- simulated carbon mikes .......... 18
- junk-box portable antenna ........ 24
- upgrade your ticket, part two .... 28
- locating geostationary satellites 66

**The Mysteries of**

**Trapped Antennas**

**focus on communications technology**
Ever since we made our first Amateur amplifier almost 20 years ago, our goal has been to make the finest, most rugged and reliable amplifier possible. Now with the 3K Classic we have accomplished this. It contains all of the famous Henry amplifier features plus the magnificent 8877 tube, rugged heavy duty power supply components and advanced antenna switch relay for semi break-in on CW. This is the amplifier of every Amateur's dreams!

The 3K Classic/X with heavy duty power supply and 10 meter operation is available for sale outside the USA where FCC type acceptance is not required.

The 2K Classic represents the culmination of years of experience in developing, manufacturing and improving the 2K series. It remains as always a "workhorse", engineered and built to loof along at full legal power for days or weeks without rest. A look inside shows why! It is truly a "Classic" amateur amplifier. Heavy duty, top quality components along with its rugged construction assures you trouble free operation. It will put your signal on the air with greater strength and clarity than you ever dreamed possible. The 2K Classic operates on all Amateur bands, 80 through 15 meters (export models include 10 meters). Price $1295.00

The 1KD-5 is another fine member of the famous Henry Radio family of superior amplifiers. And we're still convinced that it's the world's finest linear in its class. The 1KD-5 was designed for the amateur who wants the quality and dependability of the 2KD-5 and 2K-4, who may prefer the smaller size, lighter weight and lower price and who will settle for a little less power. But make no mistake, the 1KD-5 is no slouch. Its 1200 watt PEP input (700 watt PEP nominal output) along with its superb operating characteristics will still punch out clean powerful signals...signals you'll be proud of. Compare its specifications, its features and its fine components and we're sure you will agree that the 1KD-5 is a superb value at only $595.

The 2KD-5 We have been suggesting that you look inside any amplifier before you buy it. We hope that you will. If you "lift the lid" on a 2KD-5 you will see only the highest quality, heavy duty components and careful workmanship...attributes that promise a long life of continuous operation in any mode at full legal power. The 2KD-5 is a 2000 watt PEP input (1200 watt PEP nominal output) RF linear amplifier, covering the 80, 40, 20, and 15 meter amateur bands. It operates with two Elmac 3-500Z glass envelope triodes and a PI-L plate circuit with a rotary silver plated tank coil. Price $945.

Henry amateur amplifiers are available from select dealers throughout the U.S. And don't forget the rest of the Henry family of amateur amplifiers...the Tempo 2002 high power VHF amplifier and the broad line of top quality solid state amplifiers. Henry Radio also offers the 4K-Ultra and 3K Classic/X superb high power H.F. amplifiers and a broad line of commercial FCC type accepted amplifiers for two way FM communications covering the range to 500MHz.
**MFJ-1200 GENERAL PURPOSE CW Computer Interface**

Connects computer to transceiver. Converts received audio to TTL/RS-232. Allows computer to key transmitter. For use with your computer and CW Keyboard/Reader program.

Allows your rig to "talk CW" to your computer and vice versa.

$69.95

A personal computer with an appropriate program can give you a complete and very versatile CW Keyboard/Reader. But you still need interface electronics to provide compatible signals between your transceiver and computer.

The MFJ-1200 CW Computer Interface processes (noise limits, filters, detects, post filters, shapes, level shifts) the received CW audio from your transceiver to provide a clean computer compatible TTL or RS-232 level.

It also takes the keyboard generated CW (TTL or RS-232 output levels) from your computer and drives high voltage keying circuits to key your tube or solid state transmitter (300 V, 10 mA max; +300 V, 100 mA max).

Has tuning, transmit, and "ON" LEDs. Reverse normal switch inverts output level to computer. ON/OFF switch: 6 x 1/4"x3 in. Black, eggshell white aluminum cabinet. Requires 6.9 VAC or 110 VAC with optional AC adapter, MFJ-1309AC, $9.95.

Order from MFJ and try it — no obligation. If not delighted, return it within 30 days for refund (less shipping). One year unconditional guarantee.

Order today. Call toll free 800-647-1800. Charge VISA, MC or mail check, money order for $69.95 for MFJ-1200 plus $4.00 shipping and handling.

Use this MFJ-1200 to enjoy your computer as a CW Keyboard/Reader. Call MFJ or see dealer.

**CALL TOLL FREE ... 800-647-1800**

Call 601-323-5869 for technical information, order/repair status. Also call 601-323-5869 outside continental USA and in Mississippi.

**MFJ ENTERPRISES, INCORPORATED**

Box 494, Mississippi State, MS 33762

---

**MFJ SWR/WATTMETERS**

MFJ HF SWR/Wattmeter reads SWR, forward, reflected power from 1.8-30 MHz.

$49.95 MFJ-814

New low cost in-line HF SWR/Wattmeter.

MFJ-814 lets you monitor SWR forward, reflected average power in 2 ranges from 1.8 to 30 MHz. Read 200/2000 watts forward, 20/200 watts reflected power. SWR: 1:1-6:1.

Easy push-button switch operation: Has power/SWR, high/low range, forward/reflected push-button switches. SWR sensitivity control.

Lighted meter (requires 12V). Rugged aluminum eggshell white, black cabinet. 6 1/4"x4"x4"/4. SO-239 coax connectors. 2 color meter scale.

**MFJ VHF SWR/Wattmeter/Field Strength Meters**

$29.95 MFJ-812

New low cost VHF operating aids.

MFJ-812, $29.95: Read SWR from 14 to 170 MHz to monitor antenna and feedlines. Read forward and reflected power at 2 meters (144-148 MHz), 2 scales (30 and 300 watts).

Read relative field strength from 1 to 170 MHz. Binding post for field strength antenna.

Easy push-button operation: Has forward/reflected and SWR/field strength push buttons.

Aluminum eggshell white, black cabinet. 4 1/4"x2 1/4"x2 1/4". SO-239. 2 color meter scale.

MFJ-810, $24.95: Similar to MFJ-812 less field strength function.

**MFJ “Dry” 300 W and 1 KW Dummy Loads.**

$64.95 MFJ-260

$26.95 MFJ-252

Air cooled, non-inductive 50 ohm resistor in perforated metal housing with SO-239 connectors.

Full load for 30 seconds, derating curves to 5 minutes. MFJ-260 (300 W). SWR: 1:1 to 30 MHz, 1.5:1 for 30-160 MHz. 24x24x7".

MFJ-252 (1 KW). SWR: 1.5:1 for 30 MHz, 3:1:1 for 30 MHz, 3:1:1 for 30 Hz.

Order MFJ-10, 3 foot coax with connectors. $4.95.

Order from MFJ and try it. If not delighted, return within 30 days for refund (less shipping).

One year unconditional guarantee.

Order yours today. Call toll free 800-647-1800. Charge VISA, MC. Or mail check, money order. Add $4.00 each for shipping and handling.

**CALL TOLL FREE ... 800-647-1800**

Call 601-323-5869 for technical information, order/repair status. Also call 601-323-5869 outside continental USA and in Mississippi.

**MFJ ENTERPRISES, INCORPORATED**

Box 494, Mississippi State, MS 33762

---

**MFJ DIGI-DIAL ADAPTER turns your frequency counter into a DIGITAL FREQ. READOUT**

Calibrate control compensates for heterodyne errors and mode offsets.

$59.95

The MFJ Digi-Dial Adapter turns your frequency counter into an accurate digital frequency readout for your transceiver. Connects between external VFO jack and frequency counter.

Counter gives direct frequency readout to right of decimal for 7, 14, 21, 26 MHz bands. Mentally replace digits to left of decimal with MHZ band as you do now with your analog dial. For the 3.5 and 28.5 MHz band ignore digits to left of decimal and mentally add 3.5 or 28.5 MHz, respectively, to counter reading.

Calibrate for each band and mode (CW, USB, LSB, AM) to compensate for heterodyne oscillator errors (does not read CW transmit offset).

Digital mixer inverts VFO frequency to give correct frequency readout. Normal/Reverse switch gives direct VFO frequency readout (for some rigs on some bands, like Drake TR-4).

RF buffer amplifier. Crystal reference oscillator. ON/OFF switch: "ON" LED: Black, eggshell white al. cabinet. 3 1/4"x11"x3 1/4". 9.18 VDC or 110 VAC with optional MFJ-1312 AC adapter, $9.95.

Order MFJ-210 for any rig with 5-5.5 MHz VFO (TS-520, S, SE, TR-3, 4; HW-100, 101; SB-101, 102; Trion; etc.) Order MFJ-211 for Yaesu FT-101 series (8.7 to 12 MHz VFO).

Order from MFJ and try it — no obligation. If not delighted, return it within 30 days for refund (less shipping). One year unconditional guarantee.

Order today. Call toll free 800-647-1800. Charge VISA, MC or mail check, money order for $59.95 plus $4.00 shipping for MFJ-210 or MFJ-211.

Don't wait any longer to enjoy digital readout, order now. Call MFJ or see dealer.

**CALL TOLL FREE ... 800-647-1800**

Call 601-323-5869 for technical information, order/repair status. Also call 601-323-5869 outside continental USA and in Mississippi.

**MFJ ENTERPRISES, INCORPORATED**

Box 494, Mississippi State, MS 33762

---

More Details? CHECK — OFF Page 94 October 1981
Revolutionary Instant Access Digital Shortwave Scanner

- Continuous Scanning of LW, MW, SW, & FM Bands
- Instant Fingertip Tuning—No More Knobs!
- 6 Memories for Any Mode (AM, SSB/CW, & FM)
- Dual PLL Frequency Synthesized—No Drift!

A WHOLE NEW BREED OF RADIO IS HERE NOW! No other short wave receiver combines so many advanced features for both operating convenience and high performance as does the new Sony ICF-2001. Once you have operated this exciting new radio, you'll be spoiled forever! Direct access tuning eliminates conventional tuning knobs and dials with a convenient digital keyboard and Liquid Crystal Display (LCD) for accurate frequency readout to within 1 KHz. Instant fingertip tuning, up to 8 memory presets, and continuous scanning features make the ICF-2001 the ultimate in convenience.

Compare the following features against any receiver currently available and you will have to agree that the Sony ICF 2001 is the best value in shortwave receivers today:

DUAL PLL SYNTHESIZER CIRCUITRY covers entire 150 KHz to 29.999 MHz band. PLL1 circuit has 100 KHz step while PLL2 handles 1 KHz step, both of which are controlled by separate quartz crystal oscillators for precise, no-drift tuning. DUAL CONVERSION SUPERHETERODYNE circuitry assures superior AM reception and high image rejection characteristics. The 10.7 MHz IF of the FM band is utilized as the 2nd IF of the AM band. A new type of crystal filter made especially for this purpose realizes clearer reception than commonly used ceramic filters. ALL FET FRONT END for high sensitivity and interference rejection. Inter-modulation, cross modulation, and spurious interference are effectively rejected. FET RF AMP contributes to superior image rejection, high sensitivity, and good signal to noise ratio. Both strong and weak stations are received with minimal distortion.

OPERATIONAL FEATURES

INSTANT FINGERTIP TUNING with the calculator-type key board enables the operator to have instant access to any frequency in the LW, MW, SW, and FM bands. And the LCD digital frequency display confirms the exact, drift-free signal being received. AUTOMATIC SCANNING of the above bands. Continuous scanning of any desired portion of the band is achieved by setting the “L1” and “L2” keys to define the range to be scanned. The scanner can stop automatically on strong signals, or it can be done manually. MANUAL SEARCH is similar to the manual scan mode and is useful for quick signal searching. The “UP” and “DOWN” keys let the tuner search for you. The “FAST” key increases the search rate for faster signal detection. MEMORY PRESETS. Six memory keys hold desired stations for instant one-key tuning in any mode (AM, SSB/CW, and FM), and also, the “L1” and “L2” keys can give you two more memory slots when not used for scanning. OTHER FEATURES: Local, normal, DX sensitivity selector for AM; SSB/CW compensator; 90 min. sleep timer; AM Ant. Adjust.

SPECIFICATIONS

CIRCUIT SYSTEM: FM Superheterodyne; AM Dual conversion superheterodyne. SIGNAL CIRCUITRY: 4 IC’s, 11 FET’s, 23 Transistors, 16 Diodes. AUXILIARY CIRCUITRY: 5 IC’s, 1 LSI, 5 LED’s, 25 Transistors, 9 Diodes. FREQUENCY RANGE: FM 76-108 MHz; AM 150-29.999 KHz. INTERMEDIATE FREQUENCY: FM 10.7 MHz; AM 1st 66.35 MHz, 2nd 10.7 MHz. ANTENNAS: FM telescopic, ext. Ant. terminal; AM telescopic built in ferrite bar, ext. Ant. terminal. POWER: 4.5 VDC/120 VAC DIMENSIONS: 12¼ (W) X 2¼ (H) X 6¼ (D). WEIGHT: 3 lb, 15 oz. (1.8 kg).
October 1981
volume 14, number 10

Car magazine
incorporating

contents

10 trapping the mysteries of trapped antennas
Gary E. O’Neil, N3GO

18 using simulated carbon microphones with Amateur transmitters
Frank S. Reid, W8MKV

24 junk-box portable antenna
John J. Malarkey, W3SMT

28 operation upgrade: part 2
Robert Shrader, W6BNB

42 ham radio techniques
Bill Orr, W6SAI

50 avoiding built-in digital-circuit problems, part two
Penn Clower, W1BG

56 ICOM 701 owners’ report
Martin Hanft, WB1CHQ

62 SWR meter for the high-frequency bands
Ken Powell, WB6AFT

66 locating geostationary satellites
Walter E. Pfiester, Jr., W2TQK

94 advertisers index 6 letters
46 DX forecaster 81 new products
77 flea market 4 observation and opinion
91 ham calendar 9 prestop
72 ham mart 74 ham notes 94 reader service

October 1981
Observation & Opinion

From time to time I tune across the Novice bands just to see what’s going on and to learn how the beginners are developing their operating skills. I sometimes fire up my rig and work a few Novices. In most cases the Novices appreciate a more experienced CW operator invading their territory, especially if the latter is patient and understanding. I recommend that all experienced CW operators take the time to work a few Novices. It’s a welcome change from fighting the pile-ups and gives a sense of accomplishment, especially if you’ve helped a Novice improve his code proficiency and operating procedures.

Listening on the Novice frequencies can be an interesting experience. The Novice portion of the 40-meter band is a good example. Here you’ll find some operators who are pretty good — their sending, although not fast, is clear and clean, and their operating techniques are on a par with those of many General-class operators. A few have electronic keyers or keyboards, but most plod along with a straight key. At the other end of the scale, you’ll find Novices who just can’t seem to break bad operating habits. This is where an experienced CW operator can really help, but it takes a lot of patience and, above all, tact.

Many Novices don’t know what to do after they’ve called CQ. The over evening I heard a station sending CQ continuously at a rapid rate for three minutes, followed by his call sign, which was sent only once. After a pause of a few seconds, the CQing started again. This was repeated for another three or four minutes — still no response. Then I tuned up the band a few kilohertz, and there was another Novice calling CQ. The same pattern was again repeated — no response. All in all, I heard perhaps ten stations across the Novice portion of the band calling CQ. One wonders if they had their receivers turned on.

Then I tuned back to the first station and there he was, still at it. When he signed this time I gave him a call, being particularly careful to match my sending speed to his. I signed over — nothing. Then, “QRZ? QRZ?” I sent my call again at his speed. Again, “QRZ?” This went on for a few minutes, then I reduced speed to about half and the Novice finally answered. We had a pleasant contact for a while, with the Novice sending at a considerably slower rate than before, complete with all the punctuation marks.

I mentioned earlier that many Novices don’t know what to do after calling CQ. I find that many Novices, after returning to the receive mode, don’t tune around their transmitting frequency. Apparently they expect the replying station to be exactly on their transmitting frequency, which is unlikely in many cases. If the Novice is using a sharp CW filter in the receiver, the answering signal could be outside the receiver i-f passband and will never be heard.

The best answer to the CQ problem is don’t. Old-timers will recall a filler cartoon that used to run in QST years ago. It showed a mama cat walking along the top of a fence, followed by three kittens. The caption was, “If you wanna get results, you gotta make calls!” Not only did it mean CQ calls but also calls to other stations.

Another recollection of bygone days is the series of pieces in QST by T.O.M. (The Old Man). T.O.M. loved to write about “Rotten Radio.” His poignant prose was directed to everything from rotten spark sets to rotten operating. I think we could use more of T.O.M.’s scathing criticism. Although he wrote in a humorous vein, there was a lot of truth in his observations. I’ll bet if T.O.M. were alive today, he would endorse my sentiments about the operating practices of some of our Novices. I feel it’s the responsibility of the higher-class operators to give a little of themselves to assist those Novices that need help.

Alf Wilson, W6NIF
editor

October 1981
Base Your VHF/UHF Station on ICOM

Enjoy local contacts and have the lure of far off DX on a band that is capable of worldwide communications on just a few watts. The ICOM IC-551 (10W) and IC-551D (80W) series transceivers provide full 6 meter coverage in a multimode package. Talk to your ICOM dealer concerning options.

ICOM's 2 meter multimode transceiver, the IC-251A, provides the latest technology in communications on one of ham radio's most active bands. Have fun ragchewing with your friends, coordinate events or use the IC-251A's sideband capability as an Oscar link. Simplex SSB on 2 meter is growing - be there.

The IC-451A provides space age technology for space communications. Satellites, EME and local modes of communications are available by basing a system on ICOM's full featured 432 MHz transceiver.
Dear HR:

I am writing to tell you that I enjoyed reading the "RF Power Meter" article by Ralph Fowler, N6YC, that appeared in the June issue. I was particularly interested in Mr. Fowler’s discussion of the directional bridge and its associated accessories. I noted that several of Mr. Fowler’s accessories were lowpass and bandpass filters, and he referred the reader to the ARRL Handbook for lowpass filter construction information. In my opinion, there are more useful references than the ARRL Handbook for the design of the seven-pole LC lowpass filters used by Mr. Fowler, and I wish to bring these references to the attention of Mr. Fowler and the readers of ham radio.

Since 1972, I have had many articles published on passive LC filter design (references 1 through 8) in which tables of pre-calculated designs required only standard-value capacitors to simplify construction. The most recent article5 on this design aid was published in the January 7, 1981, issue of EDN. I recommend this last reference to Mr. Fowler and your readers for the expeditious design and construction of the seven-element lowpass filters mentioned in the article. (Table 2 of the reference is probably more useful for Amateur Radio applications than is table 1).

For example, on page 59 of his article, Mr. Fowler states he uses "seven-pole LC lowpass filters with cutoffs at 5.8, 9.6, 15.7, 23.1, and 30.4 MHz" to attenuate the harmonic amplitudes of his signal generator. These designs can be conveniently selected from my table 2 and only standard-value capacitors are needed. Also, all of the messy calculations are eliminated. For the previously listed cutoff frequencies used by Mr. Fowler, I suggest Filter Designs #207, 232, 138, 162, and 173, respectively. These designs have reflection coefficients of less than 9.2 percent, and they should perform satisfactorily in this application. I will be happy to provide anyone with a copy of my article if they send me a stamped, self-addressed envelope.

To further demonstrate how standard-value capacitors can simplify filter design and construction, I have made minor modifications to Mr. Fowler’s 5.3-MHz Butterworth bandpass filter (fig. 9, page 61 of his article). The Butterworth design was modified into a Chebyshev design that is easier to construct, and the passband and stopband performance of the two designs is very similar (see my fig. 1 of bandpass filter responses). (The Chebyshev design was based on my tabulation of pre-calculated five-element lowpass filters that was published in June, 1978—see reference 6.)

Note that the inductor values of the two different de-

![fig. 1. Calculated bandpass filter responses based on an inductor Q of 100 at 5.3 MHz.](image-url)
signs are very similar, and therefore the inductors of the Chebyshev design should be just as feasible to obtain as the Butterworth designs. If the bandwidth of the filter is made too small, the ratio of inductance values (L2 to L1,5) will become too large, thus making it difficult to get good inductor Q and proper filter performance. The filter bandwidth selected by Mr. Fowler seems reasonable from a construction and performance viewpoint. Capacitor values C2 are similar (70 pF compared with 75 pF) but C1,5 and C3 are quite different. This difference is a consequence of changing the Butterworth design into a Chebyshev design. Mr. Fowler’s center frequency of 5.3 MHz was slightly increased to 5.42 MHz to make C2,4 come out to a standard capacitor value (75). Mr. Fowler was correct in his concluding sentence that “improvements doubtless can be made,” and this I have attempted to demonstrate as far as the passive LC filter design aspect is concerned. I am grateful to Mr. Fowler for taking the time and effort to write his articles, and I thank ham radio for publishing them. I hope to read many more similar articles which will assist me and others in improving our technical expertise.

references

Ed Wetherhold, W3NQN

This man is looking for
AN ELECTRONIC BREAKTHROUGH.

Join him in the incredible world of electronics with NRI’s all-new training in the career of the future...Electronic Design Technology.

It’s an electronic world we live in. And the designers of electronic circuits, controls, and systems are the people who are shaping it. Take your place in this exclusive company with this exciting new training from NRI.

You can learn Electronic Design Technology at home, in your spare time. Without quitting your job, tying up your evenings at night school, or wasting gas traveling to classes. Because NRI comes to you, makes you a class of one with a complete, effective, low-cost learning program designed exclusively for home study. You get it all...at your convenience.

Hands-On Training. NRI trains you for action. You get real-life experience that builds priceless confidence, gives you working knowledge of lab practices and techniques. It’s all built into the NRI Design Lab, a complete combination of equipment, hardware, training, and reference materials.

You’ll design your own circuits from the very beginning, progressing from basic passive networks through key circuits like power supplies, amplifiers, oscillators, digital and logic circuits, phase-locked loops and more. You’ll move on to linear and digital integrated circuits, the heart of modern electronic equipment. You’ll prototype your designs and verify operation, learning professional test and measurement procedures as you progress.

Professional Equipment Included
All the way, you work with professional-quality instruments like the Beckman 6-function, 26-range LCD digital multimeter. It gives you fast, accurate measurements of voltages, currents, and resistances, even forward voltage drops across in-circuit diodes and transistors.

You’ll boardread your designs on the unique NRI Circuit Designer. It features built in multiple power supplies, variable signal generator, logic switches and LED indicators. It handles almost any circuit you can design...linear and digital integrated circuits as well as discrete components such as transistors and diodes.

Analysis and design work is speeded with the Texas Instruments TI-30 scientific calculator. This engineer’s instrument includes full trigonometric functions, logarithms, square root, squares, powers, memory, and more. All this fine equipment is part of your training, yours to keep and use in your work.

NRI Fast-Track Training
This is the unique NRI lesson concept that simplifies and speeds learning. From the very basics to advanced, state-of-the-art electronics, each lesson is especially prepared for individualized instruction. Each subject is covered fully and thoroughly, but extraneous material is eliminated. Language is clear and to the point, organization is logical and effective. From Fundamentals of Electronic Circuits through Microprocessors, your lessons are designed with you in mind.

No Experience Necessary
You don’t have to be an engineer (or even a college student) to succeed. High school graduates with some algebra handle it without any trouble. We start you at the beginning, let you advance just as quickly as you’re ready. We even include the NRI Math Refresher Module to help you brush up on your math and teach you any new concepts you may need.

Free Catalog. No Salesman Will Call
Our free, 100-page catalog gives you all the details, including lesson outlines, equipment specifications, and career opportunities. Send for it today and find the breakthrough for your future. If coupon has been removed, please write to NRI Schools, 3939 Wisconsin Ave., Washington, DC 20016.
SYNTHESIZED

INTRODUCING SANTEC’S ST-7/T

SANTEC•NOLOGY breaks into the 440 band with style! The new ST-7/T synthesizes the entire band in 5 kHz steps, works both up and down repeater splits and does it all right from your hand, with versatile power options of 3 watts, 1 watt or even 50 milliwatts (all nominal), to reach out to where you want. The high power mode of 3 watts radiates on 440 like 5 watts on 2 meters … and that’s a handfull!

Tones? This one has them … tones and subtones! The 16 button tone pad is a SANTEC Standard at no extra cost, and the ST-7/T’s optional synthesized subtone encoder is controlled by the radio’s front panel switch.

All the regular SANTEC accessories used with your HT-1200 fit the ST-7/T as well, meaning that you can enjoy both bands fully with a smaller cash investment. Grab the new SANTEC ST-7/T and join the fun on 440 MHz. See your SANTEC Dealer for delivery details.

SANTEC'S popular HT-1200 is the incomparable 2 meter leader. This little rig is handling over quality, power and features that you’d expect from something nearer the size of a bread box. SANTEC packs a 2 meter ham shack into the palm of your hand!

You can carry scan, search, 10 memories and fully synthesized key pad control around with you and still get out with a big 3.5 watts (nominal). Compare them apples to anything you want, and settle for nothing less.

SANTEC radios exceed FCC regulations limiting spurious emissions

Both the SANTEC ST-7/T and the SANTEC HT-1200 are certified under FCC Part 15.

© 1981 Encomm, Inc.

2000 Avenue G, Suite 800, Plano, Texas 75074

Phone (214) 423-0024 • INTL TLX 203920 ENCOM UR
FCC'S STAFF REPORT was finally issued July 16, and the 92-page document contains a number of inferences and suggestions that should cause concern in the Amateur community. Although the report cites CB radio as the greatest single source of RFI complaints, Amateur Radio is almost invariably mentioned along with CB in discussions of problems and solutions. 2170 problems created by radio frequency interference (RFI) are serious and getting worse," the report's chapter on recommendations begins, and then in the very next paragraph it states, "A significant part of the RFI problem is TV receiver overload caused by CB radio (and to a lesser extent amateur radio)."

Among The Proposed Solutions (to TV set overload by CB radio) are mandatory or voluntary TV receiver standards and TV receiver labeling, (as to performance). Another option would be to set a combined transmitter/receiver limited liability, which could (for the transmitter operator) include adding filters, limiting antenna height (or direction), quiet hours, or even compensating the person interfered with! Another option, even more onerous, would place all burden for TVI resolution on the transmitter operator.

This Last Interference "Remedy" comes up several times in the Commission's staff report, and would certainly be very objectionable to the Amateur service. With it an Amateur could be forced to reduce power, move or modify antennas, avoid certain bands, or even give up operating entirely in order to resolve an interference problem. This alternative remedy does seem to have some support, however, as it comes within the present alternative remedy process. The alternative remedy, regulation to require better interference rejection by home entertainment devices, is one that would require new legislation, such as Senator Goldwater's bill, S929.

A Further Notice Of Inquiry on the RFI question, General Docket 78-369, was issued along with the staff report. Reply Comments are due on November 16.

SIGNIFICANT RULES RELAXATIONS have been suggested for the Amateur Service in an FCC working paper, "Deregulating Personal and Amateur Radio." The recently released 80-page document, more a "brainstorming session" of the possible directions Amateur and CB deregulation might take than hard and fast proposals, was prepared by the Commission's Office of Plans and Policy.

Repeater Rules Are Discussed in the paper, which suggests reducing the responsibility control operators have for repeater control or eliminating it completely, and changing the prohibitions on repeaters below 29.5 MHz. Some restrictions on third-party traffic could also be relaxed, the working paper is very strong on "deregulation or liberalization," and suggests that the rules now restrict or even prohibit Amateur experimentation with packet radio, spread spectrum, and other new communications developments.

A Code-Free VHF License "for technically qualified applicants" might strengthen Amateur Radio's technological orientation it further suggests, along with improving utilization of the 28-MHz band by giving Technicians some phone privileges there. It also considers the possible benefits of allowing "some Amateur operations on 27 and 900 MHz Personal Radio Service (CB) frequencies."

The Personal Radio Service and how it can best use the new 900-MHz band occupies the bulk of the working paper. The adoption of various new communications techniques and the extension of personal radio into landmobile business communications, mobile and rural radiotelephone, and even marine radio are subjects which receive even more attention than the Amateur service does in the paper.

Though The Deregulation Ideas presented in the working paper are simply ideas at this time, they deserve consideration, as they represent some recent FCC thinking. A very few copies of the paper were available from the Commission; reproductions are also offered by Fair Press Services, (202) 463-7323, and the Downtown Copy Center, (202) 452-1422, at about $8.00 a copy.

Amateurs With Comments on the working paper can contact Alex Felker, Office of Plans and Policy, FCC, Washington, D.C. 20554.

ARRL HAS BEEN SUED FOR $50,000 by three members of the Indiana Radio Club Council, who allege in their complaint that "the defendant (ARRL) refuses to hold a recall vote" in the Central Division. League General Manager Dick Baldwin had acknowledged receipt of the Council's recall petition in a July 29 letter, in which he stated the petition had been put on the September 9 Executive Committee meeting agenda.

The First Hearing on the suit was set for September 25, in the U.S. District Court in Indianapolis.

A NEW WORLD LAND SPEED RECORD will be attempted starting on September 28 at the Bonneville Salt Flats in Utah. A special-event station with SSTV pictures of the attempt, being made by Thrust Cars Ltd. from England, will be active October 3, 4, 10, 11, 17, 18, and 24 starting at 1500Z. Frequencies will be 14240 and 21340 for SSTV, and 14290 and 21370 for SSB QSOs. Operating as WA7MTF, the Amateurs will also provide ATV along the 11-mile strip for crowd control.

October 1981
trapping the mysteries
of
trapped antennas

A quantitative treatment
of antenna trap design
and construction

Much information is available pertaining to antenna design and construction. Most of this information is written for a technically competent audience and addresses the problem of antenna performance under nearly ideal conditions. With 17 years in Amateur Radio, I have yet to live in a location where compromises are not required. One very popular compromise is the use of traps to achieve multiband operation with a single antenna.

The use of traps in commercial designs, such as verticals and triband beams, has been an accepted technique for many years. Although design guidelines are available, a quantitative definition of what is required and acceptable does not seem to exist. I was puzzled about trap designs and asked why a compromise in performance should be costly. Owning a transceiver that covers 160 through 10 meters, I wanted to use as many of the bands as possible. Separate antennas for each band were out of the question because of limited space. Having no previous experience with trapped antennas, I decided it was the right time to gain some.

what is required?

I began reading assorted handbooks and college texts. I reviewed back issues of magazines and queried colleagues. I was surprised to discover how little information is available about traps, much less their use in antennas. The following information was derived from my research:

1. Traps are parallel-resonant tuned circuits that provide an effective open circuit at their resonant frequency.
2. Traps become a series inductance at frequencies below resonance, electrically lengthening the antenna. This implies that the physical length of the antenna is shorter at lower frequencies because of the inductance provided by the coil component of the trap.
3. Traps must have a high Q.
4. High-Q capacitors must be used.
5. Large-diameter coils are recommended.
6. Capacitors and inductors providing 200 to 300 ohms of reactance at resonance provide good results.
7. Traps must be resonant very near the center of the band for which they are designed.

I needed answers to some basic questions to determine the requirements of a trap:

1. What is an effective open circuit?

By Gary E. O’Neil, N3GO, 13 Holiday Hill Road, Endicott, New York 13760
2. How high is high $Q$?
3. How large is a large-diameter coil?
4. How close to the desired frequency must a trap be resonant?
5. What effects do traps cause at the band edges?
6. How much do traps shorten an antenna?
7. How do I tune an antenna with traps?

I'd be dishonest if I claimed that I asked all these questions at once and that my initial results were where this story ends. Actually, I went through two designs before developing the trap described here and evaluated one commercially manufactured design for comparison of performance. As I progressed, I found I had questions not answered by colleagues or reference books. Some crude testing was in order.

**high $Q$ or high impedance?**

I needed to know what an effective open circuit was, and my test for this was quite simple. I built a 20-meter dipole as my reference antenna and assumed that adding a high-value resistor in series with the length of wire on the end would be like adding a high-$Q$ trap and wire for a lower band when operating on 20 meters. I assumed a quarter wavelength on 20 meters to provide a worst-case mismatch of the antenna. I cut some wire to 16.5 feet (5 meters) in length and spliced a resistor to one end; then I connected this wire onto one end of my dipole at the opposite side of the resistor and measured the VSWR.

The following results were obtained:

<table>
<thead>
<tr>
<th>Resistor Value (kilohms)</th>
<th>VSWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.7</td>
<td>2.8 to 1</td>
</tr>
<tr>
<td>3.9</td>
<td>2.6 to 1</td>
</tr>
<tr>
<td>6.8</td>
<td>2.2 to 1</td>
</tr>
<tr>
<td>10.0</td>
<td>1.7 to 1</td>
</tr>
</tbody>
</table>

The VSWR of the antenna before this test was less than 1.2 to 1. I conducted the test where the antenna was best matched to get a feel for the contribution to overall VSWR.

It appears that an impedance greater than 7 kilohms must be maintained to ensure a 2:1 VSWR. A lower trap impedance can be used and compensated for by adjusting antenna lengths; but in this case the loading effect would have caused an interaction and tuning for resonance on all bands would be a frustrating experience.

While studying my impedance data and considering $Q$, I became a bit perplexed. As losses approach zero, $Q$ approaches infinity and bandwidth approaches zero. If this were true, the trap would be useful at one frequency only. Zero bandwidth was not my problem. Given bandwidth and center frequency, I can calculate $Q$, as illustrated by this example:

Given: $F_c = 14.175$ MHz (center of 20 meters)

$$3 \text{ dB } BW = 0.35 \text{ MHz}$$

Therefore:

$$Q = \frac{F_c}{3 \text{ dB } BW} = \frac{14.175}{0.35} = 40.5$$

It follows that high $Q$ is 40.5 on 20 meters and is valid if, at $F_c$, the impedance is equal to 14 kilohms. The impedance at the band edges in this case would be 7 kilohms, which is sufficient for a 2:1 match and assumes that the antenna and traps are tuned to 14.175 MHz exactly.

A $Q$ of 40.5 and an impedance of 14 kilohms at resonance can be achieved with a wide variety of LC combinations and assorted types of capacitors.

Now assume $Q$ remains constant but impedance increases at $F_c$. The effect is a higher impedance across the band. If the impedance at $F_c$ remains constant and $Q$ gets larger, the impedance at the band edges is reduced. This implies a problem, since my crude measurements indicate a need to maintain greater than 7 kilohms across the band.

My point is, **high $Q$ may not be desirable in antenna traps**. It’s important to understand that the property of the trap providing isolation is its impedance. It is this impedance that must be kept large. Anything larger than 7 kilohms improves isolation and is therefore desirable.

A little experience will clarify the fact that, as $Q$ increases, the impedance at $F_c$ increases. This is perhaps the reason why high-$Q$ traps are considered a must for good performance. I intend to show this is not true and attempt to explain the contribution of $Q$ to losses and bandwidth rather than to impedance at resonance.

**questions answered**

The most helpful reference I could find for an answer to my original question suggests that high $Q$ is approximately 100, and a $Q$ of 50 would be considered medium. Aside from answering my original question, this information served no useful purpose. The same is true for high-$Q$ capacitors. Strictly speaking, $Q$ refers to losses in this case rather than bandwidth. And if capacitors are used, the higher the $Q$, the better should be your guide. High-voltage capacitors are popular but are generally expensive and difficult to find.

