NVARC
Nashoba Valley Amateur Radio Club

SIGNAL

A club since 1992
Since 1993
Since 1996

de N1NC November 2019 Volume 28 Number 11

In this Issue

This Month's Meeting

The November meeting will be the annual NVARC Section 1 QSL Card Sort. Come join the fun!

7:30pm, November 21, at the Pepperell Community Center.

Next Month's Meeting

The December meeting presentation will be on the New England Forrest Rally by Paul, W1SEX. To see what it is about go to:
http://www.newenglandforestrally.com/.
Paul will talk about the Ham Radio aspect of the rally.

From the President
***de* Stan, KD1LE**

It is already November and I'm looking forward to the QSL Card Sort. Last month I attended NEARfest at Deerfield. I saw quite a few members, though many were only in passing. I at least saw Rod WA1TAC; Jim, N8VIM; Leo, K1LK; and Skip, K1NKR. After walking the site several times, spending some time manning the MARS table, seeing all I wanted to see, I arranged to meet George, KB1HFT, and we walked out together to make some equipment exchanges.

Of particular note, I saw Erik, KA1RV, now ES5RV, a former NVARC President.

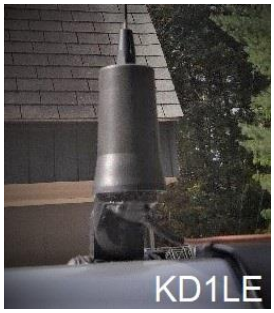
Nut Plate

At the October meeting I passed around a nut plate I had made to mount an antenna on my new vehicle. The nut plate is simply a reasonably thick metal plate. In this case sized to fit inside the luggage carrier rail on a vehicle. It has to be reasonably thick because it needs to be threaded to act as a nut for the mounting bolt. Because it is inside the rail it can't turn so the mounting bolt can be tightened from the outside. Otherwise tightening the mount requires access to the inside of the rail.

This is what it looks like from the inside of the rail.

It is important to get access to the end of the rail to see how thick a plate you can use. The rail on my vehicle had two channels in it so the channel the plate went into was much thinner than the entire rail. The plate I made was aluminum and the hardware stainless steel. The mount I used is adjustable in two axes. The thumb screw knob is to allow the antenna to be quickly folded over.

This is what it looks like from the outside of the rail.



Antenna Adjuster

On a different antenna subject, someone was talking about process of tuning a wire antenna. The trimming, cutting, measuring process. A method I have used is electrical butt splices (sometimes called a splicer reducer) for large gauge wire. See the one pictured below that are available at hardware and big box stores. This could be used when building the antenna with bare wire.

In the normal manner, cut the antenna long. Feed the wire through the butt splice and form a loop by feeding it back into the splice and then tightening the set screws. Temporarily hang the antenna to measure. Then make the antenna shorter or longer by loosening the screws and adjusting the length. You could have an insulator in the loop. If there is no insulator in the loop you can slide the splice off the loop, twist the loop and solder. There are some other styles available. One is a split copper bolt which can easily be put on and taken off the wire.

Bay State Marathon

For public service for the month of October I worked the Bay State Marathon. NVARC provided the communications for this event way back in the beginning. As far as the event goes there were few problems and no runner issues at my location which had a Tyngsboro ambulance present. But you always learn something. When preliminary information indicated the HT's would not be sufficient at my location, I planned to use a mobile rig with a base antenna or four element Yagi on a mast and tripod. That combination worked out, though we used essentially the same set up provided by the other Ham stationed there set up on a small table. The table itself was interesting as it was a roll up cloth type material top with lightweight spreaders and legs. The other option I prepared for was using the mobile radio in my vehicle in cross band repeat mode and a handheld. It took me a little while to get the crossband set up and tested at home using two handhelds and the mobile rig. Getting the tones set up and programming a couple of mobile rigs and my handhelds. At the race I tested the system after the other Ham's rig was set up and checked in with NCS and it worked perfectly. Since the we were relatively near the road, I didn't think we would need it so I shut it off to save the batteries. But moving to the edge of the road to observe runners and see bib numbers took us away from the station. After running back to the rig a couple of times to make or answer calls I turned the crossband set up back on and used it the rest of the race.

