



PCARA Update



Volume 20, Issue 2 Peekskill/Cortlandt Amateur Radio Association Inc. February 2019

Testing times

We started 2019 with the **Annual PCARA Bring and Buy Auction** on January 6, 2019 at New York-Presbyterian/Hudson Valley Hospital. There were several tables full of items that members brought and 17 members in attendance. Our resident Auctioneer Malcolm NM9J picked up the gavel and as always, did an excellent job! Through our member's generosity,



PCARA's Jan 6, 2019 Bring & Buy Auction.

\$65.00 made its way to our coffers. **Thank you** to everyone who brought and bought!

On the evening of January 16, 2019, the **PCARA UHF Workshop** held at the Town of Cortlandt CUE Room at the Cortlandt Town Center was attended by 26 people! Karl N2KZ gave a very thorough and comprehensive presentation on the 440 MHz band used by amateur radio operators including propagation and antenna types. Hopefully this helps inspire more use of UHF among our members, and greater use of PCARA's two UHF repeaters. Thanks Karl for an excellent presentation! Also, thanks to the Town of Cortlandt Recreation Department for permitting PCARA use of the CUE Room.

Saturday January 19, 2019 was a very busy day for PCARA. We began our day at 9:00 a.m. with the monthly **PCARA Breakfast** at Turco's in Yorktown Heights, NY. We continue to draw a large crowd; with 15 members in attendance — outstanding. The day continued with a **PCARA VE Test Session** at 11:00 a.m. at the John C. Hart Memorial Library in Shrub Oak, NY. Here too, we had record attendance with six candidates (five new Technicians and one upgrade to General). Thanks to Mike W2IG for coordinating the session, and Karl N2KZ, Malcolm NM9J, Larry AC2QH, Verle W2VJ, Lou KD2ITZ, Joe WA2MCR, Al K2DMV and Stan WA2NRV for their assistance and support, and of course the John C. Hart Memorial Library for allowing us room in which to hold the testing session. Our



Karl N2KZ explains 440 MHz techniques during the UHF Workshop held at the Cortlandt Community Room, Jan 16.

next VE Test Session is scheduled for Saturday March 16, 2019 at 11:00 a.m. at the John C. Hart Memorial Library. If you know of anyone who might be interested, please let them know. All are welcome.

Here are some upcoming regional Hamfests:

- Long Island Mobile Amateur Radio Club (LIMARC) Hamfest: Sunday February 24, 2019 (<https://limarc.org/category/hamfest/>).
- Orange County Amateur Radio Club (OCARC) Spring Hamfest: Sunday April 28, 2019 (<https://ocarcny.org/hamfest/>).
- Bergen Amateur Radio Association (BARA) Hamfest: Saturday May 25, 2019 (<https://www.bara.org/hamfest/>).

Our next regularly scheduled meeting is on Sunday February 3, 2019 at 3:00 p.m. at New York-Presbyterian / Hudson Valley Hospital. I look forward to seeing each of you there.

- 73 de Greg, KB2CQE

Contents

Testing times - KB2CQE	1
Adventures in DXing - N2KZ	2
Successful Ham Radio Operator's Handbook	4
Build a 440 MHz Moxon antenna - N2CKD	5
UHF Workshop - NM9J	7
WA5VJB Yagi - KD2ITZ	9
V.E. Test Session	10
Electromagnetic radiation meter	10
Digital storage oscilloscope - NM9J	11

Continued on page 2 ⇒

Adventures in DXing

- N2KZ

Know the Code

The first time can be pretty scary! After listening with curiosity for days and days it's time to give it a try. Touch the key and make a few dits and dahs. Here we go! Hopefully, the sound will be understood in a place far away.

What does it say? "N N M A N N M A" What does it mean? A seasoned operator would understand. Say the dits and dahs out loud and you will surely reveal the meaning. "I get it! I get it! They are calling CQ!"

Beginner QSOs can be irresistible. Anyone who loves Morse Code recognizes their unique sound. You can hear the desperation and fear from their fist! Like a

youngster first trying to ride a bike without training wheels, you just feel compelled to pull them through.

Your response on the receiving end? Keep it very, very short and very, very simple! As slowly and deliberate as possible, send back your call sign and see

if they can return it. Remember: If you can just exchange call signs, you can count it as a QSO. Everything else is extra gravy!

What comes next requires skill and a lot of patience. Constantly remind yourself how easy it is to overload a beginner. If you get through a call sign

Continued from page 1

Net night

Peekskill/Cortlandt Amateur Radio Association holds a weekly net on the 146.67 MHz W2NYW repeater on Thursdays at 8:00 p.m.

Join net control Karl, N2KZ for news and neighborly information.

PCARA Board

President:

Greg Appleyard, KB2CQE; kb2cq@arrl.net
Vice President/Treasurer:

Joe Calabrese, WA2MCR; wa2mcr@arrl.net
Secretary:

Lou Cassetta, KD2ITZ, radiocassetta@gmail.com
Directors:

Bob Tarsio, N2CBH

Mike Dvorozniak, W2IG

exchange and you sense some remaining energy from your rookie, try sending your name: 'NAME K A R L' twice and take a big long breath. Then send: "UR NAME?" twice.

The end is simple! Ever so slowly send: T H A N K S (their name) and imagine the sigh of relief at their end. Always follow up with encouraging e-mail and a QSL. Hopefully, they will try it again!

Dare to Learn

To first experience Morse code requires a lot of concentration and a lot of courage! I try to help people find some! When CW comes up in conversation, I often hear all sorts of excuses. These can be really creative and entertaining to hear. Honestly, I don't believe that it takes a long time to wash your camel, so please think up a better one! Yes, you really can learn code!

I taught myself Morse code. You need no equipment. All you need is your head. View anything written before your eyes and translate the letters into code. License plates, road signs, store fronts, message texts, books and newspapers are all great sources. One letter at a time is all we ask! You will go through a phase where you will need to look up a letter or two you don't remember. Listen to the Morse in your head. Just keep at it!

Find yourself a code buddy. You can start with me. I will gladly volunteer! Having taught many people Morse, I have developed a method all my own. (I looked back on my archives and found that I first taught code to PCARAns back in February and March 2002!)



Karl conducts a PCARA code class back in 2002.

My approach is a logical one. I teach everyday conversational Morse much like what you would hear on the air. During an average on-air QSO much of what you hear is repetitive with only a few fill-in-the-blanks (in *ITALICS*.) Take a look:

*NM9J DE N2KZ UR 599 599 NAME HR KARL KARL.
QTH KATONAH NY KATONAH NY. BTU NM9J DE N2KZ K.*

For a first round, you need to be able to read only four items: **N2KZ**, **599**, **Karl** and **Katonah**. The rest of the message can pass you by! Most every QSO will be

in a very similar format. Run this drill over and over again and filling in the blanks should become routine. Also, remind yourself of one of the beautiful attributes of communicating in Morse: You can miss many, many letters and still pull through the message.

Another facet of my technique is repetitive listening to common often-used words: KENWOOD, ICOM, YAESU, DIPOLE, YAGI, VERTICAL, QTH, QSB and weather words: SUNNY, CLOUDY, WARM, COLD, RAINY. These will help you get through basic QSOs, too! I also use 'call and response.' We will do a drill where I send just one word and the student has to send it back to me as a reply. Many people find this really useful and often pretty difficult.

Each on-air visit with a student also requires a new identity from yours truly. I will change my name, QTH and rig type to keep things lively. For more advanced students, I will invent imaginary people and situations to see if they are *really* copying what I am sending. A response of "You are crazy, Karl" is what I am really looking for! So, if you hear Boris reporting in from Moscow using my call sign, you'll know it's really me! I promise to make each lesson an experience in itself!

Be a Good Listener

When you join the Morse community, you need to know where to go to meet people like yourself. Beginner Morse operators cluster on 80, 40 and 20 meters. Good places to look for slow code QSOs are the watering holes of two stalwart Morse groups: FISTS (<https://fistsna.org/>) and The Straight Key Century Club (<https://www.skccgroup.com/>). Tune in on or around 3530 to 3560 kHz, 7030 to 7060 kHz and 7100 to 7125 kHz and 14050 to 14060 kHz. Here the code sent is very often 'safe' and slow, often sent by straight keys in the most basic ways possible. These are great places to visit and discover how code sounds at nice slow attainable speeds you can understand.



Staying Simple is Key

When you first venture into the world of Morse code and CW operation, the variety and expense of obtaining a first key can be overwhelming. There are so many choices and types to choose from. You can spend nearly nothing to thousands of dollars! I highly recommend newcomers begin their telegrapher careers with the simplest straight key possible.

The most inexpensive key I know is the Ameco K-1 which sells for under \$15. My all-time favorite is its all-brass big brother, the Ameco K-4 which is sadly out of production. Both are quite reasonable basic beginner keys perfect for starting your new quest. After you find

a key, create a KOB (Key On Board.) A piece of wood can be used as a simple base to secure your key as you operate it.



Ameco K-1 straight key.

A manually operated straight key is the standard stick-shift of the telegraph business. When you use a paddle in concert with an electronic keyer or an old fashioned 'bug' you are locked to one user-determined speed to send your message. The beauty of a straight key is that your sending speed is completely controlled by your fist! When sending to beginners, I can slow down to nearly nothing to emphasize difficult or complex words... and do it with grace and style.

