OUR 26TH YEAR!

EPARA BEACON

VOL. 6, NUMBER 8 THE OFFICIAL NEWSLETTER OF THE EASTERN PENNSYLVANIA AMATEUR RADIO ASSOCIATION AUGUST 2022

NEXT CLUB MEETING: AUGUST 11TH

Monroe County Public Safety Center, 100 Gypsum Rd Stroudsburg, PA 18360

Welcome to the EPARA Beacon! This newsletter is published monthly and is the official newsletter of the Eastern Pennsylvania Amateur Radio Association. EPARA has served the amateur radio community in the Pocono Mountains for over 25 years. We have been an ARRL affiliated club since 1995. We offer opportunities for learning and the advancement of skills in the radio art for hams and non-hams alike. EPARA supports Monroe County ARES/RACES in their mission of providing emergency communications for served agencies in Monroe County. Feel free to join us at one of our meetings or operating events during the year. The club meets on the second Thursday of every month, at the Monroe County 911 Emergency Control Center. The business meeting starts at 7:30 P.M. Anyone interested is invited to participate in our meetings and activities.

ZOOM Meeting Info: Meetings begin at 7:30PM!

https://us02web.zoom.us/j/85463346031?pwd=bU1KcVZ0aVZiVEUvdjRsUXlNNHZkZz09

Meeting ID: 854 6334 6031 Password: 244632

From The President

Well, I'll start with letting everyone know that the 911 center antenna repair is complete! Its installed nice and high and the feed line is neatly running from the building to the feed point. Its looks and works fantastic. Unfortunately, as you may have already heard, we did have a small mishap. In the process of rehanging the antenna an errant shot with the air cannon led to a cracked windshield on one the Control Centers vehicles. The club insurance is covering the cost of the repair, but it's still kind of embarrassing especially since I was the one firing the air cannon.

Antenna/Elmer weekend was HOT! We built and tested the 80-meter delta loop, it worked fantastic! Its resonant on 10, 12, 15, 20, 30, 40, and 80 meters and preformed very well on all the bands tested. We made contacts on ssb in the Field Day target areas with ease with great signal reports. I also ran FT8 on it and made contacts throughout Europe and to the west I reached Hawaii, Australia, and Japan. It should be a great antenna for next year's Field Day!

Now that its August we will be focusing on our next ham-fest on Sunday September 18th. Our next two meeting will be mostly focusing on getting ready for that event. Walt W3FNZ has been working hard on planning for this and I want to thank him for all that he has completed already. I ask all members to help any way you can for this. Last year's hamfest was a lot of fun and a complete success, this year should be even bigger and better. Remember the hamfest is not just how we raise funds for the club, it's how we show other hams in the area what we can do!

That's all for now, see you at our meeting on August 11th.
73 Chris AJ3C

CONTACT INFORMATION

President Chris Saunders AJ3C: aj3c@gmx.com	Vice President Bill Carpenter AB3ME: bill47@ptd.net
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Member at Large Eric Weis N3SWR: n3swr@ptd.net	ARES EC Charles Borger KB3JUF KB3JUF@gmail.com

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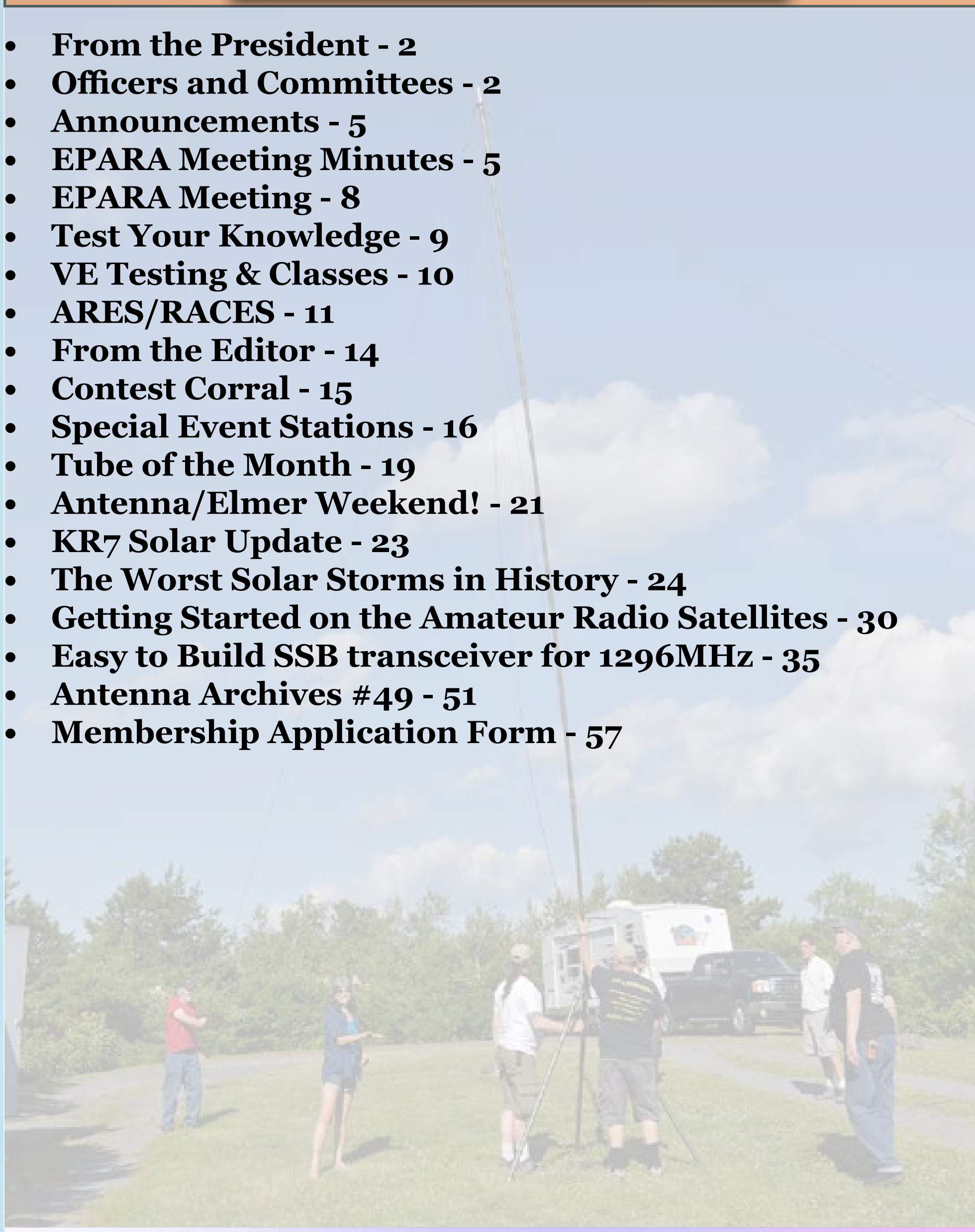
What's INSIDE this ISSUE



EPARA Net list

Monroe county ARES-RACES – Sunday's 8:30 PM, 146.865 MHz, PL -100 Hz

The Monday Night Pimple Hill repeater 8:30 PM (Repeater freq = 447.275 with a - 5MHz offset) DMR TECH Net on TG314273* Time Slot 2

SPARK Information/Swap Net – Tuesday's 8:30 PM, 147.045 MHz, PL 131.8 Hz

The Wednesday Night EPARA Hot Spot DMR Rag Chew net at 8:30 PM, TG 3149822* Time Slot 2 (N3IS Talk Group)

EPARA Tech Net – Friday's 8:30 PM, 147.045 MHz, PL +131.8 Hz

*TG = Talk Group

President
Chris Saunders AJ3C

Vice President
Bob Matychak W3BMM

Secretary
Kevin Forest W3KCF

Treasurer
Scott Phelan KC3IAO

Member at Large
Eric Weis N3SWR

****

ARES EC
Charles Borger KB3JUF

Assistant EC
Chris Saunders AJ3C
Len Lavenda KC3OND

Field Day Coordinator
Chris Saunders AJ3

Quartermaster
TBD

Membership Coordinator
Al Brizzi KB3OVB

Newsletter Editor
Eric Weis N3SWR

Photographer
Eric Weis N3SWR

Public Information
TBD

Social Media
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Eric Weis N3SWR

Hamfest Coordinator
Bill Connely W3MJ
Walter Koras W3FNZ

Technical Program Coordinator
Bill Carpenter AB3ME

Lead VE
Chris Saunders AJ3C

Webmaster
Chris Saunders AJ3C

Announcements
AND UPCOMING EVENTS

EPARA Club Dues

Club dues were due January 1st and are temporarily extended due to COVID reasons. For those that missed the chance to stay current, there are two (2) methods available to pay to help make this easy for all. Contact Scott KC3IAO via his email: KC3IAO@hobbyguild.com and you can send him a check or pay via PayPal.

ARES/RACES

There is an official S.E.T planned for Sunday, October 2nd. Contact Charlie KB3JUF for further info if needed.

Hamfest!

EPARA will host its annual hamfest this year on Sunday, September 18th, 2022. There is a new location this year - the Moose Lodge # 1336 at 705 Stokes Mill Rd., East Stroudsburg. An official flyer will come shortly. There is a huge field area and extensive parking available!

Shack Photos for our Facebook page

We are looking for shack photos from members to post on our Facebook group page, so those that are interested please send them to Bob W3BMM and they will get posted!

For those that remember Anabelle, she passed on July 2nd very suddenly. She will be remembered for the days she kept us company during the VE exams, parking cars and just about every event EPARA had. May she rest peace!

Rule #1 of Amateur Radio, it is a hobby, unless you figured out a way to fashion a living out of it.
Rule #2 of Amateur Radio, life is not a hobby and typically carries heavy responsibilities of everything that is not a hobby.
Rule #3 of Amateur Radio, never give up a LIFE event for a Ham event. You may make some great memories at the Ham event, but the guilt you may carry missing a LIFE event can be a terribly heavy millstone.
Rule #4 of Amateur Radio, as technology moves forward, so does Ham Radio - do what makes you happiest, experiment with other elements of Ham Radio as LIFE allows.
Rule #5 of Amateur Radio, it is only Ham Radio, when confused always refer to Rule #1 through #4.

EPARA GENERAL MEMBERSHIP MEETING AGENDA

EPARA Membership Meeting Minutes
July *14th 2022*

General Membership Meeting 7:30Pm

Open meeting:
Meeting called to order at 7:30 pm on July 14th 2022 by Chris AJ3C
Declaration of Quorum.
Total Attending: 14 Visitors present: 1 (No Zoom tonight)

Pledge of Allegiance / Moment of silence:

Membership Meeting - Minutes June 9th, 2022
Secretary - Kevin W3KCF:

Meeting minutes for June 9th, 2022 were posted on the EPARA website. Chris – AJ3C asked members if they had seen and read the minutes from our previous meeting. He then asked if there were any questions or objections to the minutes as they were presented. With no objections, Chris asked for a motion to accept the minutes as presented:

Motion to accept minutes as read: By RuthAnn - W9FBO 2nd by John – K3WH Motion Passed

Treasurers report:

Treasurers report: For the July 2022 EPARA Club Meeting.
By Scott Phelan, KC3IAO (Read by Chris – AJ3C)

Bank Account Statement Opening Balance 6/30/22 statement.): $3912.09

Expenses:

Chk #161, VOID.

Chk # 162, $200.00 Club Liability Insurance.

Chk # 163, $27.55 RF Connectors for the Red Cross Station.

Chk # 164, $188.03 Power Divider and Coax for the EME project. Income:

Deposit on 6/2/22: $74.00.

(Dues $40.00, 50/50 $34.00) Deposit on 6/23/22: $79.00 (Dues $50.00, 50/50 $29.00)

$0.16 Bank Interest.

Closing Balance: $3649.67

Our PayPal Account: 6/30/22 statement.

No changes since last month. Balance is $414.26

Motion to accept by AL – KB3OVB Seconded by Bob – W3BMM Motion Passed

EPARA GENERAL MEMBERSHIP MEETING AGENDA

Correspondence:

QSL card from WB2CUT 2m SSB was received – Chris said a QSL Card was sent out from the club.

Reports of officers and committee's:

Bill AB3ME – Program Committee: (Not Present)

Chris – AJ3C said there would be no presentation tonight. However, he mentioned a presentation on using Winlink would be given at the August meeting.

Charlie KB3JUF – ARES/RACES:

Charlie reiterated that all involved in ARES need to be motivated. Make sure you attend our meetings on the 4th Friday of the month and keep your Task Books up to date. Complete any and all training required and stay enthused. Charlie also stated, please check in on the Sunday Night ARES Net.

Charlie also stated that he would like everyone to bring their county ID cards, deployment vests and task books to our next meeting. He also stated that we are working with the Red Cross in October for an exercise setting up a shelter.

Ruth Ann, W9FBO – PIO:

RuthAnn reiterated what Charlie said about working with the Red Cross. She also mentioned she is working on a draft to submit to the ARRL regarding a grant for the club.

Chris AJ3C -- Instruction and Training:
Nothing to report

Chris AJ3C – Website:
Nothing to Report

Bob W3BMM – Social Media:

Everything is going well with Social Media. He would like to add club events to our media platform and expand into video as things progress. He mentioned, please visit our Face Book page a click "LIKE" ……

Field Day 2022:
Field Day was a fun and successful event! We came in at budget. AJ3C wishes to thank all who helped with the planning, donated food, and setup and tore down the FD site. The weekend would not have been a success without all the help.

Chris also showed the Proclamation from the state presented to us by Representative RoseMary Brown at field day. He also mention Antenna Weekend is coming up and will be held on the 23rd/24th of this month.

Al, KB3OVB: Membership:

AL said we are currently at 69 members until the rolls are purged for non-payment of membership dues.

Eric N3SWR – Newsletter:

All is good. Eric wants you to keep sending in material he can use in the newsletter.

EPARA GENERAL MEMBERSHIP MEETING AGENDA

Sat-Com / EME Group:

Alex said we have been getting great scans from the ISS Sat. It was also mentioned the ARRL EME event is coming up on the 27th of August.

Old business:

OCF Dipole Repair
Repair is complete, antenna has good SWR on 80, 40, 20, 17, 15, and 10 meter bands.
Damage to the control center truck windshield has been submitted to the club insurance and is covered.

Hamfest 2022: Flier complete, submitted the event to the ARRL.

Any other old business
None

New business:

Antenna\Elmer weekend: Event will be held on July 23 and 24 (Sat-Sun) We will be building and testing an 80 meter delta loop.

Any Other New Business
None

Votes / New members:
None

Announcements:
Sussex County ARC hamfest will be on July 17th.

Any Additional Announcements

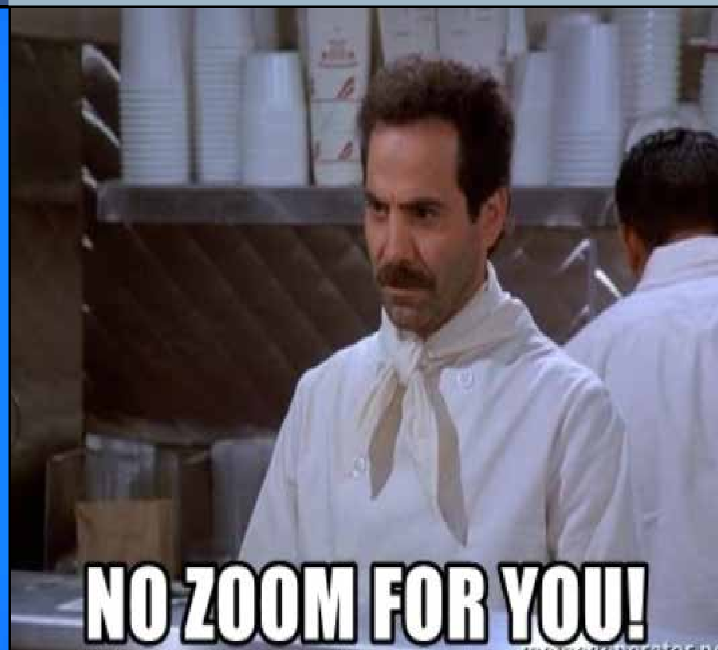
Tonight's 50/50 Raffle: $44.00. The $22.00 win was donated back to the club by Ernie – KC3OLC

Adjournment…

Meeting was adjourned at 2026: Motion to close by John – K3WH 2nd by Eric – N3SWR Motion Passed.

Secretary
Kevin Forrest
W3KCF

EPARA MEETING

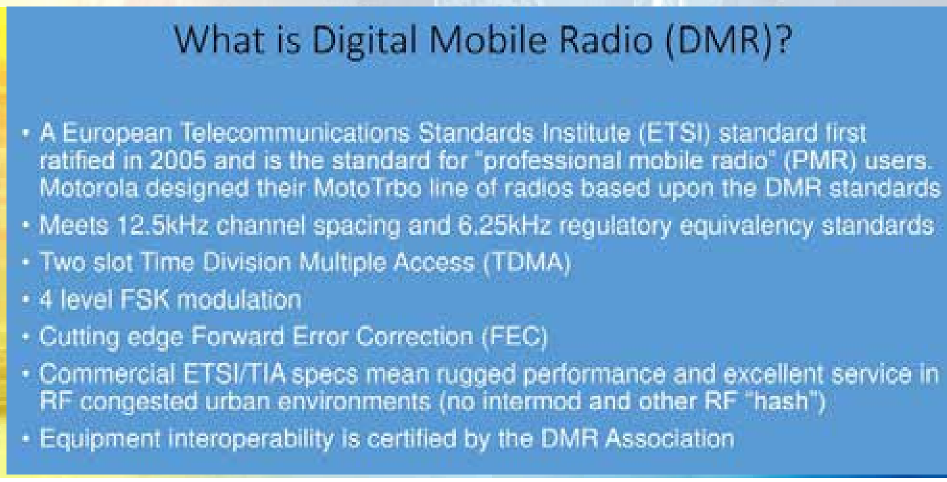


TEST YOUR KNOWLEDGE!

What is "dither" with respect to analog to digital converters?

A. An abnormal condition where the converter cannot settle on a value to represent the signal
B. A small amount of noise added to the input signal to allow more precise representation of a signal over time
C. An error caused by irregular quantization step size
D. A method of decimation by randomly skipping samples

Last month's answer was, D. Step start circuits reduce the rush of current during the charging time for the filter capacitors allowing for a lower current rating on the supply circuit. By charging the capacitors gradually we increase the life of the capacitors.



DMR
DIGITAL MOBILE RADIO

The EPARA HOT SPOT Wednesday night DMR rag chew is here!

Wednesday evenings at 8:30 PM local, 0:30 UTC!

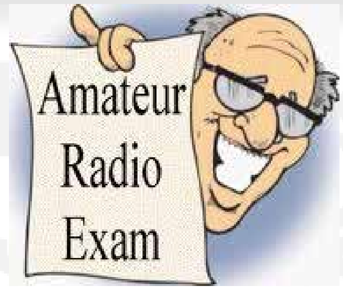
Tune your DMR radios to Talk Group 3149822 TS2 to join the

N3IS EPARA Hot Spot rag chew DMR net.

Listen to the Tech Net Friday nights on the 147.045 repeater to learn more about joining this net and for upcoming ZOOM meetings announcements to learn more about programing your radios and hot spots!

VE Testing & Classes

Anyone looking to take an exam is encouraged to contact Chris AJ3C to preregister at least one (1) week in advance of the test date. If you have any questions or to register, Chris can be reached via email AJ3C@GMX.COM. VE sessions are being held the 4th Friday of each month at 6pm at the Monroe County 911 training center. Seating is limited for the time being so we can follow the health guidelines set forth by the county and state.



VE sessions are back - contact Chris AJ3C for further information!

AMATEUR RADIO CLASSES

ARES/RACES meetings are now being held on the fourth Friday of each month at 7PM. The meetings are once again being held at the 911 call center. These meetings will serve as training sessions covering several aspects of amateur radio emergency communications. We will start with traffic handling and the use of Radiograms and the ICS 213 general message form. Future sessions will cover the use of several ICS forms and the setup and use of digital communication modes including Winlink, Packet Radio, APRS, and the FLDIGI software program. Meeting are open to all, you do not need to be an ARES/RACES team member to attend.

Want to Put Your Ham Radio Skills to Good Use? Get Involved in

EmComm!

One of the missions of the Amateur Radio Service is for amateur radio operators to provide public service and emergency communications (EmComm) when needed. We act as a voluntary noncommercial communication service and pitch in to help our communities and first responders.

So, what organizations are out there for community-minded amateur radio operators and what can we do to help?

Join In

One good entry point into public service and emergency communications is to join SkyWarn, a volunteer program run by the National Weather Service (NWS) with more than 290,000 trained severe weather spotters. These volunteers help keep their local communities safe by providing timely and accurate reports of severe weather to the NWS.

Not all of these weather spotters are amateur radio operators, but many are. Amateur radio communications can report severe weather in real time. When severe weather is imminent, SkyWarn spotters are deployed to the areas where severe weather is expected. A net is activated on a local repeater and SkyWarn spotters who are Hams check into that net. The net control advises the spotters when they might expect to see severe weather, and the spotters report conditions such as horizontal winds, large hail, rotating clouds, and even tornadoes.

