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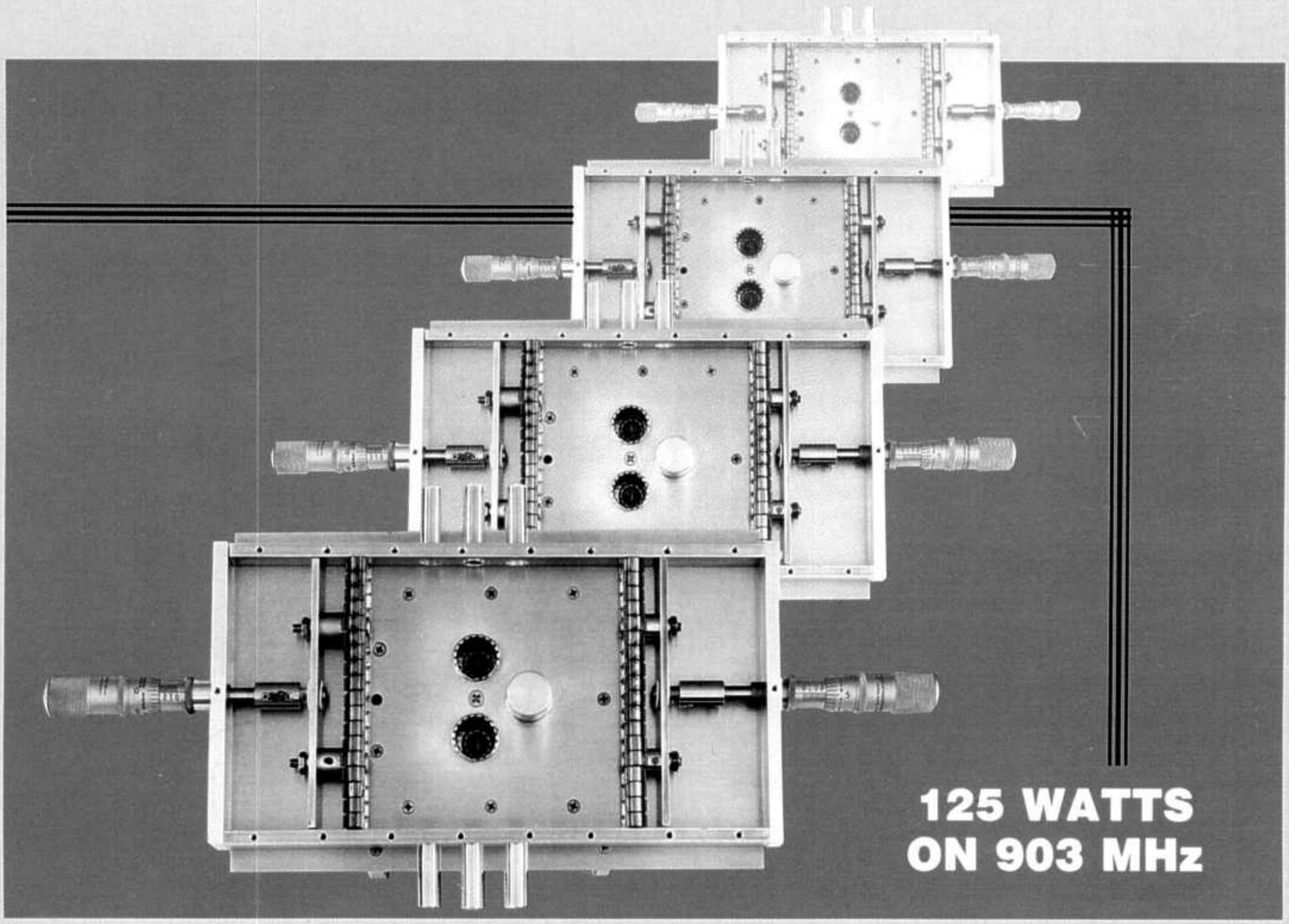

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By Geoff Krauss, WA2GFP

Surplus phase-locked oscillator/multiplier units are more readily available to the amateur community. If you're thinking of getting on the microwave bands, don't pass this up. These application ideas will help get you on the air.

COMPONENTS — **18**

By Mark Forbes, KC9C

This column returns to offer you news on the latest developments in the component industry. This month KC9C talks about an FM receiver on a chip, a double-balanced mixer and RF switch, a 9-V lithium battery and a DTMF decoder.

ABOUT THE COVER

The anode cavity of the 903-MHz amplifier. The anode bypass plate and the anode cavity top plate are removed. Micrometers are used as tuning devices.

Purposes of *QEX*:

1) provide a medium for the exchange of ideas and information between Amateur Radio experimenters
2) document advanced technical work in the Amateur Radio Field
3) support efforts to advance the state of the Amateur Radio art.

All correspondence concerning *QEX* should be addressed to the American Radio Relay League, 225 Main Street, Newington, CT USA 06111. Envelopes containing manuscripts and correspondence for publication in *QEX* should be marked: Editor, *QEX*.

Both theoretical and practical technical articles are welcomed. Manuscripts should be typed and double spaced. Please use the standard ARRL abbreviations found in recent editions of *The ARRL Handbook*. Photos should be glossy, black-and-white positive prints of good definition and contrast, and should be the same size or larger than the size that is to appear in *QEX*.

Any opinions expressed in *QEX* are those of the authors, not necessarily those of the editor or the League. While we attempt to ensure that all articles are technically valid, authors are expected to defend their own material. Products mentioned in the text are included for your information; no endorsement is implied. The information is believed to be correct, but readers are cautioned to verify availability of the product before sending money to the vendor.

Empirically Speaking. . .

Technical Excellence

Excellence is being written about and talked about these days. In one respect, it's a code word for "How come some foreign industries are doing better than ours?" Particularly, Japanese manufacturers are given credit for turning out products of high quality, with lots of bells and whistles, and at a reasonable price. German cars seem to be the vehicle of choice for cellular phones; if you don't believe it, note the cars with those squiggly little antennas (some without any coax) on your next commute. Oh, terminal gloom? Not on your life!

The fertile American inventor/innovator's mind is alive and well, thanks in large part to our culture and valuing the individual. That's no less true among Amateur Radio experimenters. Articles in *QEX* and other ham magazines attest to the variety and quality of design projects undertaken. The sophistication and intensity of specialized work is witnessed by the annual ARRL Computer Networking Conferences, VHF/microwave conferences and AMSAT Space Symposiums. Incidentally, proceedings of these conferences are available from ARRL HQ. Together these conference records show that hams don't just buy plug-and-play appliances. A capable minority is dreaming, scheming, designing, prototyping, testing and shepherding new goodies into the marketplace.

Packet radio is perhaps our best recent example of amateur innovation. The conceptual through pilot production phases were handled entirely by hams. American Amateur Radio industry made the products readily available not only to hams, but to commercial and governmental users in more countries than we can count. The amateur satellite program is another example of Amateur Radio technical prowess.

Both packet and satellites depend upon a balanced blend of individual achievement and teamwork, all within an Amateur Radio context. Without talented individuals, teamthink produces only concepts and obstacles. Without the multidisciplined team, the individual doesn't have enough time to do everything before the product is obsolete and may not have the skills to pull everything off. In April 1987, "Empirically Speaking" spoke about *incubators* as an environment for such teamwork. Some are out there incubating: AMSAT, TAPR, AMRAD, to name a few. *QEX* would welcome articles on ongoing incubators, what they're working on, how they're doing, and how they got hatched in the first place. Object? To help other groups find out how it's done.

Next, we need an inventory of Amateur Radio technical resources. It would be useful to have a data base of who has what knowledge or talent. A list of goodies (from what ham experimenter owns a silicon foundry to who can scrounge 300 hours on a Cray) would be useful. We need to figure out how to *network* the human resources by a variety of carriers—landline electronic mail, packet radio, print medium and a variety of gatherings. You say, "We have all this?" More or less, "Yes." But these pieces are scattered and have lots of disconnects. The penalty we are paying is "reinventing the wheel" whenever we need something, which is what most experimenters hate. We have some work to do to pull things together, avoid duplication and make use of the best resources available.

The pages of *QEX* are open to experimenters seeking help and those offering assistance to others. *QEX* would also welcome correspondence on how the Amateur Radio technical community can work closer together, optimize the uses of resources, improve the overall quality of our designs, and make them more useful to society. The relevance of Amateur Radio to the public good is constantly under question. We can do a better job of documenting what we're already achieving; we can increase our overall effectiveness by better "networking" in the broadest sense of that word. —W4RI

Correspondence

Article Triggers Intermodulation Investigation

The article on intermodulation (IM) by Mark Bacon, KZ9J,[1] prompted me to act on an IM problem I've had with my two receivers for months. My reception in the 0.5- to 15-MHz range had been plagued by a mixing product from AM broadcast stations that appeared on *several* frequencies. On 3340 kHz, for instance, I heard the second harmonic of WMRO mixing with WBBM (2 × 1280 kHz + 780 kHz = 3340 kHz). On 500 kHz, I heard the difference of WMRO and WBBM (1280 kHz − 780 kHz = 500 kHz).

The problem would come and go, and I couldn't correlate it to weather conditions. I could hear the interference on two different receivers: a Drake R7 and an ICOM R71A. Each is connected to different antennas. The R7 was connected through an antenna tuner to a 132-foot long center-fed dipole. The dipole is constructed of 12-gauge solid Copperweld™ wire fed with 450-Ω Copperweld "window" line. The R71A is connected to 100 feet of 20-gauge stranded, insulated wire.

Were the front ends of my receivers being overloaded by these strong broadcast stations? If so, the interference could be generated within the receivers themselves. To answer this question, I inserted a homemade broadcast-band rejection filter between the antennas and receivers. The filter attenuates signals between 535 and 1650 kHz by more than 30 dB. The filter had no effect on the interference at 3340 kHz or on other frequencies, which proved the signals were being generated outside my receivers.

Continuing my search for the signal source, I tuned one of my receivers to 3340 kHz, set the mode to USB, and disabled the automatic volume control. I locked one of my home intercoms into the transmit mode, and placed it next to the receiver's speaker. This let me monitor the receiver from other rooms in the house. I even placed an intercom by an outside window so I could hear it when I was in the back yard.

One by one, I unplugged various appliances throughout the house, but it was difficult to tell what effect that had on the signal. Sometimes the signal would appear when I plugged an appliance into a wall outlet. The signal would stop for awhile when my basement sump pump went on. Yes, the signal seemed to go on and off with just about any perturbation.

I tried banging on the pipes and heating ducts in my basement, and listened to hear if the signal changed when I banged. The tests were inconclusive, but I found some things that needed fixing anyway.

I wrapped electrical tape around water and gas pipes that crossed over each other. Using sheet metal screws, I fastened together the separate pieces of hot air ducts to ensure electrical continuity. But the signal still appeared on and off, seemingly unaffected.

Taking the search outside the house, I banged on the rain gutters and downspouts to no avail. Could the solder connections on my dipole be corroded? When the IM problem first appeared, I checked the connections visually, and they didn't look too bad.

As I lowered the dipole, the unwanted signal flickered on and off. The more I yanked on the dipole, the more the signal was affected. As I tapped the solder connections where the feed line met the center of the dipole, the correlation became almost undeniable. The solder connections still didn't look corroded, but they were!

After resoldering the feed-line connections with a propane torch, the horrid mix of AM signals vanished, and have not been heard since. The corroded joint in the dipole had been detecting the AM broadcast stations, and reradiating their harmonic mixtures into my other antennas.

Congratulations to Mark Bacon on a fine article, and to the ARRL for an interesting and useful publication.—*Bob Parnass, AJ9S, ARRL Technical Advisor, 2350 Douglas Rd, Oswego, IL 60543*

[1]Notes appear on page 4.

