QEX 16

June 1983

The ARRL Experimenters' Exchange

Greetings from Newington

On May 5, I arrived in Newington, CT with QEX material. But, the computer was shipped with household effects which arrived the following week. Unscrambling everything took some time. So, that's why QEX 16 is a bit late.

As I mentioned earlier, I plan to continue editing QEX because it is a vital link with Amateur Radio experimenters. However, Maureen Thompson, KA1DYZ, will be doing the lion's share of the typing and formatting of QEX.

Maureen has been with ARRL HQ since October, 1976 and worked in the Club and Training Department. Since June, 1982, she has been assigned to the Technical Department where she handles manuscript typing for QST, ARRL technical books and now QEX. Manuscript keyboarding is done on an IBM PC which can now transfer text via modem to other computers, word processors and phototypesetting equipment at HQ. Maureen holds a Technician class license and supports a horse.

While on the subject of who is involved in QEX, you should know that Debbie Chapor, of the Circulation Department, is the QEX circulation manager. She processes all new subscriptions, changes of address, printing of mailing labels, renewals and requests for back issues. She has been part of the Circulation Department since March, 1979 and has handled QEX circulation since its premier issue.

Packet Radio Conference Proceedings

We received an inquiry about quantity prices for "The Second ARRL Amateur Radio Networking Conference" proceedings. Prices are: 1-9 $9.00 each, 10-49 $6.75 each, and 50 or more $6.00 each. Clubs may wish to take advantage of these quantity prices. Incidentally, there has been considerable interest in these proceedings judging from orders received. If you are interested, please send a check payable in U.S. funds to "ARRL" addressed to: American Radio Relay League, 2nd Packet Conference Proceedings, Newington, CT 06111.

Technical Department Job Openings

There are two full-time immediate openings in the Technical Department at ARRL HQ. Applicants must have experience as a radio amateur, hold a current Amateur Radio license, possess a solid technical background and have writing and editing skills. Recent design experience is desired in one or more of the following areas:

(1) rf/analog circuitry
(2) digital circuitry
(3) software development, including high- and low-level languages

These are entry-level posititions with the opportunity for advancement. Salary is dependent upon academic background and experience. Contact Paul Rinaldo, W4RI, Manager, Technical Department, ARRL HQ, 225 Main Street, Newington, CT 06111, telephone 203-666-1541.

Ninth Annual Eastern VHF/UHF Conference

Chuck Hutchinson, K8CH, and Gerry Hull, AK4L, both of ARRL HQ, attended the Nashua, NH vhf/uhf conference. They met many vhf/uhf experimenters and reported that the conference was highly informative.

Here is a list of formal presentations:

"Uhf Construction Techniques," John Bilodeau, W1GAN.

"Getting Started on the 30-cm Band," Joe Reisert, W1JR.

"Modern Developments in the Yagi Antenna Structure," Tom Kirby, W1EJ.

"Low-Noise Receiver Design for 1296, 2304 and 3456 MHz," Geoff Krauss, WA2GFP.

"The Arecibo Radio Telescope," John Balboni, AC1T.

"Building, Testing and Applications of Large Antenna Arrays," Dave Olean, K1WHS.

In most cases the authors provided a handout ranging from 1 to 30 pages. If you are interested in obtaining the handouts, you may wish to contact the individual author.

In addition, there were individual rap sessions on OSCAR satellites and various bands from 6 meters and up, an antenna-measuring contest and other events.

Plans for 1984 are to hold the conference on the weekend after Mothers Day, May 18-20. Any volunteers willing to help in any way will be welcome. You may contact any of the following committee members: K1LOG (registration), W1JR (program), N1BWT and N1AHC (antenna measurements), K1FWF (hospitality), K1LPS (prizes), K1KG (noise figure measurements), W1GXT (publicity), WB1DFD and WB1DFC (YL/XYL), WA1AYS or WA1TFH.

Potential AMICON SSC Users

Hank Magnuski, KA6M, Region 2 coordinator of the AMSAT International Computer Net (AMICON) Special Service Channel (SSC) of OSCAR Phase IIIB, is interested in hearing from potential packet radio users. In anticipation of a successful launch, he would like to know immediately the following information:

1. Name, address, call, phone, net addresses.
2. Radio Equipment, antenna.
3. Packet radio controller (VADCG, TAPR, other).
4. Anticipated mode of operation (individual, club station, gateway, etc.)

Hank plans to compile a list of users and pass it along to people who respond. Hank's address is 311 Stanford Avenue, Menlo Park, CA 94025.

- W4RI

Correspondence

Feedback on ZX81 Receive Program

I was very pleased to see the article, "ZX81 RTTY Receive Program" in the March issue of QEX. I had been looking for just such information to put my computer to work in my station.

Since I do not have an RTTY system, I had to adapt the interface circuit a bit to suit my needs. I use a State-of-the-Art Terminal Unit (December 1980 QST) to key an opto-isolator. This ensures proper isolation and prevents the possibility of damage to my computer.