To become a SkyWarn spotter, you must attend a class that teaches you the basics of severe weather, how to identify potentially severe weather features, and how to report them. The classes are free and typically last about two hours. Check your local NWS website for class schedules.

ARES/RACES/CERT

Another way Hams can become involved in public service and emergency communication is to join an ARES or RACES group. Technically, these are two separate services—the Amateur Radio Emergency Service (ARES) is run by the ARRL, while the Radio Amateur Civil Emergency Service (RACES) is a function of the Federal Emergency Management Agency (FEMA). Amateur radio operators who typically take part in one also take part in the other.

To participate in RACES, you'll need to take some self-study FEMA courses in emergency preparedness and emergency-response protocols. Classes may or may not be required to participate in ARES. These requirements are set by each individual ARES group. To get involved with either ARES or RACES, ask your local club members when they meet. You can also contact the Section Manager or Emergency Coordinator for your ARRL section. To contact them, click here and find the section that you live in.

Amateur radio operators belonging to ARES (and its predecessor, the Amateur Radio Emergency Corps) have responded to local and regional disasters since the 1930s, including the 9/11 attacks, and Hurricane Katrina and Hurricane Michael, among others.

The Community Emergency Response Team (CERT) program trains volunteers—both Hams and non-hams—how to be prepared for disasters that may impact their area. They provide basic disaster response skills, such as fire safety, light search and rescue, team organization, and disaster medical operations. CERT offers a nationwide approach to volunteer training and organization that first responders can rely on during disaster situations, allowing them to focus on more complex tasks.

What Gear Do You Need?

For most local needs, a 5-watt VHF/UHF handheld transceiver is sufficient for utilizing local repeaters to relay messages and report on conditions as they exist. Replacing the radio's stock antenna with a higher gain antenna or connecting it to a magnetic mount on a vehicle will increase range significantly.

Even better is a VHF/UHF mobile radio installed in your vehicle with 25 or more watts output and a good mobile antenna. In the event the repeater loses power, you can talk over a considerably larger area in simplex mode with the extra power and a good mobile antenna.

If you work with an ARES or RACES group, you may be asked to act as a county control station. In this capacity, you'd need both HF and VHF transceivers in a fixed location, such as your house, with a good antenna system and emergency power capabilities like a generator or batteries. This allows you to make contacts within your state and throughout the U.S.

Helping Hams

Ham radio can play a key role in emergency situations. Here are a few examples:

- Ham radio connected firefighters and police departments, Red Cross workers, and other emergency personnel during the 2003 blackout that affected the northeast United States.
- In 2017, fifty amateur radio operators were dispatched to Puerto Rico to provide communications services in the wake of Hurricane Maria.
- Amateur radio operators provided communications in the aftermath of the Boston Marathon bombing when cellphone systems became overloaded.

- During Hurricane Katrina, more than one thousand ARES volunteers assisted in the aftermath and provided communications for the American Red Cross.
- During the devastating Oklahoma tornado outbreak that began in May 1999, amateur radio operators—giving timely ground-truth reports of severe weather—played a critical role in the warning and decision-making processes at the NWS Weather Forecast Office in Norman, Oklahoma.

Credit: https://www.onallbands.com/want-to-put-your-ham-radio-skills-to-good-use-get-involved-in-emcomm/

From the Editor

Eric, N3SWR

Hello folks!

I trust we all are enjoying the hot weather. Hey it could be all rainy days too ya know. Another month has passed and we managed to pulled off Antenna/Elmer weekend in this heat. To be honest, it wasn't all that bad up on the mountain. The breeze was constant and the air was dry. I missed the assembly and hoisting of the antenna unfortunately. But i did manage to capture a few pictures of those that showed for the event. For there efforts, there will be a nice 80 delta loop available for field day to use, and even though the solar index was a K4 or K5 that day and the airwaves a bit noisy, that antenna performed!

Faith W3INK and i decided to rent mountain bikes the day prior and we biked from Lehighton down south along the D&L Trail, crossed the Lehigh River at Weisport and biked all the way north through Jim Thorpe and made our destination at the Penn Haven railroad junction 14 miles away. I've been looking for the east coasts largest uranium deposit as marked during the 1950's and I found it! It was tucked away very discreetly on a hillside there. So I took a few photos and of course a few along the trail on the way back. The front cover shows the newly restored engine that is used on the Lehigh Valley trains excursions. They also will be unveiling a newly rebuilt steam engine this summer. That will be something to see!

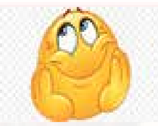
Cheers for now!

Eric
N3SWR

What does an electrician have for breakfast?
an Ohm-lette

Topics of Interest

Have an idea you would like to share with your fellow hams? Interested in one of the new exotic digital modes and would like to get others interested in it too? Found a blog somewhere that you think others would find interesting? Members are encouraged to submit items of interest for publication. Submitted articles (are suggested) to be no more than a page or two in length and may be edited for content and grammar. The EPARA officers and newsletter editor reserve the right to determine which items will be included in The Beacon. The deadline for publication is the 15th of the month. The publication date will be at the end of each month. Copyrights are the property of their respective owners and their use is strictly non-profit/educational and intended to foster the spirit of amateur radio.



If you've taken pictures at an event and would like to submit them for possible inclusion in the newsletter, forward them to the newsletter editor. Please send action shots, if possible. Faces are often preferable over the backs of heads. Many hams may be way too overweight, so please consider using a wide-angled lens.

Disclaimer

The Beacon is not representative of the views or opinions of the whole organization, and such views and opinions expressed herein are of the individual author(s).

Contest Corral

August 2022

Check for updates and a downloadable PDF version online at **www.arrl.org/contest-calendar**.
Refer to the contest websites for full rules, scoring information, operating periods or time limits, and log submission information.

Start Date-Time		Finish Date-Time		Bands	Contest Name	Mode	Exchange	Sponsor's Website
2	0100	2	0159	1.8-28,50	Worldwide Sideband Activity Contest	Ph	RS, age group (OM, YL, or Youth)	wwsac.com/rules.html
2	0100	2	0300	3.5-28	ARS Spartan Sprint	CW	RST, SPC, Power	arsqrp.blogspot.com
3	0230	3	0300	1.8-14,21	Phone Weekly Test	Ph	NA: Name, SPC; non-NA: Name	www.perluma.com/Phone_Fray_Contest_Rules.pdf
3	1700	3	2000	144	VHF-UHF FT8 Activity Contest	FT8	4-char grid square	www.ft8activity.eu
4	0000	5	0300	7	Walk for the Bacon QRP Contest	CW	Maximum 13 WPM, RST, SPC, name	qrpcontest.com/pigwalk40
4	1900	4	2100	1.8-28,50	SKCC Sprint Europe	CW	RST, SPC, name, (SKCC No./"none")	www.skccgroup.com
5	0100	5	0230	14	QRP Fox Hunt	CW	RST, SPC, name, power	www.qrpfoxhunt.org
6	0000	7	2359	3.5-28	Batavia FT8 Contest	FT8	4-char grid square	batavia-ft8.com
6	0001	7	2359	28	10-10 International Summer Contest, SSB	Ph	Name, mbr or "0," SPC	www.ten-ten.org
6	1200	6	2359	1.8-28	European HF Championship	CW Ph	RS(T), 2-digit year first licensed	euhf.s5cc.eu/euhfc_rules
6	1800	7	0559	1.8-28	North American QSO Party, CW	CW	Name, state/DC/province/country	www.ncjweb.com
6	1800	7	1800	222 and up	ARRL 222 MHz and Up Distance Contest	CW Ph Dig	6-char grid square	www.arrl.org/222-mhz-and-up-distance-contest
7	1400	7	1700	3.5-14	SARL HF Phone Contest	Ph	RS, serial	www.sarl.org.za
9	0100	9	0159	1.8-28,50	Worldwide Sideband Activity Contest	Ph	RS, age group (OM, YL, or Youth)	wwsac.com/rules.html
10	0030	10	0230	3.5-14	NAQCC CW Sprint	CW	RST, SPC, mbr or power	naqcc.info
10	0230	10	0300	1.8-14,21	Phone Weekly Test	Ph	NA: Name, SPC; non-NA: Name	www.perluma.com/Phone_Fray_Contest_Rules.pdf
10	1700	10	2000	432	VHF-UHF FT8 Activity Contest	FT8	4-char grid square	www.ft8activity.eu
12	0100	12	0230	14	QRP Fox Hunt	CW	RST, SPC, name, power	www.qrpfoxhunt.org
12	1500	14	1459	144	MMMonVHF/DUBUS 144-MHz Meteorscatter Sprint Contest	CW Ph Dig	Signal report	www.mmmonvhf.de/ctestinfo.php
13	0000	14	2359	3.5-28	WAE DX Contest, CW	CW	RST, serial	www.darc.de
13	1200	14	2359	1.8-28,50	SKCC Weekend Sprintathon	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
13	1400	13	2200	3.5-28	Kentucky State Parks on the Air	CW Ph Dig	KY park abbreviation or SPC	k4msu.com/kypota
13	1400	14	0400	1.8-	Maryland-DC QSO Party	CW Ph Dig	Entry class, county or SPC	w3vpr.org/mdcqsop
13	2300	14	0300	50	50-MHz Fall Sprint	CW Ph Dig	4-char grid square	svhfs.org
15	0000	15	0200	1.8-28	4 States QRP Group Second Sunday Sprint	CW Ph	RS(T), SPC, mbr or power	www.4sqrp.com
16	0100	16	0159	1.8-28,50	Worldwide Sideband Activity Contest	Ph	RS, age group (OM, YL, or Youth)	wwsac.com/rules.html
17	0230	17	0300	1.8-14,21	Phone Weekly Test	Ph	NA: Name, SPC; non-NA: Name	www.perluma.com/Phone_Fray_Contest_Rules.pdf
17	1700	17	2000	1.2G	VHF-UHF FT8 Activity Contest	FT8	4-char grid square	www.ft8activity.eu
18	0000	19	0300	14	Walk for the Bacon QRP Contest	CW	Maximum 13 WPM, RST, SPC, name	qrpcontest.com/pigwalk20
19	0100	19	0230	14	QRP Fox Hunt	CW	RST, SPC, name, power	www.qrpfoxhunt.org
20	0000	21	1600	3.5-28	SARTG WW RTTY Contest	Dig	RST, serial	www.sartg.com
20	0600	21	2359	10 GHz to light	ARRL 10 GHz and Up Contest	CW Ph Dig	6-char grid square	www.arrl.org/10-ghz-up
20	1600	20	1759	1.8-28,50	Feld Hell Sprint	Dig	(see rules)	sites.google.com/site/feldhellclub
20	1800	21	0559	1.8-28	North American QSO Party, SSB	Ph	Name, state/DC/province/country	www.ncjweb.com
21	1400	21	1700	3.5-14	SARL HF Digital Contest	Dig	RST, serial	www.sarl.org.za
21	1800	21	2359	3.5-28	ARRL Rookie Roundup, RTTY	Dig	Name, 2-digit year first licensed, SPC or XE province	www.arrl.org/rookie-roundup
21	2300	22	0100	1.8-28	Run for the Bacon QRP Contest	CW	RST, SPC, (mbr/power)	qrpcontest.com/pigrun
23	0100	23	0159	1.8-28,50	Worldwide Sideband Activity Contest	Ph	RS, age group (OM, YL, or Youth)	wwsac.com/rules.html
24	0000	24	0200	1.8-28,50	SKCC Sprint	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
24	0230	24	0300	1.8-14,21	Phone Weekly Test	Ph	NA: Name, SPC; non-NA: Name	www.perluma.com/Phone_Fray_Contest_Rules.pdf
26	0100	26	0230	14	QRP Fox Hunt	CW	RST, SPC, name, power	www.qrpfoxhunt.org
26	2200	28	2359	1.8-28	RTTYOps WW DX RTTY Contest	Dig	RST, 4-digit year license first issued	rttyops.com
27	0000	28	2359	2.3 GHz and Up	ARRL EME Contest	CW Ph Dig	Signal report	www.arrl.org/eme-contest
27	0400	29	0400	1.8-28	Hawaii QSO Party	CW Ph Dig	RS(T) HI district or SPC	www.hawaiiqsoparty.org
27	1200	28	0300	1.8-28,50	W/VE Islands QSO Party	CW Ph Dig	RS(T), USI/CISA Island Designation or SPC	usislands.org/qso-party-rules
27	1200	28	1200	1.8-28	YO DX HF Contest	CW Ph	YO: RS(T), county; non-YO: RS(T), serial	www.yodx.ro/en
27	1200	28	1200	1.8-28	World Wide Digi DX Contest	FT4/8	4-char grid square	ww-digi.com
27	1400	28	2000	3.5-28,50	Kansas QSO Party	CW Ph Dig	RS(T), KS county or SPC	ksqsoparty.org
27	1600	28	0400	1.8-28	Ohio QSO Party	CW Ph	RS(T), OH county or SPC	www.ohqp.org
28	1400	28	1700	3.5-14	SARL HF CW Contest	CW	RST, serial	www.sarl.org.za
30	0100	30	0159	1.8-28,50	Worldwide Sideband Activity Contest	Ph	RS, age group (OM, YL, or Youth)	wwsac.com/rules.html
31	0230	31	0300	1.8-14,21	Phone Weekly Test	Ph	NA: Name, SPC; non-NA: Name	www.perluma.com/Phone_Fray_Contest_Rules.pdf

There are a number of weekly contests not included in the table above. For more info, visit: **www.qrpfoxhunt.org**, **www.ncccsprint.com**, and **www.cwops.org**. All dates and times refer to UTC and may be different from calendar dates in North America. Contests are not conducted on the 60-, 30-, 17-, or 12-meter bands. Mbr = Membership number. Serial = Sequential number of the contact. SPC = State, Province, DXCC Entity. XE = Mexican state. Listings in blue indicate contests sponsored by ARRL or *NCJ*. The latest time to make a valid contest QSO is the minute listed in the "Finish Time" column. *Data for Contest Corral is maintained on the WA7BNM Contest Calendar at* **www.contestcalendar.com** *and is extracted for publication in* QST *2 months prior to the month of the contest. ARRL gratefully acknowledges the support of Bruce Horn, WA7BNM, in providing this service.*

Amateur Radio Special Event Stations!

07/23/2022 | RRC Kiska Island Expedition - 80th Anniversary of the Japanese Invasion of the Aleutian Islands

Jul 23-Aug 3, 0000Z-0000Z, K7K, Homer, AK. Russian Robinson Club. 7242 14242 18142 21342. QSL. Richrd J. Moen, 2935 Plymouth Dr., Bellingham, WA 98225.

07/29/2022 | Indiana State Fair

Jul 29-Aug 21, 1600Z-2000Z, W9ISF, Indianapolis, IN. Indiana State Fair ARC. 7.245 14.245 18.150. QSL. Indiana State Fair ARC, 7405 E. County Road 900 N, Brownsburg, IN 46112.

08/04/2022 | US COAST GUARD 232 BIRTHDAY

Aug 4, 1400Z-2300Z, K1CG, Port Angeles, WA. CG CW Operators Association. 3.552 7.052 14.052 21.052. QSL. Fred Goodwin see QRZ/K1CG, 424 N. Bagley Ck, Port Angeles, WA 98362. www.qrz.com/db/k1cg

08/06/2022 | 50th Anniversary Flat River Historical Society and Museum

Aug 6, 1400Z-2100Z, W8WR, Greenville, MI. Larry Alman. 7.238 14.238. QSL. Larry Alman, PO Box 312, Greenville, MI 48838. Help us celebrate the 50th Anniversary of the Flat River Museum in Greenville Michigan. Send SASE for QSL card to: PO Box 312 Greenville, MI 48838 Larry4lions@gmail.com

08/06/2022 | PASOLA 4th Anniversary

Aug 6, 1200Z-2359Z, KC3LWP, Philadelphia, PA. Sociedad De Operadores Latino Americano. 14.320. Certificate. KC3LWP, 3520 N. Front St., Philadelphia, PA 19140. www.pasola.org

08/06/2022 | River City Days

Aug 6, 1500Z-2000Z, W0R, Red Wing, MN. Hiawatha Valley Amateur Radio Club. 7.200 14.250 147.300. Certificate. Bill Eichenlaub, 1966 Launa Ave., Red Wing, MN 55066. hvamateurradioclub.com

08/08/2022 | Navajo Code Talkers

Aug 8-Aug 14, 0000Z-0000Z, N7C, Chinle, AZ. N7HG. 14.265 21.265 7.265 18.133. Certificate & QSL. Navajo Code Talkers, P.O. Box 06, Chinle, AZ 86503. n7hgster@gmail.com

08/11/2022 | Ten Mile River Scout Camps 95th Anniversary

Aug 11-Aug 15, 0000Z-2359Z, W2T, Narrowsburg, NY. Ten Mile River Scout Museum Amateur Radio Club. 14.295 7.295 3.995. QSL. James Gallo, 149 Marine Avenue, 6F, Brooklyn, NY 11209. https://www.qrz.com/db/W2TMR

08/11/2022 | WW2FLY Honors the B-17 Royal Flush

Aug 11-Aug 14, 0000Z-2359Z, WW2FLY, Attica, NY. WWII Flying Fortress Amateur Radio Club. 1.900 3.850 7.180 14.250. Certificate. Nathan Fix, 3339 Stroh Rd, Attica, NY 14011. https://www.qrz.com/db/WW2FLY

08/12/2022 | Celebrating the 75th Anniversary of the Tri-State Amateur Radio Society

Aug 12-Aug 14, 1400Z-2359Z, W9OG/75, Evansville, IN. TARS - Tri-State Amateur Radio Society. 7.262 7.045 14.250 FT8 - 40&20. QSL. Dennis Martin, 5577 Victoria Court, Newburgh, IN 47630. SASE please. www.w9og.net

08/13/2022 | Friends of Bodie Day

Aug 13, 1600Z-2300Z, W6B, Bodie, CA. California State Parks/Bodie Foundation. 7.225 14.275 21.295 28.400. QSL. John F. Pinckney, 1551 Bennington Woods Ct., Reston, VA 20194.

08/14/2022 | Medinah on the Air

Aug 14, 1700Z-2000Z, K9FEZ, Addison, IL. Medinah Shrine Amateur Radio Unit. 14.250. QSL. John Franta KA9MJE, M.S.A.R.U., 550 Shriners Dr., Addison, IL 60101. This is the 9th year of the unit, and QSL's will be sent upon receipt of an S.A.S.E..

08/19/2022 | 154th Annual Marshfield Fair

Amateur Radio Special Event Stations!

Aug 19-Aug 28, 1600Z-0059Z, NN1MF, Marshfield, MA. Whitman Amateur Radio Club. 3.860 7.260 14.260 18.160 EchoLink: WA1NPO-R IRLP:8691. Certificate. Whitman ARC, PO Box 48, Whitman, MA 02382. Times Are Daily www.wa1npo.org

08/20/2022 | Activation of Burnt Coat Harbor Lighthouse/International Lighthouse/Lightship Weekend

Aug 20-Aug 21, 1400Z-2100Z, W2DAR, Swans Island, ME. W2DAR. 7.197. QSL. Ron Jocher, W2DAR, 24 Park Ter., East Hanover, NJ 07936. Event is in conjunction with the lighthouse Sesquicentennial. www.burntcoatharborlight.com

08/20/2022 | ILLW weekend

Aug 20-Aug 21, 0001Z-2359Z, W5BMC, Berwick, LA. Bayouland Emergency Amateur Radio Service [BEARS]. 7.272 14.272. QSL. Deborah Price, N5FMI, 708 Front St., Morgan City, LA 70380. Operating from the Southwest Reef Lighthouse in Lighthouse Park on the Atchafalaya River in Berwick, LA. www.qrz.com/db/w5bmc

08/20/2022 | Port Clinton Lighthouse Activation

Aug 20, 1111Z-2121Z, W8GNM/8, Port Clinton, OH. Port Clinton Lighthouse Festival. 7.200 7.235 14.285 14.335. QSL. W8GNM/8, via LoTW, Port Clinton, OH 43452. Port Clinton Lighthouse activation on Saturday, August 20th 2022 from 15:00 to 21:00 UTC W8GNM/8 will be QRV from the Port Clinton Lighthouse during the Port Clinton Lighthouse Festival at Port Clinton, OH (ARLHS USA-922). Grid Square: EN81mm (http://arlhs.com/events/) International Lighthouse/Lightship Weekend Aug 20, 2022 at Port Clinton, OH. (US 0228) (https://wllw.org/index.php/list-3) Port Clinton Lighthouse Conservancy (http://portclintonlighthouse.org/) Check web clusters for specific frequencies. Typical 40m frequencies 7.200 or 7.235 Typical 20m frequencies 14.285 or 14.335 QSL via LoTW only to W8GNM/8. Operators: Geoff - W8GNM, Jay - K8CJY, and Jon - KB8SRQ portclintonlighthouse.org

08/26/2022 | Amateur Radio Software Award

Aug 26-Sep 5, 0500Z-0700Z, K3A, K3R, K3S, Ames, IA. Amateur Radio Software Award. 3.950 7.078 7.185 14.250. QSL. Amateur Radio Software Awards, Special Event Station, P.O. Box 126, Ames, IA 50010-0126. Special event stations K3A, K3R, and K3S are operating from Iowa, Colorado and California to promote free and open amateur radio software. During the event the 2022 Amateur Radio Software Award recipient David Rowe (VK5DGR) will be honored for Codec 2 which enables digital voice communication over HF and VHF. Nominations for the 2023 awards will also be encouraged. Please QSL with S.A.S.E. The Amateur Radio Software Award is an annual international award for the recognition of software projects that enhance amateur radio. The award aims to promote amateur radio software development which adheres to the same spirit as amateur radio itself: innovative, free and open. For more information about the Amateur Radio Software Award or a detailed schedule of the special visit www.arsaward.com. https://arsaward.com/special-event.html

08/27/2022 | Buhl Day Celebration

Aug 27-Sep 5, 0000Z-2359Z, W3B, Hermitage, PA. Mercer County Amateur Radio Club. 7.185 14.240 145.350. QSL. Mercer County Amateur Radio Club, P.O. Box 996, Sharon, PA 16146. Mercer County Amateur Radio Club is celebrating BUHL DAY, the 107th Anniversary of Buhl Farm Park, which covers 300 acres donated to the Shenango Valley Pennsylvania, community by Frank Buhl a local industrialist, for the use and recreation purposes More information at www.w3lif.org

08/28/2022 | Flying High With Amateur Radio

Aug 28, 1300Z-2100Z, N2MO, Spring Lake, NJ. Ocean Monmouth Amateur Radio Club, Lakewood Airport (N12), and the MAFC Flying Club. 7.055 7.215 14.055 14.255 28.055 28.400; local 2 meter repeater 145.110 - 600 PL 127.3. QSL. OMARC (at firehouse), 700 Sixth Avenue, Spring Lake, NJ 07762.

