16 July 83

ATCO NEWSLETTER

-SPECIAL EDITION-

23CM NOTES

In the past few months, there has been increasing interest in the 23CM band(1250mhz). The use of the band includes such things as full duplex with 439, remote links, repeater links and cross band repeaters (much easier than in-band repeaters). Most of the ATV repeaters on the West Coast are cross band machines.

These notes are from my file that I started about a year ago and include a cross section of topics from antennas to pre-amps and triplers. Most of the techniques we have learned on 439 still work on 23CM (this is probably the last band going up that yagis still work). Coax loss is a much bigger problem on 23CM than 439, but higher gain antennas for their size is a possibility. The band opens up <u>more</u> on 23CM than 439mhz through tropospheric ducts.

These notes are being sent to you because I caught you at least talking about 1250mhz at one time or another! My reason for putting together these notes is simple: I think I have a operational station on 1278.75mhz and there is no one to exhange video with! (Although Dale, WB8CJW has heard my 1296 SSB and seen my 1278.75 A5 signal - I have also seen W8DMR's signal generator signal!) Taking my normal 439 mobile gear mobile with a tripler and a 23CM antenna provided P2 pictures over a three (3) mile path. Dale, WB8CJW, who was operating my station, retransmitted my 23CM mobile signal on 439 so I could watch my own signal in the mobile!

439.25/1278.75 REPEATER

It is currently planned to aid the BancOne Marathon on October 16, 1983 by providing video coverage for the marathon officials and the press. The only way to do an effective job of covering the 'run' is with a repeater. The plan calls for mobile stations along the route to transmit on 439.25 to a cross band repeater located on a building downtown. The repeater would retransmit the mobile stations on 1278.75mhz to the 3 "monitors" at strategic locations in the downtown area. The repeater after the marathon, would be used as a cross band repeater with plans to link it to the WB8LGA ATV machine as a remote receive site.

I still need five to six "volunteers" to man both the mobile station and the "monitors" in the downtown area. This event should prove to be great exposure for ATV and I really need your help - not only that, but it is lots of fun!!

If you have any notes that you think maybe of interest to others, please send them to me and I will update this package.

C U on 23CM

73
Ken, WA8RUT

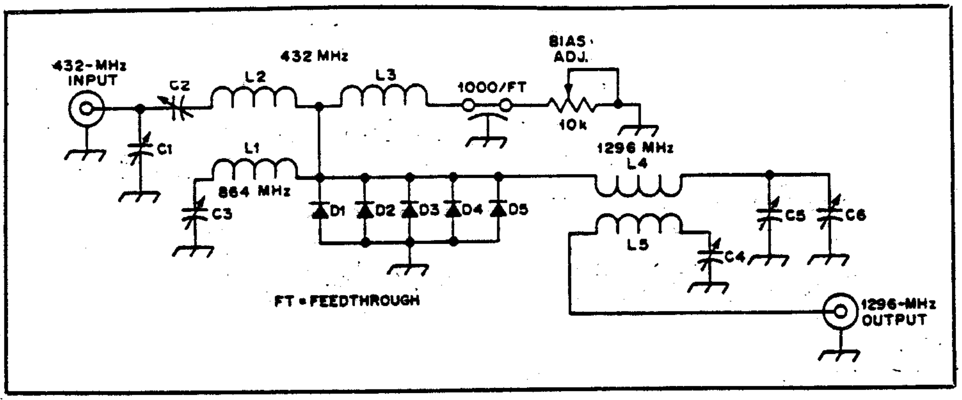


Fig. 42 — Schematic diagram and parts list for the 432- to 1296-MHz tripler.
C1-C3 — Air-variable capacitors, 3-11 pF.
C4-C6 — Piston-trimmer capacitors, 1-5 pF.
D1-D5 — 1N914 diodes or equiv.
R1 — 10-kΩ potentiometer, linear taper.

AN INEXPENSIVE DIODE MULTIPLIER FOR 23 CM

Instead of expensive and hard-to-find varactors this tripler, designed by G8AZM, uses computer switching diodes. It has been described in several RSGB publications.

A schematic diagram of the tripler is shown in Fig. 42. The unit is fabricated from sheet brass or copper. Construction details are shown in Fig. 43A and B. To increase the dissipation ability of the diodes a heat sink is fabricated, allowing up to 6 watts drive at 432 MHz and 2 watts output at 1296 MHz. The five diodes are connected between two 1 × 5/8-inch (25 × 16-mm) plates to form a stack, one side of which is bolted to the chassis. The other side is fastened to L1. Great care must be taken when soldering the diodes. Lead length should be as short as possible. To reduce the risk of damaging the diodes, the leads and the holes in the plates should be pretinned and a *hot* soldering iron used for the minimum time necessary to make each joint. The top and bottom surfaces of the stack should then be made flat by filing, and then with emery paper. It will be helpful to place the emery paper grit-side up on a hard surface, such as glass, and then draw the plate across its surface. Mating surfaces of the chassis and L1 should also be carefully flattened to ensure good thermal contact. Output loop L5 is made of no. 18 wire, 1/2-inch (13-mm) long, placed as near to L1 as possible.

The output filter, shown in Fig. 43C, is a simple cavity resonator. It may be built from thin brass or copper sheet. Before drive is applied to the tripler, the filter should be aligned. This may be done by connecting it to a receiver and peaking on a weak signal. Insertion loss should be less than 1 dB. The lock nut should be tightened and the filter connected between the tripler and a load.

Adjust R1 to its centerpoint and connect a high-impedance dc voltmeter across it. When 5-watts drive at 432 MHz is applied to the tripler, C1, C2 and C3 should be adjusted for maximum meter deflection (about 20 volts). R1 and all tuning capacitors should then be adjusted for maximum rf output.

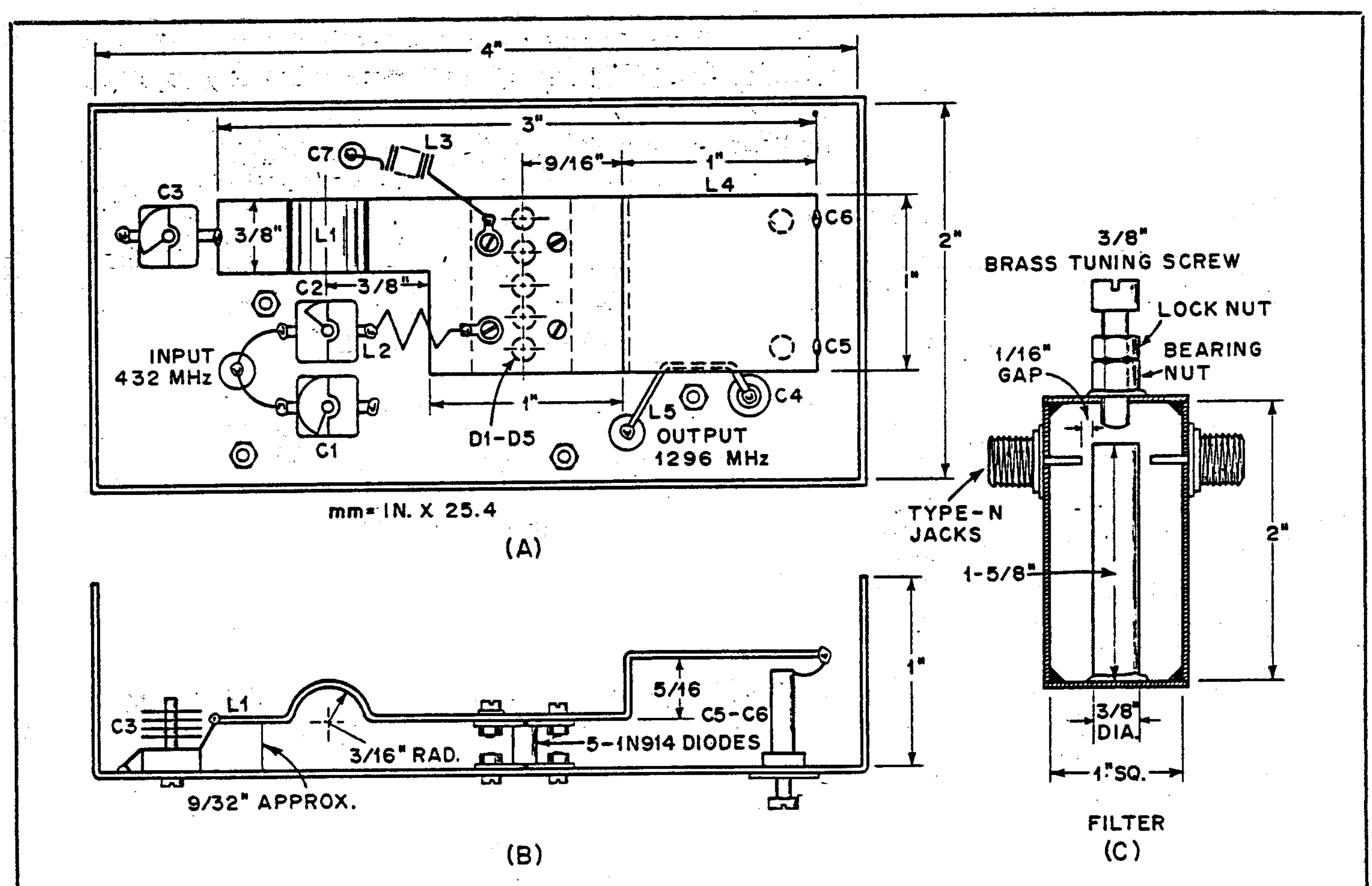


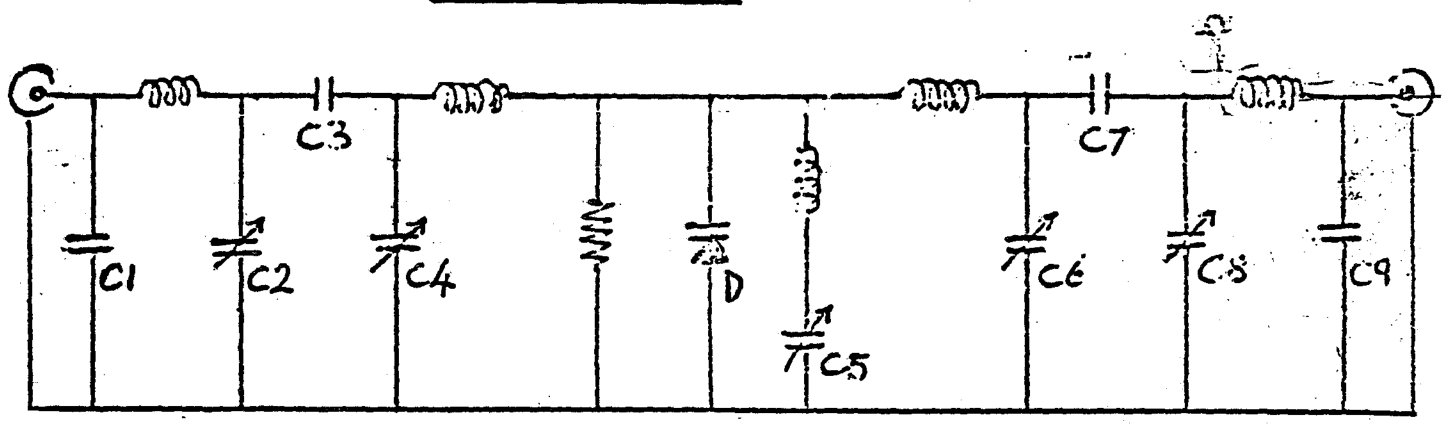
Fig. 43 — Construction information for the tripler and filter. At A, a top view of the tripler, showing the position of the components. At B, a side view of the tripler, showing the installation of D1-D5. At C, a cavity filter designed to remove undesired harmonics generated in the tripler.
L2 — 3 turns no. 24 enameled wire space ... after winding). ... wound on a 3/32-inch form (remove form after winding).