Along with the simplicity of the medium itself, you might also delight in the simplicity of the equipment necessary to get on the air with CW. Probably the most basic transmitter is a tiny two-transistor transmitter called a Tuna Tin II. It uses a tuna can as a chassis! With only a quarter of a watt output power, you can literally work the world. Take a look at PCARA member, Mike N2HTT holding a very important version. Funny... mine looks exactly like it! Thousands have been made and are used lovingly on the air to this day!



Mike N2HTT holds the original Tuna Tin II CW transmitter in his hands.

Meet Marshall

Joining the Morse community brings many benefits. You can squeeze the last decibel of signal out of the worst conditions possible. With Morse code, your message gets through reliably. You also become part of a fraternity of people all enthusiastic about their skills and their accomplishments. Code really is a treasured skill.

Ah, the stories I could tell! I have met amazing people by using Morse. I worked a deaf ham who copied code by feeling vibrations with his hand on a speaker cone. Another ham suffered from arthritis and taught himself to send with his left hand when his right hand became too painful. When his left hand fell to a

similar fate, he moved to using his right big toe! He sounded good, too.

The variety of occupations are amazing, too. I have met many old sailors and shipboard radio operators. What a thrill to work a Russian vessel sitting off the shores of the Dominican Republic or a scientist sending code from an enclave in Antarctica. Military veterans provide fantastic stories and superb operating hints. Anyone who has manned a 'mill' (an upright typewriter made exclusively for copying code) knows how to effectively handle the most difficult messages.

One person who truly is an ace is Marshall Emm, N1FN. I met Marshall after building a kit he sells that was designed by an old friend of mine, Doug DeMaw (SK) W1FB.

The Oak Hills Research OHR-100A is a nifty project — certainly the most complex and feature-loaded rig I have made. Marshall's business, Morse Express, is a comprehensive source of all things a code maven could ever want. A warm and interesting friend he is! It is a wonderful place to look, learn and enjoy this facet of our hobby:



Marshall Emm N1FN

https://www.mtechnologies.com/n1fn/.

So the invitation is out there. Let me introduce you to the ham radio version of Narnia! There is a fascinating world out there to those who know the code. Come and enjoy the fun. Drop me a line at n2kz'at'arrl.net and I will give you a tour! This article is only the beginning! There is a key waiting for you!

Until next month, 73 ES DIT DIT DE N2KZ, 'The Old Goat.'



Successful Ham Radio Operator's Handbook

In an e-mail to newsletter editors dated December 29, 2018, Vic, VE3YT and Fred, KE7X introduced "The Successful Ham Radio Operator's Handbook", a new book aimed at new or returning hams to help them learn about the exciting challenges amateur radio offers today and to help them be successful. Here is an extract from the authors' announcement describing the book in more detail.

"This new book is aimed at new or returning hams to help them understand the practical aspects of the hobby, how to use their radios, build antennas and baluns, and get on the air successfully. In it you will find explanations of how the various parts of your ham radio — the transmitter and receiver — work, plus how these are being implemented using software defined radio technology. Operating techniques for VHF/UHF repeaters, HF radio DXing techniques, and the new digital modes are covered. Radio propagation, antennas, transmission lines, SWR and the mysteries of baluns are explained. Building your HF station, choosing a radio, connecting your radio to a computer, and mobile and portable operation are extensively covered."

"Both the pdf and spiral-bound printed versions are available from Lulu.com, and the print copy is also sold by DX Engineering. You can find them via these links: <http://www.ke7x.com/successful/ordering-the-successful-ham-radio-operator-s-handbook>

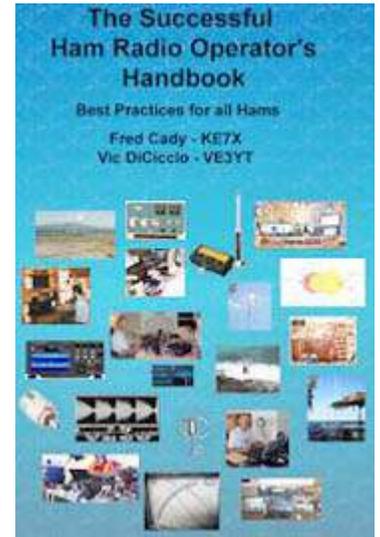
"Here is a link that describes the book in more detail: <http://www.ke7x.com/successful>

"One instructor for new and advanced ham classes has said, 'This book is exactly what is needed. I've seen some other books targeting the new hams that are less than satisfying both technically and in content but this one is right on the mark and covers so much information that I so often get asked about, during and after teaching classes.' "

TX Factor 22

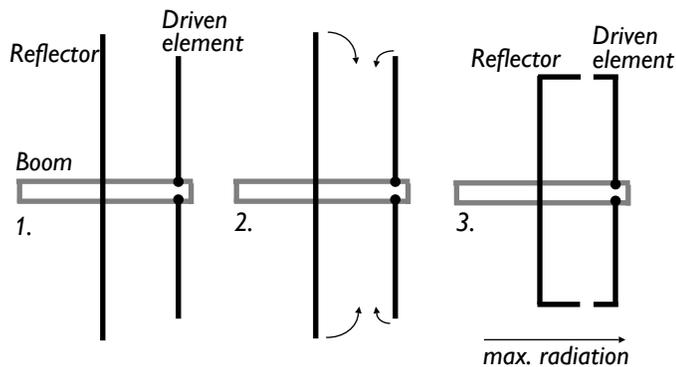
The latest episode of UK amateur radio TV show "TX Factor" is now available. Episode 22 includes a UK view of "Network Radio" and a review of the Icom IC-R8600 wideband receiver (10 kHz to 3 GHz) with real-time spectrum scope and FPGA decoding of analog and digital modes. There is also a preview of the upcoming Yaesu FT-DX101 hybrid transceiver, which combines a direct-sampling SDR for the spectrum display with conventional down-conversion for radio reception.

You can pay a visit to the TX Factor web site at <http://www.txfactor.co.uk/> or select YouTube on your streaming device and search for "TX FACTOR".



Build a 440 MHz Moxon antenna - N2CKD

The Moxon Rectangle is a simple two-element antenna. It's named after Les Moxon, G6XN (SK). The design is rectangular shaped, with approximately half the rectangle being the driven element and the other half being the reflector. It is electrically equivalent to a two-element Yagi antenna with bent driven element and reflector, but no directors. Due to the folded ends, the antenna width is approximately 70% of the equivalent half-wave dipole size. The two-element Moxon behaves like a Yagi, with a null towards the rear of the antenna and a high front-to-back ratio.



Derivation of Moxon Rectangle antenna from a two-element Yagi by folding the element ends toward each other.

[For additional background on the Moxon Rectangle, see PCARA Update articles in References section – Ed.]

A few years back I had built a similar 70 cm UHF Moxon antenna using coat hanger wire for the driven element and reflector. It still works very well but it is insufficiently rigid at the gap ends. I decided to build a more robust version using a common plastic kitchen cutting board which I bought at the local dollar store. The gain of this little antenna is between 5 – 6 dBi and performance is excellent. The total time to build is about one hour. Cost to build is zero to \$1.00 depending on your junk box.



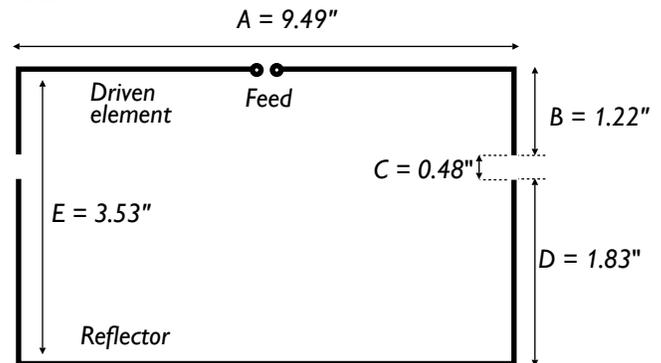
Plastic cutting board by Pride Products Corp. These boards are usually manufactured from high density polyethylene or high density polypropylene, materials with low RF losses.

Parts list

- Wire from clothes hanger — or use 12 AWG copper wire.
- Plastic kitchen cutting board. (Thin board, size 12" × 8.15", available at dollar stores or Walmart.)
- Bracket to fasten a male BNC connector. (I made mine from a curtain end bracket).
- 50 ohm BNC single-hole chassis mount socket (female).
- RG-58 coax cable approx. 4" long to connect BNC socket to driven element.
- Hot-melt adhesive and glue gun.

Construction

See diagram below for dimensions of the Moxon antenna.



Dimensions in inches of Moxon Rectangle antenna for 446.000 MHz as calculated by Moxgen program.