That brings up another thing I "learned" researching the cross-band repeat option built into many modern mobile rigs. Is it is not quite "legal" as it is used. The issue is that a repeater transmits on one frequency and has the hardware to identify on that frequency. Most mobile radios don't have any built-in ID capability and they transmit on two frequencies. Some would say the use is more correctly called a "remote base" where the user is controlling the radio via the UHF link (which by the rules the HT should use for access) and by the user/control operator identifying there which is then carried through the VHF transmitter identifying it. The problem is that when someone else accesses the "repeater" via the VHF side the remote base does not ID with the owners call sign on the UHF side. The only thing that comes through is the calling stations call sign. All that being said, the usage is fairly common and when properly done with tone control and for limited periods seems to be accepted. Putting up a permanent system that inter-

feres with other users however might be another thing. There were suggestions on adding a CW IDer using various hardware, but they are dumb IDers and ID all the time even when the system is not used and don't sense activity so they may interfere with other transmissions on the frequency since it is not "assigned" a frequency like a repeater is by coordination.

-*de* Stan KD1LE

Public Awareness and Recognition
de Skip, K1NKR

In the October *Signal*, I commented that we Amateurs, our hobby, and our club need to let the public know who we are. I've since come across an article[1] that contains some ideas along that line. Here are those thoughts (some paraphrased), with some local context inserted.

1. Get out of the shack. A world-famous ham once said, "I've got friends all over the world, but none at home." In getting out, be sure you represent yourself and your hobby in a good light.

2. Join other local organizations. Chamber of Commerce, church, neighborhood cook-out—you name it. We're "full spectrum" operators; shouldn't we be full spectrum citizens, too? People respect "those other people who are like us."

3. Devote some time to local causes and charities. OK, we've got a foot in the water here. We devote time and energy (RF energy—pardon the pun) to the Groton Road Race, TDOTA, JOTA, parades, and science fairs. Let's take credit for it. We may not get a license applicant out of every activity, but we sure will make others aware that we're here.

4. Contact a writer to pique their interest in Amateur Radio and our club's endeavors. They are always on the hunt for interesting stories. See if you can suggest stories slanted towards the excitement of the hobby and its technological achievements. Everybody already knows we still use Morse code. As a matter of fact, that may be all they know. Always remember, <u>you</u> are the expert on your business. Make yourself available to the local news media when they have questions.

5. Civic and business organizations are always looking for speakers. Volunteer to talk about issues directly affecting your interests as well as those of others. What's an issue? How about antenna restrictions, hands-free driving, public service, emergency communications, STEM education, knowledge of geography. Be careful, though. Think, act, and speak in a positive fashion. Curmudgeons turn the general public off to the speaker as well as anyone else identified with him.

6. Really good potential customers (meaning: advocates, prospects) deserve more than the same verbal "thank you and good-bye" given to everyone. Make them feel special and you may just make them feel like being one of us.

There are themes to these suggestions. Get out. Represent yourself and the hobby in a positive light. Share the excitement. Maybe we can get the outsiders to think of us as something other than "that guy who sits up all night in the attic and has no friends at home."

de Skip, K1NKR

[1] 8 Tips to Build Brand Awareness," by Terry Arnold, Col., USAF (Ret.). In Military Officer magazine, October 2019. https://www.qgdigitalpublishing.com/publication/?i=617991#{"issue_id":617991,"page":30}

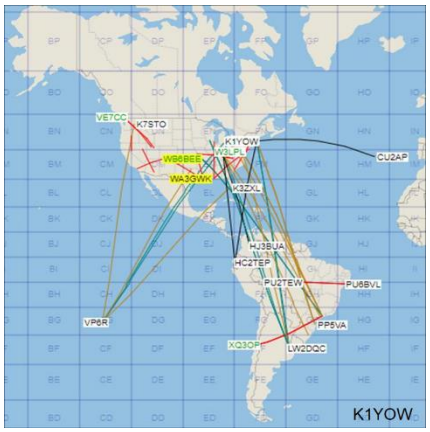
Interesting TEP Propagation Seen
de Joe, K1YOW

Just an FYI on what I have been up to. On most afternoons this fall, I have been working 8,300 Km Trans Equatorial Paths (TEPs) from New England down to PP, LU and CE land on FT8. The only problem is that Trans Equatorial Paths are not supposed to come this far north to New England, so what is going on?