Care and operation of Varactor Multipliers

The MM series of Varactor Multipliers have been tuned under wide-band swept frequency conditions at full power input. Then the drive power is slowly reduced while checking for stability and a clean spectrum, all the way down to zero drive. This is the correct way to tune up varactor multipliers, to achieve a spurious-free output signal.

PLEASE resist the temptation to retune the input and output circuits of the tripler unless you have a swept frequency source available.

CIRCUIT DIAGRAM



COMPONENT VALUES (in pF)

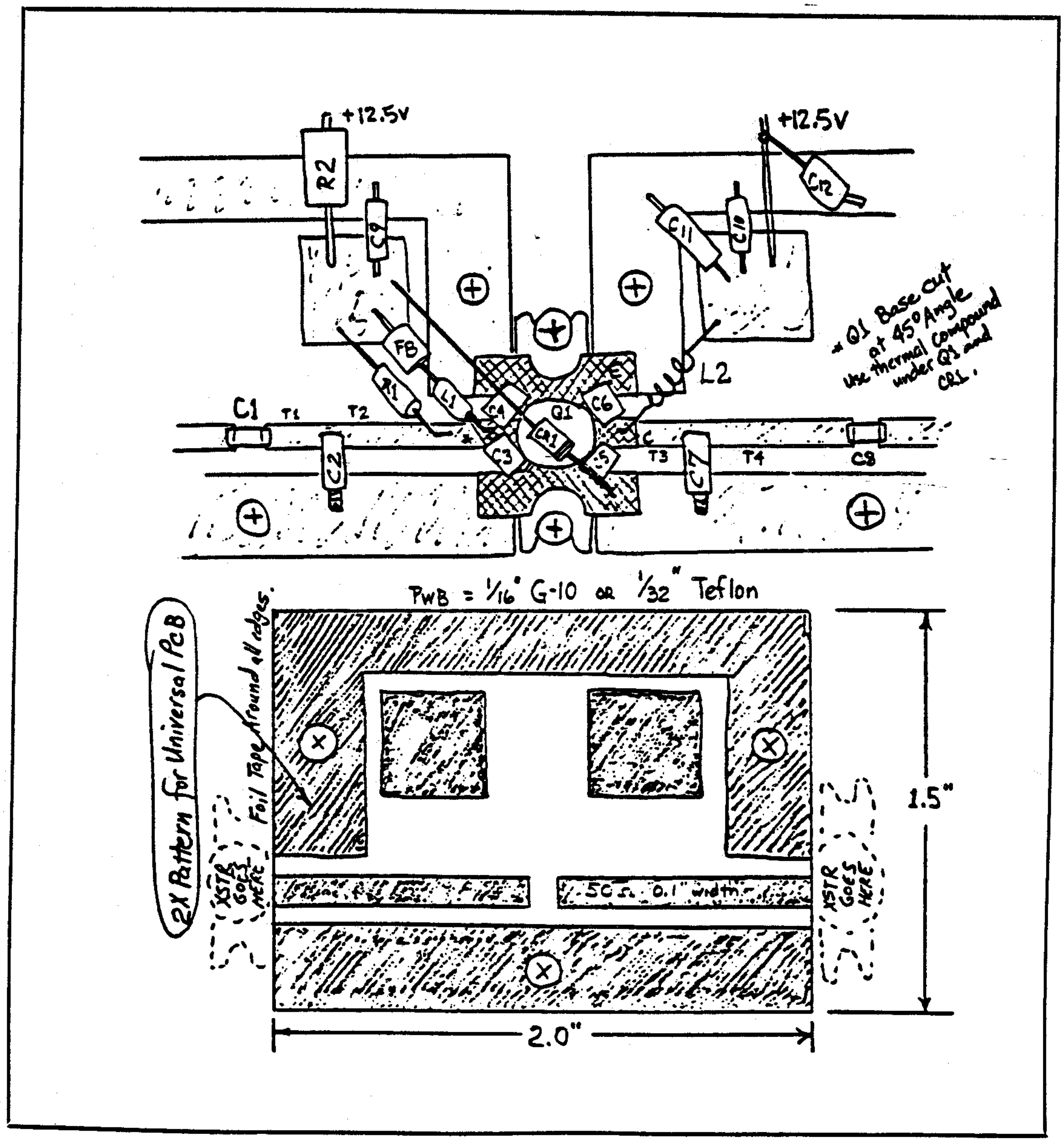
Unit	C1	C2	C3	C4	C5	C6	C7	C8	C9	D
MMV432	22	12	6.8	12	6	6	1.5	6	9.4	VBC87B
MMV1296	20	6	1.5	6	6	10	0.5	10	-	VBC77J

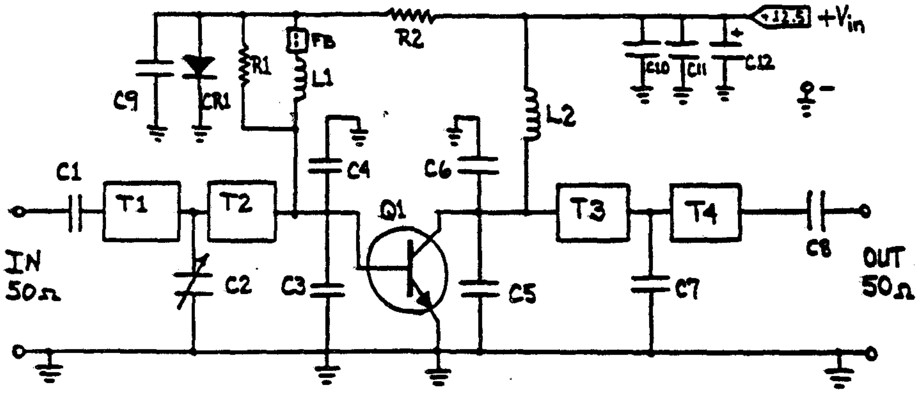
Microwave Modules Ltd., 11 Cranmore Avenue, Crosby, Liverpool, L23 0C

1296 10 WATT SOLID STATE LINEAR AMPLIFIER
from
Southeastern VHF Society Newsletter

The following is a very easy to build three stage 60 nw in for 10 watt out linear amplifier for 1296. The esign is by Jim Mitzlaff, WB9SNR (1616 Marlboro Cir., arpentersville, IL 60110). Jim is a prolific builder and roponent of use of the 23 cm (1296) band. This design omes from handouts and notes taken at his excellent cture at the '82 Central States VHF Society con- erence in Baton Rouge.

Of real importance here is the use of the last two stages to get from the 1 watt level common in so many transverters today to the 10 watt level all solid state. These two stages can be built for approx. $60. Compare this to the 10 watt Microwave Module amp for 300 and you see why I was anxious to get this in the builder's hands. Follow this amp when necessary with a one or two tube 7289 or 3CX100A5 or 2C39 type amp and you'll be in the 100-125 watt elite 23cm class of ops. Water cool the tubes with distilled water and you have a very quiet powerful setup indeed.





Parts Common to all power levels:
C1 C8 C9 C10 = 3.3 pf NPO 500v disc or
10 pf RF chip cap (90 X 110 mil)
C2 C7 = 0.5-3.0 pf piston trimmer
C11 = 0.1 uf disc
C12 = 10-25 uf electrolytic
CR1 = 150 mA rectifier (1N914, ect)
L1 = 0.15 uH choke (¼ w resistor size)
L2 = 3.5 turns # 22, 0.125"id x 0.375" L
T1 -T4 all 0.1" wide microstrip. Lengths below are ap prox. for use w/ .063" thick G10 pc board

10 Watt Stage (Q1 = NEC NE081090 [19.50])
C3 C4 C5 C6 = 6.8 pf RF chip cap
R1 = 27 ohm, ¼w 0.25" leads R2 = 100, 2W
T1 = 0.17" L T2 = 0.73" L
T3 = 0.32" L. T4 = 0.58" L
Gain = 6 db at 0.82A idling current, 1.83A peak

4 Watt Stage (Q1 = NEC NE080490 [$16.25])
C3 C4 C5 C6 = 4.7 pf RF chip cap
R1 = 47 ohm, ¼w 0.375" leads R2 = 180, 1W
T1 = 0" T2 = 0.90"
T3 = 0.33" T4 = 0.57"
Gain = 6^{5} db at 0.44A idling, 0.91A peak

1 Watt Stage (Q1 = NEC NE080190 [$12.25])
C3 C4 = 3.3 pf RF chip cap (C5 C6 not used)
R1 not used R2 = 1.2k ohm, ½W
T1 = 0.85" L T2 = 0.05" L
T3 = 0.38" L T4 = 0.52" L
Gain = 11 db at 10 mA idling, 320 mA peak