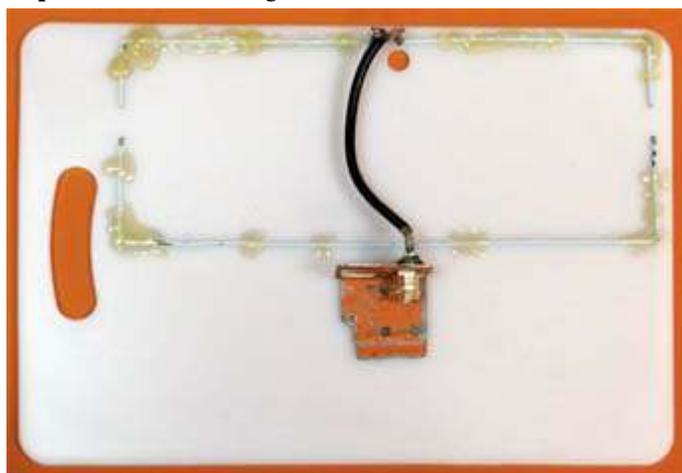
1. Cut the clothes hanger wire into two pieces. Cut one wire to a length of 11.93" for the driven element. Cut the second wire to 13.15" for the reflector.
2. Bend the driven element ends at an angle of 90°. The bent ends should both be 1.22" long.
3. Bend the reflector ends at 90°. The bent ends should both measure 1.83".
4. Cut the driven element in half at the center and clean about 1/8" of the center wire ends to prepare for soldering to the coaxial cable. Use sandpaper or steel wool so the wire ends can be easily tinned with solder.
5. Mount the BNC connector to a steel or aluminum bracket. Drill a hole in the bracket to mount the BNC socket onto the cutting board.
6. Solder the two driven element ends to the inner and outer conductors of the coaxial cable. Solder the other end of the coaxial cable to the BNC socket.



BNC connector is mounted on a metal bracket.

7. Lay the driven element wires onto the plastic cutting board and apply hot-melt glue to secure to the board.
8. Lay the reflector wire onto the cutting board with the ends facing toward the driven element and a gap of 0.5" between element ends.

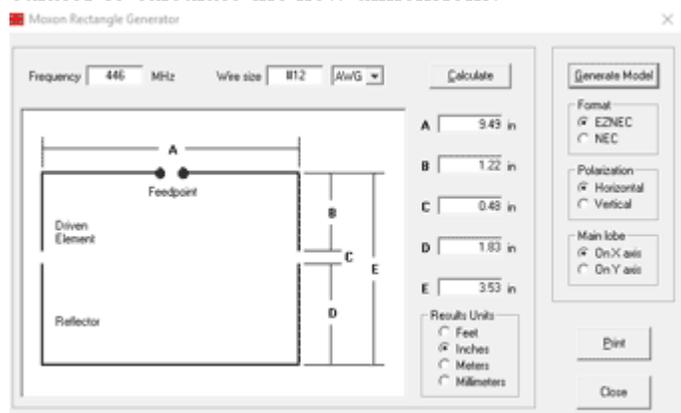
The gap between element ends is *critical* for correct matching of the antenna. I recommend temporarily taping the reflector onto the cutting board to test the SWR prior to applying hot-melt adhesive. Connect a 440 MHz transceiver and transmit on 446.000 MHz simplex through a suitable SWR meter. Adjust for lowest SWR by moving the reflector spacing to adjust the gap. Then, use hot-melt adhesive to fix the reflector in place on the cutting board.



Driven element (top) and reflector below are mounted onto the plastic cutting board and connected to the coaxial feed.

Other frequencies

For other frequencies, see the Moxon Rectangle Generator web page by AC6LA in the References section. Download the software then use the Moxgen calculator to calculate the new dimensions.



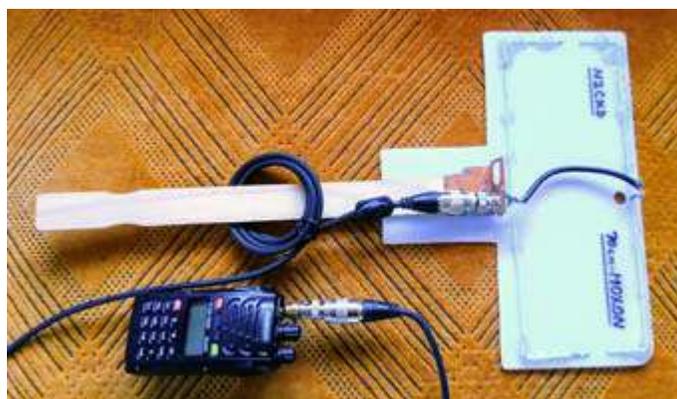
Screen-shot of Moxgen program by AC6LA, calculating dimensions for a frequency of 446.000 MHz.

Testing the Moxon

When construction is complete, connect the Moxon Rectangle antenna to a UHF standing wave

ratio/power meter, locate the antenna several feet from surrounding objects then check performance by transmitting a signal on 446.000 MHz simplex while observing SWR and power. The SWR should be very low provided the gap was adjusted properly. The power meter should then indicate an appropriate forward power level from the radio. Many HTs transmit around 4 watts of RF power at 440 MHz and 5 watts on 146 MHz while on full power setting. The SWR and forward power will vary somewhat depending on frequency. Test further by checking access to local and distant UHF repeaters, orienting the antenna for vertical polarization. *[Please identify with your call! -Ed.]*

I trimmed the cutting board to its final shape to make it lighter and glued on a paint mixing stick to make it easier to hold the antenna. No screws were used, only hot-melt glue. The SWR is 1.2:1 from 440 to 450 MHz.



Final form of Lovji's 440 MHz Moxon antenna. (N2CKD pic.)

For its simplicity, good gain and excellent front-to-back ratio, this is a great antenna for portable operation. It is also suitable for fox hunting on UHF, for example for listening to the harmonic of a 2 meter fox transmission. Why not build one?

-73, de Lovji, N2CKD

References

1. "Make a Moxon" by NM9J: *PCARA Update* Oct 2016 pp 6-10 and "Lawn chair Moxon" by Lou KD2ITZ, *PCARA Update* Dec 2016, pp 12-13.
2. "Moxon Mighty Mite" by J. Barry Shackelford, W6YE, *QST* October 2011, pp 30-33. (Available to ARRL members through the *QST* archive, <http://www.arrl.org/arrl-periodicals-archive-search>).
3. Moxgen.exe, "Moxon Rectangle Generator" program, by Dan AC6LA: <https://ac6la.com/moxgen1.html> . See web page for download and installation instructions.
4. "70cm Moxon beam" by Roger G3XBM: https://sites.google.com/site/g3xbmqrp3/antennas/70cm_moxon
5. "Moxon Antenna for 433MHz or 70 cm Band" by Bob Murphy 2E0RHM: http://ra1ohx.ru/publ/antenny_ukv/2e0rhm_39_s_moxon_antenna_for_433mhz_or_70cm_band/8-1-0-677

UHF Workshop

On the evening of Wednesday January 16, a number of people were heading toward the rear parking lot of the United Artists movie theaters, behind Walmart and Old Navy at Cortlandt Town Center. The reason for this mass migration was PCARA's first ever **UHF Workshop**, arranged by Lou KD2ITZ to take place at the Town of Cortlandt Community Room, also known as the CUE or Cortlandt Upper Teens Entertainment Center. The event had been advertised on Yahoo! Groups, invitations had been sent to surrounding clubs and there had been a mention in the first "Hudson Division Happenings" e-mail from newly-elected Hudson Division Director Ria Jairam, N2RJ,

The main presentation on 440 MHz propagation and techniques would be by Karl, N2KZ. Arriving early to setup antennas and visual aids, we noted that the L-shaped CUE room was looking very attractive thanks to a recent redecoration and some new furniture.

Attendees soon began arriving, many of whom had brought their own home-constructed antennas plus equipment for evaluation and testing. Total attendance was 26, including numerous PCARA members, plus visitors from Cold Spring, Briarcliff Manor, Fishkill and Poughkeepsie.

Prepare to repair

Shortly after 7:00 p.m., Karl N2KZ opened proceedings by welcoming everyone. The first item was a short presentation by Frank W2GIO, trustee of the 223.92 MHz repeater on Mount Beacon. Frank

explained the aims of the Repair Café - Hudson Valley (<http://www.repaircafehv.org>), which organizes repair workshops in eleven different HV locations, including — locally — Yorktown Heights (Jan 26, Grace Lutheran



Frank W2GIO played an NBC News report about the Repair Café. [K2DMV pic]

Church, 3830 Gomer Street) and Ossining. The Repair Café is a free community event where broken items can be brought in to voluntary Repair Coaches, who will attempt to fix them. The group is currently trying to organize a location in Peekskill and our January 16

Workshop was attended by Sarah Cossette of Peekskill Toastmasters, plus Councilwoman Vanessa Agudelo of Peekskill Common Council — who are both interested in the Peekskill project. Anyone interested in supporting the Peekskill Café can contact Frank using w2gio777@at@gmail.com.

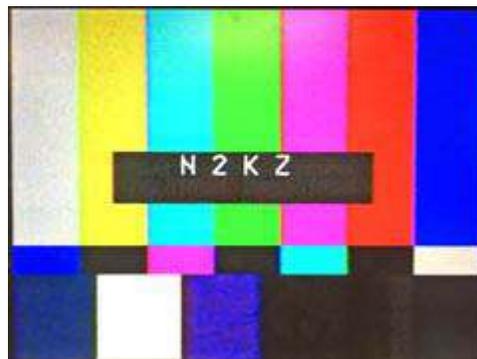
Proper UHF

Karl began the seminar proper by covering the Band Plan for the 420-450 MHz Amateur Band mentioning PCARA's two UHF repeaters, plus the activity on different digital voice modes. Karl went on to describe the various types of UHF propagation, especially modes such as knife-edge diffraction and tropospheric skip which can extend coverage well beyond line-of-sight. The effect of leaves and snow on propagation through trees was also mentioned



Karl starts his presentation on UHF propagation and techniques.