So, like I did with the 6M Es transatlantic study, I started to collect data and see what is going on, and bouncing theories and ideas off of Phil, W1PJE, and Carl, K9LA.

I put together a 40 slide Power Point slide set on that data and conclusions. It would be a good short presentation to do some time, probably as part of a show and tell, when we share the projects that we have been involved with.

It looks like we are getting two F2 hops. One F2 hop gets our signals out of New England and into the TEP circuit F2 further south.



Here is a screenshot of a DXMaps.com map showing data for 10M TEP on 10/30/2019.

-de Joe, K1YOW

A 6 Meter 100W Amp
The Easy Way – Part Four
***de* Dan, KW2T**

Bias

Last month I talked about getting a power supply for the Tech Night Radio's MRF101 power amplifier. Something that will give you around 3 Amps at 40-50 volts. Hopefully you can take one of the 3 options I suggested and be all set to power the radio up to get 100W on 6 meters.

This month I will talk about biasing the FET, and building a simple bias circuit to add to the MRF101 FET amplifier.

Transistors need bias. Being a 3-terminal device, you can think of a FET or any transistor as a switch, one that can turn on a flow of current gradually. Two of the terminals carry the big current that you are controlling, and the 3rd terminal is the control, which is referenced to one of the other 2 terminals.

For a regular old bipolar transistor, the Emitter is the common terminal, carrying the main current AND acting as part of the input for the control signal. The Base is the control signal, and the Collector is the main controlled current path. A small signal controls the big current path, and thus there is gain.

With a FET, the control terminal is aptly named the Gate, with a voltage referenced to the Source, and the main current flow is from the Drain to the Source.

Some small signal FETs are actually symmetrical, and you can swap the Source and Drain and it works the same. Not true with the MRF101 power FET that we are working with here, since the Source is used as the foundation material of the semiconductor, connected to the "substrate" under everything, which means for an N-channel FET, no other terminal can be at a lower voltage than the Source, or else what is basically a diode inside the part will turn on and short everything out. So, in an N-channel FET, the Drain must always be higher voltage than the Source. There is an interesting exception to this that I'll talk about some day at TechNight.

The FET we are working with here has an insulated gate. This means what it sounds like, there is a thin layer of glass between the aluminum metallization that is connected to the Gate terminal, which floats it from everything else inside the FET. This means that no current can flow in the Gate to anything, with the exception of the charge needed to change the voltage on the gate, since it is a small capacitor.

This glass insulator is VERY thin. It arcs over with only 20V across it. We're talking SMALL. And since it is an insulator, there is nothing stopping the Gate voltage from floating around, even to something greater than 20V, which will destroy the FET permanently. There are no 2nd chances with gate breakdown, the part is wrecked in nanoseconds. Can't get away with even a short pulse. The gate is so sensitive, that you can put your left index finger on 6V, and your right pointer finger on the Gate, and the FET will turn on. When you let it go, it will stay on until the charge leaks away. You can turn it off by moving your left finger to GND, which will instantly turn the FET off. Even a vacuum tube doesn't do this, there is always a little grid current that will move the input around.

The point here is that it's REAL EASY to blow up the MRF101 FET that's in this amplifier.

In the amplifier circuit, there are capacitors from gate to ground that help keep static charge from raising the voltage too far, but only after the FET is installed in the circuit. So, you have to handle it with care, and be careful of static electricity.