Diversity Technique Bibliography

I recently read the article by Kohl[2] and the comments by McLarnon[3] on diversity techniques. The data gathered is interesting. Although there is probably some improvement at such short spacings, the real gain in diversity reception occurs with spacings on the order of 110 feet or more[4].

It is also notable that diversity techniques are equally applicable from the VLF region well into the microwave spectrum. In fact, on particularly poor paths, various telephone companies have, in the past, employed space diversity systems on microwave trunks by putting one antenna at the top of a tower and another considerably below the other on the same tower. I have observed polarization diversity improvement on VHF contests during contacts on 2 meters over nonoptical paths.

As an aid to *QEX* readers who may have a particular interest in diversity techniques, I have put together a small bibliography. This is not a complete list, but rather an attempt to give broad coverage of the subject. Articles vary from Hints-and-Kinks-type articles to scholarly theoretical studies. Additionally, many cover applications such as RTTY and VHF tropo-specific systems.

All of these publications should be available at good university engineering libraries. Some larger municipal libraries receive the *PROC IRE* (now *PROC IEEE*). If your library does not have these publications, ask about the possibility of obtaining them through interlibrary loan. This service is generally handled through the Reference Librarian. In some cases, there may be a charge for inter-library loan requests.

I hope this list stimulates interest in this technique for enhancement of communications. If you find other articles that I have missed, please inform me. —*Domenic M. Mallozzi, N1DM, 26 Carey Ave, Apt 8, Watertown, MA 02172*

Key to citations:

PROC IRE = Proceedings of the Institute of Radio Engineers (now called *Proceedings of the Institute of Electrical and Electronics Engineers* [PROC IEEE]).

PROC IEE = Proceedings of the Institution of Electrical Engineers (published in London).

Wireless Engineer was published in London under various names including *Experimental Wireless.* This magazine is no longer published.

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Notes

[1]Mark Bacon, "Surviving in the Intermod Jungle," *QEX*, Nov 1987, p 3.

[2]Douglas Kohl, "Experiments in Signal Improvement with Fractional-Wavelength Diversity Reception," *QEX*, Jul 1987, p 6.

[3]Barry McLarnon, Correspondence, *QEX*, Oct 1987, p 3.

[4]A. H. Ross, and S. H. vanWambeck, "Performance of Diversity Receiving Systems," *PROC IRE*, Mar 1951, pp 256-264.

Bits

Central States VHF Conference Call For Papers

The 22nd Central States VHF Conference will be held July 22-24 in Lincoln, Nebraska. ARRL will again be publishing *Proceedings* of this conference. Last year's *Proceedings* contained 175 pages of articles on subjects ranging from VHF propagation to antennas to equipment design.

Amateurs active at VHF and above are invited to submit papers for publication in the 1988 *Proceedings*. Papers may be on any topic of interest to amateurs operating at 50 MHz and above. If you think you might like to prepare a paper for publication, contact Mark Wilson, AA2Z, at ARRL HQ for more information and an author's package. Submissions must be received at ARRL HQ no later than June 1, 1988.

For more information about the Central States VHF Conference, contact Roger Cox, WBØDGF, 3451 Dudley, Lincoln, NE 68503.

14th Annual Eastern VHF/UHF/SHF Conference

The 14th Annual Eastern VHF/UHF Conference will be held May 20-22, 1988 at Rivier College, Nashua, New Hampshire. Rivier College is located near Route 3, a short distance north of the Massachusetts border.

The program features a Friday night hospitality room and an informal swap fest. Technical talks by well-known VHFers will be held on Saturday. "Rap sessions" for the various VHF/UHF bands, noise figure and antenna gain measurements are Sunday's features. A host of other VHF/UHF activities are scheduled for the three-day conference.

Housing is available in dormitory rooms at the college at a nominal charge. To preregister or reserve a room, contact David Knight, KA1DT, 15 Oakdale Ave, Nashua, NH 03062 before May 14. Registration at the door is $20. Attendees wishing dormitory accommodations must include payment at the time of registration. Nearby hotels and motels provide other housing arrangements. A map of the area is included with the registration materials.

The 14th Eastern VHF/UHF/SHF Conference is sponsored by the Northeast VHF Association. The conference chairman is Thomas Kirby, W1EJ. For further information contact Lewis D. Collins, W1GXT, Publicity Chairman, 10 Marshall Terrace, Wayland, MA 01778, tel 617-358-2854 between 6 to 10 PM EST.

Parabolic Paradox

By H. Paul Shuch, N6TX
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San Jose, CA 95124

Since its invention by Heinrich Rudolph Hertz nearly a century ago, the parabolic reflector has emerged as one of the most important microwave antennas. But microwave hams are frequently confused by the complex nomographs and elaborate equations used to determine parabolic antenna gain and beamwidth. In this article, Professor Shuch derives simplified rules of thumb for predicting parabolic antenna performance.

Have you ever tried to determine the gain and beamwidth of a parabolic reflector antenna using the equations published in the standard engineering handbooks? No doubt the plethora of units, dimensions and fudge-factors you encountered was enough to make you seek refuge in a ones-and-zeroes factory. After you've plugged in antenna diameter in feet, frequency in megahertz, illumination efficiency in percent and focal length in inches, you'll no doubt have to throw in a correction for the phase of the moon before receiving results that not only bear scant resemblance to reality, but defy intuitive interpretation entirely.

Graphical solutions are no better. If you draw a straight line on the appropriate nomograph, between the vertical scale on the right (representing antenna size) and that on the left (corresponding to operating frequency), chances are your line doesn't even intersect the scales in the middle—the ones that are supposed to show gain and beamwidth. There has to be a better way!

Wherefore Gain?

If you're accustomed to working with amplifiers, you may be wondering how an antenna (obviously a passive device) can exhibit gain in the first place. There's just no way its power out can exceed its power in—in either direction. (Actually, by the "power out over power in" definition, even attenuators have gain. It's just that their gain will likely be less than unity.) When we talk antenna gain, we are really comparing the performance of a particular antenna to that of a specified reference, usually an isotropic point source.

In receiving service, an antenna's gain is related to its ability to scoop up more energy than the reference antenna; hence, gain is related to the antenna's surface area (or more properly, its effective aperture). In transmitting service, gain relates to an antenna's ability to focus more energy *in a given direction* than the reference, and this focusing action also depends on aperture. Antennas are bilateral, so given a proper impedance match, an antenna's gain in transmitting and receiving service will be the same. And that gain relates to the size of the antenna. The bigger the better (until it falls over).

"As soon as I had succeeded in proving that the action of an electric oscillation spreads out as a wave in space, I planned experiments with the object of concentrating this action and making it perceptible at greater distances by putting the primary conductor (ie, dipole) in the focal line of a large concave parabolic mirror."
— Heinrich R. Hertz (circa 1890)

How Wide the Beam?

Since any antenna achieves its gain by focusing energy in a narrow, directed beam, there will obviously be an inverse correlation between beamwidth and gain. Beamwidth is traditionally defined as the angle, in degrees or radians, measured between the two points on either side of the antenna's main lobe (or bore sight) at which the received signal power at a fixed distance is exactly half (3 dB less than) the maximum received power. You might think that an isotropic radiator would exhibit a beamwidth of 360 degrees. But remember, if it's truly omnidirectional, it has *no* −3 dB points, thus no definable beamwidth.

Another thing to watch out for is that some antenna users find it more convenient to measure the angle between bore sight and one 3-dB point, on one side of the antenna's pattern. This angle is properly referred to as half-power *half* beamwidth (not to be confused with half-power beamwidth).

The main point of all this is the relationship between beamwidth and gain. Since large antennas exhibit high gains, they exhibit narrower beamwidths than smaller antennas, all else being equal.

What About Wavelength?

But what, exactly, do we mean by "large" antennas? An antenna's electrical size may bear little relation to its physical size, and what constitutes a "large" (hence narrow-beam and high-gain) antenna at microwaves may prove a "small" (wide-beam, low-gain) antenna at VHF. High-gain, narrow-beam antennas tend to be large *relative to their operating wavelength*. Obviously, as you go higher in frequency, an electrically "large" antenna can be physically smaller. I find it easiest to define a parabolic reflector's size, for example, in terms of its diameter, measured not in feet, meters, inches or angstroms, but rather in *wavelengths* at the intended operating frequency.

Deriving an Equation

Let's start by defining an antenna's *voltage gain* (A_v) as the EMF induced into a particular antenna, measured at a given distance from a specified source, as compared to the EMF induced into an isotropic reference matched to the same impedance. For reasons that I'll not bother to derive here (we academics say it's "beyond the scope of this course"), the voltage gain of a perfectly matched, uniformly illuminated, ideal parabolic dish exactly equals its circumference, measured in *wavelengths*. That is

$$A_v = \frac{\pi D}{\lambda} \qquad \text{(Eq 1)}$$

where

A_v = voltage gain as defined above (a unitless ratio)
D = the antenna's diameter (π D is the antenna's circumference)
λ = the operating wavelength.

Note that if wavelength and diameter are specified in the same units (and they must to be dimensionally consistent), those units cancel, and voltage gain ends up, as it should, a unitless ratio.

Eq 1 is the fundamental relationship from which all of the published equations and nomographs you're familiar with are derived. By getting to the source, perhaps we can strip away some of the mystique.

Generally, we are more interested in an antenna's power gain than its voltage gain. If impedance remains unchanged, power ratio always varies with the square of voltage ratio. Because of this relationship, we can say that the power gain of an ideal parabolic antenna equals the square of its circumference (measured in wavelengths). Mathematically,

$$A_p = \left[\frac{\pi D}{\lambda}\right]^2 \qquad \text{(Eq 2)}$$

where A_p represents power gain, and the other literals are as defined for Eq 1. Note that Eq 2 is sometimes written

$$A_p = \frac{\pi^2 D^2}{\lambda^2}$$

which means the same thing.

So far, we have assumed ideal, perfectly matched feeds and uniformly illuminated parabolic reflectors. Of course, the real world isn't like that, and the power gain of an actual antenna will be something less than we've predicted above. The illumination efficiency of an antenna is a factor between 0 and 1, which we abbreviate η (the Greek letter *eta*). Applying the efficiency factor to Eq 2 gives us

$$A_p = \frac{\eta \pi^2 D^2}{\lambda^2} \qquad \text{(Eq 3)}$$

which is a more realistic indicator of expected antenna gain—if you chose the right η. The actual value of η depends on the dish surface accuracy and material, focal-length-to-diameter ratio and feed system design. Since the 1950s, the industry standard efficiency factor for parabolic antennas feed with flared rectangular waveguide feed horns has been assumed to equal about 55 percent (0.55). Advances in feed-horn technology in recent years have probably raised the typical efficiency of commercial antennas to something closer to 60%.

Finally, I am assuming you wish to express antenna gain in decibels. Since we already know the antenna's power gain, it's a simple matter to take ten times its common logarithm:

$$A_p(\text{dB}) = 10 \log \left[\frac{\eta \pi^2 D^2}{\lambda^2}\right] \qquad \text{(Eq 4)}$$

which is one of the very textbook equations I challenged at the outset. But doesn't it make more sense, now that you know where it came from?

Ditto for Beamwidth

We've already established that beamwidth varies inversely with voltage gain, so it shouldn't be difficult to derive a beamwidth equation. It turns out that the 3-dB beamwidth of a dish, in *radians*, equals the reciprocal of the dish's diameter, again measured in *wavelengths*. (Let's see . . . that's the same as the wavelength measured in diameters, isn't it?) For those of you who like equations

$$\theta(\text{rad}) \approx \frac{\lambda}{D} \qquad \text{(Eq 5)}$$

where wavelength and diameter are measured in the same units.

You say you have trouble with radians? Convert to degrees! See reference 1, or simply multiply by 180, then divide by π.

Scaling from a Rule of Thumb

The equations just derived let you compute the gain and beamwidth of any dish, of any size, at any frequency. Their derivation may help you to make some sense out of what the numbers mean. But if you suffer from acute math anxiety, fear not! Simply scale from a known dimension. The secret is to define the diameter of your particular dish not in inches, feet, meters or miles, but rather in *wavelengths*.

