



SIGNAL



de N1NC

February 2004 Volume 13 Number 2

This Month's Meeting

This month's presentation will be on the ARES Response to 9/11 by Steve Schwarm W3EVE. Steve is the Norfolk County ARES DEC.

Last Month's Meeting

Last month's meeting program was Digital Sound Card Modes by John KB1HDO. John showed several programs used for sound card mode communications and indicated there is a wide selection of both free and commercial packages available. He covered some of the hardware and interfacing options and listed several commercial equipment sources for the interface. He then covered some of the screens in the software and set up communications between two laptops using only speakers and microphones rather than a hard wired interface. After the presentation he passed out CD's with some of the freely available software on them.



Above, John KB1HDO giving his presentation.



February Board Meeting

The February Board meeting took place on the February 12th at the KD1LE QTH. In attendance were Stan KD1LE, Ralph KD1SM, Peter N1ZRG, Dave N1MNX, Bob W1XP, Larry KB1ESR, Dan N1LLG, Les N1SV, Ron W1PLW and Guest: Bill Shute, Groton Director of Emergency Management

Ralph gave a Treasurers report. Ralph reported that Steve W3EVE confirmed he will speak on the ARES 9/11 response to NY City at the February meeting.

There was a discussion about having a Marconi Museum work party. The likely task would be to paint some portion of the building exterior. More discussion when Ray Minichiello comes down to speak in April.

Add a contest calendar to newsletter.
Ron checking meeting schedule in Messenger
Start up book raffle again.

Larry proposed running APRS on some emergency vehicles at the Groton Road Race as a demonstration.

Larry and Bill spoke about trying to get some more support for ARES and RACES operation at the Groton Communication Center and for some response teams they are developing. They also need help with some radio coverage tests from the new building at Lost Lake which will have EOC space. Bill would like to get more communicators involved in Groton RACES which may be a combination of Amateur and FRS users. We talked about recruiting, emergency communications training, and some sort of emergency teams. The Groton 350th anniversary is coming up and preparations for handling emergencies with the many events was discussed.

From the President

Recently we have discussed a proposal to donate to the ARRL BPL Defense of Amateur Radio Fund and I've seen that other clubs have made such donations. I don't object to the practice and support for the ARRL but I wonder if it isn't a short sighted approach. There are certainly legal grounds to fight BPL – indeed one wonders just what the FCC is thinking here. Donations to the League can help in this particular case. But in the long run it is only a large and active Amateur community that can protect the spectrum we have. Active Hams affiliated with organizations such as the National Weather Service (NWS and SKYWARN), ARES and RACES with FEMA, and organizations such as MARS and SHARES with their affiliations with the military, FEMA and NTIA can bring more pressure to bear than the few dollars we can throw at the current (or next) problem no matter what it is BPL, spectrum issues, enforcement. Support of general public service activities are also important so the public knows who we are. Activities that promote Amateur Radio and bring in new people, particularly the young, will do more to ensure our success in the long run than anything else. Without new Hams to support the hobby all the money in the world will be irrelevant. Clubs or individuals who are inactive or don't support any public service type activities (of which the above are only a few possibilities) are just fooling themselves when they think that throwing a few hundred dollars at the problem makes them a "good citizen."

Stan KD1LE

An error crept into my article last month. Bobs series of articles, Ham Radio 101, were written as the 80th (not 100th) anniversary of the first trans-atlantic QSO. I should have been able to figure that out myself (1923- 2003) but I didn't.

