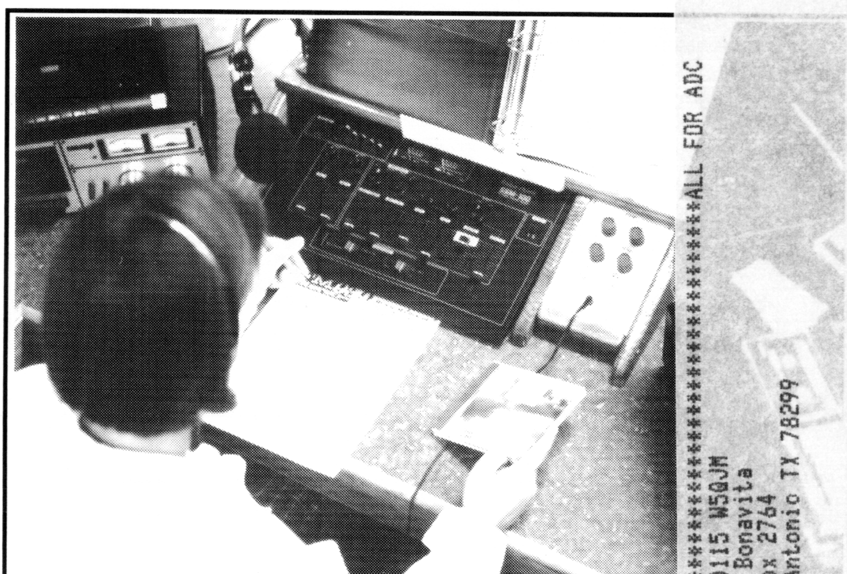
hambrew

FOR AMATEUR RADIO DESIGNERS AND BUILDERS

A Non-Amateur QRP FM Broadcasting Station

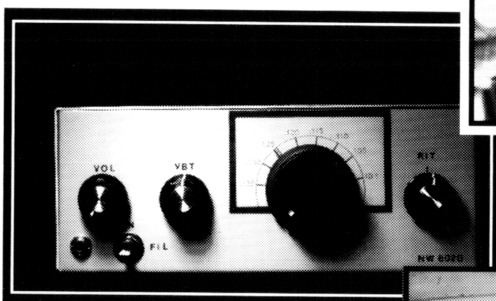


AUTUMN 1996

SECOND CLASS POSTAGE PAID AT DENVER, COLORADO

In This Issue

An Amateur's approach to a non-amateur public service project for education: A QRP FM Broadcasting Station - A project overview



Marshall Emm's review of the NW30 kit from EMTECH

More great, one-of -a -kind rigs and unique stations built by Hams who like to "roll their own"!

Important

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FOR AMATEUR RADIO DESIGNERS AND BUILDERS

AUTUMN, 1996 • VOL. 4, NO. 4

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We welcome submission of articles, photos and manuscripts (S.A.S.E. for return)

• LETTERS •

From The Publisher

To summarize the current situation regarding the continuation of this publication beyond the Spring, 1997 issue: still unsettled. We have received many offers of support, offers to assume positions, and some interest by potential publishers. I am currently exploring possible ways and means of handing off the "ball". Of all the options relative to this, I would like to propose the creation of an International Amateur Radio Builders' Society which would be composed of individual memberships.

To stake the future publisher with a startup, the initial membership fee would be in the realm of \$15-\$20 for US members (final cost to be announced), and would include a membership number (for life) and certificate, and the first year's subscription to the publication attached to the organization. Subsequent renewals would be in the price range of the current subscription rates. The size and content of the publication would be dependent on response of both subscribers and contributors. Is it not be conceivable that the initial publication could start at the level of a newsletter, and grow in size and sophistication as the publisher might determine? This would allow for a financially controlled buildup to a larger, magazine-type periodical with more content and sophistication.

I have been in contact with a lawyer, and am looking into the possibility of some different legal options to provide a structure to contain the organization relative to taxation and other concerns. At present there are no final answers to this. I will contact the individuals who are interested in the publishing part of the organization to tell them what I have found. If any of these individuals are interested and do commit to the task, we will have continuation. If not, I will refund the subscriptions which were prepaid beyond the Spring issue, and the Spring issue will be the final issue. I hope this will not the case, and the magazine's intent and concept can survive beyond April, 1997.

If you, as a reader and supporter of *hambrew*, have any ideas or suggestions regarding this transfer, please drop a line and communicate them to me. I am open to any such suggestions, and would consider them carefully as options. What do you think of the proposed initial price, etc.? I wouldbe grateful to get a "read" on this.

In this issue, I have written an article on a non-amateur subject (cover story), which I hope will not offend the purists among us. I pursued the idea of a broadcasting station for the benefit of Bishop Machebeuf Catholic High School in Denver, and wished to pass along some of the information as a sidebar to our hobby with the thought that it might prove of interest to some of the builders out there. As mentioned in the article, I did not intend to relay a detailed construction and performance review of the Ramsey transmitter, the Radio Shack mixer, or the FCC requirements for such a project.

We still have two issues remaining to publish, and there remains some space to fill. I hope you will send along any contributions which you can make until February, 1997. You may yet write for a ham magazine! Please help us to continue our forum for amateur radio building. There still is no publication quite like *hambrew*. Won't you please help to fill out these (hopefully not) final issues?

Again, sincere thanks to all who do so. We ain't dead yet!

SAVE HAMBREW!

Postitions to be filled:

Executive Directors (three to five positions)
Technical Editors
Subscription Manager/Bookkeeper (requires possession of IBM 386 or better)
Advertisin g Manager
Writers and Contributors (as always)
Promotional Manager
International Representatives (ie., European, Pacific, etc.)
Departmental Editors (kit reviews, magazine segments, etc.)

If you are ready to contribute directly to the production of *hambrew,* and wish to be considered for one of the above positions, indicate in a letter to us your preferences. If enough individuals respond, we will hand over the magazine and the organization, newly structured, to the readers and writers of this publication.

•Publisher: This position requires special equipment and qualifications. Please contact us directly if you wish to assume this job.

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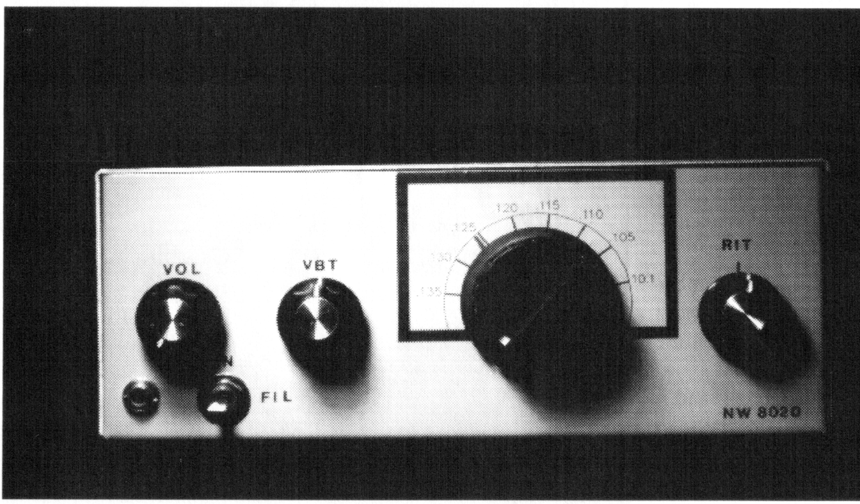
KIT REVIEW

The NW3O Transceiver Kit

Marshall Emm, AAØXI / VK5FN

75230.1405@compuserve.com

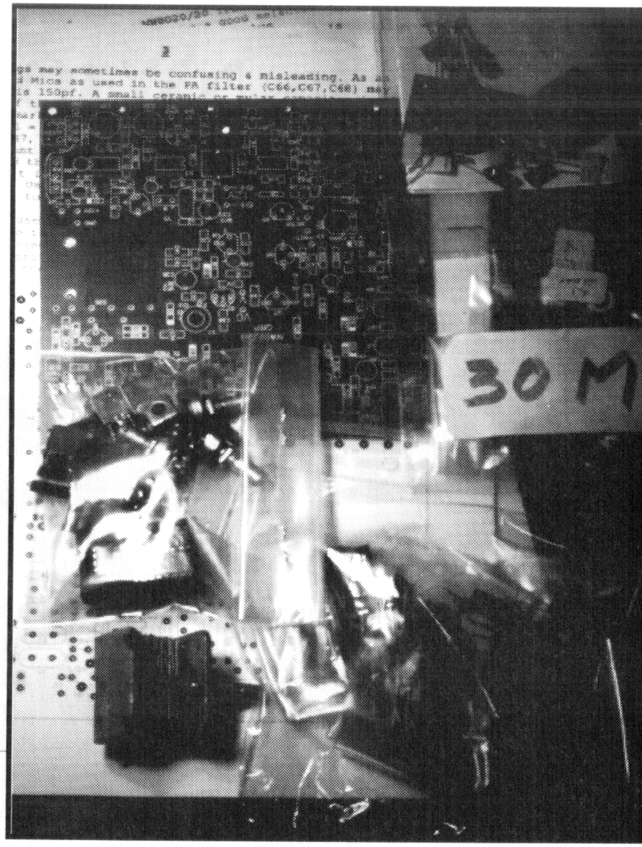


Review: NW3O Single Band QRP CW Transceiver
Cat. No. NWnn (80/40/30/20/17M*)
Board Kit $75.00 +$5.00 s/h
Enclosure Kit add $30.00
Audio Filter $20.00 +$2.50 s/h if ordered separately
EMTECH
3641A PREBLE ST.
BREMERTON, WA 98312
(360)41 5-0804

Features:

Superhet receiver with IF amplifier
4 pole crystal filter (nominal 400Hz at 3dB point) Variable bandwidth tuning on IF filter (optional, see text) Relative Power Output meter (optional, see text) RIT +/- 1 KHz
Audio adequate to drive a speaker
Full QSK
Transmit power 4-7W
Current Drain:
RX: 70mA no signal, 100mA average at 12.6V
TX: 320mA at 0.1W, 900mA at 5W
VFO Tuning Range by version:
80 200KHz
40190KHz
30 35KHz
20 80KHz
17 not available*
*The 17M version of the NW transceiver was still in development when this was written.

CW QRP operation is an odd business for the home brewer or kit builder. It can be extremely frustrating if you are seriously interested in *using* a rig; so many of them lack operator "comfort" features, stability, and reliability. Sure, you can put together a bread-board transmitter with one transistor, a crystal, and a couple of coils, caps, and resistors. It will work, and it is certainly thrilling to make a contact with it. But it is still just a toy radio, and if you have serious operating goals you will quickly find yourself looking for something a little easier to use.



There are a number of superb single-band transceiver kits on the market now, at reasonable cost, and it is always a pleasure to see a new one—especially if it adds something that the others lack. Such is the case with Roy Gregson's (W6EMT) NW30 from Emtech. For those of you who might be confused, the series was originally developed as the NW8020 because the rigs were available on all bands from 80M through 20M; the new nomenclature is less confusing.

THE ESSENTIAL NW30

The NW30 circuit is highly efficient and has a pretty low parts count compared to other transceivers in its class.