As a starting point, simply memorize this relationship: 40 wavelengths equals 40 dB. Translation: a parabolic reflector 40 wavelengths across at a given frequency, if illuminated at 60% efficiency, exhibits roughly +40 dBi of gain. Check it out using Eq 4, and you'll see this rule of thumb approximates to within better than a quarter of a decibel.

As for beamwidth, the same 40-wavelength dish has a beamwidth of about 1/40 radian, or 25 milliradians—roughly 1.5 degrees. That was easy, wasn't it?

Now, scale away to your heart's content. Dishes only half as large (that is, 20 wavelengths across) have half the voltage gain, hence one quarter the power gain, which is 6 dB less, or +34 dBi. Consequently, our 20-wavelength dish has twice the beamwidth—about 3 degrees—at the half-power points. For larger antennas, the correction goes in the other direction.

Next time you're walking down the street and spot a TVRO dish, you too can amaze your friends by proclaiming, "40 dB of gain, one and a half degrees of beamwidth." When they ask you how you figured it out without even a slide rule, answer "magic." Or hand them this issue of *QEX*.

[1]H. P. Shuch, "Radian Review," *RF Design*, Mar 1986, p 57.

Bits

Invest In Your Future

With the start of another year, new classes begin for many around the country. Included in a variety of educational programs are short courses offered to help engineers expand their professional horizons. The George Washington University in Washington, DC continuously hosts a wide range of courses in the area of communications and the safe handling of electricity. This year will be no different. Courses scheduled for 1988 are:

- Public and Private Packet-Switched Networks—The X.25 Protocol, Jun 2-3, and Oct 6-7
- Microwave Radio Systems, Sep 22-23
- Satellite Communications Engineering Principles, Oct 5-7
- Frequency-Hopping Signals and Systems, Oct 17-19
- Principles of Telecommunications Switching Systems, Nov 2-4
- Spread-Spectrum Communications Systems, Nov 7-11
- Mobile Cellular Telecommunications Systems, Oct 19-21
- Introduction to Receivers, Oct 3-4
- Modern Receiver Design, Oct 5-7
- T-Carrier Networking Decisions, Oct 13-14
- Satellite Orbit and Attitude Control, May 2-4 and Nov 7-9
- Packet Switching for Modern Data Communications, May 2-5, Aug 1-4 and Dec 5-8
- Introduction to Digital Telephony, Jun 6-10
- Communications Satellite Systems—The Earth Station, Jun 20-24 and Dec 5-9
- Spectrum Management, Jun 20-24
- Telecommunications for Distributed Processing Systems, Jul 13-15
- Electromagnetic Interference and Control, Aug 8-12
- Digital Telephony, Aug 22-26
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Two 7289s on 903 MHz

By Ken Schofield, W1RIL
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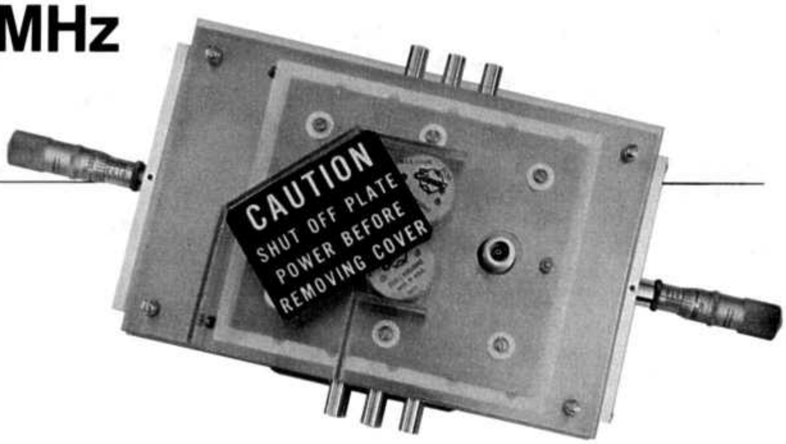

After struggling to make 903-MHz DX contacts with the 10 W or so available from most of the popular transverters, you'll probably be ready for higher power to make things a little easier. The amplifier described here uses a paralleled pair of 7289 planar triodes in grounded grid for more than 125 W output. It is a scaled version of an "old friend" originally designed for 1296 MHz and described in the March 1970 issue of *Ham Radio* magazine.[1] (A later water-cooled version was featured in the Crawford Hills VHF Club *Technical Report No. 6* in July 1971.) I highly recommend that you get a copy of the *Ham Radio* article and study it carefully before attempting the 903-MHz version. In this article, I've concentrated on the mechanical details of the 903-MHz design. Many of the details covered in the original article are not repeated here. This is not a project for the beginner; you should have some VHF/UHF construction experience and be familiar with tube-type amplifiers to get the most out of this project.

In addition to scaling dimensions to 903 MHz, other changes I made to the original design include:

1) Additional reactance loading in the anode cavity.

2) Addition of a second sliding drawer in the anode cavity to make output coupling (loading) adjustment easier.

3) Use of waveguide-beyond-cutoff air ducts to reduce RF leakage.

4) Use of aluminum wall stock in lieu of brass.

5) Use of micrometers as tuning devices.

Power output on 903 MHz is more than 125 W for 10 W drive; gain is a little more than 10 dB. Efficiency is approximately 40%. I have built several copies of this amplifier, and performance is similar for all units. The amplifier is thermally stable using air cooling. During a four-hour operating stint in the ARRL Spring Sprints, power output remained at the 125 W level—with no tuning adjustments—throughout the entire period.

Circuit Description

The input circuit is the same basic design as the original 1296-MHz amplifier. It uses an electrical half-wavelength stripline that connects the cathodes of both tubes in parallel. Part of the line consists of the internal cathode structure of the 7289s. Input tuning is accomplished by adjusting the line capacitively at the end away from the tubes. An adjustable capacitive probe provides for input coupling and matching.

The anode cavity is also similar to the original design—a capacitively loaded half-wavelength circuit tuned with a sliding drawer on one end. In the original amplifier, output coupling consisted of a one-turn loop soldered to the end of a section of transmission line that led to the output connector. I changed this to a variable loop formed by a stud attached to the output connector and a second sliding drawer on the other end of the cavity. Micrometers make tuning and loading adjustments smooth and positive.

I have not shown biasing or metering circuits. See the original article for more information. Many biasing schemes for 7289s have been published over the years—most of these work fine.

Cooling and Mounting

The amplifier is adequately cooled by air pressure forced through 3/8 inch OD (waveguide beyond cutoff) aluminum tubes in the sides of the cathode and anode compartments. There are six tubes in each compartment. Air is also blown across the plate fins of the 7289s via a plenum. Cooling and mounting can be combined successfully on a pressurized chassis by mounting the amplifier on its side with the six air ducts (three in the cathode compartment, three in the anode compartment) protruding through the chassis. An additional cutout in the chassis allows air to be directed by plenum to cool the finned anode plates.

A suitable plenum can be made from Plexiglas® sheet mounted on 3/8-inch

Table 1

Suggested Parts Sources

Material	*Source*
Aluminum, brass, Teflon sheet and rod stock, machine screws (stainless steel and brass)	Small Parts, Inc PO Box 381736 Miami, FL 33238
Connectors	Radio Shack, flea markets
Finger Stock	Instrument Specialties Broad St PO Box A Delaware Water Gap, PA 08327
	Microwave Components of Michigan 11216 Cape Cod Taylor, MI 48180
	Flea markets, liberated parts from surplus equipment

[1]Notes appear on page 8.

studs which replace the four corner screws on the top plate.[2] This also covers exposed high-voltage areas, improving safety in areas that would otherwise be accessible to straying fingers. I found pieces of Plexiglas as large as 18 × 36 inches in the scrap box at a local glass dealer. I used IPS Weld-On 16 cement to glue the pieces together. A tube of this glue goes a long way.

Construction Considerations

Figs 1-10 show complete dimensions for the various amplifier pieces. Figs 11-14 are photographs of the assembled unit. You don't need a machine shop to build this amplifier. A bench-top drill press will make the job much easier, although you could use an electric hand drill. Holes for the finger stock can be cut with a fly cutter, or you can drill a series of small holes around the inside circumference of the larger holes and file to size. This is a lot of work, so I recommend investing in a drill press. With the addition of a compound (X-Y) vise, your drill press can double as a simple milling machine. Bolt a "dead center" to the press table, and you've got a small vertical lathe. This is a good way to make the Teflon® shoulder washers (Fig 1)—it's just a matter of learning to work vertically instead of horizontally.

The key to building this amplifier is to carefully measure and mark the locations of all holes. It is important to keep the tube socket locations in the several "layers" in proper alignment. A good way to accomplish this is to lay out the anode bypass plate (Fig 1), drilling small pilot holes for the tube centers, and then use this as a template to make matching holes in the anode cavity top and bottom plates (Figs 1 and 2). Locations of the Teflon shoulder washers and other critical holes are marked in a similar manner. The cathode line can be held in place by the hole for its support insulator, allowing location of the tube centers.

The air ducts are pressed into the aluminum walls in a vise. First drill out the walls with a smaller drill and then ream to accept the beveled end of the 3/8-inch tube approximately half way through the wall. When pressed in flush, the tubes lock in firmly and make good electrical contact with the wall stock.

The "slippery" characteristic of Teflon is used as a bearing surface to convert the rotary motion of the tuning micrometers to the push/pull motion required to move the tuning/loading drawer slides. Very little play is experienced using this method.

Finger stock used in the grid and cathode areas is Instrument Specialties no. 97-251. No. 97-251 stock can also be

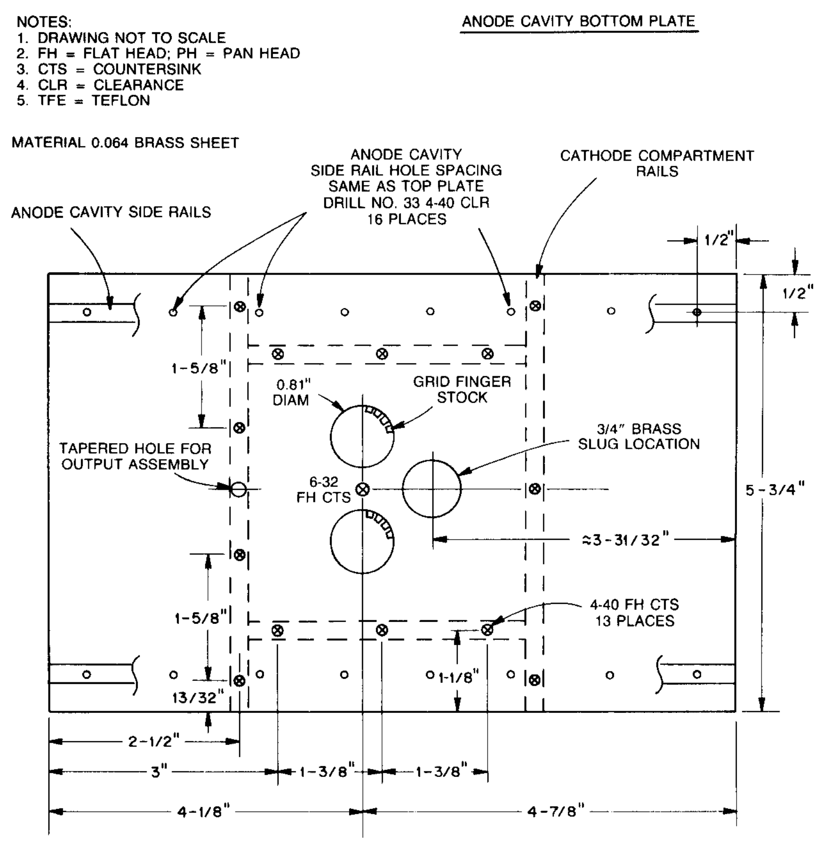

Fig 1—Construction information for the anode cavity bottom plate.

used on the tuning slides. The anode finger stock I used was obtained at a flea market and was already formed into a ring, but you can use Instrument Specialties no. 97-139 stock. Note that the hole sizes indicated in the drawings are for the specified finger stock only. If you use another type of finger stock, you must adjust the hole size accordingly.