Amateur Radio Special Event Stations!

OPEN HOUSE Exhibiting Lakewood NJ airport (N12) aviation & equipment, the Monmouth Area Flying Club (www.flymafc.com) and the Ocean Monmouth Amateur Radio Club (www.n2mo.org) special event station. Airport at 1900 Cedar Bridge Ave. Lakewood NJ 08701. joekru1@hotmail.com or www.n2mo.org

08/29/2022 | Hurricanes Katrina and Ida Commemoration

Aug 29-Aug 30, 0000Z-0000Z, W5GAD, Metairie, LA. Jefferson Amateur Radio Club. 7.235 14.285 7.035 14.035; SSB, CW and FT8 on various HF bands; D-STAR on REF048C. Not all bands and modes will be operated simultaneously.. QSL. Jefferson Amateur Radio Club, P.O. Box 73665, Metairie, LA 70033. w5gad.org

6SK7 Pentode, Remote Cut-Off, RF Amp

Also known by US military identifier VT-117A.

The 6SK7 is a remote-cutoff pentode. It is designed for use as a high-gain radio-frequency or intermediate-frequency amplifier in a radio receiver. Because of its remote-cutoff characteristic, this type will handle large signal voltages without cross-modulation or modulation-distortion and is suitable for use in receivers which employ automatic-volume-control.

Not too long ago I built Mutt Amps 0005, a guitar amp based on a Fender Deluxe circuit with some elements of the Fender Bassman (inputs), Valco/Supro/National (tone stack), and maybe even a little Vox flavoring (see why I call them mutts?). I had an old radio chassis that had all octal sockets, so that's the way I went in terms of the tube lineup. The original tube complement was 6SQ7 input (the triode section is like half a 12AX7), 6BL7 or 6SN7 phase inverter, and a pair of push-pull 6V6s for power.

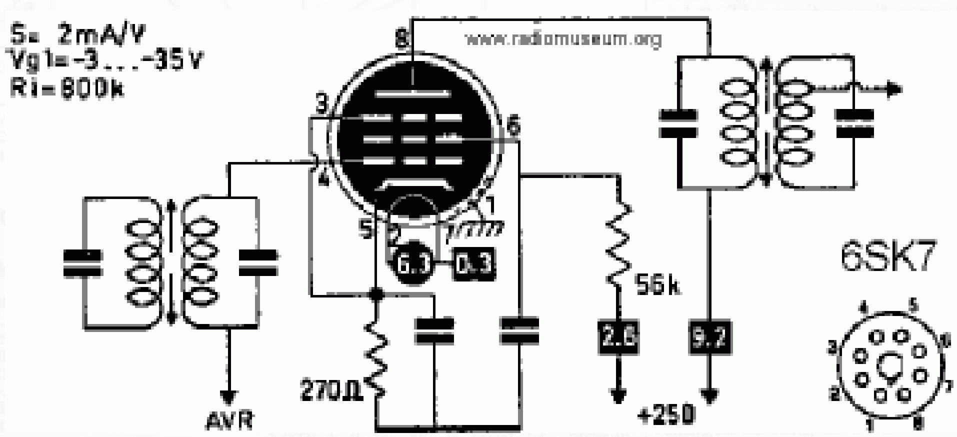
I liked it, a lot. But after studying Vox and Matchless use of the EF86 pentode I kinda got the itch to tinker. Here are the big "howevers": the EF86 ain't cheap, it's a 9-pin tube, and I didn't feel like adding a socket.

I hunted for an octal equivalent, and found it, more or less, in the 6SH7, 6SJ7, and 6SK7. Oh, and I just happened to have a bunch of them, too. The potential pitfall to using these tubes is a lot of them are microphonic. The upside is they are cheap and you can roll through a few until you find one that's not. There are a few internal differences between them, but if you tie pins 3 and 5 together, any of them will work.

While they aren't common in amps today, the 6SJ7 especially has a musical pedigree. It was used in some early guitar amps like the 5C1 Fender Champ, and the Valco-made National 1200 as these schematics from EL34 World show.

What's the effect on sound? In my experience, nice highs, beefy mids and a solid low end. It adds a throaty growl at lower volumes, and when cranked the sound is round and thick.

After rolling all three of these tubes through the amp, I don't hear a lot of difference between them. They all want to just punch you in the mouth more the higher the volume goes. I'm diggin' it. And if you're looking for something to set your sound apart, these tubes might be just what you're looking for.



Credit: https://muttaudio.wordpress.com/2014/08/29/talking-about-tubes-the-pentode-input-awesomeness-of-the-6sh7-6sj7-6sk7-family-wvideo/

Electronic TUBE

6SK7-12SK7
Description and Rating

PENTODE

The 6SK7 and 12SK7 are remote-cutoff pentodes which are identical except for heater ratings. Each type is designed for use as a high-gain radio-frequency or intermediate-frequency amplifier in radio receivers. Because of its remote-cutoff characteristic, this type will handle large signal voltages without cross-modulation or modulation-distortion and is suitable for use in receivers which employ automatic-volume-control.

GENERAL

Cathode - Coated Unipotential

	6SK7		12SK7	
Heater Voltage, A-C or D-C	6.3	. . .	12.6	Volts
Heater Current	0.3	. . .	0.15	Ampere

Envelope - MT-8, Metal Shell
Base - B8-21, Small Wafer Octal 8-Pin
Mounting Position - Any

Direct Interelectrode Capacitances *

Grid-Number 1 to Plate, maximum	0.003	μμf
Input	6.0	μμf
Output	7.0	μμf

MAXIMUM RATINGS

DESIGN-CENTER VALUES

Plate Voltage	300	Volts
Screen-Supply Voltage	300	Volts
Screen Voltage - See Screen Rating Chart		
Positive D-C Grid-Number 1 Voltage	0	Volts
Plate Dissipation	4.0	Watts
Screen Dissipation	0.4	Watt
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts

CHARACTERISTICS AND TYPICAL OPERATION

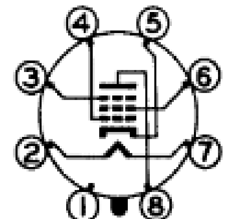
CLASS A_1 AMPLIFIER

Plate Voltage	100	250	Volts
Suppressor Voltage +	0	0	Volts
Screen Voltage	100	100	Volts
Grid-Number 1 Voltage	-1	-3	Volts
Plate Resistance, approximate	0.12	0.8	Megohm
Transconductance	2350	2000	Micromhos
Plate Current	13	9.2	Milliamperes
Screen Current	4.0	2.6	Milliamperes
Grid-Number 1 Voltage, approximate, G_m = 10 Micromhos	-35	-35	Volts

* *With pin 1 connected to pin 5.*

\+ *Pin 3 connected to pin 5 at socket.*

BASING DIAGRAM

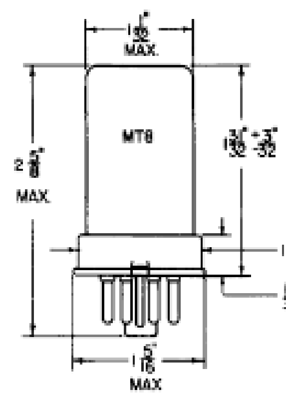


KEY
RTMA 8N
BOTTOM VIEW

TERMINAL CONNECTIONS

Pin 1 - Shell and Internal Shield
Pin 2 - Heater
Pin 3 - Grid Number 3 (Suppressor)
Pin 4 - Grid Number 1
Pin 5 - Cathode
Pin 6 - Grid Number 2 (Screen)
Pin 7 - Heater
Pin 8 - Plate

PHYSICAL DIMENSIONS



RTMA 8-1

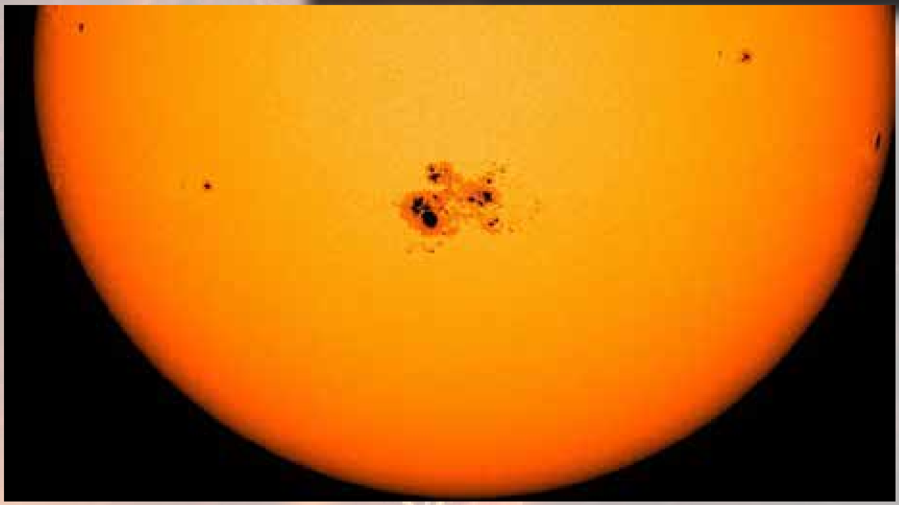
GENERAL ELECTRIC

Supersedes ET-T337A dated 4-50 and ET-T386 dated 5-46

Antenna/Elmer Weekend 2022!


PARA


EPARA



Solar activity increased over this reporting week, July 14 to 20, with average daily sunspot number rising from 102.1 to 137.3, and average daily solar flux from 147.4 to 157.6.

Peak sunspot number was 166 on July 17, and peak solar flux was 171.4 on July 15.

Geomagnetic activity peaked on July 19 when planetary A index was 26 and middle latitude A index at 19. Alaska's high latitude college A index was 43, with the K index at 6, 5, 5, 6 and 5 at 0900 to 2000 UTC.

Average daily planetary A index decreased this week from 12.4 to 9.4.

A crack opened in the earth's magnetic field on July 19, allowing

solar wind to stream in. It is documented here:

https://www.spaceweather.com/images2022/19jul22/data.jpg

At 2241 UTC on July 20 the Australian Space Forecast Centre issued a geomagnetic warning. An increase in geomagnetic activity is expected over 22 to 24 July due to the onset of coronal hole high speed wind streams."

Here is the latest forecast from USAF. Predicted solar flux seems promising with flux values peaking around 160 on July 30 through August 7 and again from August 26 through early September. Predicted flux values are 120 on July 22, then 118 on July 23 to 25, then 116, 114, 110 and 120 on July 26 to 29, 160 on July 30 through August 7, then 155, 145 and 138 on August 8 to 10, then 138 on August 11 and 12, then 128 and 125 on August 13 and 14, 130 on August 15 to 17, 135 on August 18 to 20, 138 and 148 on August 21 and 22, 150 on August 23 to 25, and 160 on August 26 to September 3.

Predicted planetary A index is 20, 40, 14 and 10 on July 22 to 25, 5 on July 26 to 28, 8 on July 29 through August 2, then 12 and 10 on August 3 and 4, 8 on August 5 to 7, then 15, 28 and 12 on August 8 to 10, 8 on August 11 to 17, then 15, 20 and 12 on August 18 to 20, and 8 again on August 21 to 29.

The worst solar storms in history

By Tariq Malik

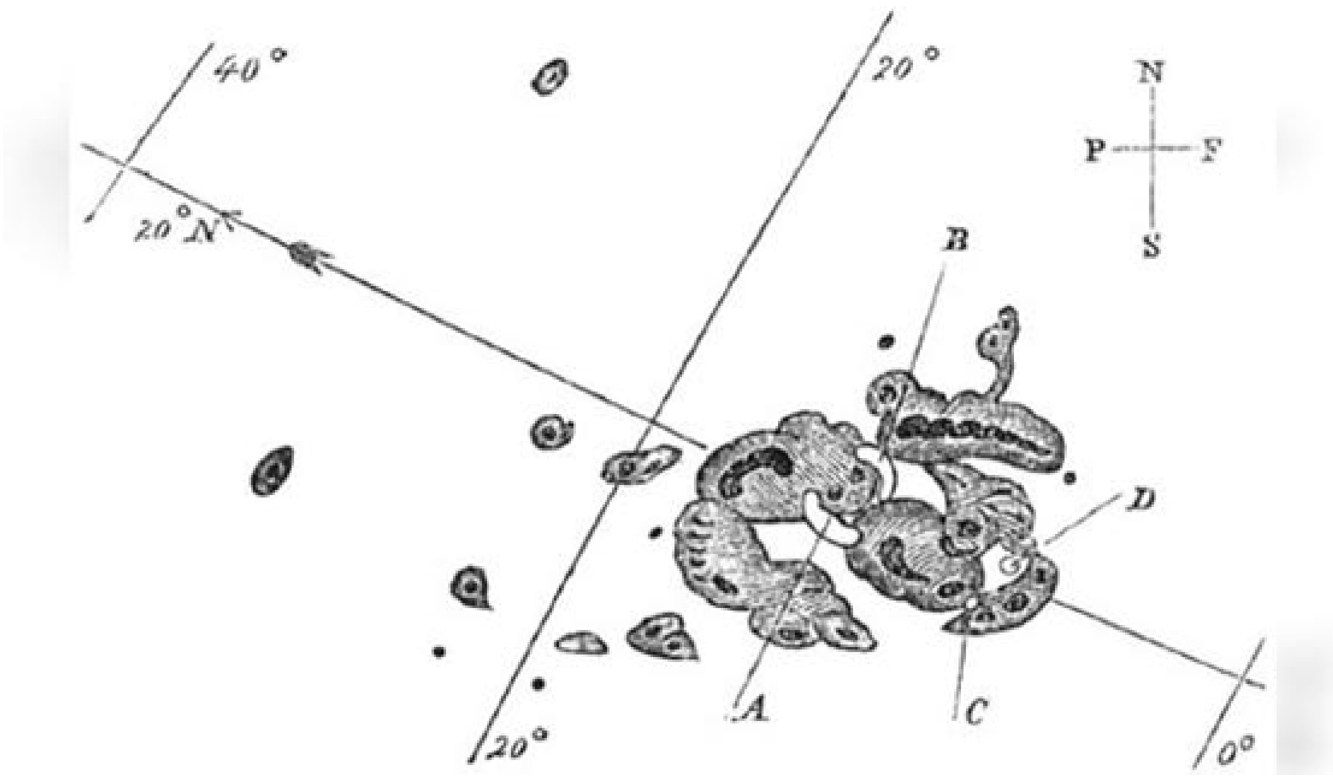
Space.com
2 days ago

Solar activity is ramping up as we experience solar cycle 25 and with it comes an increased likelihood of solar storms — a large release of energy in form of solar flares or coronal mass ejections .

Solar storms can seriously impact technology on Earth as well as satellites and spacewalking astronauts due to increased radiation exposure. Earth is no stranger to the sun 's wrath as large geomagnetic storms can interfere with high-frequency radio communications and Global Positioning Systems (GPS), according to NASA .

Here we take a look at some of the worst solar storms in history.

1859: The Carrington Event

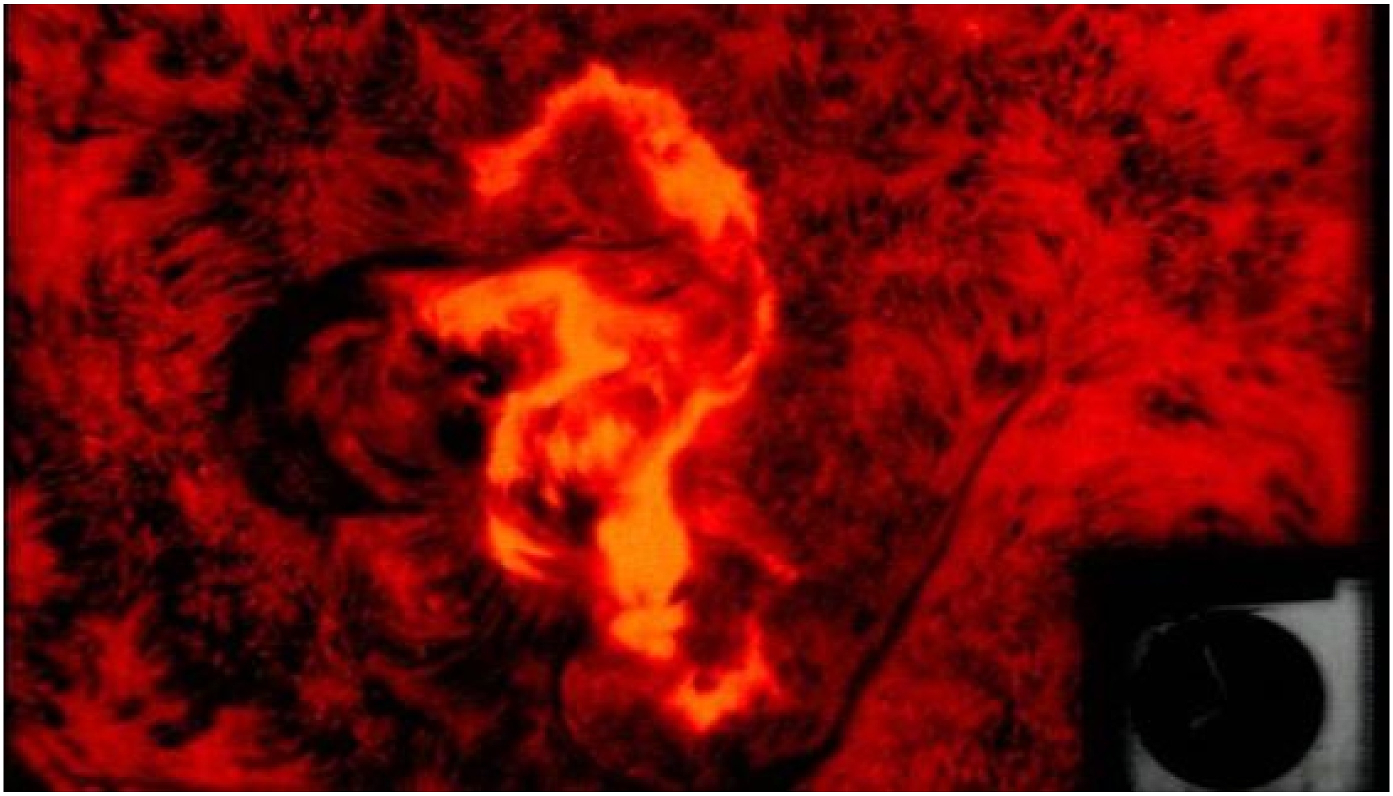


Richard Carrington's drawing of sunspots. (Image credit: Richard Carrington)

The Carrington Event of 1859 was the first documented event of a solar flare impacting Earth. The event occurred at 11:18 a.m. EDT on Sept. 1 and is named after Richard Carrington, the solar astronomer who witnessed the event through his private observatory telescope and sketched the sun's sunspots at the time. The flare was the largest documented solar storm in the last 500 years, NASA scientists have said .

According to NOAA , the Carrington solar storm event sparked major aurora displays that were visible as far south as the Caribbean. It also caused severe interruptions in global telegraph communications, even shocking some telegraph operators and sparking fires when discharges from the lines ignited telegraph paper, according to a NASA description.