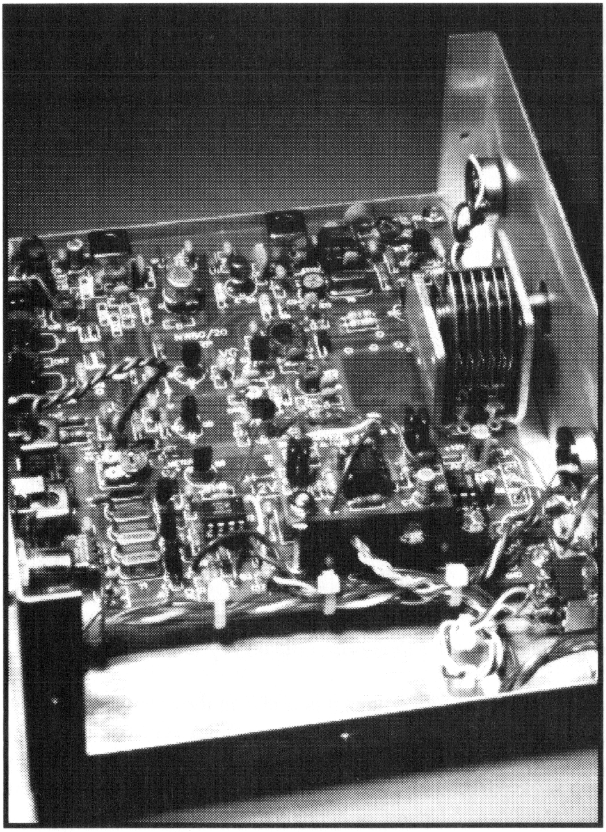
Key components are a relatively standard NE602 front end, followed by a four pole crystal ladder filter, an MC1350 amplifier, another NE602 for the BFO oscillator, and an LM386 audio amplifier.

The transmit mixer is an NE602 with a 2N2222 and a 2N2219 driving an SC1678 final amplifier.

The optional variable bandwidth tuning feature is a direct modification to the crystal IF filter, and the optional active audio filter sits between the BFO oscillator and the audio amplifier— this has the advantage of eliminating noise introduced by earlier Stages, but of course does nothing for noise introduced in or by the LM386, which can be substantial at high gain levels.

BUILDING THE NW30

The NW3O is a *nice* kit! The board is high quality, with parts overlay and solder mask,



step instructions which go so far as to tell you the color code of each resistor as you install it. At the other extreme I've seen instructions like "Using the parts list and the overlay diagram, install all of the resistors," or even "Starting at one corner, install all of the components on the board!" These methods will work, of course, but if you end up with a kit that has a smoke leak it can be extremely difficult to find the problem.

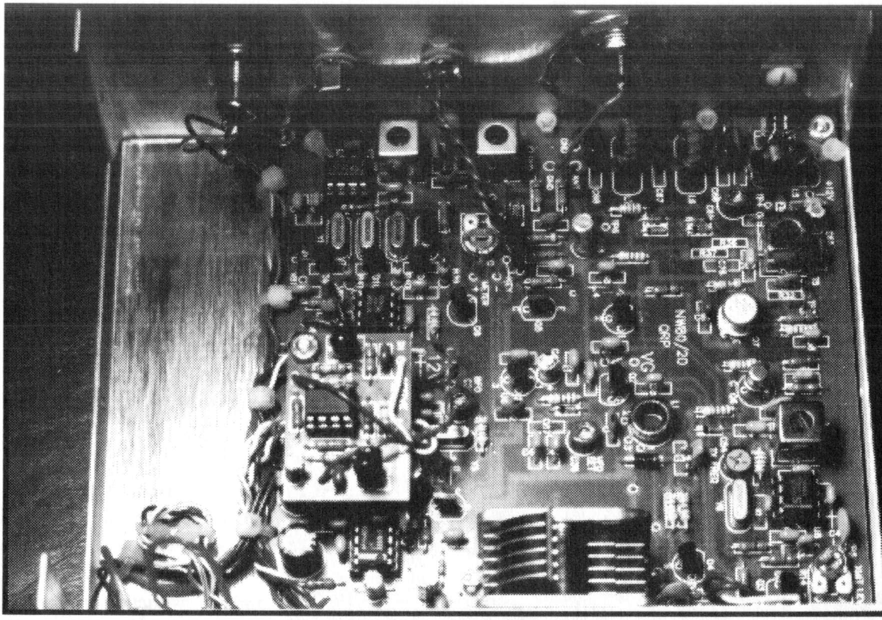
The Emtech approach is modular contruction and *testing*. First you wind the few toroids you will need, and the instructions make this easy. At that point I departed from the instructions and installed all of the IC sockets, because they are a lot easier to do with no other components on the board. Then, going back to the manual's construction sequence, I built and tested the VFO, keying circuit, audio amplifier, receiver, power meter, and finally the transmitter modules, in that order. The manual shows the relevant portion of the parts overlay, so you don't waste a lot of time looking for component locations. If you think that's trivial, I calculated on another kit that half the construction time was spent that way.

Each stage is *tested as it is completed*, so if you encounter a problem you've already got the location narrowed down considerably. A number of test points are provided on the circuit board so that you can make sure each stage is performing correctly, but they can also be useful later when you are doing modifications. An interesting wrinkle in this regard is that the relative power output meter

and all of the components are new. The 25 page manual looks a bit daunting at first, but then you realize that a number of pages are taken up with tables of parts, test values, cabinet punching overlays, and so forth.

Tools required for construction and alignment are standard, including a VOM or DVM, and a calibrated station receiver or transceiver. The manual says that an RF signal generator, an oscilloscope, a frequency counter, and capacitance meter "would be nice." I agree they'd be nice, but they are luxuries this shack doesn't afford!

In building a number of single band transceiver kits, I've found that construction methods fall into two general categories. On the one hand, you have Heathkit-style step-by



(All photos in this article by Seattle Filmworks, courtesy of Emtech.)

circuit is used to align the receiver stage by temporarily connecting its input to the audio output! And there is a VFO testpoint which you could (and I did) connect to a back-panel jack for a frequency meter.

Oh, before I forget it— *the components for each module are in separate bags!* The exception to this is the "band pack" which contains the components which are specific to the band you ordered, but the instructions tell you to look for those parts there rather than the module bag.

You have a couple of decisions to make as you build the kit. Components are supplied for variable bandwidth tuning of the crystal filter, but this is optional. I can't imagine why anyone would choose to use the fixed bandwidth option, but there it is. The option consists of a varicap diode and resistor for each pole of the filter, and connection to an off-board pot.

The relative power output meter circuit is optional— takes only a moment to build, and of course it is useful in the receiver alignment as described above. That way you can add a meter later if you want to (a meter is not supplied with the enclosure kit, nor is the front panel punched for it).

If you are building the optional audio filter, you have two choices of filter bandwidth, determined by two pairs of resistors. The options are for 750Hz and 650Hz, and the appropriate resistors for either option are supplied.

Assuming everything checks out, alignment is very simple, consisting of final setting of the VFO range, setting the BFO and the RIT center, adjusting transmitter output and sidetone level and pitch, and a final peaking of the receiver.

The enclosure kit is nice, and a bargain at $30.00, but if you don't elect to purchase it you will find very detailed instructions for mounting the transceiver in a Radio Shack 270-253 box,

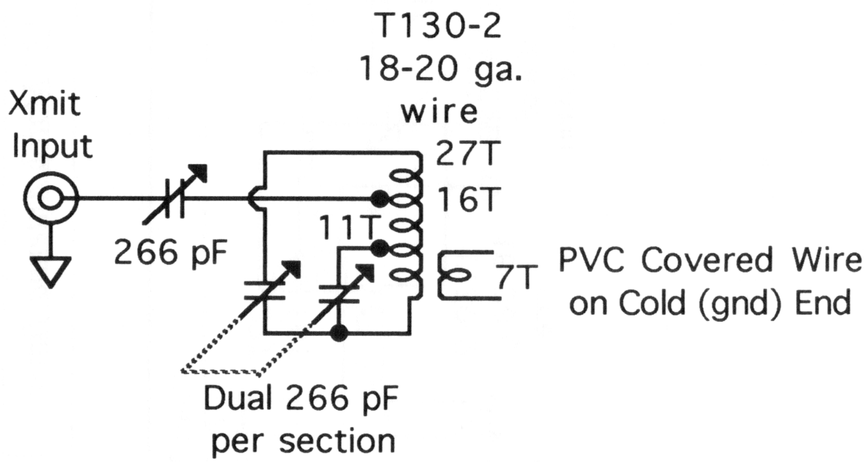
(Continued on page 37)

Your Last Antenna Tuner

Roy Gregson, W6EMT

3641A Preble St.
Bremerton, WA 98312

Basic "Z" Match
Antenna Tuner

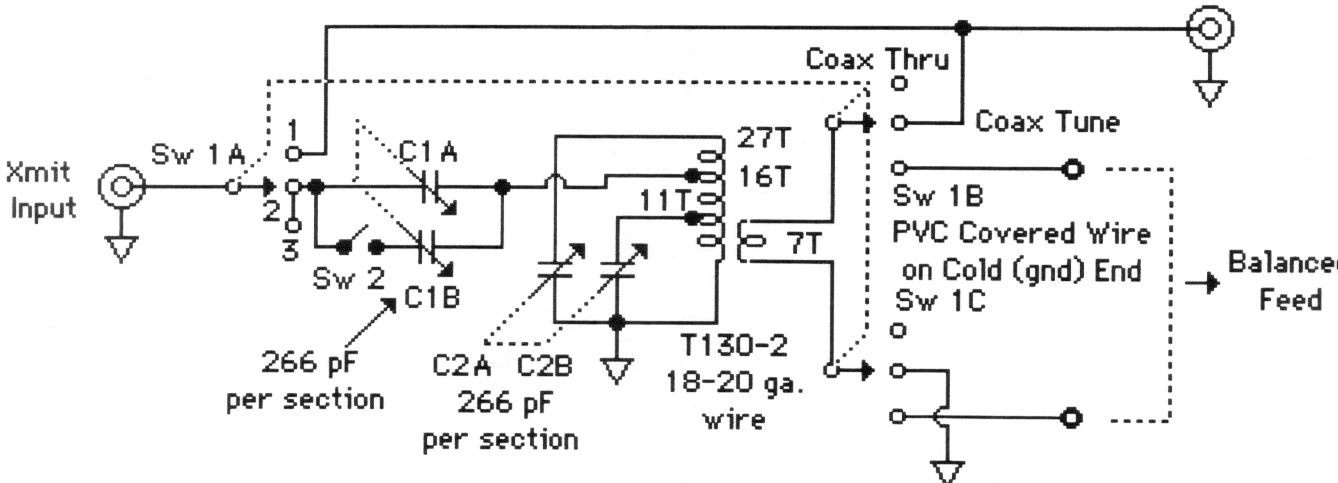


How about this: An antenna tuner that enables you to tune a wire antenna, a balanced fed antenna or a coax mismatch, from 80 through 10 meters. What, you say "this is not new"! But with this one you can do it in seconds. No, its not an autotuner, its the "Z" Match tuner from down under!