Large-diameter coils seem to imply 2-3 inches (5-7.5 cm), although most triband beam manufacturers do well with smaller diameters. This information,
along with the recommended 200-300 ohms of reactance at resonance, have worked well in the past; and experiments with trap designs of the more conventional type tend to support these recommendations. For this reason, I will not oppose the theories on which they are based.

I attempted a number of trap designs, looking for a low-cost, easily manufactured capacitor. Gary Myers, K9CZB, used coaxial cable for the capacitor in his 7-MHz trap. My tests revealed an impedance of 50 kilohms at $F_0$ for a 15-meter version using an HP-4815A Vector Impedance Meter. Its $Q$ was high (approximately 126); and to ensure 7 kilohms at the band edges, the center frequency had to be accurate and stable. With a bit of persistence, careful thought, and some RG-58/U, I was able to develop the trap described here.

**theory**

The single-element trap simultaneously uses three physical properties that can be realized with a section of coaxial cable. Using the properties of capacitance, inductance, and coupling reduces the complexity of LC networks to an appropriately configured length of coax in the form of a coil. Models have been built, tested, and evaluated in the 3.5- to 30-MHz range and calculations verified to 150 MHz with a reasonable accuracy.

A properly designed and manufactured coaxial cable has a uniform capacitance per unit length, which is predictable, between the center conductor and shield. This capacitance can be employed in an LC network such as a tank circuit, which presents a high impedance at resonance.

A second property is that coax can be coiled. The forming of a conductor (the coax shield in this case) into a coil produces an inductance greater than that of the wire alone, due to coupling between turns. This is predictable and can serve as the inductive component in an LC network. It should be noted that only the shield is considered to be coiled and is the significant contributor to the inductive component of the trap.

Since the center conductor is shielded, the effects of coiling the cable do not influence the center conductor, which maintains a given inductance per unit length of the wire alone. Although this property has negligible effect on the operation of the trap to be described and was omitted from the calculations, one should be aware of it for applications at or near microwave frequencies. The important point is that the capacitance per unit length remains unchanged by coiling the cable due to the shielding properties of the outer conductor.

**configuration**

With the source of capacitance and inductance defined, the task of wiring the device remains. Fig. 1 illustrates this requirement and shows the cable coiled as described. It is shown without a form for support as an illustrative aid. If flexible cable such as RG-58/U is used, a rigid form such as PVC plumbing stock would be required.

Fig. 2 is the schematic representation of a parallel LC network with external connections designated A and B. Notice that a dc path must be provided between terminals A and B. Also, each plate of the capacitor connects to opposite ends of the inductor. A casual look at fig. 1 may cause some confusion since it appears that, with the center conductor connected to the shield, the cable's capacitance is short circuited. This is valid only at dc as is the case in the circuit shown in fig. 2. An analysis of the phase relationships required at resonance will reveal why this connection is not only valid but also required.

The third property of the coaxial cable is the coupling between the center conductor and shield due to magnetic induction. This property (the basis of transformers) is clearly seen if viewed as a straight length of cable. Fig. 3 shows this schematically as two parallel conductors revealing the necessary components of a 1 to 1 transformer, or more aptly, a coupler.
rent injected into the primary from some source induces a secondary current in the opposite direction as indicated by the arrows. Connecting the top of the secondary to the bottom of the primary causes primary and secondary currents to oppose each other. These currents, being equal and opposite, aid the opposition of the network to current flow. At resonance, the trap has a high circulating current enhancing the coupling properties, which further improves this opposition.

![fig. 3. Electrical schematic of single-element trap as a 1:1 transformer or coupler.](image)

With the cable configured as shown in fig. 1 and referring to the schematic in fig. 2, one might assume that the input and output connections should be at the ends of the shield. This provides the tank circuit function using only the properties of inductance and capacitance. Magnetic induction is not employed when one end of the secondary remains open circuited. The connections indicated provide the return path for secondary current, and an analysis of phase relationships at resonance will validate this connection.

The inductance of the center conductor now included causes a slight shift downward in resonant frequency and was observed to be about 2.5 percent in a 15-meter trap. The significant result of this connection is the gain in impedance produced by the opposing primary and secondary currents with no detectable change in Q relative to the 3-dB bandwidth of the device. Test data provided at the end of this article illustrates the significance of this impedance gain.

Tests of traps using conventional LC configurations indicate this trap has much lower Q (wider bandwidth) but provides a comparable impedance at resonance, implying similar loss characteristics. High impedance and relatively low Q make this design superior, since the accuracy to which it is tuned and its physical stability become less critical. The result is a trap that does not need tuning.

In addition to these profound advantages, the cost is near zero. If you are considering erecting an antenna, you will likely have coax as your feedline. A local plumbing contractor may be a good source for discarded PVC stock sufficient for these traps.

**Q versus loss**

Does the low Q of the single element trap imply that it is lossy? This must be answered with another question. What is low loss? Fig. 2 represents a tank as a capacitor in parallel with an inductor. If this were an exact representation, the impedance at resonance would be infinite. Mother nature plays her role and introduces loss represented by a resistor in parallel with the tank.

At resonance, the impedance is infinity in parallel with the resistor representing the losses, or approximately the value of the resistor alone. To determine actual losses, it’s necessary to apply a voltage across the tank and solve for the power dissipated in the resistor. The power dissipated as heat in this resistor is the loss presented by the tank. It should be clear that the losses encountered are inversely proportional to the tank’s impedance. If this impedance is high, the loss will be low. If Q can be reduced without decreasing the value of the resistor representing the losses, the performance in multiband antenna applications will be enhanced.

This results from using the single-element trap described and is supported by data collected on four 15-meter traps. Trap A was a commercially manufactured unit; B is the single-element trap built as I have described; C, similar to trap A, is my first attempt at a compact, low-cost design; D was a K9CZB-style trap. The data as measured on an HP-4815A:

<table>
<thead>
<tr>
<th>trap style</th>
<th>inductor</th>
<th>capacitor</th>
<th>impedance at resonance (kiloohms)</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.7 inch (4.3 cm) dia. 14 AWG (1.6 mm) wire concentric tubing</td>
<td>40</td>
<td>142</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>1.7 inch (4.3 cm) dia. RG-58/U coax cable</td>
<td>41</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>1.7 inch (4.3 cm) dia. 14 AWG (1.6 mm) wire concentric tubing</td>
<td>27.5</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>1.7 inch (4.3 cm) dia. 14 AWG (1.6 mm) wire RG-8/U coax stub</td>
<td>54</td>
<td>126</td>
<td></td>
</tr>
</tbody>
</table>

When compared with the commercial design, the single-element trap has approximately the same impedance at resonance (equal losses) but nearly three times the bandwidth. This means the accuracy and stability can be three times worse and still achieve equal results. The traps I use were built in a hurry and are resonant out of band. There was no detectable interaction during adjustment, and the performance of the antenna has been excellent on all bands.

**pros and cons**

A brief review of the relative advantages and dis-
advantages of trap antennas compared with separate antennas per band is offered here:

advantages:
1. Multiband operation achieved with a good match on all bands.
2. Automatic bandswitching.
3. Antenna length reduced.
4. No compromise operation on highest band(s) since a full-size antenna is employed there.
5. Lower cost than separate antennas.

disadvantages:
1. Lower radiation efficiency due to trap losses on lower bands.
2. Narrowing of bandwidth due to the inductive loading presented by the traps.
3. Loss of second-harmonic rejection if bands are so related.

The first two disadvantages, though not severe, are the compromise that is made in any trapped antenna design. This is also true of the third, but this compromise deserves more comment. Single-band antennas provide second-harmonic rejection due to mismatch losses, and in a simple test nearly 20 dB of rejection was achieved. This compromise affects all of us, not just the user of the antenna, and to keep interference minimal, antenna matching systems are recommended. If a matching system is not used, careful tuning of the transmitter, and application of U.S. Regulations Part 97.67b2 will go a long way in maintaining peace and friendship within the Amateur fraternity and among other services as well.

construction

Table 1 provides the dimensions for traps below 30 MHz. These dimensions assume RG-58/U and 1.25 inches (3.2 cm) PVC stock are the materials used. Form lengths given permit 1 inch (2.5 cm) to extend beyond each side of the coiled coax. This facilitates using the form as a support for each antenna section and can be adjusted to suit personal preferences. All traps must be close wound and should be as tight as possible to ensure mechanical stability. The coax lengths permit 3 inches (7.6 cm) to extend beyond each side of the coil, permitting antenna-section splicing and the wiring of the trap itself.

With the form and coax cut as indicated in Table 1, assembly can begin. An 0.2-inch (0.5-cm) drill was selected to allow a snug fit for the coax.

1. Begin construction of the trap by drilling one hole approximately 1 inch (2.5 cm) from the end of the form.
2. Strip 3 inches (7.6 cm) of insulation off one end of the coax, and separate the shield and center conductor.
3. Strip 2 inches (5 cm) of insulation off the center conductor. Insert this end of the coax into the hole drilled in the PVC form until the coax jacket extends into the inside of the form no more than 0.25 inch (0.6 cm).
4. Very tightly wrap the coax around the form the specified number of turns and locate the point where the coiled coax should end. Mark this spot.
5. Move the coax end away, and drill a second hole at the marked location as near as possible to the next turn of the coil without cutting the jacket.
6. Tightly rewrap the coil to take up the slack that may have been introduced, and mark the end of the coax 0.25 inch (0.6 cm) beyond the hole just drilled.
7. With a sharp knife cut approximately half way through the jacket material only, then completely around the coax at this location.
8. In a similar fashion make a cut lengthwise along the cable from the first cut to the end of the coax. Do not remove the jacket material at this point. Again, tightly rewind the coil and insert the prepared end of the coax through the second hole.
9. Pull the coax from the inside of the form until it lies flat at both ends. (Some massaging of the end of the coax where it passes into the form may be required.) The jacket may be easily removed from the coax at this point and shield and center conductor separated.
10. Remove all but about 1 inch (2.5 cm) of insulation from the center conductor. Twist together the center conductor of one side and the shield of the opposite side. This connection should be internal to the coil form and tightly twisted to keep the leads as short as possible.
11. Cut off all but 0.5 inch (1.3 cm) and solder this connection.
12. Drill a hole 0.5 inch (1.3 cm) from each end and on the same side of the form. These holes are used to support the elements when used in a dipole or wire vertical.
13. Wrap a turn or two of the remaining end of the center conductor through the hole on its end of the form, and do likewise with the remaining end of the shield through the opposite hole.
The trap is now complete and ready for installation in an antenna. A silicone-base caulk may be used to seal the traps against weather. I chose not to seal mine and they have been in service for more than a year without degradation in performance.

**tuning an antenna**

The last column in **table 1** provides the effective length of wire in the trap used. This length should be subtracted on all bands where the trap looks like an inductor to provide a reasonable starting length before tuning.

Start with the highest band used and construct a halfwave dipole using the traps for that band as end insulators. Tune the antenna as desired with the traps connected before going any further. Once tuned, any lower band can be added by connecting more wire to the opposite sides of the traps and extending the antenna from this point. Calculate the length of a quarterwave section on the desired lower band, subtract half the length of the dipole just built, and finally subtract the trap’s effective length provided in **table 1**. The result is the length of wire required on the opposite ends of the traps.

Adjust the added sections only to tune the antenna so as not to affect the higher-band antenna that you have already tuned. Traps may be used as the end insulators for this new lower band, and another band (lower still) can be added using the same procedure. When completed, recheck VSWR on all bands. There should be little or no difference from where they were initially tuned.

**test data**

**Fig. 4A** is the antenna configuration I chose and is a combination of horizontal trapped dipoles. This provides five-band coverage with optimum bandwidth while remaining a simple construction task. A slight interaction was detected on 10 meters when 15 meters was added (the 10-meter center increased about 200 kHz). This was caused by the connection of the combined dipoles; not by the traps. **Fig. 5** shows the VSWR curves of this antenna. The VSWR of an antenna built as shown in **Fig. 4B** is plotted in dashed lines to illustrate the loss of bandwidth by using this approach.
Fig. 4C is an alternative approach that has not been verified but is included as an improvement suggestion to reduce the VSWR observed on 15 meters. My assumption here is that the 40-meter and 15-meter dipoles are at or near resonance on 15 meters, thus reducing the feedline impedance by a factor of 2; hence a 2:1 VSWR. I will have verified this assumption as this article goes into print, so watch the letters to the editor for a report of my findings.

Fig. 6 illustrates the impedance bandwidth gained by the wiring technique described, which uses the coupling properties of the coaxial cable.

**calculator program**

In the interest of expanding the single-element trap applications into areas other than antennas, and accommodating those who have suitable materials other than those that have been described, I can provide a TI-58/59 calculator program that computes the number of tight-wound turns required for a given resonant frequency when the physical properties of the desired materials are specified. In addition, I have described in detail the mathematical derivation of the trap and have provided a step-by-step procedure for building and tuning the antennas described in this article. For copies, send an SASE to the author with a check or money order for $1.50 to cover photo-copy fees. TI-59 owners providing a blank magnetic card will receive a recorded copy of the program.

**conclusion**

The purpose of, requirements for, and effects of using traps have been explored and supported by comparative test data. In addition, a trap design has been presented that is extremely simple to build (a pair of traps can be built in less than half an hour), costs less than half a dollar per band, and by design requires no tuning. With nothing more than an SWR meter and your transmitter for test equipment, you can have an antenna performing on 80 through 10 meters in a single afternoon.

I hope I have been successful in my attempt to unveil the secrets of antenna traps and instill confidence in those who heretofore have been hesitant, puzzled, or otherwise afraid to pursue trap antenna designs.

**acknowledgments**

At this point I would like to thank Joe Williams, N2GU, for his editorial and moral support, and Ray Avery, WA2RRS, for the use of his grid-dip oscillator and his support during testing and evaluation of my trap antennas for harmonic radiation. I would also like to thank Ed Lancki, N2BHD, for the use of his commercial antenna traps in my evaluation.

**references**

Over 200,000 persons have used TUNE IN THE WORLD WITH HAM RADIO as their steppingstone into Amateur Radio, the space-age hobby. The third edition of this popular package has been expanded with over 80 per cent new material. The code practice cassette has also been redone and improved. Packed into the Tune in the World booklet are chapters on:

- **EXPLORING HAM RADIO**: Hams come from all walks of life; age is no barrier; building your own station; a look back in time.

- **MANAGING THE RADIO SPECTRUM**: The FCC; rules and regulations; the Novice license; licensing classes.

- **LEARNING YOUR NEW LANGUAGE**: The Morse Code — why every ham knows it; how to learn it the right way.

- **UNDERSTANDING BASIC THEORY**: Easy-to-learn explanation of electronic theory and what you need to know to qualify for a Novice license.

- **SETTING UP YOUR STATION**: Choosing a location; how to select your equipment; what antenna to use; glossary.

- **OVER THE AIRWAVES PAINLESSLY**: How to operate; tuning up; safety; identifying stations in foreign countries; awards; clubs; The ARRL and QST.

The booklet consists of 134 pages of text and an additional 26 pages of equipment and publication advertising. The C-60 cassette provides 60-minutes of code practice instruction. The entire package is available for $8.50 (in U.S. funds) at your favorite dealer or order below:

<table>
<thead>
<tr>
<th>NAME</th>
<th>CALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>STREET</td>
<td>STATE/PROV.</td>
</tr>
</tbody>
</table>

Total Enclosed (or charge to MC, VISA or Chargex) $_________

VISA or Chargex No. ___________________________ Expires _________
Mastercard ___________________________ Expires _________
Bank No. ___________________________

Have you fully completed your order form? Is your check signed or charge number indicated?

THE AMERICAN RADIO RELAY LEAGUE
225 MAIN ST., NEWINGTON, CT 06111
Current-source adapter allows Amateur transceivers to use simulated-carbon microphones such as (left to right) Telex aircraft microphone, Motorola mobile microphone, Pacific Plantronics MS-50 and StarSet headsets.

**using simulated carbon microphones with Amateur transmitters**

Simulated carbon microphones have several advantages over carbon microphones—all you need is an adapter.

**Carbon microphones**, previously standard in aircraft (fig. 1) and many other mobile radios, have been largely replaced by improved types that simulate the electrical characteristics of carbon microphones. Hamfests abound with bargains on high-quality “simulated-carbon” microphones that are sturdily constructed and often include noise-cancelling features. They don’t work with most commercially made Amateur equipment, but the required adapter is very simple. (Do not confuse simulated-carbon microphones with the “power microphones” used by CBers.)

The carbon microphone is a variable resistor that changes resistance when sound energy compacts the carbon particles inside it. Unlike dynamic and crystal microphones, which generate their own tiny voltages in response to sound, carbon microphones must be connected to an external source of current to produce an electrical signal. Carbon microphones are rugged, inexpensive, and produce high-level audio signals, but they are no longer popular because of their poor audio-reproduction qualities.

The simulated-carbon microphone contains a dynamic or electret element plus a preamplifier.

**By Frank S. Reid, W9MKV, 3243 N. Louden Road, Bloomington, Indiana 47401**
fig. 2. Circuit to supply bias current to simulated-carbon microphones, and couple audio to transmitters with inputs designed for dynamic or crystal microphones.

fig. 3A. Schematic of Pacific Plantronics MS-50 headset, telephone switchboard model. Diodes ensure proper polarity to preamp regardless of how plug is inserted but may detect rf, causing feedback.
which is powered by dc microphone-bias current supplied by the transmitter. The preamplifier modulates the bias current, producing an audio signal. The preamplifier is sometimes inside a sealed unit with the microphone element, or may be on a separate circuit board.

adapter circuit

Transmitters designed for carbon microphones may supply anywhere from 10 mA to 60 mA of microphone current. Most simulated-carbon microphones will work properly over this entire range of currents. Fig. 2 shows a circuit for supplying microphone bias current. R1 and C1 form a decoupling network. R1 and R2 determine the microphone current. C2 blocks dc and couples audio to output level-control pot R3.

construction

If the adapter is built in a small shielded box, you can transfer it among several rigs. Microphone circuits pick up rf interference easily, so use good construction practice in shielding and bypassing. Shield
the wire to the external power supply, but ground only one end of the shield. Ground the adapter circuit only at the transmitter microphone connector, or ground-loop current may cause hum in the output.

The adapter components may be mounted inside the transmitter if you don’t mind modifying your equipment. The voltage-regulator IC can be eliminated if you can find a well-regulated source of 8 to 11 volts inside the rig.

adjustment

The level control must be set to provide the proper amount of audio to the transmitter input. To set the level, I connect an oscilloscope to the transmitter input terminals and observe the output of the rig’s original microphone while talking normally, then substitute the adapter and adjust the pot until the signal reaches the same peak value. On an SSB transmitter with output meter, the meter can be used to compare microphones. You should then use an oscilloscope to inspect the rf output waveform for proper modulation.

converting surplus headsets

Headsets are great for contest and mobile operation, but most are bulky, uncomfortable, and can dangerously restrict a driver’s hearing. The tiny Pacific Plantronics headsets overcome these limitations but cost up to $200 from suppliers of aircraft equipment. Slightly different models designed for telephone switchboard use are often available at hamfests and surplus outlets. Their preamplifiers contain current-steering diodes so that they will work properly with any bias supply polarity (figs. 3A, 4A). They usually work well with no modification, but they may pick up rf interference if used with high-power stations. To prevent rf feedback problems, remove diodes, rewiring as shown in figs. 3B and 4B. Replace the telephone cord with a multi-conductor replacement-type microphone cable having at least one shielded wire inside. Add your own push-to-talk switch if necessary. With diodes removed, you must determine proper polarity and use some type of polarized connector. The standard aircraft microphone plug (military designation PL-68) is wired as shown in fig. 1. It looks like a three-conductor stereo phone plug but is smaller in diameter. Surplus PL-68s are plentiful at hamfests (scouring powder will polish the brass nicely).

The circuit of fig. 2 is not recommended for small hand-held portables, where the microphone current would contribute significantly to battery drain. The 3000-ohm dynamic microphone element in most models of Plantronics headsets can drive many rigs directly, or through a small matching transformer.
**The Ultimate AM/FM Paddle**

WRITE FOR LITERATURE

Benchner, Inc.

333 W. Lake Street, Dept. A

Chicago, Illinois 60606 • (312) 263-1808

**OCTOBER SALE**

BONUS 2% discount for prepaid orders
(Cashier's check or money order)

<table>
<thead>
<tr>
<th>MFJ PRODUCTS</th>
<th>COMPLETE LINE IN STOCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>988 NEW 3KW Tuner</td>
<td>278.95</td>
</tr>
<tr>
<td>962 1.5KW Tuner mtr/swtch</td>
<td>174.95</td>
</tr>
<tr>
<td>942B 300 watt deluxe tuner</td>
<td>122.00</td>
</tr>
<tr>
<td>941C 300 watt tuner switch/mtr</td>
<td>78.42</td>
</tr>
<tr>
<td>940 300 watt tunner switch/mtr</td>
<td>69.70</td>
</tr>
<tr>
<td>484 Grandmaster memory key 12 msg</td>
<td>131.72</td>
</tr>
<tr>
<td>482 2 msg Memory Key</td>
<td>87.96</td>
</tr>
<tr>
<td>423 Passepartout Key w/Brcher BY1</td>
<td>87.15</td>
</tr>
<tr>
<td>410 Professor Morse key</td>
<td>113.95</td>
</tr>
<tr>
<td>408 Deluxe Keyer with Speed mtr</td>
<td>69.69</td>
</tr>
<tr>
<td>495 Keyboard *</td>
<td>286.96</td>
</tr>
<tr>
<td>752B Dual tunable filter</td>
<td>78.42</td>
</tr>
<tr>
<td>722 24-hour clock</td>
<td>30.99</td>
</tr>
<tr>
<td>260 Dry Dummy Loads</td>
<td>23.50</td>
</tr>
<tr>
<td>250 2XW FPE Dummy Load</td>
<td>28.25</td>
</tr>
</tbody>
</table>

**BENDER PADDLES** Black/Chrome 35.90/43.75

**ASTRON POWER SUPPLIES** (13.8 VDC)

| RS7A 5 AMPs continuous | 48.60 |
| RS12A 9 amp continuous, 12 amp ICS | 66.35 |
| RS20A 16 amp continuous, 20 amp ICS | 87.20 |
| RS2OM same as RS20A plus 6 meters | 105.50 |
| RS35A 25 amp continuous, 35 amp ICS | 131.95 |
| RS35M same as RS35A plus 4 meters | 151.95 |

**TELEX HEADRETS HEADPHONES**

| C1210/C1320 Headphones | 22.95/32.95 |
| PROCOL 200 Headset/dual Imp. Mic | 77.50 |
| PROCOL 300 tr/Headset/dual Imp. Mic | 99.50 |

**VoCom Antennas/2m Amps**

| 5/8 wave 2m hand held Ant | 19.50 |
| 2 watts in 25 watts out 2m Amp | 69.95 |
| 200 mw in 25 watts out 2m Amp | 82.95 |
| 2 watts in 50 watts out 2m Amp | 108.95 |

**MIRACLE AMPS & Watt Meters**

| MPH/HF/MPV VHF-SWR/Watt Meter | 101.95 |
| B23 2 m, 30. All Mode | 76.95 |
| B108 10 m, 80, all Mode | 151.95 |
| B1016 10 m, 160, All Mode, Pre-Amp | 275.95 |

**KENWOOD ICOM YAESU TEN-TEC** Call for Quotes

**AZDEN PCS 3000 3m Transceiver**

**SANTITI HT200 2m Hand Held**

**KDK FMA-2025A 2m Tor**

**AIA KEYSERS & ISOLANTE POLARIS CALL**

**HY-GAIN ANTENNAS**

| THDXIK Trabl Beam | 238.95 |
| THDXIK 3-Element Beam | 179.95 |
| TH3UJ 3-Element Trabant | 138.95 |
| 184T/WB 10-80 Vertical | 82.95 |
| 144AV/WS 10-80 Vertical | 50.77 |

**CLUCHEANTENNAS**

| A4 New Trabant 10-15 20m | 206.95 |
| A4 New Trabant 10-15 20m | 193.95 |
| A3 New 15-20 Vertical | 41.50 |

**ARK 28 New Ringer Ranger 2m | 34.00 |
| ARK 28 New Ringer Ranger 2m | 75.95 |
| 220B 220 20MHz | 68.95 |
| 248FJ Boymer 144-148 MH | 62.10 |
| 248FB Jr Boymer 144-148 MH | 62.10 |
| AH171 11-Element 2m | 34.50 |
| SHERBOURG HD 1 | 132.95 |

**ALLIANCE HT73 Rotor**

**CDE IVAM H/Y ROTOR**

**CABLE DEGU Foam 95% Shield**

| 8 wire Rotor 2 18 5 32 | 176.39 |
| BUTTHERF H/F-SV113 10-80 Vertical | 85.95 |

**KLM ANTENNAS** (other antennas in stock)

| 160V 160 Meter Vertical | 84.95 |
| K3A4A 4-Element Trabant Beam | 220.75 |
| K3A4A 6-Element Trabant Beam | 469.50 |
| 144-148 13LB 6 Element with balun | 71.95 |
| 144-148 26 6 Element with Oscar | 93.55 |
| 420-450 420-450 MHz 14 Element Beam | 37.54 |
| 420-450 420-450 MHz 14 Element Beam | 58.70 |
| 432 16LB 16 Element 432-434 MHz balun | 60.70 |

**HUSTLER 50V 80-100 Vertical**

**GoV 10-40 Vertical**

| 3TB A New 10-15 20m Beam | 161.95 |

**MF Mobile Receptors**

| Standard | $42.95 |
| Deluxe | $52.95 |
| Gold plate | $150.00 |

- Full range of adjustment in tension and contact spacing.
- Self-adjusting nylon and steel needle bearings.
- Gold plated solid silver contact points.
- Polished lucite paddles.
- Precision-machined, chrome plated brass frames.
- Standard model has black, textured finish base; deluxe model is chrome plated.
- Heavy steel base; non-skid feet.

**Alaska Microwave Labs**

4399 E. 5th Street • Dept. HM

Anchorage, Alaska 99504

(907) 336-0340

<table>
<thead>
<tr>
<th>TRANSISTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MF901</td>
</tr>
<tr>
<td>MF911</td>
</tr>
<tr>
<td>MF980</td>
</tr>
<tr>
<td>NEC 0213</td>
</tr>
<tr>
<td>NEC 0215</td>
</tr>
<tr>
<td>TYPE NF 270 MAG 12DB</td>
</tr>
<tr>
<td>NEC 64535</td>
</tr>
<tr>
<td>NEC 6250D</td>
</tr>
</tbody>
</table>

**HOT CARRIER DIODES**

| MBD101 | UHF-MICRO | $1.50 |
| ND4311 4GHZ | NF 5.7DB | $21.00 |
| NF 1.4GHZ | NF 6.0DB | $2.00 |

**CHIP CAPACITORS**

| APPROX 3 25 50 0 10 | $5.50 |
| APPROX 3 25 50 5 | $6.50 |
| APPROX 3 25 50 06 | $10.50 |

**FEED-THRU CAPACITORS**

| 1000 PFL AMPLIFIER | $6.50 |
| 470 PFL AMPLIFIER | $6.50 |

**DUAL GATE MOSFET**

| RCA 406/3 | GaAs FETS | $1.50 |

| MGF400NF 20DB | 40GHZ MAG 15DB | $28.50 |
| MGF410NF 40DB | 40GHZ MAG 18 DB | $75.00 |

**CHIP RESISTORS**

| SET OF 3/% CHIP RESISTORS FOR | $6.00 |

**COAX CONNECTORS**

| SMA Chassis Mount Square Flange | $6.10 |
| SMA Chassis Mount Square Flange | $8.50 |
| SMA Chassis Mount Strip-lope Tab | $6.75 |
| SMA Plug for RG-58 | $6.75 |
| SMA Plug for RG-174 | $6.75 |
| RG-58 Cable | $3.95 |

**X-BAND COMPONENTS**

| GUIN SOURCE 10.50 48 GHz 10-50MW | $37.00 |
| WR-80 WAVERGUIDE MOUNTING | $39.00 |
| IMPACT SOURCE 10.50 80-100MHZ | $39.00 |
| WR-90 MOUNTING | $30.00 |
| WR-90 MOUNTING | $13.75 |
| WR-90 WAVERGUIDE MOUNTING | $4.00 |

**SILVER PLATING KIT**

| Wrapping Copper Brass Bronze | $30.00 |
| Nickel Tin Pewter Gold and more | $30.00 |
| white metal alloy | $30.00 |

**RF CABLE**

| 141 Semi-rigid Cable Approx. 24 DB | $4.00 |

**PISTON TRIMMERS**

| TRIK 0101M 1.8 ft 3.0 1.8 | $2.50 |

| NO WARRANTY ON SEMI-CONDUCTORS |

**ORDERS ARE POSTAGE PAID**

| COD-VISA-MASTERCHARGE |

Tell ‘em you saw it in HAM RADIO!
Into electronics, computers, or amateur radio?

Choose 6 informative books for only $2.95
(values to $121.65)

7 very good reasons to try Electronics Book Club...

- Reduced Member Prices. Save up to 75% on books sure to increase your know-how.
- Satisfaction Guaranteed. All books returnable within 10 days without obligation.
- Club News Bulletins. All about current selections—main, alternates, extras—plus bonus offers. Comes 14 times a year with dozens of up-to-the-minute titles you can pick from.
- "Automatic Order". Do nothing, and the Main selection will be shipped to you automatically! But...if you want an Alternate selection—or no books at all—we'll follow the instructions you give on the reply form provided with every News Bulletin.
- Continuing Benefits. Get a Dividend Certificate with every book purchased after fulfilling Membership obligation, and qualify for discounts on many other volumes.
- Bonus Specials. Take advantage of sales, events, and added-value promotions.
- Exceptional Quality. All books are first-rate publisher's editions, filled with useful, up-to-the-minute information.

ELECTRONICS BOOK CLUB
Blue Ridge Summit, PA 17214

Please accept my Membership in Electronics Book Club and send the 6 volumes circled below. I understand the cost of the books selected is $2.95 (plus shipping/handling). If not satisfied, I may return the books within ten days without obligation and have my Membership cancelled. I agree to purchase 4 or more books at reduced Club prices during the next 12 months, and may resign any time thereafter.

714 733 841 905 955 1015 1062 1066 1076
1108 1120 1132 1211 1216 1222 1220 1230 1233
1245 1249 1251 1265 1278 1337 1339 8434

Name ___________________________ Phone ___________________________
Address ___________________________
City ___________________________ State ___________ Zip ___________
(Valid for new members only, Foreign and Canada add 20%)

More Details? CHECK — OFF Page 94

October 1981
It's not a lot of Malarkey — it's a ground plane antenna

**junk-box portable antenna**

Antenna experts have a favorite saying: "Vertical antennas radiate equally poorly in all directions." There's some truth in this statement if the ground system is inefficient. However, if you live within a reasonable coax-cable length of a lake or any water more than a wavelength (no pun intended) wide, the vertical antenna described here may be worth a try. It's a low-cost system and can be made of readily available materials. You probably have them in your garage or basement.

**background**

My wife and I have an RV (recreational vehicle). This vacation season we set up the RV right by a lake in Sussex county, Delaware. I had my Ten-Tec OMNI-D and, as usual, a 40-meter dipole antenna to string up in the trees for a little R & R. Things went well.

One day I thought, "Hey, some 10-meter operation would be fun." But that required another antenna. Then it hit me: that lake is nature's ground plane. All I have to do is get 8 feet (2.4 meters) of something to stand up on or in it. Back at home in the garage I had some 1/2-inch thin-wall conduit and some electrical outlet boxes. What could be better!

**the portable vertical**

Take a look at fig. 1. Ugly, right? But it works and works well. And it doesn't cost a bundle. All you need is the material listed in table 1. Collect this stuff, get out your electric drill motor, and heat up your soldering iron. Open a can of beer and you're ready to start.

**construction**

1. Mount set screw connectors to the top and bottom of the electrical outlet box (square or hexagonal).

By John J. Malarkey, W3SMT, 383 Windemere Avenue, Landsdowne, Pennsylvania 19050
2. Mount two Romax fittings to the sides of the outlet box.

3. Insert a 1/2-inch (12.5-mm) diameter wooden dowel 12 to 18 inches long into the Romax fittings; tighten securely. These are handles for screwing the assembly into the ground.

4. Secure a coax connector (SO-239) to a small piece of aluminum plate.

5. Drill a clearance hole (3/16-inch or 5-mm) in the aluminum plate 1/4 inch (6.5 mm) from lower left corner (in and up). This allows the coax-fitting mounting plate to use the existing screw hole that would normally be used for the cover plate and makes the ground connection.

6. Cut a 2-1/2 inch (6.4-cm) wood or plastic dowel (3/4 inch or 19 mm O.D.). This is the center insulator. Insert it into the top screw connector on the outlet box and secure with a setscrew.

7. Install a 1/2-inch setscrew coupler on top of the dowel.

8. Solder one end of a 2-inch (5-cm) piece of No. 12 (2.1 mm) wire to the center contact on the SO-239 coax connector.

9. Install a closed-eye solder lug on the other end of the wire.

10. Bend the lug to pick up the bottom screw on the setscrew coupler. Draw it down to make contact with solder lug and secure the coupler onto the center insulator.

11. Select one of the 10-foot (3-meter) pieces of conduit and, using a pipe cutter, cut a piece 72 inches (183 cm) long. (This length was chosen to make carrying in the trunk of the car easier.)

### Table 1. Materials List for the Junkbox Portable Antenna

<table>
<thead>
<tr>
<th>materials</th>
<th>quantity</th>
<th>use</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-inch outlet box (no cover)</td>
<td>1</td>
<td>to hold antenna and handle</td>
</tr>
<tr>
<td>1/2-inch setscrew connector</td>
<td>2</td>
<td>1 for ground</td>
</tr>
<tr>
<td>Romax connector</td>
<td>2</td>
<td>1 to hold vertical insulator</td>
</tr>
<tr>
<td>wood or metal rod to fit Romax connector, 12-18 inches (30-46 cm)</td>
<td>1</td>
<td>to make handle for coax cable</td>
</tr>
<tr>
<td>SO-239 coax connector</td>
<td>1</td>
<td>to hold SO-239 connector</td>
</tr>
<tr>
<td>small piece of aluminum plate</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2 1/2-inch (6.4 cm) wood or plastic dowel 3/4-inch (2 cm) O.D. to fit 1/2-inch conduit coupler</td>
<td>1</td>
<td>insulator for antenna to connect insulator to vertical element</td>
</tr>
<tr>
<td>1/2-inch conduit coupler</td>
<td>1</td>
<td>center of coax connector to top of conduit coupler</td>
</tr>
<tr>
<td>2-inch (5-cm) length of No. 12 (2.1-mm) wire</td>
<td>1</td>
<td>to make connections</td>
</tr>
<tr>
<td>solder lugs and washers, closed-eye, to fit screws on couplers</td>
<td>1</td>
<td>1 for vertical element 1 to push in mud/sand</td>
</tr>
<tr>
<td>10-foot (3-meter) length 1/2-inch electrical conduit (thin wall)</td>
<td>2</td>
<td>to hold vertical elements together</td>
</tr>
<tr>
<td>1/2-inch compression fitting</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Note: formula: 2808/f in MHz = length of 1/4-wave element in inches (2.54 cm/inch). Materials are for antenna resonant at 28.7 MHz.
12. From the remaining length of this conduit, cut a piece 25.8 inches (65.5 cm) long.