1972: Solar flare vs. AT&T



The "seahorse flare" released in August 1972. (Image credit: NASA)

The major solar flare that erupted on Aug. 4, 1972 knocked out long-distance phone communication across some states, including Illinois, according to a NASA account .

"That event, in fact, caused AT&T to redesign its power system for transatlantic cables," NASA wrote in the account.

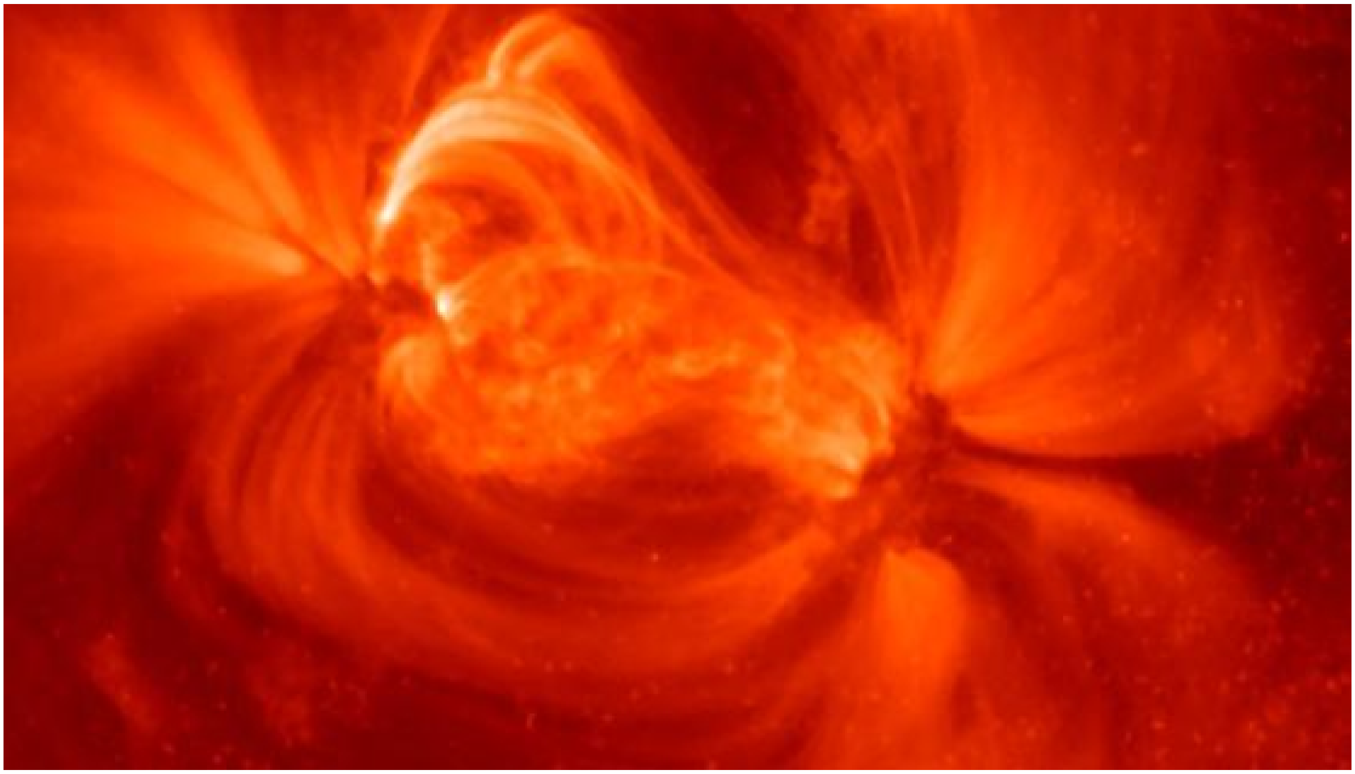
1989: Major power failures from geomagnetic storm

Damage from the March 13, 1989 geomagnetic storm caused by an intense solar flare. (Image credit: NASA/PSE&G)

In March 1989, a powerful solar flare provoked a geomagnetic storm which subsequently set off a major March 13 power blackout in Canada that left six million people without electricity for nine hours.

According to NASA , the flare disrupted electric power transmission from the Hydro Québec generating station and even melted some power transformers in New Jersey. This solar flare was nowhere near the same scale as the Carrington event, NASA scientists said.

2000: The Bastille Day Event



Close-up of the region of the flare captured by NASA's TRACE satellite. (Image credit: NASA/Goddard Space Flight Center Scientific Visualization Studio)

The Bastille Day event takes its name from the French national holiday since it occurred on the same day — July 14, 2000. This was a major solar eruption that registered an X5 on the scale of solar flares .

The Bastille Day event caused some satellites to short-circuit and led to some radio blackouts. It remains one of the most highly observed solar storm events and was the most powerful flare since 1989.

2003: The haunting Halloween storms

An animated gif showing the eruption of an X-class solar flare during the busy "Halloween storms of 2003". (Image credit: NASA Goddard Space Flight Center)

From October through November 2003, the sun unleashed a barrage of powerful solar flares and coronal mass ejections that slammed into Earth's atmosphere.

Dubbed the "Halloween Storms of 2003" by NASA these solar storms caused aircraft to be re-routed, affected satellite systems and caused power outages in Sweden. The Solar and Heliospheric Observatory (SOHO) temporarily failed during the solar onslaught.

On Oct. 28, 2003, the sun unleashed a whopper of a solar flare . The flare was so intense it overwhelmed the spacecraft sensor measuring it. The sensor topped out at X28, already a massive flare), but later analysis found that the flare reached a peak strength of about X45, NASA has said.

The Halloween storms were particularly scary as they occurred during a time in the solar cycle when solar activity should be relatively quiet — about two to three years after the solar maximum. According to NASA, 17 major flares erupted from the sun during this time.

2006: X-Ray sun flare for Xmas

The X9 solar flare was observed by NOAA's GOES-13 satellite. (Image credit: NOAA's Space Weather Prediction Center)

When a major X-class solar flare erupted on the sun on Dec. 5, 2006, it registered a powerful X9 on the space weather scale.

This storm from the sun "disrupted satellite-to-ground communications and Global Positioning System (GPS) navigation signals for about 10 minutes," according to a NASA description .

The sun storm was so powerful it actually damaged the solar X-ray imager instrument on the GOES 13 satellite that snapped its picture, NOAA officials said .

2022: A very expensive storm

A view of SpaceX's first 60 Starlink satellites in orbit, still in stacked configuration, with the Earth as a brilliant blue backdrop on May 23, 2019. (Image credit: SpaceX)

In February 2022, SpaceX witnessed the destructive power of the sun when a geomagnetic storm destroyed up to 40 Starlink satellites worth over $50 million shortly after deployment.

Starlink satellites (and other low-Earth orbit satellites) are particularly vulnerable to geomagnetic storms because they are released into very low-altitude orbits (between 60 and 120 miles (100 to 200 km), and they rely on onboard engines to overcome the force of drag, raising themselves to a final altitude of about 350 miles (550 km).

During a geomagnetic storm, Earth's atmosphere absorbs energy from the storms, heats up and expands upwards, leading to a significantly denser thermosphere that extends from about 50 miles (80 km) to approximately 600 miles (1,000 km) above the Earth's surface. A denser thermosphere means more drag which can be an issue for satellites.

This is what happened in February when the batch of recently released Starlink satellites failed to overcome the increased drag caused by the geomagnetic storm and began to fall back to Earth, eventually burning up in the atmosphere.

Credit: https://www.newsbreak.com/news/2674014319468/the-worst-solar-storms-in-history?noAds=1&_f=app_share&s=a7&share_destination_id=MTY1Njg1Mzc5LTE2NTg0NTAxMTg5Njl=

Getting Started on the Amateur Radio Satellites

by Keith Baker, KB1SF/VA3KSF, kb1sf@amsat.org

(This article was previously published as "Working Your First Amateur Radio Satellite: It's Easier Than You Think" in Monitoring Times, *Brasstown, NC 28902)*

One of the great features of Amateur Radio is that it is really several hobbies rolled into one. If you become bored with one aspect of the hobby, there is always something new and different to try. For the last 40 years or so using the fleet of Amateur Radio satellites to communicate has always been one of the more interesting aspects of Amateur Radio.

However, if you are new to amateur satellites, or the "birds" as we satellite operators often call them, it's important to establish a general understanding about how to find and track these modern day wonders *before* you make your first attempts at using them. My goal in this short series of articles for *The AMSAT Journal* will be to provide you with a general introduction to the basic concepts of tracking, operation and customs currently in use on the satellites and to give you some practical, hands on tips on how, you too, can get started in this wonderful aspect of ham radio. For starters, I'm going to be using one of AMSAT's relatively easier-to-operate (one of or so-called "EZ sats") - AO-51- as an example for you to try out your newfound knowledge.

Indeed, for most of us, the thought of using our own radio equipment to hear or talk through a satellite conjures up a sense of mystery and awe. At the same time, it creates a certain amount of fear ... fear of doing something wrong, or of not ever being successful no matter how hard we try. In years past, when only one or two amateur satellites were in orbit, hams had to really work hard to even hear one of the OSCARs (Orbiting Satellites Carrying Amateur Radio) as they whizzed overhead.

As of this writing, there are some 20 or so active ones up there, and that's not even counting the crew of the International Space Station (ISS) who use the Amateur Radio equipment installed aboard that permanent orbiting laboratory. What's even more exciting is that there are several other Amateur Radio satellites currently on the drawing boards or awaiting launch. So, it's safe to say your chances of at least hearing one of them (or, if you have at least a Technician Class ticket, actually communicating through one with your current equipment) is far better now than at any time in the recent past.

Tracking the Birds

To listen for, or communicate through, an Amateur Radio satellite you first have to find out when it will be within range of your station. Fortunately, most of us now have a computer in our ham shacks and access to the Internet so tracking satellites has become much easier than it used to be.

Today, several satellite-tracking programs are available in shareware or for purchase, as well as in a variety of different computer formats. What's more, a number of Web sites related to amateur satellite operation now have online tracking programs that make rough tracking a snap. But, if you're really serious about satellite tracking, you should also become familiar with how to use sets of orbital data called Keplerian Elements.

Known to veteran satellite operators simply as "Keps", these data are derived from observations of each satellite's orbital motion. (Kepler, you may recall, discovered some interesting things about planetary motion back in the 17th century!)

Today, NORAD, the North American Aerospace Defense Command, keeps track of almost everything in Earth orbit. Periodically, they issue orbital information on non-classified satellites to the National Aeronautics and Space Administration (NASA) for release to the general public. The information is listed by individual catalog number of the satellite and contains numeric data that describes, in a mathematical way, how the satellite is moving around the Earth.

Without getting into the complex details of orbital mechanics (or Kepler's laws!), suffice it to say this data is what your computer software uses to plot the predicted paths of satellites. That is, once you've loaded your location (latitude and longitude), the current time along with the Keplerian element files into your satellite tracking software, the computer then solves the complex orbital math to make a prediction of where a selected satellite should be at the current (or a future) time.

Because they are such a vital ingredient to this part of our hobby (and because they age over time) finding a reliable source for the latest Keplerian Elements for Amateur Radio satellites should be high on your list of things to do as you get started in satellite work. Keps are often listed on many Amateur Radio Internet Web sites. The AMSAT-North America Web site lists the latest Keps in a variety of downloadable formats at: www.

The author uses a Kenwood TH-78A dual-band HT and a lightweight Arrow Antenna to make a contact through AO-51 from the shores of Lake Huron in Michigan. When used with a 5 watt, full-duplex handheld in an open location free of foliage, such as a beach or a field, the antenna provides enough uplink and downlink gain to successfully work the FM birds, even on passes close to the horizon. (KB1OGF Photo) amsat.org/amsat-new/tools. And, as I said, for the so-called "easy FM birds" like AO-51 and the ISS, the AMSAT Web site even sports an embedded online tracking feature which allows you to simply plug in your latitude and longitude (or your Maidenhead Grid Square) to find out when those satellites of interest to you will next be in range of your location.

Beacons

Probably one of the first things you will learn to do after you find out when a particular satellite will be within range of your station is to listen for the satellite's beacon. Most satellite beacons consist of one or more transmissions coming from the satellite that will assist you in your search as well as tell you other things about the satellite's health and the nature of its transponders.

Satellite beacons operate in many modes, from Morse code to a variety of digital formats, and can usually be found on frequencies immediately above and/or below the satellite's other downlink frequencies. In addition, as most satellite beacons transmit with a fixed amount of output power, they can also serve as a superb reference point for setting up and calibrating your station antennas and other equipment.

Most satellite telemetry signals, which consist primarily of transmissions about the health of the satellite, are also sent to ground controllers by way of the beacon. What's more, some satellites even provide information regarding their transponder schedules, along with other items of interest to satellite operators, using their beacons. However, in the case of AO-51 and most of our other FM satellites, the single channel downlink is itself, the beacon.

Dubbed "Echo" before launch, the AO-51 satellite sits in the "Space Head Module," the upper stage of its launch vehicle at the Baikonour Launch Complex in Kazakhstan. (AMSAT Photo)

Transponders

Now that you have a reliable way to know when the satellite is within range of your station and you've familiar with its beacon, you next have to learn how to use its transponder. A transponder is the circuit that receives your uplink signal and then retransmits what it hears via its downlink transmitter, much like an FM repeater does. However, unlike a terrestrial FM repeater, which has a specific input and output frequency in the same band, most amateur satellite transponders receive and then retransmit what they hear on another frequency (or frequencies) on another amateur band entirely. In short, most amateur satellites act much like cross-band repeaters in the sky.

What's more, as a satellite is a moving target, signals being passed through it will exhibit a pronounced Doppler shift, just like the changing pitch of a train whistle as it approaches and then passes. During a satellite contact, as the satellite approaches you, both uplink and downlink frequencies will appear higher than those published. As the satellite passes overhead, both the uplink and downlink frequencies will then appear to slowly drop in frequency than those published. And, as if that weren't confusing enough, this apparent frequency shift will seem to be more pronounced on the higher frequency (shorter wavelength) amateur bands than on the lower ones.

Our example satellite, AO-51, uses what's called a "bent pipe" transponder. That is, whatever form of radio communication is sent up to the satellite on the uplink is simply "sent through the pipe" back down on the downlink. AO-51 sports a variety of transponders, but the one I will be helping you attempt to use is its FM voice transponder.

Operating Modes

One of the terms you will soon come across in satellite work will be a reference to the mode of a satellite's transponder. A satellite's operating mode is nothing more than a shorthand way veteran satellite operators identify the various combinations of uplink and downlink frequencies available for use.

Back in the old days of satellite operating, one or more letters of the alphabet were used to designate satellite transponder modes. For example, if a satellite's uplink frequency was on 2 meters and its downlink frequency

The author's wife, Kate Baker, KB1OGF/VA3OGF, makes a contact through the AO-51 satellite on the shores of Lake Huron in Michigan with her Kenwood TH-78A dual band HT. The extended "rubber duck" (MFJ Model 1717 from MFJ Enterprises) antenna and about 5 watts of uplink power provides just enough gain on the uplink and downlink to briefly work the satellite on near overhead passes.

was on 70 cm, the satellite was said to be operating in "Mode J". An uplink on 70 cm with a downlink on 2 M was called "Mode B", and so on.

Today, because so many satellites with different uplink and downlink transponder combinations are now in orbit, a somewhat more complex system that includes the first letter of the band in use (VHF, UHF, SHF, etc.) has emerged. As a result, the old "Mode B" has now been renamed "Mode U/V" because the satellite's uplink transponder receiver is tuned to UHF and its downlink transmitter is set for the VHF bands. Likewise, the old "Mode J" has now been dubbed "Mode V/U" and so on. For this article, the AO-51 transponder we're interested in is the one for Mode V/U … or the old Mode J … with uplinks in the 2 M band and downlinks in the 70 cm band.

Schedules

Most amateur satellites operate on a published schedule that lists when its various transponders will be switched on and off and at what times. As AO-51 has multiple transponders, it's very important to always check the published schedule for the satellite before you attempt to use it. AO-51's current operating schedule is always available via the AO-51 Control Team page

Some Popular Amateur Radio FM "Easy Sat" Frequencies			
Satellite Name	**Uplink**	**Downlink**	**Remarks**
AO-51 (Echo)	145.920 MHz 145.880 MHz	435.300 MHz 435.150 MHz	Default FM Voice
AO-27 (Eyesat)	145.850 MHz	436.795 MHz	Daytime Passes
SO-50 (SaudiSat 1-C)	145.850 MHz	436.795 MHz	67.0 Hz CTCSS Tone Required for Access

of the AMSAT Web site at: **www.amsat.org/amsat-new/echo/index.php**. Click on the "check the schedule" link and look for the "FM Repeater" frequencies. During a typical month, traffic on the transponders might be FM voice, Slow Scan TV (SSTV), low power (QRP) FM operating and/or the digital modes. By looking at the schedule you'll know when to expect the various modes and at what frequencies they'll be operating. Also, look for other activities on the schedule such as College Satellite Night or when AO-51's control operators reverse the spacecraft attitude to favor the southern hemisphere.

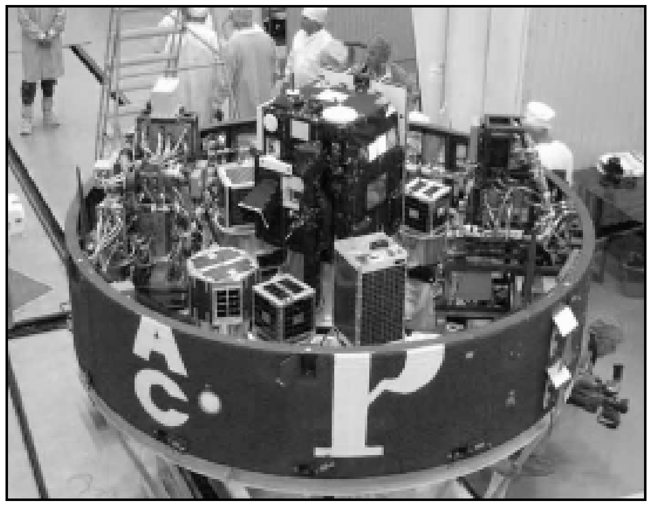
Equipment

Contrary to what you might believe, you *don't* need a super powerful FM transceiver and a huge antenna to work the birds. In fact, I (and many other amateur satellite operators) have sometimes met with success using just a simple dual-band hand-held radio and an antenna with just a bit more gain than the ordinary "rubber duck." However, because the UHF downlink output power on these "EZ sats" is usually pretty weak (often less than 1 watt) you'll have far better success if you can create some signal gain on the downlink.

Chuck Green, N0ADI, prepares AO-51 for launch at the Baikonour Launch Complex in Kazakhstan. (N0ADI Photo)

Several people have "rolled their own" Yagi satellite antennas for AO-51 using nothing more sophisticated than a series of trimmed coat hangers mounted on a block of wood. However, for many years and for most of my own AO-51 contacts, I've been using a commercially made, hand-held antenna from Arrow Antenna of Cheyenne Wyoming, **www.arrowantennas.com**. Their "Arrow II" Satellite antenna (with models starting at about $75) is specifically manufactured for hand-held radio satellite work, is very well constructed (from aluminum arrow shafts, hence the name) and is collapsible for easy portable use.

It is also important to remember that AO-51, like most amateur satellites, operates in what's called *true duplex* or *full duplex* mode, meaning that the uplink receivers and downlink transmitters are both operating at the same time. It is helpful (but not absolutely necessary!) for your ground-based equipment to do so as well. By operating your station (or your hand-held) in full duplex mode, you will get immediate feedback that the satellite hears you because you will actually hear your own uplink signal coming back down to you on the downlink.



Numerous other satellite passengers dwarf AO-51, shown here sitting in its upper stage carrying structure just prior to launch from the Baikonour Launch Complex in Kazakhstan. AO-51 is the small cube-shaped satellite shown in the lower left of the photo between the octagonal-shaped Italian UniSat-3 and the taller SaudiSat 2. (AMSAT Photo)

Unfortunately, fewer and fewer commercially manufactured radios these days have the capability to operate in full duplex mode. As of this writing, a short list of those (mostly older) radios compiled by Andrew, KE5GDB, which do so can be (temporarily) found at **http://bit.ly/bUGJR3**.

However, even if you don't have a full duplex radio, you can still get in on the fun of working these satellites by using two separate radios, or a radio that can transmit on the satellite's uplink and another radio that can receive the downlink. If there is enough gain in your antenna, the latter radio can even be a hand-held or other programmable VHF/UHF scanner of some sort. Many novice satellite ops have also met with some success on AO-51 by simply waiting for a break in the action to transmit "in the blind" on the uplink and then listening for someone answering them on the downlink.

Setting Up Your Radio

Now that you have found out what time of day AO-51 will be in range of your location and you have assembled the equipment and antennas to do so, you are *almost* ready to make your first contact. But, first, you'll need to program your radios so as to take into account the Doppler shift that we discussed earlier. If your radio has programmable memories, it's a good idea to program one or two additional frequencies into the memory bank above and below the published uplink and downlink frequencies. These can be used as the satellite first moves toward you and then away from you as it passes overhead.