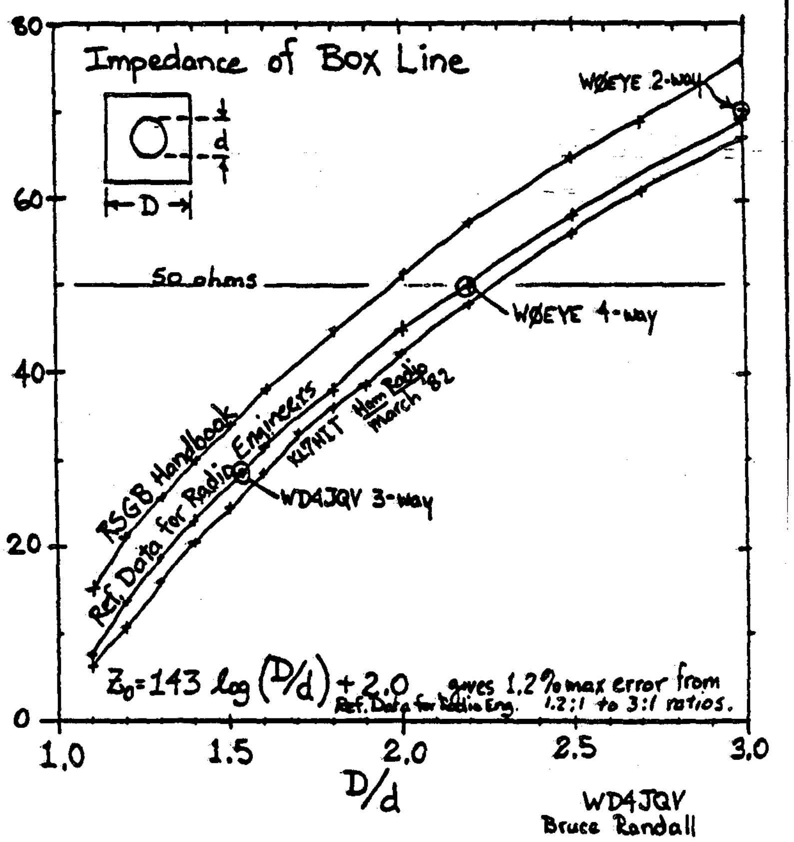
Calculating Line Impedances

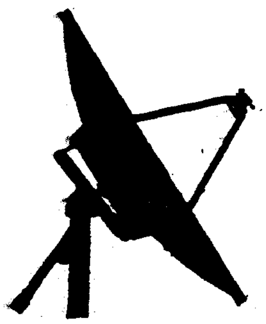
by Bruce Randall, WD4JQV
from the Southeastern VHF Society Newsletter

Here is a graph of square coaxial line impedances used in power dividers. Bruce found that some of the materials in, for instance, the **RSGB Handbook** conflict with info in other portions of the same book. He arrived a. a square line impedance formula that works well between about 12 and 75 ohms:

$Z_o = 143 \log (D/d) + 2.0$

The formula comes from **Reference Data for Radio Engineers.** This closely follows early WOEYE power divider designs and is reasonably close to design data from KL7HIT (March '82 HR). RSGB data appears to be the farthest off from other curves.





"ALL ABOARD TVRO"

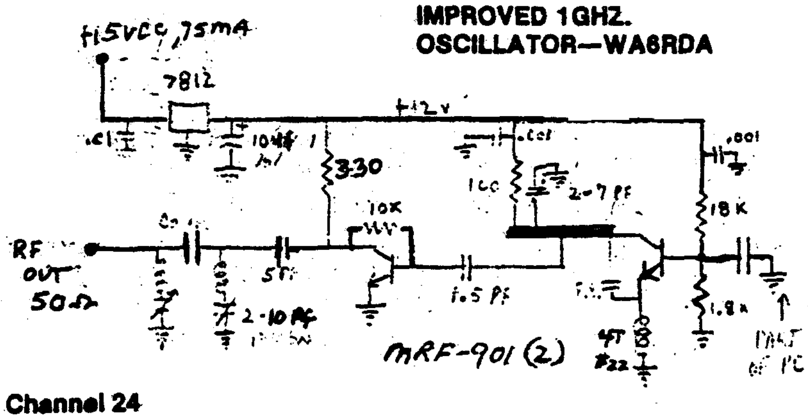
IMPROVED 1 GHZ. OSCILLATOR TVRO #10

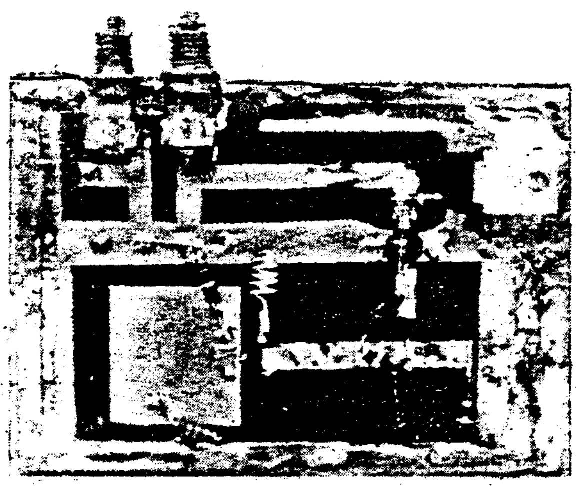
A CONTINUING SERIES OF HOMEBREW TVRO ARTICLES FOR THE AMATEUR VIDEO ENTHUSIAST

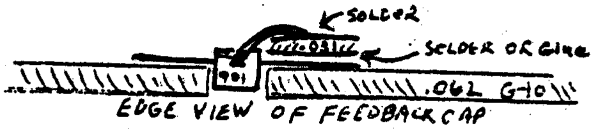
By Gerard Wilson, WA6RDA
P.O. Box 241
Glen Ellen, CA
A5 SATV CONTRIBUTING EDITOR

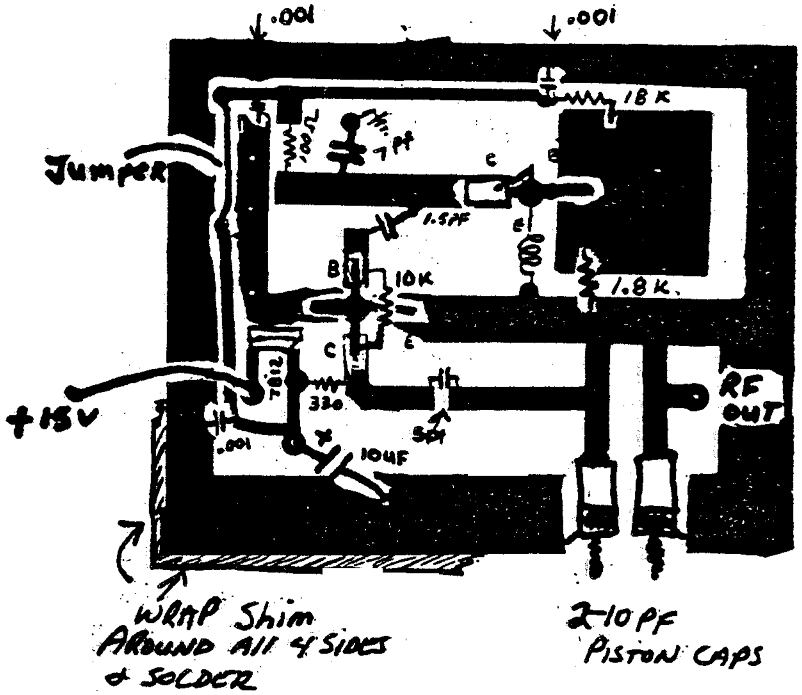
About a year ago I published an article on a simple stripline oscillator using a MRF-901 transistor. After much consideration I decided to add a buffer stage and a stripline filter. The result is a super-clean oscillator that will operate from about 920Mhz to about 1300Mhz with an output of 10 to 15mw. The stripline filter will tune 920 to 1300 providing you use 2-10pf trimming piston type capacitors. Just about any piston capacitor will work, providing its diameter is ¼" or less. Larger diameter pistons will work, but you will have to off-set them to keep from touching, plus the high end freq. may not tune in. One advantage this osc. has over the previous one is that the output of the stripline tank is coupled with a 1.5pf cap instead of a matching stub. MRF-901 Motorola transistors can be purchased at Radio Shack stores, all resistors ¼ watt, caps are ceramic disc or dip micas. 7812 or 78M12 regulator could be omitted if good stable voltage is available. Feedback capacitor is a small piece of .031 double sided pc material cut approx .250 inches square, and soldered or glued to the stripline on top of the collector lead, then solder a folded emmiter lead to the top, this "cap" is very crude, and is not critical for it seems to work if the size is varied by any degree. Base cap is etched onto the .062 epoxy glass material. Emmiter choke is 4 turns of No. 22 buss wire wound on a 6-32 screw, to derive the air-wound coil. The photo of the osc. shown was hand carved with an exacto knife, so you don't have to etch it if you don't want to. The .062 material must be double sided, with the back side left solid. Top solder all components except leads that are grounded, which should go all the way through and solder both sides. Wrap foil around the outside edge and solder all the way around. Brass shimstock .004 works good, and so does copper foil tape thats used to make stained glass windows. Auto repair has shim material. Drill relief holes for the MRF-901's bases to fit into. Form all cap and resistor leads to lay flat on the traces, keeping leads short as possible. Thru grounding holes must be drilled near the end of the pc board, by the jumper. Tuning is accomplished by sliding the 7pf cap up and down the stripline. Towards the transistor raises freq., but don't go past half way up. 7 pf will tune approx 920-950Mhz., 5pf will increase to 1Ghz, 3pf will get 1200Mhz., and 2pf is the lowest cap that will continue to osc unless the stripline is shortened. Solder a SMA or BNC flange mount connector on the other side, making sure that a relief cut for the center pin is provided on the ground plane. This osc. makes a great LO for 1296 downconverters, or for TVRO 2nd LO.