You may have spent many a frustrating hour trying to get a stubborn antenna system to tune with your ATU. There are the inductance adjustments, with the follow up capacitors to adjust, the various T, L, PI, PI-L, etc. circuits. They all work to some extent, some better than others. The bottom line goal is to get the antenna performance up and the high SWR down, that is, to get the 50 ohm output of our radios to match the impedance of the feedline at the transmitter end. And to get the best power transfer possible into the antenna. The term ATU, or antenna tuning unit, is incorrect since we are really not tuning the antenna, but matching the transmitter output to the feedline impedance whatever it may be. Or, find that sometimes elusive low SWR! **And do it fast!**

How often do we settle for a 2 to 1 SWR as the best the ATU can do? I don't know about you, but when faced with this, I always felt that the tuner was not doing its job, or I was doing

"Z" Match Antenna Tuner



Switch Positions
1 : Coax Thru (bypass)
2 : Coax Tune
3 : Balanced Feed

something wrong. I know, there are those that say the guy at the other end cannot tell if your SWR is 2 to 1 or 1 to 1. But I can tell, and sometimes my radio can tell, that's important to me.

A few moments with the "Z" Match and you'll throw out your other ATU's. The ZM has two controls, both variable capacitors. There is no inductance to mess with. In most cases, tune for maximum signals or noise in your receiver, trim for lowest SWR and your done. It has extremely sharp tuning, and the two controls interact with each other.

If your wondering, NO, I did not invent the ZM. I first heard about it from a series of articles by Bill Orr, W6SAI, in *CQ* magazine in 1993 about a developing antenna tuner from "Down under" called the "Z" Match. It was unusual in that there were no coil taps to switch, no inductance adjustments at all. It was referred to as a single coil "Z" Match.

Way back, just after WW II, the National Company brought out a multi-band tank circuit that had no band switching. It had several coils and a multi-section variable capacitor. There were two models, the MB-40 and the MB-150. I used the MB-150 in an AM transmitter with a pair of 6146's. It worked great!

This was the basis for the ZM ATU. Bill Orr, W6SAI, has a good description of the ZM "hows and whys" in his new "HF Antenna Handbook", so I'll not make a mess of his excellent work.

Looking at my "storage bench", I see several past attempts at various ATU's from a deluxe Transmatch to a simple wire tuner. There is the one with the many toroid inductors switched in and out, even a autotune version using relays and a remote motor driven capacitor. They all worked, and as the saying goes "some better than others". I think my favorite was the Transmatch with the roller coil. But it was certainly not very fast. It seems like I always had to try any new ATU ideas that came out. I had settled on the "T" match more for convienience than anything else.

Even with all these past tuner projects, I don't consider myself a tuner expert, just curious. When I read the first article about the ZM, my thought was "this is Mickey Mouse". But always willing to try something new, I dug through my junk box and came up with the capacitors, and snipped a section of air-dux from a past tuner try. I hooked everything up with a bunch of short clipleads, connected my antenna and peaked for maximum noise as suggested. Sure tunes sharp! I checked SWR, and there wasn't any showing. I checked forward power and it was about 5 watts (I'm a ORPer). Just lucky I guess. I checked the other bands, and almost the same results. 30M SWR was a little high, and one capacitor was fully meshed. 10 and 12M also not zero, but acceptable. So I'm looking at this mess of wires when it suddenly hit me that I had just tuned 80 through 10M in less than 2 minutes with fairly good SWR's. I found a chunk of wood and made things more permanent with shorter soldered connections. Rechecking the bands, I found that they all tuned to zero reflected power on the SWR meter. Amazing what short leads and solder can do !

With all my years of ATU "experimenting", I decided this thing just cannot be real. Its just too simple ! I showed it to an engineering type Ham friend, and he said it was indeed one of those "too good to be true" things and was probably acting like a dummy load, and would never work. So it went into the pile of ATU's. Next month another ZM article appeared in *CQ* magazine. "You dummy, you never tried it on the air, maybe there is something to this ZM!" It was late at night, and the bands were dead except for 80 meters. I broke into a three way SSB for a signal report.

With my limited 80 meter SSB experience, I had never had one of those many DB's over S9 reports, but I was given a 10 over in Vancouver B.C., and a 30 over in Los Angeles and Las Vegas. I quickly signed off. This cannot really be happening! Next night I got on 40, had several good solid QSO's with excellent reports. On 80, made several antenna checks with the "T" Match vs. the ZM. The ZM was always better at the other end. This thing really works! On my tri-bander beam, the "T" Match always worked with some fiddling, and, except on 15M, I could never get the SWR down to less that 1.5 to 1. The ZM will tune to zero SWR all 3 bands fast, no problem. That makes my ICOM very happy!

The biggest problem with building a ZM is finding the variable capacitors, especially a dual section 365pf. I put together a nice compact 100 watt ATU, and, as others had done, I sent pictures to Bill Orr. I was excited about this new "Z" Match! I sat down and wrote an article about my experiences to share with others. But because of the dual capacitor problem, I shelved the article. In the meantime, Bill had written the "HF ANTENNA HANDBOOK', and to my surprise, my compact 100 watt "Z" Match pictures were published !

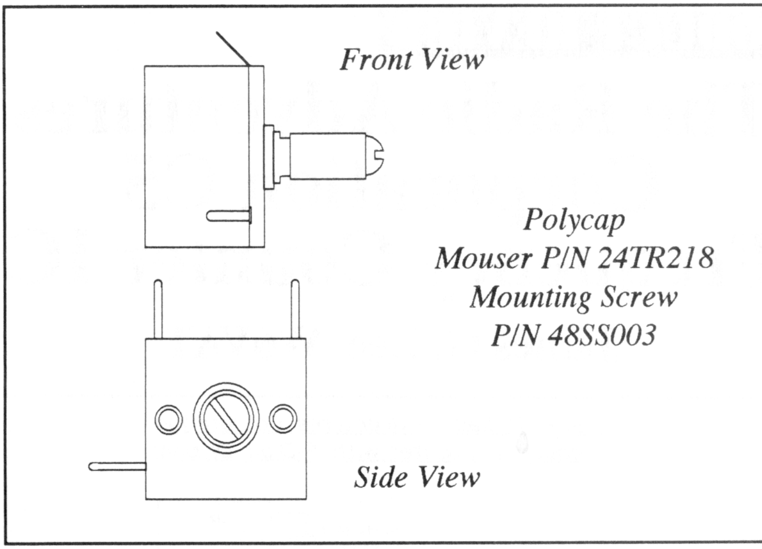
Later, in *SPRAT* (a journal of the G-QRP Club) # 84, in an article by G3WQW, "A single coil Z-Match ATU for 80-15M" the author had used a T130-2 toroid and poly variable caps for what was a very small compact ZM ATU. I tried it, and even though the caps are only about 266pf, not 365pf per section, it works very well. He claims it will handle about 15 watts. Perfect for QRP! Think about it! A tuner with the main parts consisting of a T130 toroid! That's 1.3" dia. and 2 small caps less than 1.0" square and about 1/2" thick! Thats small enough to fit inside many QRP rigs !

So now I'm going to shift gears and talk about a ORP version where a dual section capacitor is readily available! If you are able to find a dual section 365pf and a single section 365pf variable capacitor, I refer you to Bill Orr's new "HF ANTENNA HANDBOOK' for construction details of a 100+ watt version.

I have since found that Charlie Lofgren, W6JJZ, has done a considerable amount of experiments with the ZM and whom I consider a "ZM expert". His article appeared in the July 1995 issue of *QRP Quarterly*, and I understand a follow-up article is in the works! Charlie uses the T130-6 toroid for a little better "Q", and selectable links for wider impedance matching. I would suggest reading Charlie's excellent articles for the latest in ZM updates.

Although this was not intended to be a construction article, a few hints to get you started may help. Referring to the schematic, I have wound the toroid using solid enameled 22 or 16 gauge, or insulated solid 22 gauge wire from Radio Shack. I have checked the RF amps into the antenna with each, and reached the conclusion that they all work with no difference detectable on my RF ammeter. The insulated solid wire is by far the easiest when you compare to stripping off varnish for coil taps using the heavier wire. I wind 11 turns, strip the wire close to the core, twist another piece of stripped wire together (different color) wind another 5 turns, strip close to the core again, and wind the remaining 11 turns, yielding instant taps! I wind the 7 turn link using another color and interlacing with the first 11 turns at the ground end. I leave about 3" at each end for later connections. The T130-2 (or -6) toroids are available from many sources, Palomar and Amidon to name a couple. Because of the limited capacity of the poly caps, the extra section on Cl is switched in when required, for example maybe on the low end of some 80M antennas.

The variable capacitors are from Mouser, P/N 24TR218, and you'll want the P/N 48SS003 metric mounting screws. Next problem is that the poly caps have no shaft. I use a $1/_4$" dia. X 1/2" spacer with a 2.5 x 16mm metric screw for the shaft. Be extremely careful, the cap can be damaged easily by forcing it against its stop when tightening the screw. The cap must be modified too. Notice that there are 6 long leads at the rear of the cap, and 3 shorter ones at the front (knob) end. Cut off the 6 long leads, they are for the small built in trimmers, and have no connections to the main sections. You will note that there are 2 short leads remaining on one side of the cap and a single lead on another side. The single lead is the common, and the other 2 are the two capacitor sections. Full counter clockwise is maximum capacity. The poly cap can be fragile in that if forced hard against its internal stop, it will cause a wrinkling of the plates, and will



eventually short out, even at 5 watts.

From the schematic, you'll notice that Cl must be insulated, and is no problem with the Mouser caps, the mounting screws are normally insulated from the rest of the cap.

Using the ZM is same as any other tuner, except no inductance to play with. The tuning is very sharp, so you may want to consider some Jackson Brothers Vernier drives. I found that "BIG" knobs worked good too! Another big advantage of the ZM is the link coupling; it's balanced so there is no need for a lossy balun. This is perfect for 300 ohm twinlead or 450 ohm line. For a single wire antenna, I ground one side of the link and connect a ground and/or counterpoise wire. For a coax fed antenna, ground one side of the link, but no need for a counterpoise.

Use your imagination with the ZM. I envision a cabinet same size as my NW8020's with the ZM and a SWR meter built in. There is enough room left over to include a speaker, a 12V battery, plus a charging circuit, keyer, SCAF filter, maybe a freq counter! Or perhaps a ZM with the meterless SWR circuit (June 1995 *QST*) all squeezed into a miniature Radio Shack box of some sort.

If you decide to build the "Z" Match, I hope it works as good for you as it does for me. If getting the parts is a problem, I am considering supplying a "Mini-kit" which will have the modified Poly caps with 1/4" shaft and mounting hardware, the T130 toroid, insulated wire and instructions with some more 'Z" Match ideas. If you are interested, e-mail at roygregson@aol.com or mail to Roy Gregson, 3641A Preble St., Bremerton, Wa. 98312.

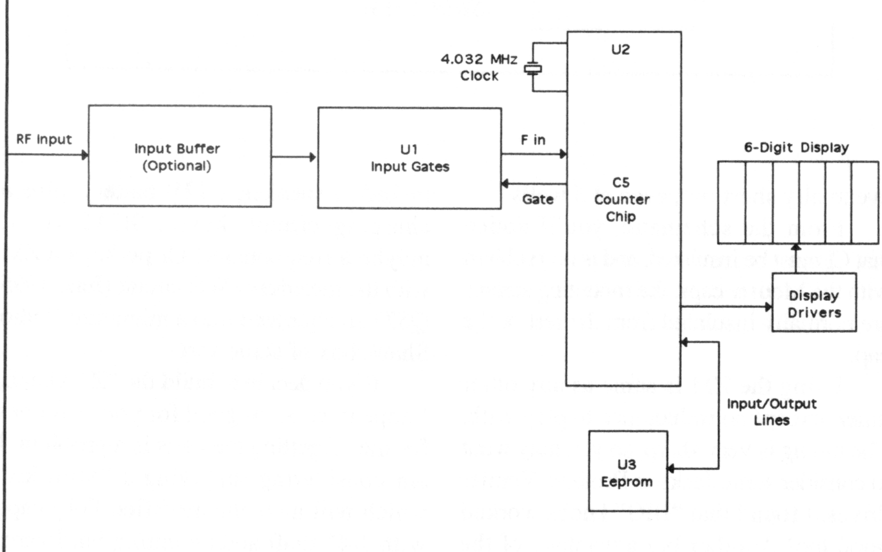
72's and have lots of fun !