After typing the program listing into my ZX81 and SAVEing it several times, I was anxious to try receiving teletype. Each time I would hit the BREAK key, several lines of gibberish would appear on the screen! I spent a few evenings trying small changes in the timing loops, thinking that was my problem. I finally began PEEKing memory locations in the program. To my surprise I found that even though I had typed the listing exactly as shown, the table of characters began at memory location 16554 instead of 16553. After changing line 150 to read:

```
150 PRINT CHR$(PEEK(16554+Z+J));
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and RUNning the program, I had perfect copy. There was no need to change the timing to receive 60-wpm RTTY. Others who have had difficulty getting their program to work may find this information helpful. - Larry Wolfgang, WA3VIL, ARRL HQ.

Fiberoptics in the Shack

Reducing RFI within the shack for computers, RTTY and some other applications is often a problem. One modern alternative to shielding and filtering is the use of fiberoptics. Of course, you can always "roll your own," but for those desiring to use functional modules as building blocks, one possible source is: Math Associates, Inc., 6 Manhasset Ave., Port Washington, NY 11050 (516-944-7050).

It may be cheaper than a comparable "roll your own" of equivalent performance. For example, $950 buys a pair of RS-232 interfaces, $100 buys a serial digital transmitter or receiver and $100-$300 buys analog interfaces of various bandwidths up to or surpassing CCTV requirements. I hope some readers find this source useful. - Ernest Gilmer, Jr., WA4VUG, 1237 Willowbrook Dr., Apt. #1, Huntsville, AL 35802.

Material for New ARRL Uhf-Microwave Book

Do you design and build "homebrew" equipment or test gear for 420 MHz to 24 GHz and up? Do you know someone who does? If so, please contact me at ARRL HQ. I will pay authors as contributing editors for unpublished, original projects suitable for use in a new ARRL book. - Chuck Hutchinson, K8CH, ARRL HQ, 225 Main St., Newington, CT 06111, 203-666-1541.

Modulation Methods

I have a proposal for a new amateur modulation method and would like to know if someone has already used it on the amateur bands. The idea is to separate carrier detection from demodulation. To do this, a continuous carrier could be transmitted allowing the receiver to phase lock on the carrier with a bandwidth limited by the transmitter and receiver stability and any doppler or path variations that may be present. This bandwidth could be made much smaller than that required to recover the information carrying signal. The information signal could be impressed on the carrier by means of bi or quad phase modulation and recovered using circuitry separate from the carrier lock circuit and whose bandwidth would match the information signal.

This system would have an application in many areas such as: An improved cw system (the carrier is on continuously), an improved replacement for fsk RTTY, an improved mode for satellite QSO's by auto tracking doppler shift and an improved mode for packet radio by sending the carrier (clock) along with the data to compensate for path phase changes.

I think a system similar to this is used for deep space data links. I wonder why BPSK or QPSK is not used on the amateur bands? - Brooke J. Clarke, N6GCE, 12544 Corbetta Lane, Los Altos Hills, CA 94022.

Ed. Note: BPSK is used on the ham bands for OSCAR control stations. Readers responding to Brooke's letter are invited to drop a copy to Editor, QEX for possible publication in this column.

More Feature Articles

May I add my support to WD4FWP's eloquent plea in QEX, March 1983, for a relaxation of the number of feature articles per month. The budget constraints which limit QEX to only one feature article per month do indeed make it potentially less useful to those of us "down under."

A search of the better American ham magazines like QST and Ham Radio reveals a sad lack of good technical articles on techniques and circuit applications for the bands above 432 MHz. Items like the survey of low noise transistors and preamp matching techniques presented in QEX number 1 raised my hopes for a continuing series of articles on these and related themes. Regrettably, so far, only a smattering...

Could I then, also add my plea to that of WD4FWP, and encourage you to develop alternatives which would allow the printing of more articles to further improve this already find medium for information exchange?

To conclude, may I offer my congratulations to you and the contributing editors for a very fine publication. The packet radio series plus the columns on 'Data Communications' and 'Components' have been well received here. - Vaughan N. Henderson, ZL1TGC, 217 Glenfield Rd., Auckland 10, New Zealand.

Pardon the Garbles