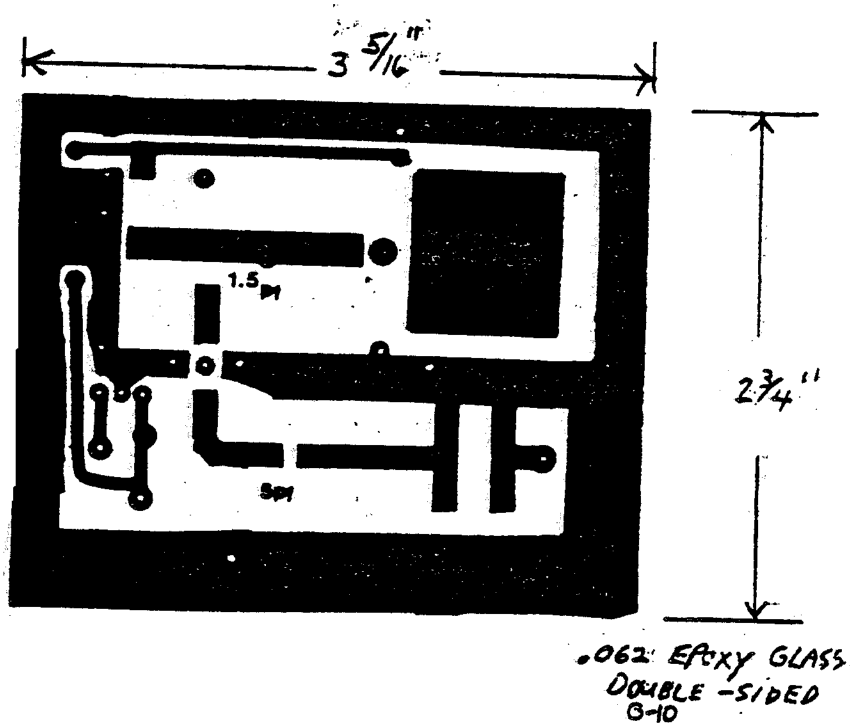
IMPROVED 1GHZ. OSCILLATOR—WA6RDA











1 GHZ OSC.

COMING NEXT MONTH IN A5; TVRO No. 11

"A very powerful, inexpensive TVRO receiver upgrade of a 4 Ghz. Polarizing Feedhorn design that you can homebrew!" WA6RDA

BACK ISSUE A5 TVRO SERIES ARTICLES ONLY $3.50 (See Channel 11)

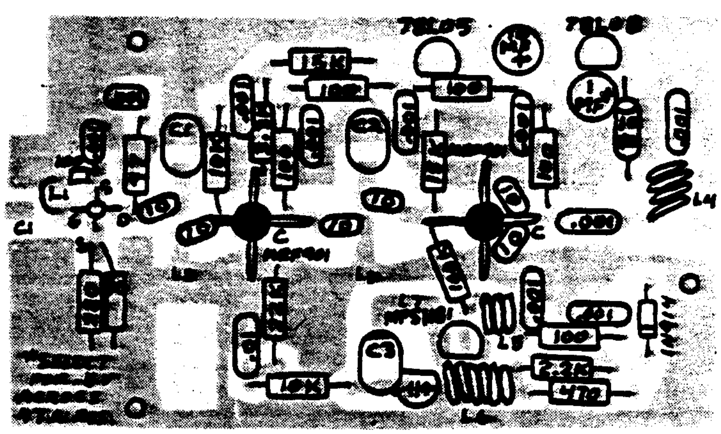
TVC-12G 1215-1300 MHZ DOWNCONVERTER

This ATV GaAsfet downconverter is designed to be mounted at the antenna for maximum sensitivity. There is no sense having a less than 1 db noise figure frontend with many DB in feedline loss infront of it. The output is on TV channel 7 or 8. While RG6 75 ohm coax has about 3 db/100 ft (Radio Shack 15-1527) at channel 8, its loss has negligable effect on sensitivity.

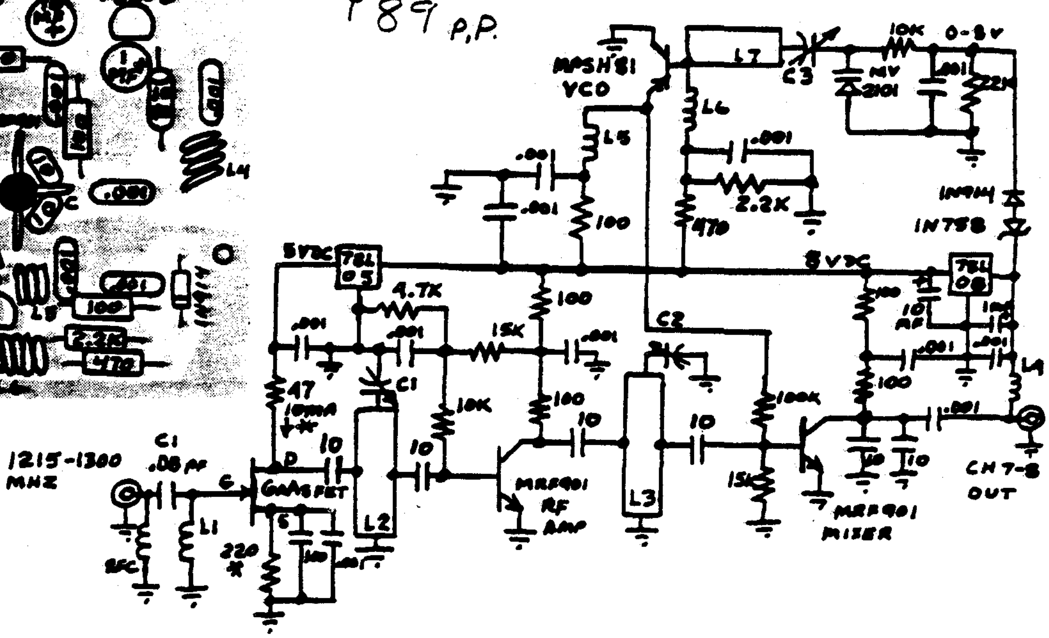
The whole 1215-1300 mHz ham band is varicap tuned by varing the supply voltage fed up the IF coax between 10 and 18 vdc. Therefore a control box, such as our DCB, must be used to supply this stable regulated voltage, and to block this DC voltage from the TV antenna input. The DCB voltage control circuit can be made from Radio Shack parts less the amplifier and put in a shielded box if you wish to build your own.

The downconverter must be well protected against moisture getting inside. Before mounting on the antenna, spray one coat of clear epoxy, then carefully run vinyl tape around the cover seam and then around and over the 4 cover screw heads. Do not put any substances in the cover seams or it could destroy the shielding. Next screw on to the "N" connector provided with the F9FT or loop yagi and wrap 2 layers of vinyl tape over the connection in opposite directions. Do likewise with the "F" connector IF output. The downconverter can then be held to the antenna mounting bracket or mast with cable ties or vinyl tape. The entire assembly can then be given a few coats of clear epoxy. Do not use colors as they may be conductive, or acrylics as they crack and peal in a short time when exposed.

Mount the antenna assembly as high as practical as foliage absorbsion is very great in this band, as well as 9 db additional pathloss compared to the 70 cm band. For duplex or crossband repeater operation where you want to see your own video coming back, you will need at least 5' vertical separation between vertical polarized antennas if you are running 10 watts output on 70 cm. More is necessary if higher power or horizontal polarization is used. You might be able to see your own 3rd harmonic from your 70 cm transmitter by tuning to the high end just above 1300 mHz. For this reason, the least overloaded freq. for duplex and repeaters is at the low end: 1241 simplex/duplex, 1253 primary repeater output, 1265 sec. rptr, 1277 rptr, 1289 link. Normal converter setup is to tune 1265 mHz to ch 8 with 13 vdc applied. Lower voltage tunes to a lower frequency and vice-versa.



$89 P.P.



DCB DOWNCONVERTER CONTROL BOX

This downconverter control box provides a regulated DC voltage between 10 and 18 volts at up to 150 ma to power antenna mounted downconverters thru the coax. It also contains a MRF901 broadband 40-220 mHz 15 db gain amplifier to make up for low gain TV sets or splitter losses when driving both a TV and a VCR. While the DCB was designed for the TVC-12G and TVC-2G downconverters, the voltage variation can be adjusted for any 8 volt range from 2 to 18 volts for other converters.

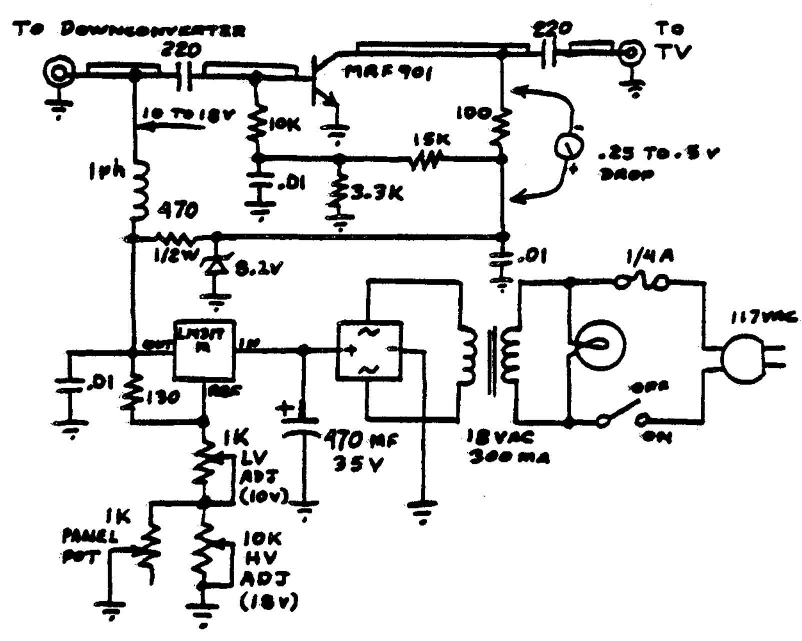
The DCB comes set for 10 to 18 volts. To reset the range, turn the front panel tuning pot to 0. Monitor the voltage on the downconverter input connector and adjust the low voltage pot marked LV ADJ on the circuit board. Next, turn the front panel pot to 10 and set the HV ADJ pot on the circuit board to the desired highest tuning voltage. If you want the widest tuning possible and there are few atv frequencies in use in your area, the LV ADJ can be set to tune in the lowest used ATV frequency with the front panel pot set to between 1 and 2, and the HV ADJ then set for the highest used ATV frequency with the front panel pot set to receive it between 8 and 9.

The TV output from the DCB should be done with RG6 coax as far up to the VHF tuner in the TV as possible to prevent strong commercial TV interferance from the adjacent channel. Radio Shack has RG6 cables in various lengths with F connectors up to 100 ft (RS 15-1527). RG59 is not as well shielded as RG6 which has a aluminum foil shield rather than braid. Most new TVs have a 75 ohm F connector antenna input. If yours has only twin lead, then it can be modified by connecting a balun (RS 15-1140) directly at the VHF tuner with the twin lead cut as short as possible. Twin lead often acts as a antenna that picks up strong adjacent channel interferance. Tape the F connector to insulate it from the shell possibly touching the TV chassis. Many TVs have a hot chassis to one side of the AC line that must remain isolated from ground.