PRODUCT REVIEW

The Radio Adventures Corporation C5 Frequency Counter IC

James G. Lee, W6VAT

Figure 1: Radio Adventures Corporation Frequency Counter with 6-Digit Display



Finding certain parts for a project can be difficult, particularly if it adds something special to the design. Digital frequency readouts fall in this category, and although they are quite common today in commercial rigs, the homebrewer sometimes doesn't go to the trouble of adding one to the project because of their complexity.

But Radio Adventures Corporation (RAC) has changed all that with their new C5 Frequency Counter IC. It is a preprogrammed microcontroller using advanced CMOS technology in a 28-pin DIP package. The C5 covers the frequency range from DC to over 50 MHz, and drives a 6-digit display for use with homebrew communications equipment including classic vacuum tube equipment. It can also be wired as a direct frequency counter for use on the workbench .

Some of the other ma)or features of the C5:

• It updates the display approximately 40 times a second to provide real time tuning response.

- A reduction of "last digit jitter" effect.

- Lead zero blanking of "MHz" digits.

- Programmable display offset to account for the difference between the VFO and operating frequencies.

- Programmable "slope" which allows normal or "inverted" tuning for "reverse" tuning VFO's.

- Programmable 100 Hz digit blanking for use with AM or FM tuning where tight frequency tolerances used with CW, SSB, or data modes are not required.

- Programmable automatic blanking when the frequency has stabilized for about 10 seconds. This turns off the display, significantly reducing the current drain. The display returns if the frequency changes more than ±2 counts, or if the operator turns the dial.

- Direct frequency input line allows actual frequency measurement with full resolution, bypassing any offset, slope or 100 Hz blanking.

- Support for 16 unique stored programs, each having fully programmable offset, slope, 100 Hz blanking, and automatic display blanking. These stored programs are contained in a low cost EEPROM.

- The C5 operates over the range of 3.0 to 6.0 volts, 0 to 70° C. with 5.0 Vdc being the recommended operating voltage.

Some of you may be wondering what an "EEPROM" is and what does it do? It stands for Electrically Erasable Programmable Read-Only Memory. Some years ago a new digital chip called a Read Only Memory (ROM) was introduced which allowed standard "housekeeping" chores to be contained on a chip. This reduced software programming but

C5 Mode Table

Mode	Invert	Blank	100Hz
00			X
01	X		X
02		X	X
03	X	X	X
04			
05	X		
06		X	
07	X	X	

had the disadvantage that if major changes occurred a new ROM chip was needed to adapt to the changes.

Soon this problem was overcome with an Erasable Programmable ROM or EPROM. Still there were problems in reprogramming the EPROM because they often required long exposure times (hours) of ultraviolet light through a quartz window on the chip to the actual circuitry to erase the existing program. Today the EEPROM allows you to change the programming at will in a very short time. For example, the C5 Mode Table shows how you can set any combination of inverted slope, display blanking, and least significant digit (100Hz) blanking simply by entering the appropriate information into the EEPROM.

The documentation supplied with the C5 is excellent, and provides detailed descriptions of each active pin on the C5. Detailed descriptions are also provided to show you how to set whatever mode or function you desire. If you only need a direct frequency counter, you can eliminate the EEPROM since it is an optional chip. I recommend that you use the EEPROM since it is quite inexpensive and only uses one extra component - a resistor - to give you a lot more capability than just direct frequency counting.

When I first began breadboarding the C5 for this review, I had occasion to request additional information about the circuitry. RAC was prompt, courteous, and answered all my questions so that I was able to complete the breadboard with no problems. A total of three chips are used for the counting function - see FIGURE 1. U1 is a 74HC02 quad 2-input NAND gate used to synchronize the input GATE functions on the C5 chip during the frequency measuring periods.

U3 is the optional EEPROM which, when used, adds great flexibility to the C5 counter. The display blanking mode is derived from the EEPROM, and allows asignificant reduction in current requirements. For battery powered equipment, this is very important.

I built the counter on a dual solderless breadboard, and with the exception of one goof in my wiring which I found and corrected before I hooked it up, the counter worked the first time I applied power. I did not use the optional input buffer shown in the block diagram. I recommend that it be used since it increases sensitivity and provides about 20 dB of isolation which is helpful in minimizing noise in receivers or tranceivers.

Only one setup adjustment is required when the counter is first turned on. It is a simple potentiometer adjustment used to bias the 74HC02 input gate up into its linear operating range for increased sensitivity. It is neither a critical nor a touchy adjustment, and I did it simply by watching the displays "come alive" as I rotated the pot with an input signal applied. Even if you've never used digital circuits before, this project is about as "user friendly" as you can get.

RAC now has available a pair of kits - complete with PC boards and components - for both the counter and display units. The PC boards are small - approximately 2" by 4" for the counter and 1-3/8" by 4" for the display. This allows them to be incorporated easily into small projects. The documentation for these two kits has even more info on hook-up and programming.

RAC can be reached at the following address:

Radio Adventures Corporation
P.O. Box 339
Seneca, PA 16346
Phone (814) 677-7221
Fax (814) 677-6456
E-Mail rac@usa.net

RAC makes a number of other kits which relate directly to homebrewing, so get one of their catalogs. As the catalogs front page says, "The Good Old Days of Radio Are Back!".

A Non-Amateur QRP FM Broadcasting Station

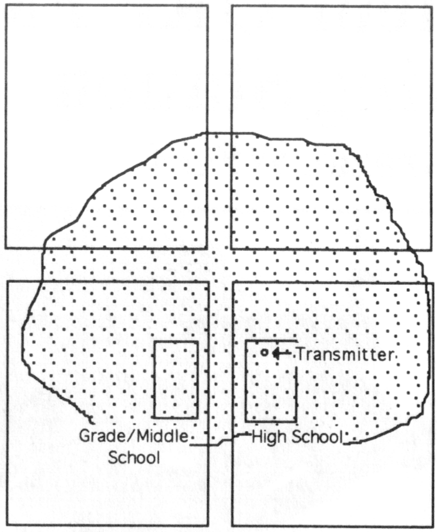
George DeGrazio, WFØK

The Radio Shack mixer has sliding pots; the line level output has a selectable high/low voltage option. The custom cue/air switches and on-air monitor is at the front right.

Last winter I had an opportunity to make use of a modest educational grant to construct a radio station for a high school in Denver. The station was to be a working classroom for a broadcast- journalism course. Before moving a muscle on construction, I began to dig around to find out what was necessary to be absolutely legal in all aspects of RF radiation, power output, etc.

Whereas I do not wish to engage in a lengthy presentation of F.C.C. rules, I will simply state that, as of this writing, to be compliant with the power requirements for a non-licensed FM radio station in the broadcast band, it is necessary to construct (or assemble, if part of a kit) an antenna for it which radiates a signal of not more than 250 microvolts as measured at a specified distance from the antenna.[1] Thus, for an FM station, the requirement is a function of output power, but measurable as antenna field strength.

I selected the FM-25 Professional Synthesized FM Stereo transmitter from Ramsey. I found that it assembled without a hitch. The parts-layout drawing is large and easy to interpret, and the step-by-step instructions in the manual were broken down into four major sections: the audio input circuits, RF amplifier, input power and synthesizer. There are two mods included on separate sheets, one on the solder side of the board which adds four capacitors, and one involving substitutions of two caps and two resistors on the component side. The former helps eliminate line hum and the latter provides correct equalization for the U.S. model. The telescoping antenna provided



Limited Coverage Area
of Transmission
Map

Ramsey FM-25 FM Stereo Transmitter $129.95 (As of May,1996)

Ramsey Electronics, Inc.
793 Canning Parkway
Victor, NY 14564
(716) 924-4560

Synthesized frequency setting from Motorola microprocessor
88-108 frequency range
Project case and AC power adaptor included

---

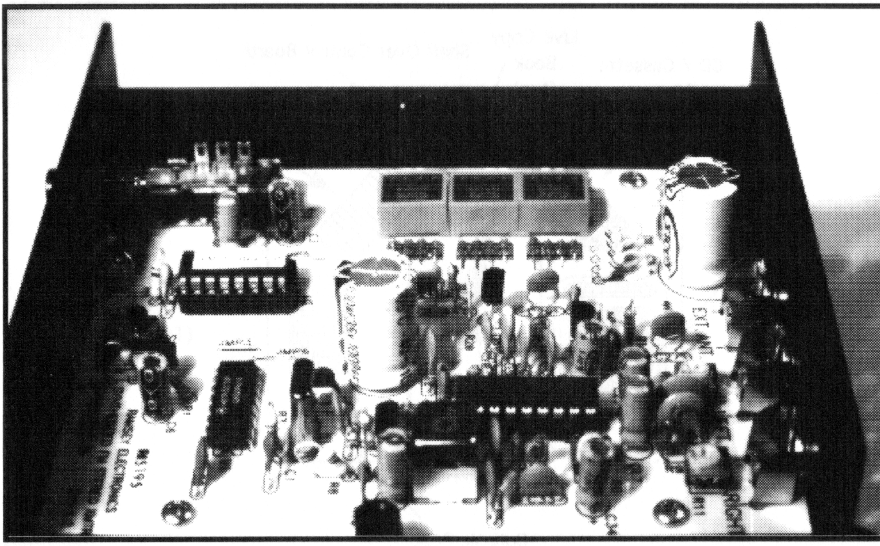
with the kit is not sized to achieve resonant quarter-wave lengths to frequencies in the 88-108 MHz broadcast band.

The circuitry revolves around a BA1404 FM transmitter chip, and the frequency synthesis is programmed to a 68HC705K1 via DIP switches on the board . Increments are in 10, 5 and 1 MHz segments. The LED on the front panel of the case indicates power on and frequency lock. The frequency has high stability and is regulated for drift by a third IC.

The Ramsey manual cautions to *carefully* determine an operating frequency, and gives some good tune-up pointers. There is a very specific and lengthy section of the manual devoted to compliance with FCC rules for the device. The object is to allow schools and individuals to be able to utilize very limited coverage areas which do not interfere with reception of the commercial broadcasting stations.

I did not have the time to construct a mixing board, although that could be an interesting future project for this or any other station of this type. Instead, I opted to utilize an SSM-100 Radio Shack stereo audio mixer[2] which was not specifically designed for on the air operation, but rather for use with public address systems, mobile DJ work, etc. A problem to be overcome with this choice is that there is no adequate cue circuitry in the model which was selected . What exists is a line-level cue which is does not have much gain. This meant that the line-level output of the various devices (cassette decks, CD decks, turntables) needed to be picked off by a switching system and routed either to a low-power monophonic or stereophonic amplifier with speaker, or to the board for mixing before reaching the transmitter. See figure 2 for the method used. Rotary switches from Radio Shack worked fine for this.