Correspondence

Allyn N1PIP, long time NVARC member writes, that his daughter Shelie is staying with him now, and she arranged a party last November to celebrate the birthday (his 85th!) he shares with his granddaughter Thea. Thea and her husband Bob came up from the Cape for the party with Allyn's great-granddaughters Sophia, 5 and Caroline, 3 in tow. Sophia used the computer to download animal outlines to color, leaving Allyn in amazement of kids and computers! In other correspondence, Allyn says he has a bit more free time of late, and hopes to become more active in Amateur Radio than in recent years.

de KB1HDO

K2 Kit Review by W1XP

The Elecraft K2 Transceiver Kit
A Review
By Bob Reif W1XP



Photo 1

When I was offered the chance to build the popular K2 amateur transceiver kit by Elecraft for another ham I was a bit reluctant to undertake the task. The positive aspect of the offer was the chance to get to use the radio and evaluate it. And write this review. So I said yes and I am not sorry I did. The following review, in two parts, is a look at this radio kit and the resulting radio and it's performance. In part 1 we will look at the kit

and the assembly of the K2, in part 2 we will examine the K2 and its implementation in detail and why it works so well.

Just who is Elecraft and what is the K2?

First a few words about Elecraft, and their philosophy. Elecraft (pronounced with the ele sound as in elegant) was founded in 1998 by two hams that are dedicated to the "hands-on" concept of ham radio. They are Wayne Burdick, N6KR, and Eric Swartz, WA6HHQ. Wayne has experience in the radio kit design area from association with the Northern California QRP club and designed the NorCal 40 and Serria transceivers. These two hams decided there was a need for a contest-class all band HF transceiver that offered features that were not available in other radios. With close to 4000 K2 kits sold I guess they have succeeded. Their goal was to take the radio kit, which has seen an increase in popularity lately, beyond the small, QRP one or two band, radio to a full featured radio that could compete with any radio on the market and still sell for less than one thousand dollars.

Elecraft also offers other kits, including the K1 which is a 4 band 5 watt QRP transceiver and the KX1, a three band 4 watt CW transceiver mainly intended for portable and backpacking use. If you are interested see the Elecraft web page at www.elecraft.com.

So what are the specifications on the K2? Well I hate to just parrot back the data sheet, but I will list some of the interesting or unusual features. The receiver dynamic range performance numbers are right up there with just about every other radio in the amateur market and better than most. That is saying something, but it is the unique design that brings this level of performance to such a small and inexpensive radio. More on this in part 2. Here is my condensed list of features. If you don't see your favorite that doesn't mean it doesn't do it. It just may not be on my list. See the Elecraft web page listed above.

- Eight bands plus 160 and 60 meters with options
- CW in basic kit, SSB and Data with option AM and FM not offered
- 15 Watts output, 100 watts with optional internal amplifier kit
- Internal 15 watt or external 150 watt automatic antenna tuner
- Internal battery

- Both an Analog and DSP audio filter option. Note the DSP filter has an open software architecture to allow users to develop and share software. A Time/date calendar included in both options.
- RS232 interface
- Noise blanker
- Interface for up to three VHF transverters with direct read out of the transverter frequency
- Dual VFO with split operation and RIT and XIT
- Memory mode
- Built in iambic keyer with memory keyer. Straight key interface for key and/or computer
- Direct frequency entry
- IF derived AGC with fast, slow and (YES!) off mode
- IF gain control, with RF amp on/off and attenuator in/out selection
- Diode switched QSK in both low and high power
- Variable IF crystal filter bandwidth
- Adjustable CW offset/sidetone, normal and reversed
- Wide supply voltage operating range, 9 to 15 volts
- Ability to tailor transceiver current in receive to maximize battery life

Some of these features will be covered in more detail later.

A picture of the K2 is shown in photo 1. The case is 2.9 by 7.8 by 8.2 inches and the radio weights 3.3 pounds. It has only 6 knobs but 17 push buttons. Most of the push buttons are dual action in what they call Tap/Hold. That means the button has two functions depending if it is given a quick tap or held for a half second or more. Ten of the buttons are used for entering the digits for direct frequency entry. This mode is accessed by depressing two buttons at the same time. I personally find this a bit awkward, but in general the front panel layout is reasonable. Having the keyer speed control on the front panel and not buried in a menu is a real plus to the CW operator. The push buttons have a reasonable feel. The main dial is used for many functions besides just frequency control when using set commands in the menu. More under operation later.