In order to demonstrate how optimum UHF reception can occur from unexpected directions, Karl had brought along a "televisual" aid — just behind the presenter's table was a cable-TV head-end modulator producing an analog NTSC TV signal on cable channel 57. When this particular channel (hyperband UU) is radiated over-the-air, it is on a carrier frequency of 421.25 MHz, and therefore within the 420-450 MHz amateur band. Karl was radiating a color-bar signal with his call sign superimposed using the low-level output from the modulator into an omnidirectional vertical antenna.



Color bars from the N2KZ analog TV transmitter on cable channel 57.

Reception of the channel 57 signal was demonstrated using a "log-periodic" Yagi connected to an

analog TV set through a long length of coaxial cable. Karl roamed around the Community Room with the antenna, showing how TV reception was possible from unusual directions as a result of reflections — and how cross-polarization could reduce reception from a strong, noise free signal down to a sea of white noise. The same applies when siting antennas or using mobile/portable radios — move the antenna around to find the sweet spot for best reception.

Karl went on to describe a range of antennas in use at UHF, using the analogy of a light bulb as an omnidirectional radiator, a rectangle of LEDs as a curtain array beaming forward, and a flashlight or LED pointer as analogous to a very high-gain antenna, with most of the radiation focused into a very narrow beam. Karl's **excellent handout** had pictures of many types of UHF antennas and emphasized the need for low-loss coaxial cable at UHF frequencies.



Karl N2KZ described a range of different antennas for UHF from omnidirectional to narrow-beam-types. [K2DMV pic.]

As a final note, Karl emphasized the importance of flat frequency response when dealing with digital TV — as used nowadays for all over-the-air TV transmissions from New York City. Harmonics from powerful FM radio transmissions can also cause problems with DTV reception.

To close the formal presentation, Frank W2GIO brought along two home-built UHF Yagi antennas, demonstrating the importance of driven element matching and use of fiberglass poles for the boom. Frank and Karl were able to show radiation patterns of the antennas using a pick-up loop connected to an LED as RF detector.

Working the workshop

The seminar then moved into practical mode. Karl had hidden a signal source somewhere in the CUE room and invited those with direction finding capabilities to locate it. The low-power signal source, radiating on 446.000 MHz simplex used the same technology as the Foxhunt University... a Radio Shack portable scanner tuned to the desired frequency \pm the first I.F.

frequency of 10.85 MHz. Your editor found the signal source using a tiny HB9CV antenna, but I had been given a clue! Others were investigating plastic boxes and similar places of concealment around the room.

Meanwhile, those who had brought in UHF antennas for assessment had an opportunity to show off their constructional skills and find out how their antennas performed. Lou KD2ITZ had his 6-element Yagi to the WA5VJB design, while Lovji N2CKD had his newly-constructed Moxon Rectangle antenna for 446 MHz. Bob N2CBH had brought in his IFR COM-120B Communications Service Monitor, covering 250 kHz to 1000 MHz plus telescopic dipole for field strength measurements.



Bob N2CBH adjusts his IFR Service Monitor while receiving local signals on the test antenna.

Bob was able to accurately measure frequency, deviation and received signal strength from any nearby transmitter.

Your editor's Funk Amateur FA-VA5 vector antenna analyzer was pressed into service to check out two 440 MHz antennas built by Fred KD2GJJ. Fred's home-brew ground plane, built around an SO-239 socket had an admirably low SWR over the range 440-450 MHz. A simple wire dipole constructed around an HF center insulator did not perform so well.



Fred KD2GJJ is watched by David KD2EVI as Fred's UHF ground plane is tested.

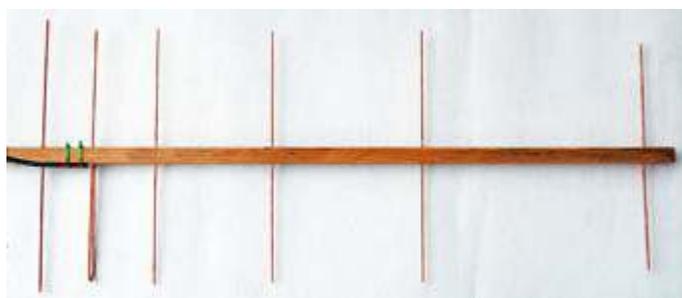
At the end of the evening, everyone believed the event had been a great success with excellent attendance, plenty of information imparted and adequate opportunity for show-and-tell of different home constructed UHF antennas.

- NM9J

WA5VJB Yagi - KD2ITZ

Among the many antennas at the PCARA UHF Workshop was my six-element beam for the 70 cm band constructed with copper wire affixed to a wooden boom. The antenna was built according to instructions published by Kent Britain WA5VJB. See PDF file: <http://www.wa5vjb.com/yagi-pdf/cheapyagi.pdf>.

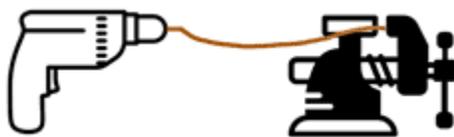
The WA5VJB Yagi was designed as a low-cost solution for building multi-element beams. Kent described them as *Controlled Impedance "Cheap" Antennas*. His plans specify antenna elements of 0.08" to 0.19" in diameter. He reported good results with a multitude of readily-available materials including: wire, welding rod, aluminum rod, and hobby tubing. Others have even obtained material from steel coat-hangers. (See *PCARA Update* May 2011, pp 7-8.)



Six element beam for 70cm as built by KD2ITZ. Designed for an estimated 11 dBi gain and 30 dB F/B.

All my elements were built using #8 solid copper ground wire (diameter 0.129") available from a major retailer for \$0.43 per foot. The wire, of course, was sold in a spool. Straightening thick copper wire by hand can be an exercise in frustration. There are several YouTube videos describing a quick mechanical method that yields good results. See:

<https://youtu.be/meZRMNF-6tQ>. A piece of wire, slightly longer than needed was clamped to a bench and the other end was locked in a drill chuck. After only a few turns, the wire straightened. Be sure to use all necessary safety precautions.



Method for straightening wire. Secure wire to bench and drill chuck. Operate drill slowly and proceed with caution!

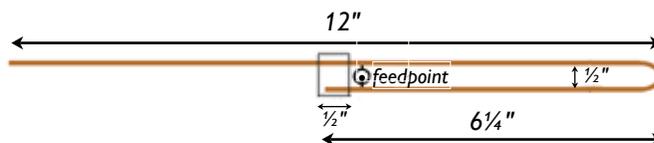
The antenna boom must be made of non-conductive material, such as wood or PVC. Wood greater than 1" square has been reported to affect the tuning. I used a 3.5 foot length of 3/4" wide by 1" high lumber and finished it with a coating of Linseed Oil. Drilling at right angles without a guide or drill press was more challenging than anticipated. Elements were secured to the boom using hot-melt glue. The total distance from the

reflector to the furthest element was 28.5 inches. The elements were arranged as shown in the table.

Antenna Dimensions. All measurements in inches.

Element	Length	Distance from reflector
Reflector	13	0
Driven element	See below	2.5
Director 1	12.1	5.5
Director 2	11.75	11
Director 3	11.75	18
Director 4	10.75	28.5

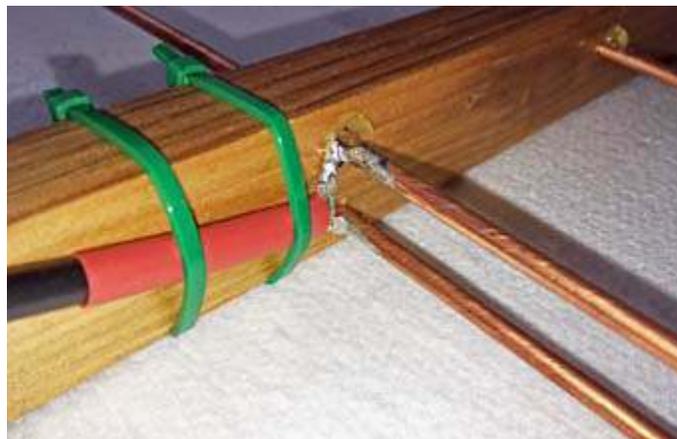
A notable feature of the WA5VJB design is the J-shaped driven element. One half of the element resembles a folded dipole. The curve was achieved by simply bending the straightened wire over a dowel. The coax braid and center conductor were soldered to the upper and lower segments of the driven element closest to the boom.



Driven element dimensions. The estimated free space impedance of the driven element is 150Ω. The impedance is approximately twice that of a dipole (72Ω) and half the impedance of a folded dipole (300Ω).

In free-space, the folded element was reported to have an impedance of approximately 150 Ω. The other elements are positioned to transform the feedpoint impedance of the array to 50 Ω. The gain was reported to be about 11 dBi with a 30 dB front-to-back ratio. (K. Britain, More "Cheap Yagis", *CQ*, September 2004)

The feedline was a 6 foot length of RG-58 terminated with a PL-259 connector. Although this coaxial cable may be lossy at UHF frequencies, the estimated cost was less than 1 dB for this short run, even with a 3:1 SWR.



Feedpoint detail. The coax braid is soldered to the upper portion of the half-folded driven element and the center conductor is soldered to the lower part. [KD2ITZ pics.]