Many thanks for publishing my letter in QEX 15; April-May 1983, p. 2. Some of the text is complicated, and the second sentence of paragraph four is downright garbled. It should read as follows: "The position of the potential commercial subscription through-the-air broadcast services seems, to me, to be that the pay TV link from station through-the-air to the subscriber is an exclusive 'line', similar to a private telephone drop, or cable-TV connection, and so rentable." - John David Weinland, N1ATB, 879 Whalley Ave., New Haven, CT 06515

Sources of Silver Solder

The latest issue of QEX noted the need for silver solder for soldering capacitor chips. Tin-silver solder is available from: Brookstone Company, 127 Vose Farm Rd., Peterborough, NH 03458. - Paul Roberts, K5HHM, 15709 Singapore St., Houston, TX 77040.

Regarding your question for a silver solder/flux source in the "chip capacitors" paragraph, you might investigate: U.S. General Tools and Hardware, 100 Commercial St., Plainview, NY 11803. Their catalog #383, p. 134, lists several types of silver solder. I have not used any of the solder listed so I cannot vouch for it.

Many refrigeration supply houses carry silver brazing materials and might have some of the low temperature types. - Harvey G. Williams, W2FFU, 1 Bonnie Lane, Willingboro, NJ 08046.

Many Modifications to the Ten-Tec Omni

By Robert E. Helms,* AF5Z

Being an incurable experimenter, I have made numerous modifications to my Ten-Tec Omni-D Series B. These changes are applicable to most models of the Omni and some of the Triton 540s and 544s. The improvements are "removable" in that no holes are drilled and irreversible changes are used. The modifications provide squelch, selectable receiver agc decay times, 500-Hz crystal filtering for RTTY reception, accurate frequency spotting during cw operation, full break-in cw with a companion kW amplifier, automatic frequency control (afc) to eliminate VFO drift, power supply over voltage protection and QRP operation with alc control. Each modification is independent and need not be done with another.

Squelch

In all Omnis, except the latest Omni-Cs, the components for the squelch circuit are on the audio board (#80447) and the i-f/agc board (#80448). The later manuals do not show the schematics to these parts though they are installed. An operative squelch system requires only a control and switch. The zero-beat push switch may be unmounted, insulated and taped inside the radio to allow mounting the new squelch control. A linear 10-kΩ sub-miniature bushing mounted control with a long shaft and a spst rotary switch is recommended. See Fig. 1 for wiring connections.

Selectable Receiver Agc Decay Time

I was disappointed with the agc system response for two reasons. When a strong signal appears, the slow attack of the agc causes a loud pop, particularly on cw with headsets. Or in a net with strong and weak signals, the slow decay of the agc prevents hearing weak signals for several seconds after a strong signal has ceased transmitting. A change of component values and the addition of a switch will cure both problems. I used the Fast/Slow QSK switch for this purpose since I always used fast QSK. I broke the connection between the switch and the Audio/Sidetone board (#80447) and rewired the QSK switch to the i-f-agc board (#80448) to give fast and slow agc choices. The circuit is changed as shown to decrease the attack time thereby eliminating the "pops." The capacitor values shown provide agc decay times that were half (on fast) and double (on slow) the time constant originally provided. Choose the capacitor values according to your taste. The "slow" capacitor is soldered to the board on the positive end and to the switch for a ground. Remove R24, a 680-k ohm resistor, and use low leakage tantalum capacitors to lessen the load on the agc amplifier and detector to reduce the attack time. See Fig. 2 for the circuit.

500-Hz Cw Crystal Filter for RTTY

Luckily, when the 500-Hz crystal is in use on "reverse" sideband mode (SB-R), the carrier oscillator frequency is such that the audio output passband will be about 1900- to 2400-Hz. Operation in this manner will provide excellent lsb RTTY operation on the 14- through 28-MHz bands -- provided the cw audio filtering centered on 750 Hz is not used. Standard 2125-Hz Mark and 2295-Hz Space RTTY "high" tones used to operate most common radioteletype modems (terminal units) can be received in this manner. Unfortunately, the Omni Series B front-panel selectivity control does not allow the use of the 500-Hz cw crystal filter without also utilizing the internal audio filter. The addition of a switch wired as shown in Fig. 3 will allow the 500-Hz crystal filter to be used in both the 1.8-kHz and the 0.5-kHz selectivity control positions. This allows the choice of either bypassing or using any portion of the audio filter in conjunction with the 500-Hz crystal filter. The dc control wiring for the crystal filter selection is brought out of the rear panel through the center of the hollow rivets holding the phono jacks to the panel to connect to the switch. A small spst switch on the "L" bracket allows a choice of either the 1.8-kHz or the 0.5-kHz crystal filter to operate in the 1.8-kHz position on the front panel control. The added switch is shown in the normal or "unmodified" position in the figure.