A console table was constructed of plywood with a formica top and stained edge trim on a 2' X 3' pine frame. A wooden surround with a shelf top was built around the mixer. This also provided for installation of the amplified switching circuit for cueing, and an air-monitor earphone jack connected to a hidden receiver. Volume controls were provided for both cueing and air-monitor audio. A Radio Shack Highball Dynamic Microphone (RS#33-



948D) was attached to the shelf via a gooseneck, and a second, Cardioid Dynamic Microphone (RS#33-1073A) , sits on the newsdesk facing the console.

The payoff of this project is definitely reflected in the faces of the broadcast journalism students at Bishop Machebeuf Catholic High School in Denver. Their delight and intense sense of professionalism as they go about the chores of putting out a classical-music, news, weather -and sports-formatted broadcast across

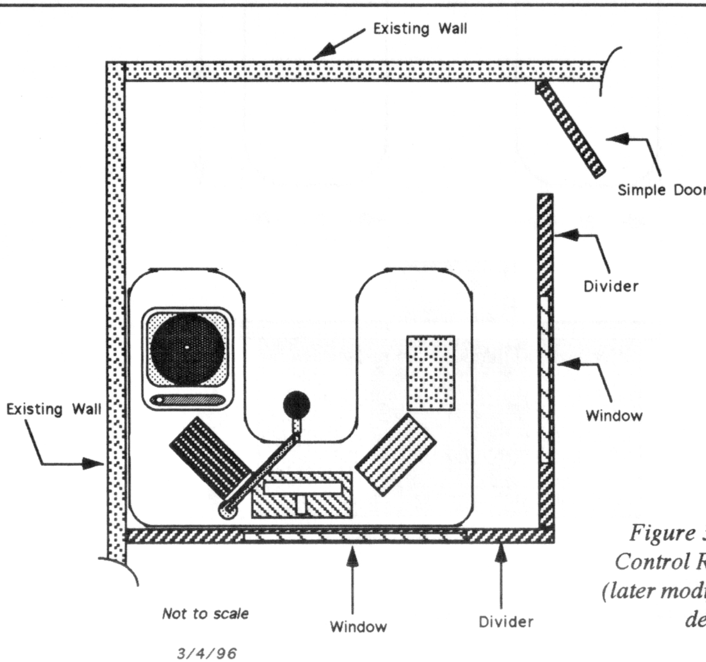


Figure 3: Original Control Room Layout (later modified from this design)

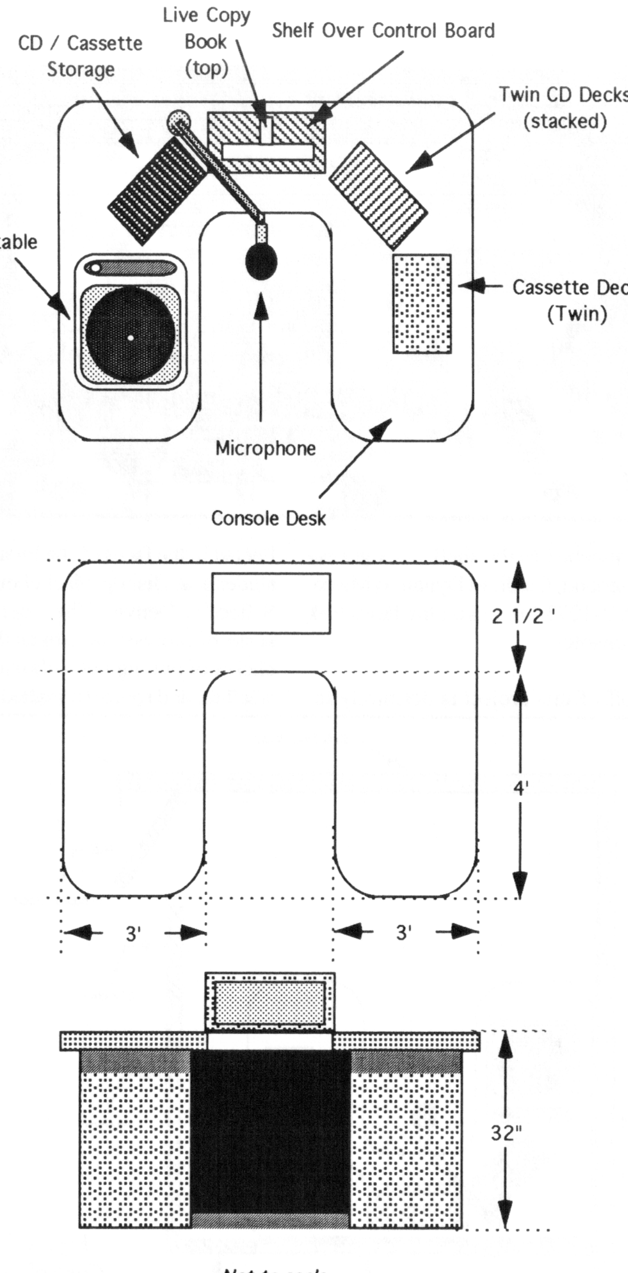


Figure 4: Console Constructtion and Layout

3/4/96

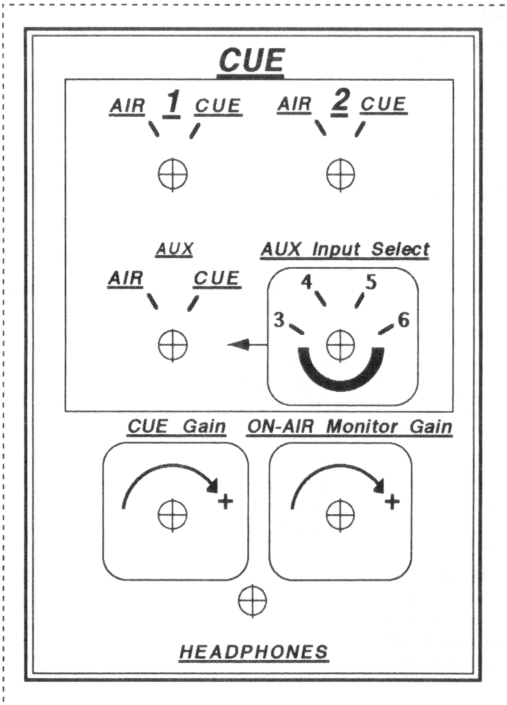
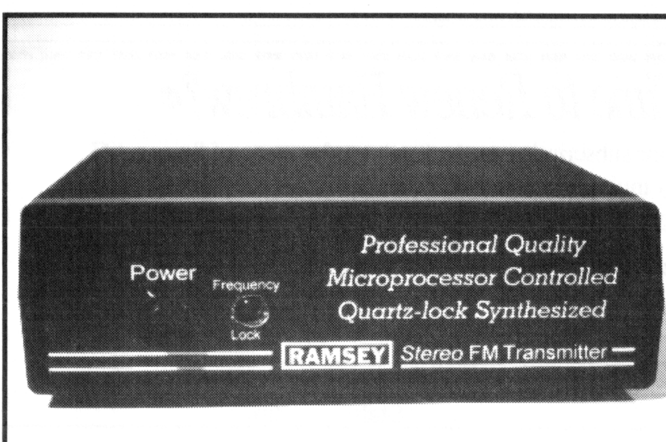


Figure 5: Cue Circuit Switching Panel Layout



Front Panel exterior. The LED power-on and frequency lock indicator is to the right of the power switch. The antenna output jack on the back panel is a phono-type.

the school campus is easy to perceive! Academic information in lively interviews and high-quality programming make their learning experience limitless. Interest in broadcast radio has brought about a dialog about the physical nature of radio also, and could easily lead to the international realm of amateur radio.

This article has notbeen written to cover the individual issues of a detailed transmitter review, nor to present the FCC guidelines for this application in depth; the important idea is that our building experience can benefit educational and other worthy institutions in a positive and dramatic way. If this idea appeals toyou, I hope you can avail yourself to those who might also need your help to get started.

Notes:

1. For a detailed explanation of these and other requirements related to this project, carefully read Understanding The FCC Regulations For Low-Power, Non-Licensed Transmitters (OET Bulletin No. 63), Office of Engineering and Technology, Federal Communications Commission.

2. R.S. catalog number 32-1212

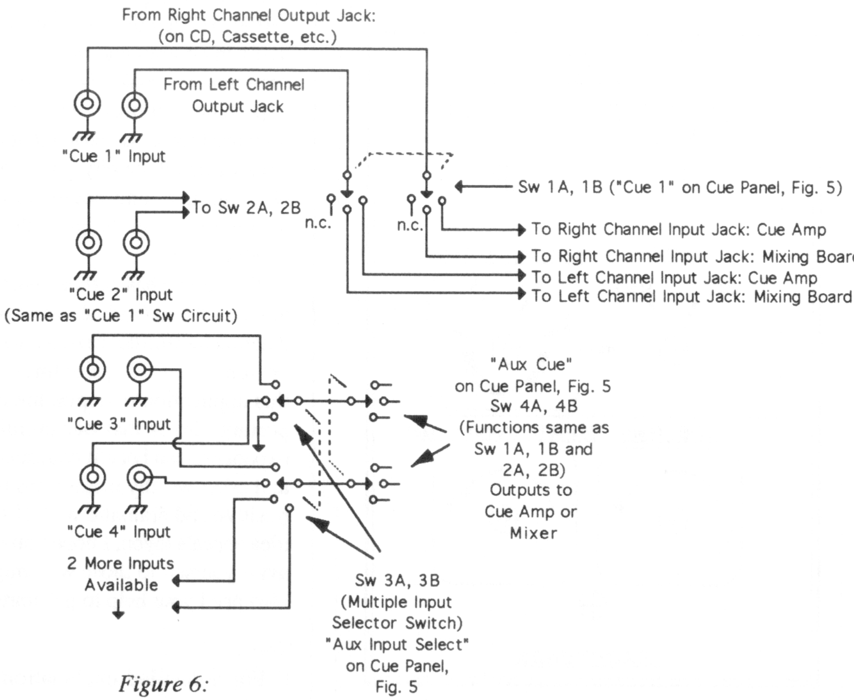
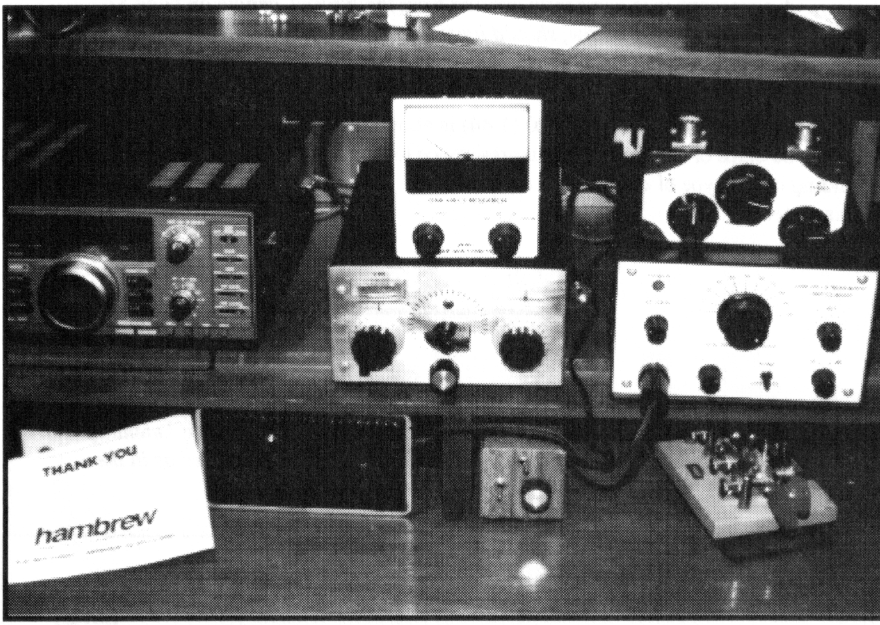
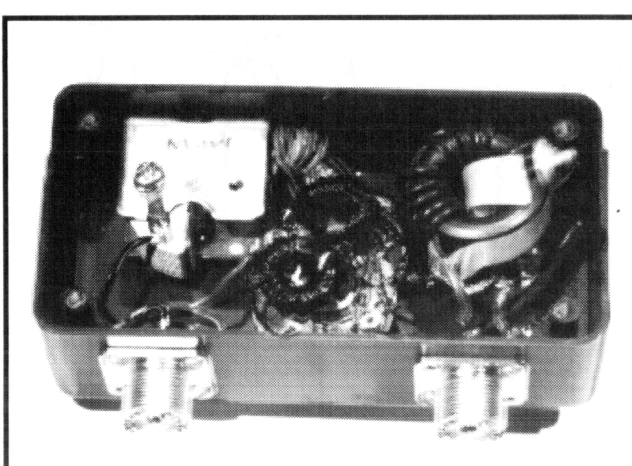