For example, if the operating downlink frequency for AO-51 is listed in the satellite's operating schedule on the AMSAT Web site as 435.300 MHz, you should program memories into your radio for 435.320 and 435.310 on the high side and 435.290 and 435.280 MHz on the low side of the published downlink frequency. Likewise, if the uplink frequency is listed as 145.920 MHz, you should program memories for 145.925 and 145.930 MHz on the high side and 145.915 and 145.910 on the low side of the published uplink frequency.

Also, like many of today's terrestrial repeaters, a number of our FM satellites require a CTCSS tone for access be sent on the uplink, so be sure and determine if the satellite you want to use requires one and set your radio accordingly. As of this writing, AO-51 required a 67 Hz CTCSS tone for access.

For a whole lot of reasons that are well beyond the scope of this article, the Doppler shift is more pronounced as the operating frequency increases. This means the Doppler shift will appear more pronounced on AO-51's downlink frequency than on its 2 M uplink. I've most often found that simply switching between my programmed 435 MHz downlink frequencies as the satellite passes overhead is usually enough to keep the satellite's downlink on frequency in my radio during the time that it is in range.

Power: How Much is Enough?

The issue of power is a relative one. It depends on the number of other people using the transponder; how much uplink gain you have in your antenna system, and how close or far away (overhead *vs.* at the horizon) the satellite is compared to your location. Usually, a 5-watt HT and the antennas shown in some of the pictures in this article are sufficient to work AO-51 on non-contentious days.

I say "non-contentious" because it is important to remember that the satellite is much like a terrestrial repeater mounted on a 500-mile high tower. With only one channel, it can get very busy, particularly on weekends. On some days, my 5-watt, dual band HT and an extended rubber duck antenna are sufficient for a quick contact on a near-overhead pass. On the other hand, during some busy weekend satellite passes, even my external Yagi and 50 watts of power isn't enough to overcome the high-powered uplinks of some inconsiderate operators.

Working in the Footprint

While it is technically possible to work these satellites at the horizon, you'll need something more than 5 watts from an HT and a hand-held antenna to do so. It is important to remember that the footprint of the satellite, which is the area on the Earth where two people can see these Low Earth Orbiting (LEO) satellites and work each other through them, is about the size of North America.

Some hams on the U.S. East coast have, for example, used AO-51 to make contacts into Western Europe (and from the U.S. West coast to Hawaii). But that happens *only* when one person is on the extreme edge of the footprint and their counterpart is on the other edge. [And those contacts don't last long because the mutual footprint coverage moves away very quickly! – Ed.]

Polar orbit satellites such as AO-51 will typically give you three chances to work them, twice a day. Pass duration … the time during which you'll be in the footprint … can range from 7-15 minutes depending on whether you are in the full footprint or just part of it during the pass.

It's interesting to note that on many passes the footprint will cover the entire Atlantic Ocean. I know of several hams who have taken their Arrow, Elk or home-brew hand-held Yagi antennas and HTs along on cruise ships and made contacts from the outside deck of their ship ... after, of course, obtaining the appropriate permission from the captain of the vessel!

Putting it All Together

Now is a good time to visit the AMSAT Web site (if you haven't already) and download a set of current online pass predictions for AO-51 from **www.amsat.org/amsat-new/tools/predict**. Select the satellite for the prediction (AO-51) and then enter either your Maidenhead Grid Square or your latitude and longitude into the online prediction tool. Then, click on "predict" icon and, presto! A list of satellite pass dates and times (in UTC) and directions (in degrees) will pop up. You can also click the view the current location of AO-51 link for a snazzy map-based view of AO-51's next few orbits.

In the table, the acronym AOS stands for Acquisition of Signal which is the time when the satellite will first come over your horizon. The acronym LOS stands for Loss of Signal which is when the satellite will fall back below the horizon at your location. Both azimuth and elevation headings are expressed in the degrees of a 360-degree compass from your location.

You will also note that AO-51's satellite passes at your location follow a repeating

The AO-51 satellite launches on a converted Russian ICBM rocket on 29 June, 2004 from the Baikonour Launch Complex in Kazakhstan. (AMSAT Photo)

pattern. As the satellite is in a near polar orbit (which means it orbits over the Earth's north and south poles) this means the satellite will be in view of every spot on the planet several times each day as the Earth (and you!) slowly rotate underneath. For AO-51, and most other polar orbiting satellites, you'll usually observe a string of three passes … one moving from north to south (or south to north) off to the east, one nearly overhead, and then one off to the west, with each pass spaced about 90 minutes apart. A similar string of passes will repeat some 12 hours later in the opposite north/south direction.

When you are first starting out, it's probably also best to pick a satellite pass that will put the satellite close to being nearly overhead (90 degrees) of your location. So, look for those pass elevations in the table that are well above 45 or 50 degrees. These will be your targets of best opportunity.

What to Listen For

Now, it's time to actually listen for the satellite. At the appointed AOS time, step outside, turn your radio(s) on and set it (or them) for one of the frequencies on the upper side of what's published for both the uplink and downlink. Then, wait for the satellite to pop above your horizon. If you are using a Yagi antenna of some sort, aim it at the horizon in the direction of the AOS prediction and start sweeping the antenna back and forth horizontally. Be sure to turn the radio's squelch on the downlink frequency off and (carefully!) listen for the radio to quiet. Once it does … congratulations … you'll be listening to AO-51 in orbit some 500 miles above Earth!

You may want to practice tracking the satellite with your antenna and simply listening for the rest of that satellite pass (or a few more) to get a better idea of how the conversations flow on the bird. It is important to remember that, not only is the satellite rapidly moving toward and away from you, which is causing the observed Doppler shift in frequency, the satellite is *also* slowly tumbling in orbit. So, at multiple times during each pass, its transmit and receive antennas will be cross-polarized with yours, which, in turn, will create a significant loss in signal strength. If the satellite signal fades (or the down link gets garbled) try switching downlink frequencies on your radio up or down. Twisting or moving your antenna around to better match the satellite's changing antenna polarization with yours should also help.

During the pass, you'll probably hear one or more hams simply saying hello or exchanging their Maidenhead Grid Square numbers. Indeed, most conversations on AO-51 are usually very brief "hello – and – goodbye" exchanges similar to an HF DX exchange so as to give the many others listening in, a chance to work the bird. As you might guess, long-winded rag chews are *not* welcome on the FM birds.

It's Showtime!

When you've gathered up enough courage to actually try your hand at making a contact (and if you are using the same radio in full duplex mode on the uplink and downlink) you also need to make sure you are using a speaker separated from your microphone. This can be an earpiece or an external speaker of some kind. In full duplex mode, using a microphone and a speaker located right next to each other (such as on a handheld) will cause howls of feedback … through the satellite! Needless to say, such activity will *also* not make you a popular camper on the bird, either!

However, once you are ready to try your luck at actually making a contact, simply wait for a pause in the action and then (quickly!) drop your call sign in between contacts. Hopefully, you will immediately hear your own signal on the downlink, a discovery that will provide immediate confirmation that you are, indeed, getting in. But, please refrain from calling CQ because, just like causing long distance feedback and rag chewing, calling CQ on the FM birds is considered another amateur satellite protocol no-no.

But, regardless of how, where and when you do it, the first time you hear your own voice coming back down from a satellite (or someone answers your call), the thrill will be much like your very first ham radio contact, shaking hands, sweaty palms and all! It was for me.

See you on the birds!

About the Author

First licensed in 1976, Keith Baker, KB1SF/VA3KSF, holds an Extra Class license in the USA and an Advanced Class license in Canada. He is a Past President and the current Treasurer of AMSAT-North America and also served as AMSAT Executive Vice President from 1994 to 1998. Keith was also a member of the AMSAT Board of Directors from 1994 to 2003. Besides *The AMSAT Journal*, his amateur satellite-related articles and photos have appeared in *The ARRL Handbook, The ARRL Satellite Anthology, QST Magazine, CQ Magazine, CQ VHF, CQ Ham Radio (Japan), and OSCAR News (UK)*. Keith was the author of *How to Use the Amateur Radio Satellites*, a work that was published in several editions by AMSAT-North America throughout the 1990s. He later donated that work to several other AMSAT organizations around the world where it was eventually translated into five different languages. Currently, Keith writes the quarterly "Sky Surfing" column about amateur satellites for *Monitoring Times* magazine. Some of his other more recent creative projects include writing portions of the AMSAT-NA publication "*AMSAT: The First Forty Years,*" as well as serving as an editor for the ARRL's new *Satellite Handbook*. Keith currently makes his home in the small town of Corunna, Ontario, Canada with his wife, Kate (KB1OGF/VA3OGF) and daughter Emily.

Getting the Right Antenna

As with any radio installation, the more money you put into it, the more versatile it will be. Still, you don't have to break the bank to get started. Here are some antenna tips to help give you a better chance for working AMSAT's so-called "EZ sats" with success.

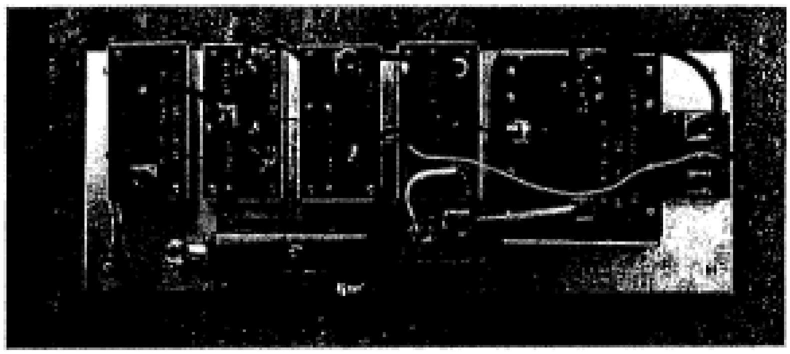
The output power of these satellites is usually little more than a watt. Most often, the satellite's handlers will have the bird's downlink transmitters powered back into the 500 milliwatt range to help extend the life of the satellite's batteries. This means that any antenna you can muster on the ground to listen to the UHF downlinks from these satellites will help.

On the other hand, a somewhat more useful arrangement consists of a higher gain, externally mounted VHF/UHF vertical antenna such as that used for Amateur Radio repeater operation. This antenna installation will usually provide a bit more success if you want to hear satellite passes, for example, near the horizon.

Another very reliable antenna arrangement that many FM satellite enthusiasts have used consists of an externally mounted, dual-band, rotatable VHF/UHF, three or four element Yagi beam antenna set up for terrestrial operation. This approach allows users to aim their beam antenna at the horizon and work through the satellite as it rises. Then, as the satellite passes overhead, they swing their beam antenna around in the opposite direction and catch the satellite as it sets. Such an arrangement is useful for contacts on satellite passes up to about 45 degrees in elevation.

Now, of course, the ultimate satellite antenna for full pass coverage is a high gain, three or four-element set of VHF/UHF Yagi beam antennas mounted on an altitude/azimuth rotator. But, you don't need that just to work the "EZ sats."

(Left) Until its successful launch, AO-51 was called "Echo" as it was the fifth satellite built entirely by AMSAT-North America. The AO-51 moniker (which denotes it as the 51st AMSAT OSCAR satellite successfully launched) was awarded once the satellite achieved orbit and transmitted from space. (AMSAT Photo)



easy-to-build ssb transceiver for 1296 MHz

Complete description of a simple sideband system for the amateur 23-cm band — the same technique can be used for the other uhf bands

H. Paul Shuch, WA6UAM, 14908 Sandy Lane, San Jose, California 95124

The simple microwave ssb system presented here was used to achieve Northern California's first recent two-way ssb communications on 1296 MHz, between WA6UAM and K6UQH, on April 14, 1974.* Aside from any precedent which may have been established, the method used to transmit and receive microwave ssb represents a significant breakthrough in that it is simple, straightforward, inexpensive and readily reproducible by any uhf enthusiast. Neither specialized tools nor elaborate test equipment is required to build this equipment — equipment that provides the capability for line-of-sight ssb contacts on the amateur 23-cm band.

Fig. 1 shows the scheme generally used for the transmission and reception of uhf ssb signals. The received signals are down-converted in the conventional manner into the high-frequency spectrum where they are detected by the station receiver. Similarly, a high-frequency signal generated by the station exciter is heterodyned up to uhf, then amplified and transmitted. Note the high degree of redundancy present in this system. Both the transmit and receive converters use a mixer and local-oscillator chain, the function of each being essentially identical to its counterpart.

Assuming the availability of a bilatera

*Some years ago, K6HCP and W6GDO rar successful 1296-MHz ssb schedules, each using a 2C39 as a simultaneous mixer and LO doubler The resulting ssb output was easily copyable, if not exactly spectrally pure. Bandpass filters were used to attenuate the undesired products at the antenna. The equipment currently used by WA6UAM and K6UQH, described in this article, uses diode balanced mixers with injection at the ultimate LO frequency. This method of heterodyning produces clean 1296-MHz ssb without excessive intermodulation products
Editor

mixer (one which operates equally well in both the *forward* and *backward* directions), the system can be simplified as indicated in **fig. 2.** Obviously, a passive mixer must be used in this application. Any active device designed to provide conversion gain in, say, the *up* direction, cannot function as a *down* mixer as well. Fortunately, singly- and doubly-balanced diode mixers function effectively in either direction, with only a few dB of conversion loss.

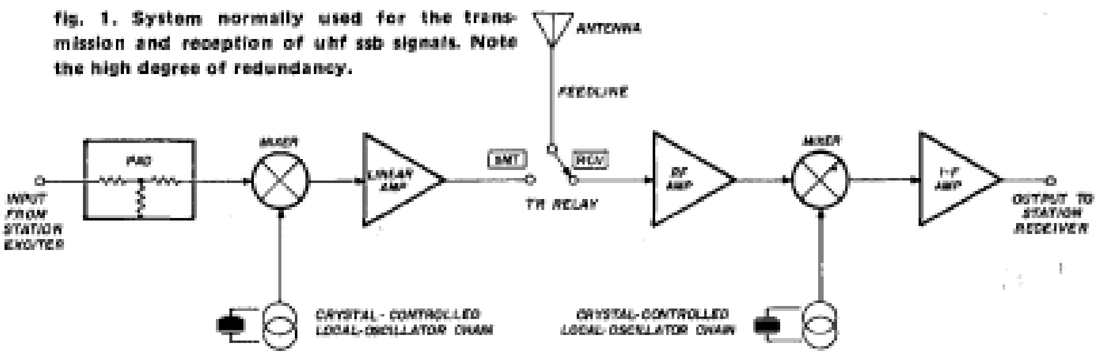
The greatest drawback of the diode mixer, so far as transmit conversion is concerned, is its limited power-handling capability: This normally requires the use of numerous stages of linear amplification *after* the transmit conversion.

It is evident from fig. 2 that by eliminating redundant circuitry, the TR switching complexity has increased threefold. Assuming that means could be found for eliminating the requirements for separate receive and transmit amplification, TR relays K1 and K2 could then be eliminated, too. Of course, such drastic simplification would jeopardize both the receive sensitivity and transmit power. However, depending upon the application, these tradeoffs might well be justified. Such was the case with the 1296-MHz station at WA6UAM.

The details for the Simple 1296-MHz Sideband System are shown in **fig. 3.** Equal emphasis was placed on simplifying the system to its minimum required content, and optimizing each subassembly to provide reliable communications over a reasonable range. Free-space loss and receiver noise calculations indicate that ssb communications between two such stations would be practical to distances of at least 100 miles (160 km).

Note the total elimination of TR relays and feedlines (and their resultant losses) in the microwave portion of this system. This is accomplished by mounting the mixer, filter and LO chain directly at the antenna (readily accomplished, as these modules are both lightweight and relatively small), and pumping only 28-MHz energy (plus 12 Vdc for the local oscillator) up and down the tower. The rf modules and antenna might even be

fig. 1. System normally used for the transmission and reception of uhf ssb signals. Note the high degree of redundancy.



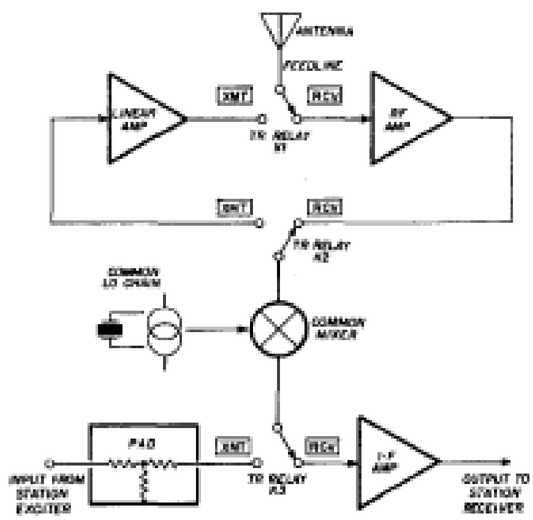


fig. 2. This uhf ssb system, which uses a common local-oscillator chain and balanced diode mixer, minimizes circuit redundancy but requires three TR relays.

combined into a single physical unit, as shown in fig. 4.

mixer

So far as design tradeoffs are concerned, the mixer is, by far, the most critical component of the Simple Sideband System. To obtain a reasonable receive noise figure, low conversion loss is of paramount importance. At the same time usable transmit rf levels dictate high power-handling capabilities. As will be shown in a minute, these two criteria tend to be mutually exclusive. With readily available Schottky-barrier (hot-carrier) diodes in a balanced mixer, the system seems to optimize at about 6-dB conversion loss, with 3 mW of usable output power. Don't scoff at these seemingly restrictive figures. Calculations (see page 21) will show that this type of performance is more than satisfactory for communications to the edge of the visual horizon, and perhaps beyond.

Several reproducible uhf balanced mixers have been published recently.[1,2,3,4] The balanced mixer presented here is based upon a design developed by W6FZJ, and currently used by him on 2304 MHz. Versions for 1296 MHz have been built by both WA6UAM and WB6JNN, and provide a considerable improvement over the single-diode trough-line or interdigital designs frequently used by amateurs in uhf transmitting and receiving converters. An improved version of the W6FZJ mixer, which uses a commercially available balun to match the rf port of the mixer to the 50-ohm transmission line, will also be described.

Whatever mixer design is chosen, the diodes you select will determine its conversion loss and power-handling capability. One high-power, low-cost device is the Hewlett-Packard 5082-2817.*

*Hewlett-Packard 5082-2817 hot-carrier diodes are available in small quantities for $1.50 each from any Hewlett-Packard sales office. Matched pairs (5082-2818, $3.25), and matched quads (5082-2819, $7.00) are also available. If you can't find a Hewlett-Packard sales office in the *Yellow Pages*, write to Hewlett-Packard, 1101 Embarcadero Road, Palo Alto, California 94303.

These diodes have a burnout rating of 4.5-watts peak, or 1-watt CW, and are capable of conversion efficiencies of better than −5 dB.

practical mixer circuit

The complete 1296-MHz mixer shown in fig. 5 uses hybrid construction (discrete components on etched microstripline), making duplication relatively straightforward for anyone with access to PC board fabrication facilities. Given sufficient time and patience, you can even "etch" your substrate with an Exacto knife and straightedge. At least four such manual efforts have been completed to date, and performance is equal in all respects to photochemically produced versions.

The equivalent circuit shown in fig. 6 will help to clarify the operation of the mixer. Rf energy injected into the delta (Δ) port is transformed by the balun so that there is a 180° phase difference between the signals applied to the two diodes. The diodes are effectively in series and of like polarity so that the applied rf simultaneously biases both diodes on and then off, for alternate half-cycles.

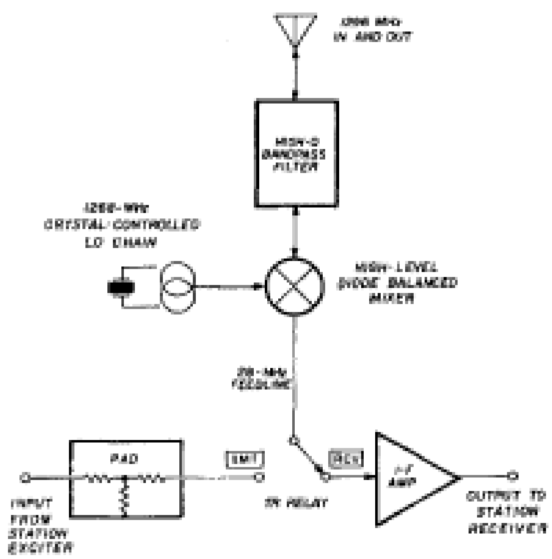


fig. 3. The Simple Sideband System, shown here, has been reduced to its ultimate simplicity but can still provide beyond-the-horizon communications when used with a high-gain antenna.