When tested on an analyzer, the SWR was 1:1 at 446.37 MHz. The SWR was 1:2 at 443.66 MHz and 448.24 MHz. This frequency range is an excellent match for FM simplex and repeaters. The SWR climbed to 1:5 at 440 MHz. The design was not optimized for usage in the lower segments of the band, but other WA5VJB plans are available: 421.25 (amateur TV), 432 MHz (weak signal), 435 MHz (AMSAT).

While running 10 watts from a Kenwood TM-V71a mobile radio, the antenna was able to reach repeaters far from home. Good signal reports were received from other operators on the 449.625 MHz WB2SEB repeater in Manhattan (35 miles) and the 442.70 MHz W2MR repeater in Alpine, NJ (21 miles). This was encouraging, as the antenna was positioned indoors and was attenuated by the structure of the house.

The WA5VJB Yagi does not sacrifice performance, despite the low cost of the materials. Additional plans are available for 144 MHz, 222 MHz, 902 MHz, and 1296 MHz. Anyone desiring more gain for less money should consider this design.

- Lou, KD2ITZ

V.E. Test Session

PCARA's third Volunteer Examiner Test Session (of the modern series) took place on Saturday January 19, at the John C. Hart Memorial Library in Shrub Oak. PCARA's **VE Team Liaison** Mike W2IG had once again set out the Children's Reading Room, where we had a record **six** candidates plus seven Volunteer Examiners and two PCARA helpers.

Five of the candidates had no previous license and all five qualified for Technician. As of the Jan 19 test date, partial shutdown of the Federal Government was still in effect, with the FCC unable to act on any new amateur radio license applications since January 3, 2019. On January 25 the Senate and House unanimously passed a bill to temporarily end the shutdown, which President Trump signed into law.

Congratulations to Henry Gaffney, Brian Scesney, Joseph Dianna and father/son team Richard Montross I



Volunteer Examiners confer around the administration table during PCARA's January 19 test session.

and II who should be notified of their new Technician calls when the FCC returns to normal working.

Our sixth candidate Marek W2ZAY (White Plains) already had a license and was successful in upgrading from Technician to General. Well done!

Thanks to all the volunteer examiners who officiated, including Mike W2IG, Larry AC2QH, Lou KD2ITZ, Verle W2VJ (welcome to the VE Team!), Karl N2KZ, Stan WA2HRV and NM9J. Support was also provided by Joe WA2MCR and Al K2DMV.

PCARA's next V.E. Test Session will take place on Sat March 16, 11:00 a.m. at the John C. Hart Library.

Electromagnetic radiation meter

Larry AC2QH brought his new "Heliognosis EM2" electromagnetic exposure meter to the January 19 V.E. test session. Larry had been following up on the *PCARA Update* article "RF and you" in the December 2018 issue (pp 10-13) describing results from exposing laboratory rats to cellphone-style RF radiation.

According to Canadian supplier Heliognosis, frequency response of the EM2 is from 50 Hz to 18 GHz and its sensitivity is from $0.005\mu\text{W}/\text{cm}^2$ to $40\text{mW}/\text{cm}^2$.

"The new design includes a fast response analog display for detecting pulsed transmissions from digital equipment such as Wi-Fi, cell networks and smart meters. The included rubber boot is comfortable to hold and elegant while providing protection from bumps and falls. The display employs a unique logarithmic scale to capture both very weak and very strong signals without the need to switch ranges... EM2 detects all electromagnetic emitters from ELF (extremely low frequencies) up to microwaves. This includes virtually all sources of electromagnetic radiation like:

- Wi-Fi, cell and mobile phones
- Radio and television broadcast towers
- AC power lines, smart meters
- Microwave ovens
- Amateur and CB radio
- Military, aircraft and police band radio
- High-efficiency fluorescent tubes."

The EM2 is available from Heliognosis in Ontario, Canada (<https://www.heliognosis.com/>) and from DX Engineering (<https://www.dxengineering.com/parts/hgs-he-em2>).



EM2 electromagnetic exposure meter belonging to Larry AC2QH.

Digital storage oscilloscope – Siglent SDS1202X-E

There has been an analog oscilloscope in the G3VNQ or NM9J radio room since my earliest days on the air. (See “Test equipment for the radio shack, part II”, *PCARA Update* July 2017, p 14).

I was thinking about upgrading my 32-year old Heath IO-4225 25 MHz Dual Trace Oscilloscope when I came across a Siglent America advertisement in December 2018 *QST* claiming “the best value in electronic test and measurement”.



Siglent America ad from QST, December 2018.

One item on offer was a new digital oscilloscope costing \$379.00. When I checked online, the price of the Siglent SDS1202X-E 200 MHz 2-channel digital oscilloscope was subject to a \$20.00 price discount. Reviews were positive, so I placed an order.

Out of the box

A few days later, a small cardboard box arrived bearing the Siglent logo — a design somewhat reminiscent of Agilent's logo. (Agilent Technologies was spun off from Hewlett Packard's instrument division in 1999. Agilent has a branch in Shenzhen, China — the same city in southern China where Siglent Technologies is based.)

Inside the box was the oscilloscope itself, a printed “Quick Start” manual, Calibration Certificate, power cord with IEC connector, standard A-B USB cable plus two test probes, model PP215 rated to 200 MHz with frequency compensating adjustment. The test probes



Fresh out of the box — Siglent SDS1202X-E oscilloscope, power cord, test probes, USB cable and Quick Start guide.

had a full complement of color-identifying rings, a shortened ground spring and various covers for the probe tips.

Compared with my old Heath analog scope, the Siglent model is relatively small, measuring only 12¼" wide by 6¼" tall by 5½" deep. The reduction in depth from my Heathkit scope's 18 inches is possible because a long cathode ray tube has been replaced by a liquid crystal display screen. Small size means the instrument can easily be carried to a job site — rather than stuck on a shelf or wheeled around on a cart.

The Siglent's external case is molded in two-tone plastic, with a folding carry handle on top and two hinged feet on the base to angle the screen upward. With a plastic case, I was concerned about poor RF shielding — fortunately there is a substantial metal enclosure inside, surrounding both the power supply and the electronic circuitry.



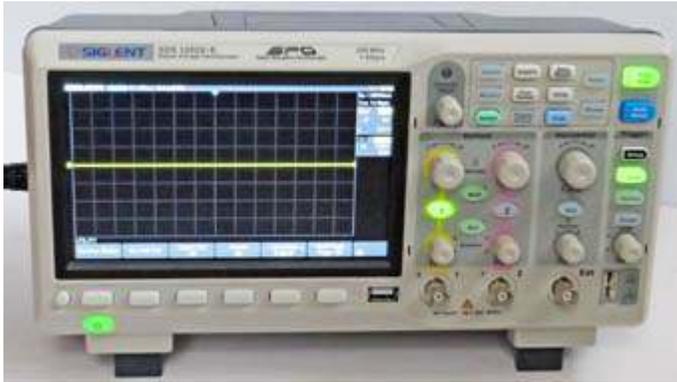
Metal chassis under the Siglent 'scope's plastic case provides adequate shielding.

First switch-on

I followed instructions in the “Quick Start” manual to switch the oscilloscope on and connect one of the test probes. At power-up, the Siglent logo appears on-screen, the front panel controls are briefly backlit, several relay clicks are heard then the graticule* appears on the display, along with labels for the soft keys. Meanwhile a very quiet noise emerges from the fan, positioned at the right side of the case.

*Graticule = transparent scale in front of an oscilloscope screen or other measuring instrument.

I was pleased to see that the 7-inch display is very bright and crisp. Resolution is 800 × 480. It is *not* a



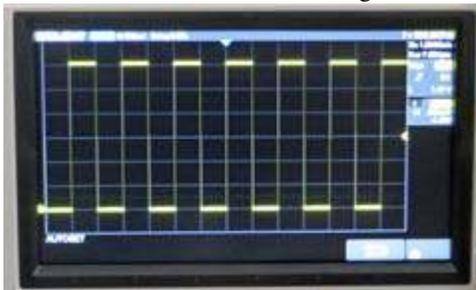
Siglent SDS1202X-E oscilloscope powers up with the active buttons backlit and a yellow trace on the display.

touch-screen display, instead there are six soft key buttons below the display with corresponding on-screen labels appearing just above. At initial power up, the “Utility” menu appears first, showing soft key labels for “System Status”, “Do Self Cal”, “Language” etc.

I continued following the Quick Start instructions, connecting a test probe to the Channel 1 BNC socket, then attaching probe clips to the 1 kHz square-wave output terminals at lower right on the front panel. Pressing the blue “Auto Setup” button produced a bright yellow square wave trace on the display. Switching the test probe from 1× to 10× attenuation gave a different pattern, which could then be adjusted using the probe’s compensation trimmer for a perfect square wave. Similar results were obtained on



Test probe is wired into Channel 1 BNC socket with probe clips connected to the front panel square wave output terminals.



A perfect square wave.

Channel 2, this time with a violet trace on the display.

Analog approach

In an analog ‘scope the Y input signal is attenuated or amplified then the output is applied to the vertical (Y) deflection plates of the cathode ray tube. Meanwhile, a saw-tooth waveform is applied to the horizontal (X) deflection plates. As the electron beam is pulled from left to right across the phosphor screen by the timebase oscillator, vertical deflection of the beam

paints a graph on the display, plotting the original waveform against time. Front panel controls allow amplifier gain and timebase frequency to be varied, with timebase triggering available to show a steady, repeating waveform on the display.