13. Now, from the second 10-foot (3-meter) piece of conduit, cut a piece about 5 feet (1.5 meters) long. Flatten one end to make a point (so it can be pushed into sand or mud). Set it aside.

**on-site assembly**

1. Join the 72-inch (183 cm) and the 25.8-inch (65.5 cm) conduit with a 1/2-inch compression coupler. Set all this aside. This is the vertical element.

2. Attach the 5-foot (1.5-meter) piece to the bottom set screw connector on the outlet box.

3. Push the outlet box with its 5-foot (1.5-meter) piece to the bottom. This is the horizontal element.

4. Put the vertical element, previously assembled in step 1 above, into the top set screw coupler in the outlet box; tighten.

5. Connect 50-ohm coax to SO-239 and to transmitter.

6. Start calling CQ.

**results**

They were great! First contact: VE6CGN in Alberta, Canada. Then HP1XWA, in Panama. The antenna was doing fine. The SWR was 1.2:1 over the phone band. I did not use a tuner at all and ran full output from the OMNI D.

**afterthought**

Late in the evening I remembered I had a piece of metal tape from a broken windup rule. Why not? It turned out that, you guessed it, 35 feet (10.6 meters) was left with the hook end. So I cut it at 32 feet, 4 inches (9.9 meters), drilled a hole in the end (using light pressure, because thin metal will split, then backed it up with wood). I installed two solder lugs (closed-eye) back-to-back. Then I sanded the paint off the end of the rule and attached a solder lug with a machine screw and nut. Next, I put a piece of nylon fish line over a tree limb at the edge of the lake and pulled up the 40-meter vertical. The end with the solder lugs was put under the screw in the setscrew coupler, and the 10-meter element was removed.

**results**

Again, results were great! The VSWR was 1.4:1 over the phone band; plus it also worked on 15 meters.

So give it a try; you'll like it! I have some experiments going on with garden hose — I'll keep you informed.

---

**Call Or Stop-In And See HAL Equipment At Your Favorite Amateur Dealer.**

Write today for HAL's latest RTTY catalog.

HAL COMMUNICATIONS CORP.

Box 365, Urbana, Illinois 61801

217-367-7373
CT2100
HAL Puts MORE Behind The Buttons

Communications Terminal

- 45-1200 Baud RTTY
- 1-100 WPM Morse
- 72 or 36 Character Lines
- Status Indicator on Screen
- Black or White Characters
- Unshift on Space (For Baudot)
- Half or Full Duplex
- Synchronous Idle ("Diddle")
- Auto TX/RX Control

Four Internal RTTY Demodulators
- High Tones (U.S. Standard)
- Low Tones (IARU Standard)
- 103 Modem (1070/1270 Hz)
- 202 Modem (1200/2200 Hz)

Auto Mark-Hold
All 3 RTTY Shifts (High or Low Tones)
Audio or RS232 Data
Transmit and Receive With RTTY Loop Devices
Audio Monitor For Either Input or Output Signals
Internal Speaker Plus External Output

LED Tuning Indicators
- Plus
- On-Screen Tuning Bar
- Plus Ext. Scope Connections

CT2100 System:
- CT2100 Communications Terminal
- KB2100 Keyboard
- Video Monitor
- Printer (300Bd Serial ASCII-MPI-88G)
- RM2100 Rack Adapter
- MSG2100 2000 Character "Brag Tape" ROM

- 24 Line Display
- 2 Pages of 72 Character Lines
- 4 Pages of 36 Character Lines
- Split Screen (with KB2100)

NOW! HAL Equipment is in stock at leading Amateur Dealers.

HAL COMMUNICATIONS CORP.
Box 365
Urbana, Illinois 61801
217-367-7373
The second part in a continuing series designed to help you get that higher ticket

Last month, in the first of our series of articles, we explained some of the topics identified by the FCC as being in the tests for Amateur licenses. That article explained in basic terms such fundamental things as voltage, current, resistance, Ohm's law, inductors, capacitors, and power, and how they are interrelated in some relatively simple dc circuits.

This month we will try out some ac circuit theory involving these same concepts. This is an area of electricity that many people seem to shy away from because of its angles, tangents, cosines, and so forth. But much of this information is quite important if you want to understand how radio circuits actually work. Our engineering friends may turn up their noses at this down-to-earth treatment of a highly complex field of theory, but let's plunge in anyway.

**Inductive Reactance and Impedance**

Our discussions about the inductance of a coil of wire indicated that a counter EMF (CEMF) develops whenever current changes value in an inductor. The CEMF always tries to oppose whatever the current wants to do. If the current tries to increase, the CEMF tries to prevent it. If the current tries to decrease, the CEMF tries to increase it. The resulting opposing, or resisting, effect produced by the CEMF is properly called inductive reactance, symbolized by $X_L$ ($X$ indicates reactance, $L$ indicates inductance). The unit of measurement of $X_L$ is the ohm, usually shown by either a capital Greek letter omega, $\Omega$ (the same as is used for resistance), or by a lower-case omega, $\omega$. We will use $\Omega$ for purely resistive values, and $\omega$ for values having reactance. This should help prevent confusion when we are talking about the various forms of oppositions in electricity.

The formula to determine how much opposing effect that inductive reactance has in ohms is:

$$X_L = 2\pi f L$$

By Robert Shrader, W6BNB, 11911 Barnett Valley Road, Sebastopol, California 95472
If the source of EMF had been shown as a battery or a dc generator, from Ohm's law \( I = E/R \) the current in the circuit would have been \( I = E/R \), or 100/100, or 1 amp. In this case, with dc flowing, \( X_L \) would have no opposing effect, and the load in the circuit would be the resistor alone. What do you think voltmeter \( V_1 \) would read? \( V_2? \) \( V_3? \)

\( V_1 \) would read the 100-volt source voltage. With dc being used, \( V_2 \) is measuring across zero ohms resistance (the coil is assumed to have no \( R \) value) and therefore would read zero volts. And \( V_3 \) would have to read the 100 volts of the source. What power would the circuit be dissipating? (Remember, the basic power formula is \( P = EI \).) Work it out for yourself. \( P = \)_____

This brings up an important point. Since in this case, the coil has dc flowing through it, there is no varying magnetic field around the coil and no CEMF is being developed. There is energy in the coil’s magnetic field, but it is static (meaning stationary). Any energy stored in the static magnetic field will be returned to the circuit when the current is turned off. The only thing dissipating energy (heat in this case) is the resistor. It is dissipating \( P = EI \), or 100(1), or 100 watts of heat.

Now let’s return to the illustration as it is shown, with the source 100 Vac. The load is a 100 \( \omega \) \( X_L \) in series with a 100 \( \Omega \) \( R \), right? So the total opposition to the ac is going to be 100 + 100 = 200 ohms — right? WRONG! It will be only 141.4 \( \omega \). Where did that value come from? Let’s see.

Resistance is a true and constant opposition under essentially any conditions. We can draw a horizontal vector arrow representing 100 \( \Omega \) resistance and label it \( R \), as shown in fig. 2. The reactance of the coil does not oppose the flow of current by 180 degrees as the reactance does, but it opposes the current at exactly 90 degrees. Therefore, we draw the oppo-

---

**fig. 1.** Ac circuit with inductive reactance and resistance in series as the load.

where \( X_L = \) inductive reactance in ohms, \( \omega \)

\[
\pi = 3.1416
\]

\[
f = \text{frequency in hertz, Hz}
\]

\[
L = \text{inductance in henrys, } H
\]

As an example, the inductive reactance of a 2.5-henry coil to 1000-Hz ac is \( X_L = 2\pi fL \), or (6.28) (1000) (2.5), or 15,500 \( \omega \). Can you see from this formula that the same inductor (coil) will have twice the reactance at twice the frequency because \( X_L \) is directly proportional to \( f \)? A resistor, on the other hand, has the same resistance value regardless of the frequency of the ac, or even if dc is used with it.

In a resistor, the current that flows through it varies in phase (in step) with any voltage change occurring across the resistor. If the voltage increases across a resistor, the current increases proportionally. In a coil, which has inductive reactance, the voltage of an alternating current passing through the inductor can, of course, be plotted (with respect to time) as a sine curve. The current passing through the coil can also be plotted (with respect to time) as a sine curve. It will be found that, if the two curves are compared on the same graph, the sine curve representing the current will lag 90 degrees behind that representing the voltage. We can consider this to be caused by the building up of the magnetic field around the coil, and by the counter-EMF developed in the coil.

Let’s see what we can find out about the ac circuit shown in fig. 1. An ac generator or alternator (the circle with a one-cycle sine wave in it) feeds a circuit composed of \( X_L \) in series with an \( R \). Since this is a series circuit, the same current flows in all parts of the circuit, so only one ammeter is needed. The three voltmeters measure all possible voltages in the circuit.
tion of the $X_L$ at an angle of 90 degrees from the resistance, at right angles, or upward. By drawing dotted lines parallel to both the $R$ and $X_L$ vector arrows, the resultant opposition of $R$ plus $X_L$ will be that shown by the dashed vector arrow labeled $Z$. This resultant opposition is called the impedance, $Z$, of the circuit, and has a value of 141.4 $\omega$. (We use $\omega$ for ohms because part of the opposition is reactive.) How did we get the 141.4 $\Omega$ value? Well, you could lay out the vector arrows to scale on a piece of graph paper and measure the impedance value with a metric ruler, which is probably the simplest but least accurate way of doing it.

A second method is to use the Pythagorean theorem for right-angled triangles, which says that the square of the $Z$ side of this right-angled triangle (made up of the $R$, the $Z$, and the dotted $X_L$ side) is equal to the sum of the squares of the $R$ and $X_L$ sides. As a formula this is expressed as:

$$Z^2 = R^2 + X_L^2$$

Or, in our particular circuit:

$$Z^2 = 100^2 + 100^2$$
$$Z^2 = 100,000 + 10,000$$

Solving for $Z$ (taking the square root of both sides of the equation),

$$Z^2 = 20,000$$
$$Z = 141.4$$

The complete formula to find impedance is therefore:

$$Z = \sqrt{R^2 + X_L^2}$$

Here is a problem to try. The answer is at the end of the article. **Problem 1**: What would be the impedance of a series ac circuit having $R = 80\Omega$, $X_L = 40\omega$? Answer _______.

A third way you might find the impedance is to first determine the phase angle (how many degrees the $I$ lags or leads the $E$ in a reactive circuit). The phase angle, usually shown as the Greek letter theta, or $\Theta$, is the angle developed at the meeting point of sides $R$ and $Z$. In our circuit, with $R = 100$ and $X = 100$, and being at right angles or 90 degrees, the $R-Z$ angle must be half of 90 degrees, or 45 degrees. Thus, the phase angle, or $\Theta$, for this circuit is 45 degrees.

However, when $R$ and $X$ are not equal, we must find $\Theta$ some other way. One way is to use a protractor to measure the angle if you graph the problem. The tangent ($\tan$) ratio of our triangle, which is the ratio of the $X$ side to the $R$ side, or $X/R$, can be used to find $\Theta$ very accurately. $\tan\Theta$ in our case is $X/R$, or 100/100, or 1.0000. Refer to table 1, which shows a few selected tangent and cosine ratio values and their angles. By searching through the table you will find that, when $\tan\Theta = 1.0000$, $\Theta = 45$ degrees. (With one type of electronic calculator, enter the tangent value of 1.000, then punch in ARC, then TAN, and it should show 45 degrees. However, your calculator may use a different method of determining tangents.)

Now that we know the phase angle (how many degrees the current lags behind the voltage in an inductive circuit), what about the impedance value? Whereas the tangent ratio of the $RXZ$ triangle is $X/R$, the cosine ratio is $R/Z$. This cosine ratio is handy for us because it includes not only the $R$ and $\Theta$ values, which we know, but also the $Z$ value, which we want to know. Using the cosine ratio we can determine the $Z$ value with the information we now have. The cosine (cos) formula is

$$\cos \Theta = \frac{R}{Z}$$

From the table you can find that cos 45 degrees is equal to 0.707. By plugging the known information into the cos formula we get

$$\cos \Theta = \frac{R}{Z}$$
$$0.707 = \frac{100}{Z}$$

If you have not been doing much math lately, let's try solving for the unknown value ($Z$) of this equation by using the cheap and dirty method of cross multiplying and then dividing out the unwanted to find what

<table>
<thead>
<tr>
<th>angle (degrees)</th>
<th>tan</th>
<th>cos</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td>5</td>
<td>0.0875</td>
<td>0.9962</td>
</tr>
<tr>
<td>10</td>
<td>0.1763</td>
<td>0.9848</td>
</tr>
<tr>
<td>15</td>
<td>0.2678</td>
<td>0.9659</td>
</tr>
<tr>
<td>20</td>
<td>0.3640</td>
<td>0.9397</td>
</tr>
<tr>
<td>25</td>
<td>0.4663</td>
<td>0.9063</td>
</tr>
<tr>
<td>30</td>
<td>0.5774</td>
<td>0.8660</td>
</tr>
<tr>
<td>36.87</td>
<td>0.7500</td>
<td>0.8000</td>
</tr>
<tr>
<td>39.8</td>
<td>0.8333</td>
<td>0.7682</td>
</tr>
<tr>
<td>40</td>
<td>0.8381</td>
<td>0.7660</td>
</tr>
<tr>
<td>45</td>
<td>1.0000</td>
<td>0.7071</td>
</tr>
<tr>
<td>50</td>
<td>1.1918</td>
<td>0.6428</td>
</tr>
<tr>
<td>55</td>
<td>1.4281</td>
<td>0.5736</td>
</tr>
<tr>
<td>60</td>
<td>1.7321</td>
<td>0.5000</td>
</tr>
<tr>
<td>65</td>
<td>2.1445</td>
<td>0.4226</td>
</tr>
<tr>
<td>70</td>
<td>2.7475</td>
<td>0.3420</td>
</tr>
<tr>
<td>75</td>
<td>3.7321</td>
<td>0.2598</td>
</tr>
<tr>
<td>80</td>
<td>5.6713</td>
<td>0.1737</td>
</tr>
<tr>
<td>85</td>
<td>11.430</td>
<td>0.0872</td>
</tr>
<tr>
<td>89</td>
<td>57.290</td>
<td>0.0175</td>
</tr>
<tr>
<td>90</td>
<td>Infinite</td>
<td>0.0000</td>
</tr>
</tbody>
</table>
Z equals. In this case
\[ \frac{0.707}{1} = \frac{100}{Z} \]

Now, by cross multiplying top and bottom values we get the relatively straightforward equation
\[ 0.707(Z) = 100(1) \quad \text{or} \quad 0.707Z = 100 \]

To find the Z value, divide out from both sides of the equation the unwanted information on the left side, giving us
\[ \frac{0.707Z}{0.707} = \frac{100}{0.707} \]

This leaves
\[ Z = \frac{100}{0.707} \]
\[ Z = 141.4 \, \Omega \]

Incidentally, the sine \( \Theta = X/Z \) formula shown in fig. 2 could also have been used to solve for Z if sine tables are used. These three trigonometry formulas, tangent, cosine, and sine (sin), are very handy in ac circuit computations.

How about trying to solve an impedance problem on your own? Problem 2: What is the Z of the series circuit shown in fig. 3? \( \tan \Theta = \frac{X}{Z} \) \( \cos \Theta = \frac{Z}{X} \) or \( X = \frac{Z}{\cos \Theta} \)

Of course, it is possible to compute ac circuits of this type if only the inductance in henrys and the resistance are given. You would have to first convert the inductance value to inductive reactance. The frequency of the ac would also have to be known to find the \( L \) value. You would be surprised what you can do with these ac circuits if you list what values you know, and then consider filling in the information into one or more of the formulas that you know. You can find voltage-drops across components (with Ohm’s law), currents, phase angles, impedances, reactances, power values, and so on, provided you understand the relatively few facts we have discussed so far. This doesn’t mean that ac circuits can’t become extremely complicated. They can!

**Capacitive reactance and impedance**

In fig. 4, a series ac circuit is shown using a capacitor in place of the inductor of fig. 1. If the capacitor has very little capacitance, only a small current can be driven back and forth through the resistor with a given ac voltage. If the capacitor is larger it can be charged and discharged with more electrons and the ac charging current that would now flow through the resistor will increase. Thus a capacitor must have both an ac conducting and an opposing effect, or reactance. Capacitive reactance, \( X_C \), opposes ac somewhat like resistance does, but it is not the same as resistance.

To determine just how much opposing effect, in ohms, a capacitor will have in an ac circuit, use the formula
\[ X_C = \frac{1}{2\pi fC} \]

where \( X_C \) = capacitive reactance in ohms, \( \omega \)
\[ \pi = 3.1416 \]
\[ f = \text{frequency in hertz, Hz} \]
\[ C = \text{capacitance in farads, F} \]

As an example, what reactance does a capacitor of 0.01-μF have to a 7 MHz ac?
\[ X_C = \frac{1}{2\pi fC} \]
\[ X_C = \frac{1}{6.28(7,000,000)(0.00000001)} \]
\[ X_C = \frac{1}{0.4396} \]
\[ X_C = 2.27 \, \Omega \]

Can you see that a 0.01-μF capacitor acts as a pretty good conductor of ac at 7 MHz, which is one edge of the 40-meter Amateur band? A 0.001-μF capacitor would have only 22.7 Ω. Thus, to couple rf ac from one circuit to another, capacitors make very good coupling devices. Capacitors may couple ac, but they will stop dc current completely. However, if the dc is varying, a capacitor will pass the varying part, or ac component, and block the dc component. Note that the same capacitor used on the 3.5-MHz Amateur band will have twice the reactance that it would have at 7 MHz, because \( X_C \) is inversely proportional to frequency.

In a resistor the current through it and the voltage-drop across it are always in phase. As mentioned pre-
vously, an inductor always has its current lagging behind the circuit voltage by 90 degrees. A capacitor always has its current leading the circuit voltage by 90 degrees. These reactive phase shifts are important in the operation of ac circuits. For one thing, it is possible to add capacitance to an inductive-resistive circuit to reduce a phase lag of the current caused by the inductance.

What would be the phase angle, the impedance, the current, and the voltage drops in the fig. 4 circuit? We can apply exactly the same computing ideas to a capacitively reactive circuit as we did with the inductively reactive circuit before. The phase angle (the number of degrees by which the current leads the voltage) may be found by \( \tan \Theta = X/R \), or in this case \( \tan \Theta = 30/40 \), or 0.750. From the table, the angle \( \Theta \) is 36.87 degrees.

Knowing \( \Theta = 36.87 \) degrees, then \( \cos \Theta = R/Z \), and by cross multiplying, \( Z = R / \cos \Theta \). In this case, from the table of cosine values, \( \cos 36.87 \) degrees = 0.8000, or \( Z = 40/0.8000 \), or \( Z = 50 \) \( \Omega \).

If \( Z = 50 \) \( \Omega \) and the effective source voltage, \( E_s \), is 100 volts we can make the dc Ohm's law formulas work for ac circuits by substituting \( Z \) for \( R \). Thus, \( I = E/Z \), or \( E = IZ \), or \( Z = E/I \). In our circuit, \( I = E/Z \), or \( 100/50 \), or 2 amps flows through the capacitor and the resistor. (Actually, electrons do not flow through a capacitor, but it charges and discharges through the resistor, allowing current to flow through the resistor and the ac source.)

There is an interesting thing about computing power in ac circuits. If we have a 2-amp current flowing in the fig. 4 circuit and a source voltage of \( E_s = 100 \) volts, then from the power formula \( P = EI \) we would expect to have 100(2), or 200 watts being dissipated. But a wattmeter in this circuit would show only 160 watts! The 200 value from a voltmeter and an ammeter is called the reactive power, or the volt-amperes (\( VA \)) of the circuit. The true power, that amount of energy actually lost by the circuit, is what the resistor alone is dissipating. (Remember, the reactor does not lose energy. It may store energy, but it returns it all to the circuit when the current is turned off.) The true power can be found by \( P = E_I_R \), or by \( P = I^2_R \), or by \( P = E_s^2/R \). Since we do not know the voltage across the resistor at this time, we can use the formula \( P = I^2R \), or \( 22(40) \), or 160 watts. So, for this circuit the reactive power is 200 \( VA \), and the true power is 160 watts. Note that a wattmeter always indicates true power, and that the formula \( P = I^2R \) always tell us the true power.

The ratio of true power (\( P \)) to volt-amperes (\( VA \)) is known as the power factor of the circuit. In our circuit of fig. 4, the power factor (\( pf \)) is \( P/VA \), or 160/200, or 0.8000. You can express a pf of 0.8000 as a pf of 80 percent by moving the decimal point over two places and adding the percent sign. You will also find that the power factor is always equal to the cosine of the phase angle (\( \cos \Theta = pf \)). For our circuit, the pf is 0.8000, the cosine of \( \Theta \) is 0.8000, and from the table, \( \Theta = 36.87 \) degrees as determined previously.

In our circuit, if a 2-amp current flows through a \( 30 \) \( \Omega \) \( X_C \), the voltage-drop across \( X_C \) by Ohm's law, but using reactance in place of resistance, is \( E = I X_C \), or 2(30), or 60 volts. The voltage-drop across the \( R \) will be \( E = I R \), or 2(40), or 80 volts. Note that the simple sum of the vector voltages across \( X_C \) and \( R \) add up to more than the source voltage. That is, \( E_{x_c} = 60 \) volts, and \( E_r = 80 \) volts, for what appears to be a total of 140 volts. But if we try plotting these two voltages as vectors at right angles as we did with \( X_C \) and \( R \), we will find that the resultant vector, which represents the source voltage, will be exactly 100 volts, as it should be.

Suppose we have a circuit with \( X_L \), \( X_C \), and \( R \) all in series, as in fig. 5. The reactances are graphed as before, \( X_L \) upward, \( X_C \) downward, and \( R \) to the right. Can you see that the \( 50 \) \( \Omega \) \( X_L \) is cancelling 50 of the 75 \( \Omega \) of \( X_C \), resulting in a total of only 25 \( \Omega \) of effective reactance (capacitive) for the circuit? To determine the impedance of this series circuit we would use the values of 30 \( \Omega \) of \( R \), and the resultant value of 25 \( \Omega \) of \( X_C \). To check your understanding try Problem 3: With \( X_C = 25 \) \( \Omega \) and \( R = 30 \) \( \Omega \), what is tan \( \Theta \)? ____ \( \Theta \)? ____ \( \cos \Theta \)? ____ \( Z \)? ____ \( \Omega \)? ____ \( E_s \)? ____ \( E_x \)? ____ \( P? \) ____ Does \( I \) lag or lead?____

**Series and parallel circuits**

When two resistors are connected in series, as in fig. 6A, the total resistance is simply the sum of the two resistors, or \( R_t = R_1 + R_2 \). But if the two resistors are in parallel as in B, they form a better conductor (less resistance) than either one alone. There are
two formulas given which produce the proper total resistance of two parallel resistors. These are

\[ R_t = \frac{R_1 R_2}{R_1 + R_2} \text{ and } R_t = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} \]

If \( R_1 \) is 100 \( \Omega \) and \( R_2 \) is 100 \( \Omega \), what will the total resistance be? Try working this out with both formulas and see if you don’t come up with 50 \( \Omega \) in each case. What if there are more than two resistors in parallel? Well, if there are three, then compute two of them in parallel and use this answer to compute the third resistor in parallel. If there are four in parallel compute the first three and use this answer along with the fourth in parallel.

When two inductors are connected in series as in fig. 6C, the total inductance in henrys is the simple sum of the two inductors. Similar to resistors, two parallel inductors, as in D, can be computed with the same two parallel component formulas, substituting \( L_s \) for \( R_s \) in the formulas.

When two capacitors are connected in series, as in fig. 6E, between the top of the circuit and bottom there is now a greater dielectric separation than for either capacitor alone, and therefore less capacitance. So we cannot use the simple addition of capacitances, but must use the parallel resistor type formulas for capacitors in series, or

\[ C_t = \frac{C_1 C_2}{C_1 + C_2} \text{ or } \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}} \]

When two capacitors are connected in parallel, as in F, the total capacitance is the simple sum of the two capacitors, or \( C_t = C_1 + C_2 \).

In fig. 7 we have the same circuit configurations but this time the components are labeled in resistance, inductive reactance, and capacitive reactance. Now, all oppositions, resistance and reactances, if in series, are found by simply adding the component values. Similarly, when in parallel you use the parallel resistance type formulas to determine the total oppositions, substituting \( X_s \) for \( R_s \).

In fig. 8A, the circuit is shown with resistance, inductance, and capacitance values given. To compute the circuit parameters (values) it is necessary to first convert the \( L \) value to an \( X_L \) value, using the given frequency and the formula \( X_L = 2\pi fL \). The capacitance must similarly be converted to \( X_C \) by the formula \( X_C = \frac{1}{2\pi fC} \) (using farads, not the \( \mu F \) value that is given). The impedance of such a series RLC circuit is computed as explained in the previous section. In this case the \( Z \) value is computed as 200 \( \Omega R \) and 796 \( \omega X_C \) minus 314 \( \omega X_L \), or as 200 \( \Omega R \) and 482 \( \omega X_C \), or \( Z = \sqrt{200^2 + 482^2} \), or 521.8 \( \Omega \).

The circuit in fig. 9 shows a resistance and an inductive reactance in parallel. There are a variety of
fig. 8. (A) Series RLC circuit must be converted to (B) R, X_L, and X_C values to compute it, using the given frequency.

fig. 9. Parallel R and X_L circuit, labeled in ohms and in siemens.

ways of computing the impedance of such a circuit. We will discuss only one of them. We cannot use the series-type impedance formula \( Z = \sqrt{R^2 + X^2} \) unless we use reciprocal values in it. \( 1/R \) is the reciprocal of \( R \), called conductance, symbolized \( G \). \( 1/X \) is the reciprocal of \( X \), called susceptance, \( B \). \( 1/Z \) is the reciprocal of \( Z \), called admittance, \( Y \). The unit of measurement of these reciprocal values is either mho (reverse spelling of ohm), or siemen, \( S \). So, to solve a parallel RX circuit as fig. 9, the basic formula would be

\[
\frac{1}{Z} = \sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{X}\right)^2} \quad \text{or} \quad Y = \sqrt{G^2 + B^2}
\]

Substitute the values given in fig. 9 into the second formula, and check these steps:

\[
Y = \sqrt{0.04^2 + 0.03^2} = \sqrt{0.0016 + 0.0009} = \sqrt{0.0025} = 0.05 S
\]

\[
Z = \frac{1}{Y} = \frac{1}{0.05} = 20 \Omega
\]

Note that in any simple \( R \) and \( X \) parallel circuit the total \( Z \) will always be less than either of the \( R \) or \( X \) component values. As you might expect, a parallel \( R \) and \( X_C \) would be solved in exactly the same way as a parallel \( R \) and \( X_L \). In the inductive circuit the phase angle of the source current would be lagging, in the capacitive case the current would be leading, but not by 90 degrees.

If a capacitor is added across a parallel \( R \) and \( X_L \) circuit, as in fig. 10, we have a parallel RLC circuit. Since the \( B_C \) and \( B_L \) values would plot 180 degrees apart (as their \( X_C \) and \( X_L \) values do), the total susceptance, or \( B \), will be equal to the smaller susceptance subtracted from the larger. (Do not subtract \( X_C \) from \( X_L \) in parallel circuit computations!) In our problem, the formula is expanded to subtract \( B_L \) from \( B_C \), and is worked as shown. Can you follow each step?

\[
Y = \sqrt{(0.04)^2 + (0.05 - 0.02)^2} = \sqrt{0.0016 + 0.0009} = \sqrt{0.0025} = 0.05 S
\]

\[
Z = \frac{1}{Y} = \frac{1}{0.05} = 20 \Omega
\]

If you think about it a little, you will see that if \( X_C \) and \( X_L \) happened to be equal in fig. 10, then \( B_C \) and \( B_L \) will be equal and would cancel each other completely, resulting in a reactance value of zero. Such a circuit is said to be parallel resonant, which we will discuss later. The total impedance would then be the
resistance value only, or $Z = 25 \, \Omega$, not $25 \, \Omega$, because now the source sees a circuit that is exhibiting no reactive effects at all.

**impedance matching**

One of the most important requirements when operating rf ac power equipment is to match the impedance of the load to the internal impedance of the source. Consider the circuit shown in fig. 11. Here a load impedance (resistor $Z_L$) is coupled across an ac source ($Z_s$). Assume that the source produces 100 volts and has an internal impedance of 50 $\Omega$ (or 50 $\Omega$). Using a $Z_L$ of 50 $\Omega$ to match the source impedance, the current through the load will be

$$I = \frac{E}{Z} = \frac{100}{(50 + 50)} = 1 \text{ amp}$$

The simplest means of determining the power dissipated in the load would be by

$$P = I^2R = I^2(50) = 50 \text{ watts}$$

Incidentally, the power dissipated in the source would also be 50 watts, and the whole circuit would be 50 percent efficient.

If the load resistance is doubled, to 100 $\Omega$, the impedances mismatch. The circuit current would now be $I = \frac{E}{Z}$, or $100/(150 + 100)$, or 0.66 amp. Now, the power output, or that dissipated in the load resistor, would be $P = I^2R$, or 0.66$^2$(100), or 0.436(100), or 43 watts. The power dissipated in the source would be 0.436(50), or 21.5 watts. The efficiency is 43/64.5, or 66 percent. The efficiency may be higher, but the power output into the load is lower.

If the load resistance is halved, to 25 $\Omega$, the impedances again mismatch. The circuit current would now be $I = \frac{E}{Z}$, or $100/(50 + 25)$, or 1.33 amps. The power output in the load would now be $P = I^2R$, or 1.33$^2$(25), or 1.77(25), or 44.25 watts. Again the power output is less than when the impedances matched. The power dissipated in the source is now $P = I^2R$, or 1.33$^2$(50), or 1.77(50), or 88.5 watts. With this mismatch the efficiency is only 44.25/132.75, or 33 percent. So, if you have a transmitter with 50 $\Omega$ output circuit you had better be sure that the antenna you couple to it also has an impedance as close to 50 $\Omega$ as it is possible to arrange. This way you will get maximum power into your antenna.

Transformers can be used to match impedances, particularly in audio frequency ac circuits. If a transformer has a primary with 100 turns and a secondary with 300 turns, it will step up any ac voltage applied to it by three times (may be shown as either a 1:3 or 3:1 ratio). If 2 volts ac is applied to the primary, the secondary voltage should be 6 volts. If a transformer is used to match impedances, a 1:3 transformer will convert the primary impedance by a factor equal to the turns ratio squared. Thus a 1:3 turns ratio allows the transformer to convert the output or secondary impedance to $3^2$, or to 9 times the impedance of the primary. Formulas that may be used are

$$\left(\frac{T_P}{T_S}\right)^2 = \frac{T_P}{T_S} = \frac{Z_P}{Z_S}$$

These formulas say that the turns ratio squared equals the impedance ratio, or the turns ratio equals the square root of the impedance ratio. As an example, you want to match a 30 $\Omega$ transistor output circuit to a 4 $\Omega$ loudspeaker, fig. 12. What ratio transformer should you use? With the second formula, if the impedance ratio is 30/4, or 7.5:1, the turns ratio must be equal to the square root of 7.5 (or $\sqrt{7.5}$), or 2.74:1. Actually, either a 2:1 or a 3:1 turns ratio transformer would operate quite satisfactorily, with the 2:1 possibly sounding a little better, although somewhat weaker. The higher the load impedance the less audio distortion that may be produced.

With air-core radio-frequency transformers, impedance matching is usually controlled by the degree of primary-to-secondary coupling. The tighter the coupling the lower the impedance reflected back into the primary circuit.

**series and parallel resonance**

Whenever the $X_C$ of an ac circuit matches the $X_L$ in series with it, a condition of resonance occurs. If the capacitor and coil are in series the circuit is said to be resonant, or series resonant, fig. 13A. If the capacitor and coil are in parallel the circuit is said to be anti-resonant, or parallel resonant, fig. 12B. These two resonant type circuits do not behave the same in any way.

In a series resonant circuit, as in fig. 13A, the two reactances completely cancel the reactance effects of each other. In any series circuit there is only one current. In the series resonant circuit the $X_C$ voltage
will lag the current by 90 degrees, and the $X_L$ voltage will lead the current by 90 degrees. These two equal but opposite voltages (180 degrees out of phase) cancel, leaving the source looking at a zero voltage-drop load, or a short circuit. A series resonant circuit acts as an impedance of zero ohms, and if there is no resistance in the line the ammeter and the source might burn up.

In an anti-resonant, or parallel resonant, circuit, as in fig. 13B, the two reactances cancel each other in another way. Since the current lags in an inductor and the current leads in a capacitor, at anti-resonance there is one voltage across the circuit, with equal but opposite currents in the two reactances. A 90-degree current lag + a 90-degree current lead means the two currents are 180 degrees out of phase. If the current flows up in the inductor and an equal current flows down in the capacitor, there is zero current demand from the source. The source sees the circuit as no load at all, or as infinite impedance ($Z = \infty \Omega$, since the reactances cancel). The ac current circulates back and forth between the $L$ and $C$, but the source is required to produce no further current once the current starts oscillating back and forth in the $LC$ circuit at the $LC$ circuit's resonant frequency. The ammeter would read zero amperes once the $LC$ circuit current starts oscillating. If there were any resistance anywhere in the $LC$ circuit there would be a $P = IR$ loss in the resistance, and the meter would read the current value needed to support this power loss. Also, if a secondary coil is coupled to the inductor of the $LC$ circuit and the secondary has a resistance load on it, this load will reflect back a resistance effect into the $LC$ circuit coil, and the ammeter will read higher. The tighter the coupling the higher the ammeter will read, and the greater the power output, until the reflected resistance value drops below the source impedance value. This would represent overcoupling, an impedance mismatch, and less power output.

There is a very significant point about oscillating $LC$ circuits. If there is no resistance in them, once they start oscillating theoretically you can disconnect the source and the $LC$ current will continue to oscillate indefinitely. Of course there is no such thing as a resistance-free circuit. The more resistance in the $LC$ circuit the faster the amplitude (strength) of the oscillating current will damp (die) out. This ability to maintain an oscillation in an $LC$ circuit is known as flywheel effect. It is the basis of operation of all oscillator circuits using $LC$ circuits and determines their frequency of operation.

Most resonant circuits in radio have either the $L$ or the $C$ made variable so that the reactances can be made to be equal at some desired frequency of operation.

The basic formula of oscillation for any resonant or anti-resonant circuit is:

$$X_C = X_L \quad \text{or} \quad \frac{1}{2\pi f C} = 2\pi f L$$

From the second form of the formula we can algebraically rearrange the symbols to develop formulas to tell us, for example, what capacitance is needed to match a given inductance for a certain frequency of operation. These formulas are:

$$f = \frac{1}{2\pi \sqrt{LC}}$$
$$C = \frac{1}{(2\pi f)^2 L}$$
$$L = \frac{1}{(2\pi f)^2 C}$$

where $f = \text{frequency in hertz, Hz}$
$C = \text{capacitance in farads, F}$
$L = \text{inductance in henrys, H}$

For example, if you have a known value coil and known value capacitor and you connect them in parallel (or series), use the first formula to determine the
frequency at which they will be anti-resonant (or resonant).