Rf energy applied to the sigma (Σ) input is transmitted down a quarter-wavelength, two-way power divider (which looks like a tuning fork) so that the signals it applies to the two diodes appear in phase. Since the diodes are in reverse polarity with respect to their bias return (common junction), this rf is applied to the two diodes out of phase. The simultaneous application of in- and out-of-phase rf signals to the diode pair results in a signal at their junction composed of the rf applied to the sigma (Σ) port, chopped at the rate of the rf applied to the delta (Δ) port. This complex repeating waveform can be shown by Fourier analysis to contain components of the sigma frequency, the delta frequency, their sum and their difference. Mixing, by the traditional definition, has occurred. The circuitry shown to the right of the diodes in **fig. 6** serves the purposes of signal conditioning (filtering out all but the difference-frequency component), dc bias return and a means of measuring diode bias current.

The most significant advantage of the balanced mixer over a single-ended design is that rf injected into the delta port is isolated from the sigma port, and vice-versa. To see how this is accomplished, consider a balanced signal applied to the two diodes through the delta port. In addition to feeding the diodes, this signal is shunted by the sigma port's power divider. Note that the power divider appears to this signal as a balanced transmission line shorted at the load end. Since this transmission line is a quarter-wavelength long at the delta frequency (assuming the delta and sigma signals are close in frequency), it transforms the short to an open, and the sigma port is effectively nonexistent so far as the delta signal is concerned.

Conversely, rf injected into the sigma port divides down the power divider, and appears to the diodes as two signals, equal in amplitude and phase. Looking toward delta, these two signals are cancelled in the balun and, thus, never reach the delta port.

It should be noted that single-balanced mixers provide no isolation whatever between the i-f port and either the delta or sigma port. Hence, filtering is required to remove the higher-frequency components from the i-f. Such filtering is accomplished in the hybrid balanced mixer by virtue of stubs at the i-f side of each diode, a quarter-wavelength long at 1296 MHz and open at the far end. These

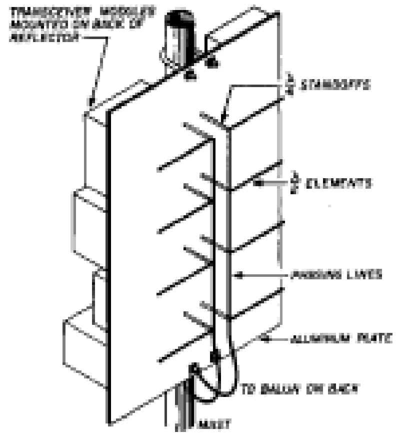
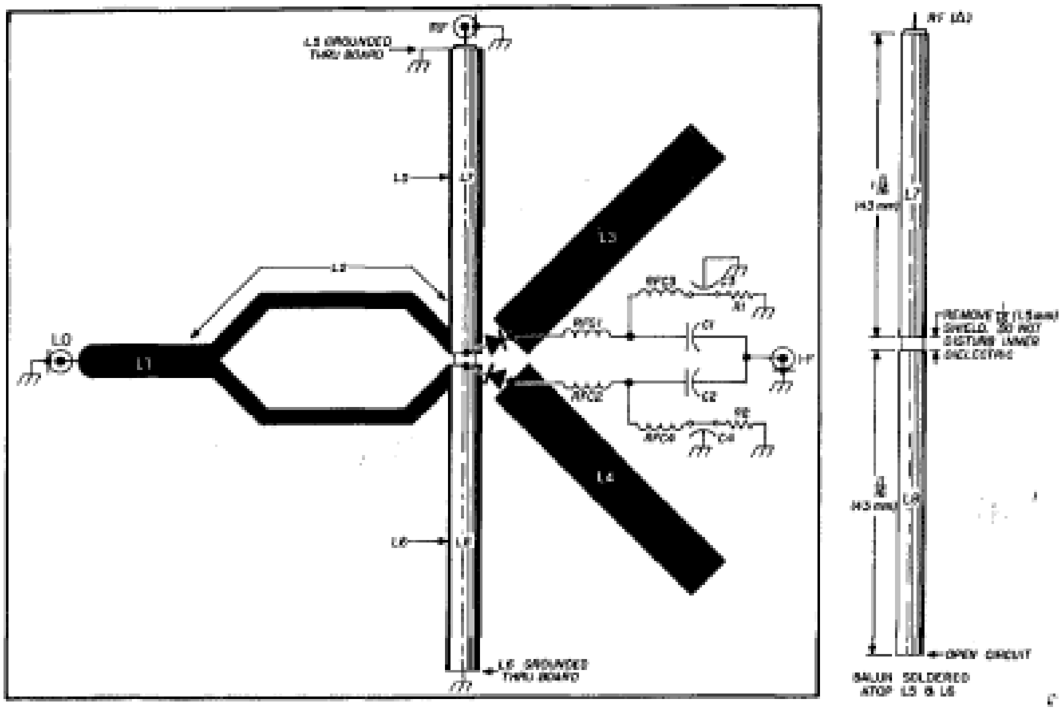


fig. 4. Antenna-mounted transceive converter. With this arrangement, using the system of fig. 3, only 28-MHz energy must be run down the tower to the operating room.

quarter-wavelength sections ground out the i-f port to energy near 1296 MHz.

Derivation of the balun used in the hybrid balanced mixer is shown in **fig. 7. Fig. 7A** is a coaxial balun frequently used in antenna work. In **fig. 7B**, the same balun is straightened out to improve symmetry. Note that a common ground is still required between the far end of the stub and a point one quarter-wavelength back on the feedline. This ground is frequently accomplished by connecting to the walls of the half-wave-long box in which the balun is built. In the case of the hybrid balanced mixer, the return is to a ground plane, on the opposite side of a substrate to which the balun is attached.

Both bandwidth and balance may be improved by modifying the in-line balun



C1,C2	0.01 μF disc ceramic	L5,L6	50-ohm micro-stripline, 0.168" (4.5 mm) wide, 1-19/32" (40.5 mm) long
C3,C4	1000-pF feedthrough	L7,L8	50-ohm UT-141 coaxitube, 0.141" (3.5 mm) diameter, 1-11/16" (43 mm) long
CR1,CR2	hot-carrier diodes (H-P 5082-2818)	R1,R2	10-ohm, ¼-watt carbon composition resistors
L1	50-ohm micro-stripline, 0.168" (4.5 mm) wide, any length	RFC1,RFC2	2" (51 mm) no. 32 wire, close wound on 0.050" (1.5 mm) diameter form or ferrite beads on leads of C1 and C2
L2	75-ohm micro-stripline, 0.080" (2.0 mm) wide, 1-7/16" (36.5 mm) long, (along center)	RFC3,RFC4	22μH
L3,L4	38-ohm micro-stripline, 0.25" (6.5 mm) wide, 1-7/16" (36.5 mm) long		

fig. 5. This high-performance 1296-MHz balanced mixer uses etched 1/16" (1.5 mm) thick Teflon-fiberglass printed-circuit board and a coaxial balun. Full-size printed-circuit layout is shown in fig. 8. An equivalent circuit of this mixer, illustrating circuit operation, is given in fig. 6.

of fig. 7B as shown in fig. 7C. In this version the stub is a piece of coax identical to the original feedline. The center connector of the feeder is now connected to the center conductor, rather than to the shield of the stub. At the far end of the stub the center conductor is open. A quarter-wavelength toward the source (at the junction of the feeder and the stub) this open is transformed to a short, and rf sees the center conductor of the stub as being continuous with the shield. Therefore, the circuit at fig. 7C is electrically identical to that of fig. 7B, but with improved physical symmetry. Balanced output is taken from the same point as before.

Note that at the far end of the stub the center conductor must be open, and the shield grounded. Again the balun may be constructed upon a substrate, with return through it to a groundplane.

The balun used in the 1296-MHz mixer is made from a single piece of UT-141 type semirigid coax (50-ohms, Teflon dielectric, 0.141-inch [3.5-mm]

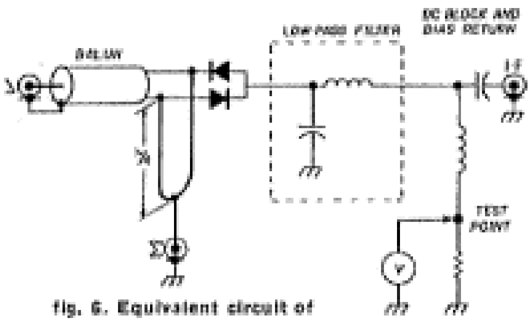


fig. 6. Equivalent circuit of the balanced mixer shown in fig. 5.

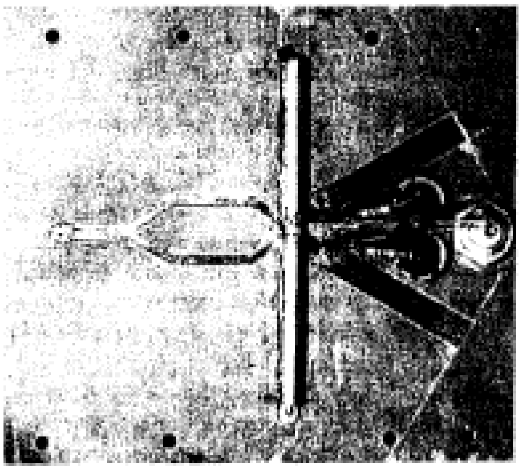
OD). Correcting for velocity factor, the quarter-wavelength sections are each 1-11/16-inches (43-mm) long. Judicious use of an Exacto knife and small tubing cutter will aid in the removal of 1/16-inch (1.5-mm) of the outer conductor at the junction of the feeder and the stub. Since no physical connection must be made to the center conductor at this junction, the Teflon dielectric should not be disturbed. Allow a short length of center conductor to extend beyond the quarter-wavelength section comprising the feeder coax. This will be attached to the center pin of the delta port's coax connector.

The mixer's substrate is etched on one side of a 1/16-inch (1.5-mm) thick, double-sided, 1 ounce, copper-clad, Teflon-fiberglass PC board. *Do not* use fiberglass-epoxy board, as its dielectric constant is not correct for the dimensions provided in fig. 5. The use of Teflon PC board is necessary in this design so that the velocity of propagation (and hence the electrical wavelength) of the striplines will approximate that of the coax balun. The full-sized PC layout is shown in fig. 8. All micro-striplines must be opposite a groundplane (the other unetched side of the double-sided board).

Although Teflon PC board makes an excellent substrate for micro-striplines at 1.3 GHz, it is quite expensive (and in some areas, totally unobtainable). The use of fiberglass-epoxy board, though it would increase losses slightly, would bring this type of equipment within reach of many experimenters who might otherwise be deterred. Of course, a glass-epoxy substrate is incompatible with the UT-141 coax balun because of the widely different velocities of propagation of the two mediums. In order to develop a 1296-MHz balanced mixer on glass-epoxy board, a different method of unbalanced-to balanced transformation is required.

Anzac Electronics manufactures an appropriate balun of moderate cost, excellent electrical performance and small physical size which frees the mixer design from restrictions as to substrate material.* Mixers built on 1/16-inch (1.5-mm) G-10 double-clad PC board using the Anzac balun exhibited improved matching at the rf port, an effect which more than offsets any additional losses in the glass-epoxy dielectric.

A schematic of the improved 1.3-GHz balanced mixer using the commercial balun is shown in fig. 9. Note that pins 1, 3 and 5 of the balun must be grounded *through* the substrate to the groundplane. When mounting the balun, do not allow its case to short out the striplines of L2.



Construction of the doubly-balanced mixer of fig. 5, showing installation of the coaxial balun. Capacitors C1 and C2 can be seen between the two feedthrough capacitors.

*Anzac model TP-101, 500 kHz to 1.5 GHz, 50-ohms balanced to 50-ohms unbalanced transformer with midband insertion loss of 0.4 dB maximum and vswr 1.6:1 maximum, $15.50 in single quantities from Anzac Electronics, 39 Green Street, Waltham, Massachusetts 02154.

Full-size artwork for a mixer board on 1/16-inch (1.5-mm) G-10 PC board (ϵ = 4.8) is provided in fig. 10. Either of these two balanced-mixer designs (fig. 5 or fig. 9) will provide satisfactory performance in the Simple Sideband System for 1296 MHz.

output power - noise figure tradeoff

To avoid excessive intermodulation distortion in the transmit mode, it is desirable to inject into the i-f port a signal level at or below the mixer's 1-dB compression point. This is the level beyond which incremental increases in input power result in an ever-diminishing increase in output power. Such a situation typically occurs with i-f injection 5-dB below the local-oscillator signal level.

Due to the ready availability of any desired signal level at 28 MHz, the i-f injection level is not considered a limiting factor in system design. The following discussion assumes the use of the optimum i-f injection level in the transmit mode; that is, 5-dB below whatever LO insertion is applied.

In the transmit mode the usable output power is equal to the i-f injection level minus the mixer's conversion loss, L_c. For operation at the 1-dB compression point, this relationship can be expressed as

$$P_{out} = P_{LO(dBm)} - 5\ dB - L_c$$

This formula implies that the system power output continues to improve for increases in LO injection. This would be true were it not for the fact that conversion loss does not remain constant for all levels of LO injection. Fig. 11 demonstrates the variation in conversion loss, as well as optimum power output, as a function of LO injection level for a typical microwave diode balanced mixer. Note that optimum conversion loss occurs at an LO injection level of around +8 dBm.

Beyond this point, though conversion efficiency degrades, output power continues to increase. Indeed, within the power restriction of the HP 5082-2817 diodes, it is possible to obtain about 16 mW of clean output power. However, recall that the Simple Sideband System uses the same mixer and local-oscillator chain for both transmit and receive. Any

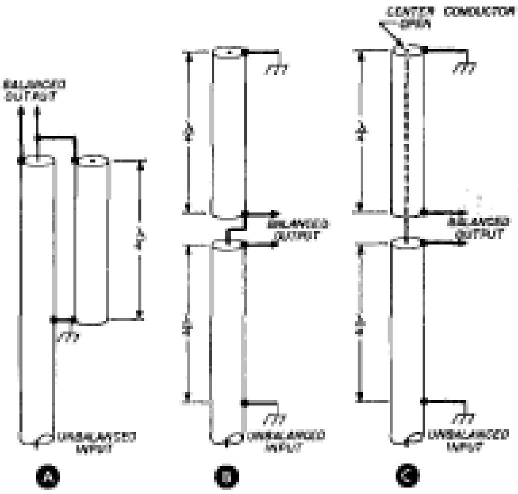


fig. 7. Derivation of the coaxial balun used in the balanced mixer of fig. 5. Conventional balun in (A) has been straightened out in (B) to improve symmetry. Balun in (C) is identical, electrically, to the circuit in (B) but symmetry has been further improved.

decrease in mixer conversion efficiency will degrade receive noise figure accordingly. Beyond +10 dBm of LO injection, transmitter power is gained only at the expense of receiver noise figure.

The break-even point occurs at an LO power of +16 dBm. Beyond this level, each dB of increase in transmitter output results in one dB of receiver degradation. Thus, the Simple Sideband System optimizes at 6-dB conversion loss, 40-mW of LO injection, 12.6-mW of i-f drive and 3-mW of output power. The tradeoff involved in determining this optimum performance point is illustrated by the $P_{out} + L_c$ curve of fig. 11. The sum of conversion loss and output power is used as a figure of merit for communications between two identical systems. This sum represents the output power available at the i-f port of a receive mixer which is driven by an identical transmit mixer operating at the 1-dB compression point. Note that as local-oscillator power is increased, a knee is reached beyond which additional power will serve no

passband. The actual transmitter output power, after the filter, will thus be

+7.8dBm − 3.0dB − 0.5dB = 4.3dBm = 2.7 mW

Note that the filter will also eliminate receiver image noise, as well as blocking those out-of-band signals which might

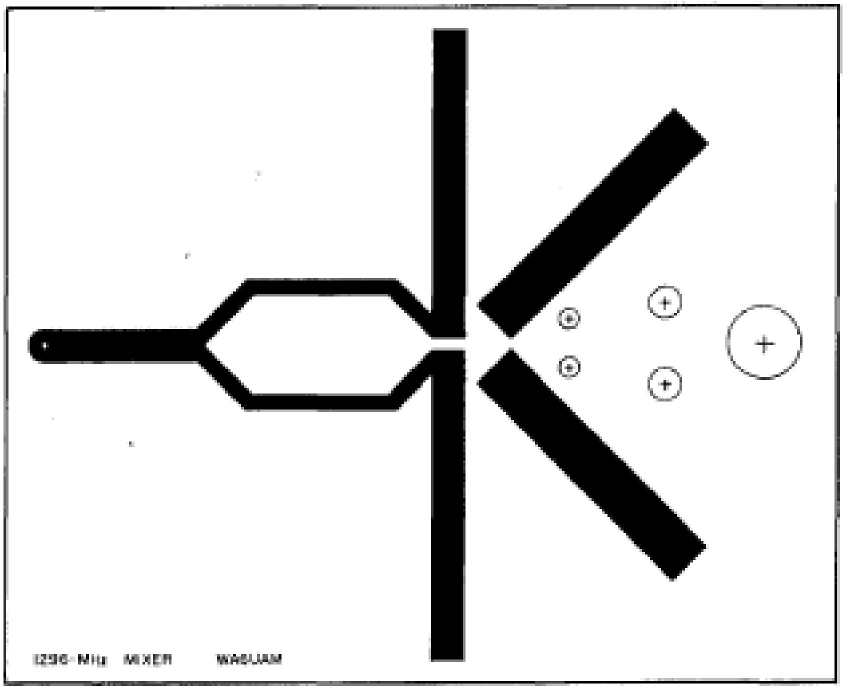


fig. 8. Full-size printed-circuit layout for the balanced mixer of fig. 5. Material is 1/16" (1.5 mm) thick, double-sided Teflon-fiberglass circuit board.

useful purpose. Thus it is desirable to operate the system at the knee of this curve, which I call the *transceive figure of merit* curve.

bandpass filter

With 40 mW of LO injection in the transmit mode, and using the balanced mixer described above, a mixer output power of 6 mW is indicated on a power meter. It must be remembered that this signal represents both the desired output signal (LO + i-f) and the image (LO − i-f). A bandpass filter with sufficient skirt selectivity to reject the image will also have about 0.5-dB insertion loss in the

otherwise enter the mixer and cause cross-modulation distortion and interference. Of course, filter insertion loss must be added to mixer conversion loss and i-f noise figure when determining receive converter performance.

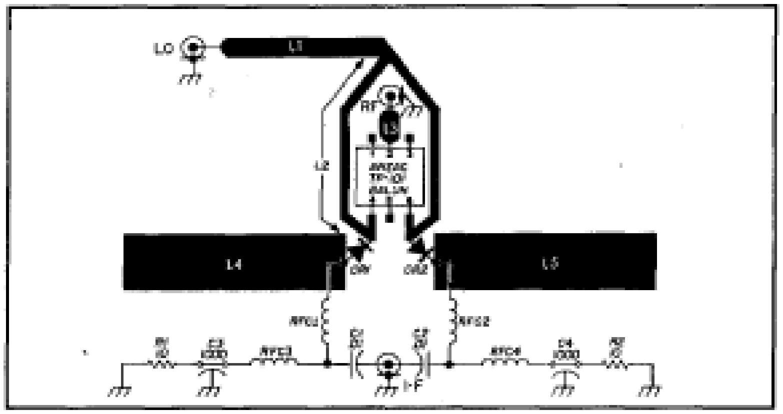
Physically, the bandpass filter can be a half- or quarter-wavelength coaxial resonator, or a trough-line cavity such as has been used in previous 1296-MHz receiving converters. Coupling in and out can be accomplished by means of links, loops, taps, capacitors or even the coaxial matching scheme used by K6UQH in his latest converters.[5] In the interest of avoiding multiple responses, a similar filter at the output of the LO chain may prove desirable.

local-oscillator chain

The key criteria here are stability and spectral purity. For maximum stability it is advisable to invest in the best possible low-temperature coefficient crystal you can afford.* An additional ten dollars invested in a quality crystal can do much to alleviate slight frequency drift which (when multiplied into the microwave region) can make ssb transmission and reception a running battle between your right hand and the tuning dial. The oscillator circuit should be designed to provide minimum crystal feedback consistent with ready starting, and should of course be buffered.

Spectral considerations dictate very careful selection of the multiplication scheme used to reach the desired injection frequency. High-order multiplication in a single stage is out, as the resultant harmonic comb requires extensive filtering. W6FZJ, whose success on both 432-MHz EME and 2304-MHz troposcatter speaks well for his expertise in such matters, recommends doubling in every stage of any LO multiplier. If the starting frequency (the crystal-oscillator stage) is in the 70- to 125-MHz region, any spurious responses present after repeated doubling will be sufficiently separated in frequency to be easily filtered.

The balanced mixer used at WA6UAM receives 40-mW of LO injection. Obtaining this power level at 1200 MHz is relatively simple with today's low-cost



C1,C2	0.01 μF disc ceramic	L4,L5	25-ohm micro-stripline, 0.30" (7.5 mm) wide, 1.14" (29 mm) long
C3,C4	1000-pF feedthrough	R1,R2	10-ohm, ¼-watt carbon composition resistor
CR1, CR2	hot-carrier diodes (H-P 5082-2818)	RFC1, RFC2	2" (51 mm) no. 32 wire, close wound on 0.050" (1.5 mm) form or ferrite beads on leads of C1 and C2
L1,L3	50-ohm micro-stripline, 0.10" (2.5 mm) wide, any length	RFC3, RFC4	22 μH
L2	75-ohm micro-stripline, 0.045" (1.0 mm) wide, 1.24" (31.5 mm) long (along center)		

fig. 9. Improved 1296-MHz balanced mixer uses commercial balun and double-clad epoxy circuit board. Full-size printed-circuit layout is provided in fig. 10.