The K2 Kit and Construction

Photo 2 shows the kit out of the box. The bags of capacitors, resistors, and other small parts can be a bit intimidating. Heat up the soldering iron.



Photo 2

Photo 3 is a view of the K2 and the 100 watt power amplifier.



Photo 3

Inside the case are three main printed circuit boards. Other options are plugged into the main board or mounted in the case and connected by plug in jumper cables. The first board is the front panel board, which contains the front panel switches, controls and the LED and liquid crystal display. The bar LED is used as an S meter, ALC and Power output meter. The bar graph can be used in three modes, bar, dot and off to reduce current when desirable. The liquid crystal display is the frequency display. It also indicates mode, and other status such as Pre amp on/off, attenuator in/out, VFO, RIT/XIT, noise blanker and antenna selection. The liquid crystal display is back lighted for viewing in any ambient light level. This lighting level is adjustable for optimum visibility and minimum current drain. The display is

also used for the menu mode set up. When the CW keyer speed is adjusted or the power level changed the display also briefly displays that quantity. In the tune mode it displays the power out and with the 100 watt amplifier option, the SWR. It will also flash messages such as High Current or High SWR. There is also a Display feature that when pushed reads out the transceiver supply voltage and current drawn. This can be very useful when in use with battery power.

The second PC board is the control board and has the transceiver's main microprocessor. The AGC and Audio amplifier are also on this board. The third board is the largest and is called the RF board. It contains the frequency synthesizer, RF band pass filters, receiver RF and IF amplifiers, crystal filters, BFO and product detector. The Transmitter mixer, driver and power amplifier circuits along with the transmitter low pass filters are on this board.. These three boards are interconnected by plug in connectors with the RF board acting as a mother board. There are a very minimum of wire connections in the radio. This modular concept is followed in the case design as well. The enclosure is made up of six pieces of sheet metal all held together by screws. It all cleverly goes together and comes apart easily. It is necessary to install the boards and the case and then disassemble them several times in the assembly process, but because of the clever mechanical design it all goes very well. There is a large empty space in the basic K2 enclosure that can be used for options. This includes a low power automatic antenna tuner, noise blanker, either a digital or analog audio filter, a 100 watt amplifier or SSB adapter. There is also an internal battery available. An RS232 interface is part of the 100 watt amplifier option or it can be added by itself. There is a 160 meter option and a 60 meter option. The 160 meter option is in the K2 I built. And lastly a vhf transverter option. The transverter option takes off a low level signal so that the power amplifier is not required to save power. This is a real plus for the portable vhf/uhf operator. Not all options can be incorporated in a K2 at one time. For example the 100 watt amp and 15 watt internal antenna coupler can not be used in the same K2 at the same time. But there is a 150 watt antenna tuner option, so there does not have to be a loss in functionality. The 100 watt amp option replaces the sheet metal top cover with an extruded heat sink that has the amplifier circuits mounted on the inside. This amplifier can be removed with a screw driver and the plug in cables removed, the

original top cover put back on and the K2 is again a 15 watt low current radio for portable or field day operation. Because of the low drain of the radio even in the 100 watt version, it might make a good candidate for a battery powered field day radio. There has obviously been a lot of thought given to the design both electrical and mechanical. I think the clean design and modularity of the circuitry is a major reason for the K2's popularity as a kit. It really goes together easily.

So how does the K2 go together?

Well it is a lot of fun! I was never big on building kits, but it has been fun putting the K2 together. It is a first rate kit! The manual is clear and detailed. If you can read and follow the instructions and solder you can build a K2. But it is probably not a good first kit for someone that has not built a kit before. I would recommend starting your kit building with something simpler. Maybe a K1? Several suggestions are get a good temperature controlled soldering iron and a good pair of flush cutters for trimming leads. Also a good magnifying glass for part identification and board inspection. Work slowly and don't push to get the job done. The time to build is estimated to be about fifty hours for a typical builder. I was going to keep track of the time but decided not to because I knew that would add pressure that I didn't want. They break the assembly up into sections where you actually stop construction and test and align part of the radio before proceeding to the next part. This includes a detailed inspection, DC resistance measurements and finally powering up the circuits and checking them out. At the end of the second such break in construction you actually have signals through the receiver on one band.