A note of warning: *Do not use nylon shoulder washers on the anode bypass.* They *will* arc! Teflon washers work fine, even with 1400 V or more on the anode.

Tune-up and Results

Preset the load drawer to approximately ¼ inch away from the load stud and the tune drawer to approximately ¾ of the way out. Apply 500 V to the anode and adjust the bias circuit for a resting cathode current of 50 mA. Apply about 1 W drive power and adjust the cathode tuning control for maximum cathode current. Adjust the anode load and tune controls alternately for maximum output. Slowly increase the anode voltage and adjust the bias circuit to keep the resting cathode current around 50 mA. Repeak all controls. Increase drive. Input SWR can be adjusted by varying the BNC input connector disc spacing. At the 10 W drive level, with 1100 V on the anode, the cathode current should be approximately 290 mA. Power output should be around 125 W.

Notes

[1]R. E. Fisher, et al, "A Power Amplifier for 1296 MHz," *Ham Radio*, Mar 1970, pp 43-50.

[2]A set of full size templates for making the air plenum and most other amplifier parts is available from the author for a 9 × 12 inch self-addressed envelope and $1 to cover copying and postage costs.

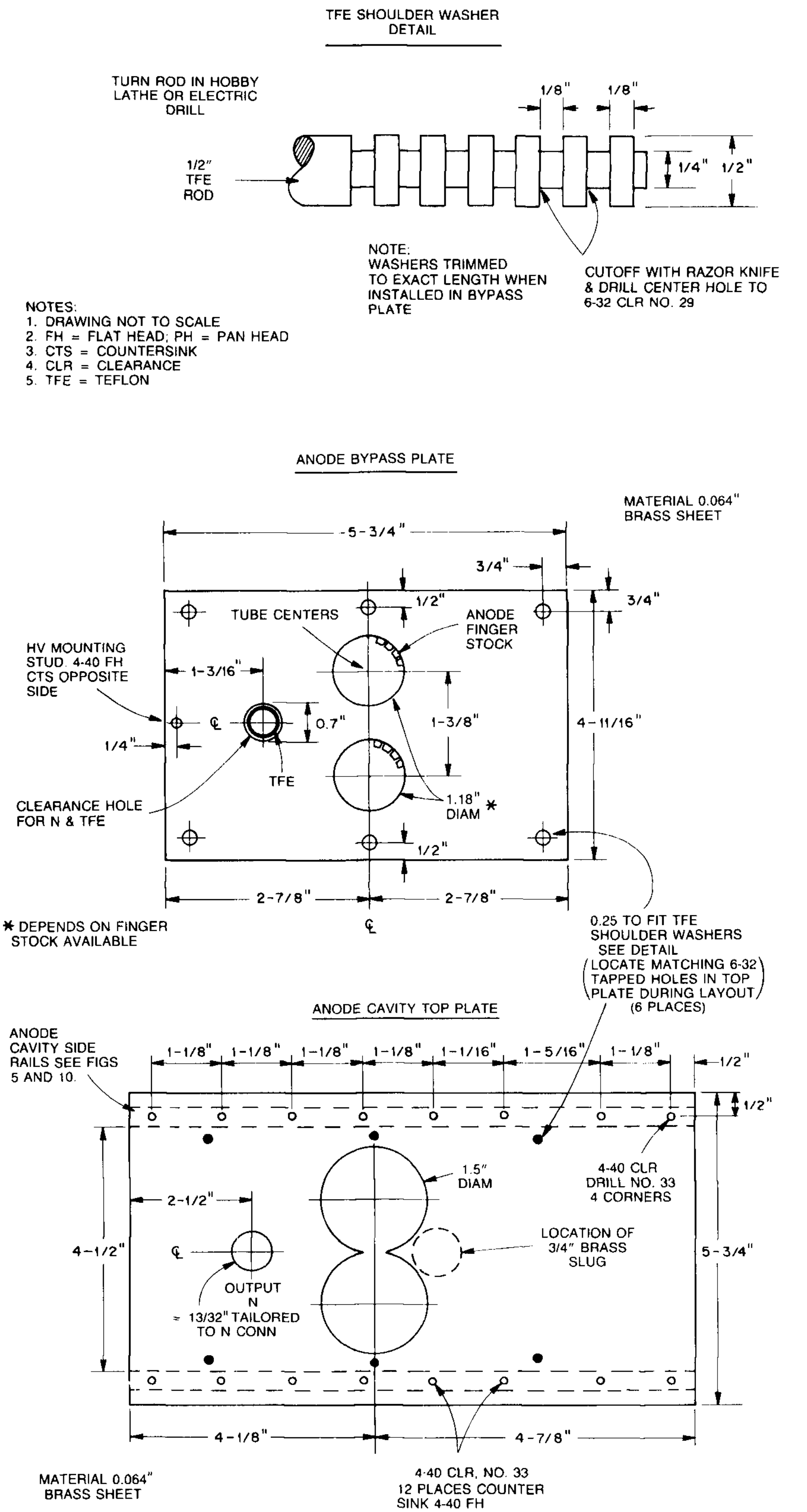

Fig 2—Details of the anode bypass plate and anode cavity top plate.

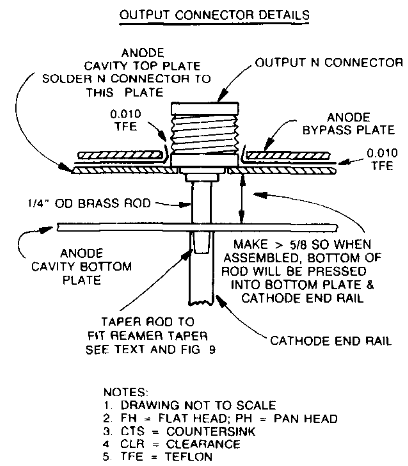

Fig 3—Output connector details.

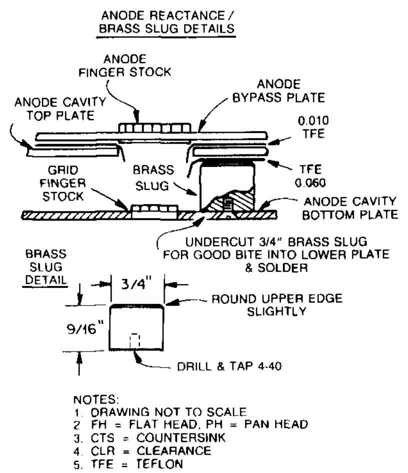

Fig 4—Construction and assembly of the brass slug that provides additional reactance in the anode cavity.

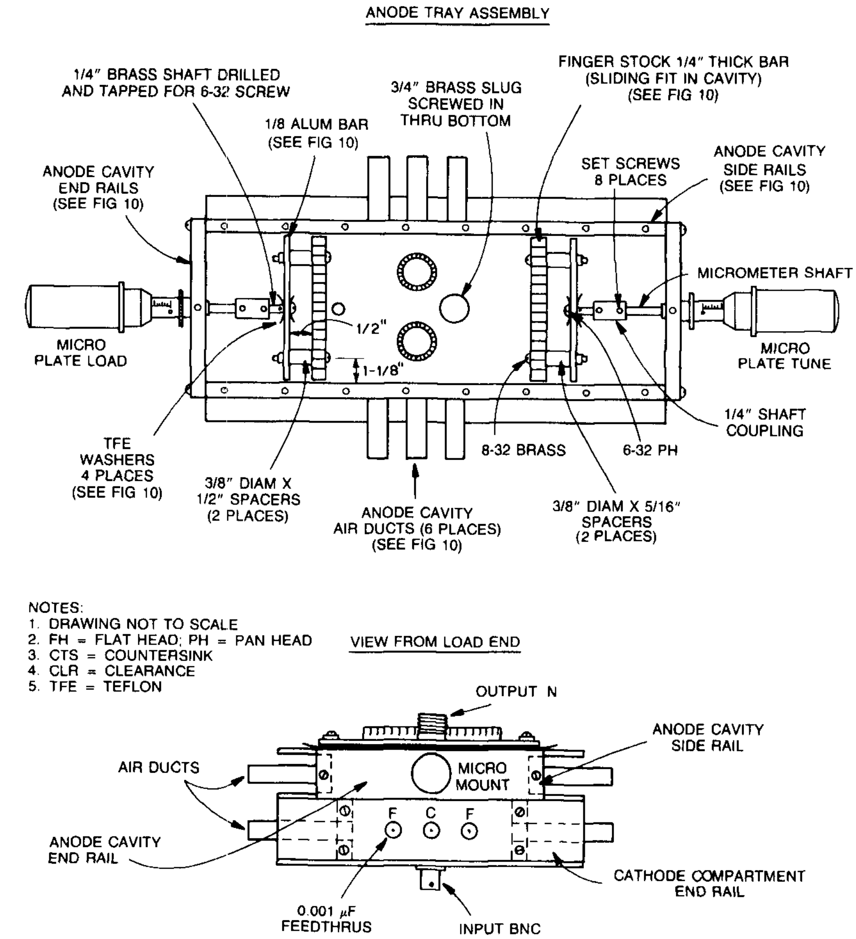

Fig 5—Assembly of the anode cavity.

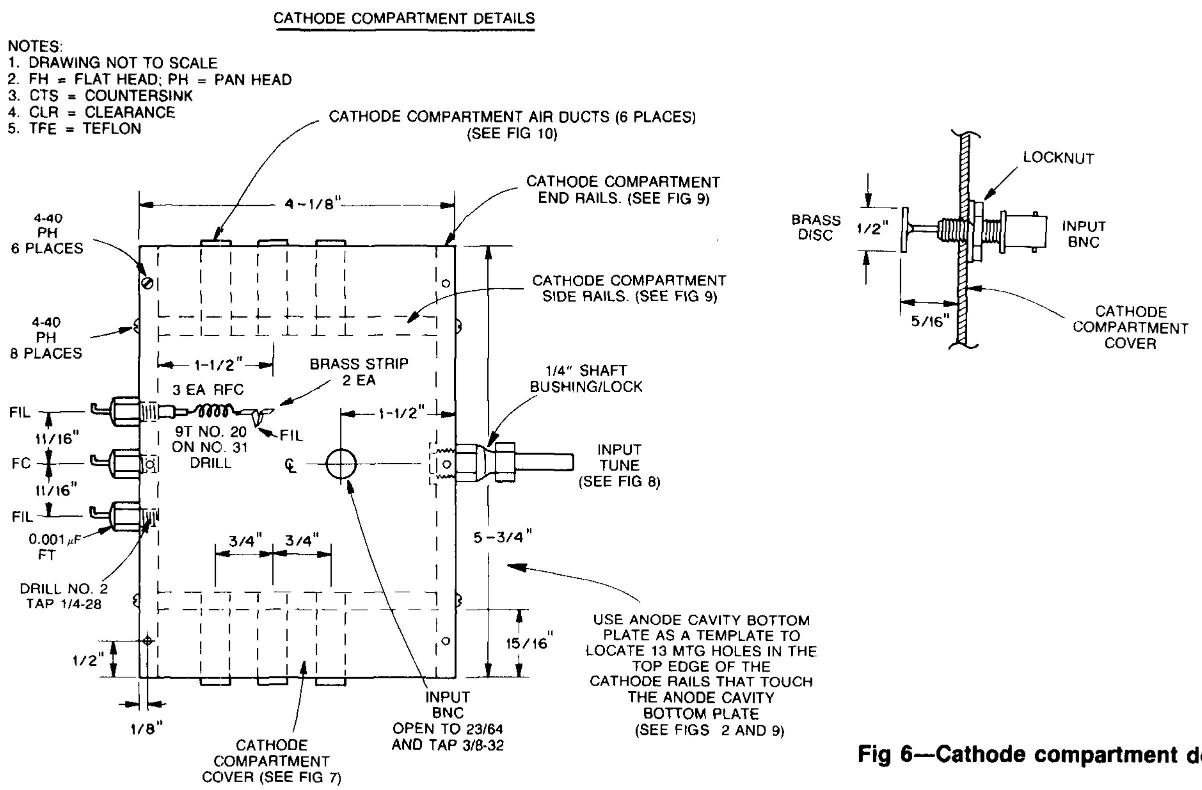

Fig 6—Cathode compartment details.