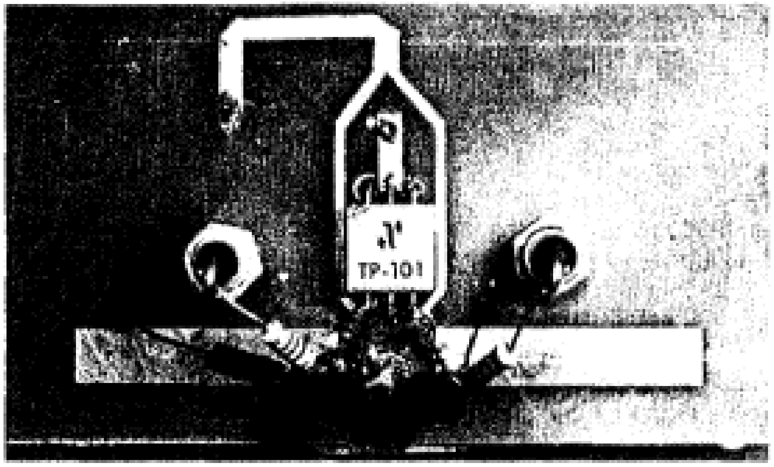
*The Croven C180DBX-00 5th-overtone crystal is highly recommended. This series-resonant, HC-18/U crystal has a calibration tolerance of ±10 ppm and temperature tolerance of ±5 ppm from 15° to 35° C. $12.00 in single quantities, or $8.00 each for two or more crystals of the same frequency. Write to Croven Ltd., 500 Beech Street, Whitby, Ontario, Canada.

uhf transistors. Stability will be enhanced by designing the second stage of the LO chain (buffer) for 100-mW output, and running succeeding doublers at or close to unity gain. Resistive 3-dB pads between stages will alleviate excessive drive and provide impedance matching.

When designing active frequency doublers, recall that second-harmonic generation is enhanced by a collector conduction angle of 180°. This condition is easily met by grounded-base, zero-bias operation. Fortunately, this is also probably the simplest frequency-multiplier circuit to drive and adjust. Incidentally, it was stated earlier that the components of the Simple Sideband System could be duplicated without the use of specialized test equipment. In the case of the LO chain, alignment can be accomplished and injection measured by merely monitoring the diode current of the balanced mixer.

local-oscillator circuits

The primary advantage of the modular system which I use is the ease with which substitutions can be made, and performance of various circuits compared. The Simple Sideband System has already worn three different LO chains; no doubt others will be attempted in the future. The block diagram of fig. 12 shows what



Construction of the doubly-balanced mixer using the Anzac TP-101 balun.

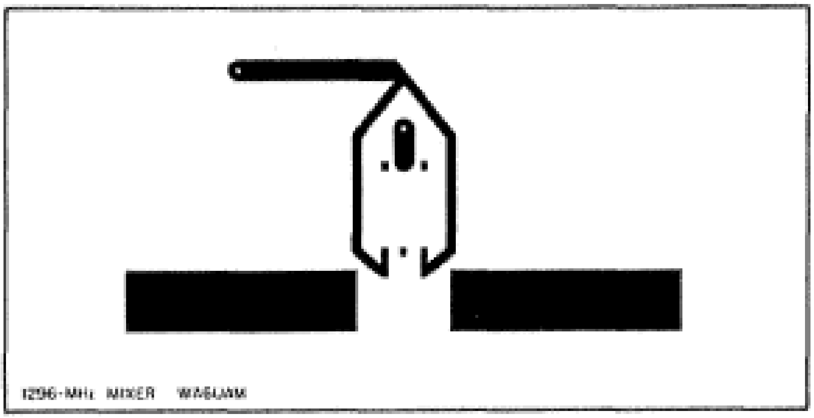


fig. 10. Full-size printed-circuit layout for the improved 1296-MHz mixer. Board is 1/16" (1.5 mm) thick, double-clad 1-ounce copper G-10 fiberglass-epoxy circuit board.

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has thus far proved the most workable compromise between stability and spectral purity on the one hand, and low cost, simplicity and ease of alignment on the other.

However, this LO chain violates a number of the *ideal* design principles outlined above. For example, the purist will want the last multiplier to double rather than triple, and would probably use an active device rather than a diode. The decision to go with a diode multiplier was based primarily on the cost of 1.3 GHz transistors at the required power level. Tripling was used here because of the greater ease of generating a high level of power at 422 MHz, as compared to 630 MHz. The common-base configuration, although simple, was abandoned in the lower-level stages in deference to the greater gains available from common-emitter circuits.

The active multipliers are all operated at a low power level as a concession to stability, with the two 422-MHz power amplifiers providing plenty of drive to the tripler. Considering the low conversion efficiency of the diode tripler circuit, a high drive level is a must.

The low-level stages shown in **fig. 13** were designed by W6FZJ for use in a 432-MHz receiving converter, and published in his *432 Newsletter*. Except for the crystal frequency and the number of turns on two inductors, his original circuit is unchanged when used in the 1296-MHz LO chain. Copies of the original circuit have been successfully built by a number of San Francisco area 432-MHz enthusiasts, and spectrum analyzer tests prove the W6FZJ design to be superior to any of my own attempts to date.

Since the tripler which raises the injection frequency to 1267 MHz exhibits about 10-dB conversion loss,* a half-watt of drive is necessary at 422 MHz to achieve the desired 40-mW of LO injection. This is accomplished by applying the 10-mW output of the low-level LO module to two stages of power amplification, operating at 10- and 7-dB of gain, respectively. The 2N3866s were selected because of their low cost and ready

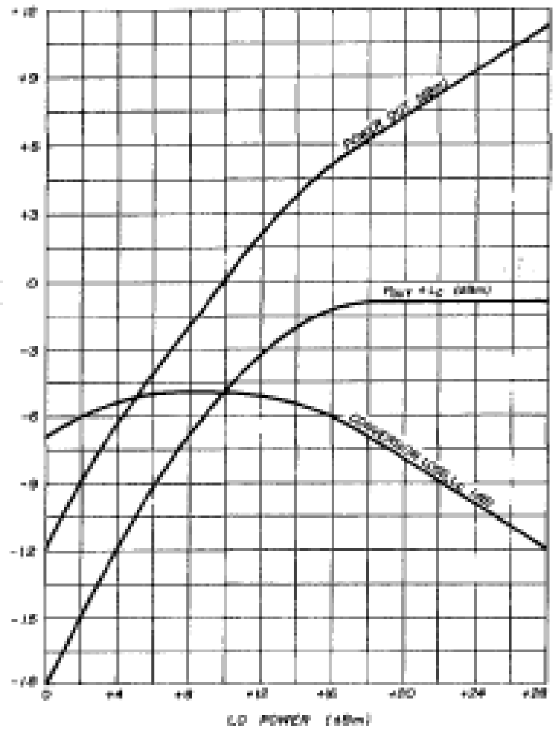


fig. 11. Balanced mixer conversion loss, output power at the 1-dB compression point and their sum (transceive figure of merit) for a typical microwave balanced mixer, all as a function of local-oscillator injection level. The transceive figure of merit represents the i-f output power available from a receive mixer driven directly by the output of an identical transmit mixer.

availability from a number of mail-order surplus component dealers.

The power amplifier circuits are shown in **fig. 14.** Care should be taken to closely duplicate the input and output tank circuits unless a spectrum analyzer is available, as adequate spectral purity occurs when these particular circuits are tuned for maximum indicated output. The slab inductors in the collector

*Greater tripler efficiency is possible through the use of an idler circuit, a technique avoided by the author in the interest of simplicity.

circuits provide high output Q, and the pi-network filter (C8, L3, C9) feeding the second stage tends to suppress any harmonics generated by the first. The first 2N3866 in biased to class AB for increased gain; the second stage is run in class C for improved collector efficiency. If the stages are built separately, each can be tuned for maximum power into a 50-ohm load.

The diode tripler and filter assembly was first built in the popular trough-line configuration. Later, an interdigital filter was attempted. In both cases performance was satisfactory. However, the construction process required extensive metalworking. As many amateurs avoid projects which involve bending sheet metal or cutting brass tubing, I decided to reduce the tripler/filter to a PC board. The result is shown schematically in fig. 15.

Rf energy from the 422-MHz power amplifier, fig. 15, is applied to CR1, a GE 1N4154 high-speed switching diode through an L-network (L1, C1) similar to that used by K6UQH in his trough-line multiplier/mixers. The harmonic comb developed at the output of the diode is applied to a two-pole resonator (L2, C2, L3, C3) which blocks all but the 1267-MHz component.

The filter combines lumped and distributed constants. Design of the poles was accomplished as follows: It was desired that the filter resonate with the tuning capacitors (C2, C3) at midrange, or 1.5 pF. Assuming an additional 0.5 pF of stray and coupling capacitance, the capacitive reactance of 2 pF at 1267 MHz is 62.8 ohms. To resonate this circuit the inductors (L2, L3) must exhibit the same reactance at the frequency of interest. A shorted micro-stripline can be used as an inductor, its reactance determined both by characteristic impedance (width) and phase angle (length) as given by the relationship

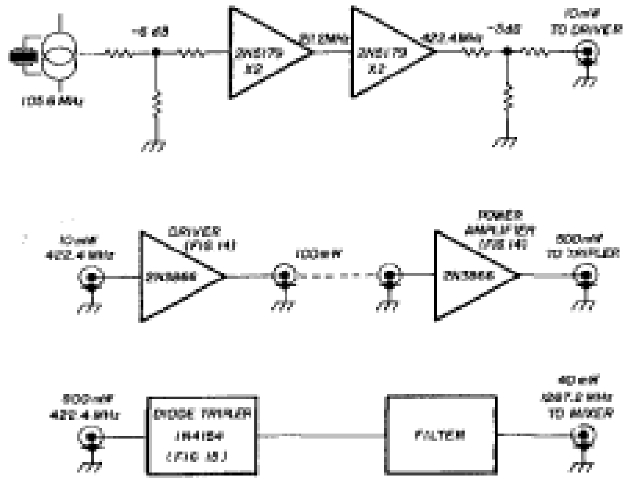


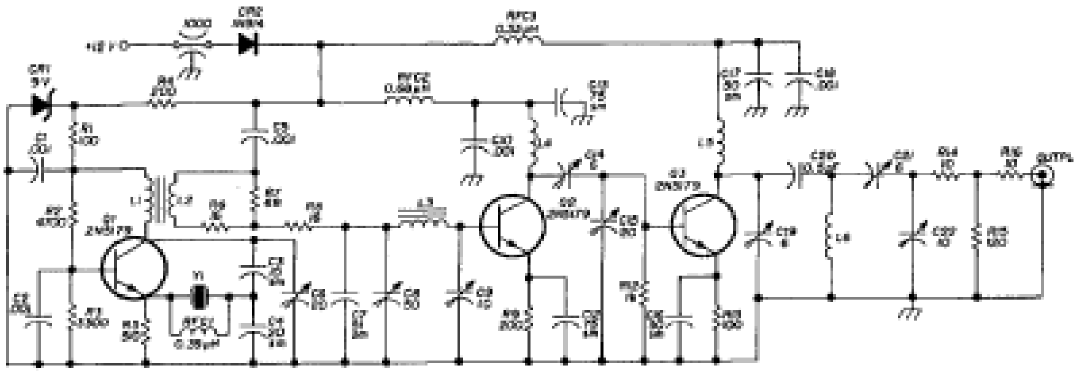
fig. 12. Block diagram of the local-oscillator chain used with the Simple Sideband System for 1296 MHz. Each of the individual sections is built into a small module; these are connected together with miniature 50-ohm coaxial cable.

$$\theta = \arctan \frac{X}{Z_o}$$

where θ represents wavelength of the stripline in *degrees*. To convert to fractions of a wavelength, divide θ by 360°. Thus, for 62.8-ohm inductive reactance with an arbitrarily selected stripline characteristic impedance of 25 ohms,

$$\theta \arctan \frac{62.8}{25} = 68.3^\circ = 0.19 \text{ wavelength}$$

A 25-ohm micro-stripline on 1/16-inch (1.5-mm) G10 PC board is 0.3-inch (7.5-mm) wide. The 0.19 wavelength at 1267 MHz (correcting both for velocity factor and width-to-height ratio) is 0.865 inch (22 mm).



C6,C15	20-pF trimmer (JFD DJV 300)	L3	12 turns no. 28 on Micrometals T-25-13 toroid core
C8	50-pF trimmer (JFD DVJ 305)	L4	6 turns no. 24, close wound on 0.1" (2.5 mm) diameter form
C9,C22	10-pF trimmer (JFD DVJ 302)	L5,L6	1½ turn no. 22, 1/8" (3 mm) diameter, 1/4" (6 mm) long
C14,C19, C21	6-pF trimmer (JFD DVJ 301)	RFC1	0.39 µH miniature inductor (Nytronics Deci-Ductor)
C20	0.5-pF ceramic (two 1-pF capacitors in series)	Y1	5th overtone crystal, series resonant, HC-18/U holder, 105.600 MHz for 28.8-MHz i-f
L1	10 turns no. 28 on Micrometals T-25-13 toroid core		
L2	4 turns no. 28 on cold end of L1		

fig. 13. Crystal-controlled local oscillator circuit, based on a design by Joe Reisert, W6FZJ.

Matching the resonators to the relatively low impedances of the diode and the output transmission line can be accomplished by tapping up on the micro-striplines the required distance above ground. Although formulas exist for approximating the required tap position, matching in the circuit shown was determined empirically.

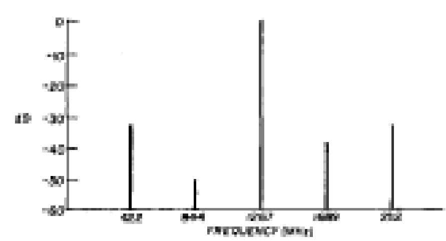
An important (and often neglected) consideration in diode multipliers is bias current. Resistor R1 in **fig. 15** enables the diode current to be varied over a wide range. Remember that diode current will affect conduction angle, which should be 120° to maximize third-harmonic generation.

transmit i-f attenuator

Proper operation of balanced mixers requires that each port be terminated in its characteristic impedance (usually 50 ohms). Most methods used to sample a low-level ssb signal from a high-frequency transmitter would result in a horrendous impedance mismatch at the mixer's i-f port. As 12.6-mW of sideband injection is desired, one recommended method of assuring i-f impedance matching is to run about one watt of ssb into a 20-dB resistive pi- or T-pad at the mixer's i-f port. Since the attenuation pad will provide the proper termination to the mixer, the method of coupling out of the station transmitter has no effect on the mixer's operation.

i-f amplifier

The noise figure of a receiving converter without pre-conversion gain is the



Spectrum output of the 1267.2-MHz local-oscillator chain when tuned for maximum mixer diode current. The 422- and 2112-MHz spurs are down 32 dB, the 1689-MHz spur is down 38 dB and the 844-MHz spur is down 50 dB.

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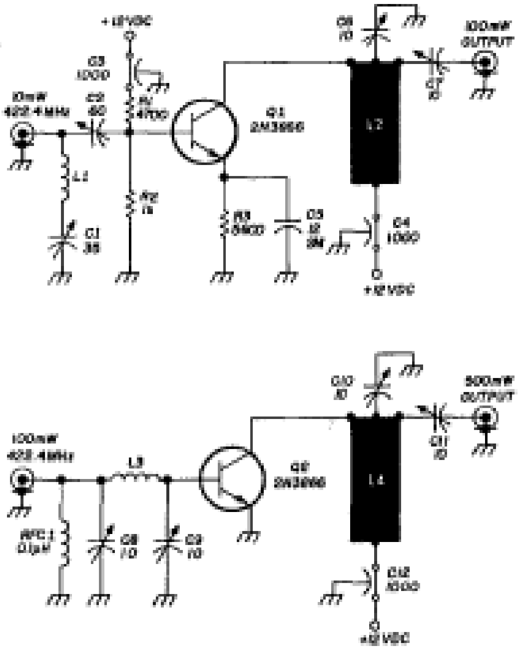


C1	3-35 pF trimmer
C2	8-60 pF trimmer
C6-C11	10-pF concentric piston trimmers
L1	2 turns no. 18, wound on 1/4" (6 mm) mandrel, 1/8" (3 mm) long
L2,L4	brass strip, 0.5" (12.5 mm) wide, 1.5" (38 mm) long, mounted 1/8" (3 mm) above ground plane
L3	2 turns 1/8" (3 mm) wide brass strip, 0.1" (2.5 mm) diameter, 0.5" (12.5 mm) long

fig. 14. The two 422-MHz power amplifiers provide one-half watt output. The first stage, Q1, provides 10-dB gain, while the second stage, Q2, provides 7-dB gain.

sum of the feedline and TR relay losses (if any), input filter insertion loss, mixer conversion loss and i-f amplifier noise figure. For the system presented here the noise contribution of these stages prior to the i-f amplifier is less than 6.5 dB. Feeding the output of the mixer into a high-frequency ssb receiver would, however, result in a system noise figure approaching 20 dB. Many amateurs are surprised to learn that the noise figure of even a high quality commercial communications receiver is seldom below 10 or 15 dB. In the high-frequency spectrum the level of man-made and atmospheric noise exceeds that of receiver noise by several orders of magnitude, so noise figure, per se, is not usually a significant consideration in high-frequency receiver design. Of course, such is not the case in the microwave region. To achieve a reasonable noise figure in any uhf converter, a low-noise i-f amplifier must be used to mask the following receiver noise.

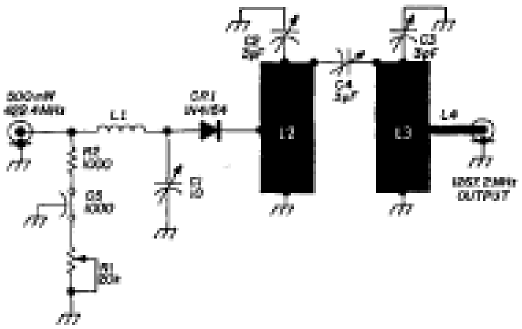
Numerous circuits have been described in the past which will yield reasonable gain at 28 MHz with a noise figure under 1 dB. WB6NMT, known for his pioneering efforts in 220-MHz EME, uses neutralized fets, while W6FZJ favors a dual-gate mosfet following the mixer. An appealing circuit by W9PRZ uses a dual jfet in a cascode configuration and is described in a Siliconix applications note.[6]

system performance calculations

It remains to be shown that the simple microwave ssb system described here lends itself to satisfactory communications over reasonable distances (my experience shows the following calculations to be somewhat on the conservative side). The overall noise figure of the receive system is the sum of filter loss (0.5 dB), mixer conversion loss (6 dB) and i-f noise figure (1 dB). Thus, a receive noise figure of 7.5 dB is assumed. With the 2.1-kHz i-f bandpass of a good sideband receiver, the graph of fig. 16 indicates the receive sensitivity to be about −133 dBm.

Good intelligibility on single sideband requires a 6-dB signal-to-noise ratio. Allowing a 10-dB signal-to-noise ratio for good measure, the receiver requires a −123 dB signal. At +4.3 dBm of transmitter power, given 10-dB of antenna gain at each end, and allowing 5-dB of additional loss for antenna aiming errors, the permissible path attenuation between transmit and receive stations is 142.3 dB. The free-space loss formula is[7]

$$L_{FS} = 36.6 + 20 \log_{10} f_{MHz} + 20 \log_{10} d_{miles}$$



C1	1-10 pF concentric piston trimmer
C2,C3 C4	0.3-3 pF concentric piston trimmer
CR1	1N4154 high-speed switching diode
L1	2 turns no. 20, 0.1" (2.5 mm) diameter, 0.25" (6 mm) long
L2	micro-stripline, 0.3" (7.5 mm) wide, 0.865" (22 mm) long, grounded at bottom, tapped 0.20" (5 mm) from ground end
L3	Same as L2 but tapped 0.25" (6 mm) from ground end
L4	50-ohm micro-stripline, 0.1" (2.5 mm) wide, any length
R1	20k, 10-turn trimpot

fig. 15. The 422- to 1267-MHz diode tripler is built on 1/16" (1.5 mm) double-clad, glass epoxy circuit board.

which can be rewritten to solve for distance at 1296 MHz

$$\log_{10} d_{miles} = (L_{FS} - 98.85)/20$$

Given 142.3 dB of permissible free-space loss, an HP-35 calculator yields

$$d(\text{maximum}) = 161 \text{ miles } (259 \text{ km})$$

Amateurs who have operated simple equipment in the 23-cm band find it difficult to believe that a 161-mile path is possible with only 3-mW of output power. After all, they reason, that's greater than the APX-6's range, and those have 3-watts output. It should be remembered, however, that directly-modulated oscillators tend to be extremely unstable, and that reception of their emissions requires a wideband receiver. The APX-6 i-f strip is about 5-MHz wide and bandwidth has a serious impact on receiver sensitivity. **Fig. 16** indicates a deterioration in receiver sensitivity of 10 dBm for each tenfold increase in i-f bandwidth. This more than offsets any path increase afforded by the greater power of the APX-6 or similar equipment.

direct conversion

If simplicity is the goal, there is practically no limit to the evolutionary process. This last step occurred almost by accident, while developing test equipment for 1296 MHz. A weak-signal source was built for 1296.00 MHz to permit calibration and receiver testing. Since a few milliwatts of stable power was desired, I used the same techniques as I used for building the converter local oscillator. Later a key was added, and the signal source used for on-the-air CW contacts over a limited range.