I can not say enough about the quality of the pc boards. They are first rate with a very good solder mask that makes soldering much easier. The board plating is good, the layout clean and with reasonable space to work. All parts are through hole. All semiconductors are soldered in with the exception of the 40 pin controller ICs which are mounted in sockets. The parts are easily located on the silk screened parts outlines on both sides of the pc boards. Parts are mounted on both sides of the boards but probably 80% are on the top. The directions are quite clear as to where the part is located in most cases. Placement flows from left to right and back to front. It is best to not stop in the middle of a part placement step. Also keeping to the order of the manual is important. I find reading ahead a few steps so I have a

feeling what is going on in the assembly process is a big help to me. There are coils to wind. After all it is a radio. But there is a second source that will provide a set of pre-wound toroids. Elecraft does approve the source, but I wound the coils. The coils are wound with thermaleze wire that is easy to strip with a hot soldering iron and solder. The quality of the sheet metal and painting is also good with all the holes showing up in the right places.

The only test equipment required is a volt/ohm meter. A frequency counter and RF power meter are handy for adjusting the reference oscillator and calibration of the output power meter but are not necessary. Another receiver can be used as a frequency reference. You can use the built in digital volt meter and frequency counter to calibrate the transceiver but an external volt ohm meter is much handier. The alignment was completed in an hour or so after final assembly partly due to some of it having been completed in the earlier test steps.

There is a large well organized trouble shooting section in the manual. I have not had to use it but I have read through some of it and it seems to be very clearly thought out and organized. Someone flow charted the procedure first. You answer some questions, make some measurements and then it tells you where to go (In the trouble shooting section of course.) The kit includes the parts and small PC board to build an RF probe for trouble shooting. There is also a suggested circuit for a small test oscillator if a test signal is required to trouble shoot a difficult problem and the builder does not have another source of a test signal.

The assembly instructions suggest you do a parts inventory first. If any parts are missing, you can request them via E mail or call them during west coast business hours. I wish I had a better report on this. I requested one part for the K2 kit and it arrived in a few days via snail Mail from the coast. Great! I was missing a few more parts for the 100 watt amplifier kit and that request took 10 days. I called on the phone after waiting over a week and that was a positive experience. I talked to a person who transferred me to the right person who said my parts had been shipped and I should have them. The only complaint I really have is the week delay in shipping the parts. They offered no excuses and I did not ask for any. I certainly have had much poorer experiences with customer service with other radio companies, so I'll give them a "B". They also

sent an e mail asking me to check a part in a kit I bought and haven't started building yet. I returned the e-mail after inspecting the kit saying that yes the part in the kit was wrong and they shipped the part immediately. So maybe that takes it up to "A minus". So far dealing with the people at Elecraft has been a pleasure.

I am going to break the review here so the Editor won't have to break the postage budget or listen to complaints about long down loads. Next month I'll cover the operation and a description of why the K2 works so well. But I won't keep you waiting for my overall impression of the K2

The Bottom Line

So what do I think of the K2. Well I have only used it for about three weeks, but I am impressed. I did use it in the 160 meter contest and it performed very well. Later I hope to get to try it in a bigger contest on a more active band, like 40 meter and see how it holds up. I suspect it will do just fine. It's got some of the right stuff!

When you add up the price of the basic kit and options it still works out a bit cheaper than all but the lowest priced HF radios, but some of them will give you additional bands and modes. And you have to put the K2 together. Well I am sure that can be looked on as a plus. Not many hams today can say they built their radio. Even if it is a kit. But if building a kit isn't important to you and you don't want a radio that really has state of the art receiver performance in a small light weight package that will run on a couple of lantern batteries for many hours and not break the price budget, then you are probably not interested in the K2. But I hope that after reading this review you will give it a look when you consider your next HF radio. Next month I will look at operating the K2 and what makes it work so well.