Figure 6:
Cue Circuit
Switching Panel Schematic

• RIGSHOTS •

Bob, WØLK of Mountain View, AR, sent us these great shots of his shack and some projects. In the top photo below are shown a homebrewed tuner under the OHR Wattmeter. The tuner in the bottom photo can be seen on top of the OHR QRP Classic just above and to the right of a homebrewed keyer (left of paddle). More shots from the WØLK shack are on page 30 (photos this page and page 30 by WØLK).





Bob says "I call this the NAT (Not Another Tuner). It is a typical T-type built in a plastic box, with a balun on the input side so it can be used with balanced feeders. The Balun is an RG 174 on a Ferrite Core."

20/20 Hindsight

Looking Back Into Past Issues • Updates & Elaborations

Summer, 1996 Issue

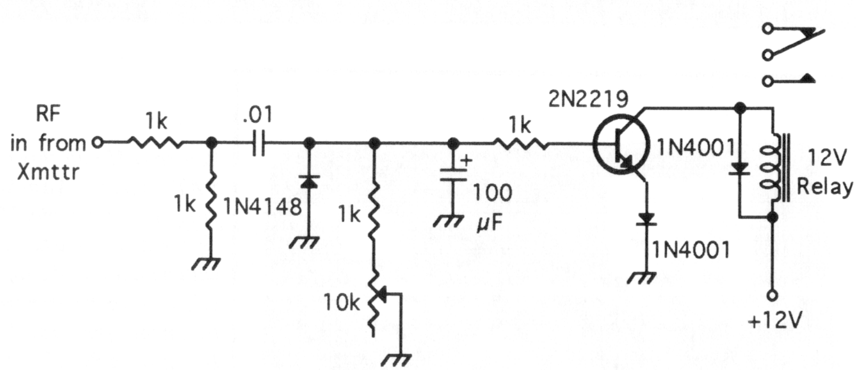
A paragraph was accidently omitted from the W6VAT article on page 37. The paragraph, below, should have been placed just prior to the final paragraph of the article.

The logarithm of 27.8 = 1.44 and 20 (1.44) is about 29 dB, so you lose 8 dB of gain simply by adding 50 ohms of unbypassed emitter resistance to the circuit. This can be a high price to pay, depending on the type of circuitry you are building.

This appears....etc.

Autumn, '95

On page 30 is a Roy Gregson (W6EMT) RF-Sensing Relay for the Noise Antenna featured in the Autumn, '94 issue. The 1N4001 diode should be polarized as in the drawing below.



Eye on 50 MHz

Dick Pattinson, VE7GC, of Salt Spring Island, B.C., Canada, has sent along this receive converter for a Neophyte receiver used as a tunable IF at 5.0 to 5.6 MHz. Dick did not specify the transformer turns at the front end of the NE602 in Figure 1 below, but a 10 turn secondary with a 2 turn primary on a T50-2 might do the trick. The input impedance of the NE602 is 1.5kΩ, so experimentation around these values should lead to success. Dick adds "I used a 15 MHz computer crystal which is selling up here for 25 cents. It oscillates fine but I had difficulty in getting it to overtone, so I put in another stage as a tripler. I left room on the chassis board for an RF amplifier which I may add. I use...(an RF amplifier) in front of the Neophyte to up the gain. It is a pleasure to tune in signals, as the oscillators are so steady". - Thanks, Dick!

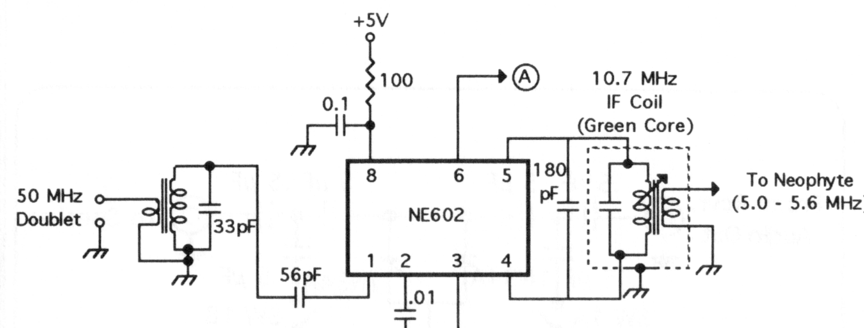


Figure 1: The converter front end

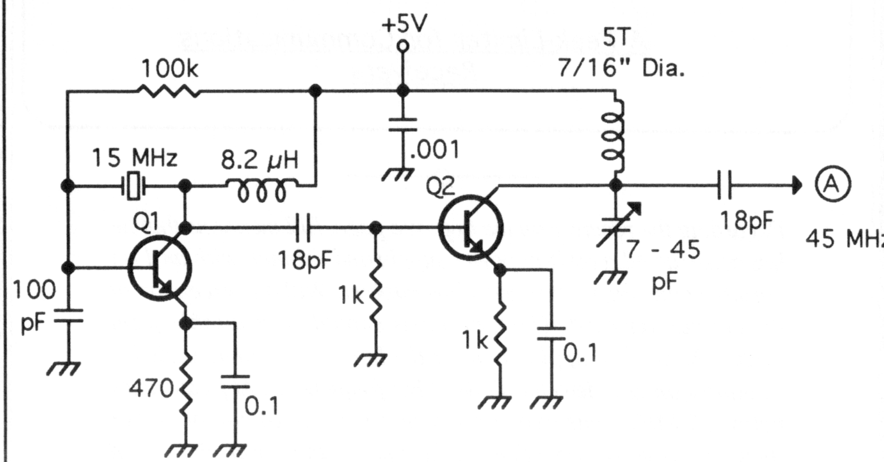
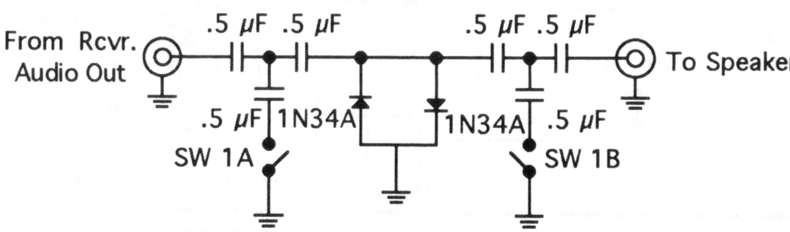


Figure 2: converter oscillator-tripler

From The Drawing Board

Bill Copeland, WB6RVE, of Baldwin Park, California, has sent us some interesting and useful-looking schematics. Although he tells us little about the construction details, we are reproducing them here for your experimentation and use.

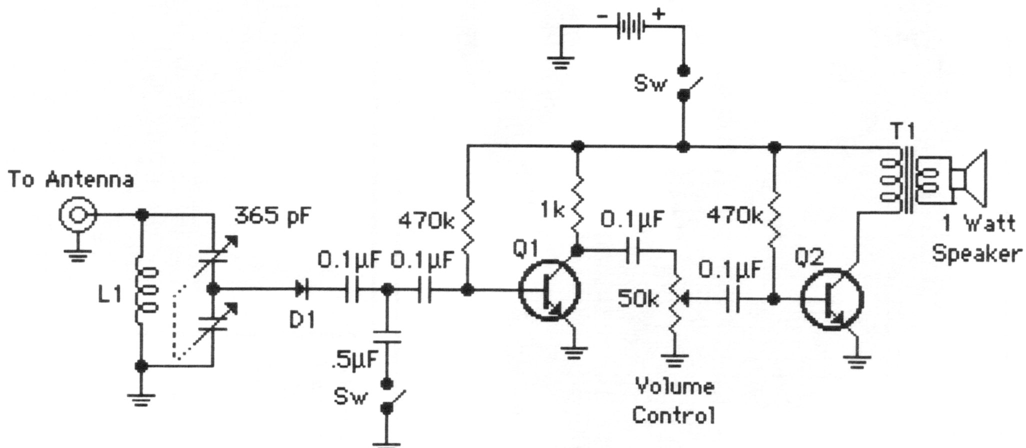


A Peak-Limiter for Communications Receivers

Regarding the receiver on the opposite page, Bill mentions that he has constructed a built-in power supply and cabinet with an 11m portable antenna on the back of the cabinet."With the exception of the hot carrier diode (D1), all parts should be available from Radio Shack, One application for the hot carrier diode includes its utilization as a detector diode at HF frequencies. At frequencies below 30 MHz, sensitivity of this receiver circuit can be better than 2 microvolts, depending on the type of hot carrier diode used in this circuit configuration," adds Bill.