If you have a known value of inductance and you want to know what value of capacitance is required to bring such an LC circuit to resonance at a given frequency, use the second formula.

If you have a known value of capacitance and you want to know what value of inductance to use with it to make it oscillate at a desired frequency, use the third formula.

Before we start wrestling with very big and very small numbers, let's make sure you understand powers of 10. For example:

\[ 1 \times 10^1 = 10 \]
\[ 1 \times 10^2 = 100 \]
\[ 1 \times 10^3 = 1,000 \]
\[ 1 \times 10^4 = 1,000,000 \]
\[ 1 \times 10^9 = 1,000,000,000 \]
\[ 1 \times 10^{12} = 1,000,000,000,000 \]

In other words, the power (number) attached to the 10 indicates how many zeros to add after a 1. Thus, 3 x 10^6 means 3 x 1,000,000, or 3,000,000. Also, 4,250 can be expressed as 4.25 x 10^3.

We can also use powers of 10 to express small numbers:

\[ 1 \times 10^{-1} = 0.1 \text{ (one tenth)} \]
\[ 1 \times 10^{-2} = 0.01 \text{ (one hundredth)} \]
\[ 1 \times 10^{-3} = 0.001 \text{ (one thousandth, m)} \]
\[ 1 \times 10^{-6} = 0.000 001 \text{ (one millionth, µ)} \]
\[ 1 \times 10^{-9} = 0.000 000 001 \text{ (one billionth, n)} \]
\[ 1 \times 10^{-12} = 0.000 000 000 001 \text{ (one trillionth, p)} \]

A negative power (such as 10^{-3}) indicates how many decimal places to put in front of a number. Thus, 3 x 10^{-6} means 3 x 1 x 10^{-6}, or 3 x 0.000 001, or 0.000 003, which is three one-millionths. Also, 7.35 x 10^{-4} can be expressed as 0.000 735 by moving the decimal point over four places and inserting the necessary zeros. Note that 10^{3} indicates unity, or 1.

Just for fun, let's see if we can engineer a coil and capacitor LC circuit that will resonate at 4 MHz, which is one edge of the 80-meter Amateur band. Assume we have a 50-pF capacitor to start with. What inductance coil do we need? Using the third formula, and plugging in the given values,

\[ L = \frac{1}{(2\pi f)^2 C} \]
\[ L = \frac{1}{[2(3.14)(4 \times 10^6)]^2 (0.000 000 000 05)} \]
\[ L = \frac{1}{(2.5 \times 10^{14})(5 \times 10^{-11})} \]
\[ \text{(Now subtract } 10^{-11} \text{ from } 10^{14} \text{ = } 10^3) \]

\[ L = \frac{1}{3.155 \times 10^3} = \frac{1}{31550} \]

\[ L = 0.000 0317 H \text{ or } 31.7 \mu H \]

A difficulty with LC circuits is all of the stray resistances and capacitances that may occur in circuits. These can degrade the operation of a resonant circuit. For one thing, all wires have some resistance, and as a result the Q of LC circuits tends to be lowered. Q can be thought of as meaning quality. A coil with little resistance is essentially all inductance and no resistance. Its quality as an inductor is high. Q can be determined by

\[ Q = \frac{X_L}{R} \text{ or } Q = \frac{2\pi fL}{R} \]

From the second formula form it would be assumed that as frequency (f) increases the Q would also increase. However, when ac current flows in a wire the CEMF tends to force electrons to flow less in the center of the wire and more on the outer surface, or skin, of the wire. Constricting the usable volume of a wire makes the wire appear to be smaller to the ac current, and the wire exhibits greater resistance to the current flow. This is called skin effect. Skin effect increases the R value in the Q formula, tending to lower the Q at higher frequencies.

Since capacitors have very little wire associated with them they tend to have high Q, even though the Q of a capacitor can be computed by the formula

\[ Q = \frac{X_C}{R} \text{ also. In an LC circuit the Q is usually assumed to be essentially that of the coil. However, when loaded (ac power coupled out of it), an LC circuit's Q lowers. A high-Q rf LC circuit in a radio receiver, for example, may have a Q value of perhaps 100 or more. If loaded normally, the working Q of a transmitter amplifier LC circuit may range from perhaps 8 to 15. If overcoupled the Q may drop below the value of 8. Adding resistance in series with either the capacitor or the inductor of an LC circuit, or across the circuit, will lower the circuit's Q.} \]

Consider an LC circuit connected across an ac source whose output ac frequency is variable from a low frequency to a very high frequency, fig. 14. At a low frequency the reactance of the coil would be very low. As a result, the voltage developed across the LC circuit would be very small. Most of the ac voltage would be dropped across resistor R. At a very high frequency, the reactance of the capacitor would be very low, and again the voltage across the LC circuit would be very small. However, at some intermediate frequency, where \( X_L \) equals \( X_C \), the two reactances cancel to form a nearly infinite impedance, resulting in maximum voltage-drop across the LC circuit and none across R. When this is graphed we see a peaked resonance curve, with the LC circuit voltage (or current) peak occurring at the frequency
An application of a resonant LC circuit is shown in fig. 15. An antenna wire is connected to a coil and the bottom of the coil is "grounded" to a water pipe or a pipe driven into the earth. Coupled to this antenna coil is the inductor of a tuned LC circuit. The LC circuit in this case has a variable capacitor to enable the resonant frequency to be changed, or "tuned." (A fixed capacitor with a variable inductor might also have been used.) There are two different frequency radio waves shown crossing the antenna and inducing two different frequencies of ac into it. If the LC circuit is made resonant to 7 MHz, the receiver will receive maximum response at this frequency, and will tend to attenuate (decrease) the response to the 7.2-MHz signal. If the capacitance is lessened so that the resonant frequency of the LC circuit is raised to 7.2 MHz, this frequency will produce maximum signal for the receiver and the 7 MHz signal will now be attenuated. The basic idea of a radio receiver is to use tuned LC circuits to select which frequency is to be received. The higher the Q of the LC circuit the narrower the bandwidth or the more selective the LC circuit and the receiver will be. Bandwidth is usually measured from the low frequency half-power point on the resonant curve, through resonance, to the half-power point on the high frequency half of the curve.

The bandwidth of an LC circuit is determined by $Q$, in the ratio

$$BW = \frac{f_0}{Q}$$

where $BW$ = half-power point frequencies (in Hz, kHz, or MHz)

$f_0$ = resonant frequency (in same units)

In general, the higher the frequency of resonance the wider the bandwidth that LC circuits will have. The LC circuits of 28-MHz Amateur band circuits will have much wider bandwidths than 3.5-MHz band cir-
circuits. It will be harder to tune out nearby frequencies on the higher frequency bands.

filter circuits

While most ac signal generators generate only a single frequency at one time, there are some special devices that can generate what is called white noise. This term denotes the production of a broad spectrum of frequencies all at the same time, from a few hertz to hundreds of megahertz. If a white-noise generator’s output is fed through an L-type (from its L shape) lowpass filter, fig. 16A, only the low frequencies will pass through, and the high frequencies will be attenuated as indicated by the curve of fig. 16B. The circuit of this LP filter can be analyzed as having the \( X_L \) passing low frequencies (low reactance to them) to the load resistor, and opposing or attenuating higher frequencies. The \( X_C \) has almost no shunting (shorting) effect on low frequencies, but acts as a shunt or short circuit across the circuit for high frequencies. The larger the \( L \) and \( C \) values used the lower the frequency that the knee of the response curve will have. For audio frequency work, iron-core inductors are used.

If the positions of the \( L \) and \( C \) are reversed, as in fig. 17A, and a second inductance is added, a \( \pi \)-type (from its \( \pi \) shape) highpass filter results. The drop-off past the knee of the curve is much steeper (B) with the added component. In fact, the more components used in filters the steeper the skirts become.

Another form that filters take is the T type (from their component configuration), fig. 18. This is also a highpass filter, and can have characteristics similar to those of the filter in fig. 17.

Two resonant circuits connected as shown in fig. 19A produce a band stop filter. If both are tuned to the same frequency, 6 MHz for example, \( XL_1XC_1 \) acts as an infinite impedance to this frequency and almost none of this frequency can pass through the filter. If any does, then the zero impedance of the series resonant circuit, \( XL_2XC_2 \), shorts the ac signal at that frequency to ground. A band stop filter is also known as a notch filter. Frequencies on both sides of resonance will pass, fig. 19B. If the two \( LC \) circuits are resonant to different frequencies, perhaps 1 kHz apart, the curve will flatten off at its base (dashed curve) rejecting a wider group of adjacent frequencies, increasing the bandwidth of the filter. If only one resonant circuit is used to stop a frequency, such an \( LC \) circuit may be termed a wave trap. Wave traps are handy circuits for keeping unwanted rf ac out of electronic equipment. Band stop filters are sometimes called stop-band filters.

If the resonant circuit positions are reversed, as in fig. 20A, the circuit becomes a bandpass filter. Both circuits work to pass the frequency to which they are tuned. An air-core transformer with either or both primary and secondary tuned to the same frequency is also a form of bandpass filter. Several of these are used in every receiver and transmitter.
The simple lowpass and highpass filters of figs. 16 and 17 are known as constant-k filters because if the $X_L$ and $X_C$ values are multiplied together for any one frequency, the same product value (or k) will be produced at any other frequency. These filters do not have very steep skirts unless many similar sections are used in cascade (one following the other). Since every section produces some attenuation of the signal being passed through it, many-section filters may have excessive attenuation values.

Another form of LC filter, called an m-derived filter, uses a resonant circuit in it to force a steep slope. An example of a π-type m-derived lowpass filter is shown in fig. 21A with its response curve, fig. 21B.

Inductor $L_1$ and capacitor $C_1$ pass low frequencies but attenuate highs as in any lowpass, constant-k filter. The series resonant $L_C$ circuit shorts out its resonant frequency, $f_o$, but the response pops up past this frequency until it meets the descending constant-k response, shown dashed. The m value refers to the difference in frequency between the knee of the constant-k part of the filter and $f_o$. If the knee frequency and $f_o$ are the same, $m = 0$ and the circuit acts like a constant-k filter with a wave trap in it. If the frequency at the bottom of the constant-k curve and $f_o$ are the same, $m = 1$ and the circuit acts as a simple constant-k filter. An m value of about 0.6 gives a rapid drop-off and relatively little pop up past $f_o$, and is often the m value used.

The m-derived filters can be made in the π-type LP form as shown, or in HP, BP, and BS forms. Composite filters can be made with some constant-k sections cascaded with one or more m-derived sections. All filters are engineered to operate from and into given impedance values. If the proper impedances are not used, the filter will not work properly.

If resistors are substituted for the inductors in constant-k-type, highpass and lowpass filters, the steepness of the resulting curves are not very good. However, in many cases an RC filter will do the job adequately. They are much lighter and less costly than LC filters.

### black box circuits

The FCC speaks of replacement of a voltage source and a resistive voltage divider with an equivalent circuit consisting of a voltage source and one resistor. This is an application of what is known as Thevenin's theorem, which says in effect, “Any complex resistive circuit with one or more voltage sources in it may be replaced with an equivalent operating circuit consisting of a single series resistor and a single voltage source.”

The “black box” of fig. 22 illustrates a resistive voltage-divider circuit and a battery inside the box. All we can see of this circuit are points A and B. Effectively, what single resistor in series with a single battery will work the same as this more complex circuit as far as any load connected across terminals A and B is concerned?

The answer to this can be determined by using a resistor load, an ammeter in series with it, and a voltmeter, as indicated. First, we measure the A to B voltage with no load. Let’s assume it is 25 volts. Next, connect the load across A and B and read the voltage again. We will assume it is now 20 volts. We can say that connecting the load produces a change in voltage (delta V, or $dV$) of 5 volts. When no load is connected, the external current flow is zero amperes. Let’s assume that with the load connected the current is 0.8 amp. This means that changing from load to no-load conditions produces a $dI$ of 0.8 amp. Using our $dE/dV$ from the Ohm's law resistance formula results in $R = dE/dI$, or $dV/d0.8$, or 6.25 Ω internal resistance. Since we know that the effective internal EMF is 25 volts, the internal circuit could be replaced with a 25-volt battery and a 6.25Ω resistor in series.
FCC test topics

Although there are no specific Novice FCC test topics in this article, it would be wise for Novice applicants to begin to learn the necessary theory for future Technician/General, Advanced, and Extra class licenses.

The following Technician/General class FCC test topics are discussed in this article, but should be understood by Advanced class license applicants also:

- Reactance
- Impedance
- Electrical power calculations
- Power measurement
- Series and parallel combinations of resistors, of capacitors, and of inductors
- Impedance matching
- Turns ratio, voltage, current, and impedance transformations in transformers
- Highpass, lowpass, and bandpass filters

The following Advanced class FCC test topics are discussed in this article, but should be understood by Extra class license applicants also:

- Phase angle between voltage and current, given resistance and reactance
- Reactive power
- Power factor, given phase angle
- Series and parallel resonance
- Selecting a coil or capacitor to resonate at a given frequency
- Resonant frequency, bandwidth and Q of RLC circuits, given component values
- Skin effect
- Filters: constant-k, m-derived, stop band, notch, pi-section, T-section, L-section (general characteristics, not design equations)

Replacement of a voltage source and a resistive voltage divider with an equivalent circuit consisting of a voltage source and one resistor.

**Problem answers:**
1. \( 89.4 \omega \)
2. \( 1.4286 \), 55 degrees, 0.5736, 73.2 \( \omega \)
3. \( 0.833 \), 39.80 degrees, 0.7682, 39.05 \( \omega \), 2.561 amps, 76.83 volts, 64.03 volts, 196.8 watts; it leads.

For additional information on these subjects you can refer to *Electronic Communication*, by Robert L. Shrader, W6BNB, McGraw-Hill Book Company, available through Ham Radio's Bookstore.
Loading problems and cures with regard to solid-state transmitters

My column "A Survey of Antenna Tuners" in July, 1981, *Ham Radio* brought some feedback in the form of interesting mail. The subject under discussion was the problem of loading a solid-state, high-frequency transceiver into some of today's modern antennas. Many proud users of the latest in ham gear experienced loading problems, feedback, TVI, erratic operation, a "hot" microphone and other melancholy exceptions to normal operation.

What is the problem? What causes this unusual plague of difficulties?

It seems to reduce down to this: The modern, state-of-the-art, high-frequency transceivers with transistor output stages all have one thing in common — they provide their full power into an antenna load only under conditions of a low SWR on the transmission line. Many solid-state transceivers, when presented with a high-SWR antenna load, simply start to turn themselves off. As an example, one popular transceiver, when working into an SWR of about 2 to 1, will reduce its output by 25 percent (100 watts to 75 watts). And when the SWR reaches about 3 to 1, the transceiver output drops by 50 percent (100 watts to 50 watts).

Someone may say "small potatoes," but a 50-percent power drop is a signal loss of 3 dB, and when the user is paying for the power, I don't see why he can't use it! Fig. 1 sums up the problem.

**what to do about loading problems**

Perhaps the loss in power output is not important, but the attending problems mentioned previously are often coupled with the SWR problem. It is all of one piece, so to speak. The answer, then, is to tailor the antenna system to provide a better and more compatible load for the solid-state equipment.

From the mail I get on the subject, the antenna that seems to provide the greatest loading problems is the popular tri-band Yagi beam for 10, 15, and 20 meters. Sometimes this antenna is a "bearcat" to tame, especially on 10 meters. So let's take this antenna as an example, remembering that the discussion applies to other antennas as well.

The problem breaks down into two separate parts. First, getting the rf power where it belongs — into the antenna — and not where it is liable to end up — in the telephone wires, utility wires or Grandpa's new stereo system. Second, making the antenna system compatible with the transceiver so the latter "looks into" a reasonably low value of SWR. Neither problem is insurmountable.

**getting the rf power where it belongs**

It is easy to allow the output power from your transmitter to get into outlandish places. A favorite 40-meter dipole of mine had to be taken down because when I ran a few hundred watts into it, the dining room light fixtures illuminated by themselves, even with the light switch in the off posi-
tion. And a friend of mine had a talking garbage disposal whenever he went on 15-meter SSB. Many operators have been bitten from a “hot” microphone on 10 meters. Sometimes speech processors break into oscillation, or loading changes when the microphone is grasped.

All of this means that the transmitter rf is getting where it is not supposed to be — into the power mains and back into the transmitter’s exciter stages. There are several ways to combat this problem.

First, it is bad medicine to have the station in the near-field of the antenna. Getting the antenna up in the air, away from the station equipment, helps a lot. When the antenna is on a short tower right above the radio room, the station equipment is exposed to the strong radiation field from the antenna. Moving the antenna away from the station is the answer. Or, moving the station away from the antenna accomplishes the same result. My antenna, for example, is on a tower near my garage. Moving the station from the garage workshop to a spare bedroom certainly helped a lot. (My wife had other ideas about that move, but that’s another story.)

antenna currents
One aspect of the problem is caused by antenna currents that flow on the outside of the coax to the antenna. Antenna currents can be caused by current induced into the outer shield of the line because it is in the field of the antenna. The worst case is when the line length is resonant; that is, a multiple of a half wavelength at the operating frequency. Under this circumstance, you have a resonant conductor (the transmission line) in the near-field of the antenna. Maximum line pickup comes about when the transmission line runs parallel to the antenna.

Antenna currents can be reduced by detuning the line and moving it so that it doesn’t run parallel to the antenna. In the case of a rotary beam, it is a good idea to bring the coaxial line and rotor control cable down to ground level and run them along the ground, or bury them inside a garden hose sunk below ground level. A bad idea is to string the coax and cable above the ground from tower to radio room. My coax and cables came off my tower at about the 10-foot (3-meter) level, then ran across the rooftop to the window of the operating room. This caused no end of problems, especially on 10 meters.

I finally dropped the wires down to ground level and brought them into the radio room through a hole drilled into the corner of a closet floor (when no one was looking). Relocating the cables improved transmitter operation and stability immensely.

The ARRL Antenna Book has a good dissertation on antenna currents and how to decouple the line to avoid line resonance. The solution proposed is to cut the line to a length that avoids resonance. Recommended lengths for the high-frequency bands that avoid the problem are: 27, 39, 57, 76, 95, 110, and 145 feet (8.2, 11.9, 17.4, 23.2, 29, 33.6, and 44.2 meters).

the line choke
Another approach is to wrap a few turns of the transmission line into a coil, forming an rf choke, that will suppress antenna currents that might flow on the outside of the outer shield of the coax. I have used five turns of RG-8A/U, about a foot (30.5 cm) in diameter. In one instance, where I didn’t use a balun, but fed a balanced beam with a coaxial line, I noticed that my front-to-back ratio was very poor. The beam seemed to have a bidirectional pattern. The five-turn choke coil was placed in the coaxial line, atop the tower, and about 3 feet (0.9 meter) from the feedpoint of the beam. (Placement was determined by the fact that I am a coward atop the tower, hanging on with both arms and a safety belt.) Once the line was wrapped and taped into a roughly shaped coil, the front-to-back ratio of the beam improved dramatically. Another stunt is to wrap two turns of the transmission line around a large ferrite core. I’ve used the Amidon T-200 (6-mix, yellow, with a u = 8) with two turns of RG-8A/U through it in a 12-inch (30.5-cm) diameter coil with good results, too.

summing up
So there you have it. Don’t run your coax line parallel to the antenna elements or, if you must, run it along the ground. Do make sure your coax line is not resonant at your operating frequencies. Either detune the line by trimming it to the previously sug-
gested lengths, or wrap a portion of the line into an rf choke. Bring the line down to the tower — don’t run it off at an angle below the antenna.

**if all else fails**

Sometimes attention to antenna currents on the transmission line doesn’t completely solve the problem of rf feedback, a “hot” microphone, or RFI (Radio Frequency Interference). I know. Some years ago I lived in an area remarkably free of TVI. I had no TVI problems, including TVI in my own home. One fine day a neighbor decided to add an extra room to his garage — sort of a combined rum- pus room and workshop. No sooner was the room added when the neighbor complained to me of severe TVI from his new set installed in the garage room. Sure enough, I wiped it out! And a highpass filter in the TV lead in didn’t seem to do any good.

Well, after a lot of fruitless investigation, on-the-air checks, and so on, we discovered that the TVI on this particular receiver could be completely eliminated by merely moving the set from the garage room back into the house!

It seems that my neighbor’s house, my house, and the surrounding houses had been wired with solid electrical conduit. That is, all electric wiring was encased in metal conduit which, in turn, was grounded at several points in the homes.

To save building costs, my neighbor decided that conduit was too expensive, so his new garage room was wired with exposed, knob-and-tube wiring! The result was that the electrical wiring acted as a giant antenna, picking up my signal and pumping it directly into the power line of the TV set. Moving the set back in to the house, which was wired with solid shielded conduit, completely protected the vulnerable input circuits of the receiver.

What to do? Investigating around the attic area of the new room revealed that the 120-volt wiring was as “hot as a baker’s apron” when I was on 20 meters, less so on 15 meters, and again sensitive to 10-meter operation.

It was impossible to retroactively shield the wiring, so an attempt was made to cool things off. At every wall outlet each side of the power line was bypassed to the neutral wire (a three-wire circuit: 120 volts, 120 volts, and ground) with 0.01-µF 1.4-kV disc ceramic capacitors, rated for 125 volts ac and 1400 volts dc. (The capacitors are tested at 2800 volts.)

Three well known manufacturers that supply these line capacitors, and their type number are: Aerovox type AC-7, Centralab type CI-103, and Sprague type 125L-S10. These capacitors, or their equivalents, are suitable for the 120-volt, 60-Hz power line. Do not use garden-variety 600-volt disc ceramic capacitors, as they are not rated for this service.

Bypassing the line at various points helped to clean up the trouble, and when a highpass filter was placed in the ribbon line to the TV set, it did the job. Result: no more TVI in the new garage room!

**the line flattener**

Taming the rf floating around the radio room and cleaning up your neighbor’s receiver doesn’t go all the way in solving the loading problems inherent in some solid-state rigs, but it surely helps. The last trick in the deck is to use a line flattener — this is a simplified matching network that is placed between the transmitter and the antenna to reduce the SWR on the line to a value acceptable to the transmitter. Mind you, the SWR at the antenna and on the line doesn’t change — the line flattener is merely a matching device that makes the real world more palatable to the station equipment. A good line flattener can drop an SWR of more than 5 to 1 to unity in the wink of an eye!

The schematic of a line flattener for power levels up to 250 watts PEP (or slightly more) is shown in fig. 2. A connoisseur will recognize this circuit as a simple pi network with three adjustable components. The line flattener is inserted into the transmission line after the SWR meter, and the

---

**fig. 2. Line flattener for coaxial cable.** Many components for the line flattener can be found in the junk box. J1, J2 are coaxial receptacles to match the plugs used in your antenna system (type SO-239 receptacles mate with plug PL-259, for example). Capacitors C1 and C2 are 100 pF (for 10-15-20 meter operation) and 250 pF for 40-80 meter operation. Single-spaced, receiving types will be satisfactory for power levels up to 100 watts PEP output. For higher power levels, the surplus capacitors found in the BC-series “Command” transmitters are ideal. Fair Radio Sales, in Lima, Ohio, has a good selection of transmitting capacitors.

The coil, L1, is ten turns of No. 12 (2.1 mm) 1 inch (2.54 cm) diameter and 1-1/2 inches (3.8 cm) long (10-15-20 meters); 20 turns, 1 inch (2.54 cm) diameter 3 inches (7.6 cm) long (40-80 meters). Five taps, every other turn on every fourth turn. The coil is not critical; the air-wound type is satisfactory, or it may be hand wound on a ceramic form. Use what you have. Switch S1 is a ceramic affair with an insulated shaft extension. Or, it may be mounted on an insulated plate affixed over an oversized panel hole. Remember: the arm of the switch is at rf potential. Again, Fair Radio Sales is a good choice for suitable switches.
controls are adjusted to reduce the SWR to a minimum value. Suitable components for the line flattener are listed in the drawing caption.

To keep everything shipshape and rf tight, the line flattener should be built into an enclosure such as an aluminum utility cabinet. The Bud AU-1040, measuring 9 by 6 by 5 inches (22.8 by 15.2 by 12.7 cm), will do the job as will any equivalent cabinet that is all-metal and does not have plastic end panels. The input and output coaxial fittings can go on either end of the cabinet, or on the rear, depending upon your particular equipment layout.

It is a good idea to use extra screws to hold the box panels in place; the box is pretty leaky when it comes to rf shielding. And don’t forget to clean any paint off the mating lips of the box and panels to make a good electrical joint.

tuning the line flattener

Easy! Place the SWR meter between the line flattener and the coax line to the transmitter. You’ll need a short, extra length of line to reach from flattener to transmitter. And be sure to properly install all coax plugs on your antenna line as recommended by the manufacturer. A sure-fire way to get into trouble is to improperly use the connectors. The temptation is great to jam the connectors onto the cable and forget about soldering the shield and inner conductor. Don’t do it!

When everything is together, fire up the transmitter and adjust the controls of the line flattener for the lowest value of reverse power (or SWR) as read on the SWR meter. That’s all there is to it. Log the control settings for each band for future use.

Need more information on antennas, feedlines, and beams? Read The Radio Amateur Antenna Handbook, by W6SAI and W2LX. It’s available from Ham Radio’s Bookstore, Greenville, NH 03048. Price, $6.95 plus $1 to cover shipping and handling.

ham radio
last-minute predictions

The lower-frequency bands are expected to be favored for DX for the first half of the month; then the higher bands, 10-15-20, will pick up with excellent openings in the last part of the month. Some periods of disturbance may be experienced around the 10th, 19th, and 30th, with fairly lengthy (3-5 days) of low signal strengths on polar paths and excellent trans-equatorial long-hop openings. Both paths may have some QSB and DX from unusual locations associated with the disturbances.

October is an equinoctial month so expect more than normally disturbed conditions. The solar flux is still high enough in the declining part of the 11-year cycle to give good high maximum usable frequencies for trans-equatorial propagation. The 10 and 15 meter bands have most of this type propagation as one can see on the charts. Some of the 10-meter openings are marked with an asterisk, which indicates possible openings on 6 meters during that hour during the month. The best chance for these openings are during high solar flux values and high geomagnetic A or K values as broadcast from radio station WWV at 18 minutes after each hour.

During October the Orionid meteor showers are visible from the 15th to the 25th. The maximum rate is between 10-20 per hour on the 20-21st of the month. The moon is full on the 13th and perigee on the 15th of the month, which may be of interest to the moonbounce DXers.

October may be a good month to get antennas ready for the winter DX season, since the summer yard work is over. You may want to consider how effective your antennas are in coupling to the ionosphere (see January 1981 DX Forecaster). For getting maximum distance per hop to your favorite DX land for short skip, E region propagation of 1200 miles (2000 km) you need a takeoff angle of about 20 degrees, and for long or regular skip to about 2500 miles (4000 km) about 10 degrees. For the higher-frequency DX bands with the usual horizontal antennas this is approximately 0.75 wavelength and 1.25 wavelength heights above ground respectively. This table gives the approximate heights in feet to shoot for:

<table>
<thead>
<tr>
<th>band</th>
<th>short skip</th>
<th>regular</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>15</td>
<td>38</td>
<td>60</td>
</tr>
<tr>
<td>20</td>
<td>50</td>
<td>80</td>
</tr>
</tbody>
</table>

Hope you have a good DX season coming up.

band-by-band forecast

Six meters should provide frequent band openings with a peak during the early afternoon hours on many days. Trans-equatorial north-south paths will be the best. Your guide to possible openings will be strong openings on 10 meters and high values of solar flux.

Ten and fifteen meters will be loaded with good DX signals from morning until early evening hours almost every day. Times of geomagnetic disturbance will limit the number of signals heard, but listen carefully — they can be from very unusual places. Fifteen meters should be open later in the day than 10 meters. So, hit 10 first and finish off with 15.

Twenty meters will be the main daytime DX band, as it is almost always open to some part of the world. It opens to the east as the sun rises and extends into the late evening hours to the west. Geomagnetic disturbances do not affect this band as much as the higher ones, but still look for unusual trans-equatorial DX locations to be coming through once in a while. One-hop trans-equatorial DX of 5,000 to 7,000 miles (8,000 to 11,200 km) may be possible in the late evening hours during some of these unusual conditions.

Forty and eighty meters will have much short skip during daylight hours and turn to DX after dark. The bands will open to the east soon after sundown, swing more to the south to Latin America about midnight, and end up to the Pacific areas during the hour or so before dawn. Some nights these bands will be as good as during the winter DX season coming up in November-February. The coastal regions usually have the edge for working the rare DX on these bands.

One-sixty meters will be quieting down substantially now. This band should have renewed interest in DX possibilities with LORAN phasing out and privileges restored. It works much like 80 meters so give it a try.

ham radio
### WESTERN USA

<table>
<thead>
<tr>
<th>GMT</th>
<th>PDT</th>
<th>N</th>
<th>NE</th>
<th>E</th>
<th>SE</th>
<th>S</th>
<th>SW</th>
<th>W</th>
<th>NW</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td></td>
<td>10</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>10*</td>
<td>10*</td>
<td>10</td>
</tr>
<tr>
<td>0100</td>
<td></td>
<td>10</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>15</td>
<td>10*</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>0200</td>
<td></td>
<td>10</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>0300</td>
<td></td>
<td>10</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>0400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0600</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0700</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0800</td>
<td></td>
<td>20</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>0900</td>
<td></td>
<td>40</td>
<td></td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>1000</td>
<td></td>
<td>40</td>
<td></td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>1100</td>
<td></td>
<td>40</td>
<td></td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>1200</td>
<td></td>
<td>20</td>
<td></td>
<td>20</td>
<td>20</td>
<td>40</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>1300</td>
<td></td>
<td>20</td>
<td></td>
<td>20</td>
<td>40</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>1400</td>
<td></td>
<td>20</td>
<td></td>
<td>20</td>
<td>40</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>1500</td>
<td></td>
<td>20</td>
<td></td>
<td>20</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>1600</td>
<td></td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>10*</td>
<td>15</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1700</td>
<td></td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>10*</td>
<td>10</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1800</td>
<td></td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1900</td>
<td></td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>2100</td>
<td></td>
<td>15</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2200</td>
<td></td>
<td>10</td>
<td>20</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2300</td>
<td></td>
<td>10</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

### MID USA

<table>
<thead>
<tr>
<th>MDT</th>
<th>N</th>
<th>NE</th>
<th>E</th>
<th>SE</th>
<th>S</th>
<th>SW</th>
<th>W</th>
<th>NW</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0600</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0700</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0800</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0900</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1600</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1700</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1800</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1900</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### EASTERN USA

<table>
<thead>
<tr>
<th>EDT</th>
<th>N</th>
<th>NE</th>
<th>E</th>
<th>SE</th>
<th>S</th>
<th>SW</th>
<th>W</th>
<th>NW</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0600</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0700</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0800</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0900</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1400</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1600</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1700</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1800</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1900</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Look at next higher band for possible openings.*

**October 1981**
VBT, notch, IF shift, wide dynamic range

Now most Amateurs can afford a high-performance SSB/CW transceiver with every conceivable operating feature built in for 160 through 10 meters (including the three new bands). The TS-830S combines a high dynamic range with variable bandwidth tuning (VBT), IF shift, and an IF notch filter, as well as very sharp filters in the 455-kHz second IF. Its optional VFO-230 remote digital VFO provides five memories.

**TS-830S FEATURES:**

- **Wide receiver dynamic range**
  Junction FETs (with optimum IMD characteristics and low noise figure) in the balanced mixer, a MOSFET RF amplifier operating at low level for improved dynamic range (high amplification is not needed because of low noise in mixer), dual resonator for each band, and advanced overall receiver design result in excellent dynamic range.

- **Variable bandwidth tuning (VBT)**
  Continuously varies the IF filter passband width to reduce interference. VBT and IF shift can be controlled independently for optimum interference rejection in any condition.

- **IF notch filter**
  Tunable high-Q active circuit in 455-kHz second IF, for sharp, deep notch characteristics.

- **IF shift**
  Shifts IF passband toward higher or lower frequencies (away from interfering signals) while tuned receiver frequency remains unchanged.

- **6146B final with RF NF**
  Two 6146Bs in the final amplifier provide 220 W FEP (SSB)/180 W DC (CW) input on all bands. RF negative feedback provides optimum IMD characteristics for high-quality transmission.

- **Built-in digital display**
  Six digit large fluorescent tube display, backed up by an analog dial. Reads actual receive and transmit frequency on all modes and all bands. Display Hold (DH) switch.

- **Adjustable noise-blanker level**
  Built-in noise blanker eliminates pulse-type (such as ignition) noise. Front-panel threshold level control.

- **Various IF filter options**
  Either a 500-Hz (YK-88C) or 270-Hz (YK-88CN) IF filter may be installed in the 8.83-MHz first IF, and a very sharp 500-Hz (YG-455C) or 250-Hz (YG-455CN) IF filter is available for the 455-kHz second IF.

- **More flexibility with optional digital VFO**
  VFO-230 operates in 20-Hz steps and includes five memories. Also allows split-frequency operation. Built-in digital display. Covers about 100 kHz above and below each 500-kHz band.

- **Built-in RF speech processor**
  For added audio punch and increased talk power in DX pileups.

- **RIT/XIT**
  Receiver incremental tuning (RIT) shifts only the receiver frequency, to tune in stations slightly off frequency. Transmitter incremental tuning (XIT) shifts only the transmitter frequency.

- **SSB monitor circuit**
  Monitors IF stage while transmitting, to determine audio quality and effect of speech processor.

More information on the TS-830S is available from all authorized dealers of Trio Kenwood Communications 1111 West Walnut Street, Compton, California 90220.

Matching accessories for fixed-station operation:

- **IF-230 external speaker**
  With selectable audio filters
- **VFO-230 external digital VFO**
  With 20-Hz steps, five memories, digital display
- **AT-230 antenna tuner/SW and power meter**
- **MC-50 desk microphone**

Other accessories not shown:

- **TL-922A linear amplifier**
- **SM-220 Station Monitor**
- **PC-1 phone patch**
- **HC-10 digital world clock**
- **YK-455C (500-Hz) and YG-455CN (250-Hz) CW filters for 455-kHz IF**
- **YK-88C (500-Hz) and YK-88CN (270-Hz) CW filters for 8.83-MHz IF**
- **HS-5 and HS-4 headphones**
- **MC-30S and MC-35S noise-cancelling band microphones**

Specifications and prices are subject to change without notice or obligation.
Miniaturized, 5 memories, memory/band scan

**TR-7730**

The TR-7730 is an incredibly compact, reasonably priced, 25-watt, 2-meter FM mobile transceiver with five memories, memory scan, automatic band scan, UP/DOWN manual scan from the microphone, and other convenient operating features.