In a digital storage oscilloscope (DSO) the three rotary controls for vertical sensitivity, timebase speed and trigger point are usually duplicated to make the scope’s operation feel more familiar.

Significant specs

The specifications for a digital storage oscilloscope are mostly different from an analog scope, but they do give some insight into how the digital circuitry operates. Here are key figures from the spec. sheet for the Siglent SDS1202X-E:

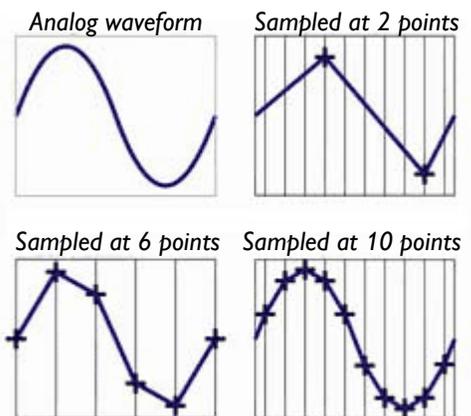
Bandwidth:	200 MHz
Sampling Rate:	1 GSa/s (single channel active), 500 MSa/s (two channels active)
Channels:	2 + EXT
Memory depth (max):	14 Mpts/Ch (single channel), 7 Mpts/Ch (two channels)
Waveform capture rate :	100,000 wfms/s MAX
Vertical resolution:	8-bit

Bandwidth is similar to the figure for an analog scope, specified as the lowest frequency at which input signals are attenuated by 3 dB (-30% amplitude error). Bandwidth of the SDS1202X-E is specified as **200 MHz**, considerably better than my old 25 MHz Heathkit ‘scope.

Vertical resolution. In a digital storage oscilloscope the Y-input signal is continuously sampled then converted to a digital representation of the signal amplitude. The number of levels is determined by resolution of the analog-to-digital converter (ADC). In the SDS1202X-E, the **vertical resolution** is specified as **8-bit**, allowing 256 (2^8) voltage levels. These digital values are stored in high-speed memory for subsequent processing and display.

Sampling rate

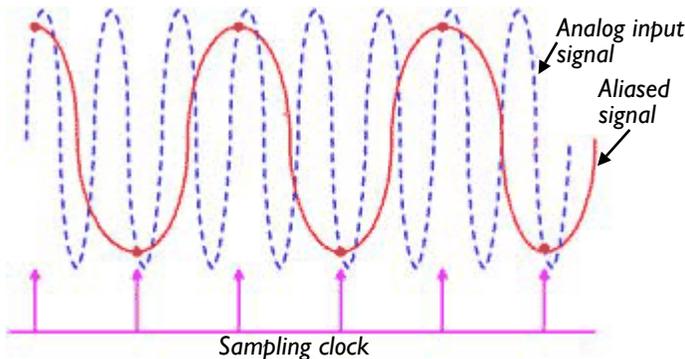
must be sufficiently rapid to capture waveform shape at maximum analog bandwidth, assumed to be the highest frequency of operation. To avoid aliasing*, the sampling frequency should be



Sampling rate must be sufficiently high to capture the waveform shape.

at least twice the highest frequency (Nyquist rate). A more typical sampling rate for a practical ‘scope would be at least 4 or 5 samples for each waveform. Specification for the Siglent SDS1202X-E is a sampling rate of 1GSa/s (1×10^9 samples per second) when only one channel is in use. At the frequency of maximum bandwidth (200 MHz) this would allow 5 samples per waveform.

***Aliasing** = generation of distortion artifacts when an analog signal containing higher frequency components is sampled too slowly. A familiar example is the ‘wagon wheel effect’ where the spokes of a rotating wheel filmed at 24 frames per second appear to slow down or even rotate backwards.



If a waveform with a highest frequency component f is sampled at less than Nyquist frequency $2f$, then aliasing occurs and distortion artifacts will be present in the reconstituted waveform.

Sample memory depth, also known as record length, is the number of sampled waveform values that can be stored for a single trigger event. The more memory available for storing digitized samples, the more a signal under study can be panned left/right or zoomed into for close examination of unwanted ‘glitches’. The Siglent SDS1202X-E can store up to 14 Mpts per channel (14×10^6 points per channel) with one channel active.

There is a relationship between waveform length (timed in seconds), memory depth and sample rate as follows:

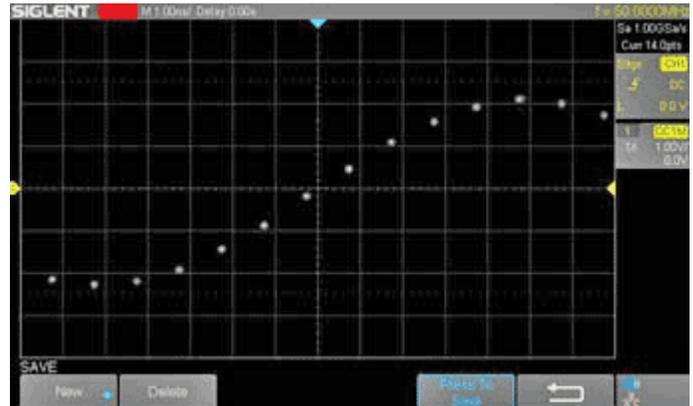
$$\text{maximum waveform length in seconds} = \frac{\text{memory depth}}{\text{sampling rate}}$$

When the Siglent scope is running at its maximum sampling rate of 1 GSa/s, the maximum waveform length will be $14 \times 10^6 / 1 \times 10^9 = 14 \times 10^{-3}$ seconds, or 14 milliseconds. Since the screen is 14 horizontal divisions wide, this corresponds to a horizontal timebase speed of 1ms/div. If the timebase is slowed down any further, then the sampling rate has to be reduced to avoid overfilling of memory.

To find out how many data points are required to fill the current display screen we can use the following formula:

$$\frac{\text{points per waveform}}{\text{waveform}} = \text{sampling rate} \times \text{time/div} \times \text{number of divisions.}$$

For the SDS1202X-E with a 1 GSa/s sampling rate and 14 time divisions across the horizontal scale, if we set the timebase to 100 ns/div, the number of points to fill the display is equal to $1 \times 10^9 \text{ pts/s} \times 100 \times 10^{-9} \text{ s/div} \times 14 \text{ div}$, or 1400 points (1.40 kpts). If we speed up the timebase to 1.00 ns/div (the upper limit) the number of points to fill the display is reduced to: $1 \times 10^9 \text{ pts/s} \times 1 \times 10^{-9} \text{ s/div} \times 14 \text{ div}$, or 14 points.



Screen-shot of Siglent ‘scope displaying a 50 MHz sine wave with dots display. Timebase is set to 1.00 ns /div, sampling rate is 1.00 GSa/s and current sample points = 14.0 pts.

The current timebase speed in sec/division (or millsec/div or nanosec/div) is shown on the very top line of the Siglent display, with the waveform frequency at far right. The sampling rate and current memory depth are indicated underneath this frequency, to the right of the graticule, along with information about trigger settings and vertical input sensitivity — as shown in the enlarged screen-shots at right.



Digital differences

A few of the controls on the Siglent SDS-1202X-E are similar to my previous analog ‘scopes, while others are quite different. The Siglent has 8 rotary controls and 28 push buttons on its front panel. So many capabilities — but how best to make use of them all?

DSO in practice.

After reading through the “Quick Start” guide, I was looking for further information. There is a full **User Manual** available as a PDF download from the web site: <https://www.siglentamerica.com/>. Click on “Resources”, “Document Downloads” then look for the

SDS1000X-E Series. Hint: print out the manual at two sheets to a page and double-sided. The English is a little shaky at times but easily understandable.

I tried using the new scope to make some typical waveform measurements. I connected the test probe to ‘Channel 1’, and introduced a 60Hz sine wave.

As with an analog scope, the amplitude can be adjusted by locating the **Variable** control for Channel 1 in the “Vertical” group. This rotary control has 20 ‘detent’ positions in a full revolution. There are no markings for “volts/division” or “mV/division” around this rotary control — instead the actual value selected in volts or millivolts per division appears briefly on the display (“200mV/”) as adjustments are made. The vertical sensitivity is also displayed continuously to the right of the graticule. Values decrease and increase in a “5, 2, 1” sequence, for example 500mV/, 200mV/, 100 mV/, 50 mV/, 20mV/ etc. (A “fine adjustment” is also available with much smaller steps, e.g. 48.2, 48.8 mV/div.)

The lower rotary control for vertical Channel 1 is a smaller knob which allows the trace **position** to be moved upward or downward (DC offset). Rotation is continuous with no detent positions.

Adjustment of the timebase takes place in a similar manner to the vertical sensitivity, using the upper **Horizontal** rotary control. Numeric values of time per division are displayed briefly on-screen (“5.00ms/”, “2.00 ms/”) as adjustments are made, then the actual value appears permanently at the top of the display. With a timebase speed of 10.00 milli-

seconds per division, three cycles of my test wave filled 5 horizontal divisions (50 ms) so one cycle occupies $50 \times 10^{-3} / 3$ seconds and $\text{freq.} = 3000/50 = 60 \text{ Hz}$.

The lower rotary control for the horizontal timebase allows position of the trace to be shifted left or right, similar to the vertical position controls .

There is another set of buttons and a single rotary control for the timebase **Trigger**. Turning this control adjusts the input voltage that starts the Horizontal timebase moving across the screen. The actual trigger voltage is indicated momentarily on-screen by numeric display (“-10.2mV”) and by a gray horizontal line across the waveform. Trigger voltage and type are also shown at the far right of the display.