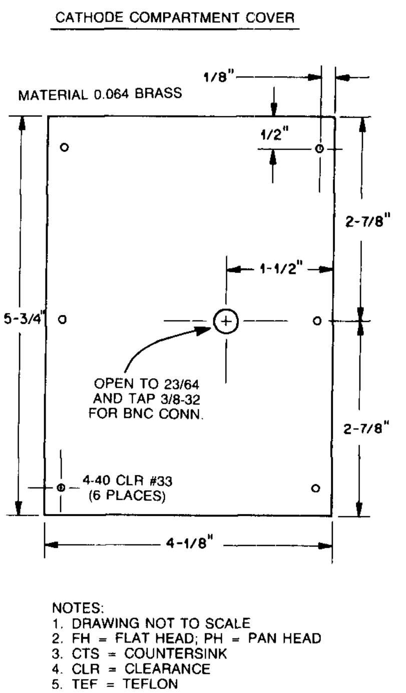

Fig 7—Cathode compartment cover drilling information.

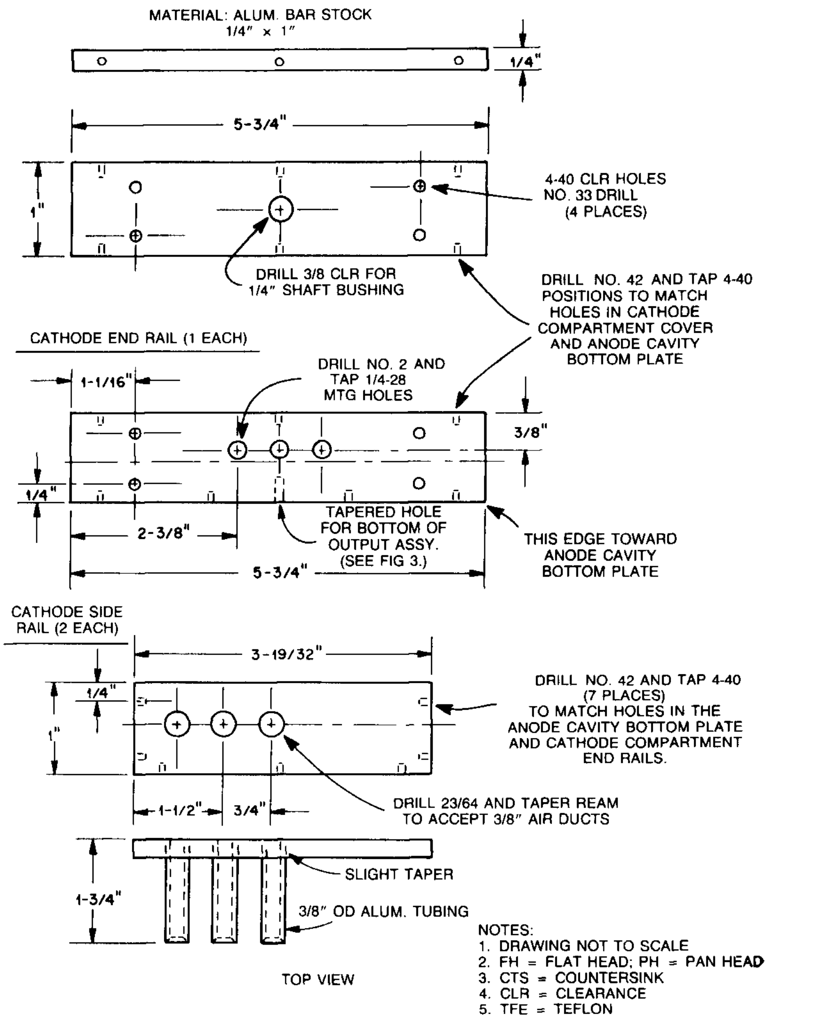

Fig 9—Construction information for the cathode compartment end rails, side rails and air ducts.

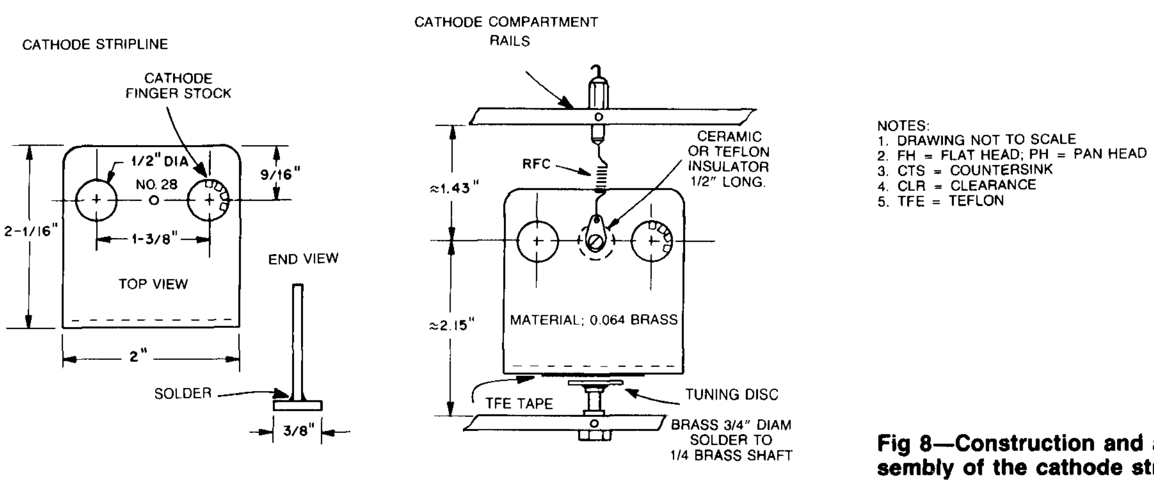

Fig 8—Construction and assembly of the cathode stripline.

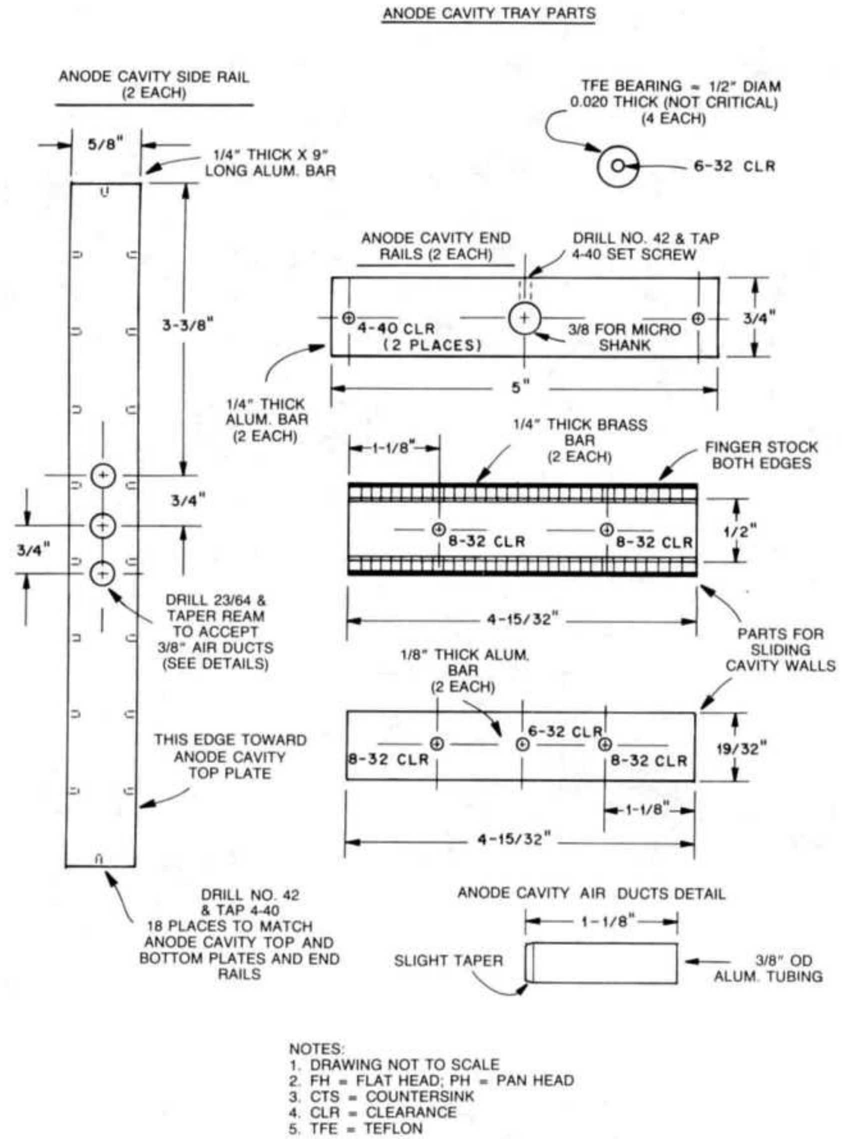

Fig 10—Construction information for the anode cavity parts.

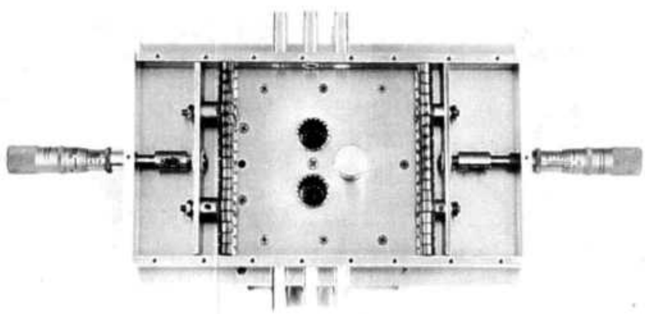

Fig 11—View of the anode cavity with the anode bypass plate and anode cavity top plate removed.

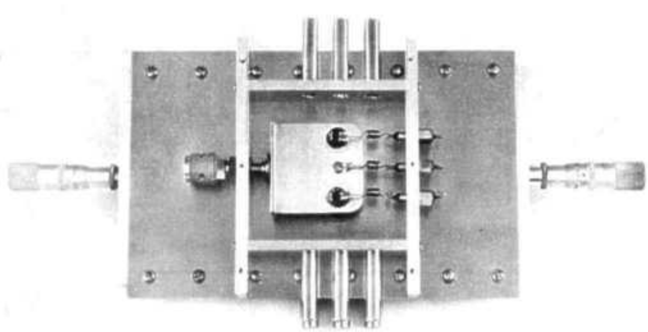

Fig 12—View of the cathode compartment with the cover removed.

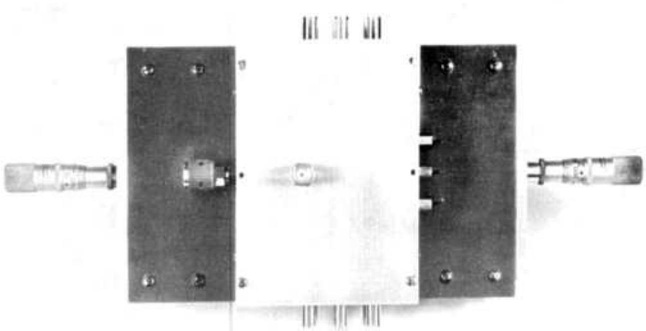

Fig 13—Underside of amplifier with the cathode compartment cover in place.