Eventually, a means for monitoring transmit quality from the ssb converter was desired. An antenna and tuned cavity feeding a diode detector and audio amplifier produced the characteristic ssb "Donald Duck" squawk in a speaker. However, for high-quality signal monitoring a ssb converter was required. By using the 1296.0-MHz signal source developed earlier, driving a balanced mixer with its i-f port feeding an audio amplifier, a direct-conversion receiver was built. If the

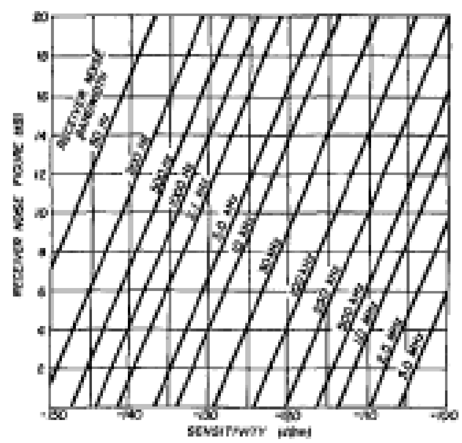


fig. 16. Receiver noise figure vs sensitivity for various receiver bandwidths.

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transmitter (suppressed) carrier frequency and the receiver LO frequency are the same, the difference frequency at the i-f port of the mixer will be audio sidebands. No input filter is required because the image is merely the other sideband — and at 1296 MHz QRM is hardly a problem yet.

If a direct-conversion double-sideband receiver will work, there's no reason to expect otherwise for direct double-sideband generation. Indeed, when audio was applied at the i-f of the balanced mixer, sidebands around 1296.0 MHz appeared at the rf port. Though extremely low power, the signals could be copied in a sensitive receiver at a range of about a mile.

The resulting direct-conversion double-sideband transceiver is shown in **fig. 17.** Though primarily a lab accessory and demonstration rig, it provides reliable communications over moderate distances. It is simple in the extreme, and suggests the possibility of microwave double-sideband walkie-talkies. The concept may even work at greater power levels than the few microwatts attempted to date. Certainly there's no more basic a way to produce a microwave sideband station.

conclusion

The primary advantage of ssb in the microwave spectrum, as anywhere else, is in the significant increase in receiver sensitivity resulting from the narrow bandwidth which is required. The only limiting factor is stability, a criterion which can be readily achieved by judicious application of good engineering practice to the design and construction of local-oscillator chains. The design trade-offs presented here make microwave ssb feasible over considerable distances, while requiring a minimum of specialized skills, equipment or technique.

acknowledgements

I wish to express my deep appreciation to Don Farwell, WA6GYD, for giving me my first contact on 1296 MHz and kindling the fire, to Frank Pacier, W6VMY, for the countless hours we spent together working on APX-6s in the early days, to Bill Troetschel, K6UQH, who shamed me into giving up modulated oscillators by his snide remarks at uhf conferences, to Bob Ney, WB6LLD, who gave me my first microwave transistors, and to Joe Reisert, W6FZJ, who taught me how to use them. And most important, a word of thanks to my wife, Suk, who for the past three years has shown more understanding of the hours spent on the 1296 project than I had any right to expect.

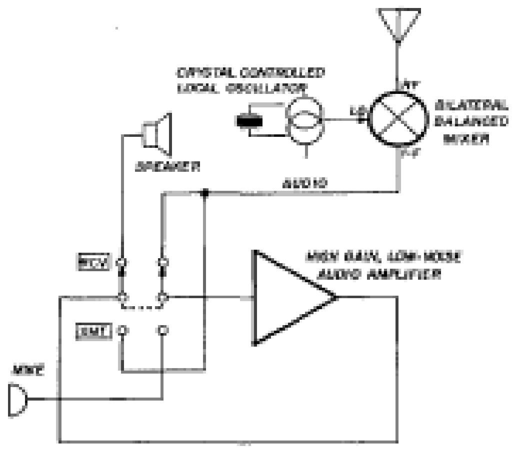

fig. 17. Simple direct-conversion double-sideband transceiver for 1296 MHz.

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ham radio

Weekend Antennas No. 2
The Versatile Vee Beam

Our second "weekend antenna" project is an aerial that you can use on all eight High Frequency amateur bands (80, 40, 30, 20, 17, 15, 12 and 10m) with an antenna tuner, and which gives significant gain on the five bands from 20m to 10m. It is easy to construct, requiring only wire, spacers and suitable supports, has no trap coils to wind, metalwork, or critical dimensions, and has a low visual profile so many neighbours won't even notice it!

The Long Wire

A good way to understand the Vee Beam is to start with the humble long-wire antenna, a length of wire at least one wavelength long fed against ground. The far-field pattern of a long wire antenna consists of a number of lobes at different angles to the wire. The number of lobes depends on the length of the wire, in wavelengths, while the strongest lobe is always the one closest to (i.e. making the smallest angle with) the wire. Figure 1 shows the far-field pattern of a wire 2 wavelengths long that runs horizontally along the page and is fed at the left-hand side.

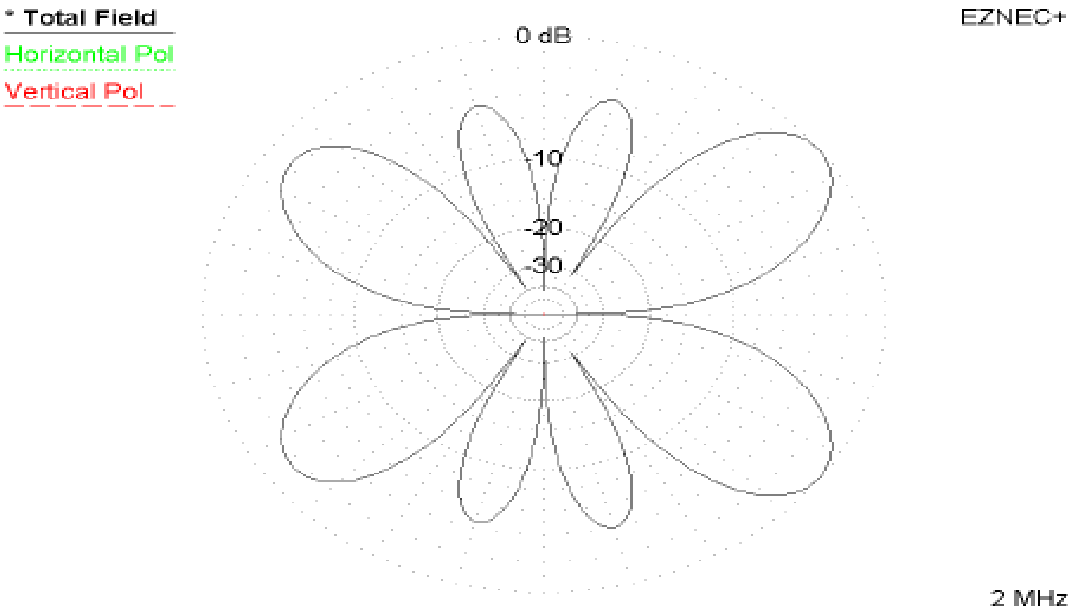

Fig. 1: The far-field pattern of a 2-wavelength long wire

In this case the main lobe is at an angle of about 40 degrees from the wire. As the wire gets longer, the number of lobes increases and the main lobe gets stronger and closer to the axis of the wire. Note that the lobes in the direction from the source to the end of the wire (in our case, from left to right across the page) are slightly stronger (by about 1.5 dB) than the lobes in the other direction.

Long wires have always been popular because of their simplicity and because with the help of an antenna tuner they can be made to work on all bands. However they do have a couple of disadvantages:

1. The antenna starts right where the tuner is, which is typically in the shack, so a significant amount of radiation ends up in the shack, where it can cause havoc with equipment, and does not contribute to your signal.

2. Like all antennas that are fed against ground, a significant percentage of the power applied to the antenna may be lost due to ground losses. Although the losses can be reduced by installing a ground radial system, this defeats the object of a simple antenna system.

3. The pattern has multiple lobes, and the angle of the lobes to the wire depends on frequency, so it is difficult to aim the antenna at a particular geographical area.

Vee Beam Basics

Fortunately all these problems can be solved by the simple expedient of putting two long wires at an angle to each other to form a vee, and feeding the wires against each other using a balanced feed at the apex of the vee. The resulting antenna is called a "Vee Beam". Figure 2 shows the layout of Vee Beam seen from above.

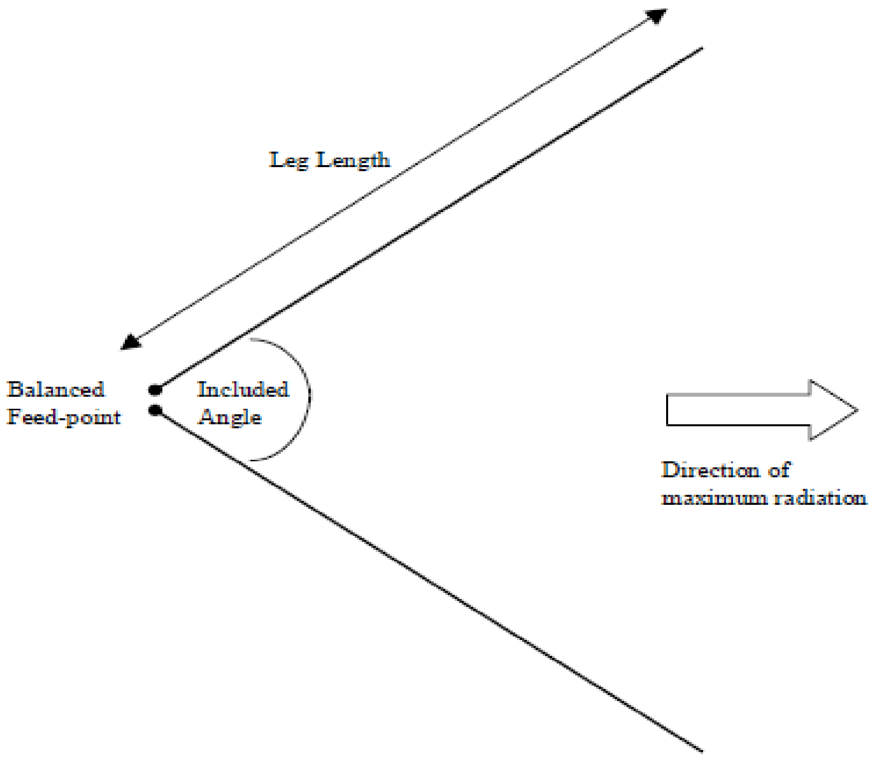

Fig. 2: Layout of the Vee Beam

The two key parameters of a Vee Beam are the *leg length* – the length of each wire, measured from the feed-point – and the *included angle* – that is, the angle that the two wires (legs) make to each other. A Vee Beam will perform well as a directional antenna with a leg length of between 1 and 5 wavelengths. The longer the "legs", the greater the gain and the narrower the beamwidth. If the leg length is below about one wavelength, the antenna no longer gives gain in the direction indicated, although it is still possible to match the antenna with a leg length as short as ¼ wavelength, where it is effectively a "bent dipole".

The angle between the legs is chosen so the main lobes of the long-wire patterns from the two wires reinforce each other, giving an additional 3dB gain advantage over a long wire antenna of the same length as one of the legs of the vee. The optimum included angle depends on the leg length, in wavelengths. The table below shows the optimum included angle and the resulting free-space gain (in dBi) and -3 dB beamwidth for various leg lengths.

Leg length (wavelengths)	Optimum included angle (degrees)	Free-space gain (dBi)	-3 dB beamwidth (degrees)
1.0	90	5.3	31
1.5	82	6.8	22
2.0	68	7.8	20
3.0	56	9.0	16
4.0	48	9.9	13
5.0	42	10.5	12

It might appear from the table that the Vee Beam is not a good choice for a multi-band antenna since the optimum included angle will be different for each band. Fortunately, however, the performance of the Vee Beam is not very sensitive to changes in the included angle, so it is possible to find a compromise that will give good results on several bands. One such compromise is to make the leg length about one wavelength at 14 MHz (21.4m), with an included angle of 80°. This gives the following gain and –3dB beamwidth figures for various amateur bands:

Frequency (MHz)	Gain (dBi)	-3dB Beamwidth (°)
14.000	5.3	34
18.068	6.5	26
21.000	7.0	23
24.890	7.5	19
28.000	7.6	18

There is nothing special about a leg length of 21.4m – it was chosen simply to allow comparison with the previous table. As you can see, the gain at 14 MHz (where the leg length is 1 wavelength), at 21 MHz (leg length 1½ wavelengths) and at 28 MHz (leg length 2 wavelengths) are at most a couple of tenths of a decibel off the optimum.

Figure 3 shows the free-space azimuth pattern of a Vee Beam with legs that are one wavelength long at 14 MHz. As with the long wire, the gain in the forward direction (towards the open end of the vee) is about 1.5 dB greater than the gain in the reverse direction. Although the leg length is not critical (in general, the longer the better, up to a maximum of about 5 wavelengths at the highest frequency of operation), it is important that the two legs be the same length to preserve the balance and symmetrical radiation pattern of the antenna.

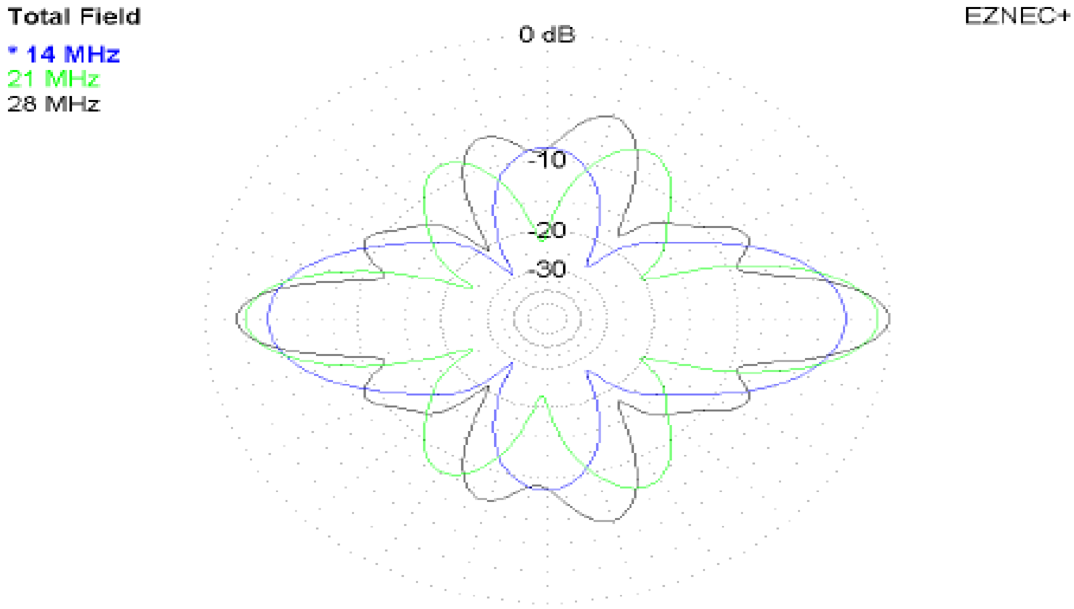

Fig. 3: Free-space pattern of a Vee Beam with 21.4m legs and an included angle of 80°

Feeding the Vee Beam

The Vee Beam needs a balanced feed for best results. This can be obtained either from a remote balanced tuner at the feed-point (if you are lucky enough to own one), or by feeding it with balanced feed-line such as window line or open-wire line to either a balanced tuner or a single-ended tuner with a balun in the shack.

If you use a remote tuner located at the feed-point, then it may be advisable to choose a leg length that is not an integer number of half wavelengths long on any of the frequencies to be used, to avoid presenting the tuner with a very high feed-point impedance. If you feed it with balanced line, then there is no need to avoid these leg lengths, as the feed-line will in any case transform the impedance seen by the tuner. However if your tuner struggles to match the antenna on any bands, then you should increase or decrease the length of the balanced feeder until a length is found that allows the tuner to match the antenna on all bands.

To Terminate or not to Terminate

If both legs of the Vee Beam are terminated by resistors of the correct value (usually about 500 or 600Ω) connected to ground then it becomes a traveling wave antenna. The input impedance becomes fairly constant (about 600Ω) across a wide range of frequencies, and the rearward radiation pattern is suppressed making the terminated Vee Beam unidirectional. However this does *not* increase the forward gain of the vee, since the power that would have been radiated in the reverse direction is simply dissipated in the resistors. In fact, the forward gain of a terminated Vee Beam is actually slightly less than for the same Vee Beam without terminating resistors. The termination resistors must be non-inductive and should each be capable of dissipating about a third of the power applied to the antenna. I decided not to terminate my vee, for the following reasons:

1. The forward lobe is aimed along the short path to North America, so the reverse lobe allows me to work the long path.

2. I didn't want any reduction in the forward gain.

3. It simplified the construction of the antenna, as terminating resistors were not required.

Construction

Construction is simple, the only problem being to find three suitable supports (for the apex and the ends of each leg). In my case, I was fortunate to have a couple a suitably positioned trees in the garden to support the ends of each leg; and I erected a 10m wooden mast made from two poles near my shack to support the apex of the vee. I made the antenna and feed-line using two equal lengths of 1mm^2 panel wire. Each length serves both as one side of the antenna and as one side of the feed-line, so there are no joints to corrode or fatigue. I chose panel wire with green insulation, which blends in with the foliage of the trees, making the antenna quite hard to spot. The two sides of the feed-line are spaced apart using surplus plastic insulators about 5 cm long, which I was fortunate enough to obtain when our club sold off some surplus "junk". The panel wire is secured to the insulators using a drop of quickset epoxy. If you don't have suitable insulators, then you can easily make them from a sheet of Bakelite, Perspex or printed circuit board material (with the copper removed, of course). I fed the feed-line into the shack through a plastic "ventilation brick" in the shack wall, remembering to space it away from conductive objects, and connected it to a W2DU-type balun (a number of ferrite beads slipped over a 30cm length of coax) fed by a very short (50 cm) length of RG213 coax from my transceiver, a Kenwood TS-850S with an internal ATU.

The feed-point of my Vee Beam

So how does it play?

Being an avid (if inexperienced) contester, I decided to put the Vee Beam to the test in the harshest possible environment, the 48 hours of fun and madness called the CQWW International DX contest. I used the vee as my sole antenna for the 2004 CW contest, where I operated on the 40, 20, 15 and 10 metre bands. My overall impressions were good. On the higher bands (10, 15 and 10 metres) it seemed to give my low-power (100W) station some added punch into North America compared to the dipoles I had been using, and I certainly didn't feel under-equipped compared to stations with triband beams. Of course, since the beam is not rotatable and was aimed at North America, I was at a considerable disadvantage when working other parts of the world. Nevertheless, I still managed to put a reasonable signal into Europe, at least when the bands were open, showing that side-lobes do have their uses! On 40m the performance was similar to any low dipole (weak and omni-directional) but I still managed to work 35 DXCC entities, including 9N7BCC in Nepal.

I found that the TS850's internal ATU did not match the vee on all frequencies in the bands, so perhaps a more capable external ATU (preferably balanced) is called for. I also noticed an RFI problem with the shack computer on 10m, which seemed to be caused by the open-wire feeder coupling to the computer keyboard cable. A snap-on ferrite core solved the problem. Other than that, the antenna performed flawlessly, and I made 895 QSOs over the weekend, a couple of hundred more than last year. Now all I need are a couple more Vees pointing at Europe and Japan. Darling, we need a house with a bigger garden…

MEMBERSHIP APPLICATION

EPARA

Eastern Pennsylvania Amateur Radio Association

Address: PO Box 521, Sciota, PA 18354

Email: N3IS@qsl.net

Website: www.qsl.net/n3is

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Name: ____ **Callsign** _________________

License: Novice Technician General Advanced Extra

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City: ______________________________________ **State:** _____ **Zip:** _________

Home Phone: _____________________________________

Cell Phone: _______________________________________

Email: ____

* **Note**: We do not publicize your phone or email information.

ARRL Member: _____ **Skywarn Spotter:** _____ **ARES/RACES Member:** _____ **VE:** _____

Interests:

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How did you get interested in Ham Radio?

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Please list any relevant qualifications or assets you have or are willing to share/contribute to the club.

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