Before connecting the downconverter coax to the DCB, check the center lead to shell of the coax to make sure there are no direct shorts. Also adjust the fine tuning on the TV, with the AFC off, to the proper open channel you will be using for the downconverter output, for least adjacent channel interferance.

$59pp

If the same antenna is used for transmitting, a single T/R relay such as the Magnacraft W120X-14 can be mounted in the weatherproof enclosure with the downconverter, and should be energized in receive mode. This will minimize the chance of transmitting accidently into a open relay. Do not use a single down coax with a second T/R relay as they do not switch fast enough to prevent transmitting for a few milliseconds into the output of the downconverter and damaging it.



P. C. Electronics
2522 Paxson Lane
Arcadia CA 91006

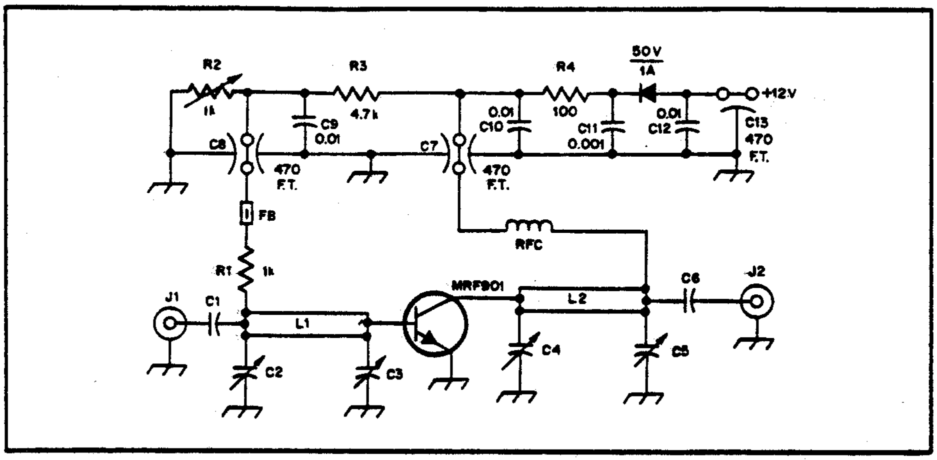


Fig. 41 — Circuit diagram of the 1296-MHz preamplifier.

C1, C6 — Microwave capacitor, ceramic chip or leadless disc, 100 pF or greater.
C2-C5 — Piston trimmer capacitor, 0.8-10 pF.
J1, J2 — Coaxial connector suitable for frequency range (type BNC acceptable).
L1, L2 — Copper strips; see Fig. 43.
RFC — 8 turns no. 28 enam. wire, closewound. 0.1-in. dia air core.

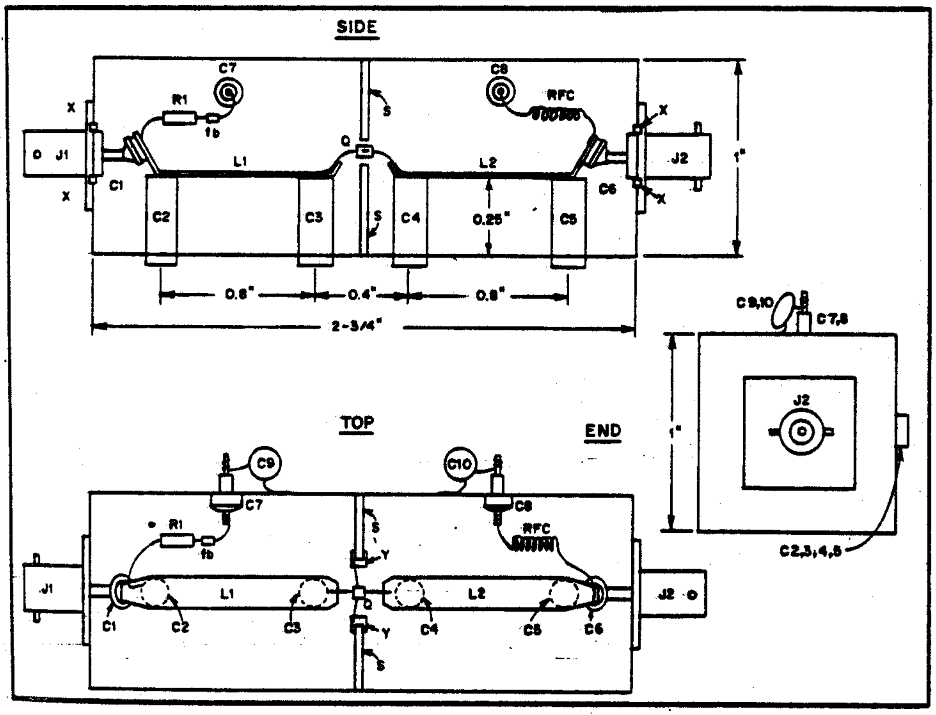


Fig. 42 — Assembly drawings for the 1296-MHz preamplifier. Improved access for easier construction can be had by increasing the width to 2 in. The other dimensions are more critical. The enclosure is copper and the pieces are soldered together. Do not install the transistor until the other components have been soldered.

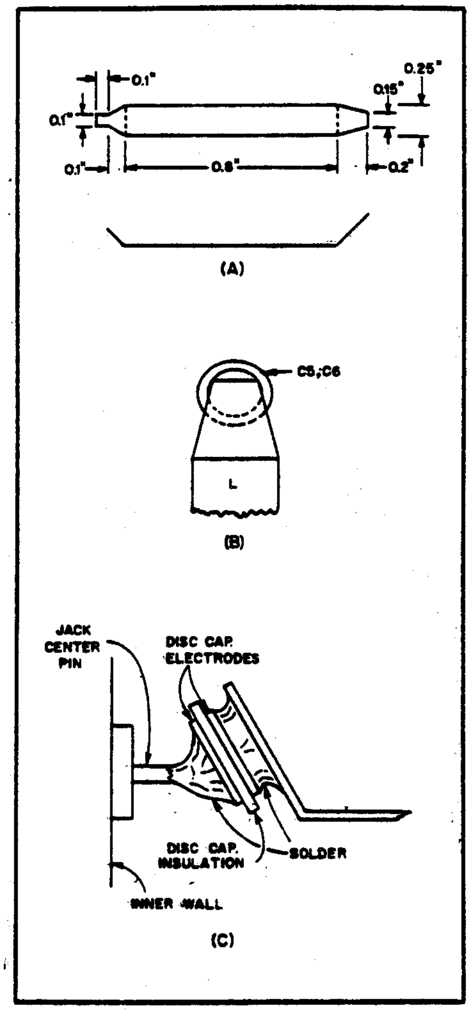


Fig. 43 — (A) Dimensional drawing of the inductors. (B) Detail of tapered end of inductor. (C) Method for installing a leadless disc capacitor at C1 or C6.

machine screw until maximum mixer current is measured at J1. When resonance is found, R1 should be adjusted so that about 2 mA of mixer current is obtained. As an alternative to mounting a potentiometer in the converter, once a value of resistance has been found that provides correct performance it can be measured and the nearest standard fixed-value resistor substituted. Some means of adjusting the collector voltage on the multiplier stage must be provided initially to allow for the nonuniformity of transistors.

A 2304-MHz Version

Fig. 39 and 40 show the schematic diagrams of the 2304-MHz converter and multiplier. The mixer and i-f preamplifier was built on a separate chassis since, at the time of their construction, a multiplier chain from another project was available. An i-f of 144 MHz was chosen, although 50 MHz would work as well. An i-f output of 28 MHz, or lower, should not be used since this would result in undesirable interaction between the mixer and multiplier interdigital filters.

The 2304-MHz mixer and i-f amplifier section, shown in Fig. 39, is very similar to its 1296-MHz counterpart. Q1, the dual-gate MOSFET, operates at 144-MHz and thus has a noise figure about 1-dB higher than that obtainable at 28 MHz.

The multiplier chain, Fig. 40, has a separate oscillator for improved drive to the 2N3866 output stage. Otherwise the circuitry is similar to the 1296-MHz version.

COST-EFFECTIVE PREAMP FOR 1296 MHZ

Obtaining a low noise figure in amateur microwave receiving systems is no longer the expensive proposition it once was. The preamplifier shown in Figs. 41, 42 and 43 is taken from a catalog of designs published by Geoffrey Krauss, WA2GFP, in June 1982 *QST*. Featuring a simple circuit using a commonly available transistor, the unit boasts a noise figure of less than 2.5 dB with a 10-dB power gain.

Construction information is given in Figs. 42 and 43, with additional instructions in the captions. All controls should be adjusted for minimum noise figure (maximum signal-to-noise ratio with a weak signal). Start with all capacitors at minimum capacitance, adjusting the output network first. Repeat the adjustments several times because they interact. R2 sets the collector current. Minimum noise figure will occur in the 3 to 7 mA range.

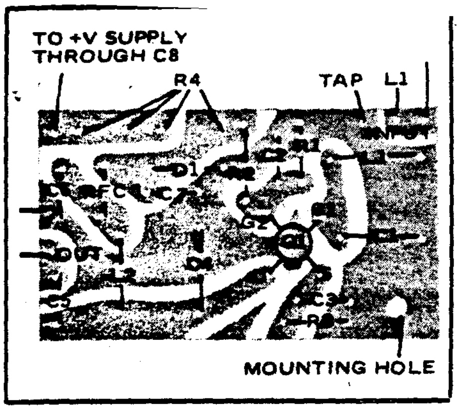


Fig. 17 — Full-scale layout and parts placement guide for the pc board. Foil side shown.

The dc voltage for the preamplifier is fed through one arm of a coaxial T fitting at the receiver input. This assumes use of some sort of blocking capacitor in the receiver input, to prevent grounding the dc through a coupling loop or tap on a grounded tuned circuit. The rf choke in the preamplifier circuit, RFC1, and the one used at the receiver input (to isolate the dc from the rf) are not critical. Any reasonably good vhf choke should do. If you're still willing to take the losses involved in the line, and you want to use the preamp at the receiver input, leave RFC1 out of the circuit, and connect the dc as shown in Fig. 18.