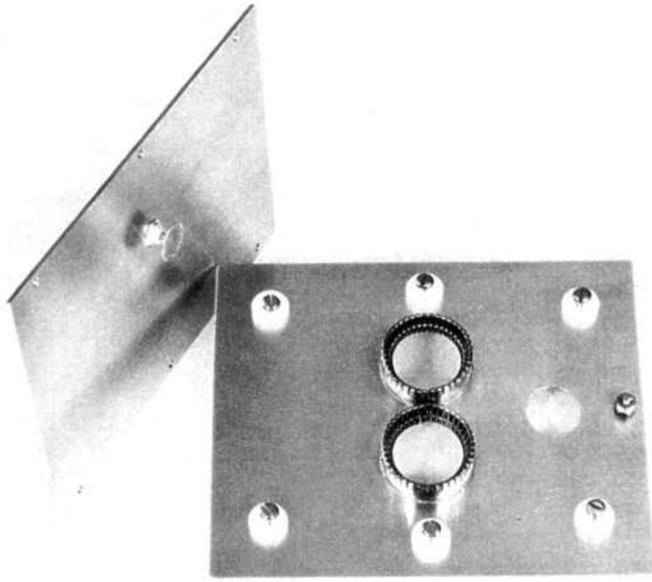

Fig 14—Cathode compartment cover and input coupling disc (left); assembled anode bypass plate (right).

Bits

Transpolar Skitrek and Project North Ski Communications

Between eleven and fourteen skiers (four Canadians and seven to ten Russians) have planned a skiing expedition from northernmost Russia to northernmost Canada via the North Pole. The skiers left Cape Arktichesky on the Svernaya Zemlya Islands in the Soviet Union around March 1, 1988, and will reach Cape Columbia on Ellesmere Island, Canada, between 90 and 100 days later.

The skiers prepared for their 1730-km journey by training in the Tien Shan mountains of Central Soviet Asia and at Frobisher Bay, Baffin Island. The skitrek was privately organized by "Komsomolskaya Pravda" (the Soviet youth newspaper) and the Polar Bridge Company of Canada, a group organized by the Canadian skiers. Their mission is a scientific expedition to make geomagnetic, glacial and meteorological observations, and to conduct experiments in physiology and biochemistry to determine the limits to human endurance and social isolation. Obstacles they face are open water, thin ice, pressure ridges, low temperatures (−50° C) and storms. All equipment, including tents, inflatable rubber rafts, sleeping bags, heaters/cookers, food, scientific equipment, navigation and communications gear, are contained in backpacks weighing from 80 to 90 pounds.

Supplies will be delivered in six air drops. Communication is via Amateur Radio. Support bases in Russia, Canada and on an ice island will be linked by packet radio. Navigation is provided by emergency locator transmitters search and rescue satellites (SARSAT) and their Russian equivalents (COSPAS), and the talking computer on board UoSAT-OSCAR 11. The skiers will hear their location using hand-held radios as UoSAT passes over about every 100 minutes. Celestial navigation will also be used when possible.

An exciting aspect of such an expedition is bringing Amateur Radio into the classroom. Necessary equipment is a hand-held 2-meter transceiver and a whip antenna. You won't need transmit capability to receive the UoSAT Digitalker. A prediction sheet for your location that covers the entire three-month-plus skitrek period beginning March 1 is included in an information packet available upon request. All suitable passes of UoSAT-OSCAR 11 will take place between 8 AM and Noon local time.

Involve the students in making a map of the polar area where the skiers will journey, and plot the trek's progress as you receive positions from the Digitalker. A basic map that can be converted to an overhead transparency or enlarged on an opaque projector is included in the information packet. A special postcard commemorating your reception of the Digitalker will be available from the Canadian Radio Relay League. For your information packet, write Richard C. Ensign, AMSAT Science Education Advisor, 421 N Military, Dearborn, MI 48124, tel 313-278-0900 (during the school day) or 313-274-1718 on weekends.—*Tnx Richard Ensign*

LEMO Connectors

LEMO electronic connectors come in a variety of sizes, including multi- and mixed-contact configurations, coaxial, triaxial, plastic, fiber optic, environmental, high voltage, thermocouple and pnumatic/fluidic. Custom designs and cable assemblies are also available. LEMO connectors are not cheap, but are well-suited for applications where quick connect-disconnect is important and where connectors are frequently engaged and disengaged. For more information on LEMO's family of electronic connectors, contact LEMO USA, Inc, 335 Tesconi Circle, PO Box 11488, Santa Rosa, CA 95406, tel 707-578-8811.—*Maureen Thompson, KA1DYZ*

By Bill Olson, W3HQT
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RF Filters for VHF and UHF: An Overview

RF filters are one of the most important passive components in any modern radio circuit. Since there are volumes—probably whole libraries—written on the subject, I'm certainly not going to try to be comprehensive here. Instead, I will explain what filters are and why they are important, and then describe a few designs that are useful to VHF or UHF experimenters.[1]

To generalize, a filter is simply a component or circuit with the ability to pass one band of frequencies while rejecting another. Filters fall into four basic categories: band-pass, band-stop (or notch), low-pass, and high-pass. The names are fairly self-explanatory—see Fig 1.

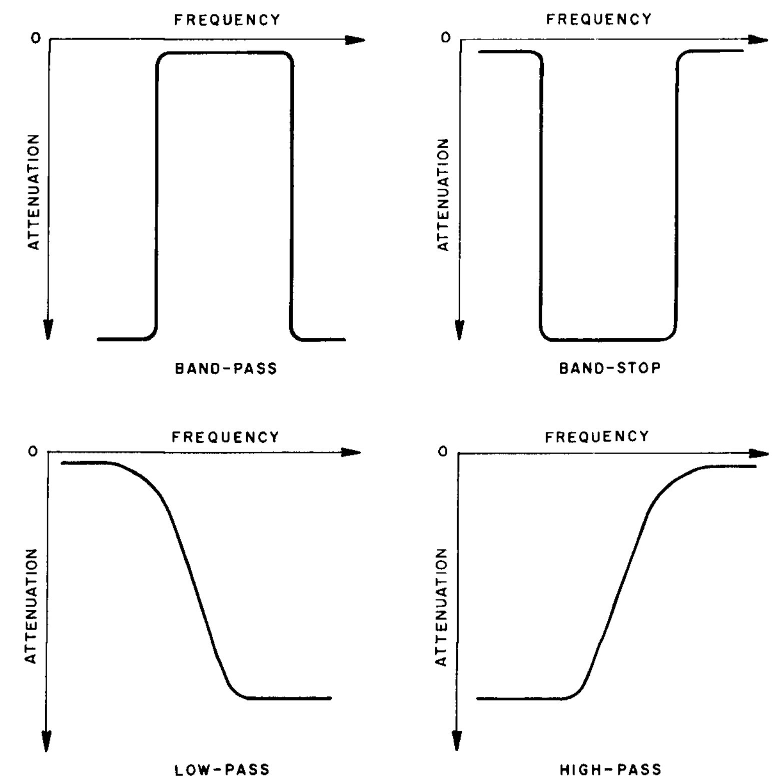


Fig 1—Frequency versus attenuation characteristics of filters.

Filter Parameters

Filters are usually specified as to their bandwidth, cutoff frequency (or passband or stopband) and insertion loss. In addition, filter designers are often interested in the attenuation ripple within the passband and stopband, as well as attenuation at various points outside the passband.

Ideally, we want a filter that totally rejects one set of frequencies (the stopband) and passes the rest with no attenuation (the passband). In the real world, however, there is a transition frequency range between the passband and stopband. This characteristic is usually described by specifying bandwidth at various attenuation levels. For example, a filter might be described as having a 3-dB bandwidth of 2 MHz and a 40-dB bandwidth of 10 MHz. See Fig 2.

Also remember that an RF filter is a reactive device; it has low SWR in the passband and high SWR in the stopband. A filter reflects signals in the unwanted range back to the source. In cases where reflections back to the source are a problem, we can use a *diplexer filter*. A diplexer reflects undesired signals into a resistive load, thereby keeping the filter SWR low over a very wide range of passband and stopband frequencies.[2]

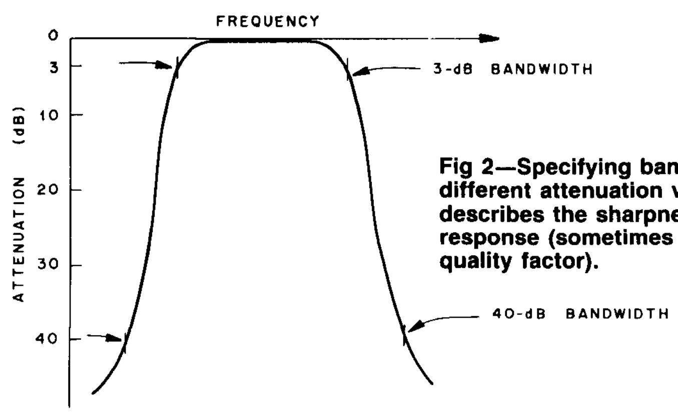


Fig 2—Specifying bandwidth at different attenuation values describes the sharpness of filter response (sometimes called Q, or quality factor).

Filter Applications

Filters can be very simple or very complicated. Each type has its place in modern VHF or UHF equipment. Filters are used everywhere in modern radios—from local oscillator (LO) chains, to amplifier stages in receivers and transmitters, to antenna lines. See Fig 3. Although the basic purpose is the same—to suppress unwanted signals—various applications require different kinds of filters.

Receivers

In receivers, we are mainly concerned

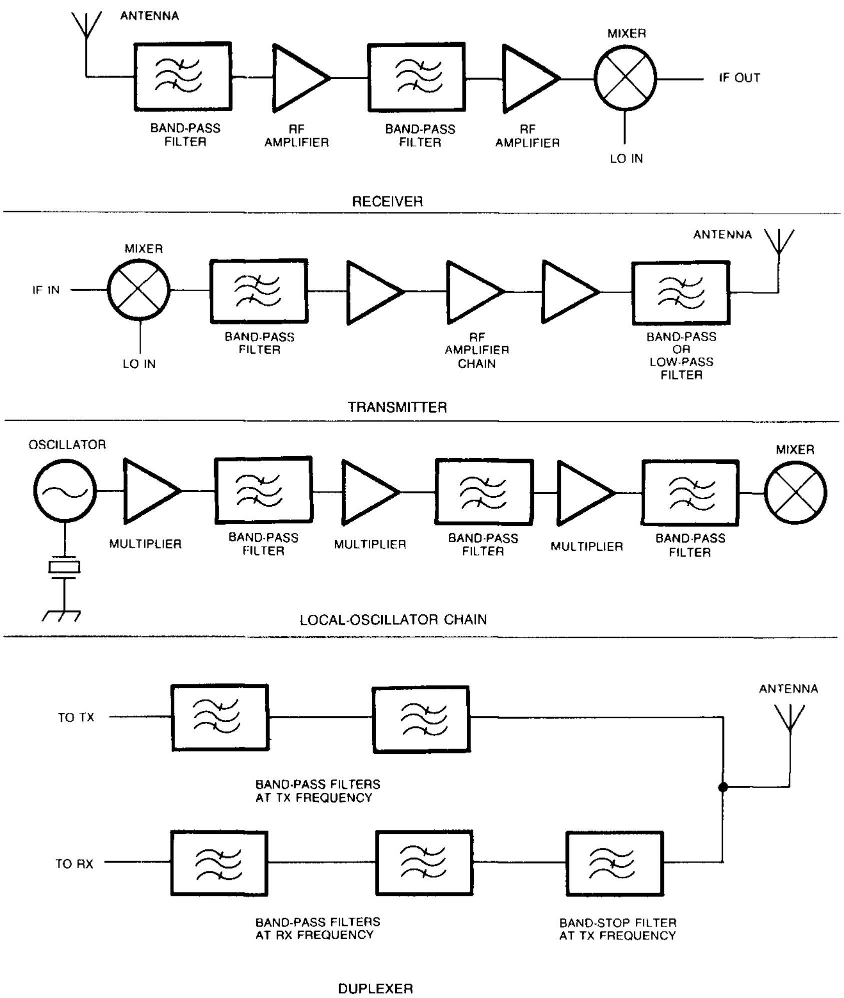


Fig 3—Common filter uses in VHF and UHF equipment. See text.

with suppressing signals at frequencies other than those we want to hear. High RF levels abound, and those who are not lucky enough to live out in the sticks in a relatively RF-free environment know about this! Signals from sources such as FM broadcast and television stations, radar, land-mobile repeater installations and nearby amateurs(!) can wreak havoc on your receiver. These strong out-of-band signals can degrade the dynamic range of a receiving system by overloading the front end or following stages and hurting weak-signal performance. They can also cause unwanted mixing products in the receiver, producing "birdies" in the receiver passband. (Usually, one of these birdies is right where you are about to run a sked with someone in a new grid or state!) A filter in the receiver front end can keep the out-of-band signals out of the receiver, eliminating the overload problem and helping with the mixing problem. Additional interstage filtering can make the birds fly away.