One safe way to deal with this is take a piece of bare #34 wire and wrap it around the leads of the FET, shorting all 3 together. Of course, don't solder that wire on when you install the part, or if you do, cut it with an exacto knife. Even installed in the circuit board, if you put the 40V Drain voltage on the gate, the part will be destroyed.

There is yet another risk of putting voltage on the Gate terminal. In this amplifier, there is no current limit unless it is built into the power supply. So, if you turn the FET on with, like, a battery powering it, you will cook the part from too much Drain current. That thin gate insulator will be fine, but the rest of the part will be cooked. And since it's insulated gate, it doesn't take any current to do this. You can blow the part up with your finger this way, not static electricity, but just 6V. This kind of failure is not nanoseconds, it's a thermal process, so you have a few milliseconds. A current limiter can actually save the part.

All this is why we need a well-regulated bias supply, which isn't too hard to build.

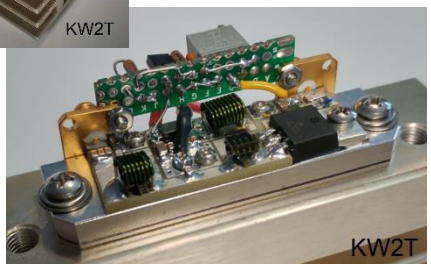
Why do we need bias at all? It turns out that our MRF101 amplifier FET is what's called an enhancement mode part, as opposed to a depletion mode, which means that if you put zero volts on the input terminals (Gate and Source), the part is off, and you need to add Gate voltage to "enhance" the Drain current. Some FETs are built so that the Drain will carry current with zero volts on the gate, and you have to put negative bias on the Gate to turn it off. The IF amplifier FETs in the TechNight radio are such parts. There we put zero volts on the gate, and take what drain current that gets us.

This MRF101 needs about 2.5 V on the gate to turn it on. If you put 1V it is completely off, if you put 4 volts, it is completely on. We want to bias it just a little on, so the RF voltage we put on the Gate to amplify will make a big difference in the Drain current. This makes for a linear amplifier, which means if you double the input signal, the output signal also doubles. That's what we want for the cleanest signal. BUT it's not the most efficient way to use this part.

The TechNight radio does not do any linear modes. It does CW and digital modes and FM, but not AM or SSB. So, we don't need a linear amplifier, we can bias it lower and let the RF turn it on, which is very non-linear, but wastes less power in heat. I made the bias on my amp adjustable, so you can set it for either mode.

Your first idea for bias might be to just put a little 3 terminal regulator off the drain power supply, like a 7805 or an LM340 or 317 kind of part. The problem is our drain supply is 50 volts, which would blow those parts up. But there is available a high input voltage 3 terminal regulator which works for this. It has an input rated up to 100V, so handles this situation no problem. It is the LR12. This part was made by a small semiconductor company, named Supertex, that had a lot of unusual low-demand parts like this, but in 2014 they were bought by Microchip, the maker of the PIC microcontroller. Fortunately Microchip kept the part line going. The LR12N3-G used here is a $1 part from Mouser or Digikey.

So, this is easy: a 3-terminal regulator from the 50V Drain voltage, set to make 4.0V, which goes to a 5K trim pot. The wiper on the trim pot goes to the gate bias input. I decided to build this



onto a small prototyping board piece, screwed onto the SMA connectors that came with the amplifier kit, onto the top unused screw holes.

I used #2 screws and nuts, and I used the wire end of a screw terminal lug to connect to ground. The regulator and bypass caps (2 x 0.1uF 50V min) and voltage setting resistors (6.04K and 14.0K) are on this board, as well as the setting pot. The input has a short wire connecting it to the power input on the amplifier board, and a short wire connecting the pot to the bias input. The ground connection comes from the 2 connectors. I suppose another ground jumper could be added to the ground point on the board. Can't have too many ground connections on something with 100 Watts of RF on it.

My main fear of this biasing thing working is how it performs at full power. If RF gets into it and the regulator goes nuts, I could blow my amplifier FET.