All three upper rotary controls have large knobs with 20-detents per rotation. A single press on either of the vertical knobs toggles between coarse and fine adjustment of volts/division. A single press on the horizontal control splits the display in two with an expanded “Zoom” view of the original waveform appearing in the bottom half of the screen.

The three lower rotary controls that affect position have *no* detents. A single press returns the position offset to zero.

The three lower rotary controls that affect position have *no* detents. A single press returns the position offset to zero.

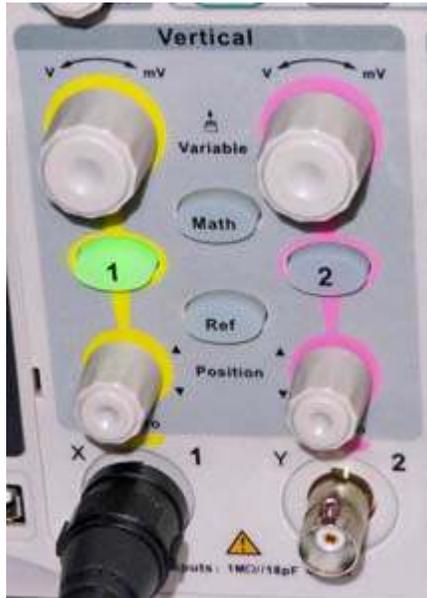
Auto Setup

If you are already familiar with analog oscilloscopes, you know that the vertical, horizontal and trigger controls all require careful adjustment before a stable display appears on-screen, and this can take some time — especially when a new signal is being investigated. On a digital oscilloscope, the same controls can be adjusted manually — but fortunately there is a quick workaround. On the SDS1202X-E just press the blue “Auto Setup” button on the front panel and in a few seconds the correct settings will be chosen ‘automagically’ to present a stable picture of your waveform on-screen.

Run/Stop

Under normal conditions, the oscilloscope is continuously acquiring data and displaying it on-screen. Any variations in the signal — such as noise, modulation, glitches etc. — are displayed momentarily then disappear with the next sweep of the timebase.

While this situation continues, the “Run/Stop” button at top right of the front panel is backlit green to indicate that data acquisition is running.



Group of controls for the vertical inputs on SDS1202X-E ‘scope. Green backlight shows Channel 1 is active.



Horizontal timebase and trigger controls for SDS1202X-E.

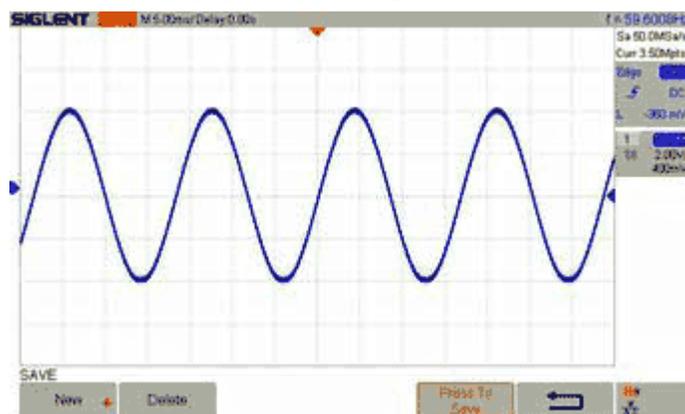


Auto Setup and Run/Stop buttons are top-right on the front panel.

In order to examine rapidly changing signals it is possible to stop acquisition and show whatever is currently in memory as a static display on-screen. A single press of the “Run/Stop” button accomplishes this change and also switches the backlight from green to red, indicating that acquisition has been paused. With the display ‘frozen’ it is then possible to examine the trace in great detail using the vertical and horizontal controls.

Save

The static display is helpful for recording details of an event. This is convenient for taking a photograph of the screen with a camera — but that method is so ‘old-school’. While acquisition is either running or stopped, you can **save** a picture of the screen to internal or external storage. With a USB memory stick inserted into the front panel socket, it is possible to press the “Save/Recall” button to save a screen-shot to the USB drive in either .jpg, .bmp or .png format.

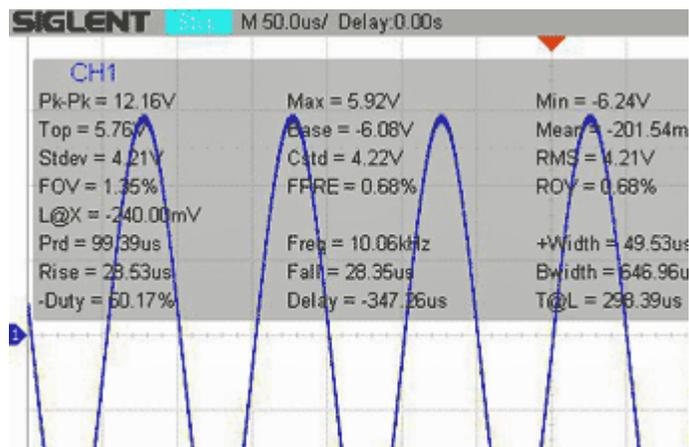


This screenshot of a 60 Hz sine wave — displayed at 5ms/division — was saved to a USB stick. After transfer to computer, the image was photo-edited to invert all colors for clearer printing.

Measure

In the old, analog days, measurement of waveform voltage or period displayed on an oscilloscope required estimation of vertical or horizontal distances on-screen using the ‘scope graticule’ — which was either etched on the glass or overlaid as a transparency above the cathode ray tube.

The process is easier and more accurate with a digital oscilloscope. On the SDS1202X-E, just press the “Measure” button which lights up green. A new menu appears above the soft keys allowing various items to be marked for measurement. Another choice brings up a display of *all* available measurements. Some of the items useful in an amateur radio workshop include peak-to-peak voltage, maximum / minimum voltage and RMS (root mean square) value. Period and frequency measurements are also available.

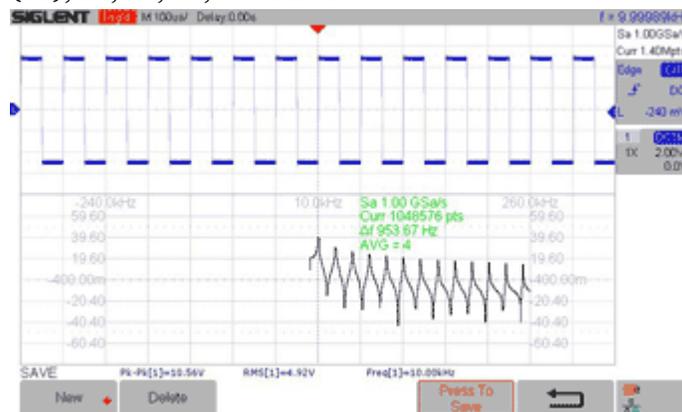


Detail from screen shot of 10 kHz sine wave — with all “Measure” parameters displayed on screen. (Colors inverted.)

Mathematical operations

The digital oscilloscope includes several mathematical functions. Pressing the “Math” button allows operations such as graphing Channel 1 + Channel 2 or Channel 1 × Channel 2. Perhaps most interesting is the “FFT” (Fast Fourier Transform) capability — this converts the oscilloscope into a simple spectrum analyzer.

Feed in a complex waveform (such as a square wave), press the “Math” button then use the “Operator” soft key to choose “FFT”. A graph appears on the lower half of the display showing strength in dB of the individual frequency components. Feeding in a 10 kHz square wave shows signal components at the odd harmonics: (10 kHz), 30 kHz, 50 kHz etc. Changing to a triangle wave shows components at all harmonics: (10), 20, 30, 40, 50 kHz etc.



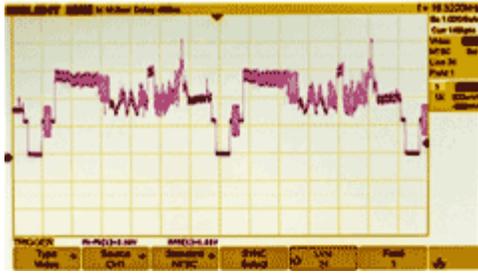
“FFT” plot on lower half of screen shows fundamental frequency and odd harmonics for a 10 kHz square wave.

Amateur radio applications

There are all sorts of ways that an oscilloscope can prove useful to the radio amateur and electronic hobbyist. Anytime there is an AC signal involved, it can help to clip the ‘scope test probe onto the relevant circuit stage and study the waveform. For example, you

might have an audio amplifier which is misbehaving. Or you might want to inspect the modulation on an incoming FM signal by monitoring a receiver's discriminator output.

This can yield information about audio distortion, PL tones and deviation level. If you have an interest in video, the SDS1202X-E



Waveform showing line 24, field 1 of an NTSC analog video signal (colors inverted).

can trigger from various video signals, presenting the waveform of a specific line number and field.

Bandwidth of the SDS1202X-E is quite adequate for examining radio frequency signals up to and even beyond 50 MHz. It can be fascinating to watch the output from an HF or VHF transceiver while sending CW or SSB. However, be sure to operate into a dummy load and attenuate the signal so as not to overload the oscilloscope's input. It could be worthwhile assembling a signal tap-off point between transceiver and dummy load using a coaxial-tee fitting.