Remember that noise is an unwanted signal too, so front-end filtering and interstage filtering also improve signal-to-noise ratio. This is especially true in a receiver where the IF is low enough that noise at the image frequency can get into the mixer and raise the system noise figure.

You don't get something for nothing, though. A lossy filter in front of your receiver will degrade its noise figure and gain. It's safe to say that front-end filters are always designed for low loss so they don't adversely affect receiver sensitivity. So, here is a trade-off for the designer to play with.

Most receivers have additional filtering at one or more of the IFs to provide selectivity. Usually, the selectivity is obtained by using crystal or mechanical filters.

Transmitter Filters

In the transmitter we are mainly concerned with keeping the transmitted signal clean—we want to transmit only the desired signal and no others. The objective here is to comply with FCC rules and to avoid interfering with other hams or other services. In addition, however, transmitting a lot of garbage along with the desired signal can lower the gain of transmitter amplifier stages, degrade the linearity of these stages and cause power-measurement equipment to give inaccurate readings.

Even relatively low-level harmonic output from an amateur transmitter can get into a broadcast or TV receiver. A band-pass or low-pass filter at the transmitter output can often clean things up.

Local-Oscillator Chains

In a local oscillator, filters are used after the multiplier stages to pass the desired multiple and reject the others. This helps to keep unwanted signals out of the transmitter amplifier chain. In a receiver LO, filtering keeps unwanted signals and birdies out of the receiver. All spurious products and subharmonics should be at least 40 dB below the carrier in a good LO design. More can't hurt!

Special Uses

A few other filter uses are popular among hams. The first that comes to mind is a filter for preventing TVI and other interference to consumer electronic equipment. TV receivers are usually much more susceptible to overload than amateur receivers, and a perfectly clean amateur signal can completely wipe out the front end. High-pass and notch filters are usually used here.

Another special use of filters is to allow the simultaneous use of one antenna on both transmit and receive in a duplex system. In the ham world, most duplex systems are repeaters where the same antenna is used for the receiver input and transmitter output. Transmitter and receiver frequencies are usually separated by only a few percent. A *duplexer* is a high-selectivity filter that separates the transmit and receive signals, and keeps the transmit signal from overloading the receiver (possibly burning out the receiver front end!).

Next month I will discuss some standard filter designs and show where each is used. Then I plan to show some of the new computer-generated filter designs and describe the advantages and limitations of each.

Notes

[1]The amateur handbooks are a good place to start to learn more about filter design. The reference material listed in the bibliographies at the end of the filter chapters will probably give you more detailed information than you want.

[2]Paul E. Drexler, WB3JYO, "The Diplexer Filter: A method for Enhancing Double Balanced Mixer Performance," *Proceedings of the 1987 Mid-Atlantic States VHF Conference*, available from the ARRL.

VHF+ Technology

By Geoff Krauss, WA2GFP
16 Riviera Drive
Latham, NY 12110

Update on TWTA Information Requests

To date, six readers have responded to my plea[1] for a copy of a Hughes 1177 TWT amplifier operating manual. The information I received was distributed to those who requested it. Some previously unknown TWT owners came forward after seeing that others were interested in the same type of information. We thank these helpful VHF+ers! Maybe we can look forward to hearing more 2-plus GHz activity in the next contest!

I also received information on the Collins-Rockwell TWT (no. 257-0163/Varian VTX-2612) for X-band use, its companion power supply 270-0479, Varian TWTs and amplifiers. *Please* include an SASE with your inquiry! I will try to answer your questions in other areas as well, although you may find that the "Strays" in *QST* is widely read and may be a better place to ask for help.

Another Method for Getting on the Microwave Bands

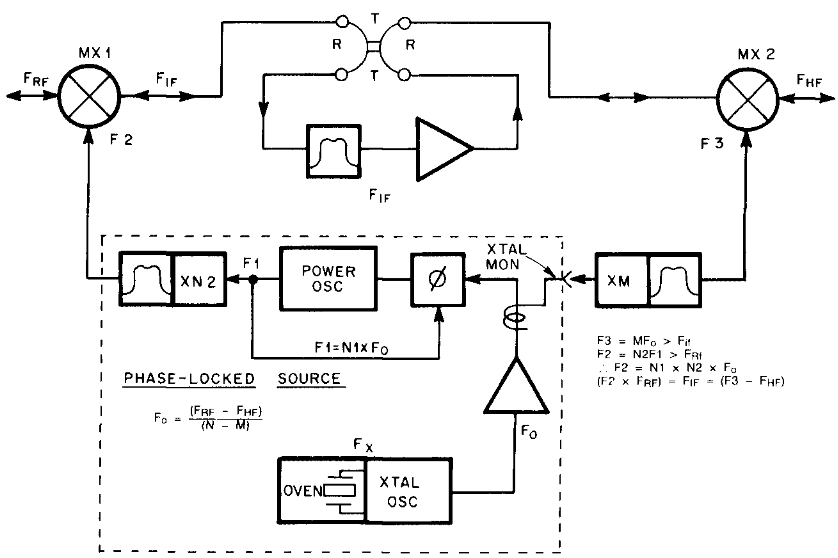
Highly-stable phase-locked oscillator/multiplier units seem to be more available to amateurs. Sellers of these surplus commercial units can be found in VHF+ data sources. One ad in *QST* led VHF+ers to surplus from a large, well-known Texas manufacturer of microwave equipment. The sources advertised provided about +10 dBm output at one of 4, 6 or 11 GHz, with the frequency set by a TO-5 can fifth-overtone crystal in an internal oven. (The frequency can be changed by using "standard" units available from a crystal manufacturer, such as International Crystal Manufacturing Co.)

Several callers have wondered if listed sources could be recrystaled and retuned to a lower, ham-band frequency. One unit, for example, was listed to work between 3.85 to 4.2 GHz, well above the 3.456-GHz weak-signal frequency for the 9-cm band. As it turned out, the power oscillator (that runs at about 1.0 to 1.5 GHz and is locked to the crystal oscillator operating at about 100 MHz), cannot be lowered sufficiently to put the source at 3456 MHz. For these particular units, it is also impossible to lower the 5.85-to-6.45-GHz source to 5.76 GHz, or the 11.2-to-11.7-GHz source to 10.368 GHz, the weak-signal frequencies in the 6-cm and 3-cm bands. Does this mean that such nice VHF+ equipment must go to waste and not be used? Of course not!

One idea is to use these sources for high-side local oscillators for heterodyne-type up and down converters. If we use the X-band source (a Frequency-West MS-76X, with a multiplication factor of 108) at 11664 MHz (crystal frequency equal to 108.0 MHz) and subtract a 1296-MHz signal, our result is a 10368-MHz signal. This is acceptable for CW, FM and so on, but not for SSB. With SSB, the desired sideband will be inverted—a standard USB signal at the IF (1296 MHz) is reversed by high-side mixing and appears as a nonstandard LSB signal at the output (difference) frequency (10368 MHz).

If both the transmit and receive station know that the sense of their signal sidebands are inverted, there is no problem. There may be difficulties, however, for random-QSO usage. A VHF transceiver may be required if the IF falls in a VHF ham band. Overloading and similar problems may be expected in a multiband contest situation (which is when this type of equipment is likely to be used).

Another use for the phase-locked oscillator/multiplier units is to use them as a double-conversion heterodyne unit with a common oscillator for both mixers, as shown in Fig 1. This configuration runs smoothly if an "oscillator-sample" output is available on the source. If a sample of the crystal frequency (F_x or F_o) is not available, signal pickoff can almost always be added. By using a combination of doublers and/or triplers on the picked-off signal, the injection signal, F3, can be relatively easily provided to the second mixer, MX2, while the normal source output signal, F2, is coupled to the first mixer, MX1. This scheme causes double-inversion of the sideband sense, which results in *no* inversion. It also allows for the use of an IF that is close to the optimum (geometric mean of the final high frequency F_{rf} and the final low frequency F_{hf}), for ease of adjusting F_{if} signal amplitude and frequency characteristics (ie, image filtering). Because most of these "bricks" are capable of oscillator frequency adjustment, I use a *slightly higher crystal frequency*, F_x, and "pull" the oscillator output frequency, F_o, down to set the resulting F1, F2 or F3 frequency to specification. (The fre-



F_{RF}	N	M	F_{HF}	F_o	F_{IF}	F2	F3	F_X
3456.0	39	6	28.200	103.872	595.036	4051.036	623.236	103.875
5760.0	60	4	28.400	102.350	381.00	6141.000	409.400	102.353
10368.0	108	8	28.500	103.395	798.66	11166 660	827.16	103.398

Fig 1—A double-conversion heterodyne unit with a common oscillator for both mixers. See text for an explanation of how this setup works.

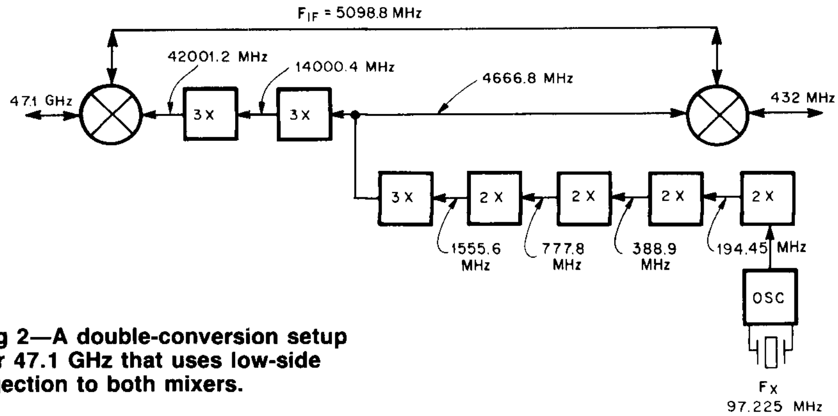


Fig 2—A double-conversion setup for 47.1 GHz that uses low-side injection to both mixers.

quency that is set depends on which is most readily available for monitoring.) Note that I have set the F_{hf} frequencies to be slightly different. This reduces breakthrough if two or more bands are in use at the same time and in the same location.

This idea can be used for other bands and with other types of sources. Fig 2 is one possible double conversion setup for 47.1 GHz that uses low-side injection to both mixers. Because of the narrow band now available (47.0 to 47.2 GHz), wide-band high-drift sources, like most Gunn oscillators, are not usable.