**TR-7730 FEATURES:**

- **Smallest ever Kenwood mobile**
  Measures only 5-3/4 inches wide, 2 inches high, and 7-3/4 inches deep, and weighs only 3.3 pounds. Mounts even in the smallest subcompact car, and is an ideal combination with the equally compact TR-8400 synthesized 70-cm FM mobile transceiver.
- **25 watts RF output power**
  Even though the TR-7730 is so compact, it still produces 25 watts output for reliable mobile communications. HI/LOW power switch selects 25-W or 5-W output.
- **Five memories**
  May be operated in simplex mode or repeater mode with the transmit frequency offset ±600 kHz. The fifth memory stores both receive and transmit frequency independently, to allow operation on repeaters with nonstandard splits. Memory backup terminal on rear panel.
- **Memory scan**
  Automatically locks on busy memory channel and resumes when signal disappears or when SCAN switch is pushed. Scan HOLD or microphone PTT switch cancels scan.
- **Extended frequency coverage**
  Covers 143.900-148.995 MHz in switchable 5-kHz or 10-kHz steps, allowing simplex and repeater operation on some MARS and CAP frequencies.
- **Automatic band scan**
  Scans entire band in 5-kHz or 10-kHz steps and locks on busy channel. Scan resumes when signal disappears or when SCAN switch is pushed. Scan HOLD or microphone PTT switch cancels scan.
- **UP/DOWN manual scan**
  With UP/DOWN microphone provided, manually scans entire band in 5-kHz or 10-kHz steps.
- **Offset switch**
  Allows VFO and four of five memory frequencies to be offset ±600 kHz for repeater access or to be operated simplex during transmit mode.
- **Four-digit LED frequency display**
  Indicates receive and transmit frequency during simplex or repeater-offset operation.
- **S/RF bar meter and LED indicators**
  Bar meter of multicolor LEDs shows relative receive and transmit signal levels. Other LEDs indicate BUSY, ON AIR, and REPEATER offset.
- **Tone switch**
  Activates internal subaudible tone encoder (not Kenwood-supplied).

**Optional accessories:**

- **MC-46 16-button autopatch (DTMF)**
- **UP/DOWN microphone**
- **SP-40 compact mobile speaker**
- **KPS-7 fixed-station power supply**

More information on the TR-7730 and TR-8400 is available from all authorized dealers of Trio-Kenwood Communications 1111 West Walnut Street, Compton, California 90220.

---

Synthesized 70-cm FM mobile rig

**TR-8400**

- **Synthesized coverage of 440-450 MHz**
  Covers upper 10 MHz of 70-cm band in 25-kHz steps, with two VFOs.
- **Offset switch**
  For 2.5 MHz transmit offset on both VFOs and four of five memories, as well as simplex operation. Fifth memory allows any other offset by memorizing receive and transmit frequencies independently.
- **DTMF autopatch terminal**
  On rear panel, for connecting DTMF (dual-tone multifrequency) touch pad (for accessing autopatches) or other tone-signaling device.
- **HI/LOW RF output power switch**
  Selects 10 watts or 1 watt output.
- **Virtually same size as TR-7730**
  Perfect companion for TR-7730 in a compact mobile arrangement.
- **Other features similar to TR-7730**
  Five memories, memory scan, automatic band scan (in 25-kHz steps), UP/DOWN manual scan, four-digit LED receive frequency display (also shows transmit frequency in memory 5), S/RF bar meter and LED indicators, tone switch, and some optional accessories.

Specifications and prices are subject to change without notice or obligation.
Part one of this series stressed the importance of timing to avoid the race condition by providing examples of different counter circuits. Race conditions and spikes are found in all marginal logic designs. But all have solutions. This part of the article looks deeper into counter chains; shows methods of supply bypassing and handling switch controls; and provides methods of reducing RFI for all logic circuits.

**an inside look at a synchronous counter**

Fig. 11 is a simplified schematic of the ripple carry output circuit in 74161 and 74163 counters. A carry output will not occur until all counter stages are high and the enable-T pin is high. This configuration allows cascading devices to be used, so that a carry output from the last device occurs only when all previous counters are high or logic 1.

A counter cascade, such as in fig. 12, should work well. But I’ve found a situation with 74163 devices that causes a small glitch that can make the output unsuitable for driving other circuits. The cause is a small, differential delay, between a) the enable-T

By Penn Clower, W1BG, 459 Lowell Street, Andover, Massachusetts 01810.
PRICES 20% LOWER FOR ISOPOLE™ ANTENNAS

The IsoPole antenna has the reputation for high quality, unique design and superior performance. IsoPoles have become the “standard of performance” in VHF/UHF base station antennas.

The demand for IsoPole antennas has grown steadily since their introduction. To meet the demand, AEA has installed an automated production line. We’ve actually improved the quality of construction but most importantly we have lowered production costs. This lower cost is now passed on to you with the price of IsoPole antennas 20% lower.

The IsoPole is designed for ease of installation. You can customize your mounting by using low cost TV masting up to 1½” diameter. (Mast not supplied.) More than ever, the IsoPole is the logical choice for a VHF/UHF base station or repeater antenna.

The IsoPole antenna gives you exceptionally broad frequency coverage. You obtain maximum gain attributable to the antenna’s length, plus a zero angle of radiated power. The unique cone design (pat. pend.) assures superior resistance to icing and wind. IsoPole antennas are weather proofed and made of top quality components. They use stainless steel hardware, Amphenol connectors, corrosion resistant aluminum alloys and a dielectric material with excellent mechanical and electrical properties.

Note the typical SWR plots for the IsoPole-144 and the new IsoPole-440.

There is an IsoPole antenna for 220 MHz also. See these fine antennas at your favorite dealer, or contact Advanced Electronic Applications, Inc. P.O. Box 2160, Lynnwood, WA 98036 Call 206/775-7573

Prices and specifications subject to change without notice or obligation

For information call
(817) 265-0391
TOLL FREE — ORDERS ONLY
(800) 433-5172
MC, VISA, Phone or Mail Orders Accepted.

As we enter our second year of business, we invite you to take advantage of these price reductions.

SUPERVERTER I $199.95 $99.95
The ultimate in converter technology! Dual stage selective preamp, mixer, i.f. amplifier and no-drift crystal controlled oscillator. We recommend this kit for the experienced kit builder.

SELECTIVE PREAMP $99.50 $44.50
This new unit is not like other wide band preamps. Experienced kit builders can easily add this unit to our existing boards or to other manufactured boards to improve overall performance.

COMING NEXT MONTH. Our own design Satellite TV Receivers with a complete line of high performance accessories.

2300 MHz Downconverter $35.00
PC Board, all components and instructions for a working unit.

VARIABLE POWER SUPPLY $24.95
Complete kit includes all components for working unit including deluxe box and overlap.

DISH YAGI ANTENNA $25.00
Complete kit with PVC and mounting brackets. Stronger than loop yagi, equal in gain.

New 4 ft. Dish $49.95
Overall 25 dB gain. Partial assembly required. Shipped UPS ground only.

UNIVERSAL COMMUNICATIONS P.O. Box 339 Arlington, TX 76010

More Details? CHECK — OFF Page 94

October 1981
New and unique Lightning Protection

...an industry first

Experience of more than 30 years in Amateur Radio, in part as Sales Manager of a major amateur radio manufacturer, has given me a unique opportunity to evaluate most radio equipment, and to gain an insight into the needs of the amateur, and the professional communicator.

The first project demanding our attention is in a critical but unserved area—that of providing specially designed field-serviceable lightning surge protectors for solid state communications equipment.

Don Tyrrell, WRAAD

---

**Alpha Delta Communications**

**Transi-Trap Surge Protectors**

with the exclusive, field-replaceable Arc-Plug™ Cartridge

Solid state communications equipment is far more sensitive to the effects of lightning-induced transients than tube equipment, making conventional protection techniques ineffectual. Considering the high cost of solid state equipment, a better type of protection is now necessary.

Although a lightning-induced transient is very short (about 250 μsec wide) it can do enormous damage to semiconductors, even if not caused by a near-hit. Even a distant storm front, out of the operator's sight, sends enough energy to ruin solid state communications equipment.

High 30 to 80 volts still exists across the arc, enough to damage semiconductors.

Solid state communications equipment is far more sensitive than tube equipment. Making conventional protection techniques ineffectual. Considering the high cost of solid state equipment, a better type of protection is now necessary.

Protection System solves these problems and more.

**Unique Design** maintains Receiver Front-End performance—unlike other designs, Transi-Trap protectors have no effect on receiver intermod, crossmod, or interfering point.

Models available:

- **Transi-Trap Model R-T Low Level Protector**—for use with solid state receivers, transceivers or transmitters running up to 200 watts at 50 ohms (hf to uhf)...
  - $29.95 ea., plus $4.00 shipping and handling

- **Transi-Trap Model HV High Voltage Protector**—for use with linear amplifiers running up to 2 kW at 50 ohms (hf to uhf)...
  - $32.95 ea., plus $4.00 shipping and handling

- **Replacement Arc-Plug Cartridge** for Model R-T...
  - $9.95 ea., plus $2.00 shipping and handling
  for Model HV,...
  - $12.95 ea., plus $2.00 shipping and handling

Ohio residents add Sales Tax to prices.

Master Card, Visa, checks accepted. Order by phone or mail.

Alpha Delta Transi-Trap Protection Systems are designed to reduce the hazards of lighting-induced surges. These devices, however, will not prevent fire or damage caused by a direct stroke to antenna or other structure.

---

**ALUMINUM**

**SMITEH® ALUMINUM**

**SOLD VIA UPS!!**

High-quality 6061-T6 seamless drawn tubing & lengths - 3/8”-wall

<table>
<thead>
<tr>
<th>Dia.</th>
<th>Price</th>
<th>Dia.</th>
<th>Price</th>
<th>Dia.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>2.30</td>
<td>7/8</td>
<td>5.75</td>
<td>1-1/2</td>
<td>9.75</td>
</tr>
<tr>
<td>3/8</td>
<td>4.10</td>
<td>1</td>
<td>4.40</td>
<td>1-5/8</td>
<td>10.90</td>
</tr>
<tr>
<td>5/8</td>
<td>6.15</td>
<td>1-7/8</td>
<td>5.75</td>
<td>1-7/8</td>
<td>11.50</td>
</tr>
<tr>
<td>7/8</td>
<td>7.60</td>
<td>2</td>
<td>6.00</td>
<td>2</td>
<td>12.55</td>
</tr>
</tbody>
</table>

Ohio residents add Sales Tax to prices.

Also in stock: 10-6 stainless steel U-bolts, gasket plate, sleeves, etc.

Catalog - 40 CENTS + DATA SHEETS, SASE.

Smiteh Aluminum

P.O. Box 273
Homestead, Florida 33032

Tell 'em you saw it in HAM RADIO!
path to carry out, and b) the counter toggling to carry out.

causes, cures and don't-cares

Spike generation is set up when all counters except the last are all ones; the last is one count less than all ones. Enable-T input of the last counter is high. Arrival of a clock edge begins to toggle all counters. All but the last go low after a short delay, while the last counter goes high.

Enable-T input of the last counter can remain high slightly longer due to its output gate delay. If this high state remains, the last counter carry output can go high for 10 to 30 nanoseconds. This short high state is shown in the lower, expanded-time trace of fig. 13. With an amplitude of about a volt, it may or may not affect any following circuitry.

Low-pass filtering of long (breadboard) leads may mask this spike, but it can show up in the final, clean-layout circuit. One way to eliminate the spike is to carry it through a low-power inverter to the next circuit. This works with a 74L TTL inverter following a medium-speed or 74LS counter; interfamily loading rules must be followed to apply the 74L inverter properly.

If following circuits are clocked by the same counter input line, the glitch will not affect operation. Clock-triggered devices must have inputs set up before the clock edge arrives. The best design is one that pays attention to time delays before using any family mixes or R-C brute-force filtering. You must study all the fine print in data books.

initialization

Initialization is the process of defining starting conditions so that a sequence can begin correctly. There's no guarantee that a flip-flop will start up in a desired state, so all counter or shift register feedback gating must ensure that any start-up state will eventually get into the desired sequence.

A divide-by-20 counter could be made with a 20-state, circularly connected shift register. If 19 states are low and one is high, the single high bit will cycle around once for every 20 clock pulses. There must be some setup to achieve this pattern when starting; odds of starting by chance are one in $52,428$. This is

*20 acceptable patterns out of $2^{20}$ possibilities.
an extreme chosen to make the point, but many real-life situations do occur.

Start-up states could be initialized by extra circuitry and a front-panel switch. A better way is to study the design in detail and, if necessary, add or rearrange gating for automatic initialization on start up.

layout

Anyone who has built high-gain amplifiers knows that outputs are not placed close to inputs. A completed layout is never exactly like its circuit diagram, since all components have parasitic capacitance, resistance, or inductance. Proper layout can minimize feedback and parasitics. This is also true for digital circuitry.

It is all too easy to think of digital signals as being simply ones or zeroes, disregarding actual voltages. If a digital device has supply-line spikes, outputs of that device will have spikes, and a following IC may interpret these as signals.

power-supply wiring

Proper routing of power-supply currents is crucial in dense circuits. Those with a modest amount of ICs will benefit from care in routing. Supply-line spikes are generated by logic state changes in concert with parasitic supply line and ground inductance.

A clue to the ground-noise problem is a system malfunction when individual system circuits, such as breadboards, work well by themselves. Relief may be achieved by adding bypass capacitors directly at high-current ICs. These capacitors provide local current storage, which reduces the high-frequency current drawn through the entire supply system.

A better correction to decreasing supply impedance is a "supply tree" shown in fig. 14. A conventional daisy-chain supply of fig. 14A would make U1 susceptible to supply glitches from all others. The tree configuration of fig. 14B spreads supply spikes to small branches, while capacitors smooth out branch currents.

layout for the supply lines

Power and ground conductors should be as large as possible; inductance decreases as surface area increases. A good way to reduce impedance is to use...
a double-sided circuit board with ground on one side, supply on the other. Supply impedance becomes quite low.*

Nonprinted layouts should avoid the supply daisy chain of fig. 14A. Bypass capacitors should be added locally. Ceramic caps with values from 0.001 to 0.1 µF, are typical. Leads should be short to avoid series resonance. Harmonic content of spikes is quite high, and a bypass capacitor above series resonance will become an inductor. Electrolytic or tantalum caps in the 1-10 µF range should be added to provide low-frequency smoothing on each board.

**off-board wiring**

Long digital lines to and from the board are susceptible to crosstalk, signal distortion, and RFI. An example is that of fig. 15. The panel switch is a data selector. Long lines to the switch cannot be filtered without destroying the data, and they act as antennas for rf pickup. A better solution is to add a dc-controlled digital selector on the board, such as the quad gate in fig. 16. External control is a dc line that can be easily filtered without disturbing data selection.

Many medium- and large-scale ICs have dc control inputs. Using these inputs allows, among other things, oscillator switching, presetting counters, and resetting flip-flops. Multiple data-line switching can be done with multiplexers such as the 74150 or 74151. Adding another device may be a bother, but the RFI elimination may be worth the expense.

**curing switch-contact bounce**

A clocking waveform should never be generated directly from a mechanical switch. Switches bounce, stutter, and generate a number of transitions for each operation.

A new pushbutton switch was connected, as in fig. 17A. The output appears in fig. 18. It can get longer and more ragged with age. The cure is to add two gates in a flip-flop latch arrangement, as shown in fig. 17B. The first low input from either contact will flip the latch, providing both a sharp logic step and masking the following contact bounce. Gate inputs can be heavily filtered for RFI.

**explanations, experience, and understanding**

Many possible explanations are available as to why a digital design doesn’t work properly. Some faults may be due to inexperience, such as wrong application or lack of complete knowledge of an IC’s operation.

---

*Commercial prototype PCBs with individual circuit bypasses are available. While expensive, they are worthy of consideration.
ICOM 701 owners’ report

A survey of owners’ opinions on the ICOM 701

In recent months, *ham radio* has presented the results of its Collins owners’ survey. Thanks to all who participated. This month, we are presenting the results of our survey of the owners of the ICOM IC-701 transceiver. Ninety responses were received and tabulated.

The IC-701 is a solid-state transceiver that delivers 100 watts PEP output on all modes and bands, 160 through 10 meters. It uses a single control knob to tune built-in dual VFOs; frequency readout is by means of eight-digit LEDs. Tuning of the synthesizer can be done at either 100 Hz per division (5 kHz per turn) or 10 kHz per division (500 kHz per turn).

the good features

In response to the question, What is the rig’s best feature?, the most frequent responses were small size (portability) and the built-in dual VFOs. A full 32 percent of all who responded to this questionnaire mentioned the small size of this transceiver, and its applicability as a mobile rig, as one of the best features. Thirty percent of the 701 owners who replied to the questionnaire mentioned the dual VFOs and split-frequency operation.

Other features of the 701 frequently mentioned were the solid-state advantages of the transceiver and the fact that no tune-up is necessary, the ease of operation, and the rig’s stability. Here are some representative comments:

“Receiver section. Separate rf stage per band. Excellent dynamic range on 80 and excellent sensitivity on 10.” — AK0P

“Stability, no-tune output.” — N7BZ

“Synthesized, large digital display, dual VFOs.” — K0MK

“Built-in dual VFOs, CW filters, portability (the rig was used on a mini-DXpedition to Rhodes and Crete), 100-Hz tuning segments (after I got used to it!), useful meter.” — W6GBG

“Digital step tuning that allows selection of tuning speed, microprocessor interface capability, simple controls yet sophisticated capabilities, solid state finals, dual VFO system! The headphone jack that works with either mono or stereo phones is a stroke of genius!” — N1BEJ

“Reliability, no problems at all; sensitive receiver.” — KB5CA

“Compactness, easy to use and operate and extremely stable. It’s pretty too.” — K5ESG

“Ease of operation, fast frequency change via high-speed tuning mode, and exceptionally wide bandspread in slow tuning mode. This rig is simplicity itself to operate. Once the af/rf gains and mic/CW levels are set, just tune around and operate.” — WB1CHY

“Accuracy of frequency readout and ease of dropping to low power.” — W5QAR

“Very easy to use, dual VFOs, good filters, etc., but mostly I like it because I just turn it on and go!” — AA70

“Compactness, multiple features, stability, good audio on both transmit and receive, ability to interface with RTTY easily. It is a classic, ahead of its time. I own two, one mobile and one in the house.” — W4VOL

“Wonderful synthesized frequency control and readout system.” — W7EMP

By Martin Hanft, WB1CHQ, Production Editor, *ham radio* magazine
"Rotary dial with digital readout is the smoothest dial I have ever used, because of the electronic method of operation. Stability of the frequency reading is perfect and frequency itself is extremely stable. Audio quality and sensitivity are excellent!" — VE3UD

"Ease of operation. Everything you need is right up front." — KA0EJX/5

"No tuneup, just turn it on and go. Built in dual VFOs. At the time I purchased the rig there were no options available — it had everything!" — N5ADJ

"Dual VFOs built in. Ease of operation. Portability and mobile use. A lot for the money." — WA2DXJ

"Broadband tuning and high quality construction." — W2JCM

"Operating convenience." — KA1CMR

"I can swish across the band with a twist of the wrist and not have to retune the final. A great feature." — K7GCO

"Slow tuning rate makes it very easy to scan the band." — AA4RE

"Very selective and sensitive receiver, compact size, excellent speech processor. Almost no distortion with the extra average power." — NH6B

"Probably the most advanced circuitry in all hamdom." — VE3AHR

"In my opinion the fast bandswitching and QSY with no tuneup of the final is the best feature. I also am very impressed with the performance of the receiver. The frequency control features and stability are outstanding." — WA5JXC

**and the bad**

In response to the question, What is the rig’s worst feature?, the highest percentage of respondents, 13 percent, replied that the worst feature of the 701 is the fact that the radio returns to the bottom of the band every time it is turned off. One Amateur, who apparently has power-failure problems, said that this is an inconvenience for him, especially when operating split frequency.

The second most frequent complaint was about the front-panel knobs, which were described by many as "tiny." Twelve percent of those responding mentioned the size of the knobs on the front panel. Other features named as worst included lack of passband tuning on CW, low power output, lack of full break-in, and a tendency for the finals to get too warm. Here are some sample replies to the question, What is the rig’s worst feature?

"Next to impossible to repair yourself because of small size and board layout. Instruction book doesn’t help much." — WB3FYL

"Seems to lack punch in a DX pileup. Power reduction occurs rapidly away from a 50-ohm load. Linears used must have tuned input." — N2AQS

"When you power the rig up or change bands it..."
table 1. Best feature. The percentage refers to the number of respondents who listed that feature as best. Note that many respondents listed more than one "best feature."

<table>
<thead>
<tr>
<th>Feature</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small size, portability</td>
<td>32</td>
</tr>
<tr>
<td>Built-in, dual VFOs</td>
<td>30</td>
</tr>
<tr>
<td>Ease of operation</td>
<td>28</td>
</tr>
<tr>
<td>No tune-up needed</td>
<td>27</td>
</tr>
<tr>
<td>Stability</td>
<td>16</td>
</tr>
<tr>
<td>Broadband tuning</td>
<td>15</td>
</tr>
<tr>
<td>Ease of changing bands</td>
<td>14</td>
</tr>
<tr>
<td>Memory capability</td>
<td>10</td>
</tr>
<tr>
<td>Fast/slow tune</td>
<td>9</td>
</tr>
<tr>
<td>Receiver</td>
<td>9</td>
</tr>
<tr>
<td>Display LEDs</td>
<td>8</td>
</tr>
<tr>
<td>Quality construction</td>
<td>7</td>
</tr>
<tr>
<td>Audio</td>
<td>7</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>7</td>
</tr>
<tr>
<td>Built-in CW filters</td>
<td>5</td>
</tr>
<tr>
<td>Narrow tuning</td>
<td>5</td>
</tr>
<tr>
<td>Appearance</td>
<td>3</td>
</tr>
<tr>
<td>Split frequency capability</td>
<td>3</td>
</tr>
</tbody>
</table>

table 2. Worst feature. The percentage refers to the number of respondents who listed that feature as worst.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatic revert to bottom of band when rig is turned off</td>
<td>13</td>
</tr>
<tr>
<td>Tiny knobs</td>
<td>12</td>
</tr>
<tr>
<td>No passband tuning on CW</td>
<td>9</td>
</tr>
<tr>
<td>Power output too low</td>
<td>7</td>
</tr>
<tr>
<td>Receiver overloads</td>
<td>7</td>
</tr>
<tr>
<td>Not selective enough</td>
<td>6</td>
</tr>
<tr>
<td>Lack of full break-in</td>
<td>6</td>
</tr>
<tr>
<td>Inexact tuning</td>
<td>5</td>
</tr>
<tr>
<td>Finals get too hot</td>
<td>5</td>
</tr>
<tr>
<td>Requires low SWR</td>
<td>5</td>
</tr>
<tr>
<td>Lack of general coverage ability</td>
<td>4</td>
</tr>
<tr>
<td>Poor service manual</td>
<td>3</td>
</tr>
<tr>
<td>Hard to repair</td>
<td>2</td>
</tr>
<tr>
<td>No expansion to WARC bands</td>
<td>2</td>
</tr>
<tr>
<td>Hard to hook up linear</td>
<td>1</td>
</tr>
</tbody>
</table>

always starts at the bottom of the band." — WA0VNH

"Low power output." — K9GA

"Passband tuning not usable in CW mode." — AK0P

"Overloads. Shotgunning when strong signals close. Not selective enough." — N7BZ

"None." — K5STR

"Too easy to use. I am always on the air, and my XYL threatens divorce." — N9AGB

problems

The most common response to the question, Have you had any problems?, was "None." That is certainly a strong recommendation for the ruggedness of this rig. Some 36.6 percent of those responding to the survey had never had any sort of problem with the 701. The most common problem that was reported was blown final transistors: in many instances this was attributed to the operator's own carelessness. It is very likely that the 701 is the first solid-state rig ever owned by many of the Amateurs responding to this survey, and that fact may account for at least a few of the blown final transistors. There were also the usual sprinkling of assorted problems, including some cold solder joints, diode failures, and dirty switch contacts. Here are a few sample responses to the question, Have you had any problems with this rig?

"Cold solder joint. Had to return the rig to Dallas. This happened after six months of use." — WA2DXJ

"Output transistor failure in first few months, but corrected under warranty."

"T/R switch section went bad and blew finals."

"Finals get too hot. They were replaced at no cost with a caution to tune at reduced power." — K8EX

"Mode switch defective; intermittent CW reception." — NH6B

"None. In terms of maintenance, this has been the

always starts at the bottom of the band." — WA0VNH

"Low power output." — K9GA

"Passband tuning not usable in CW mode." — AK0P

"Overloads. Shotgunning when strong signals close. Not selective enough." — N7BZ

"None." — K5STR

"Too easy to use. I am always on the air, and my XYL threatens divorce." — N9AGB

problems

The most common response to the question, Have you had any problems?, was "None." That is certainly a strong recommendation for the ruggedness of this rig. Some 36.6 percent of those responding to the survey had never had any sort of problem with the 701. The most common problem that was reported was blown final transistors: in many instances this was attributed to the operator's own carelessness. It is very likely that the 701 is the first solid-state rig ever owned by many of the Amateurs responding to this survey, and that fact may account for at least a few of the blown final transistors. There were also the usual sprinkling of assorted problems, including some cold solder joints, diode failures, and dirty switch contacts. Here are a few sample responses to the question, Have you had any problems with this rig?

"Cold solder joint. Had to return the rig to Dallas. This happened after six months of use." — WA2DXJ

"Output transistor failure in first few months, but corrected under warranty." — WB6LSF

"T/R switch section went bad and blew finals." — K7GCO

"RF feedback with the electret desk mike." — VE5YD

"Fan never worked from the day it was placed in line." — HP1XKR

"Antenna switching diodes shorted." — DJ4EI

"T/R switching diodes blew up." — DF2KT

"Finals failed when tuning up end-fed wire with tuner at full power. They were replaced at no cost with a caution to tune at reduced power." — K8EX

"Mode switch defective; intermittent CW reception." — NH6B

"None. In terms of maintenance, this has been the
finest piece of equipment I've ever used." — K9BIL

"None! It gets almost constant use now and still no gremlins or breakdowns." — KB5AH

"Using the standard ICOM mikes I have had rf feedback problems when used with a linear amplifier. Bypassing and filtering have not helped." — WA5JXC

"Continual problem with the mode switch; have to switch and wiggle for good contact." — N7BZ

accessories and related findings

WB1CHY's response to the question, What accessories have you purchased for this rig?, was typical: "None needed. Everything needed comes as standard equipment — VFOs, mike, and power supply. Great!" It's not surprising, then, that 38 percent of those surveyed have never bought an accessory. Most of the Amateurs who did buy accessories bought either ICOM's RM2 remote controller (27 percent) or the EX1 extension terminal (17 percent). About 7 percent of those responding mentioned keyers, and some 6 percent had acquired a tuner. Three percent had purchased a desk mike.

To the question, Have you had the rig serviced?, 54 percent answered yes, 54 percent no. Of those who did have factory service, 85 percent found the service satisfactory. Eighty-four percent reported obtaining accessories or parts found them satisfactory, and 90 percent of those who had obtained accessories or parts found them satisfactory.

Among the 90 Amateurs who responded to the ICOM 701 questionnaire, there were only two Novices and one Technician. Fifty percent of those who replied held an Advanced class license, thirty percent held an Extra class ticket, and 18 percent were Generals.

The following twelve categories were scored from 1 to 10 (with 1 being poorest, 4 to 6 average, and 10 perfect): Ease of Operation, Reliability, Durability, Instruction Book, Factory/Dealer Service, Quality of Workmanship, Performance, Maintenance, Parts Availability, Accessories (ease of connection), Price, and Flexibility. The scores are reported in fig. 1.

would you buy one again?

Seventy-seven percent of those responding said that, yes, they would buy a 701 again. That's a very good showing, and one which demonstrates the ICOM 701 to be one of the most popular rigs we've covered in this series of owners' surveys. No one rig can satisfy everyone. But with 77 percent of the owners of ICOM 701s reporting that they would buy one again, it's clear that the ICOM people are doing something right.
HAM RADIO'S FALL FEATURES

AVAILABLE SOON

Order Now! We'll ship as soon as they are released!

1982 U.S. RADIO AMATEUR CALLBOOK
Radio Amateur Callbooks will be ready for shipping week of December 1, 1981. No Amateur station is complete without the very latest Callbook! The new 1982 U.S. Callbook features over 390,000 up-to-date names and addresses right where you want them — at your finger tips. Also contains many helpful operating and Station aids. ©1981.

CB-US $18.95 + $3.05 shipping (U.S.A.) = $22.00

1982 FOREIGN CALLBOOK
If DX is your "thing" then you need a copy of the 1982 Foreign Callbook. Getting a QSL card can be quite a chore without proper names and addresses. Make sure you don't miss out. ©1981.

CB-F $17.95 + $3.05 shipping (U.S.A.) = $21.00

Get 'em both and be really prepared. You save money too! CB-USF Only $39.95

CALLBOOKS AVAILABLE DECEMBER 1, 1981

BRAND NEW 1982 ARRL RADIO AMATEUR'S HANDBOOK
Order today for delivery by late November. Be one of the first to get your copy. Internationally recognized, universally consulted. It's the all purpose volume for radio. Jam packed with information, drawings, and illustrations that are useful to the Amateur and professional alike. ©1981.

AR-HB82 Softbound $10.00
(Available late November)

AR-BB82 Hardbound $15.75
(Available mid December)

PRE-PUBLICATION SPECIAL!

REG. $26.95 NOW $22.95 till Oct. 31
Available — Mid November

BRAND NEW 22ND EDITION OF THE FAMOUS RADIO HANDBOOK by Bill Orr, 6WSAI
The Radio Handbook has been an electronic best seller for over 45 years! This brand new edition reflects all of the latest state-of-the-art advances in a comprehensive, single source reference book. An invaluable aid for hams, technicians, and engineers alike. Also clock-full of projects and other ideas that are of interest to all levels of electronics expertise. 1136 pages. ©1981.

21874 Hardbound Reg. $26.95
Until October 31, 1981 $22.95

WORLD PRESS SERVICES, FREQUENCIES
by Thomas Harrington

In today's fast moving world, staying up-to-date can be a very difficult undertaking. Tuning in to the different world wide press services is one way to keep abreast of all the latest developments. There are hundreds of news service teletype stations operating around the clock from all parts of the world. The easiest way to find these stations is to have a copy of this brand new book on your operating table. Stations are listed by time and frequencies for easy locating and listening. Author Harrington also gives you plenty of helpful hints on the ins and outs of RTTY equipment and other "tricks of the trade." A must if you want to stay tuned to the latest world developments. ©1981.

UE-PS Softbound $5.95

MODERN ELECTRONIC CIRCUIT MANUAL
by John Markus

3600 circuits, from amplifiers to zero voltage reference switches! Exhaustively researched and arranged for ease of use, this comprehensive volume is an invaluable aid to anyone interested in electronics. For the ham there are filters, amplifiers, counters, clippers and more. Electronics hobbyists will also find this book full of valuable and interesting circuits that can be used in a variety of different ways. It would seem that the list is almost endless. Circuits are fully referenced as to where they come from, so that further research can be done if necessary. It's big, it's heavy and it's expensive. But it's a must if you want your library to be complete. ©1980, 1336 pages, 6.5 pounds.

MH-40446 Hardbound $44.50 plus $2.50 shipping

OWNER REPAIR OF RADIO EQUIPMENT
by Frank Glass, K6RO

"The successful repair of any device results in restoring its operation at least to the level it had just before it quit." With this basic concept in mind, author Frank Glass gives you step by step instructions on how to repair all kinds of electronic equipment. Fourteen chapters cover every aspect of repair procedure from component use and failure and how to read schematic diagrams to a most important subject, safety. This book is required for the amateur new to servicing his own equipment. 85 pages. ©1979.

RO-OR Softbound $7.95

AVAILABLE NOW FROM BEVERAGES THRU OSCAR — A BIBLIOGRAPHY
by Rich Rosen, K2RR

Beeverages Thru Oscar — A Bibliography is a complete list of every article that would be of interest to a Radio Amateur or professional that has been published over the last 65 years. References are from QO, Ham Radio, 73, QST, Proceedings of both the IRE and IEEE and Wireless Engineer, to name just a few. In fact, over 292 Magazines have been listed in this book with 92 different subject areas referenced. If you can't find it in this wonderful compilation, chances are, it was never published. Never before has a book like this been put together. Don't wait another minute to get this invaluable reference tool. It costs just $29.95 but is worth much, much more. ©1979.

PR-BO Softbound $29.95

THE 10 METER FM HANDBOOK
by Bob Neil, KE0ID

Here's an exciting and inexpensive new way to have fun. Convert that old CB radio to 10-meter FM. 10-meter FM is very similar to 2-meter FM, except you can talk around the world with broadcast quality signals. This new book gives you simple, precise, step-by-step instructions on how to convert most CB radios to 10-meter FM. The author also goes through a complete description of everything else you need to know to get on 10-meter FM: band plan, operating procedure, amplifiers, antenna systems and how to put a 10-meter repeater on the air. If you want a way to chat with the world from your car, but don't want to put a bulky HF transmitter in the front seat, 10-meter FM is a natural for you. ©1980.

MP-FM Softbound $4.95

ARRL LICENSE MANUAL
78th Edition
Do you have your copy? Brand new, fully revised, covers the latest FCC exams. The new 78th Edition should be required reading for everyone studying for the Technician, General, Advanced or Extra class license. This "grandfather" of all study guides has been carefully researched and prepared to ensure that you are capable of passing the Amateur exam. Get a copy now and be one of the first to receive the new 1981 release. Availability - early 1981.

AR-LG Softbound $4.00

ELECTRONIC COMMUNICATION
by Robert Shrader

1980 edition based on the latest exams. This popular volume presents in a simple step-by-step method, the basic practical theory and electronics. This revised edition covers every FCC exam from Amateur Radio Novice to Commercial. In wide use as a text book, Electronic Communication is based upon the most up-to-date FCC sample exam questions available. To reinforce learning, every few pages there is a quiz that tests your comprehension. A carefully planned home study program, this book will allow you to pass any of the FCC exams. ©1980. 783 pages.

MH-57138 Hardbound $26.95

INTERFERENCE HANDBOOK
by William R. Nelson, WA6FGQ

RFI is a very tricky problem. It can ruin your operating fun and worse. This brand-new book covers every type of RFI interference that you are likely to encounter. Emphasis is placed on Amateur Radio, CB and power line problems. The author has spent over 33 years investigating RFI difficulties. Author Nelson solves the mystery of power line interference — how to locate it, cure it, safety precautions and more. He also gives you valuable steps on how to eliminate TV and stereo problems. To help you understand this perplexing problem even more, this new book gives you interesting , real case histories, tips on how to build, mobile, telephone, CATV, and computer problems and ideas on how to solve them. Profusely illustrated and packed with practical, authoritative information. ©1981. 247 pages, first edition.

RP-IH Softbound $8.95

Cataloque # Title QTY Price Total

Allow 2-4 weeks for delivery. Prices subject to change without notice.

SHIPPING $2.00

TOTAL

SEND TO: HAM RADIO'S BOOKSTORE
GREENVILLE, NH 03048

Tell 'em you saw it in HAM RADIO!
The SWR meter, or standing wave ratio meter, is a small, self-contained device that provides an indication of the match — or degree of mismatch — between your transmitter and antenna system. The unit described here covers the high-frequency bands (80 through 10 meters) and is designed to operate with 50-ohm coaxial feedline, such as the popular RG-8 and RG-58 coaxial cable used in many Amateur installations. The sensitivity is such that it will operate well with most of today’s transceivers in the 100+ watt class, and the unit can be left in the line for continuous monitoring of the system performance.