Accurate Cw Transmit Spotting

The front-panel zero beat switch is difficult to use except on very strong signals. Even then the true zero beat spotting is seldom achieved since hearing "zero beat" with a product detector equipped receiver is quite a feat! The following alignment procedure change will produce easy, accurate matching of your transmit frequency to the frequency of the received signal. No parts or hardware change is required. A frequency counter is helpful but a crystal calibrator and an additional receiver will suffice. The following steps must be followed **in sequence.**

1) Determine the center audio frequency of the sharpest receiver filtering available. Carefully tune in a strong steady carrier such as the spurious response on 28.980 MHz or the external crystal calibrator so the S-meter indication is peaked with all the built in audio and crystal filters in use. Measure the audio frequency across the speaker with a counter.

2) Set the sidetone oscillator to the frequency determined in Step 1. Adjust the sidetone pitch (frequency) to the reading obtained in Step 1. Lacking a counter, you may simply match the pitch of the two signals by ear.

3) Set the carrier oscillator/BFO on the ssb Gen board (#80449) to provide a transmit frequency offset equal to the frequency in Step 1. Measure the carrier or BFO oscillator frequency on the ssb Gen board across R17 (220 ohm) with a counter while in the SSB-N receive mode. Next, adjust the BFO frequency with trimmer capacitor C5 on the board while in the LOCK mode. The desired frequency is the sum of the SSB-N BFO frequency and the frequency obtained in Step 1. If the external receiver is used in lieu of the counter, proceed as follows to accomplish Step 3. Perform Steps 1 and 2 by tuning to the external crystal calibrator in both the Omni and the external receiver. Adjust the trimmer described above to place the transmitter exactly on the frequency of the calibrate signal by listening to the signal in the external receiver. The Omni is placed in the LOCK mode and the drive advanced just enough to obtain a signal. Repeat all steps to insure accuracy.

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After these adjustments are done properly, you should be on frequency with another station. Simply tune in a signal on the receiver so that the pitch matches your sidetone pitch exactly. This procedure will also match your radio to any external audio filters designed for a 750-Hz center frequency that you might desire to use.

Retaining QSK with an Amplifier

In order to retain the excellent full break-in cw capability of the Omni while using an amplifier, two things must be achieved. First, the receiver antenna signals must be obtained from the antenna side of the amplifier. Second, a means of switching or "keying" the bias on the amplifier must be provided to prevent noise generated within the amplifier from interfering with reception.

The receive antenna switching will be described first.

The control signal for the external antenna switching is obtained from the radio by the wiring change shown in Fig. 4. The interface wiring shown in this figure is connected to the radio through the use of the phono jacks on the rear of the unit for these purposes. I use the EXT T/R jack and the PTT jack along with the existing AUX 12-V dc jack for these connections. Once the amplifier is modified, the EXT T/R control is not required. The schematic for the antenna relay switch box and the system hookup diagram is Fig. 6. The receive antenna select switch on the rear panel of the Omni must be in the RECEIVE or separate position. A shorted plug is attached to the original antenna relay control on the amplifier since it stays energized any time the amplifier is on. Study the timing diagram, Fig. 5, before attempting to adjust and use the circuit.

The pre-delay identified in trace E of Fig. 5 allows time for the relay contacts to close before the transmitter is keyed. This is done by the relay contacts wired in series with the keyline to the Omni. The post delay (weighting) shown in trace D holds the transmitter keyed for an additional period of time **equal** to the length of pre-delay. This prevents altering the weight of the cw which will cause very short dits at high keying speeds. The relay delay in trace B allows time for the transmitter rf output to drop to zero before the relay switches the antenna back on the receiver.