State of the Art

Bill Olson, W3HQT, covered the 33-cm band (902 to 928 MHz) generally well.[2] Only a few additional observations should be made: Complete transceivers (FM or multimode) are not now commercially available, because of the nonavailability of this band in most countries. Presently available transverters have fairly high transmitter intermodulation products, that are acceptable only at the present relatively low levels of band activity. Receiver converter noise figures could, and should, be lower; more work needs to be done on providing unconditionally stable LNAs. Note that power amplifiers with output power approaching the legal limit are not available, as amateur-affordable tubes do not exist; however, a pair of water-cooled 7289s should be capable of 300-plus watts. The biggest area of choice and experimentation? Antennas! The 33-cm band is just about at the point of crossover between Yagi (linear *or* loop elements?) versus parabolic dish (solid *or* open mesh?) electrical and mechanical performance.

Notes

[1]G. Krauss, "Traveling Wave Tubes," VHF+ Technology, *QEX*, Dec 1987, p 15.

[2]B. Olson, "33-cm Band Survey," >50, *QEX*, Feb 1988, p 12.

Book Review

The National Radio Club's Antenna Pamphlets

Published by The National Radio Club, Publications Center, PO Box 164, Mannsville, NY 13661. Pamphlets 5½ × 8½ inches, $3.50 each.

Low-band DXers are continually looking for the best antenna designs for pulling weak signals out of the mess of domestic stations. AM broadcast-band DXers face competition from the din of local 50-kW rock "n" roll stations; many have spent hours finding antenna designs that work for them. The National Radio Club (NRC) has published many of these ideas in a set of four pamphlets.

The NRC is a 50-plus year old broadcast-band DXer's club. Many NRC members are hams. The information presented in most of their technical pamphlets are not simple-minded presentations for non-technical readers. Some are quite technical and include a mathematical background to back up the verbiage. Here's a look at what's available.

The NRC Antenna Reference Manual—Vol 1

R. J. Edmunds, ed., 4th ed, 1982, 59 pages.

This volume is devoted mostly to air-core loops and detailed construction information on the NRC 2- and 4-foot FET Altazimuth loops. The 4-foot loop has impressive performance characteristics, especially its null depth.

The NRC Antenna Reference Manual—Vol 2

R. J. Edmunds, ed., 1982, 55 pages.

The discussion on air-core loops and loop preamplifiers continues from Vol 1. Information on phased Beverages and phased short-wire antennas is included, as is construction information on the phasing units, which should be easily adaptable for 160 to 80 meters.

Beverage and Longwire Antenna Theory and Design

M. J. Knitter, ed., 1983, 49 pages.

As is obvious from the title, the main theme of this pamphlet is the Beverage antenna (and the phased Beverage). Over 30 pages are devoted to a comprehensive discussion of the Beverage, its patterns, and angles of signal arrival. A discussion of the results achieved by using a good Beverage for AM band DXing completes the pamphlet.

Loop Antennas, Design and Theory

M. J. Knitter, ed., 1983, 62 pages.

This pamphlet covers air-core and ferrite-core loop antennas. The discussions include modifying loop directional patterns, multi-rod ferrite loops, using loops in skywave direction finding, problems encountered with homemade loops and their suggested solutions.

Two drawbacks of the pamphlets are the artwork and the print. The artwork is not professionally prepared and the graphics sometimes requires interpretation. Some of the print is small—I kept a magnifier handy for reading. For the price, however, you can't beat the information. If you're looking for antenna ideas, these inexpensive pamphlets are worth a glance.—*Domenic M. Mallozzi, N1DM, 26 Carey Ave, Apt 8, Watertown, MA 02172*

Components

By Mark Forbes, KC9C
ETO, Inc
PO Box 888
Cañon City, CO 81212

Veteran readers of *QEX* will remember the "Components" column that I authored during its first 1½ years of publication. Since then, I have worked in the disk drive industry and was the editor of a computer trade magazine. Currently, I am the Director of Marketing for ETO, manufacturers of the ALPHA line of Amateur Radio linear amplifiers. It's great to be back in the pages of *QEX* and closely associated with Amateur Radio again.

Through my writings in this bimonthly column, I hope to keep you apprised of developments in circuit components that are of use to the Amateur Radio experimenter. Most of the components that I discuss will be new RF and digital devices, microprocessors, packet radio devices, batteries, enclosures and everything in between. At times, I'll discuss products that are not new, but may be unfamiliar to the ham community.

Although I am an active electronics experimenter and builder, I don't always have the opportunity to design and build circuits with most of the components that appear in this column. The data is presented as supplied to me by manufacturers. I can't make any claim for the reliability of the data from a user's point of view, except on rare occasions. If you have any comments, questions or criticisms, drop me a line or give me a call.

FM Receiver on a Chip

Motorola has introduced the MC3362, a new FM receiver on a chip. The MC3362 can be used as the heart of a quality amateur FM receiver. Power supply voltage is 2 volts and maximum current drain is only 35 mW!

The MC3362 contains a dual-conversion circuit that provides the entire FM receiver section from the antenna-input signal to the audio-preamp output. Direct inputs up to 180 MHz can be handled by the MC3362. With an external local oscillator, you can use the circuit through the 70-cm band.

In addition to providing all receiver functions, the chip has a signal-strength output and comparator circuitry for demodulating FSK data at up to 30 kbit/s. The best part of all is the price: In quantities of 100 the MC3362 sells for $1.80. Small-quantity lots may be available for under $10. For more information on the MC3362, contact Motorola, Inc, PO Box 52073, Phoenix, AZ 85072, tel 602-897-3842.

Radio Shack™ also sells an FM receiver on a chip—the TDA7000 (RS 276-1304). This circuit isn't as sophisticated as the Motorola part, but may be easier for most people to acquire. The TDA7000 includes an RF mixer, IF and demodulator, and sells for $5.95.

Double-balanced Mixer and RF Switch

Mini-Circuits has available two products for ultraminiature RF applications (the RMS-1 and RMS-2). The RMS-1 is said to be the "world's smallest surface-mount mixer." RF transformers and a four-diode array are mounted inside a package about the size of a four-pin, minidip bridge rectifier. The result is a double-balanced mixer. RMS-1 covers 500 kHz to 500 MHz and RMS-2 handles 5 MHz to 1 GHz. Both devices sell in the $10 range.

The KSW-2-46 RF switch is also available from Mini-Circuits. While PIN-diode switches can become ineffective below 1 MHz, the KSW-2-46 switches in 2 ns from dc to 6 GHz. Insertion loss is 1 dB and it provides 50 dB of isolation, with a typical SWR of 1.3:1. Control voltages are −5 V dc (on) and 0 V dc (off). These little switches can be handy, but aren't cheap. . . single pieces cost $32.95. For more information on the RMS-1, RMS-2 and KSW-2-46, contact Mini-Circuits, PO Box 350166, Brooklyn, NY 11235-0003, tel 718-934-4500.

Nine-volt Lithium Battery

Kodak, along with Tauber Electronics, has introduced the first 9-V lithium battery. It is packaged in a standard rectangular package, with top-mounted terminals. The battery can last up to 200% as long as alkaline batteries, and because of self-discharge loss of only 2% per year, it has a shelf life of 10 years. For more information on the 9-V lithium battery, contact Kodak/Tauber Electronics, Inc, 4901 Morena Blvd, Ste 314, San Diego, CA 92117, tel 619-274-7242.

DTMF Decoder

Radio Shack sells the Silicon Systems SSI-202 dual-tone multifrequency (DTMF) decoder chip (RS 276-1303). I have built several decoders with this chip and its predecessor, the SSI-201.[1] The SSI chips use switched-capacitor filtering for minimum external parts count and maximum reliability. Clocking for the switched-capacitor filters is provided by an on-board oscillator and an external 3.58-MHz color-burst crystal.

Output can be in either hexadecimal or binary coded 2 of 8. This circuit is simply the best DTMF decoder I have worked with. The SSI-202 chip is extremely reliable and will work with quite a bit of noise on the signal. The SSI-202 decoder chip sells for $12.95.

Notes

[1] V. Yakamavich, "Professional Quality DTMF Decoder and SELCALL System," *QST*, Feb 1988, p 19.

Bits

Inexpensive UHF Spectrum Analyzer

Penntek Instruments has introduced its new SA-500E 550-MHz spectrum analyzer. With your X-Y display or oscilloscope connected to the SA-500E, you're allowed frequency domain signal viewing with an on-screen dynamic range of 70 dB. The display center frequency is adjustable from 1 to 550 MHz. A precision 70-dB front-panel RF input step attenuator is included as is crystal-controlled frequency markers at 5- and 50-MHz intervals. Uses for the SA-500E include measuring harmonic signal levels, finding spurious signals, CATV signal level measurements, off-the-air signal analysis, production test and alignment and two-way radio servicing. Price and availability is $1495, delivery stock to 3 weeks. Contact Penntek Instruments, 14 Peace Dr, Lewistown, PA 17044, tel 717-248-2507.—*Maureen Thompson, KA1DYZ*

Bits

Newest OSCAR Readied For June Launch

Final preparations are being made for shipping AMSAT's Phase 3C spacecraft to South America for launch. The most powerful OSCAR ever built will be lofted to orbit from the European Space Agency's (ESA) Kourou, French Guiana launch site.

The launch vehicle will be an Ariane 4 rocket, the largest ESA has ever flown. This will be the twenty-second flight of such a rocket, and is designated V-22. The 300-pound AMSAT spacecraft, one of three satellite payloads on Ariane, will eventually operate from a high elliptical orbit, and will complete just over two orbits of earth per day.

The new AMSAT satellite has four separate transponders (repeaters) covering frequencies from 145 MHz to 2.4 GHz. A packet radio transponder is one of the four. One transponder will be capable of carrying more than 75 simultaneous QSOs. Another transponder can be used on FM and could be suitable for beaming bulletins for relay by terrestrial VHF repeaters.

Phase 3C will get its OSCAR designator number after it is successfully operating in orbit. That should occur about 30 days after launch.

The satellite should operate for more than 5 years. Upgraded computer memory chips are "hardened" for the severe radiation encountered in orbit.

This satellite is the third in the Phase 3 series. Phase 3B became AMSAT-OSCAR 10 upon its successful launch in 1983.

On-air coverage of the June launch will originate with a network of stations around the world, including ARRL HQ station W1AW. Repeater systems can link into the network via landline circuits.

Besides routine QSOs, Phase 3C will be used for so-called "Techno-Sport" activities. These on-air competitions emphasize technical skills and recognize superior ability with plaques and awards. The AMSAT "ZRO-Test" tests a station's receive sensitivity by sending successively weaker signals from the satellite. The new "SatFox Test" is a version of fox and hound transmitter hunting done by satellite. More Techno-Sports are in the planning stages.

AMSAT Phase 3C is a joint project of AMSAT North America (founded in 1969) and AMSAT DL, with additional contributions from other AMSAT affiliated organizations. The project cost more than $400,000. Initial design of the Phase 3 generation of OSCARs began in the mid-seventies. (For more information, or to be placed on AMSAT's mailing list for press releases, contact AMSAT HQ, PO Box 27, Washington, DC 20044. Call 301-589-6062 during business hours.)—*Tnx Vern Riportella, WA2LQQ, President AMSAT-NA*

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A Marker Tailored for Flat Ribbon Cable

Paper and polyester labels stick poorly to ribbon cable's ribbed surface. Wrap-around markers limit the cable's flex range. Cabelabel™ solves these problems at a low cost. A clear vinyl cover that securely seals over a white write-on area is soft and flexible to conform to the corrugated cable surface and stretches as the cable is bent. The cover also protects the label from dirt, abrasion and other oils or fluids that may deface the label. Operating temperature range is −55 to +125 C. Cabelabel sizes range from 1.8 inch × 1.8 inch to 1.8 inch × 0.25 inch. Quantities vary from 36 to 108 per set, depending on size. Price per set is $7.80. Contact the DATAK Corp, 3117 Patterson Plank Rd, N Bergen, NJ 07047, tel 201-863-7667.—*Maureen Thompson, KA1DYZ*