For ease of operation, two meters are employed in the design, thus allowing simultaneous readings of both the transmitter output and the reflected voltage without switching. A single control, used for calibration, is the only operator control on the SWR meter.

This SWR meter is ideal for the first-time builder, or for the casual builder who does not have a lot of special tools at his disposal. Common hand tools and a drill are about all that are required for the project. The construction is easy and the component count is low. The parts cost is also low. The completed unit measures 5 inches wide by 6 inches deep by 3 inches high (13 x 15 x 8 cm).

the circuit

The circuit of the SWR meter, as shown in fig. 1, has been in use among the Amateur community for many years and has been constructed in many different forms. The rf signal from the transmitter is applied to the SWR meter via the input jack J1. From J1, the signal travels along the coaxial-cable center conductor to the output jack J2, where it exits the metering package for the antenna feedline. Within

By Ken Powell, WB6AFT, 6949 Lenwood Way, San Jose, California 95120
the metering package we try to maintain the 50-ohm characteristics of the overall system, so as not to make the meter look like a "bump" or mismatch in the feedline system.

The two sense lines which parallel the coaxial-cable center conductor pick up a small portion of the rf signal, and this bit of the signal is rectified, filtered, and applied to the meters for monitoring purposes. Germanium diode CR1 and its associated sense line will pick up the incident or forward signal, rectify it, filter it with capacitor C1, and display the magnitude of this signal on the forward meter, M1. In a like manner, CR2 and its associated sense line will sample the reflected or reverse signal and present its magnitude on the reflected meter, M2. The sense lines and their associated circuits are identical but arranged in such a manner as to read the sampled voltage developed in the cable assembly in opposite directions. The use of two meters allows us to measure both of these samplings at the same time without the need for switching.

The calibration control R1/R2, which is a dual potentiometer, is used to maintain both metering circuits at the same level of sensitivity. This is necessary since the relationship of the forward and reflected meters must be constant. In use, the transmitter is keyed and the calibration control adjusted for a full scale reading on the forward meter. This adjustment of the control will set the same level of sensitivity on both meters, and the SWR, or percentage of reflected voltage, can be read directly on the reflected meter. The reflected reading represents the portion of rf voltage that has been applied to the feedline but has been reflected back from the antenna system due to mismatch.

The setting of the calibration control will differ from band to band, because this type of sampling circuit is very sensitive to frequency and the rectified output will increase as the frequency of operation is increased. A few watts of rf will provide full-scale deflection of the forward meter on the 10-meter band, while approximately 60 watts will be required for full-scale deflection on the 80-meter band. This makes the circuit a natural for today's transceivers but makes it impractical for QRP rigs.

**Construction**

The construction of the SWR meter makes it ideal for the first-time builder. The values of the components used are not overly critical, nor can they be damaged as easily as solid-state devices. The rf circuits are sometimes critical, but the SWR meter allows quite a bit of leeway in construction. Standard hand tools and a drill will get you started, and, as the case specified in the parts list is made of a soft-grade of aluminum, the mechanical portion of the project is quite easy. A bit of filing is necessary for the rectangular meter cut-outs, but the remainder of the sheet-metal work is accomplished with a drill. I did a bit of sanding and painting on the unit pictured, but that's not essential.

The heart of the SWR meter is the coaxial-cable sampling assembly, illustrated in fig. 2. This cable assembly is formed with RG-58/U coaxial cable, and the completed dimensions for the assembly are shown in the illustration. Begin construction of the assembly with the 24-inch (61-cm) length of coax; we will trim it down to size as construction progresses. Remove the entire outside jacket of the coax by cutting it the long way with a hobby knife. With the outside jacket removed, expand the diameter of the shield (braid) slightly by pushing the braid toward the center from each end. This slight expansion of the shield will aid in the easy removal of the center conductor complete with its insulation.

Using No. 24 or No. 22 AWG (0.5 or 0.6 mm) solid wire, cut two lengths approximately 24 inches (61 cm) in length to form the sense wires. Two different colors should be used to aid in identification. Cut the coax braid to a length of 16 inches (41 cm) and insert...
the two sense lines into the braid, leaving an equal amount of wire protruding from each end. Bend the excess length of the sense wires over the ends of the braid so the sense wires will not fall out. Now, feed the coax center conductor back into the braid with the sense wires installed. It is easy to manipulate the diameter of the braid by compressing it along its length, and the center conductor should reinstall easily.

After the center conductor is in place, stretch the braid to its normal length to restore it to its original diameter, making it look like a 50-ohm device again. This operation should leave an ample amount of the center conductor and sense line exposed at each end of the braid. The assembly should now begin to resemble that of fig. 2.

With a hobby knife or awl, start a small hole in the braid approximately 1 1/2 inches (40 mm) from the end of the braid. To form this opening in the braid, don't cut the braid but rather start an opening where the braid windings intersect and expand the size of this opening by compressing the braid from the end. Now manipulate the sense wires within the braid until the ends of the sense wires are visible through the hole in the braid. Fish the sense lines out of the braid through the hole and leave approximately 4 inches (10 cm) of the sense line exposed, as in fig. 2. Fold the sense lines back so they are not pulled out of the assembly accidentally.

The hood, a UG-177/U fitting, can now be soldered to the coaxial cable braid. Prior to soldering the hood, pull the cable center conductor back toward the other end of the cable for a distance of 2 inches (5 cm) or so. In this manner, if the center conductor insulation gets a bit warm during the soldering operation the damaged portion can be cut from the cable when it is fitted to the UHF connector. When you have finished the first end of the cable assembly, the sense lines and the hood can be completed similarly for the other end of the coax assembly. When the assembly is complete, stretch the braid out again to restore the original diameter and check the assembly against fig. 2. If it is reasonably close, you can put it aside and start on the case.

the case

If you use the case shown in the parts list, or one of similar dimensions, you can follow the general layout seen in the photo. The front panel requires two rectangular cut-outs be made for the meters and a single hole for the calibration control. The rear panel requires holes for the UHF connectors, and a single hole is needed for mounting the two solder lugs that support the diodes, resistors, and capacitors that form the metering circuit. After you've checked all the case-mounted components to make sure they'll fit, the case may be sanded lightly with 320 paper and a couple of coats of spray lacquer applied. While the case is drying we can do a little modification on the two meters.

the meters

The meter assemblies are held together with transparent tape and can be disassembled easily. The meter scales are held in place by two tabs that are parts of the meter face. These two tabs may be straightened out and the meter faces removed for modification. Gently flatten the meter face out and, using a typewriter eraser, remove all the printed words from the meter faces, leaving only the scales, which consist of 20 divisions.

Using rub-on lettering, modify the meter faces as in fig. 3. The lettering kit used for this purpose was Letraset K19/5, which is a meter lettering set containing both red and black materials. All the lettering on the SWR meter was done in black with the exception of the horizontal line on the reflected meter that
extends from the center of the meter scale to the right edge, or full scale position. This was done in red to remind me to keep things in the system under 3:1. When the meter scales are complete, a light coating of clear spray will lend a professional finish to them. After they have dried, the scales can be reinstalled on the meters and the assemblies held in place with transparent tape.

The front and rear panels can now be lettered with rub-ons, and, if desired, the racing stripes may be added by using Prestape, available at art supply stores. A coating of clear spray will protect the lettering and level out the finish on the case. I mounted the meters to the case with a dab of epoxy at each of the two mounting ears, to avoid more holes on the front panel. After components have been mounted to the case, the wiring should be completed as in the schematic diagram. The photo of the interior of the unit will assist you with wire routing and general layout. The center conductor of the coax is trimmed to size and wired to the UHF connectors; the hoods are put in place using the UHF connector mounting hardware.

As shown in the diagram, the common, or ground portion, of the circuit is connected to the shield of the coaxial cable assembly at the approximate center of the assembly. In turn, the cable assembly is connected to case-ground via the hood assemblies at the UHF connectors. These are the only connections to the case of the SWR meter. When the wiring has been completed, the case can be closed, the calibration knob installed, and the unit is ready for testing.

testing and use

To test the SWR meter, connect your transmitter output to J1 using 50-ohm coaxial cable. The antenna feedline is connected to J2. Key the transmitter and adjust the calibration control for a full-scale reading on the forward meter. Note the SWR reading on the reflected meter at this time. Next, transpose the input and output leads on the SWR meter. Now the transmitter will be feeding the output jack J2, and the antenna system will be connected to J1. If the sense lines and their associated circuits are working well, the readings on the two meters will be transposed. The reading noted on the reflected meter will now be displayed on the forward meter. If this condition approximates your results, both the sampling circuits have the same sensitivity and the input and output cables can be returned to their normal positions. The SWR meter is now ready to go to work on your antenna systems, checking operation of the system and assisting you in tuning the system to your favorite spot on the band.

I made the graph in fig. 4 for checking the operation of my 80-meter dipole antenna. Initially, the lowest SWR reading was found at the lower limit of the band and the SWR increased with frequency. This indicated that the dipole elements were a bit too long and a little pruning eventually led to the second reading indicated by the solid line in fig. 4. Now the resonant point is at 3.7 MHz and the SWR is well within reason on both the CW and phone segments of the band. Remember, if resonance is at the high end of the band the antenna elements are short; resonance at the low end means elements are long. In this manner, you can really get a good idea of what your system is doing and get things tuned for the highest efficiency. In tuning a multiband antenna system, such as a trap dipole, start with the highest frequency band and work your way down in frequency. Once you are satisfied that the antenna system is working well, the SWR meter can be left in the line if desired to provide a constant indication of transmitter output and antenna resonance.

In conclusion I would say that the SWR meter is a good project for the newcomer or the old-timer getting back into the swing of home brew, and, while I would not call it a lab instrument or anything even close, it is a handy device for keeping your antenna system humming.
locating
geostationary satellites

Calculator program for solving basic equations

Satellite tracking is becoming very much a part of Amateur Radio. The OSCAR program is alive and well. AMSAT is strong. The future for the Amateur space community looks good. A geostationary Amateur satellite, tentatively named SYNCART (for SYNchronous geosynchronous Amateur Radio Transponder), is in the works. This spacecraft, which is on the drawing board, will be launched into geosynchronous orbit. This means that SYNCART will be at an altitude of about 22,500 miles (36,225 km) and will be on station over the equator.

This article provides information for locating any geostationary satellite, given basic geometric data, using a popular handheld calculator. Editor.

By using an inexpensive calculator, such as the Texas Instruments TI58 (or TI59), the look angle (relative to true north) and elevation angle may be determined easily from any point on the globe to any geostationary (fixed) satellite. The only requirements are that the latitude and longitude of the earth station must be known, and the longitude of the satellite must be known. (They are listed later in this article.)

The program takes eight minutes to load and check; fifteen seconds to run. The results, relative to true north, may be used directly or put in terms of magnetic north through correlation with the declination angle, as shown on topographical maps.

basic equations

The calculator program uses the following basic equations:

\[
Az^\circ = 180 + \tan^{-1} \left( \frac{\tan \theta}{\sin \alpha} \right) \tag{1}
\]

where \(Az^\circ\) is the look angle of the earth station relative to true north (azimuth)
\(\theta\) is the relative longitude between the earth station and the satellite (earth-station longitude-satellite longitude)
\(\alpha\) is the earth-station latitude

\[
El^\circ = 90 - T - R \tag{2}
\]

where \(El^\circ\) is the elevation angle looking at the satellite, and

\[
R = \cos^{-1} (\cos \theta \cos \alpha)
\]

\[
T = \tan^{-1} \left( \frac{\sin R}{6.6166 - \cos R} \right)
\]

running the program

After the program has been entered into the calculator, data may be entered and the equations solved:

Earth-station latitude (in degrees, minutes, seconds): STO 00.
Earth-station longitude (in degrees, minutes, seconds): STO 01.

By Walter E. Pfiester, Jr., W2TQK, 1 Skadden Terrace, Tully, New York 13159

October 1981
Spacecraft longitude (in decimal form): STO 02. Then, reset the program: RST R/S calculates antenna azimuth relative to true north. Pushing the R/S button a second time results in the antenna elevation.

**example**

42.48 04 STO 00  
76.06 37 STO 01  
135.0  STO 02  (location of RCA SAT-COM 1)  
RST R/S 247.704° azimuth: R/S 13.839° elevation

Should the answer for elevation angles be negative, the satellite is below the horizon and is not in a position to be viewed by the earth station.

**additional program notes**

For locations south of the equator, change the following program steps: 21, 22, 23 from 180 to 360.

**register notes:**

<table>
<thead>
<tr>
<th>register</th>
<th>use</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>earth-station latitude</td>
</tr>
<tr>
<td>01</td>
<td>earth-station longitude</td>
</tr>
<tr>
<td>02</td>
<td>spacecraft longitude</td>
</tr>
<tr>
<td>03</td>
<td>azimuth</td>
</tr>
<tr>
<td>04</td>
<td>elevation</td>
</tr>
<tr>
<td>05</td>
<td>del longitude (used later)</td>
</tr>
<tr>
<td>06</td>
<td>earth-station latitude, later reused, scratch-pad memory</td>
</tr>
</tbody>
</table>

For satellites located at east longitude, enter as a negative number (–) in register 02. No other program changes need be made.
Accessories. Call or write Kitty today for Your Quote.

October — Yaesu FT 902DM — Best Prices and accessories for all major lines.

BARRY’S HAS HAND-HELD

**TEMPO S-4 70 cm**  Icom IC-2AT
Santec ST-7/T

Yaesu 208R  Santec HT-1200  Tempo S-4T & S-5

**VOCOM ANTENNAS AND AMPLIFIERS**

FOR YOUR HANDHELD.

**ICOM IC 290, IC 251A, & 25A • BIRD WATTMETERS**

**MIRAGE 2M amplifiers • MURCH UT 2000B**

Good Deal on ROBOT 400 SSTV

It’s Barry’s for the Drake TR/DR-7, R-7, L75 and Teletype

CW Ops — we’ve got NYE keys, Vibroplex, Bencher paddles and electronic keyers, AEA Morse-A-Matic MT-1, KT-1, MN-1; ICOM IC-720A, IC-730, and IC-22U.

Slings Dipolels, HiGain Antennas, 2 m beams & mobile, 18AVT/WB, KLM, Cushcraft and Ham IV Rotators, STACO variable transformers

The outstanding Yaesu FT-707, FT-902DM, FT-107M or the FT-1012D MK II

RPT Repeaters in stock. Completely interchangeable with VHF Engineering models 144-174 MHz 25W, 210-240 MHz 15W, and 430-480 MHz 10W. Call or write.

**FT 720VRH, 25 watts, 2 meter transceiver. FT-720RU,**

UHF transceiver. FT 480, 2 meter, all mode, 30 watts. FT-780R, all mode 430-440 MHz, full line of accessories.

Kantronics Field Day and Mini-Reader

Cubic Portable Radio Station — Astro Diplomat 150.

**Make your own DXpedition — in a suitcase. CALL.**

* Complete selection of radio books including 1981 Handbook and Repeater Directory

---

**locations of nonmilitary geostationary satellites**

<table>
<thead>
<tr>
<th>satellite</th>
<th>location (degrees east longitude)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOES 2</td>
<td>0-35</td>
</tr>
<tr>
<td>OTS</td>
<td>10</td>
</tr>
<tr>
<td>RADUGA 3</td>
<td>35</td>
</tr>
<tr>
<td>RADUGA 4</td>
<td>35</td>
</tr>
<tr>
<td>SYMPHONIE 2</td>
<td>49</td>
</tr>
<tr>
<td>INTELSAT F5</td>
<td>57</td>
</tr>
<tr>
<td>INTELSAT IVA F3</td>
<td>60.2</td>
</tr>
<tr>
<td>INTELSAT III F3</td>
<td>65.3</td>
</tr>
<tr>
<td>MARISAT</td>
<td>73</td>
</tr>
<tr>
<td>PALAPA 2</td>
<td>77</td>
</tr>
<tr>
<td>RADUGA 2</td>
<td>80</td>
</tr>
<tr>
<td>RADUGA 1</td>
<td>80</td>
</tr>
<tr>
<td>INODISAT</td>
<td>80</td>
</tr>
<tr>
<td>PALAPA 2</td>
<td>83</td>
</tr>
<tr>
<td>MOLNIYA 1S</td>
<td>90</td>
</tr>
<tr>
<td>EKRAN 1</td>
<td>99</td>
</tr>
<tr>
<td>EKRAN 2</td>
<td>99</td>
</tr>
<tr>
<td>KIKU 2</td>
<td>135</td>
</tr>
<tr>
<td>HIMAWARI</td>
<td>140</td>
</tr>
<tr>
<td>INTELSAT IV F8</td>
<td>174</td>
</tr>
<tr>
<td>INTELSAT IV F4</td>
<td>179</td>
</tr>
<tr>
<td>MARISAT 1</td>
<td>176.5</td>
</tr>
<tr>
<td>METEOSAT</td>
<td>0</td>
</tr>
<tr>
<td>INTELSAT IV F7</td>
<td>1</td>
</tr>
<tr>
<td>INTELSAT IV F7</td>
<td>6.4</td>
</tr>
<tr>
<td>SYMPHONIE I</td>
<td>11.5</td>
</tr>
<tr>
<td>STATIONAIR 4</td>
<td>14</td>
</tr>
<tr>
<td>MARISAT II</td>
<td>15</td>
</tr>
<tr>
<td>SIRO</td>
<td>15</td>
</tr>
<tr>
<td>INTELSAT IV F1</td>
<td>18.5</td>
</tr>
<tr>
<td>INTELSAT IV F3</td>
<td>21.7</td>
</tr>
<tr>
<td>INTELSAT IVA F1</td>
<td>24.5</td>
</tr>
<tr>
<td>INTELSAT IVA F4</td>
<td>34.5</td>
</tr>
<tr>
<td>ATS 5</td>
<td>70</td>
</tr>
<tr>
<td>SMS 2</td>
<td>75</td>
</tr>
<tr>
<td>GOES 2</td>
<td>75</td>
</tr>
<tr>
<td>WESTAR V</td>
<td>79</td>
</tr>
<tr>
<td>WESTAR III</td>
<td>91</td>
</tr>
<tr>
<td>COMSTAR D2</td>
<td>95</td>
</tr>
<tr>
<td>WESTAR 1</td>
<td>99</td>
</tr>
<tr>
<td>ANIK III</td>
<td>103</td>
</tr>
<tr>
<td>SMS 1</td>
<td>105</td>
</tr>
<tr>
<td>ATS 3</td>
<td>105.6</td>
</tr>
<tr>
<td>ANIK II</td>
<td>109</td>
</tr>
<tr>
<td>ANIK IV</td>
<td>109</td>
</tr>
<tr>
<td>ANIK I</td>
<td>114</td>
</tr>
<tr>
<td>CTS</td>
<td>116</td>
</tr>
<tr>
<td>SATCOM II</td>
<td>119</td>
</tr>
<tr>
<td>WESTAR II</td>
<td>123.5</td>
</tr>
<tr>
<td>COMSTAR D1</td>
<td>128</td>
</tr>
<tr>
<td>SATCOM 1</td>
<td>135</td>
</tr>
<tr>
<td>GOES 3</td>
<td>135</td>
</tr>
</tbody>
</table>

---

**BOATERS:** Satellite Navigation Equipment.

Call for info on “SATNAV.”

**BUSINESSMEN:** Ask about BARRY’S line of business band equipment. We’ve got it!

Amateur Radio License Classes:

Wednesday & Thursday: 7-9 pm, Saturday 10 am-noon

---

BARRY ELECTRONICS

512 BROADWAY
NEW YORK, N.Y. 10012-4493

TELEPHONE (212) 925-7000
TELEX 12-7670

---

Tell ’em you saw it in HAM RADIO!
We’ve got a Secret...

Our products and customer service will soon be one of the best known secrets in communications monitoring. Want to know more?

WRITE TO DEPT. D FOR NEW 1982 CATALOG

"...searching for the sounds of tomorrow"

GROVE ENTERPRISES, INC.
Brasstown, North Carolina 28902
XZ-2 AUDIO CW FILTER

...THE COPY MACHINE

- 4 active stages, true bandpass filter
- Tunable center frequency
- 4 bandwidths—90Hz, 115Hz, 150Hz & SSB
- Simple to operate
  - Especially designed for the CW operator, useful on SSB

XZ-2 Audio Filter $69.95
12V Power Supply $9.95

WRITE FOR LITERATURE

333 West Lake St., Chicago, IL 60606 (312) 263-1808

BENCHER, INC.

SYNTHESIZED SIGNAL GENERATOR

MODELS: 55-102C $320.95

- Covers 100 to 179.999 MHz in 1 kHz steps with a ±0.001% accuracy
- Internal frequency modulation from 0 to 100 kHz at a 1 kHz rate
- Spurs and noise at least 50 dB below carrier
- RF output adjustable from 5-5000 mV
- Operates on 12-volts @ 1/2 amp. In stock for immediate shipping.

VANGLADY LABS
196-23 Jamaica Ave., Hollis, NY 11423
Phone: (212) 468-2720

NEW COAX SWITCHES FROM BARKER & WILLIAMSON

Model 593
- Single Pole 3 Position
  - Crosstalk (measured at 30 MHz) is -45dB between adjacent outlets and 60 dB between alternate outlets

Model 594
- 2 Pole 2 Position
  - Crosstalk 45dB (measured at 30 MHz)

Specifications for both switches
- Power 1 KW-2 KW PEP
- Impedance 50-75 ohms
- VSWR 1.2:1 up to 150 MHz
- Dimensions 3" x 2 1/4" x 1/4"
- Weight 1 lb.
- Mount Wall or Desk
  - Available at your B&W dealer

New

COAX SWITCHES
from Barker & Williamson

Model 593
- Single Pole 3 Position
- Crosstalk (measured at 30 MHz)

Model 594
- 2 Pole 2 Position
- Crosstalk 45db

Specifications for both switches
- Power 1 KW-2 KW PEP
- Impedance 50-75 ohms
- VSWR 1.2:1 up to 150 MHz
- Dimensions 3" x 2 1/4" x 1/4"
- Weight 1 lb.
- Mount Wall or Desk
  - Available at your B&W dealer

It's Incredible!
Now You Can...

Master code or upgrade in a matter of days! Code Quick is a unique breakthrough to revolutionize the learning of Morse Code. Instead of an endless maze of dots and dashes, each letter will magically begin to call out its own name! Stop torturing yourself with old-fashioned methods. Your amazing kit contains 5 power-packed cassettes, visual breakthrough cards, and on-loan manuals. All this for only $39.95! Send check or money order today to WHEELER APPLIED RESEARCH LAB, P.O. Box 3261, City of Industry, CA 91744. Ask for Code Quick #107. California residents add 6% sales tax.

You can't lose! Follow each simple step. You must succeed or return the kit for total immediate refund!

ALUMA TOWERS
EXCELLENT FOR ALL TYPES OF COMMUNICATIONS

- Telescoping (Crank Up)
- Tilting Easy to Tilt Over
- All Aluminum—Strong—Light
- Rust & Weather Resistant
- Crank Down Easily
- Also in Steel!

Easy to Install,
Low Prices—Many Models Mfg.
Crank-Ups to 100 Ft. High.
We Also Mfg. Trailer, Van or Truck Mounted Towers in Steel or Aluminum.

ALUMA TOWER COMPANY
BOX 20068HR
VERO BEACH, FLA 32960
(305) 567-3423 TELEX 80-3405

AZDEN only $295.00 FREE T/T KIT

- Azden P3000 (2 meter FM)
- 6 AMP, precision regulated power supply $41.00

Order 24 hours a day (215) 884-6010
FREE UPS - N.P.S. Inc. WA3FQ
1138 BOXWOOD RD., JENKINTOWN, PA 19046

Tell 'em you saw it in HAM RADIO!
If You Want The Finest

**ETD ALPHA 77DX**

- Alpha 77DX: The ultimate amplifier for those who demand the finest.
- Tube: Eimac 8877 - 1500 watts of plate dissipation
- Transformer: 4.4 KVA Hypersil®, removable, plug-in
- Filter Capacitor: oil filled, 25 MFD
- Bandswitch: 20 AMP 6 KV
- Teflon - Insulated Toroid Inductors
- QSK CW: Full break-in, (2) vacuum relays
- Tuning Capacitor: Vacuum
- Cooling: Ducted air, large, quite blower, computer grade
- Price: $4945, limited warranty 24 months, tube by Eimac
- Other Alphas: 78-$3185, 76CA-$2395, 76PA-$2195, 76A-$1895, 74A-$2395, 75X-$5935 (EXPORT ONLY)

**ETD ALPHA 78**

- ALPHA 78: Has everything an amplifier needs.
- TUBES: 3 Eimac 8674, 1200 watts dissipation
- TRANSFORMER: 2.4 KVA Hypersil®, removable plug-in.
- TUNE UP: Bandpass (no tune-up) or manual
- QSK CW: Full break-in, (2) vacuum relays
- WARRANTY: 24 mos., limited warranty tubes by Eimac.
- BLOWER: Noise and vibration isolated — QUIET.
- PLATE INPUT: 2.5 kW PEP-SSB, 1.5 kW CW
- NO TIME LIMIT
- PRICE: $3185, call for Special Sale Prices.

Phone Don Payne, K4ID, for a brochure, special prices, and his experience with Alpha Amplifiers

If You Want The Finest

Personal Phone — (615) 384-2224
P.O. Box 100
Springfield, Tenn. 37172

PAYNE RADIO

---

Now, send RTTY with a keyer or CW keyboard!

**Micro-RTTY™**

$299.95 sugg. price

Kantronics brings you the newest development in RTTY send/receive devices with the **Micro-RTTY™**

**Micro-RTTY** can instantly convert CW from any keyer or CW keyboard into standard AFSK two-tone RTTY or two-tone CWID.

**Micro-RTTY** sends and receives RTTY at 60, 67, 75 and 100 WPM plus ASCII 110 baud. Advanced programming of the internal micro-computer and panel controls provide for transmit/receive, CW ID and automatic or manual carriage return/line feed (CR LF) functions.

**Micro-RTTY** will receive any shift of RTTY and display the message on ten big, bright florescent displays. An active 100 Hz filter at 2295 Hz and a ‘tuning eye’ make tuning fast and easy. Power is supplied by a 9 Vdc adapter that’s included.

All these features, and more, are packed into a small 2½” by 5½” by 5½” enclosure.

See your Authorized Kantronics Dealer for a demonstration or write for a FREE brochure.

---

Kantronics
(913) 842-7745
1202 E. 23rd Street
Lawrence, Kansas 66044

More Details? CHECK — OFF Page 94
Ham Radio’s guide to help you find your local

Arizona

POWER COMMUNICATIONS CORPORATION
1640 W. CAMELBACK ROAD
PHOENIX, AZ 85015
602-242-6030 or 242-8990
Arizona’s #1 “Ham” Store. Kenwood, Yaesu, Icom and more.

California

C & A ELECTRONIC ENTERPRISES
2210 S. WILMINGTON AVE.
SUITE 105
CARSON, CA 90745
213-834-5868
Not The Biggest, But The Best — Since 1962.

Florida

AMATEUR ELECTRONIC SUPPLY
1998 DREW STREET
CLEARWATER, FL 33755
813-461-HAMS
Clearwater Branch
West Coast’s only full service
Amateur Radio Store.

AMATEUR RADIO CENTER, INC.
2805 N.E. 2ND AVENUE
MIAMI, FL 33137
305-573-9383
The place for great dependable
names in Ham Radio.

RAY’S AMATEUR RADIO
1590 US HIGHWAY 19 SO.
CLEARWATER, FL 33716
813-535-1416
Atias, B&W, Bird, Cushcraft,
DenTron, Drake, Hustler, Hy-Gain,
Icom, K.D.K., Kenwood, MFJ, Rohn,
Swan, Ten-Tec, Wilson.

Illinois

AUREUS ELECTRONICS, INC.
1415 N. EAGLE STREET
NAPERVILLE, IL 60540
312-420-8629
“Amateur Excellence”

ERICKSON COMMUNICATIONS, INC.
5456 N. MILWAUKEE AVE.
CHICAGO, IL 60630
Chicago — 312-381-5818
Outside Illinois — 800-621-5802
Hours: 9:30-5:30 Mon, Tu, Wed & Fri.;
9:30-9:00 Thurs; 9:00-3:00 Sat.

Indiana

THE HAM SHACK
806 NORTH MAIN STREET
EVANSVILLE, IN 47710
812-422-0231
Discount prices on Ten-Tec, Cubic,
Hy-Gain, MFJ, Azden, Kantronics,
Santec and others.

Kansas

ASSOCIATED RADIO
8012 CONSER, P. O. BOX 4327
OVERLAND PARK, KS 66204
913-381-5900
America’s No. 1 Real Amateur Radio
Store. Trade — Sell — Buy.

Maryland

THE COMM CENTER, INC.
LAUREL PLAZA, RT. 198
LAUREL, MD 20610
301-638-4486
Kenwood, Drake, Icom, Ten-Tec,
Tempo, DenTron, Swan & Apple
Computers.

Massachusetts

TEL-COM, INC.
675 GREAT ROAD, RTE. 119
LITTLETON, MA 01460
617-486-3040
The Ham Store of New England
You Can Rely On.

TUFTS RADIO ELECTRONICS
206 MYSTIC AVENUE
MEDFORD, MA 02155
617-381-3200
New England’s friendliest ham store.

Minnesota

MIDWEST AMATEUR RADIO SUPPLY
3462 FREMONT AVE. NO.
MINNEAPOLIS, MN 55412
612-521-4662
It’s service after the sale that counts.

New Jersey

RADIOS UNLIMITED
P. O. BOX 347
1760 EASTON AVENUE
SOMERSET, NJ 08873
201-469-4599
New Jersey’s only factory authorized
Yaesu and Icom distributor. New and
used equipment. Full service shop.

Dealers: YOU SHOULD BE HERE TOO!
Contact Ham Radio now for complete details.

72 October 1981
Amateur Radio Dealer

ROUTE ELECTRONICS 17
777 ROUTE 17 SOUTH
PARAMUS, NJ 07625
201-444-6717
Drake, Cubic, DenTron, Hy-Gain,
Cushman, Hustler, Larsen, MFJ,
Butternut, Fluke & Beckman
Instruments, etc.

WITTIE ELECTRONICS
384 LAKEVIEW AVENUE
CLIFTON, NJ 07011
201-546-3000
Same location for 63 years. Full-line
authorized Drake dealer. We stock
most popular brands of Antennas and
Towers.

New Mexico
PECOS VALLEY
AMATEUR RADIO SUPPLY
112 W. FIRST STREET
ROSWELL, NM 88201
505-623-7388
Now stocking Ten-Tec, Lunar, Icom,
Morsematic, Bencher, Tempo,
Hy-Gain, Avanti and more at low,
low prices. Call for quote.

New York
BARRY ELECTRONICS
512 BROADWAY
NEW YORK, NY 10012
212-929-7000
New York City's Largest Full Service
Ham and Commercial Radio Store.

GRAND CENTRAL RADIO
124 EAST 44 STREET
NEW YORK, NY 10017
212-590-2630
Drake, Kenwood, Yaesu, Atlas,
Ten-Tec, Midland, DenTron, Hy-Gain,
Mosley in stock.

HARRISON RADIO CORP.
20 SMITH STREET
FARMINGDALE, NY 11735
516-293-7980
"Ham Headquarters USA" since
1925. Call toll free 800-645-9187.

RADIO WORLD
ONEIDA COUNTY AIRPORT
TERMINAL BLDG.
ORISKANY, NY 13424
TOLL FREE 1 (800) 448-9338
NY Res. 1 (315) 357-0203
Authorized Dealer — ALL major
Amateur Brands.
We service everything we sell!
Warren K2IXN or Bob WA2MSH.

Ohio
UNIVERSAL AMATEUR RADIO, INC.
1260 AIDA DRIVE
REYNOLDSBURG (COLUMBUS), OH
43068
614-866-4267
KENWOOD: The biggest and best
Ham Store in the Midwest featuring
quality Kenwood products with working
displays. We sell only the best.
Authorized Kenwood Service.

Oklahoma
DERRICK ELECTRONICS, INC.
714 W. KENOSHA — P.O. BOX A
BROKEN ARROW, OK 74012
Your Discount Ham equipment dealer
in Broken Arrow, Oklahoma
1-800-331-3688 or
1-918-251-9923

Pennsylvania
HAMTRONICS,
DIV. OF TREVOSE ELECTRONICS
4033 BROWNSVILLE ROAD
TREVISE, PA 19047
215-357-1400
Same Location for 30 Years.

LARUE ELECTRONICS
1112 GRANDVIEW STREET
SCRANTON, PENNSYLVANIA 18509
717-343-2124
Icom, Bird, Cushman, Beckman,
Fluke, Larsen, Hustler, Astron,
Antenna Specialists, W2AUW2VS,
AEA, B&W, CDE, Sony, Vibroplex.

SPECIALTY COMMUNICATIONS
2523 PEACHT STREET
ERIE, PA 16502
814-455-7874
Service, Parts, & Experience For Your
Atlas Radio.

Virginia
ELECTRONIC EQUIPMENT BANK
516 MILL STREET, N.E.
VIENNA, VA 22180
703-938-3350
Metropolitan D.C.'s One Stop
Amateur Store. Largest Warehousing of
Surplus Electronics.

Washington
THE RADIO STORE
1505 FRUITDALE BLVD.
YAKIMA, WA 98902
509-248-4777
Your complete Ham store for sales/
service. All major brands. TRADE-
SELL-BUY!
a "free" RTTY tuning indicator

A free lunch may be hard to come by, but here's a trick for getting a simple tuning indicator on a radiotele-type demodulator without any increase in the parts count.

As shown in fig. 1, in my RTTY terminal unit I use a conventional active filter tuned midway between the mark and space frequencies, and a diode clipper to limit the signal. The unconventional part is the use of LEDs instead of ordinary diodes for the clipper. One of the LEDs is mounted on the front panel of the terminal unit where it can be seen as the receiver is tuned.

As the receiver is adjusted to produce the desired 2125- and 2295-Hz tones from an FSK signal, the LED will start to flicker as the correct adjustment is approached. When the two tones straddle the peak frequency of the filter the LED will appear to be steadily lit. Any drift in the receiver or transmitter will be revealed by the reappearance of flickering. The human eye is quite sensitive to the flicker that results from normal Amateur baud rates, and this is a surprisingly effective aid to tuning. Of course, selective fading will also cause the LED to flicker, but one can quickly learn to use both eyes and ears to interpret what is happening.

By using LEDs to limit the RTTY signal after it passes through a 2210-Hz bandpass filter, the limiting action is made visible, and proper tuning is indicated by minimum flicker. Proper action depends on a relatively broad filter response, so component values are not critical. Those shown were what were available and close to calculated values. The first section of the filter shown here is a 2000-Hz highpass filter to increase the rejection of lower audio frequencies; the idea described here will work without this section, but the system will be more vulnerable to interference.