BTW, I chose this big honking heatsink to be safe. I found it on a power supply at the surplus place in Manchester that was featured in the last Signal, Electronic Surplus Services. I got it for $5 and ripped out the heatsink, drilled and tapped 6-

32 holes in it to match the amplifier block.

Before you turn on any power to the amplifier, make sure you turn the pot ALL THE WAY DOWN. Then you apply 40V, watching the current being pulled by the amplifier. There should be only a few milliamps, from the bias supply. Then you slowly turn that pot up until you start to see current being pulled on the power supply (Drain current). Then you stop when the Drain current gets to 100 mA, for linear operation. Then you're done. Don't go any higher. Maybe try lower. With bias on, the FET starts getting warm, make sure a heat sink is attached.

Next month we'll see how well the amp works! What kind of gain and power output we can get? That should be exciting. We'll see how many parts I blow up...

-*de* Dan, KW2T

Arduino Group Re-Branded

The Arduino Group has been meeting for several years now but from the original purpose of learning about Arduinos, which was manifest in the building of a number of different Arduino based antenna analyzers, our interests have gotten much wider. So, we are re-branding our meetings as the “Tech Morning Group”. We meet every Monday at 10:15am at the Pepperell Community Center. Come Join Us!

While some work continues on the antenna analyzers, some other topics covered in a recent meeting were solar power system design considerations for powering the ham shack. Especially balancing the solar panel wattage vs the charge controller capability vs charge amperage vs the battery bank amp hour rating.

A recent project was setting up a Raspberry Pi to support a BitScope device to do oscilloscope and logic circuit analysis work.

Here, Bill, AB1XB, is working with Peter, N1ZRG, on getting that device working.

At the same session, George, KB1HFT, was showing one of the versions of the “NanoVNA” Vector Network Analyzer he has acquired. In the photo the VNA is connected to his computer as he runs through the calibration procedure. The VNA is the small package at the right corner of his computer.

-*de* Stan KD1LE

Around & About
***de* Dan, KW2T**

On Nov 9, a group of interested people went on a tour of the Museum of Broadcast Technology, which is in downtown Woonsocket, RI. The trip was organized by some Framingham club (FARA) members.

The museum is not open to the public, and tours are by appointment only, with maximum of 10 people. There were 7 of us on this tour.

I was interested due to my involvement with the broadcast world, from 1973-1976 when I worked at the local CBS affiliate in South Bend, IN, and when I later designed broadcast transmitters at Axcera in Pittsburgh as their CTO and VP of Engineering from 2006-2009. My days at the TV station were very memorable, as the 1970's was pre-internet and broadcast TV was at its peak. My station, WSBT, was the oldest continuous operating UHF TV station, and had more than one locally originated show. The live times on the air were very exciting, and kept you on your toes.

I have several disaster stories of tape machines failing during critical moments causing on-air black screen and panic in the studio.

The museum brought back all the memories, as in that building are all the VCRs and cameras that I dealt with. This museum is almost exclusively about broadcast television. It was put together by a small group of very dedicated

television system enthusiasts. Paul Beck, seen above, is the president of the museum. In an earlier life he stood behind an RCA TK42 camera out in Fenway Park for many years. The chief technologist at the Museum, Jay Ballard, was an engineer for NBC, ESPN, and other major network organizations. Paul led our tour, with Jay filling in details along the way.

The museum is housed in an old bank building, built around 1912, when banks were big beautiful stone buildings with huge vaults. The building lost it's tenant when people wanted rural drive-thru tellers, and the old mill town of Woonsocket went into a depressed state. The State took over the building as a Welfare center, doing some major renovations, and then they too abandoned it. The group of television people got together and bought it for less than $200K about 8 years ago, moved in some equipment they had, and then began collecting one of everything from the 1950s to the 1990s from all over the country. Since they own the building outright, there is no way for the town to kick them out or force them to move their huge collection of very heavy equipment when a lease doesn't get renewed, a perfect situation for such a collection. They are putting in many hours refurbishing and making much of it functional again.