There is advice on RF measurements with an oscilloscope from WA2BVK in *QST* for June 2016 pp 42-44 and from H. Ward Silver N0AX in *QST*, July 2016 pp 55-56. A useful review of the earlier Siglent SDS1102X 100 MHz scope by Paul Danzer N1II appears in *QST* for April 2016, pp 54-57.

Too much RF!

The SDS1202X-E is **ten times** more sensitive on its vertical input than my old Heath scope — the Siglent's highest sensitivity is 500 μ V per division. In our part of the world, you may find that the flamethrower signal from our 50kW neighbor WHUD (100.7 MHz) or the 5 kW AM transmitter of WLNA (1420 kHz) can cause more disturbance on the input terminals than the weak signal that you are trying to observe. If that happens, make sure the test probe ground is connected to the circuit under test and that all wiring to the probe is as short as possible. It may be necessary to use the short ground spring or enclose the circuitry in a Faraday cage. Also worth noting – the SDS1202X-E Channels 1 and 2 have a “BW Limit” soft key to limit signals to a 20 MHz bandwidth — useful for investigating lower frequency waveforms with limited high frequency components.

Scope for troubleshooting

Shortly after receiving my new oscilloscope, I had an opportunity to use it for troubleshooting a tricky

problem in the radio room.

At the PCARA Bring and Buy Auction I acquired a Beckman “Circuitmate” FG2 function generator from Bob, N2CBH

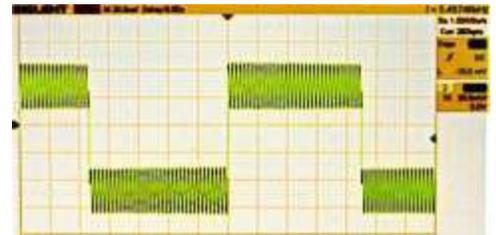


Beckman Circuitmate FG2 function generator covers 0.2 Hz to 2.0 MHz.

for a very reasonable sum. I was hoping to replace a 45-year old home-brew audio generator that sits on my test shelf. But when I turned on the FG2 to check operation, something was wrong with the output as viewed on my analog scope.

For a more critical inspection, I placed my new digital scope alongside the FG2 on the workbench and connected them together with a shielded BNC cable.

Looking closely at the function generator's output, there was an additional signal visible on the waveform. Zooming in for a closer look, I could see the expected 5 kHz square wave output



Beckman FG2 function generator had a 400 kHz sine wave superimposed on its 5 kHz square wave output. (SDS1202X-E screen photo with colors inverted.)

— but there was a sine wave ripple also present at a much higher frequency.

Searching online, I found a copy of the FG2 Operator's Manual, containing the circuit schematic. I had a suspicion that the \pm 15.5 volt power supply might be responsible, so I removed the top cover and located suitable test points. DC voltages measured with a Fluke multimeter were satisfactory, so I connected the digital oscilloscope probe and examined the voltages using AC coupling. The

negative 15.5 volt supply was clean, but the positive 15.5 volt supply rail had a significant ripple present — at a higher frequency of 400 kHz.



C107 (arrowed), Luxon 47 μ F electrolytic capacitor had to be replaced in the FG2.

This was odd because the output from the transistor regulator had C107, a Luxon 47 μ F electrolytic

capacitor, between the +15.5V and 0V rails. I replaced the original with a new 47 μ F capacitor and the ripple on the supply line disappeared. The function generator output was also cleaned up — now there was just a clean output waveform, whether it was sine, square or triangle wave selected on the FG2 front panel. That old 47 μ F capacitor that I removed measured only 2.5 μ F on an Agilent LCR meter, confirming the bad capacitor theory.

The Beckman Circuitmate FG2 function generator is now sitting on my shelf generating perfectly pure waveforms. Thank you Bob, and thank you Siglent oscilloscope for allowing a rapid diagnosis.

Niggles and quibbles

The Siglent SDS1202X-E offers very good performance at an economy price. But there are a few minor annoyances that are worth a mention.

Old style analog oscilloscopes had a graticule calibrated in centimeters — so the vertical and horizontal units were (for example) volts/cm and msec/cm. The Siglent's graticule has 8 vertical divisions and 14 horizontal divisions in an area of 7 × 13.4 cm, so the distance per screen division is a little less than 1 centimeter. Not a huge problem but bear it in mind when taking measurements off the screen.



Front panel Intensity/Adjust knob is used to modify all sorts of values in the on-screen menu system.

The “Intensity/Adjust” knob on the front panel is a rotary control used for selecting various items in the on-screen menu system — for example in the “Display” menu you can use this control to select from six choices for display persistence time. Unfortunately, the “Intensity/Adjust”

knob is one of the smaller rotary controls with **no** tactile detent positions, making it very easy to overshoot the desired item. The lack of detents can also cause the rotary control to turn one click too many when pressing the knob in to make a selection.

The top line of the oscilloscope display contains a



The black bezel around the screen obscures the top part of the display when viewed from slightly above.

good deal of useful information including the timebase speed, delay time and frequency of the input signal. Unfortunately, this part of the screen is partly obscured by the black plastic bezel, even when the case is angled upward by extending the two front legs.

The oscilloscope has an analog-to-digital converter for the vertical input channel with a resolution of only **8-bits**. This means the amplitude of the input signal can be assigned to one of only 256 (2^8) levels. When viewed on the 400 pixels of the vertical axis, a 256 level signal which is hovering ± 1 bit around a steady value can appear quite noisy — until you stop acquisition then zoom in and examine the digitized waveform in detail. (This 8-bit resolution is not unusual... the similarly-specified 200 MHz Tektronix DPO2022B digital scope which costs **\$2,300+** also has a vertical resolution of only 8 bits.)

Plus points

The SDS1202X-E contains more features than I can cover in this review. Good news — the extra features are all included at **no extra cost**. Other brands of economy oscilloscope block access to optional software features until you pay for an activation code to enable them!

Some of the Siglent SDS1202X-E's **additional features** include...

- multiple trigger choices, including video, HDTV and serial bus,
- serial decoding built-in (useful for micro-controller projects),
- color grading shows different trace intensities by false color,
- roll button for continuous right-to-left display without waiting for data acquisition / triggering,
- built-in Help, just hold down the relevant button until on-screen help appears,
- Ethernet and USB connections for remote control from a PC using e.g. “LXI Tools” or “EasyScope X” software (free download).

Incidentally, the **four**-channel version of this Siglent oscilloscope, the SDS1204X-E (\$759) has a built-in web server that allows remote control via standard web browser.

Even though the SDS1202X-E oscilloscope is an economy model, it still provides 99% of the requirements for trouble-shooting and experimentation in an amateur radio workshop. All this in a small package that can be easily carried around. What's not to like? Perhaps one day Siglent will introduce a spectrum analyzer at a similar price.

- NM9J

Peekskill / Cortlandt Amateur Radio Association

Mail: PCARA, PO Box 146, Crompond, NY 10517

E-Mail: mail 'at' pcara.org

Web site: <http://www.pcara.org>

PCARA Update Editor: Malcolm Pritchard, NM9J

E-mail: NM9J 'at' arrl.net

Newsletter contributions are always very welcome!

Archive: <http://home.lanline.com/~pcara/newslett.htm>

PCARA Information

PCARA is a **Non-Profit Community Service**

Organization. PCARA meetings take place the first Sunday of each month* at 3:00 p.m. in Dining Room B of NewYork-Presbyterian/Hudson Valley Hospital, Rt. 202, Cortlandt Manor, NY 10567. Drive round behind the main hospital building and enter from the rear (look for the oxygen tanks). Talk-in is available on the 146.67 repeater. *Apart from holidays and July/August break.

PCARA Repeaters

W2NYW: 146.67 MHz -0.6, PL 156.7Hz

KB2CQE: 449.925MHz -5.0, PL 179.9Hz

N2CBH: 448.725MHz -5.0, PL 107.2Hz

PCARA Calendar

Sun Feb 3: PCARA meeting, NewYork-Presbyterian /Hudson Valley Hospital, 3:00 p.m.

Sat Feb 16: PCARA Breakfast, Turco's, Yorktown Hts. 9:00 a.m.

Hamfests

Sun Feb 24: Long Island Hamfest and Electronics Fair, Levittown Hall, 201 Levittown Parkway, Hicksville, NY. 9:00 a.m.

VE Test Sessions

Feb 2: Yonkers ARC, Yonkers Office of Emergency Management 789 Saw Mill River Rd., Yonkers NY. 11:30 a.m. Pre-reg. John WB2AUL, (914) 969-6548.

Feb 11: Columbia Univ ARC, 531 Studebaker Bldg, 622 W 132nd St, New York. 6:30 pm, Alan Crosswell (212) 854-3754.

Feb 14: WECA, Westchester Co Fire Trg Center, 4 Dana Rd., Valhalla, NY. 7:00 p.m. S. Rothman, (914) 949-1463.

Feb 15: Orange County ARC, Munger Cottage, 183 Main Street, Cornwall NY. 6:00 p.m. Contact Joseph J. DeLorenzo (845) 534-3146.

Mar 16: Peekskill/Cortlandt ARA, John C. Hart Memorial Library, 1130 E Main St., Shrub Oak, NY. 11:00 a.m. Contact Michael Dvorozniak W2IG, (914) 488-9196.



Peekskill / Cortlandt Amateur Radio Association Inc.
PO Box 146
Crompond, NY 10517