A.S. Woodhull, N1AW

light-bulb dummy loads

Light-bulb dummy loads have been used for transmitter testing since the beginning of Amateur Radio. Light bulbs can harmlessly dissipate lots of rf power, and they give a visual indication of approximate power output.

But, as dummy loads, they have two major shortcomings: they are inductive, and their resistance depends on the power level. When checked with an ohmmeter, the cold resistance will usually measure less than 1/10 the full-brilliance resistance. The inductance of a typical 100-watt, 120-
volt bulb is in the vicinity of 1/2 microhenry. At any given frequency this inductance can be tuned out by series resonating it with a capacitor of equal reactance.

The load, usable from with the low SWR so long as the inductive reactance is tuned out with a series capacitor.

Fig. 2 shows an experimental 200-

watt, 200-ohm balanced dummy load used to test a 4:1 flyback balun. By adjusting the series capacitor and power level it was possible to obtain a 1:1 SWR on any band, 80 through 10 meters. Theoretically, the bulb resistance should be 288 ohms at full brilliance, which would be an SWR of 1.44 on 50-ohm coax when measured through a 4:1 balun. This, in fact, is what it measured. An SWR of 1.0 was observed at about the 100-watt level, and remained below 1.4 from 50-200 watts.

Fig. 2. The 1200-pF variable is a three-gang, 400 pF-per-section unit with the stators connected in parallel.

Fig. 3. The 1200-pF variable is the same as in fig. 1. The switch is a three-position rotary type.

Fig. 3 shows a 50-ohm version of this load, usable from 50-200 watts on all bands, with an SWR below 1.4.

Series and parallel combinations of light bulbs of suitable wattage ratings can be combined to construct a dummy load of any power capacity with the low SWR so long as the inductive reactance is tuned out with a series capacitor.

Fredrick W. Brown, Jr., W6HPH

dipole antenna length reference chart

Here's a handy reference chart if you're thinking about putting up a dipole for one of the new or old ham bands. Using the formula \( L = \frac{468}{f} \) (MHz), the length will be correct for practical purposes, and you can prune the antenna later if necessary.

<table>
<thead>
<tr>
<th>frequency (kHz)</th>
<th>length (ft.)</th>
<th>length (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,800</td>
<td>260</td>
<td>0</td>
</tr>
<tr>
<td>1,920</td>
<td>257</td>
<td>1</td>
</tr>
<tr>
<td>1,860</td>
<td>252</td>
<td>11</td>
</tr>
<tr>
<td>1,875</td>
<td>249</td>
<td>6</td>
</tr>
<tr>
<td>1,900</td>
<td>246</td>
<td>4</td>
</tr>
<tr>
<td>2,000</td>
<td>234</td>
<td>0</td>
</tr>
<tr>
<td>2,500</td>
<td>133</td>
<td>8</td>
</tr>
<tr>
<td>2,600</td>
<td>130</td>
<td>0</td>
</tr>
<tr>
<td>2,700</td>
<td>126</td>
<td>6</td>
</tr>
<tr>
<td>2,800</td>
<td>123</td>
<td>0</td>
</tr>
<tr>
<td>2,900</td>
<td>120</td>
<td>0</td>
</tr>
<tr>
<td>4,000</td>
<td>117</td>
<td>0</td>
</tr>
<tr>
<td>7,000</td>
<td>66</td>
<td>10</td>
</tr>
<tr>
<td>7,050</td>
<td>66</td>
<td>5</td>
</tr>
<tr>
<td>7,100</td>
<td>66</td>
<td>0</td>
</tr>
<tr>
<td>7,150</td>
<td>65</td>
<td>6</td>
</tr>
<tr>
<td>7,200</td>
<td>65</td>
<td>0</td>
</tr>
<tr>
<td>7,250</td>
<td>64</td>
<td>7</td>
</tr>
<tr>
<td>7,300</td>
<td>64</td>
<td>1</td>
</tr>
<tr>
<td>10,000</td>
<td>46</td>
<td>10</td>
</tr>
<tr>
<td>10,100</td>
<td>46</td>
<td>1</td>
</tr>
<tr>
<td>10,200</td>
<td>45</td>
<td>11</td>
</tr>
<tr>
<td>10,300</td>
<td>45</td>
<td>5</td>
</tr>
<tr>
<td>10,400</td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td>10,600</td>
<td>44</td>
<td>7</td>
</tr>
<tr>
<td>14,000</td>
<td>33</td>
<td>5</td>
</tr>
<tr>
<td>14,100</td>
<td>33</td>
<td>2</td>
</tr>
<tr>
<td>14,200</td>
<td>32</td>
<td>11</td>
</tr>
<tr>
<td>14,300</td>
<td>32</td>
<td>8</td>
</tr>
<tr>
<td>21,000</td>
<td>22</td>
<td>4</td>
</tr>
<tr>
<td>21,100</td>
<td>22</td>
<td>1</td>
</tr>
<tr>
<td>21,200</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>21,300</td>
<td>21</td>
<td>11</td>
</tr>
<tr>
<td>21,400</td>
<td>21</td>
<td>10</td>
</tr>
<tr>
<td>24,500</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>24,600</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>24,700</td>
<td>18</td>
<td>11</td>
</tr>
<tr>
<td>24,800</td>
<td>18</td>
<td>10</td>
</tr>
<tr>
<td>24,900</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>25,000</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td>28,000</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>28,100</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>28,200</td>
<td>16</td>
<td>6½</td>
</tr>
<tr>
<td>28,300</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>28,400</td>
<td>16</td>
<td>5½</td>
</tr>
<tr>
<td>28,500</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td>28,600</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>28,700</td>
<td>16</td>
<td>3½</td>
</tr>
<tr>
<td>28,800</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>28,900</td>
<td>16</td>
<td>2½</td>
</tr>
<tr>
<td>29,000</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>29,100</td>
<td>16</td>
<td>1</td>
</tr>
</tbody>
</table>

Many of the new transceivers now have all of the new band crystals installed. You might as well be listening to shortwave broadcasts with a dipole antenna and using the positions until the bands open!

Ed Marriner, W6XM

data retrieval program

using the APPLE II computer

One day I was talking to KN5KSO on 40 meters and he mentioned that we had worked each other once before. I scanned my log quickly but couldn't find KN5KSO. Then the band went out before I could get more specific information.

Haunted by the fact that we had worked before, I started searching through my logs and lo and behold! There it was: one of my first contacts.

I pondered the situation and stared at my station, which included an APPLE II computer with a tape recorder. I decided I needed a data-retrieval program that's short (for maximum RAM storage), provides fast search of two or three fields, prints all items on the monitor in an easy-to-read format, and provides easy data entry. I found such a program and revised it to run on disk or tape. I now have a disk drive and use the APPLE II for log-data retrieval as well as send/receive SSTV, CW, RTTY, and ASCII — all done with software provided by C.H. Galfo, WB4JMD.

I have over 650 log entries, and it takes about 28 seconds to search all of them. The program is set up to hold 1000 entries or less, depending on RAM size, and the program can be easily modified to suit your needs. I'll be glad to supply a copy of the program. Send a self-addressed stamped envelope with 28¢ postage to WB6YHS, 1220 Vienna Drive, No. 715, Sunnyvale, California 94086.

It's nice to have the capability of quickly finding data on former radio contacts. Another use of the APPLE II

Charles M. George, WB6YHS
MINIATURE AUTOMATIC C.W. STATION IDENTIFIER

MODEL 97813, ONLY $74.95

+ COMPLIES WITH NEW FCC RULES, PARTS 89, 91, 93, 95
+ MULTI-MODE OPERATION: MANUAL, SEMI-AUTO AND AUTO
+ MANUAL MODE — A pushbutton switch triggers the identifier which keys the transmitter for the duration of the ID cycle.
+ SEMI-AUTO MODE — The PTT line activates the ID filter if the repeat interval time has expired and keeps the transmitter keyed throughout the duration of the ID cycle.
+ AUTO MODE — The identifier will key the transmitter and ID every time the repeat interval time has expired.
+ CONNECTS DIRECTLY TO MICROPHONE AND PTT INPUTS OF MOST TRANSMITTERS. MINIATURE SIZE MAKES IT FEASIBLE TO MOUNT INSIDE THE TRANSMITTER.
+ PROGRAMMABLE CODE SPEED, TONE, AND REPEAT TIME.
+ ADJUSTABLE CODE AUDIO LEVEL.
+ PREPROGRAMMED MEMORY ELEMENTS — 254 OR 510 BIT (OPTIONAL).
+ SIZE — 1 X 4 INCHES
+ INCLUDES SWITCHES, WIRING AND INSTRUCTION MANUAL
+ ONE YEAR WARRANTY • MADE IN U.S.A.

Include $3 ship/hand., $5 foreign.
CA res. add sales tax. Allow four weeks delivery.

Securltron
P.O. Box 32145 • San Jose, Ca. 95132
Phone (408) 294-8383

IF WE WERE YOU

I'D BUY FROM US
YOUR INQUIRY OR ORDER WILL GET OUR PROMPT ATTENTION
AUTHORIZED DISTRIBUTOR

Model 6154 Termaline®

Tell 'em you saw it in HAM RADIO!
RATES Noncommercial ads 10c per word; commercial ads 60c per word both payable in advance. No cash discounts or agency commissions allowed.

HAMFESTS Sponsored by non-profit organizations receive one free Flea Market ad (subject to our editing) on a space available basis only. Repeat insertions of ad (subject to our editing) on a space available basis only. Repeat insertions of ad (subject to our editing) on a space available basis only. We reserve the right to reject unsuitable copy. Ham Radio cannot check each advertiser and thus cannot be held responsible for claims made. Liability for correctness of material limited to corrected ad in next available issue.

DEADLINE 15th of second preceding month.

SEND MATERIAL TO: Flea Market, Ham Radio, Greenville, N. H. 03048.

QSL CARDS

QSL's - BE PLEASANTLY SURPRISED! Order our three colored QSL's - all ads for $5.00 per 100 or $1.00 per 100. Satisfaction guaranteed. Samples 1.00 each (refundable). Constantine Press, 1219 Ellington, Myrtle Beach, SC 29577.

QSL's & RUBBER STAMPS - Top Quality Card Samples andamp; Stamp info - 50c - Ebert Graphics SR, Box 70, Waseca, Minnesota 56093.

500 QSL's, $10. Catalogue, 743 Harvard, St. Louis, MO 63130.

QSL's: No stock designs! Your art or ours; photos, originals, 50c for samples & details (refundable). Certified Communications, 4138 So. Ferris, Fremont, Michigan 49412.

DISTINCTIVE QSL's - Largest selection, lowest prices, top quality photo and completely customized cards. Make your QSL's truly unique at the same cost as a standard card, and get a better return rate! Free samples, catalogue. Stamps appreciated. Sun 23922 Print, P.O. Box 412, Rocky Point, NY 11778 (516) 744-8280.

CADILLAC OF QSL CARDS, 3 to 4 colors, send $1 for samples (refundable). Mac's Shack, P.O. Box 3417, Seven Points, TX 77581.


APARTMENT DX - Get out of that bandit from apartment or condo - Handbook of Apartment Operation by Dan Fox, W2IQA. Only $8.95 + $1.00 postage and handling. 30-day money-back guarantee. Send check, VISA, or MasterCard to Wessex Publishing Co., Dept. A9, P.O. Box 175, N. Chalfont, MA 01883.

RTTY JOURNAL-EXCLUSIVELY AMATEUR RADIOTELETYPE, year one subscription $7.00. Beginners RTTY Handbook $5.00, RTTY Index $1.50. P.O. Box 24, Cardiff, CA 92007.

HEATH HW-101, CW filter, AC PS, noise blanker, home brew DC PS, $325.00, excellent condition w/ manuals. Dave Weits, KDBTC, P.O. Box 2737, Oakland, CA 94602.

ROHN TOWER - direct to you from worldwide distributor, all products available. Sample prices - 25 G sections 1.00 each, 45 G sections 1.00 1.00 each. 48 Tower $31.00 each. Hill Radio, Box 1405, 2503 G.E. Rd., Bloomington, IL 61701. 815-663-2141.


SEND MATERIAL TO: Flea Market, Ham Radio, Greenville, N. H. 03048.
WHY PAY
FULL PRICE FOR AN 80-10 METER VERTICAL

...if you can use only 1/3 of it on 107
...or only 1/2 of it on 20
...or only 3/4 of it on 40?

Only Butternut's new HF5VIII lets you use the entire 26-foot radiator on 80, 40, 20 and 10 meters (plus a full unloaded quarter-wavelength on 15) for higher radiation resistance, better efficiency and greater VSWR bandwidth than conventional multi-trap designs of comparable size. The HF5VIII uses only two high-Q L-C circuits (not traps) and one practically lossless linear decoupler for completely automatic and low VSWR resonance (typically below 1.5:1) on 80 through 10 meters, inclusive. For further information, including complete specifications on the HF5VIII and other Butternut antenna products, ask for our latest free catalog. If you've already "gone vertical," ask for one anyway. There's a lot of information about vertical antennas in general, ground and radial systems, plus helpful tips on installing verticals on rooftops, on mobile homes, etc.

400T ANTENNA TUNING UNIT WANTED for cash or trade. DCO. 10 Schuyler Avenue, No. Arlington, NJ 07032. (800) 526-1270.

MOBILE IGNITION SHIELDING provides more range with no noise. Available in most models. Many other suppression accessories. Literature, Estes Engineering, 930 Marine Dr., Port Angeles, WA 98363.

KH 181, HR1680, P293 Heath Twins EC asking $300.00. Globe Chief 90A, Clegg 22' er, AMECO 621 VFO, Kantronics Freedom VFO (80 & 40) — all best offer. Pete, WA2ROF, (201) 236-8106.

WANTED: Government Surplus radio equipment, microwave equipment and "old" General Radio test equipment. P. J. Pfister, 2 Lake Avenue Extension, Danbury, CT 06810 WAILDU.


ANTIQU SPACE RADIO SET. Good condition. RR-A radio receiver. RTX-6 transmitter. Power supply $500. Best offer, John Pankow, Box 207, Royal Oak, MI 48071. (213) 205-7040.

NEEDED: Western Electric and Bell System manuals on residential telephones and accessories, including model 500, Trimline, Touch-A-Matic 5, speakerphone, jacks, wiring, installation procedures, etc. C. G. Serber, 256 West 88th St., New York, NY 10021. 212-674-3529.

FT-191E, fan, three filters SSB, 600, 250 installed. Includes spare tubes (originals ok), free UPS shipping. $675.00. John Skubick, 701-106 Ave., Naples, FL 33940. (813) 613-1719.

ETCH IT YOURSELF PRINTED CIRCUIT KIT, Photo-Positive Method — no darkroom required, All the supplies for making your own boards, direct from magazine article in less than 2 hours. Only $29.95, S.A.S.E. for details. Excel Circuit Co., 4415 Renfrew, Royal Oak, MI 48073.

FOR SALE: Kenwood TS-120S, absolutely mint, $495; Kenwood TS-180S, w/DPC and Dual IF Filters, excellent, $725; Hammarlund HQ-170AC VHF, 180-2m, clock, $135; MFJ-752 SSB/AM Superfilter, mint, $90; Heathkit HD30, mint, $15; Motorola VHF FM Walkietalkie H131-1AL, $25; TAS-12 receiver, $18. WAZQY, 208-245-270. 238-10th, St. Mary's, ID 83661.

MIRROR-IN-THE-LID, and other pre-1946 television set wanted. Paying $100 for any complete RCA "TRK" series, or General Electric "HE" series set also looking for 12AP4, MW-31-3 picture tubes, parts, literature on pre-war television. Arnold Chase, WA1RYY, S Rushleigh Road, West Hartford, Conn. 06117 (203) 521-5280.

HELP WANTED SPARE TIME. UHF RF power devices PCB board design. Commitee, 9625 Cattell, La Porte, TX 77571.

PRINTED CIRCUIT BOARDS: From $0.25 to $2.40 per square inch with your estimates. Communications Design, Inc. 1105 Lehr, West Memphis, Arkansas 72301.

SWAN 350c 10-40 meters with power supply and speaker, very good condition, $250. 1 ship UPS. Paul, WAGJPS, 1146 East 78th, Cleveland, Ohio 44103 (216) 391-0241.


8251 FOR SALE. Anyone wanting to complete his S-line, J. Darmer, WAGSKX, Rt. 3, Box 900C, Merritt Island, FL 32952.

WANTED: AN-MS connectors, synchro's, etc. Send list, Bill Williams, P.O. 7057, Norfolk, Virginia 23509.

2 SINGER-GERTSCH FM-7, 1 Motorola T1020A frequency deviation meters, cables & covers, covers. 20-10000 MHz, 0.0001% accuracy, AM/FM modulation. $30 each. Technical Enterprises, 21851 Newland #244, Huntington Beach, CA 92646. (714) 960-2169.

WANTED: Micor and Master II base stations, 400-420 MHz. Any solid state 2 and 6 GHz microwave equipment, AXTB, 4 Ajax Place, Berkeley, CA 94708.

COAXPROBE — In-Line Coaxial RF probe for frequency counters and oscilloscopes. Monitor your transmitted signal directly from the coax line with the CoaxProbe RF Sampler. The CoaxProbe provides 3-15 volts output from 1 to 2000 watts with 3000 volts of isolation for your equipment. Connect the CoaxProbe into your transmis-

RED HOT SPECIALS
AZDEN PCS 3000 2 m. ........................................ 297.00
NEWI KDK 2025 MKII........................................ 307.00
JALEX CSAS 2m Preamp........................................ 36.00
BEGI AL-2200 Scanner........................................ 299.00
KANTRONICS FIIID Code Reader.......................... 360.00
ANALOG METER................................................ 120.00 off list
TEN-TEC Argosy Xcvr.......................................... 474.00
TEN-TEC Delta Xcvr........................................... 738.00
TEN-TEC Osce Ocvr............................................ 1040.00
BENCHER Black Padlock..................................... 36.00
SANTEC ST-7T 440 MHz Handheld...................... 290.00
Any KLM 2m Amps........................................... 25.00 off list

Prices subject to change without notice.

SAGE for our Large Specials and Used Equipment Lists.

BEN FRANKLIN ELECTRONICS
1151 N. Main
Hillsboro, KS 67063
316-947-2269

PC BOARD BARGAINS, GLO FRP 1/16" 1 OZ COPPER
1 SIDE 12" x 12".............................................. PKG OF 5 $31.25
1 SIDE 5½" x 11½"............................................ PKG OF 5 $18.75
2 SIDE 12" x 12".............................................. PKG OF 5 $35.25
2 SIDE 5½" x 11½"............................................ PKG OF 5 $21.25

MARCO
P.O. BOX 2310, WEIRTON, W.V 26062

FACSIMILE
COPY SATELLITE PHOTOS, WE FAX MESSAGES, PRESS OR PERSONAL
The Faxes Are Clear — on our full size (18-1/2") wide, record-quality paper.

TELETYPE
RTTY MACHINES, PARTS, SUPPLIES
ATLANTIC SUPPLIES SALES
(201) 372-0249
2370 NAUTIUS AVE BROOKLYN N.Y. 11224

More Details? CHECK — OFF Page 94
GLB ID-1 AUTOMATIC IDENTIFIER

- For transceivers and repeaters!
- Small - only 2.3" x 1.7" x 0.6"!
- Low cost - only $39.95 (wired & tested)!
- Easy installation - 2 wires plus ground!
- Pots for speed & amplitude!
- 8 switchable messages!
- Each message up to 2000 bits long!
- Automatic operation!
- Reprogrammable memory!
- Allow $1.50 for shipping & handling!

We have a complete line of transmitter and receiver strips and synthesizers for Amateur and commercial use. Write for our catalog.

We welcome MasterCard or Visa

GLB ELECTRONICS
1952 Clinton St., Buffalo, N.Y. 14206
1-(716) 824-7936, 9 to 4

COMPUTERIZED GREAT CIRCLE MAPS

- Great Circle Map Projection
- Centered on your exact QTH
- Calculated and drawn by computer
- 11 x 14 inches
- Personalized with your callign: $12.95 p.p.d.
- (Air Mail add $2.00)
- Beam Heading Printout with bearings to 660 locations, $9.95

Great idea, too!

Bill Johnston, N5KR
Dept. H.
1808 Pomona Drive
Las Cruces, New Mexico 88001

FILTER CASING WORKS!

You can get significantly better performance from your Receiver by improving its IF filtering. The most cost-effective way to do this is to place a superior 8-pole SSB filter essentially in series (or Cascade) with the original unit. The resulting increase in the number of poles of filtering is so massive as to cause a dramatic increase in selectivity and reduction of adjacent channel QRM. The authors of the following major articles all stress the effectiveness of FOX-TANGO filters in this application and their method of assembly is simple and trouble-free. As a bonus, CW performance is improved as well as SSB, at no extra cost or effort!

Recent Magazine Articles on Filter Cascading

YAESU FT-901/902, See 73, Sep. 1981
KENWOOD TS820 See "QG", March 1981

Tell our original article or send $1 to Fox-Tango for copies of the articles that interest you. To make the modification, order the appropriate cascading kit from below. Each contains the parts specified in the article, the recommended FOX-TANGO filter, and complete instructions.

FOX-TANGO Cascading Kits in Stock

YAESU FT-901/902 Series . . . $60
HEATH SB1044 Series . . . . . . $40
KENWOOD TS820 Series . . . . $65 w/min imp.
*KENWOOD TS220 Series . . . . . . $65 w/min imp.
*YAESU FT-101 Series (not ZD) $85 w/case bd
*Proven mods based on articles in preparation

Shipping via AirMail: $2 US/Can, $5 Elsewhere
Florida Residents: Add 4% sales tax

FOX-TANGO stocks the widest variety of custom-made time-tested crystal filters available from any source for Yaesu, Kenwood, Heath, Drake, and Collins rigs. Cascading is only one application for these filters. Others include replacing outdated or inferior original units, filling spots provided for optional filters, or adding extra filters using diode switching boards if the "spots" are filled. However, since the degree of improvement depends upon the quality of the filter used, cheap substitutes are no bargain! FOX-TANGO has never spared expense or effort to make its filters the very BEST and guarantees satisfaction - plus fast, friendly, knowledgeable service and support. For information about our complete line, including SSB, CW and AM filters, phone or write for our free brochure. Specify the set you want to improve.

We welcome mail or phone orders and accept payment by VISA, MASTERCARD, M.O., Check, or C.O.D. (at your expense)

FOX TANGO CORPORATION
Since 1971. By and for Radio Amateurs
Box 15944H, W. Palm Beach, FL 33406
Phone: 1-305-663-9567

INTERFERENCE HANDBOOK

BY WILLIAM R. NELSON, W6AFQ

RFI is a very sticky problem. It can ruin your operating fun and worse. This brand-new book covers every type of RFI interference that you are likely to encounter. Empath is placed on Amateur Radio, CB and power line problems. The author has spent over 30 years investigating RFI difficulties. Author Nelson solved the interference problem - how to locate it, cure it, safeguard precisions and more. He also gives you practical advice on how to eliminate TV and stereo problems. To help you understand this perplexing problem even more, this new book gives you interesting RFI case histories, tips on how to buy or build, mobile, telephone, CATV, and computer problems and ideas on how to solve them. Profusely illustrated and packed with practical authoritative information. © 1981 247 pages, first edition.

RP-III Softbound $8.95

HAM RADIO'S BOOKSTORE
Greenville, N. C. 30348

October 1981 79

Tell 'em you saw it in HAM RADIO!
APPLE Disk Based System:
APPLE Game Paddles available

BEST BUYS for

ICOM
HOURS:
CALL TOLL FREE
(800) 621-5802

440 MHz linear 5289.95
Apple Limited Special $21.95
Frequency Counter
For

IC-2A Hand-Held
9:30-5:30
October 1981

Engineers*Regency*Robot
Mini-Products*Mirage*Mosley

TS-830s $144.95
Watt
MHz

with

Wednesday, November 18; ends 2359 UTC, Sunday, November 22, 1981.

Check-In on 146.52 and 52.525 MHz and 144.2, 144.19, and 144.11 MHz. For special
GSL send to N6CDD, 902 23rd Street, Vienna, VA 22180.

Operating Events

October 10 and 11: The Jefferson County ARC, DeSoto, MO, will be operating a special occasion event, KABAR, commemorating the Population Center of the U.S., as determined by the 1880 census, from 1700 GMT, October 10-11. Approximate frequen-
cies: 2845 from upper bottom edge of General portions of 10, 15, 20 and 40 meters; and center of Novice po-
tions.

For certification: SASE to: KABAR, 3009 High Ridge Blvd., High Ridge, MO 63049.

October 10, 10: 9 Land QSO Party. Starts 1800 UTC, Saturday, October 10; ends 2359 UTC, Sunday, October 11. Stations outside the U.S. are encouraged to contact AO-10, AO-11, AO-12, AO-13, and AO-14. QSLs to: CW, SSB, 160, 80, 40, 20, 15, 10, 6, 2 meters, 2.5 meters, 3 meters, 4.6 meters, 7.0 meters, 10.1 meters, 14.1, 18.1, 21.1, 24.1, 28.1, and 50.1 meters. For further information: SASE to: W7KNZ, 2811 W. Valley Dr., Phoenix, AZ 85021.

October 10-12: The Southern Sierra ARC, Tehachapi, is conducting a dual-site expedition using KBR from Bad-
dee, Death Valley, and the summit of Mount Whitney, California, during the Columbus Day weekend. 1900 UTC October 10 to 0100 UTC October 12. Modes: CW QRP 21.10 and 26.105. 7.05 MHz. Two CW stations will be on different bands. 2 meter FM on 145.56 MHz simplex. The Badwater station will operate from 1900 UTC October 10 to 1900 UTC October 11 on CW ± 21.10 and 7.110 MHz. For a commemorative certifi-
cate confirming your QSO, send GSL and $1.00 to SARS, Rt. 2, Box 338, Tehachapi, CA 93561.

October 13, 14, 18: The Colquitt County Ham Radio Society will be operating club station W4DKW from the fourth annual Sunbelt Agricultural Exposition. 0900 to 1600 EDST each day. The Sunbelt Expo, Spence Field Airpark, Spence Field, Ga., is the largest agricultur-
al show in the south. Operations on 40 and 20 meters around 7.250 and 14.300 MHz with some in the other HF bands. William S. Sullivan, K4AW, 1004 Alabama Ave., Ohio 317, invites visitors to meet the group at the Expo. For further information: SASE to: W4DKW, Box 3, Tifton, GA 31793.

October 15, 16, 18: The Stark RTTY Group, WBRVM, will be operating a special event station at the MidWest Mall Hobby Show, Canton, Ohio, to demonstrate Amat-
uer Radio to the general public. Modes and frequencies: SB, 5 kc up from low end and of general portions of 80 thru 10 meters; CW, 3540, 7040, and 14.060. RTTY on 14040 and 3620. Local contacts on 146.52 MHz from 1400 to 0100 GMT, October 15; and October 15, 16, 17 from 1400 to 2200 GMT, October 16. A special certificate awarded to all Ama-
uteers contacted during this period. Send GSL and SASE (9 x 11) to: The Stark RTTY Group, WBRVM, 138 Page Street NW, Massillon, OH 44646.

October 17: 27th Annual VHF Conference, Kohrman Hall, Western Michigan University, Kalamazoo, MI 49008. This is a technical/educational conference for Amateurs and Radio Engineers. For further information: SASE to Western Michigan University, Department of Electrical Engi-
neering, Kalamazoo, MI 49008. Att: Dr. Glade Wilcox, WR9UH.

October 17, 18, 19: QRP Amateur Radio Club's Interna-
tional CW QSO Party. From 1200 UTC, Saturday, October 17 to 2400 UTC Sunday, October 18. Suggested frequen-
cies: 3570, 7110, 21100, 28100. Call: QRP de Geoff, K8JU. For further information: SASE to: QRP ARC Contest Chairman, William W. Dickerson, WA2JOC, 352 Crampton Drive, Monroe, MI 48161.

October 21 & 22, November 4 & 5: YL ANNI-
VERSARY PARTY. All licensed women operators worldwide are invited to participate, October 21, 1800 UTC to Thursday, October 22, 1800 UTC. Phone-Wednesday, November 4, 1800 UTC to Thursday, November 5, 1800 UTC.

October 24 and 25: The Wiesbaden Amateur Radio Club invites operation on all bands, 10 through 80 meters. Station location: Germany. For further infor-
mation: Steve Hutchins or Claude Matchette, HHC, V803, Massillon, OH 44646.

October 31: The High Sierra ARC, Alamed, Ca., will be operating a special event station, 6LSS, commemorating the non-commercial station 6L at Almeda, Ca., which operated from 1900 to 1940. QSLs to: 6LSS, Rt. 2, Box 38, Alamed, Ca. 94501.
ETS Morse-code training package

Many methods have been offered for learning Morse code, some good and some not so good. This is a good one. We at ham radio have had an opportunity to study the Morse-code training package by Educational Technology and Services, Incorporated (ETS). This training package is not just an ordinary collection of code tapes that progress from low to high speed. The training method is based on scientific principles — a Perceptual Learning Model developed at the University of Minnesota and from research conducted at Southern Illinois University and at the Research and Development facility of ETS.

It has been found that, when using conventional Morse-code teaching methods, students progress to a speed of 10-13 WPM, at which point they reach a plateau. From then on, learning to copy code at higher speeds becomes more difficult. This plateau results from the shift from one method of copying, in which the student must analyze the code character, to another method in which the student begins to perceive the code character. ETS studies have resulted in the identification of the variables that contribute to the plateaus experienced in the Morse-code learning process and have developed a concept that eliminates the problems associated with traditional Morse-code training programs.

With the ETS package, the entire alphabet can be learned in 25 trials. The letters are presented at, and spaced at, 18 WPM. Now this may scare you off — whoever heard of starting to learn Morse at 18 WPM?

That's where the ETS perceptual learning concept comes in. You learn to recognize, and translate to paper, letters and words not at, say, 5 WPM with gradually increasing speed, but at 18 WPM from the very beginning. Trial number one starts you off with two letters randomly presented. Each successive trial adds a single letter until the entire alphabet is learned. When the last trial is mastered, the entire alphabet can be copied at 18 WPM. The method allows you to master the code in 40 percent less time than conventional Morse-code instruction techniques.

The ETS Morse-code training package consists of four phases:

1. Twenty-six letters of the alphabet
2. Numbers
3. Punctuation and special characters
4. Plain text practice

The ETS Morse-code training package, consisting of five cassettes (6½ hours total practice) is available at Ham Radio's Bookstore for $18.95. — ham radio staff.

MFJ CW/SSB/notch filter

All modern receivers have more than adequate filtering capabilities. However, despite all the fancy filters available, there are still those of us who need more help. MFJ, long known as the supplier of add-on accessories, has designed an excellent outboard audio filter: the MFJ 722 Signal Optimizer. Using the latest chip technology, the Signal Optimizer design includes a tunable notch filter and selectable high-pass/low-pass filter on SSB, and a bandpass filter on CW.

Hookup and installation of the 722 is simple and straightforward. The receiver audio is routed through the filter and back to the speaker. A 1/4-inch (6.4-mm) jack is included in the filter so you can use headphones should you prefer. The only other connection is to provide 12 volts dc to the filter. Signal Optimizer design allows ease of use under any operating situation.

As with every new piece of equipment, there is a learning curve associated with using the filter. The 70-dB notch filter is a bit tricky to use at first. But MFJ's operating manual clearly explains the tricks of using the notch, and that complete explanation eliminates any problem you might have.

When filtering in the SSB mode, the 722 attenuates all the high and low frequencies. In the high-pass position, all signals below 375 kHz are efficiently eliminated. When switched to 2.5, 2 and 1.5 kHz a low-pass filter is engaged in progressively narrower units to achieve desired filtering.

On CW, the Model 722 uses an active IC bandpass filter of progressively narrower windows. One problem that has occurred before with some outboard filters is that the narrower the filter becomes, the more it tends to ring or give you the impression you are listening through a pipe. The MFJ 722 has no ring.

During many hours of use, both in casual rag chewing and DXing, the Model 722 filter has been quite a nice addition to the shack. A real test comes each summer with 160-meter QRM.

The MFJ Signal Optimizer measures 5 x 2 x 6 inches (13 x 5 x 15 cm) and sells for $69.95 plus shipping. A 12-volt dc power supply is also available for $79.95 plus shipping. For more information write MFJ Enterprises, Box 494, Mississippi State, Mississippi 39762.

wire cut and strip tool

A new concept for easy and clean stripping of wires for wire-wrapping, electronic, and appliance applications, the ST-100 strips without nicking and automatically generates the proper strip length. Biomechanically designed for maximum efficiency, its slim design makes it ideal for storage in pocket, belt holder, or tool kit.

Simply place wires (up to four) in stripping slot with ends extended beyond cutter blades, press tool and pull. Wire is cut and stripped to prop-
Rohn 'BX' Towers

- For Home TV, Ham Radio and CB.
- Up to 18 sq. ft. antenna capacity.
- Available to 64' in 8' sections.
- All riveted construction — no welds.
- Beaded channel leg for added strength.
- All steel — galvanized for added life.
- Can be used with Concrete Base Stubs. Cylinder Base or Hinged Concrete Base.

UNR-Rohn
Division of UNR Industries, Inc.
6718 West Plains Road, P.O. Box 2000
Peoria, Illinois 61616
USA

THE PROFESSIONAL TOUCH TONE ENCODER

An ultra high quality encoder for professional applications. Absolute reliability and function makes the difference. There's a Pipo encoder for every call and application. Totally serviceable, easy to operate and install. Call or write for free catalog and information! (213) 852-1515 or P.O. Box 3435, Hollywood, CA 90028.

PATENTED

PipoCommunications

Emphasis is on Quality & Reliability

ALL BAND TRAP ANTENNAS!

- PRETUNED - COMPLETELY ASSEMBLED - ONLY ONE NEAT SMALL ANTENNA FOR UP TO 7 BANDS! EXCELLENT FOR CONGESTED HOUSING AREAS - APARTMENTS.
- LIGHT - STRONG - ALMOST INVISIBLE!

COMPLETE AS SHOWN with 90 ft. RG58U-52 ohm feedline, and PL259 connector, insulators, 30 ft. 300 lb. test dacron end supports, center connector with built-in lighting arrestor and static discharge - molded, sealed, weatherproof, resonant traps "X"-8" - you just switch to band desired for excellent worldwide operation - transmitting and receiving! Low SWR over all bands - Tuners usually NOT NEEDED! Can be used as inverted V's - stagers - in-attic, on building top or narrow lots. THE ONLY ANTENNA YOU WILL EVER NEED! GUARANTEED FOR 2000 WATTS SSB 10000 WATTS CW. WARRANTY ON NOVICE AND ALL CLASS AMATEURS!

For further information call or write:

SKYTEC
Box 535
Talmage, CA 95481
(707) 462-6882

Jan 1, 1981

ERNEWED HOUSING AREAS

inexpensive bridge rectifiers

Four new low-cost, single-phase, rectifier bridge assemblies — the MDA2550/1 and the MDA3550/1 — have been introduced by Motorola. These economy 25- and 35-amp bridges use prime button rectifiers from Motorola's high-volume, low-cost automotive alternator rectifier line.