The tour went through the first floor, all full of video tape recorders, from the 1956 first "Quad" machine, which recorded vertically on 2" wide

tape, on thru the digital cassette days of Sony in the 1990s. Of particular interest to me was an RCA TCR100, which could be loaded up with 1-minute tapes of commercials in little cartridges on a rotating belt, and the machine would select, load, and play these short tapes one after another, handling complete commercial breaks automatically.

I had memories of this machine jamming and 8 people standing around it trying to clear a stuck tape out of the back while the director was upstairs yelling "GET ME SOMETHING TO PUT ON THE AIR!!!". This machine actually loaded and cued up 2 tapes while we watched.

Upstairs was the large collection of B&W and Color cameras. Here's me the Cameraman behind an RCA TK14 B&W Turret Lens camera that had one large Image Orthicon tube in it, and a whole pile of other vacuum tubes to go with it. One of about 50 cameras in their collection.

Also in their collection were slide and film players, flying spot scanners for image capture, slo-mo video disc machines, 7 GHz microwave relays, microphone booms, and some old 1940s TV sets.

Our tour lasted 2.5 hours, and left me amazed at the dedication of this small group of enthusiasts, trying to keep their life experiences alive, even though all the technology is now surpassed by this little phone I have in my pocket: better resolution in lower light, and more recording time, than anything they had there. But the good ole days of "real" television will be preserved a little longer thanks to their efforts.

A great place to see some impressive electronic and RF technology of the past, only an hour drive away.

-*de* Dan, KW2T

Calendar

All Year

WA1WCC celebrates 100 years of RCA

WA1WCC is commemorating the founding of RCA in a year-long celebration. Watch for WA1WCC/100RCA on the bands during 2019. Participants can request the RCA Special Event Certificate. (Ed: Also, a great shot of the back of Bruce, K1BG's head!)

https://ema.arrl.org/2019/01/19/wcc-ara-celebrates-rca-centennial/

November

15 YO Romanian International PSK31 Contest. 1600Z-2200Z.
http://www.yo5crq.ro/Rules.htm

16 ARRL EME Contest. CW, Phone, Digital; 50-1296MHz. 0000Z – 2359Z 17Nov.
http://www.arrl.org/eme-contest

16 →18 ARRL SSB Sweepstakes. 2100Z → 0300Z 18Nov
http://www.arrl.org/sweepstakes

17 Homebrew & Oldtime Equipment Party. Single Op, CW. 1300Z → 1500Z (40m), 1500Z – 1800Z (80m).
http://www.qrpcc.de/contestrules/hotr.html

21 NVARC Meeting. presentation on the New England Forrest Rally by Paul, W1SEX.
http://www.newenglandforestrally.com/

December

7 FT8 Roundup. 80, 40, 20, 15, 10m. 1800Z → 2359Z 8Dec. http://www.rttycontesting.com/ft8-roundup/rules/

14 → 15 ARRL 10m Contest. 0000Z → 2400Z 15Dec.
http://www.arrl.org/10-meter

22 ARRL CW Rookie Roundup. 1800Z – 2359Z.
http://www.arrl.org/rookie-roundup

NVARC Swap Shoppe

The following items are available for a donation to NVARC. Monies to be paid to the Treasurer. Items to be picked up from me:

- MFJ 944 Versa Tuner II $20
- MFJ 12728BX mic/tnc switch $5
- MFJ 12738BTV mic/tnc switch $5
- MFJ 1118 Deluxe High Current DC Outlets binding post style $25
- HP V1905-24 POE switch $50
- MFJ MFJ-949E Versa Turner II $30
- LINKSYS WRT54G, BEFSR41, BEFW11S4 $5 each
- Astatic D104 microphone $20

-de Stan KD1LE

Board Meeting Notes

Attendees:

Stan, KD1LE
John, KK1X
Ralph, KD1SM
George, KB1HFT
Ed, N1YFK
Bruce, K1BG,
Jim, AB1WQ

- Card sort this month.
- Property list updated.
- Need help for loading boxes for card sort.
- Paul Topolski, W1SEX, will talk in December.
- Homebrew in January.
- Short Subjects in February.
- Harry Chase might be available for a talk on Arecibo.
- Bruce has prepared a letter promoting radio as science fair fodder for students at Bromfield School.
- Does anybody know of a school hosting a science fair? Contact Bruce K1BG.
- The Board extended GM3TCW's membership for another year.