In order to properly adjust the timing in the switch box, make all interconnections except the rf input and receive antenna. Temporarily disconnect the diodes across the receive antenna jack inside the box. The radio should key normally at slow speeds with the timing pots set to mid-range. Gradually adjust the cw keying speed upward while sending continuous dits. Note that the relay follows the keying at slow speeds but will stay energized at high speeds. Vary the setting of the 50-k relay delay trimmer pot and note that the relay switching speed will vary. Set the relay delay to the maximum delay position so the relay will stay energized while you verify the weighting or post delay is functioning. Again, use a keyer to send continous high speed dits, this time observing the transmitter rf output pulses with a scope. Varying the setting of the 10-k weighting trimmer pot should cause the duty cycle or length of the dits to vary. To adjust the weight you should strive for the same duty cycle as you have when the switchbox is bypassed. A bypass cable with phono plugs between the two jacks on the Omni going to the TR point on the control board and the mode switch will allow operation without the external switchbox. To adjust the relay delay (50-kΩ trimmer pot) connect the scope across the receive antenna jack on the box and connect the rf input to the antenna coax with a T adapter. Fig. 7 shows typical waveforms obtained by 40-wpm dits and various settings of the relay delay control.

Always adjust the weighting first and then the relay delay. If you get the controls misadjusted so the rf output from the transmitter is passed through the relay, it will burn the 15-ohm 1/8-W resistor in the switchbox receive antenna line. The two protection diodes across the antenna output jack will protect the Omni receiver if this should happen.

Several excellent articles have been written on amplifier "rf bias switching." Fig. 8 shows the simplified circuit used in my Henry 2k-3 amplifier. See the references at the end of this article for detailed data.

My QSK system using these circuits allows any computer to copy my cw keyboard at speeds greater than 60 wpm. I find it amazing that an off-the-shelf Radio Shack relay will give QSK at 40 wpm plus.

VFO Afc

An automatic frequency control system may be applied to the Omni VFO to prevent warm-up drift. A sort of "poor man's synthesizer", the circuit digitally counts the VFO frequency using the digital display clock signal as a reference and "locks" the VFO output frequency to a 5-Hz wide segment. Refer to Fig. 9 along with the following theory of operation.

Q1, U1 and U2 form a frequency counter that counts the VFO output signal. The counter timebase is the digital display timebase. The afc counter counts to the nearest 5 Hz -- so the output from U2A pin 1 is either +5-V dc (high logic) or 0-V dc (low logic) depending on whether the VFO output frequency is an odd or an even multiple of 5 Hz.

The CA3140T, U3 and the 2 uF capacitor act as an integrator or very low pass filter. When the unit is first turned on, you should disable the afc which centers the output of the afc system in its lock range. Once that is done, the disable switch is opened (system enabled) and the counter output will increase or decrease the charge on the integrator capacitor. That increase or decrease will cause the VFO frequency to vary until it reaches the next 5-Hz step. The counter output will change and the change in charge will reverse. In other words -- the VFO frequency is slowly moved up and down in one 5-Hz wide band and not allowed to drift outside of it. A 5-Hz change is just audible if you listen to a low pitch beat note from a carrier.

The afc circuit is built in a shielded box mounted to the brace for digital display in the Omni D. All connections are made with RG-174/U miniature coax. Refer to Fig. 9 for connections made to the pins on the VFO assembly. The 5-Hz clock signal for the afc unit is obtained from the junction of IC1 pin 4 and IC2 pin 12 on the digital display timebase circuit board. Obtain +12-V dc power for the unit from the terminal on the digital display assembly also. The disable switch may be a spst normally open push button switch. The zero-beat switch can be used if you'd like the afc to function most of the time. The 2-uF integrator capacitor **must** be a low-leakage type such as a tantalum.

The disable circuit is adjusted by closing the switch and adjusting the trimmer pot. This is done until the frequency of the receiver does not change when the connection is made and broken between the afc output and the VFO offset circuit.

Power Supply Over-Voltage Protection