73 Bob W1XP

Contest Calendar

FEBRUARY

14-15 World Wide RTTY WPX Contest
exchange RST 3 digit s/n

21-22 ARRL DX Contest CW
exchange RST and state or province

28-29 CQ World Wide 160 Meter Contest SSB
exchange RST and state or province

MARCH

6-7 ARRL DX Contest SSB
exchange RST and state or province

14 North American Sprint RTTY
exchange other call, your call, s/n, state province
or country

20 9KCC 15M Contest CW/SSB
exchange RST QSO number

20-21 Bermuda World Wide CW/SSB
exchange RST

27-28 CQ World Wide WPX CW
exchange RST 3 digit s/n

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PSLIST FEBRUARY 4TH

Listing public events at which Amateur Radio communications is providing a public service and for which additional volunteers from the Amateur Community are needed and welcome. Please contact the person listed to identify how you may serve and what equipment you may need to bring. The most up-to-date copy of this list is maintained as <http://purl.org/hamradio/publicservice/nediv>.

**** Every event listed is looking for communications volunteers ****

Date	Location	Event
Contact	Tel/Email	

Apr 19	Hopkinton	Boston Marathon Start
Steve K1ST	k1st@arrl.net	

Hopkinton/Boston Boston Marathon Course
Steve W3EVE baa2004@amateur-radio.net
Boston Boston Marathon Finish
Paul W1SEX w1sex@arrl.net

Apr 25 Groton MA Groton Road Race
Ralph KD1SM 978-582-7351 kd1sm@arrl.net

May 2 Boston MA Walk for Hunger
Bob K1IW 413-647-3111
wfh2004@amateur-radio.net

May 15-16 NH-ME Lung Assoc bike trek
David KA1VJU 603-581-2602
ka1vju@dmegin.com

May 16 Devens MA Parker Classic Road Race
Stan KD1LE 978-433-5090 kd1le@arrl.net

See <http://purl.org/hamradio/publicservice/nediv>

FROM THE ARRL LETTER

AMATEUR RADIO EDUCATION & TECHNOLOGY PROGRAM'S RANKS, ENTHUSIASM EXPAND

Since becoming ARRL Amateur Radio Education and Technology Program Coordinator some six months ago, Mark Spencer, WA8SME, has seen the number of the program's pilot schools rise from 50 to 70. Fourteen schools came aboard last fall, while another three schools already in the program received progress grants of up to \$500 to help them continue their program activities.

"The new schools coming onboard are approaching this program with a lot of enthusiasm that I hope will continue," Spencer said. He's hoping their upbeat attitude will be infectious, and that other schools will follow the lead of the ones that have experienced the greatest success.

"The success of a program school boils down to the teacher, community and administration support and local Amateur Radio club support," Spencer says. "Those schools that can get all these things together are really doing well."

The ARRL program subsidizes the cost of an Amateur Radio station for each participating school--typically about \$2800, Spencer says. To better spell out the League's expectations, lead teachers and principals now must agree in writing to make a good-faith effort to integrate Amateur

Radio and wireless technology into their curricula for at least three years. "We have a responsibility to our donors," Spencer explains.

Spencer sees his role as supporting pilot schools by helping teachers to integrate the Education and Technology Program's curriculum into their classroom pursuits. "This has to be a grassroots activity," he says. The program curriculum is available on the ARRL Web site <<http://www.arrl.org/FandES/tbp/Curriculum-Materials.html>>.

On the other hand, he recognizes that schools in recent months have faced heavy budget cuts that have compelled school administrators to pull back on enrichment activities. "Our program has mitigated the costs for schools," said Spencer. But since the ARRL cannot provide much more than initial seed money for equipment, affiliation with a local club becomes all the more essential.