Hot Carrier Diode Receiver
For AM Broadcast Reception

Bill Copeland, WB6RVE



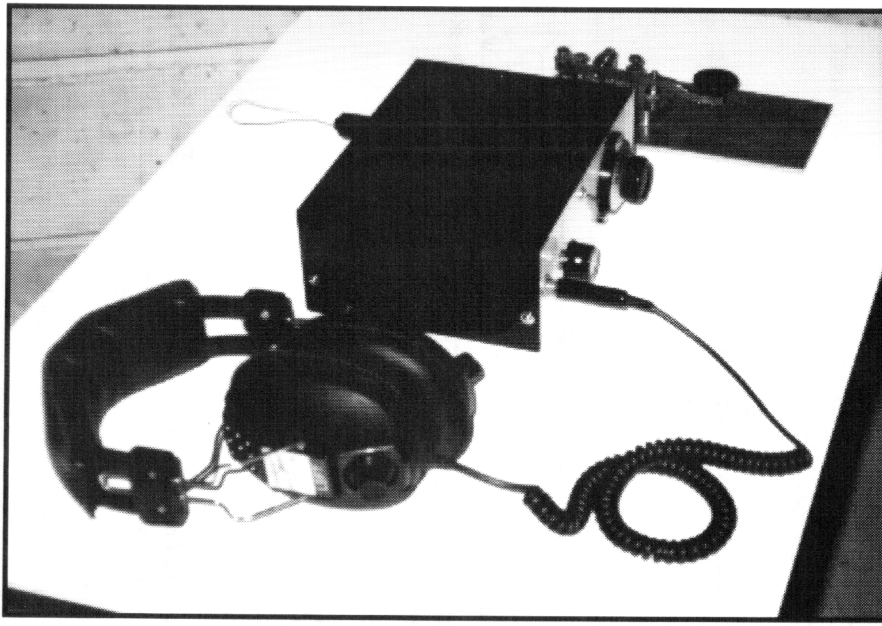
D1 : Hot Carrier Diode (Motorola HPA-2800 or equiv.)
L1 : 50 T #22 wire over 10mm coil form
Q1 , Q2 : 2N2222
T1 : 1k to 8Ω Audio Transformer

Tuning Range = 500 - 1600 KHz (+/-)
Sensitivity = 5 µV (+/-)
Selectivity = 4 KHz (+/-)

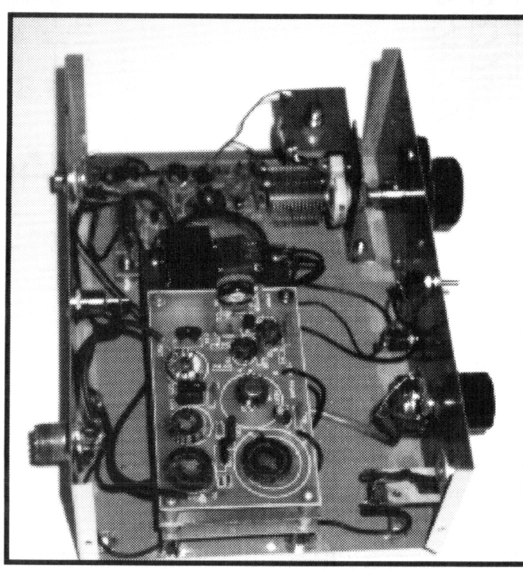
With the exception of the hot carrier diode, all parts should be available from Radio Shack.

• RIGSHOTS •

More WØLK photos: The top shot shows an "Ugly Weekender" rig set up and ready for business. The photo at the bottom shows the interior board and parts placement of the same rig. (Photos, this page and page 25 by WØLK)



Regarding this rig and the photos on page 25, Bob adds "As you can see I have been quite taken with the OHR kits. I (have given) the OHR QRP Classic a good workout in the CW Sweepstakes. It did a fine job. I particularly like its very good selectivity, both IF and audio. It is great for contesting. I am going to convert the Ugly Weekender to 30 meters so I will have a QRP rig for that band. And by the way, the rig is missnamed- it took me many weekends to accumulate the parts and put it together!! I also want to find a 6L6 tume and other parts to duplicate my first rig (1938)."
Bob has frequently contributed to hambrew;we value his input.



My List of Mail Order Electronics Companies

John Woods, WB7EEL

jfw@jfwhome.funhouse.com

Here is my list of companies which will sell electronic components in small quantities. Many of these places I have bought from, several I haven't. Being a ham radio operator, I am most interested in RF components, and in particular, air variable capacitors, which tend to be scarce (and tend to be used or surplus even if I've otherwise labelled the seller as "NEW").

Categories are: • NEW COMPONENTS: Distributors and sellers of new components, or "new and some used" in a couple of cases.• SURPLUS ELECTRONICS: Usually overstocks, occasionally used equipment. Ideal for stocking the junkbox, usually have dependable stock lines of resistors, capacitors, and some semiconductors, but won't have those LCD modules forever... An invaluable resource, don't shy away from them.• SPECIALTY COMPONENTS: In particular, crystals and toroidal cores. • KITS: Ham radio kits, random electronic kits, whatever they have. • LITTLE GUYS: Separated out because of some twisted sentimentality, I suppose. Intended to honor one or two ham spare-bedroom operations. Note that sending $1 along with catalog requests is a big help for these folks. ª PUBLICATIONS: A small selection of publications dealing with electronics, especially RF electronics. • QRP CLUB PUBLICATIONS: Clubs for low-power amateur radio enthusiasts; frequently have publications with quite a bit of technical content (which is why I'm a member of QRP clubs headquartered thousands of miles from where I live. Note, this is generally practical technical content (how to build it) rather than theoretical technical content (why it works), but definitely more than Contester's Quarterly.

Note on shipping costs: I don't always update these frequently enough, and they're generally for continental US unless otherwise mentioned.

LITTLE GUYS:

Kanga US
Bill Kelsey
3521 Spring Lake Dr.
Findlay, OH 45840
419-423-5643
call between 7 - 11 pm eastern time please. stamp for a catalog.
"I import kits from Kanga in the UK - most of them come from SPRAT - the journal of the G-QRP Club. I also have the Super Tee Antenna Tuner, and a range of kits from Elktronics that are based on the DDS articles in 73 Magazine.

R&R Associates
3106 Glendon Avenue
Los Angeles, CA 90034
213-474-1315 (res)[Richard Rathburn, KB6NQ]
"I mainly sell pc boards from QST, Radio Electronics, etc., and a few of in-house design. I also sell IC's, etc." Send a SASE every now and then for his most recent flyer. He also has boards for some Motorola Application Notes. (Jan 94 — a member of the QRP mailing list reports some dissatisfaction with R&R.)

CW Technology
7328 Timbercreek Court
Reynoldsburg, OH 43068-1181
COD Orders at 800-547-7479
"I have a small (just me) mail order company through which I sell kits. My starter products were kits for computer/transceiver interfaces to go along with my 2/93 *QST* article. Since, I have added a programmer kit for the MC68HC705K1 microcontroller and an optoisolated stepper motor controller kit. I also sell the PCBs and difficult parts for these projects." - Wally Blackburn AA8DX

GNP Sales
POB 77011
San Francisco, CA 94107.
"Business size SASE for our current list. We are very small, all three of us have "real" jobs. We buy and sell vacuum caps, vacuum relays, various high voltage parts, coax relays, mostly radio stuff."- Peter Gerba, pgerba@crl.com

Radio Devices
Bob, KD1GG
32 Queens View Road
Marlboro, MA 01752
(508) 480-0502
internet order form on WWW homepage http://www.raddev.com/biz/raddev/
Oak Hills Research Kits - authorized dealer
Ramsey Kits - authorized dealer (only one in MA) Ham Radio CDROMs (QRZ!,Buckmaster) Antennas West - authorized East Coast Distibutor
Anli Antennas & Power Stations
Walnut Creek CDROMs

MANUALS:
Eico Electronic Instruments Co., Inc.
363 Merrick Rd
Lynbrook NY 11563
Note: No current kits, EICO manuals and schematics only

A.G. Tannenbaum
P.O. Box 386
Ambler PA 19002
215-540-8055
215-540-8327 (FAX)
"sells original SAMS, copies of service data from Riders, Gernsback
and original manufacturers's manuals. Vintage parts and high voltage components are also available. We will send out a free catalog on request." {Note from Jim Tannenbaum (son of the proprietors) entitled "Resource for parts and service data for Antique Radios".}

• Amateur Radio Book Review •

If you enjoy the quarterly column in *hambrew* by Jim Lee, W6VAT, there is a book authored by him entitled *An Introduction to Radio Wave Propagation*, published by Babani Publishing, Ltd. in Great Britain. The book is a sturdy paperback (116 pages), and deals with many interesting aspects of the subject, including the sun's role, sunspots, the ionosphere, radio wave propagation, non-ionospheric propagation, noise, and an appendix on logarithms and decibels.

Jim holds a B.A. degree in Mathematics and Physics from the University of California at Los Angeles.While in military and government service, he served as a Communications specialist and radio wave propagation prediction, among other engineering duties.

Jim has proven his solid and extensive knowledge of the theories and applications of radio in our pages. Now it is possible to include his information on propagation and related topics (sample: did you know that man-made noise is mostly vertically polarized?) on your bookshelf. The price on the cover is £3.95 (U.K.).

Available from

Electronic Technology Today, Inc., PO Box 240, Massapequa, NY 11762. Check on U.S. price and credit-card orders at (516) 293-0467.

DESIGN BASICS SERIES

Thoughts On Theory

The Emitter-Follower

James G. Lee, W6VAT

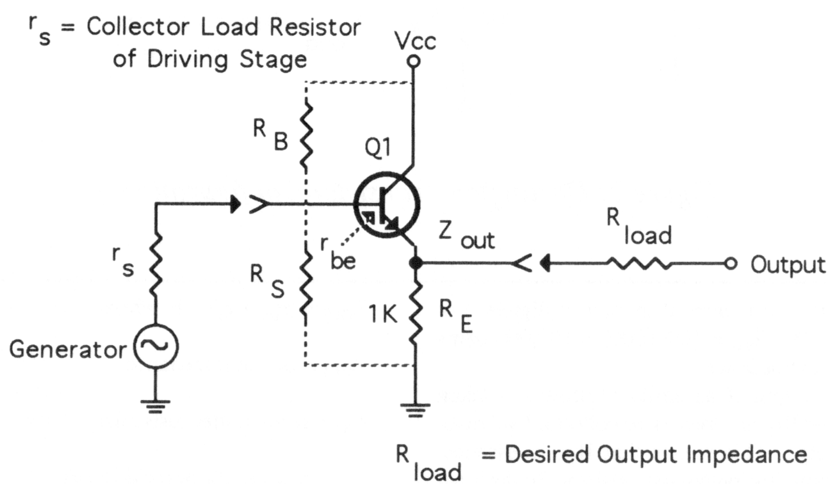


Figure 1: Emitter Follower

Last time I talked about increasing the input impedance of a common-emitter stage by leaving part of the emitter resistance R'_E unbypassed so that it is visible to the signal. Although this approach does limit the possible gain of the stage, sometimes matching impedances is more important than stage gain. Sometimes you want to put a signal into as high an impedance as possible for isolation purposes, such as buffering the output of a VFO. This also has the effect of making the AC load line even closer to the DC load line which will maximize your unclipped peak-to-peak voltage output .

One way of getting a very high input impedance is to use the common-collector circuit, or, as it is more commonly called, the emitter-follower. In this case the whole emitter resistor R_E is left unbypassed. This means the input impedance goes up significantly. For example in FIGURE 1, the input impedance is, as you recall :

$$Z_{in} = \beta (r_{be} + R_E)$$

where Z_{in} = input impedance

r_{be} = base-emitter resistance. and

R_E = emitter resistance.

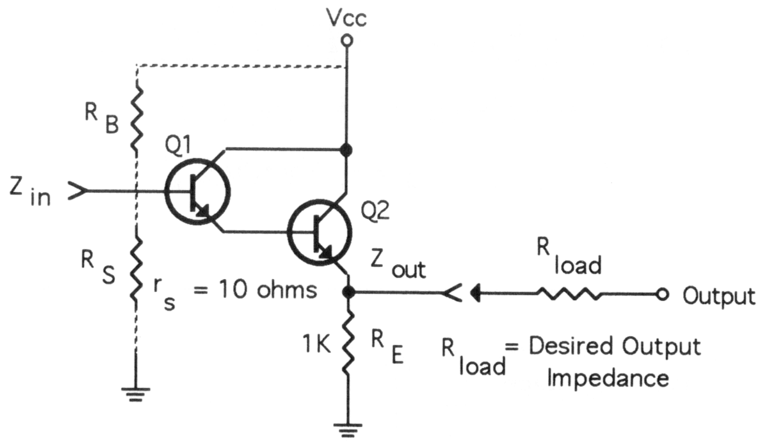


Figure 2: Darlington Transistor Configuration

If R_E is 1000 ohms, then r_e is negligible. For $\beta = 100$, $Z_{in} = 100(1000) = 100{,}000$ ohms input impedance.