Adjustment

First set R1 for about 5 mA current drain, ... neutralizing coil, L2. If there is any change in current, the stage is oscillating. Keeping contact with L2 (to prevent oscillation), readjust R1 for 5 mA. Using a strong 220-MHz test signal, adjust C4 for maximum signal indication. Set C1 to minimum capacitance, and peak C2. Increase C1 slowly until signal no longer rises, then back off one turn and readjust C2 and C4 for maximum signal.

Now reverse the preamplifier, connecting J1 to the receiver input, and feeding the signal to J2. With the dc still applied, tune L2 to minimum signal feed-through. If L2 has an ungrounded brass slug, the amplifier attenuation should be about 50 dB. Drain current should remain at 5 mA.

Connect the amplifier normally, and repeat the process outlined above, until the tuning of C4 remains nearly constant. Finally, adjust C1 for best signal-to-noise ratio (lowest noise figure) and readjust C2. This should yield a noise figure of 1.5 to 2 dB, and gain of 12 to 18 dB, depending on the transistor used. Often the lower-gain condition will also give the best noise figure.

LOW-NOISE GaAs FET PREAMPLIFIERS FOR 432 AND 1296 MHZ

Gallium-arsenide field-effect transistors (GaAs FETs) have recently come into use as low-noise microwave amplifiers. Amateur experimentation has shown that they can provide excellent performance on the uhf and lower microwave amateur bands. These devices are rather expensive, particularly the ones characterized as C-band and X-band (4-12 GHz) microwave low-noise amplifiers. However, other GaAs FETs, characterized as *power amplifiers* for low and medium-power (up to 1/4 watt) microwave applications will provide almost the same noise figure at uhf and are being made available to amateurs. The power devices also have wide dynamic range, providing less intermodulation distortion and lower susceptibility to burnout. The receiver preamplifiers to be described are relatively simple to construct and have sufficient tuning range for almost any GaAs FET available. They were first described by K2UYH and WA2ZZF in June 1978 *QST*.

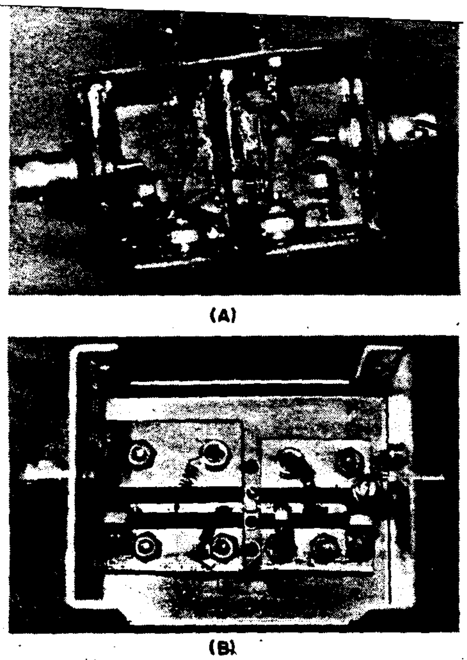


Fig. 19 — At A, 432-MHz GaAs FET preamplifier built by K2UYH. The transistor is mounted at the central shield by soldering the source lead directly to the copper foil. The drain lead of the transistor passes through a hole in the shield. At B, a 1296-MHz GaAs FET preamplifier built by WA2ZZF. In this model, the transistor is connected to striplines etched on glass-epoxy board. SMA-type coaxial connectors are shown although type N or BNC connectors may be used.

Construction

These preamps for 432 MHz (Fig. 19A) and 1296 MHz (Fig. 19B) use power GaAs FETs made by Microwave Semiconductor Corp.; however, devices made by NEC (Nippon Electric Co.) perform at least as well, and many similar devices will also certainly work. Construction details are shown in the photographs and schematic diagrams. The 432-MHz preamp is built in a 2-1/4 × 1-1/2 × 1-inch (57 × 38 × 25-mm) box made of double-sided printed-circuit board. A cover plate is recommended but does not significantly affect tuning. The GaAs FET source is soldered to the central shield board with

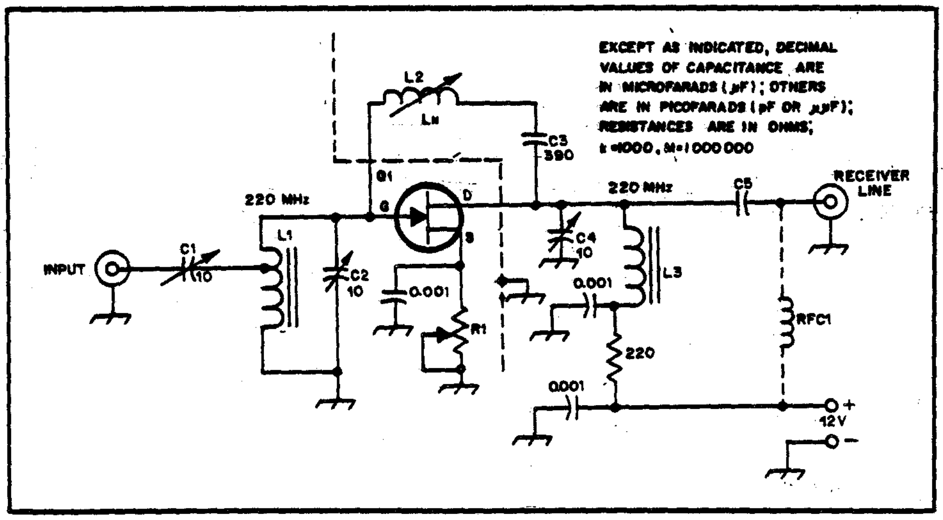


Fig. 18 — Circuit and parts information for the WB6NMT 220-MHz preamplifier.

C1 — 0.8 or 1 to 10 pF glass trimmer, Johanson 2950 of JFD VAM or MVM series.
C2 — Like C1, or Corning Direct Traverse CGW. 0.8 to 10 pF.
C3 — 390-pF silver mica.
C4 — Like C1, C2 or less-expensive type with 1 to 10-pF range.
C5 — Experiment with values 1 to 5 pF, for maximum gain in system as it will be used.
J1, J2 — SMA or N-type connector.
L1 — 4 turns no. 22 enam. or Micrometals T-37-0 toroidal core (Amidon Associates). Tap 1 turn from top, subject to adjustment for lowest nf. Air-wound coils also usable, but toroids preferred.
L2 — 9 turns no. 28 enam. on 1/4-in. (6.3 mm) slug-tuned form (Miller 4500, brass slug). Do not ground the slug.
L3 — Like L1, but no tap.
Q1 — 2N5245, 2N5486, MPF-107, TIS-88.
R1 — 200- or 250-ohm control.
RFC1 — Vhf rf choke, 0.8 to 3 μH. Use only when preamp is antenna mounted (see text).

the drain lead projecting through a hole. Several other versions have been constructed; in one of these, the wire inductors are replaced by straps placed parallel to the bottom plate, and spaced approximately 1/8 inch (3 mm) above it; a typical strap dimension would be 3 inches (76.2 mm) long by 1/2 inch (13 mm) wide. The 1296-MHz preamp is constructed in a 2-3/4 × 2-1/8 × 1-5/8-inch (70 × 54 × 41-mm) Minibox (BUD CU-3000A or equivalent). The GaAs FET is bolted between two pieces of 1/16-inch (1.6-mm) printed-circuit board, using 0-80 screws (available at many hobby shops). The lead height is just right to sit on top of the 50-ohm lines printed on these boards. The ground connection for the tuning capacitors is provided by mounting screws and by copper foil soldered around one edge of each board. The ground plane sides of the board are smoothly tinned to reduce copper-to-aluminum corrosion.

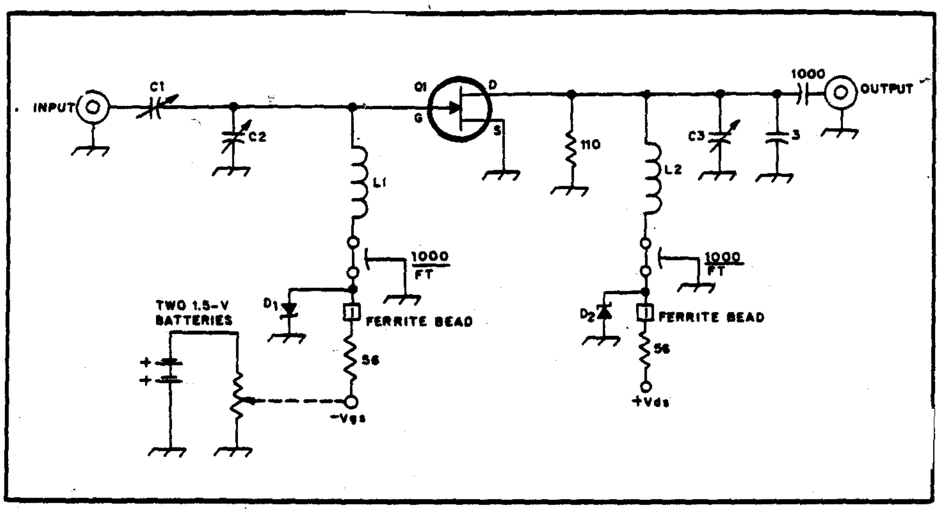


Fig. 20 — Schematic diagram of the 432-MHz preamplifier.
C1 — 0.03- to 3.5-pF piston trimmer (Johanson or JFD).
C2, C3 — 0.8- to 10-pF piston trimmer (Johanson or JFD).
D1, D2 — Zener diode, 5.6 volts (4.7 to 6.2 volts usable).
L1 — 1 turn no. 18 wire (see photo) or stripline (see text).
L2 — no 18 wire, 0.9 in. (23 mm) long.
Q1 — GaAs FET (see text).

Handling Precautions

The MSC GaAs FETs have static-resistant gold gates, and are only susceptible to damage from overvoltage or excess heating. Some other types, particularly those of Japanese manufacture, have aluminum gates which are very sensitive to static burnout, and should be handled in the same manner as unprotected MOS devices. In any case, work quickly when soldering the devices and use a grounded or cordless soldering iron. After assembly, the Zener diodes shown should protect the device in normal operation. Of course, it should be realized that these devices are physically small and require reasonably careful handling.