A weak point in the Ten-Tec transmitter duty cycle and rf output is the thermal design of the Model 252MO power supply. Full duty cycle RTTY transmit above 10 amps current drawn from the supply is risky even with a fan on the regulator pass transistor heat sink. The results of overtaxing the supply is usually a shorted pass transistor and +22- to 24-V dc applied to your transceiver. The units I have repaired with that condition had blown LM-380 audio output ICs and damaged IC1s on the timebase board in the digital display. The over-current protection applied to the SCR in the original design will **not** protect the radio from over-voltage due to a failure of Q3, Q4 or Q1. The "crowbar" circuit shown in Fig. 11 will protect the radio by shorting the supply output to ground thus blowing the added 20-amp fast-blow fuse. This will happen regardless of the reason that the regulated output exceeded the threshold of about +15.6-V dc.

Slight additional cooling for the pass transistor can be obtained by applying silicone heat sink grease to the junction of the heat sink and
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the rear panel of the power supply chassis. Improved replacement pass transistors for the model 252MO supply are the 2N5685 (E & B pins are reversed physically) and the ECG387. A ECG181 will about equal the performance of the original 2N6258 type.

I also made considerable wiring changes and added a few components to achieve external voltage regulator sensing from the Vcc terminal on the rf power amplifier assembly. The improvement in regulation was marginal hence the circuit is not included here. It is available upon request.

Alc-Controlled QRP

The range of alc control on my unit was 30- to 95-W rms rf output. A desire to operate battery powered cw/ssb in the 10-W dc input class for Field Day contesting led me to develop this circuit. The alc control line is routed to an external alc detector attached to the antenna line by a coaxial 'T' adapter. Fig. 12 shows the circuit including the connection to the alc line at the low-level driver circuit board (#80444). The external detector rf and alc connections must be removed to restore full power operation. With the circuit connected, the resistor values shown provide an alc control range of about 750-mW to 12-W rms rf output depending on where the front-panel alc control is set. Mount the components in a small box with the necessary rf connectors.

General Notes

1) Replace the bayonet based meter lamps with higher-voltage types such as #1815 14-V (Radio Shack #272-1118). Replace Omni-A, remote VFO (Model 243) and Omni-D VFO dial lamps with 12-V 'grain of wheat' bulbs with wire leads (Radio Shack #272-1141). The 252MO power supply output lamps is this type also.

2) To obtain maximum transmit rf output on all bands, set the alc set trimmer R2 on the low-level driver board (#80444) as per the manual. Adjust it for 18 amps current from the power supply with the alc knob fully clockwise on the band that draws the **least** current. To prevent tripping the power supply over-current protection on the other frequencies while operating, use the alc to limit the current to 18 amps with full drive in the lock mode. Do not advance the alc beyond the point that is determined to limit the current to that value.

3) Onmi-A owners with serial numbers below 545-0500 and Omni-D owners with serial numbers below 546-1500 who have **not** had their units updated to Series B should insure a Ten-Tec service note SN-1-545/546 is incorporated in the radio. This change removes a 0.01 uF bypass capacitor from the alc line and changes that wire to a piece of RG-174/U coax between the low-level driver board (#80444) and the SWR-TR board (#80450). This improves the alc attack time and reduces susceptibility to rf.

4) The Omni-C noise blanker and 250-Hz cw crystal filter will work if plugged into older units. The blanker is considerably improved.

5) The drive level is very critical to adjust on ssb due to excessive mike audio amplification. Change R18 on the ssb Gen board (#80449) to 22k and add a 47-k resistor in series with C12 on the board to reduce the gain. Vary the value of the series resistor to match your mike.

6) Rf feedback may cause fming and distortion on ssb transmit when using an antenna tuner on the higher bands. Bypass capacitors will eliminate the problem when used with a heavy ground braid between each item of equipment used with the radio. Bypass the mike audio at the mike jack with 470 pF. Bypass the side of the ac power switch next to the +13-V input with at least a 0.033-uF 600-V capacitor to ground. If the remote VFO is used, bypass the T line (transmit voltage) on the control board (#80504) in the VFO with a 0.02-uF capacitor. Place a 0.005-uF capacitor across Zener diode D7 and bypass the cathode of the diode to ground with a 0.001-uF capacitor in the Model 252MO power supply. The use of shielded cable for virtually all connections to the radio will improve RFI immunity.

Summary

This article was written to publicize circuits for adding other operating features to Ten-Tec transceivers. It is recommended that the circuits are built and tested one at a time using the owners manual in conjunction with this article. The sources for basic circuits and ideas are original or can be found in the references at the end of the text. It is through the excellent design of those authors that my Omni has been considerably improved.

