant 1: _____ dBi**
Ant (2) Gain = (A_3 + PL + LC - A_2 - A_1) ÷ 2 = **Ant 2: _____ dBi**
Ant (3) Gain* = (A_1 + PL + LC - A_3 - A_2) ÷ 2 = **Ant 3: _____ dBi**
Beamwidth: *Boresight.* **____°** *Left* -3dB**. ____°** *Right* -3dB**. ____° = ____- ____ = ____°**
F/B Ratio: *F.* **____** *dB / B.* **____** *dB* **= ____ - ____ = _____ dB**
F/S Ratio: *F.* **____** *dB / S.* **____** *dB* **= ____ - ____ = _____ dB**

Antenna Being Evaluated

"*Everything should be made as simple as possible, but not simpler*." -Albert Einstein

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Dave's lifelong electronics journey began dramatically at age 4, causing a farmhouse blackout, and then a "shocking encounter" at age 8, sparked more intense curiosity. Self-taught through correspondence and mentoring, he was running a radio/TV repair service by age 14. In 1965, he earned an FCC First-Class Ticket with Radar Endorsement, leading to a role at GE (General Electric), testing Apollo program components. In 1967, Dave joined the Navy, serving 23 years as a Communications Technician, maintaining complex HF systems within a Wullenweber Antenna array. During a 1974 NSA (National Security Agency) assignment, he obtained his ham radio Extra Class license, actively engaging in DXing, contesting, and getting his code speed up to 20 wpm, before a 42-year hiatus. Post-Navy, he spent two decades with the NCPA (Northern California Power Agency), first as a geothermal electrician based out of Middletown, and Roseville, then as a SCADA (Supervisory Control and Data Acquisition) technician for a hydroelectric plant in Murphys. Three years ago, he reignited his passion for ham radio, delving back into antenna and transmission line theory.