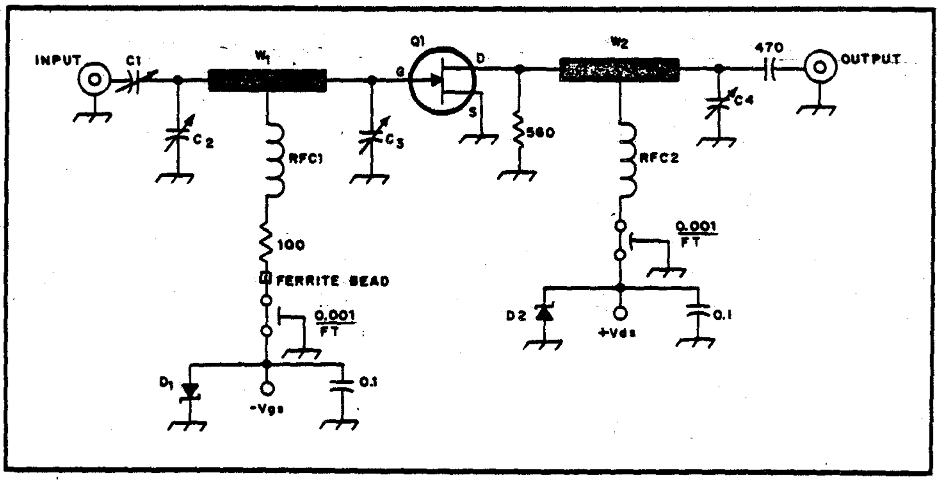


Fig. 21 — Schematic diagram of the 1296-MHz preamplifier.
C1, C2, C4 — 0.8- to 10-pF piston trimmer (Johanson or JFD). Note: C1 may be replaced by a fixed low-inductance capacitor of 10-pF or more.
C3 — 0.3- to 3.5-pF piston trimmer (Johanson or JFD).
D1, D2 — Zener diode, 5.6 V (4.7 to 6.2 V usable).
Q1 — GaAs FET (see text).
RFC1 — 3 turns, 1/16-in (1.6-mm) ID, in lead of resistor, spaced wire diameter.
RFC2 — 5 turns no. 32 wire, 1/16-in (1.6-mm) ID, spaced two wire diameters.
W1 — 50-ohm microstripline, 0.105 in. (2.7 mm) wide by 0.9 in (23 mm) long on 1/16-in. (1.6-mm) thick double-sided G-10 printed-circuit board.
W2 — 50-ohm microstripline, 0.105 in. (2.7 mm) wide by 1.1-in (28-mm) long on 1/16-in. (1.6-mm) thick double-sided G-10 printed-circuit board.

Adjustment and Performance

Normal operating voltages are $V_{DS} = 1.5$ to 3V, $V_{GS} = -0.5$ to -2V; gate current is negligible and may be supplied from a battery. Peak the tuning capacitors on a strong signal, then trim them and adjust the drain and gate voltages with the aid of a noise-figure meter or weak-signal source. Minimum noise figure occurs near the tuning for maximum gain. Output tuning should have little effect, but the noise figure is sensitive to the input tuning and gate voltage; varying the drain voltage should give a broad peaking of S/N. Drain current is controlled by gate voltage. After peaking up the preamp, drain current will probably be between 20 and 100 mA.

It should be emphasized that these devices have extremely high gain at uhf and will readily oscillate unless adequate precautions are taken. Stability is obtained by the use of the resistor connected *directly* from the drain to ground, at the expense of some gain reduction. The values shown should provide adequate stability if good bypassing is used; gain will be around 20 dB at 432 MHz and 15 dB at 1296 MHz. Any increase in the value of these stabilizing resistors is at your own risk!

Typical noise figures to be expected with these preamps are on the order of 1 dB at 432 MHz and 3 dB or less at 1296 MHz. The devices are capable of even better performance than this; significant improvements are obtainable at 1296 MHz with attention to good uhf construction techniques and low-loss circuitry. However, the circuits shown are easily reproduced and still provide excellent performance.

DOUBLY BALANCED MIXERS

Advances in technology have, in recent years, provided the amateur builder with many new choices of hardware to use in the building of receivers, converters, or preamplifiers. The broadband doubly balanced mixer package is a fine example of this type of progress, and as amateurs gain an understanding of the capabilities of this device, they are incorporating this type of mixer in many pieces of equipment, especially receiving mixers. The combined mixer/amplifier described here was presented originally in March 1975 *QST* by K1AGB.

Mixer Comparisons

Is a DBM really better than other

1265 MHZ OMNI GAIN REPEATER ANTENNA

BY W6ORG

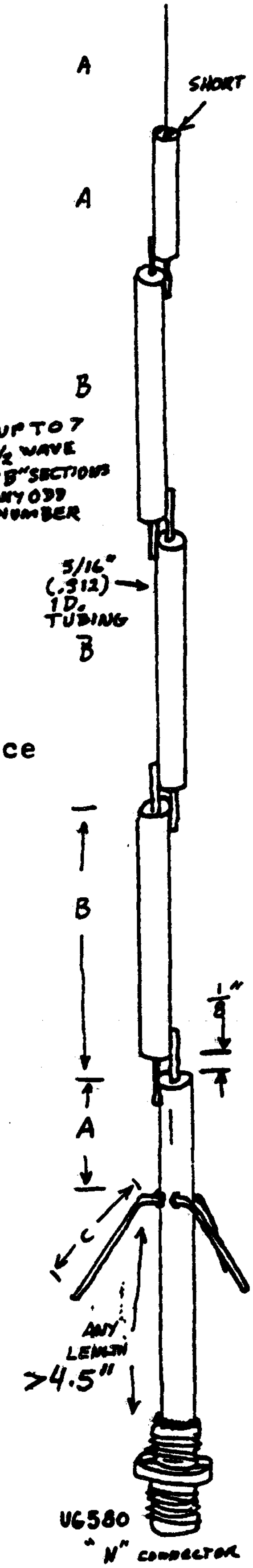
This transposed coax antenna differs from that found in the 73 VHF Antenna book in that it uses air dialectric instead of coax cable. At UHF coax cable dialectric may not be the expected .67 velocity factor for figuring lengths just as capacitors change their apparent capacity with increasing frequency. In fact manufacturers typically spec their velocity factor as being within only 10%. Full sized elements also give better radiation efficiency. At 1200 mHz the elements are so small that full sized multielement antennas are physically stable and practical.

The elements are made from 5/16 ID brass hobby tubing and 1/8" brass welding rod. Any odd number of ½ wave (B) elements may be used. But after about 7 ½ wave elements the coupling efficiency prevents getting much more gain with additional elements. 7 elements gave us about 7 to 8 db over a dipole.

Start construction with a type N female chassis connector. Solder a brass rod to the center pin as straight as possible. Next drop a 5/16 id piece of brass tubing of any length greater than or equal to 4.5" over the rod and carefully solder to the ground of the connector. Make sure the rod is kept in the center of the tubing. Transistor heatsink mounting washers make a good spacer. (see the screw insulating washers at Radio Shack 276-1371) These shpacers can also be used between elements. Next lay the next piece of tubing on a flat surface with the last piece conector side hanging over the edge. Tack solder the rods to the tubing and check for alignment and spacing. Do not allow more than 1/8" spacing between tubing or the thickness of two spacer washers. If it looks right then solder a fillet along each rod connected to the tubing for about 1". On the top section short the rod to the tubing at the top of thetubing. A 50 watt Ungar 4033-S soldering iron does a good job without over heating and melting everything. Bend the 4 decoupling radials at a 45 degree angle about ½" out from one end. Solder this in place with plenty of solder 2.2" down the bottom tubing. Use pliers to hold in place for soldering. Its a good idea to pretin each area of brass before joining.

Do not fill any gaps full or wax or other fillers as it will change the electrical length. You can put a dab of 5 minute epoxy at each rod and tubing joint for mechanical stability. Slide a piece of schedule 40 PVC 1" pipe over the antenna. Hacksaw grooves at the bottom about 1½" long for the radials. Use a end cap at the top. At the bottom use a 1" to internal threaded pvc adaptor. Screw on a short piece of metal pipe after attatching the coax and test. The pipe will make a solid clamping surface. PVC is too soft and will cold flow over time. Seal the exposed radial slots against the weather with silicon sealer. Just tape the PVC pipe joints as you may want to get into it later if you change frequency or want to try more elements, etc.

The gain of this omni vertical antenna is due to narrowing vertical beam width by phasing colinear ½ wave sections. Any metal within 1 wave length will change the pattern. A cardioid pattern of 180 degrees with some increased forward gain may be desired by spacing ¼ wave from the metal pole.



1265 MHZ	OTHER FREQ.
A = 2.2"	L" = 2780/F
B = 4.4"	L" = 5560/F
C = 2.5"	L" = 3160/F

W6ORG 2-81

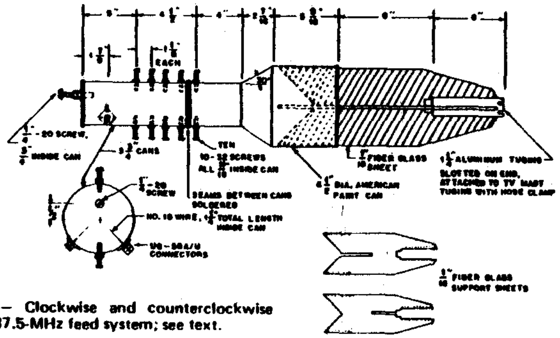


Fig. 12-17 – Clockwise and counterclockwise polarized 2287.5-MHz feed system; see text.

launches an ordinary linear wave. The small cans are "Scotts Oats" type from Scotland or "Camp" drain cleaner cans from the U.S., 3-3/4 inches ID. The large can is a one-gallon paint can, 6-1/2 inches ID. The 30-degree section is galvanized sheet metal. Tabs on each end add strength and make soldering the cans together easier.

The two UG-58A/U connectors are each fastened to the cans with two 4-40 bolts, and 4-40 nuts are soldered to the inside. The outside of the can is tinned in the area of each connector to assure good electrical contact. The ten 10-32 bolts are 1-1/4 inches long with a 11/16-inch total length inside the can. Each bolt has a 10-32 nut soldered to the outside of the can and a second 10-32 nut placed on top as a locking device. The 1/4-20 bolt is 1-1/2 inches long with 3/4 inch inside the can. Outside is a 1/4-20 nut soldered to the can and a second 1/4-20 nut added for locking purposes.

The two 1/16-inch fiber-glass mounting sheets are each slotted along half of their length, slid together at a right angle, and epoxy cemented. All cemented edges of fiber glass are first roughened with coarse sandpaper. Many very small holes are drilled into the fiber glass in the areas of metal contact.