-de John, KK1X

Treasurer's Report

Income for October was $215 from membership dues, $2 from ARRL membership renewals, and $24 from Field Day pin purchases. Expenses were $0.74 for PayPal fees leaving a net income for the month of $240.26.

The Community Fund received contributions of $130 from the Swap Shoppe.

Current balances:

General fund	$2,643.43
Community fund	$5,678.25

As of 7November we have 46 members who are current with their dues and 18 renewals outstanding.

Thank you to those of you who mail or hand in your dues before Ralph comes to you. Please check your renewal status on the roster circulated at the monthly meeting or ask Ralph.

Membership dues can now be remitted via PayPal:

Go to https://www.paypal.me/nvarc

Please remove the checkmark in the box "Paying for goods or a service".

as PayPal deducts a fee for their "purchase protection" if you leave this checked.

If your "shipping address" is displayed then the box is still checked, adding an expense to the Club.

Enter your callsign in the "Add a note" field.

If you are joining ARRL or renewing your membership please consider letting Ralph send in the paperwork for you. The Club will buy the stamp and will get a commission from ARRL. ARRL membership checks should be made payable to NVARC; Ralph deducts the Club commission before forwarding your paperwork to Newington. As a Special Service Club, the ARRL expects a majority of Club members to also be ARRL members.

-de Ralph KD1SM

Elmering

If you know of a young person who has recently become licensed, or who might be interested in becoming a Ham Radio Operator, and is in need of equipment to set up a station, an NVARC member has the resources to assist.

Through the generous donation of a fellow ham, he can supply the hardware and setup know-how to get a young-un up and on the air. If you know of such a person, please contact Jim, N8VIM at: N8VIM@arrl.net

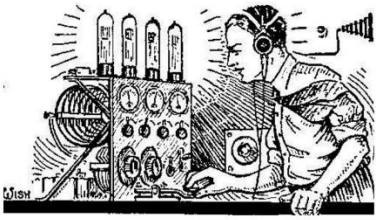
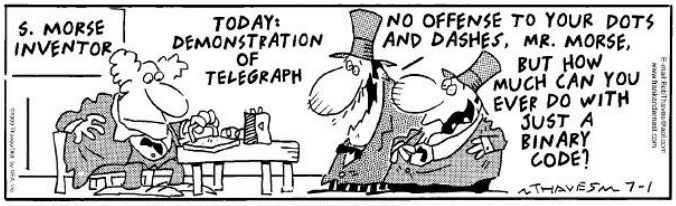


Image from May, 1926 QST, courtesy ARRL

"A Message from Milwaukee"



NVARC

Nashoba Valley Amateur Radio Club
PO Box # 900
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http://www.n1nc.org/

President: Stan Pozerski, KD1LE
Vice President: Jim Hein, N8VIM
Secretary: John Griswold, KK1X
Treasurer: Ralph Swick, KD1SM
Board Members:
Jim Wilber, AB1WQ, 2016-2019
Ed Snapp, N1YFK, 2017-2020
Bruce Blain, K1BG, 2018-2021

Property Master: John Griswold, KK1X
Librarian: Peter Nordberg, N1ZRG
Emergency Coordinator: [open]
N1NC Trustee: Bruce Blain, K1BG

Join NVARC! Annual membership dues are $15; $20 for a family.

Meetings are held on the 3rd Thursday of the month at 7:30 p.m. in the Pepperell Community Center.

Contact us on the N1MNX repeater.
442.900 (+), 100Hz
147.345 (+), 100 Hz
53.890 (–), 100Hz

This newsletter is published monthly. Submissions, corrections and inquiries should be directed to the newsletter editor:
editor@n1nc.org.
Articles and graphics in most PC-compatible formats are OK.

Editor: George Kavanagh, KB1HFT

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