Not just money but time is at a premium for today's educators, especially for extra-curricular activities. "Teachers are already stretched too thin," he says. That's where local Amateur Radio clubs come in. "The clubs can do a better job than we can do from here in supporting a participating school's program." Some clubs have provided additional equipment to the schools too. Even more important: Club members often offer their ham radio experience and expertise to mentor youngsters in participating schools. Spencer says it's hard to put a price tag on that kind of contribution.

While the Amateur Radio Education and Technology Program typically is an after-school activity, Spencer says more and more schools are integrating Amateur Radio into their science curriculum. More private schools also are applying to participate, and even home-schooled youngsters are making use of the program's curriculum, he notes. Spencer reports there have been more than 1200 downloads so far.

Although licensing students is not a primary program goal, many youngsters have become Amateur Radio operators as a result of their program involvement. More important to Spencer is the exposure to technology the program provides. "They're spending an average of five hours per week talking about wireless technology and Amateur Radio," he says.

There's more information about the ARRL Amateur Radio Education and Technology Program

on the ARRL Web site <<http://www.arrl.org/FandES/tbp/>>. The ARRL Development Office invites support for this initiative <<https://www.arrl.org/forms/development/donations/education/index.html>>.

LEAGUE FILES "A PLAN FOR THE NEXT DECADE" WITH FCC

The ARRL has filed a Petition for Rule Making asking the FCC to amend its Part 97 rules to complete the Amateur Service restructuring the Commission left unfinished in 1999. The League wants the FCC to create a new entry-level license, reduce the number of actual license classes to three and drop the Morse code testing requirement for all classes except for Amateur Extra (see "ARRL to Propose New Entry-Level License, Code-Free HF Access" <<http://www.arrl.org/news/stories/2004/01/19/1/>>). The ARRL says its petition follows in the footsteps of changes in Article 25 of the international Radio Regulations adopted at World Radiocommunication Conference 2003. Among those changes, WRC-03 left it up to individual countries to determine whether or not to mandate Morse testing for HF access. While several countries--including Germany, the UK and Australia--already have dropped their Morse requirements, the ARRL emphasized in its petition that Morse code is not the central issue.

"Changes in Morse telegraphy are one aspect of the proposal, and it would be insufficient for the Commission to address those issues in a vacuum," the League said, calling its licensing proposal "a plan for the next decade." The ARRL said that plan's overall intention is "to encourage newcomers to the Amateur Service and to encourage those who enter its ranks to proceed further on a course of technical self-training and exposure to all aspects of the avocation."

Last fall a total of 14 Morse-related petitions were filed with the FCC. Several called on the Commission to drop the Morse requirement altogether, while others proposed to keep and even expand the requirement or put forth various license restructuring schemes of their own. The petitions, RM-10781-10787 and RM-10805-10811, attracted thousands of comments from the amateur community.

Beyond the Morse question, the ARRL says, the time is right--now that WRC-03 has finished its work--to follow through on the restructuring proc-

ess the FCC began with its 1999 restructuring Report and Order (WT 98-143) <<http://www.arrl.org/announce/regulatory/wt98-143ro.pdf>>. Among other things, that landmark Order, which became effective April 15, 2000, reduced the number of Morse code test elements from three to a single 5 WPM requirement for all license classes offering HF privileges.

Simply dropping the Element 1 (5 WPM) Morse requirement, the ARRL asserted, would fail to address the critical need for an entry-level ticket other than the Technician. Calling the Technician license "a dead end" for many people, the ARRL said its proposed entry-level license--being called "Novice" for now--would offer newcomers a much wider sampling of Amateur Radio. It would require passing a 25-question written examination--but no code test--and offer limited HF phone, image, CW and data privileges at modest power output levels.

"This structure provides a true, entry-level license with HF and other operating privileges which will both promote growth in the Amateur Service and integrate newcomers into the mainstream of Amateur Radio," the ARRL told the FCC. "It will better introduce newcomers to more seasoned licensees who will assist them."