References

[1] Frey, "How to Modify Linear Amplifiers for Full Break-in," April 1978, Ham Radio Magazine.

[2] Lawson, "Break-in with a Keyed High Speed Vacuum Relay," February 1973, QST.

[3] "The ETO Alpha 77 Linear Power Amplifier," March 1973, QST.

[4] Hertzberg, "Improved Break-in with the Collins 75S-3B," February 1974, QST.

[5] Bryant, "Electronic Bias Switching for RF Power Amps," Bryant, May 1974, QST.

[6] Pluess, "Fast QSK System Using Reed Relays," December 1976, QST.

[7] Hertzberg, "CW & SSB Break-in with a Vacuum Relay," September 1976, CQ.

[8] Joyce, "Accu-Control -- QSK for Kenwood TS-820 & R-820," February 1981, QST.

[9] Rolek, "RF Bias Switching for the SB-220," July 1971, QST.

[10] "VFO AFC," June 1971, Ham Radio.

[11] Various ARRL Publications including "Solid State Design" and the "Radio Amateur's Handbook."

AMSAT OSCAR Phase IIIB Launch

June 16, 1983 is now the scheduled launch date for the Phase IIIB satellite, according to the latest word from AMSAT president, Tom Clark, W3IWI.

The date has slipped a number of times, so listen to W1AW and the various AMSAT nets for the latest news.

Keep your fingers crossed!

Data Communications Column

This issue should have included Dave Borden's column on Data Communications. In fact, he wrote it on his computer/word processor and transmitted it to a data communications network. Murphy's Law strikes again! When we signed on the network and read the incoming mail, for some unknown reason our computer did not save to disk. When we signed back on and seemed to have solved that problem, the network then ran out of ports and subsequently said that the host was not available.

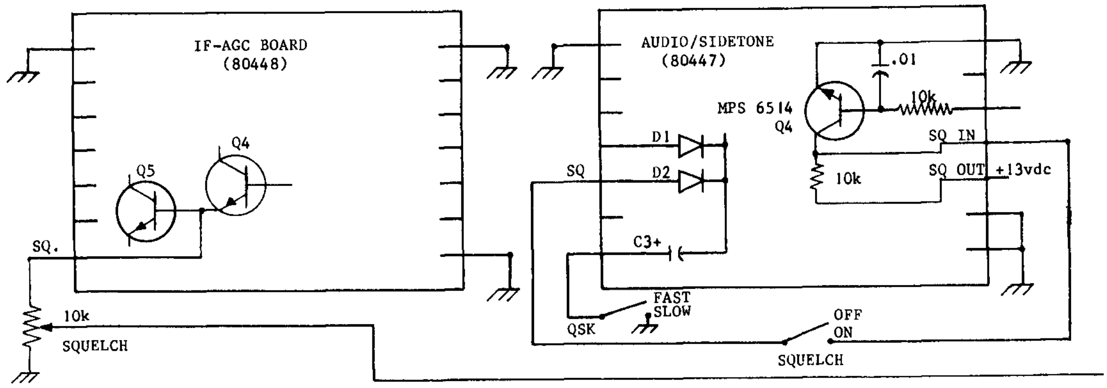


FIGURE 1 SQUELCH WIRING

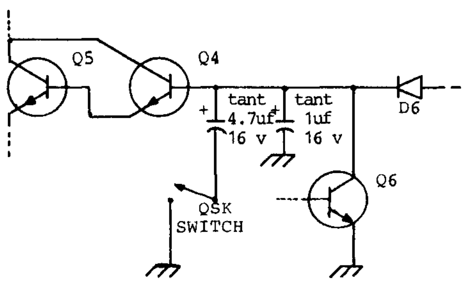


FIGURE 2 AGC WIRING

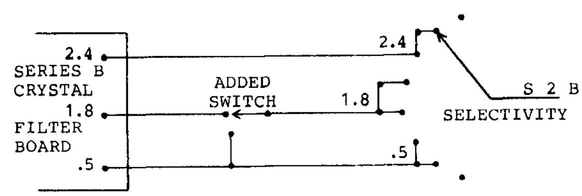
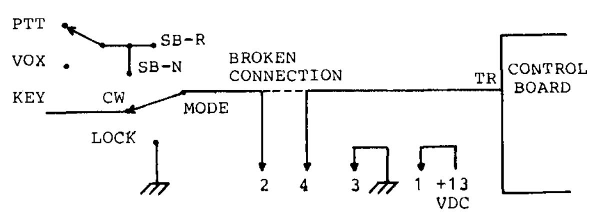


FIGURE 3 FILTER SELECT WIRING



CONNECTION TO SWITCH BOX

FIGURE 4 AMP QSK MOD TO RADIO

Drawings by
Mel Brechin, N3CEG

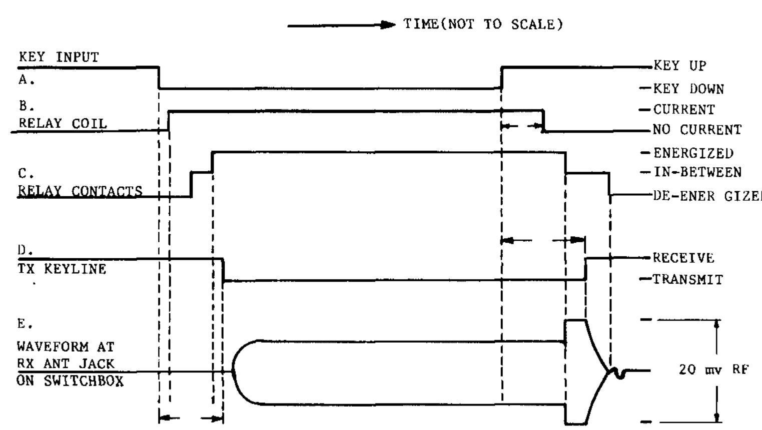
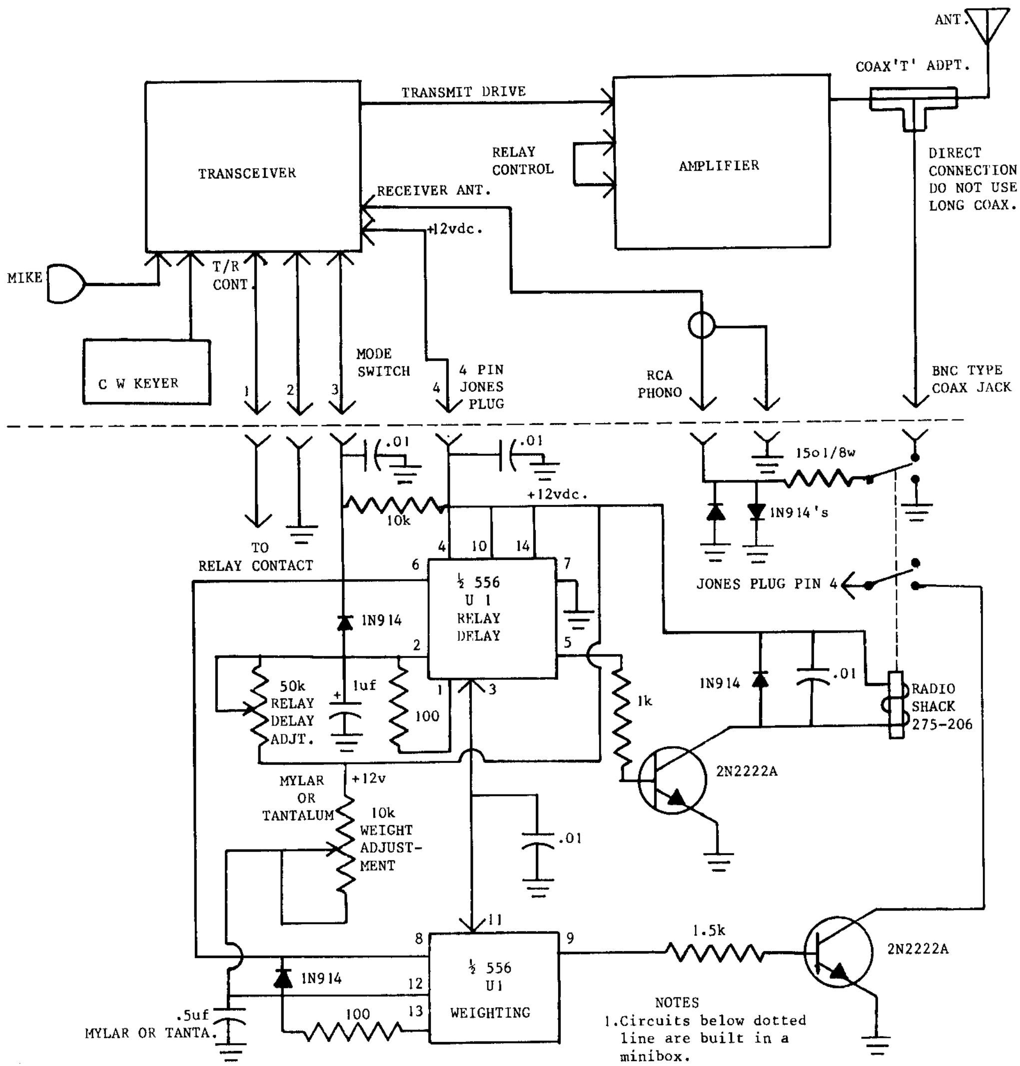


FIGURE 5 QSK TIMING



NOTES
1. Circuits below dotted line are built in a minibox.
2. Connections between box and other equipment are made with RG-174/U small coax.

FIGURE 6 QSK SYSTEM

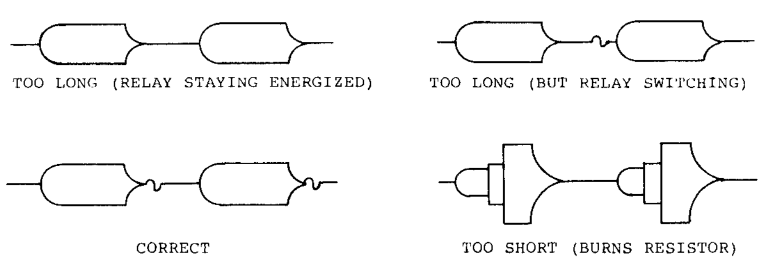


FIGURE 7 RELAY DELAY ADJUSTMENT

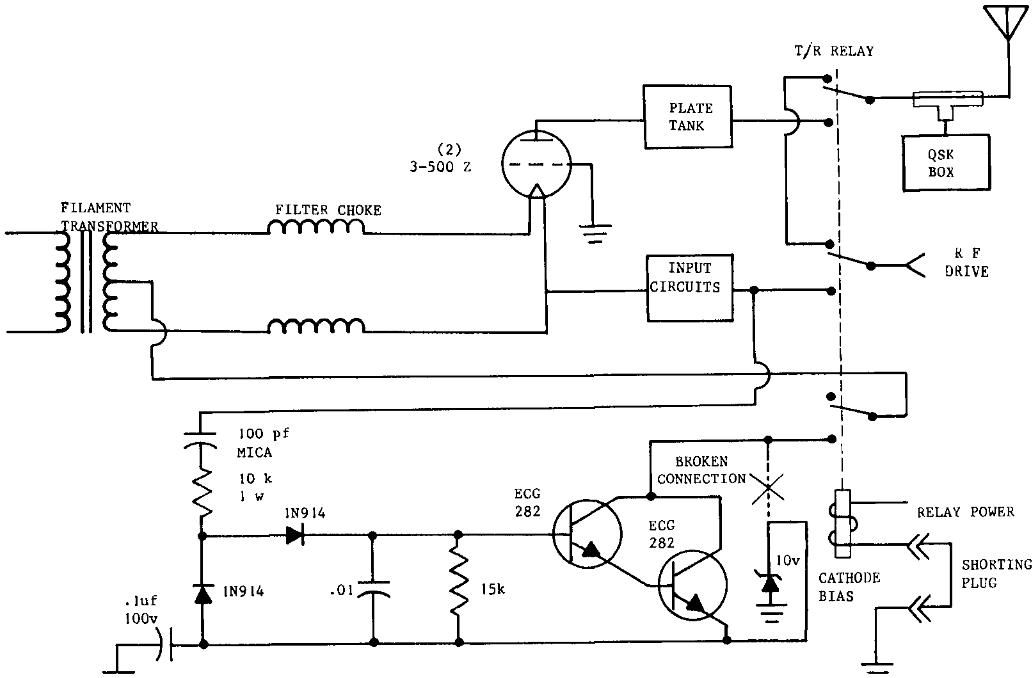


FIGURE 8 AMP. MOD.

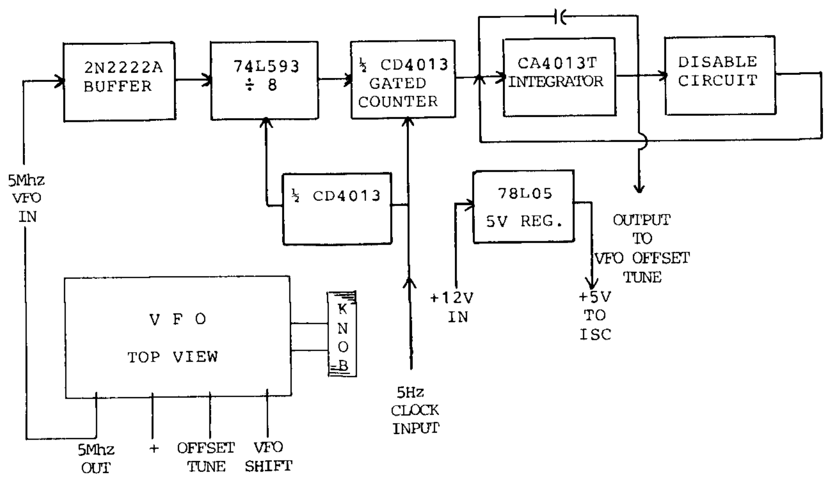


FIGURE 9 AFC

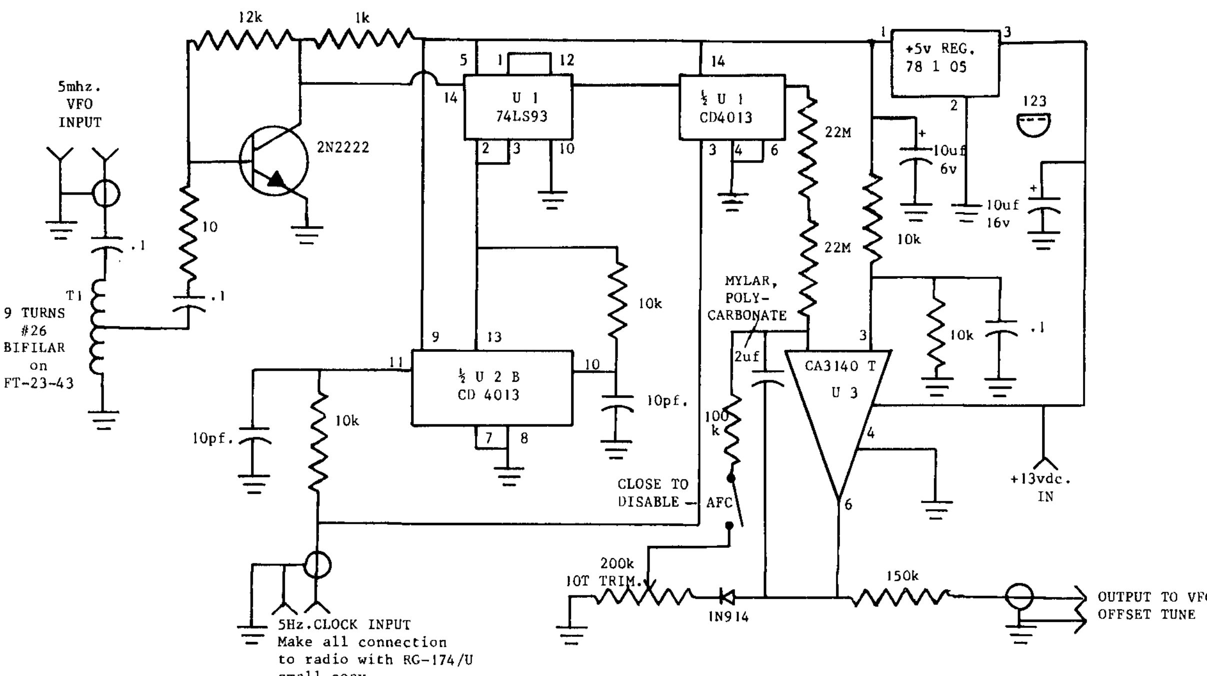


FIGURE 10 AFC CIRCUIT

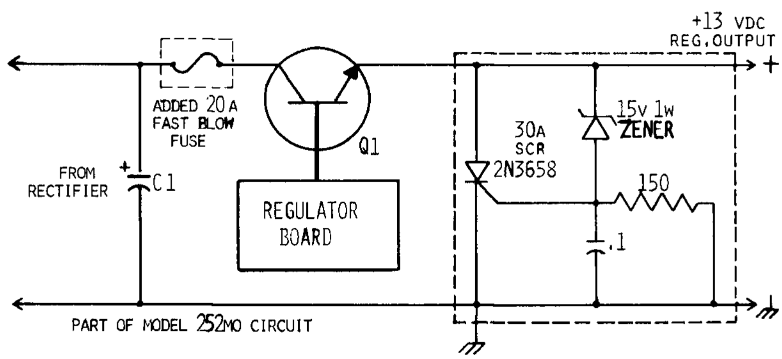


FIGURE 11 OVER VOLTAGE PROTECTION ADDED

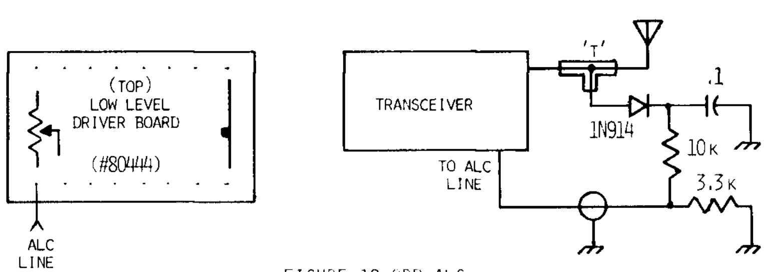


FIGURE 12 QRP ALC

Lowpass Speech Filter Using Surplus Inductors

By Ed Wetherhold,* W3NQN

The advantages of attenuating frequencies above 3 kHz to improve speech communication effectiveness is well known to the radio amateur. But little has been published on high-performance, easily constructed and inexpensive audio filters. Although designs of active filters have been published widely, they are relatively complex, difficult to build, and best suited for large-volume commercial manufacture. For "home-brew" construction, the passive LC filter using surplus inductors is easy for the amateur to build (where only one or two filters are needed). However the modification and mounting of the individual inductors is tedious and time consuming.

This article discusses a new concept in passive LC filter design and construction that makes use of one unmodified commonly available 88-mH inductor stack [1] wired in a special way to realize a unique 3-section elliptic design. In this design, two inductors have identical values that are realized with two of the five inductors in the stack. The third inductance value required by the design is realized by wiring the three remaining inductors in appropriate series/parallel combinations.

Three-Section Elliptic Filter Is Best for Speech Filtering

Of the many modern filter designs available (Butterworth, Chebyshev, elliptic, etc.) the elliptic is best suited for speech filtering because of the abruptness of attenuation rise. The articles published within the last 14 years described design procedures and performance parameters for both the 2- and 3-section elliptic filters.[2][3] An application of the 2-section elliptic filter for speech filtering was explained in a <u>QST</u> article,[4] but the minimum stopband attenuation was only 40 dB, including a reasonable stopband-to-cutoff-frequency ratio of 1.27. Frequently, stopband attenuation greater than 40 dB is desirable, and this can be obtained with a 3-section elliptic filter. The 3-section elliptic filter designs discussed in this article have stopband attenuation levels greater than 45 dB and stopband-to-cutoff-frequency ratios between 1.2 and 1.37. These designs will satisfy practically all the lowpass audio filtering requirements encountered by the radio amateur.