The output of an emitter follower is taken across R_E, and there is no collector load resistor R_L. This means that R_E, in essence, becomes the output load resistor. So the input impedance is determined, in part, by the output impedance. The reverse is also true - the output impedance is determined, in part, by the input impedance seen by the emitter-follower. Put another way, the output load is part of the input, and the input load is part of the output .

But not to worry since the calculations for each impedance is straightforward. The input load seen by the emitter follower is the output mpedance shown by the driving stage. This consists of R_L, the collector load resistor. FIGURE 1 shows this at the left-hand side as a generator symbol and a series resistor r_s. Here r_s and R_L of the driving stage are one and the same. For the moment let's just consider how r_s affects the output impedance . Thefollower's output impedance is found by the following: :

$Z_{out} = (r_{be} + r_s) \div b$, where

Z_{out} = output impedance

r_{be} = base-emitter resistance

r_s = generator (or driving) impedance .

If r_{be} = 26 ohms and thecollector resistor r_s is 1000 ohms, r_{be} again can be neglected. For b = 100 the output impedance Z_{out} becomes $1000 \div 100 = 10$ ohms.

So the emitter- follower in FIGURE 1 has an input impedance of Z_{in} = 100K and an output impedance of Z_{out} = 10 ohms. The actual input impedance will be reduced by the value of the parallel bias resistors R_B and R_S. Because of the large amount of emitter degeneration. you can use only one base bias resistor and still have reasonable control over the operating point . But there will still be some sensitivity to β, and poor transistors which have high leakage currents can cause saturation to occur. The H-bias method is still the best way to go for good stability .

The gain of the emitter follower is a

maximum of 1 or unity. Modern day transistors with low leakage and stable biasing circuits give gains ranging from 0.95 to 0.99. This is not much of a price to pay for the other benefits the emitter follower provides. There is no inversion of the waveform as there is in the common-emitter (or common-base) amplifier since the emitter voltage follows the base voltage differing only by v_{be} which is 0.7 volts for a silicon transistor. The emitter current is essentially equal to the collector current since it also is I_b times β.

To keep the input impedance high when using the H-bias method, you can use something less than the recommended 10 times I_b when calculating R_B and R_S. This will keep their values high and so minimize their effects on input impedance. If you do this I don't recommend going less than 5 times I_b for calculating these two resistors . But you can make "tradeoffs" in this area and one rule of thumb is to make $R_S = (bR_E) \div 10$. Recall that the ratio of $R_S \div R_E$ is one measure of circuit stability. If R_S is made small for stability, it will lower the input impedance, making it harder to get a signal through the stage , So this is an area where you make tradeoffs between stability and input impedance.

Another important effect is related to the generator (or driving) impedance r_S and the input impedance of the stage. As you can see in FIGURE 1, r_S and the input impedance of Q1 are really a voltage divider. So the higher the ratio of r_S to the total impedance of ($r_S + r_{input}$), the lower the input voltage delivered to the transistor. This is another reason to make the input impedance as high as practical in the emitter follower stage.

DARLINGTON TRANSISTORS

FIGURE 2 shows an interesting bit of circuitry. It is called the "Darlington" configuration after its developer, Sidney Darlington - then of Bell Laboratories. Note that it is a "compound" configuration with an emitter follower driving a second transistor. A very important point is that both β's are multiplied together. Most single transistors are limited to maximum β's of around 300 or so, but what if you need a b much higher than this? The Darlington configuration is one way

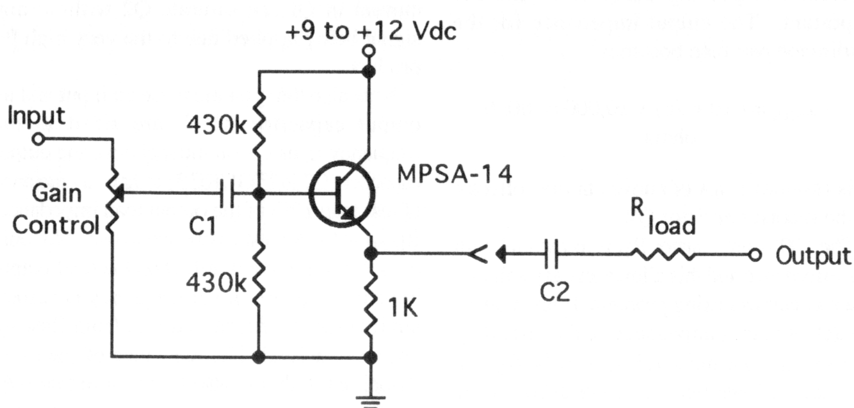


Figure 3: Sample Darlington Transistor Circuit

to get it.

If the betas of the two transistors are equal, then the combination of the two is simply β^2. If they are not equal, then the overall β is simply their product, $\beta_1 \times \beta_2$ - where β_1 is the β of transistor Q1 and β_2 is the β of Q2. If both β's are = 100, then their product is 100 (100) = 10,000.

If R_E is 100 ohms then the input impedance of the Darlington pair is (10,000) 1000 = 10 Megohms. This value will be reduced by any biasing resistors and any stray capacitance, but it can still remain much higher than a single emitter follower. The above calculation is an approximation since the real formula for Z_{in} is

$$Z_{in} = \beta^2 (r_{be1} + r_{be2} + R_E), \text{ where}$$

β^2 = the product of the two β's

$r_{be} = 26 \div I_E$ for each transistor, and

R_E = any unbypassed emitter

When used as a comnound emitter follower, the output impedance of the Darlington pair is very low - often less than an ohm. For example, if Q1 in FIGURE 1 is the driving transistor for the second transistor in FIGURE 2, then its calculated output impedance of 10 ohms is important. The output impedance for the Darlington pair then becomes

$$Z_{out} = (10 + 26) \div 10{,}000 = .0036 \text{ ohms.}$$

This assumes 1 mA of current tn the collector of the second transistor Q2.

The 1000 ohm resistor R_E is in parallel with this impedance and this allows an easy solution to a sometimes vexing problem. It lets you set the actual output impedance of the circuit by choosing just one resistor, R_{load}, in the figures. This also allows one other condition to be satisfied.

Often you need not only control of the output impedance of a generator but control of the amplitude as well. A simple low value pot for R_E is not the answer, because although you can get variable amplitude from the pot, the impedance will not be constant. By using a follower type amplifier you can simply add a resistor of the proper value to its output - R_{load} in the figures.

Then by moving the gain control upstream to the followers' input as in FIGURE 3, you have the variable output you need with a constant output impedance. This technique is called using a "build-out" resistor to set whatever output impedance you need.

FIGURE 3 shows a circuit I designed a couple of years ago using a Darlington transistor as an output amplifier for signal generators (Yes, you can get a complete Darlington pair in one case - TO-3 or TO-92 - and use them as if they are one transistor). I've used the circuit of FIGURE 3 from 600 Hz to 45 MHz, with input signals ranging from millivolts to several volts peak-to-peak.

The MPSA-14 transistor is in the three-for-a-dollar class of transistors and has an f_T of 125 MHz, which means it provides usable output as high as 6 Meters. The Darlington transistor (or configuration) can be used in any circuit configuration and is not limited to follower-type circuits. One caution to remember if you use two separate transistors is that the transistors should be low-leakage silicon transistors, since excessive cutoff current in Ql can saturate Q2 without any signal being applied due to the very high β^2 product.

Note also that you must use an input and an output capacitor which are sized to the frequency in use. You must choose the output capacitor (C2 in FIGURE 3) to have a reactance of less than 10% of the output load impedance. R_{load} at the lowest frequency in use. Not only does this minimize its effect on the total output impedance as the signal frequency is varied, but it keeps the emitter current from flowing out into the load. The reactance of the input capacitor C1 should also be no more than10% of the input impedance presented by the follower circuit since it acts as part of a voltage divider to the signal, and also prevents currents from going where they're not supposed to go.

Just as the common-base amplifier transforms a low impedance into a high impedance, so the emitter follower transforms a high impedance into a lower impedance. The Darlington configuration isn't seen too often in the ham world, but it can be a very handy circuit, particularly since the two transistors are available in a single package. The follower-type circuit can replace more bulky and expensive transformers when you want to keep both size and cost low. The Darlington amplifier can be used in any other circuit configuration as well - just think of it as a "super-β" transistor.

(Continued from page 10)

including drilling/punching templates.

THE NW3O ON THE AIR

The first thing you notice when you power up the NW30 is that the receiver is very sensitive and the audio output is *huge*, easily enough to drive an internal or external speaker. The price you pay for so much audio gain is that the volume adjustment is a bit sensitive— if you are working a weak signal and then tune to a strong one, prepare for a headache! The VBT works very nicely, and I found that for routine operation I could just leave it set to mid-range. Filtering is sharp, and with the VBT narrowed down and the audio filter selected, a drifty signal could disappear outside the bandwidth pretty quickly, but the RIT brings it right back. (For the benefit of any beginners reading this— you tune a drifting received signal with the RIT, *not* the main tuning dial or you will have *two* signals chasing each other around the band!).

I found it necessary to re-visit the sidetone level adjustment, setting it near its minimum audible range, because the sidetone is amplified in the audio output circuit.

QSK is smooth and quiet, as good as any I've used. Delay time is such that at about 20wpm you will be able to hear quite well between words as you send them.

With the 30M version I found that maximum power out was around 7W, so at 5W (operating from a 13.8V supply) the transmitter is cruising at around 70% of "military power," which is important for two reasons. First, it extends the life of the final power transistor, and second, it gives it more tolerance for a less than perfectly matched load. The output power can be reduced to less than 100mW, and it looks to me as if an offboard power level pot could be installed in place of the existing trimmer.

The NW30 is very stable, with no signs of drift, chirp, wow, flutter, or any other vices. Admittedly, the narrow bandspread on 30M would tend to minimize any such problems, but if you can't even *detect* them on 30M they are unlikely to be serious problems on the other bands. The documentation does suggest that if you have a problem with drift, it might be remedied by literally baking the rig in an oven at 1 30-140 degrees for an hour or two. I didn't need to do that with the NW3O, but will probably find it useful for some other rig.

The VFO dial markings are surprisingly accurate. Again, that may be something that is due to the narrow bandspread on 30M, but whatever the reason, I found I could easily resolve frequencies to a KHz by reading the dial.

WRAPPING UP

I've said it before, and I'll say it again. It's always a thrill when *(Continued on page 39)*

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(Continued from page 37)

you make that first contact with a rig you built yourself. I was surprised and delighted when the NW30 gave me a contact on the *very first call!* Jim KB9LRP in Chicago gave me a 5/9 report and said "GUD SIG FER QRP HI" without my having sent anything but my callsign.

Emtech's done a very good job with this kit. I give it an unequivocal A+, and I'm looking forward to the Z-match antenna tuner and the 10M transceiver which are reported to be in development.

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