During Apollo reception, connector No. 1 is connected to the preamplifier (if one is used) with a short piece of cable. The preamplifier output cable runs straight to the perimeter of the dish. When no preamplifier is used, consider placing the 2287.5-MHz converter at the feed horn and running power to it. This will result in a lower system noise figure since all cables are quite lossy at 2287.5 MHz.

The inside and outside of the horn may be painted with spray lacquer for preservation. The completely painted horn had a total loss from connector No. 1 to radiated circular wave out the throat of less than 0.1 dB. With this new feed, greater than 9 dB of S-band sun noise was realized.

Possible Variations

The stressed parabolic antenna, as described, is a new construction technique for which a patent application has been filed. Because of its newness, all of its possibilities have not been explored. For instance, a set of fishing strings or guy wires could be set up behind the dish for error correction as long as it does not permanently bend the aluminum spokes. This technique would also protect the dish against wind loading from the rear. An extended piece of TV mast would be an ideal place to hang a counterweight and attach the back guys. It would strengthen the structure.

HELICAL ANTENNAS

The helical antenna has suffered in popularity (but not in performance) because it is not generally well understood. With various design dimensions and construction, that corkscrew is capable of generating linear, elliptical, or circular polarization, but perhaps because of its attendant problem of matching an odd-ball feed impedance to a standard transmission line, it seems to find little acceptance in amateur circles. It is common in communication with missiles and satellites, however.

The helical antenna represents the transition point between linear-element antennas and the loop antenna. It has several modes of operation which are controlled strictly by its geometry. It can radiate in an axial mode, along the axis of the helix, or in a broadside mode, perpendicular to the helix axis. The axial mode is that normally used at vhf and uhf. Once the basic geometry is established for axial-mode radiation, we find that other changes in the geometry can create either of the two linear polarizations, horizontal or vertical. Elliptical polarization or circular polarization can also be generated. To make the subject even more interesting, the antenna can also be of either right-hand or left-hand circularity, depending on how it is constructed.

The helix is inherently a broad-band antenna, which eliminates SWR problems over an amateur

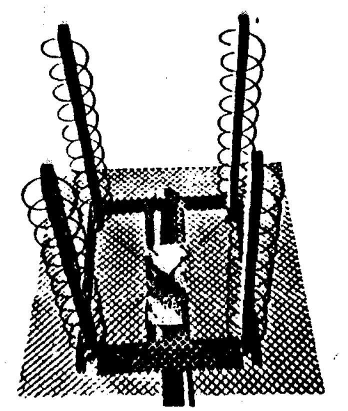


Fig. 12-18 – A front view of an early version of a quadhelix for 1296 MHz. Later versions have the elements mounted on ceramic cone insulators which are attached to the wooden booms. This procedure is strongly recommended, especially for use at 2300 MHz.

uhf band. Bandwidth is on the order of 1.7 to 1 in frequency. Expressed in terms of the helix circumference wavelength, this represents a range of from approximately 0.73 to 1.22 wavelengths. Over this range, the VSWR varies very little, remaining in the order of 1.15 to 1. Also over this range, the input impedance can be seen to vary on a Smith chart in tight curls from about 120 to 160 ohms – thus the generally quoted figure of 140 ohms. The pattern of the antenna is a well-defined lobe in both the vertical and horizontal planes over the antenna bandwidth, with pattern breakup occurring at the limits. There is a definite sharpening of the antenna pattern when the helix is used near its upper frequency limit.

The only difficult part of constructing and adjusting the helical antenna is the problem of matching the feed line to the impedance of the helix. Several articles have described one- to three-helix arrays, and have described how to build the coaxial matching section required to match the array. There is nothing wrong with the theory, but coaxial sections are tedious to build, they do fill up with moisture, and it takes considerable faith to be sure that the matching section is really 1/4 or 3/4 wavelength, or some other needed value, at these frequencies. A simple tapered line, used as the matching section, gets around this problem.

A QUADHELIX FOR 1296 MHz

If one helix is good, two - properly matched and phased – are approximately 3 dB better. Four helices are another 3 dB better yet – and are easy to match by the method described.

Construction

The quadhelix shown in Fig. 12-18 consists of four ten-turn helices formed from No. 10 AWG copper house wire from which the insulation has been stripped. Construction details are shown in Figs. 12-19 and 12-20. The helices are mounted on booms made from 1 × 2-inch smooth lumber. These booms are attached with wood screws and wood glue to a frame made from the same size lumber. The wooden portion should be painted or stained as a weather preservative. Fastened to the top and bottom of the frame are two 8-inch pieces of 1 × 1-inch angle iron from your favorite hardware store. These angle-iron pieces are drilled to accommodate the U bolts, which are used to fasten this antenna to the mast.

The sheet reflector is made from perforated aluminum. This also forms the ground plane for the matching lines. From the photograph it can be seen that a small piece of sheet aluminum was used to stiffen the ground plane at its center, where the coax connector is attached. Mounted on the antenna side of the ground plane are tapered lines, which make up the matching section. These lines are connected together at the coax feed point, and the other ends provide the feed to the individual helices. The tapered lines are of such a geometry as to transfer the approximately 140-ohm impedance of the helices to a 200-ohm point at the coaxial fitting. Strapping all four of the 200-ohm points together provides the 50-ohm feed point required

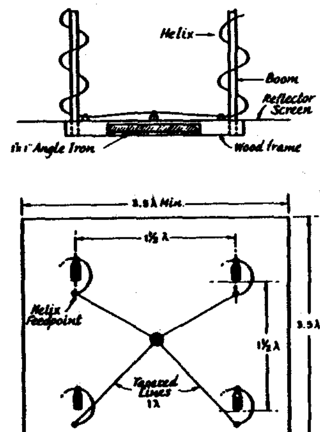


Fig. 12-19 – Top and front views of the quadhelix array. The feed lines from the individual helices terminate at the center of the array. The common meeting point for these lines is at the center conductor of a short extension of coaxial cable. This extension should be of the same impedance as the cable used to feed the array.

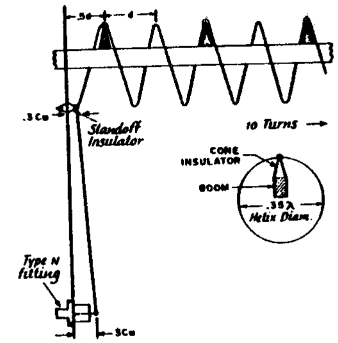


Fig. 12-20 — The method of feeding one of the four helices in the array. The feed-line extension is a short piece of copper pipe or tubing. The diameter ratio to the center conductor should be such that this extension is of the same impedance as the transmission line to the station. The height of the extension is not frequency dependent but rather is adjusted to provide a match when paralleling four helices. The slope of the line from the coax extension to the feedpoint of the individual antenna is also important in obtaining a match. See Table 12-IV for value of d.

for RG-8, -9, -14, or -17 coaxial cable. The tapered lines are also made from No. 10 AWG wire.

If you desire to vary the impedance ratios because of a different feed-line impedance, the following calculation is typical. For a single wire near a ground

$$Z_o = 138 \log_{10} \frac{4h}{d}$$

where h is the height to the conductor center, and d is the wire diameter. In order to reduce any interaction of the fields between the helices and the tapered phasing lines, it is important to keep the tapered lines as close to the ground plane as practical. This condition can be met by using No. 10 wire for the tapered lines. The diameter of this size wire is 0.1019 inch. Then, assuming that the impedance at a helix feed point is 138 ohms,

$$\log_{10} \frac{4h}{d} = \frac{138}{138} = 1$$

$$\frac{4h}{d} = 10$$

$$h = \frac{10 \times 0.1019}{4} = 0.255 \text{ in.}$$

This is the height at the feed-point end of each helix. At the coax end where the four tapered lines join,

$$\log_{10} \frac{4h}{d} = \frac{200}{138} = 1.45$$

$$\frac{4h}{d} = 28.2$$

$$h = \frac{28.2 \times 0.1019}{4} = 0.718 \text{ in.}$$

Slight discrepancies here are nearly meaningless as the VSWR is between the four tapered lines in parallel and the 52-ohm coax line. For other conditions, just substitute the appropriate numbers. The important point is to keep the matching lines as close to the ground plane as possible.

The helices are mounted (center to center) on a square whose sides are 1.5 wavelength, or 13.7 inches for 1296 MHz. The tapered lines will then be approximately one wavelength long. In any case, keep the tapered-line lengths equal. The aluminum reflector screen should be 3.5 wavelengths (minimum) on a side. The details of the individual helices are shown in Fig. 12-20. The overall layout can be seen in the photographs. Mounting of the helix turns on the wooden booms was accomplished in earlier versions by using small metal horseshoe brads. A more elegant method is to mount the turns on small standoff insulators, and recent models using this method show increased stability with respect to weather effects. Care should be taken when adjusting the position of the helix coils on the boom to assure that the pitch angle (spacing between the turns) is the same for each turn of the helix. You should visually

TABLE 12-IV
Helix Design Data

Diameter D = .35λ, and Circumference C = 1.1λ.

Pitch Angle α = 12.5°; range may be from 12° to 15°.

No. of Turns = minimum of 3.

Spacing of Turns d = λ tan α: for 2300 MHz = 130 mm × .222 = 29 mm; for 1296 MHz = 231 mm × .222 = 51 mm.

1. The above figures will cause the helix to perform best for gain and pattern near its high-frequency end.
2. The pitch angle chosen will compensate for the dielectric constant of the boom material where the material is of good rf quality, such as dry wood, PVC, Plexiglas, etc.
3. Helix will operate axially over a freq. range of 1.7 to 1.0 from a design center where C_λ = 1.0.

check to be sure that the helix circumference remains constant along the helix axis.

One very important consideration when building the helices is to make some provision for keeping the conductivity of the driven-element material high. The current is quite high in some portions of the helix, and losses there will degrade the performance severely. Copper is recommended and it should be cleaned very thoroughly and sprayed with a preservative such as Krylon. To really ensure long-time performance a coating of silver will be a good investment.

In recent years, bargain prices for 75-ohm cable have led to a modification of the original feed and matching dimensions. These are indicated in Fig. 12-20. The quadhelix is also beginning to show up in 2300-MHz circles. The reader interested in building one for that band need only apply the correct numbers to the formulas for determining pitch angle and diameter. The feed-point modifications are not frequency dependent.

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