Precalculated Designs Simplify Filter Selection

Fig. 1 shows the 3-section, equally terminated elliptic filter and its typical attenuation response. Four designs have been precalculated for 300-, 400-, and 500-ohm impedances, and they are listed in Table 1. These impedances are easily matched to 8-ohm impedance levels with standard transformers. The cutoff frequencies (FAp) range from 2.4 to 3 kHz. In addition to the pertinent performance such as As, Ap, FAp, etc., all component values have been calculated. Of particular interest are the values for L2, L4 and L6. As explained previously, these unique elliptic designs have equal values for L4 and L6, and this is shown in Table 1. The 22-mH value is obtained by paralleling the two windings of one or two of the inductors in the stack. The odd values of 33, 17.6 and 29.3 mH are obtained by connective the windings of the remaining inductors in parallel/series combinations explained in the table notes. Fig. 2 shows the connections at the stack terminals for the 88- and 22-mH inductances.

Filter Construction and Tuning

All capacitors should be Mylar R and are mounted conveniently on the stack terminals. The odd-numbered capacitors should be within five percent of the listed values in Table 1. The even-numbered capacitors should be adjusted to tune the inductors as close as possible to the F2, F4 and F6 frequencies. Add capacitors in parallel as required to get the desired resonant frequencies.

To tune the resonant sections of the filter, it is suggested that the filter be assembled except for C2, C4 and C6. Place the filter between a signal generator and an audio VTVM, both having the impedance required by the filter (see the "R" listing in Table 1). Adjust the signal generator for maximum output and set it to the F2 frequency. Adjust C2 for minimum output level (60 dB or more below the signal generator output). The dip in voltage level will be relatively sharp because of the high inductor Q at frequencies above 3 kHz. Repeat this procedure for F4 and F6 while adjusting C4 and C6, respectively. When finished, check all attenuation peakes to see that they are within 0.3% of the design frequency. A frequency counter is helpful in this procedure. The filter insertion loss at 1 kHz should be less than 0.5 dB. The finished filter is conveniently mounted to a chassis with a single plastic component clip designed for a 1-3/8-in. diameter.

Send a 4- x 9-1/2-inch s.a.s.e. to the author for information on how to get inductor stacks for building this and other high-performance audio filters.

*ARRL Technical Advisor (Passive LC Filters), 102 Archwood Avenue, Annapolis, MD 21401, 301-224-4500 Extension 243 (work).

References

[1] H. Mitchell, NØARQ, "88-mH Inductors -- A Trap!, <u>QST</u>, January 1983.

[2] E. Wetherhold, W3NQN, "Modern Filter Design for the Radio Amateur," <u>QST</u>, September 1969.

[3] W. H. Allen, G2UJ, "Modern Filter Design for the Radio Amateur," <u>Radio Communication</u>, August 1971.

[4] E. Wetherhold, W3NQN, "An Amateur Application of Modern Filter Design," <u>QST</u>, July 1966.

Table 1. Elliptic Lowpass Filter Designs Using One Stack of 88-mH Inductors

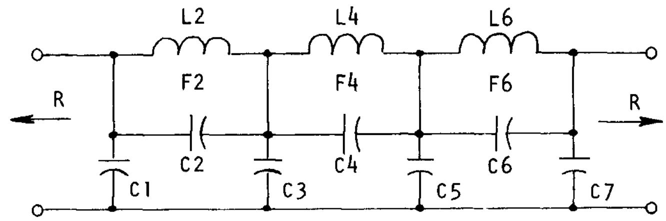
Design Parameters (See Fig. 1)	Design Reference Number			
	1	2	3	4
F_{A_p} (Hz)	3007	2840	2814	2405
R (ohms)	500	300	400	400
A_s (dB)	45.6	64.5	56.2	45.6
A_p (dB)	.028	.104	.058	.028
F_{A_s} (Hz)	3611	3891	3627	2889
F2 "	6714	7766	7037	5371
F4 "	3662	3960	3683	2930
F6 "	4195	4658	4288	3356
L2 (mH)	33.0[1]	22.0	29.3[3]	33.0
L4,6 (mH)	22.0	17.6[2]	22.0	22.0
C1 (nF)	85.7	206.5	136.4	134.0
C2 "	17.0	19.1	17.5	26.6
C3 "	138.6	313.4	213.4	216.6
C4 "	85.9	91.8	84.9	134.2
C5 "	121.0	286.2	191.2	189.0
C6 "	65.4	66.3	62.6	102.2
C7 "	53.7	168.8	102.6	84.0

NOTES:

1. Stack wiring for L2 = 33 mH: 22 & 22mH in parallel, and this combination in series with 22mH. [22||22 + 22 = 33]. L4 & L6 = one each 22mH inductor.

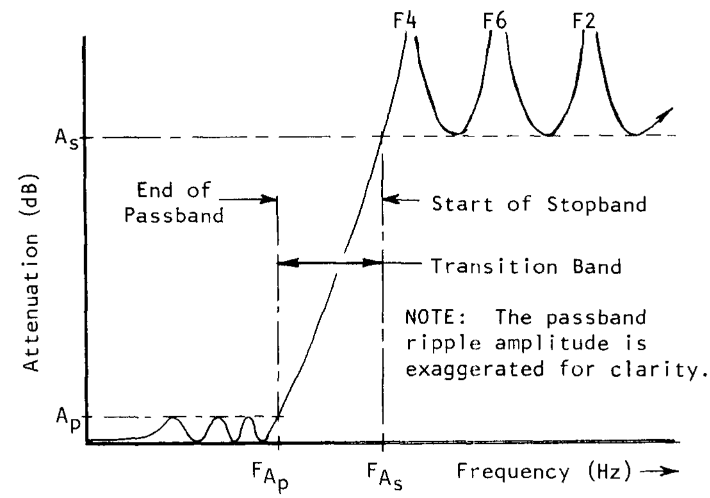
2. Stack wiring for L4 & L6 = 17.6 mH: 88 in parallel with 22mH. [22||88 = 17.6]. L2 = one 22mH inductor.

3. Stack wiring for L2 = 29.3 mH:
(a) three 88mH inductors in parallel, 88||88||88 = 88/3 = 29.3;
(b) 22 in series with 22mH, and this combination in parallel with 88mH, (22 + 22)||88 = 29.3.
L4 and L6 = one each 22mH inductor.



Tune L2 & C2 to F2, L4 & C4 to F4, L6 & C6 to F6.

(A) Schematic diagram showing component designations



(B) Attenuation response

Figure 1. Schematic diagram and typical attenuation response of a 7th-degree elliptic-filter design.

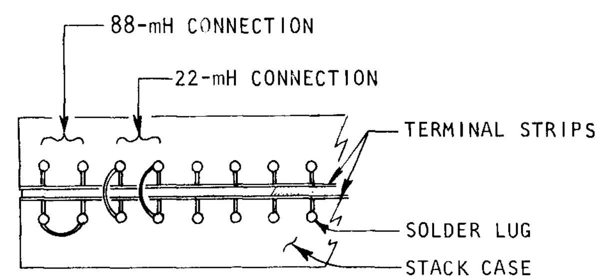


Figure 2. Pictorial diagram of part of inductor stack showing connections for 22- and 88-mH.

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