The League proposal also would consolidate current Technician and General licensees into General class without further examination. Future General applicants would not have to pass a code test, but the written exam would remain the same. Current Advanced licensees would be merged into Amateur Extra class without further testing, and the Extra exam would remain intact. The ARRL proposal would retain the Element 1 Morse exam for Extra class applicants.

The ARRL said its overall plan dovetails with the FCC philosophy and goals stated in its 1999 Report and Order--to simplify the license structure and streamline the licensing process. The League said its plan would implement licensing requirements and privileges that are in harmony with each other and is designed to attract and retain "technically inclined persons, particularly the youth of our country" and encourage them to advance in areas "where the United States needs expertise."

"Now, the issue is not merely whether there should or should not be Morse telegraphy as an examination requirement," the ARRL said, "but rather what is the best overall approach for posi-

tioning the Amateur Service for future growth and incentive-based self-training."

A copy of the ARRL's Petition for Rule Making is available on the ARRL Web site <<http://www.arrl.org/news/restructuring2/restrux2-petition.pdf>>. The FCC has requested that individuals refrain from contacting or attempting to comment to the FCC on the ARRL's restructuring proposal before the FCC issues a Rule Making (RM) number for the ARRL petition and invites public comments on it. Until that happens, it is premature to comment to the FCC.

NVARC Loaner Equipment

Kenwood TS-451 transceiver
Cushcraft R-7 antenna
Astron RS-35M power supply
Practice Oscillators MFJ557 Keyer

\$January Treasurers Report\$

Income for January was \$60 in membership dues, and \$35.75 from bank savings interest. Expenses were \$14.80 for newsletter postage, and \$44 for the Post Office box annual rental leaving a net income of \$36.95 for the month.

Current balances:

General fund	\$4641.42
Community fund	\$1842.55



We have 54 current members.

Not yet an ARRL Member? Consider joining this month. If you give your ARRL membership to me with a dues check made out to NVARC, I will send it to ARRL for you -- saving you a stamp and earning the club a rebate. The ARRL rebate applies only to new members who join through an Affiliated Club.

73, Ralph KD1SM



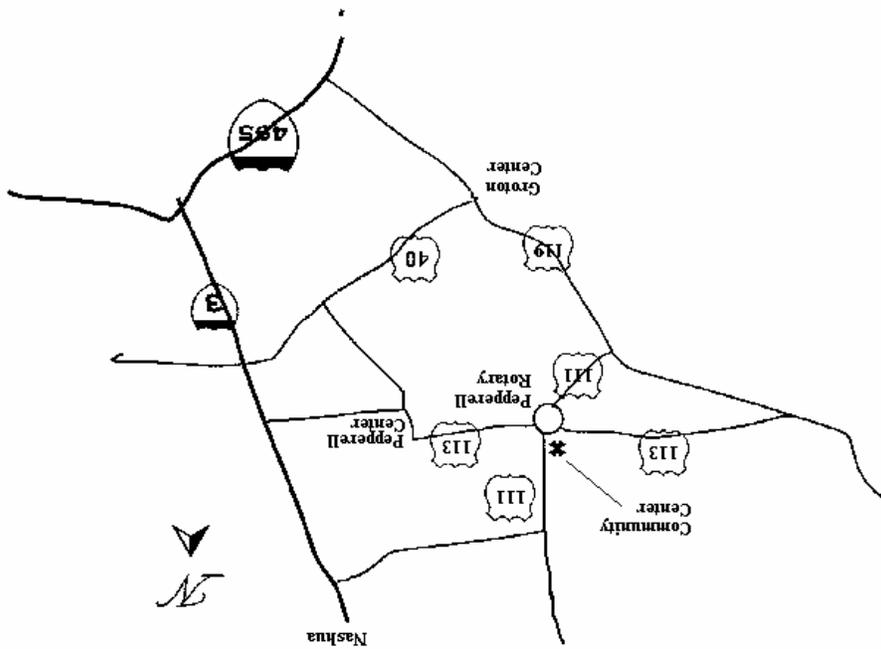
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