The new devices are offered in the most popular 50- and 100-volt ratings. These bridges have 400-amp surge capability and an electrically isolated base up to 1800 volts. Immediate availability is from OEM and authorized Motorola distributor stocks (or contact Motorola Semiconductor Products, Inc., P.O. Box 20912, Phoenix, Arizona 85036).

Mini-Reader

Only a few years ago, to receive in the RTTY mode, you had to spend hours putting together a demodulator, learning how to operate a Model 15 or 19 machine, reloading paper, and on and on. Seemed like you felt more like an auto mechanic than a Radio Amateur. Big and bulky was the name of the game.

Things have changed. The great strides of the electronics industry to miniaturize components have resulted in smaller and smaller products. A good example is the Kantronics Field Day Code and RTTY Reader. The
Field Day Reader is large — about the size of an fm transceiver. Kantronics engineers then miniaturized the Field Day to hand size and renamed it the Mini-Reader. The Mini-Reader can do everything that its larger brother, the Field Day, can but in a much smaller package, measuring only $5.75 \times 3.62 \times 1.25$ inches ($14.6 \times 9.2 \times 3.2$ cm). The Mini-Reader fits easily into your pocket and comes at the attractive price of $314.95.

Mini-Reader features

The Mini-Reader copies Morse from 3-80 WPM; RTTY with any shift at 60, 67, 75, and 100 WPM Baudot; and 110 and 300 WPM ASCII.

To assist in logging, the Mini-Reader can function as a 24-hour clock. And if that isn't enough, the Mini-Reader can also be programmed to function as an audio-frequency counter. For tuning ease, the Mini-Reader has a tuning LED that indicates exactly when a station is properly tuned in. Also, the Mini-Reader has a built-in 250-Hz bandwidth filter to reduce interference. The earlier Field-Day Reader used digital circuitry, which required a fairly large package. To accomplish miniaturization, Kantronics has designed the Mini-Reader around a programmed microprocessor.

interfacing with your receiver

Hookup of the Mini-Reader is carefully explained in the owner's manual and takes only a few minutes. While connecting the Mini-Reader to a receiver in preparation for this review, we inadvertently put plus to minus and minus to plus. With some equipment this would mean sure disaster or irrevocable damage. But the Mini-Reader, thanks to careful design, took our abuse in stride and worked perfectly when we realized our mistake and corrected the power leads.

The real test came when audio from the receiver was applied. Tuning across the top of 20 meters, we found a nice strong RTTY signal that was...
receiving manual CW

Enough about RTTY. Now it's time to try the Mini-Reader on CW. As the instruction manual states, decoding CW is not an easy task. This is because of the different techniques and styles of sending Morse code. If everyone's spacing and character weight were the same, code readers wouldn't have any problems.

Despite a bit of skepticism on our part, the Mini-Reader copied every signal we listened to except a ham who was using a bug and seemed to delight in his Lake Erie swing.

The Mini-Reader had a field day with the speed merchants on the low end of the 40-meter band. The only time the Mini-Reader failed to decode signals was in the presence of loud static crashes and QRM.

specifications

Morse speed tracking: 3-80 WPM
Filtering: active 250-Hz bandwidth; 750-Hz center frequency
Display: 10 alphanumeric, 14-segment units
Modes: Morse; Morse with speed display. Morse practice RTTY at 60, 67, 75, 100 WPM, ASCII at 110 and 300 WPM. Clock test and audio-frequency counter.

Audio-frequency counter: 0-79 kHz + 0.01 percent
Power: 8-18 Vdc at 240 mA.

The Mini-Reader is a fascinating addition to any Amateur station. For more information contact Kantronics, 1202 E. 23 Street, Lawrence, Kansas 66044. — ham radio staff.
STEP UP TO TELREX®
Professionally Engineered Antenna Systems

Single transmission line "TRI-BAND® ARRAY"

MONARCH
TB5EM/4KWP

By the only test that means anything... on the air comparison... this array continues to outperform all competition... and has for two decades. Here's why... Telrex uses a unique trap design employing 20 HQ 7500V ceramic condensers per antenna. Telrex uses 3 optimum-spaced, optimum-tuned reflectors to provide maximum gain and true F/B performance.

ILLUSTRATION BALUN

ILLUSTRATION TRAP

For technical data and prices on complete Telrex line, write for Catalog PL 7

FAST SCAN ATV

WHY GET ON FAST SCAN ATV?
- You can send broadcast quality video of home movies, video tapes, computer games, etc., at a cost that is less than sloscan.
- Really improves public service communications for parades, RACES, CAP searches, weather watch, etc.
- DX is about the same as 2 meter simplex — 15 to 100 miles.

ALL IN ONE BOX
TC-1 Transmitter/Converter... Plug in camera, ant., mic, and TV and you are on the air. Contains AC supply, T/R switch, etc. at a cost that is less than sloscan.

PUT YOUR OWN SYSTEM TOGETHER
TXAS ATV Exciter contains video modulator and xtal on 434 or 439.25 MHz. All modules wired and tested... $89 ppd
PA5 10 Watt Linear matches exciters for good color and sound. This and all modules run on 13.8 vdc... $89 ppd
TVC-2 Downconverter tunes 420 to 450 MHz. Outputs TV channel 2 or 3. Contains low noise MRF901 preamp... $55 ppd
FMAS Audio Subcarrier adds standard TV sound to the picture... $29 ppd

PACKAGE SPECIAL all four modules... $249 ppd

SEND SELF-ADDRESSED STAMPED ENVELOPE FOR OUR LATEST CATALOG INCLUDING:
Info on how to best get on ATV, modules for the builder, complete units, b&w and color cameras, antennas, monitors, etc., and more.

Credit card orders call (213) 447-4565, Check, Money Order or Credit Card by mail.

P.C. ELECTRONICS

Maryann
2522 FAXON
 ARCADIA, CA 91006

Tom
W6QRG

October 1981
**RF Power Device**

MRF454 Same as MRF458
12.5 VDC, 3-30 MHz
80 Watts output, 12dB gain

$17.95 ea.

**E.F. JOHNSON TUBE SOCKETS**

#124-0311-100 ........ 6.99 each
For 8072 etc.

#124-0107-001 ........ 13.99 each
For 4CX250B/R, 4X150A etc.

#124-0111-001 ......... 4.99 each
Chimney for 4CX250B/R and 4X150

#124-0113-001 and #124-0113-021 .... $12.99 each
Capacitor for #124-0107-001

#123-209-33 Sockets ..... 6.99 each
For 811A, 572B, 866, etc.

**UNELCO CAPS**

6.8pF 47pF
8.2pF 62pF
10pF 100pF
12pF 160pF
13pF 180pF
14pF 200pF
20pF 240pF
24pF 380pF
33pF 470pF
36pF 1000pF
43pF 350V $1.00 each

**High Voltage Caps**

30 MFD @ 500 VDC 1.69
22 MFD @ 500 VDC 1.69
100 MFD @ 450 VDC 2.29
150 MFD @ 450 VDC 3.29
225 MFD @ 450 VDC 4.29

**Crystrals**

5.120 7.4825 9.565 10.150 11.155 11.905 17.315
7.4615 7.4985 10.000 10.180 11.705 12.050 37.600
7.4625 7.5015 10.010 10.240 11.730 12.100 37.650
7.4685 7.5065 10.030 10.595 11.755 17.015 37.750
7.4715 7.5095 10.040 10.605 11.800 17.065 37.800
7.4725 7.5025 10.0525 10.615 11.850 17.165 37.860
7.4785 9.555 10.140 10.635 11.900 17.265 37.950
7.4815 9.555 10.140 10.635 11.900 17.265 38.000

**MINIMUM ORDER $10.00**

Tell 'em you saw it in HAM RADIO!
ARCO CAPS

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>304</td>
<td>100-550pF</td>
</tr>
<tr>
<td>400</td>
<td>.9-7pF</td>
</tr>
<tr>
<td>402</td>
<td>1.5-20pF</td>
</tr>
<tr>
<td>420</td>
<td>1-12pF</td>
</tr>
<tr>
<td>423</td>
<td>7-100pF</td>
</tr>
<tr>
<td>426</td>
<td>37-250pF</td>
</tr>
<tr>
<td>464</td>
<td>25-280pF</td>
</tr>
<tr>
<td>465</td>
<td>50-380pF</td>
</tr>
<tr>
<td>467</td>
<td>110-580pF</td>
</tr>
</tbody>
</table>

TUBES

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>6KD6</td>
<td>5.00</td>
</tr>
<tr>
<td>6LQ6/6JE6</td>
<td>6.00</td>
</tr>
<tr>
<td>6MJ6/6LQ6/6JE6</td>
<td>6.00</td>
</tr>
<tr>
<td>6LF6/6MH6</td>
<td>5.00</td>
</tr>
<tr>
<td>12BY7A</td>
<td>4.00</td>
</tr>
<tr>
<td>2E26</td>
<td>4.69</td>
</tr>
<tr>
<td>4X150A</td>
<td>29.99</td>
</tr>
<tr>
<td>4CX250B</td>
<td>45.00</td>
</tr>
<tr>
<td>4CX250R</td>
<td>69.00</td>
</tr>
<tr>
<td>4CX300A</td>
<td>109.99</td>
</tr>
<tr>
<td>4CX350A/8321</td>
<td>100.00</td>
</tr>
<tr>
<td>4CX350F/3/8904</td>
<td>100.00</td>
</tr>
<tr>
<td>4CX1500B/8660</td>
<td>300.00</td>
</tr>
<tr>
<td>811A</td>
<td>20.00</td>
</tr>
<tr>
<td>6360</td>
<td>4.69</td>
</tr>
</tbody>
</table>

RF Transistors

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRF49</td>
<td>12.65</td>
</tr>
<tr>
<td>MRF49A</td>
<td>12.65</td>
</tr>
<tr>
<td>MRF50</td>
<td>11.00</td>
</tr>
<tr>
<td>MRF50A</td>
<td>11.77</td>
</tr>
<tr>
<td>MRF52</td>
<td>15.00</td>
</tr>
<tr>
<td>MRF53</td>
<td>13.72</td>
</tr>
<tr>
<td>MRF54A</td>
<td>21.83</td>
</tr>
<tr>
<td>MRF55</td>
<td>14.08</td>
</tr>
<tr>
<td>MRF55A</td>
<td>14.08</td>
</tr>
<tr>
<td>MRF474</td>
<td>3.00</td>
</tr>
<tr>
<td>MRF475</td>
<td>2.90</td>
</tr>
<tr>
<td>MRF476</td>
<td>2.25</td>
</tr>
<tr>
<td>MRF477</td>
<td>10.00</td>
</tr>
<tr>
<td>MRF485</td>
<td>3.00</td>
</tr>
<tr>
<td>MRF492</td>
<td>20.40</td>
</tr>
<tr>
<td>MRF502</td>
<td>.93</td>
</tr>
<tr>
<td>MRF604</td>
<td>2.00</td>
</tr>
<tr>
<td>MRF629</td>
<td>3.00</td>
</tr>
<tr>
<td>MRF648</td>
<td>26.87</td>
</tr>
<tr>
<td>MRF649</td>
<td>12.65</td>
</tr>
<tr>
<td>MRF901</td>
<td>3.99</td>
</tr>
<tr>
<td>MRF902</td>
<td>9.41</td>
</tr>
<tr>
<td>MRF904</td>
<td>3.00</td>
</tr>
<tr>
<td>MRF911</td>
<td>4.29</td>
</tr>
<tr>
<td>MRF917</td>
<td>11.73</td>
</tr>
<tr>
<td>MRF8004</td>
<td>1.59</td>
</tr>
<tr>
<td>BFR91</td>
<td>1.25</td>
</tr>
<tr>
<td>BFR96</td>
<td>1.50</td>
</tr>
<tr>
<td>BFW92A</td>
<td>1.00</td>
</tr>
<tr>
<td>BFW92</td>
<td>.79</td>
</tr>
<tr>
<td>MMC18B</td>
<td>14.30</td>
</tr>
<tr>
<td>MMC222</td>
<td>15.65</td>
</tr>
<tr>
<td>MMC2369</td>
<td>15.00</td>
</tr>
<tr>
<td>MMC2484</td>
<td>15.25</td>
</tr>
<tr>
<td>MMC3960A</td>
<td>24.30</td>
</tr>
<tr>
<td>MWA120</td>
<td>7.80</td>
</tr>
<tr>
<td>MWA130</td>
<td>8.08</td>
</tr>
<tr>
<td>MWA210</td>
<td>7.46</td>
</tr>
<tr>
<td>MWA220</td>
<td>8.08</td>
</tr>
<tr>
<td>MWA230</td>
<td>8.62</td>
</tr>
<tr>
<td>MWA310</td>
<td>8.08</td>
</tr>
<tr>
<td>MWA310</td>
<td>8.08</td>
</tr>
</tbody>
</table>

CRystal Filters

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>EFCL455K13E</td>
<td>3.99</td>
</tr>
<tr>
<td>EFCL455K40B2</td>
<td>2.99</td>
</tr>
<tr>
<td>FX-07800L</td>
<td>12.99</td>
</tr>
<tr>
<td>FHA103-4</td>
<td>12.99</td>
</tr>
</tbody>
</table>

ORDERING INSTRUCTIONS

Check, money order, or credit cards welcome. (Master Charge and VISA only.) No personal checks or certified personal checks for foreign countries accepted. Money order or cashiers check in U.S. funds only. Letters of credit are not acceptable.

Minimum shipping by UPS is $2.35 with insurance. Please allow extra shipping charges for heavy or long items.

All parts returned due to customer error or decision will be subject to a 15% restock charge. If we are out of an item ordered, we will try to replace it with an equal or better part unless you specify not to, or we will back order the item, or refund your money.

PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE. Prices supersede all previously published.

We now have a toll free number, but we ask that it be used for charge orders only. If you have any questions please use our other number. We are open from 8:00 a.m. - 5:00 p.m. Monday thru Saturday.

Our toll free number for charge orders only is 800-528-3611.

MINIMUM ORDER $10.00

NEW CHERRY BCD SWITCH

New end plates

Type T-20 ............ 1.29 each

Johnson

AIR Variables

<table>
<thead>
<tr>
<th>Value</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-3-5</td>
<td>1 to 5 pF</td>
</tr>
<tr>
<td>T-6-5</td>
<td>1.7 to 11 pF</td>
</tr>
<tr>
<td>T-9-5</td>
<td>2 to 15 pF</td>
</tr>
<tr>
<td>189-6-1</td>
<td>1 to 10 pF</td>
</tr>
<tr>
<td>189-502-Y</td>
<td>1.3 to 6.7pF</td>
</tr>
<tr>
<td>189-503-105</td>
<td>1.4 to 9.2pF</td>
</tr>
<tr>
<td>189-504-5</td>
<td>1.5 to 11.6pF</td>
</tr>
<tr>
<td>189-505-5</td>
<td>1.7 to 14.1pF</td>
</tr>
<tr>
<td>189-506-103</td>
<td>1.7 to 14.1pF</td>
</tr>
<tr>
<td>189-507-105</td>
<td>1.8 to 16.7pF</td>
</tr>
<tr>
<td>189-508-5</td>
<td>2 to 19.3pF</td>
</tr>
<tr>
<td>189-509-5</td>
<td>2.1 to 22.9pF</td>
</tr>
<tr>
<td>189-508-5</td>
<td>2.4 to 24.5pF</td>
</tr>
<tr>
<td>545-043</td>
<td>1.8 to 11.4pF</td>
</tr>
</tbody>
</table>

More Details? CHECK—OFF Page 94
Maybe your friends were expecting *ham radio* last Christmas

Now that he has everything, why not give him something he'll really enjoy! Give *ham radio* this Christmas and your friends will thank you all year 'round. Each month they'll be introduced to the very latest technical advances in Amateur Radio, and become involved with such very special features as W9KNI's DX'ers Diary or Ham Radio Techniques by Bill Orr. Of course there will also be W6BNB's upgrade series and the many other exciting features that make *ham radio* such a special magazine for today's Amateur. So do your friends a favor and subscribe now at our very special gift price below. While you're at it, put your own name and address down — you deserve a money-saving gift too.

Send to:

1st Gift — $15.00 — Save $1.50
- NEW  - EXTEND
Name __________________________ Call __________________________
Address __________________________ __________________________
City __________________________ State ______ Zip ____________

2nd Gift — $14.00 — Save $4.00
- NEW  - EXTEND
Name __________________________ Call __________________________
Address __________________________ __________________________
City __________________________ State ______ Zip ____________

3rd Gift — $14.00 — Save $6.50
- NEW  - EXTEND
Name __________________________ Call __________________________
Address __________________________ __________________________
City __________________________ State ______ Zip ____________

Foreign gift subscription prices:
Europe, Japan, Africa: Air Delivery $28.00 per year. Canada and other countries: $21.50 per year.

- YES!
Please send my *ham radio* gift subscriptions as indicated. Also send a handsome gift acknowledgment card. (A gift card will be sent to each gift recipient if order is received by December 18, 1981.)

From:
Name __________________________ Call __________________________
Address __________________________ __________________________
City __________________________ State ______ Zip ____________

- Check or Money Order Enclosed
- VISA  - Master Charge
Acct. # __________________________ MC Bank # __________________________
Expires __________________________

□ Bill me after January 1, 1982.
Food for thought.

Our new Universal Tone Encoder lends its versatility to all tastes. The menu includes all CTCSS, as well as Burst Tones, Touch Tones, and Test Tones. No counter or test equipment required to set frequency—just dial it in. While traveling, use it on your Amateur transceiver to access tone operated systems, or in your service van to check out your customers’ repeaters; also, as a piece of test equipment to modulate your Service Monitor or signal generator. It can even operate off an internal nine volt battery, and is available for one day delivery, backed by our one year warranty.

- All tones in Group A and Group B are included.
- Output level flat to within 1.5db over entire range selected.
- Separate level adjust pots and output connections for each tone Group.
- Immune to RF
- Powered by 6-30vdc, unregulated at 8 ma.
- Low impedance, low distortion, adjustable sinewave output, 5v peak-to-peak
- Instant start-up.
- Off position for no tone output.
- Reverse polarity protection built-in.

<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEST-TONES:</td>
<td>TOUCH-TONES:</td>
</tr>
<tr>
<td>600</td>
<td>697 1209</td>
</tr>
<tr>
<td>1000</td>
<td>770 1336</td>
</tr>
<tr>
<td>1500</td>
<td>852 1477</td>
</tr>
<tr>
<td>2175</td>
<td>941 1633</td>
</tr>
<tr>
<td>2805</td>
<td>114 82A</td>
</tr>
</tbody>
</table>

- Frequency accuracy, ±1 Hz maximum - 40°C to + 85°C
- Frequencies to 250 Hz available on special order
- Continuous tone

Model TE-64 $79.95
MBA READER™
A NAME YOU SHOULD KNOW

What does MBA mean? It stands for Morse-Baudot and ASCII. What does the MBA Reader do? The RO model (reader only) uses a 32 character alphanumeric vacuum fluorescent display and takes cw or tty audio from a receiver or tape recorder and visually presents it on the display.

The copy moves from right to left across the screen, much like the Times Square reader board. Is the AEA model MBA Reader different from other readers? It certainly is! It is the first to give the user 32 characters of copy (without a CRT), up to five words at one time. It can copy cw up to 99 wpm and Baudot at 60-67-75 and 100 wpm. Speeds in the ASCII mode are 110 and hand typed 300 baud. The expanded display allows easy copy even during high speed reception.

The AEA model MBA has an exclusive automatic speed tracking feature. If you are copying a signal at 3-5 wpm and tune to a new signal at 90 wpm, the MBA catches the increased speed without loss of copy.

The MBA Reader allows a visual display of your fist and improves your code proficiency. It is compact in size, and has an easily read vacuum fluorescent display.

The Reader operates from an external 12 VDC source. This allows for portable/mobile or fixed operation.

Check the AEA model MBA Reader at your favorite dealer and see all the features in this new equipment. If your dealer cannot supply you, contact Advanced Electronic Applications, Inc.
P.O. Box 2160, Lynnwood, WA 98036 Call 206/775-7373

Prices and specifications subject to change without notice or obligation

ANTENNAS by Bill Orr, W6SAI
ALL ABOUT CUBICAL QUAD ANTENNAS
The cubical quad antenna is considered by many to be the best DX antenna because of its simple, lightweight design and high performance. In Bill Orr's latest edition of his well known book, you'll find quad designs for everything from the single element to the multi-element monster quad, plus a new, higher gain expanded quad (X-0) design. There's a wealth of supplementary data on construction, feeding, tuning, and mounting quad antennas. It's the most comprehensive single edition on the cubical quad available. 112 pages. ©1977.

BEAM ANTENNA HANDBOOK
Here's recommended reading for anyone thinking about putting up a yagi beam this year. It answers a lot of commonly asked questions like: What is the best element spacing? Can different yagi antennas be stacked without losing performance? Do monoband beams outperform tribanders? Lots of construction projects, diagrams, and photos make reading a pleasurable and informative experience. 198 pages. ©1977.

Prices include $1.00 to cover shipping and handling.
<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978 REPEATER ASSOCIATION'S ANNUAL FLEXI MARKET</td>
<td>BLOSSOMLAND ARA 39TH ANNUAL HAMFEST</td>
<td>AMSAT Extracast Net</td>
<td>SCOTTSDALE ARC SOUTH WESTERN DIVISION CONVENTION</td>
<td>WEST COAST QUALIFYING RUN</td>
<td>TEXAS STATE CONVENTION</td>
<td>RADIO AMATEURS OF GREATER SYRACUSE HAMFEST</td>
</tr>
<tr>
<td>- Beaucour 6V7W, Post. 56 Bellingham St., Newton, MA. 1978.</td>
<td>- Lawrence Co. 6V4H, South of Newton, MA. 1978.</td>
<td>3860 kHz 9:00 PM EDST (0200Z Wednesday Morning)</td>
<td>- havan cc South of the Bar - 9:00 PM EST (0200Z Wednesday Morning)</td>
<td></td>
<td></td>
<td>- An 8 &amp; home Rd., NY State Fairgrounds, WADD 1978.</td>
</tr>
<tr>
<td>GIANT ELECTRONICS FLEXI MARKET</td>
<td>giant electronics parking lot, 4404 macon Ave., Scranton, PA, call 610-986-1933.</td>
<td>AMSAT Mid-Continent Net</td>
<td>AMSAT Mid-Continent Net</td>
<td></td>
<td></td>
<td>- SUNOCO CONVENTION - Station 5, Beaufort, SC. arrangements.</td>
</tr>
<tr>
<td>YORK COUNTY 39TH ANNUAL HAMFEST</td>
<td>YORK COUNTY 39TH ANNUAL HAMFEST</td>
<td>AMSAT Mid-Continent Net</td>
<td>AMSAT Western Net</td>
<td></td>
<td></td>
<td>- MIDWEST DIVISION - S. 7. John Sheuy, 2737</td>
</tr>
<tr>
<td>- York Park, 600 W. 1/4000.</td>
<td>- York Park, 600 W. 1/4000.</td>
<td>3860 kHz 9:00 PM EST (0200Z Wednesday Morning)</td>
<td>3860 kHz 8:00 PM EDT (0200Z Wednesday Morning)</td>
<td></td>
<td></td>
<td>- MISSISSIPPI COAST ARA - Gulf, MS. 1978.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AMSAT Western Net</td>
<td>AMSAT Western Net</td>
<td></td>
<td></td>
<td>CALIFORNIA QSO PARTY - 24.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3860 kHz 8:00 PM EDST (0200Z Wednesday Morning)</td>
<td>3860 kHz 8:00 PM EDST (0200Z Wednesday Morning)</td>
<td></td>
<td></td>
<td>VHF QSO CONTEST - 24.</td>
</tr>
<tr>
<td>11Hoosier Hills Ham Club Annual Hamfest</td>
<td>Internet QSO Party</td>
<td>WWW QUALIFYING RUN</td>
<td>FIRST ANNUAL IRVING, ILLINOIS QSO PARTY</td>
<td>FIRST ANNUAL BIG RAPIDS QSO PARTY</td>
<td></td>
<td>WESTERN NORTH CAROLINA ARA 1978 AUTUMNPARTY</td>
</tr>
<tr>
<td>- Lawrence</td>
<td>- Lawrence</td>
<td>3860 kHz 9:00 PM EDST (0200Z Wednesday Morning)</td>
<td>- 1000 kHz 9:00 PM EST (0200Z Wednesday Morning)</td>
<td></td>
<td></td>
<td>- Denver Civic Center, Asheville, NC. 19.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AMSAT Mid-Continent Net</td>
<td>AMSAT Mid-Continent Net</td>
<td></td>
<td></td>
<td>- CW QSO CONTEST - Contact WB4CND for details. 19-11.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3860 kHz 9:00 PM EDST</td>
<td>3860 kHz 9:00 PM EDST</td>
<td></td>
<td></td>
<td>DELTA DIVISION CONVENTION - Memphis, TN. 19-11.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0200Z Wednesday Morning)</td>
<td>(0200Z Wednesday Morning)</td>
<td></td>
<td></td>
<td>5-LAND QSO PARTY - Contact W4NHF for details. 19-11.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AMSAT Western Net</td>
<td>AMSAT Western Net</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3860 kHz 8:00 PM EDST</td>
<td>3860 kHz 8:00 PM EDST</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0200Z Wednesday Morning)</td>
<td>(0200Z Wednesday Morning)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Contact 8M0CK.</td>
<td>- Contact 8M0CK.</td>
<td>3860 kHz 9:00 PM EDST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EDST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EDST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EDST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EDST (0200Z Wednesday Morning)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AMSAT Mid-Continent Net</td>
<td>AMSAT Mid-Continent Net</td>
<td>AMSAT Mid-Continent Net</td>
<td>AMSAT Mid-Continent Net</td>
<td>AMSAT Mid-Continent Net</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3860 kHz 9:00 PM EST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EST (0200Z Wednesday Morning)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AMSAT Western Net</td>
<td>AMSAT Western Net</td>
<td>AMSAT Western Net</td>
<td>AMSAT Western Net</td>
<td>AMSAT Western Net</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3860 kHz 8:00 PM EDST</td>
<td>3860 kHz 8:00 PM EDST</td>
<td>3860 kHz 8:00 PM EDST</td>
<td>3860 kHz 8:00 PM EDST</td>
<td>3860 kHz 8:00 PM EDST</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0200Z Wednesday Morning)</td>
<td>(0200Z Wednesday Morning)</td>
<td>(0200Z Wednesday Morning)</td>
<td>(0200Z Wednesday Morning)</td>
<td>(0200Z Wednesday Morning)</td>
</tr>
<tr>
<td>- Framingham Police Station 69th St. Contact K7HFM for more details. 32.</td>
<td>- Framingham Police Station 69th St. Contact K7HFM for more details. 32.</td>
<td>3860 kHz 9:00 PM EDST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EDST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EDST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EDST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EDST (0200Z Wednesday Morning)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AMSAT Mid-Continent Net</td>
<td>AMSAT Mid-Continent Net</td>
<td>AMSAT Mid-Continent Net</td>
<td>AMSAT Mid-Continent Net</td>
<td>AMSAT Mid-Continent Net</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3860 kHz 9:00 PM EST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EST (0200Z Wednesday Morning)</td>
<td>3860 kHz 9:00 PM EST (0200Z Wednesday Morning)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AMSAT Western Net</td>
<td>AMSAT Western Net</td>
<td>AMSAT Western Net</td>
<td>AMSAT Western Net</td>
<td>AMSAT Western Net</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3860 kHz 8:00 PM EDST</td>
<td>3860 kHz 8:00 PM EDST</td>
<td>3860 kHz 8:00 PM EDST</td>
<td>3860 kHz 8:00 PM EDST</td>
<td>3860 kHz 8:00 PM EDST</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0200Z Wednesday Morning)</td>
<td>(0200Z Wednesday Morning)</td>
<td>(0200Z Wednesday Morning)</td>
<td>(0200Z Wednesday Morning)</td>
<td>(0200Z Wednesday Morning)</td>
</tr>
<tr>
<td>24WIATW Schedule</td>
<td>WIATW Schedule</td>
<td>WIATW Schedule</td>
<td>WIATW Schedule</td>
<td>WIATW Schedule</td>
<td>WIATW Schedule</td>
<td>WIATW Schedule</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UTC. 25 kHz Code Practice</td>
<td>UTC. 25 kHz Code Practice</td>
<td>UTC. 25 kHz Code Practice</td>
<td>UTC. 25 kHz Code Practice</td>
<td>UTC. 25 kHz Code Practice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80 kHz Code Practice</td>
<td>80 kHz Code Practice</td>
<td>80 kHz Code Practice</td>
<td>80 kHz Code Practice</td>
<td>80 kHz Code Practice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 kHz, 30 kHz, 100 kHz</td>
<td>10 kHz, 30 kHz, 100 kHz</td>
<td>10 kHz, 30 kHz, 100 kHz</td>
<td>10 kHz, 30 kHz, 100 kHz</td>
<td>10 kHz, 30 kHz, 100 kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80 kHz, 160 kHz</td>
<td>80 kHz, 160 kHz</td>
<td>80 kHz, 160 kHz</td>
<td>80 kHz, 160 kHz</td>
<td>80 kHz, 160 kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.5 kHz Code practice</td>
<td>3.5 kHz Code practice</td>
<td>3.5 kHz Code practice</td>
<td>3.5 kHz Code practice</td>
<td>3.5 kHz Code practice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 kHz Code practice</td>
<td>3 kHz Code practice</td>
<td>3 kHz Code practice</td>
<td>3 kHz Code practice</td>
<td>3 kHz Code practice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for more details see Coming Events</td>
<td>for more details see Coming Events</td>
<td>for more details see Coming Events</td>
<td>for more details see Coming Events</td>
<td>for more details see Coming Events</td>
</tr>
</tbody>
</table>
All the popular sizes and mixes. Fast Service. Same day shipment via first class mail or air.

IRON POWDER TOROIDS:

<table>
<thead>
<tr>
<th>CORE SIZE</th>
<th>MIX 2</th>
<th>MIX 6</th>
<th>MIX 12</th>
<th>SIZE 2D</th>
<th>PRICE USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-200</td>
<td>120</td>
<td>2.00</td>
<td>4.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-106</td>
<td>135</td>
<td>1.06</td>
<td>1.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-80</td>
<td>55</td>
<td>45</td>
<td>1.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-66</td>
<td>57</td>
<td>47</td>
<td>21</td>
<td>68</td>
<td>95</td>
</tr>
<tr>
<td>T-50</td>
<td>51</td>
<td>40</td>
<td>18</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>T-37</td>
<td>42</td>
<td>30</td>
<td>15</td>
<td>37</td>
<td>60</td>
</tr>
<tr>
<td>T-25</td>
<td>34</td>
<td>27</td>
<td>12</td>
<td>25</td>
<td>45</td>
</tr>
</tbody>
</table>

RF FERRITE TOROIDS:

<table>
<thead>
<tr>
<th>CORE SIZE</th>
<th>MIX Q1</th>
<th>MIX Q2</th>
<th>MIX H</th>
<th>SIZE 2D</th>
<th>PRICE USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-240</td>
<td>1300</td>
<td>2.40</td>
<td>9.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-114</td>
<td>1500</td>
<td>1.14</td>
<td>2.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-87</td>
<td>900</td>
<td>300</td>
<td>87</td>
<td>1.25</td>
<td></td>
</tr>
<tr>
<td>F-50</td>
<td>750</td>
<td>250</td>
<td>5000</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>F-37</td>
<td>550</td>
<td>200</td>
<td>4000</td>
<td>37</td>
<td>60</td>
</tr>
<tr>
<td>F-23</td>
<td>250</td>
<td>100</td>
<td>1500</td>
<td>23</td>
<td>50</td>
</tr>
</tbody>
</table>

Chart shows uff per 100 turns
Ferrite Beads slip over 18 ga. wire
FB-1 for 50-200 MHz $2/dozen
FB-2 for 50 MHz & below $2/dozen
Jumbo Beads slip over #12 wire
FB-3 for 50 MHz & below $3/dozen

EXPERIMENTER'S KITS
Iron Powder Toroids $10.00
Includes:
1 ea. T25-12, T37-2, T80-2, T106-2
2 ea. T25-6, T37-6, T50-2, T50-6
3 ea. T66-2

RF Ferrite Toroids $10.00
Includes:
1 ea. F50-Q2, F114-Q1
2 ea. F23-Q1, F23-Q2, F37-Q1
F37-Q2, F50-Q1, F87-Q1

TO ORDER. Specify both core size and mix for toroids. Packing and Shipping $1.50 per order USA and Canada. California add 6% sales tax.

Pre-Publication SPECIAL
Bill Orr's NEW 22nd EDITION Radio Handbook

The Radio Handbook has been a best seller for over 45 years. This brand-new edition covers in complete detail all of the latest state-of-the-art advances in electronics. Hams and engineers alike will find this handy, single-source reference an invaluable aid. Chock-full of projects from simple test equipment to complex receivers and amplifiers. Chapters include an explanation of Amateur Radio communications, electronic and electrical theory, tubes and semiconductor devices; a special chapter on RFI and more. . . . This invaluable book is a must for every ham shack. Orders yours today and save. 1136 pages. ©1981. □21874 UNTIL OCTOBER 31, 1981 . $22.95 After October 31, 1981 . . . . . . . $26.95

SEND ORDER TO:
ham radio's BOOKSTORE
Greenville, NH 03048

Can't Wait? NOW!

Tell 'em you saw it in HAM RADIO!
NOW IN STOCK...
FULL LINE OF AEA KEYERS
SUPER EFFICIENT ISOPOLE ANTENNAS

CALL TOLL FREE 1-800-325-3609 IN MISSOURI
MID-COM ELECTRONICS • 8516 MANCHESTER ROAD • BRENTWOOD, MO 63144

2300 MHz MICROWAVE DOWNCONVERTERS

DOWNCONVERTER
Kit ........................................... $28.50
Assembled ................................ $48.50

2300 MHz PREAMP
Kit ........................................... $25.00

POWER SUPPLY
Assembled ................................ $35.00

SATELLITE TV EARTH STATION
• 24 Channel Receiver
• 10’ Antenna
• Dexcel 120° LNA
Call for details and price

Also Available: Commercial System with Bogner Antenna ............... $169.00

PB RADIO SERVICE
1950 E. PARK ROW • ARLINGTON, TX 76010

CALL ORDER DEPT. TOLL FREE (800) 433-5169
FOR INFORMATION CALL (817) 460-7071

More Details? CHECK—OFF Page 94
Here are 7 brand new books you'll want to put in your radio library
Order your copies today.

For a limited time
Ham Radio's
Bookstore is
offering all 7 books
as a super package

**TUNE IN THE WORLD**
by ARRl staff WITH HAM RADIO
This package contains the goodies needed by the beginner to get started in Amateur Radio. Assuming you have no prior knowledge of radio, the reader is taught how to pass the Novice exam, both code and theory, and how to set up a station. Unique code study method makes learning the Morse code easy as 1-2-3. It's full of worksheets to help clarify difficult technical points. 160 pages. ©1981. 3rd edition.

**INTERFERENCE HANDBOOK**
by William R. Nelson, WAFPG
RFI is a very tricky problem. It can ruin your operating fun and worse. This brand-new book covers every type of interference that you are likely to encounter. Emphasis is placed on Amateur Radio, CB and power line problems. The author has spent over 33 years investigating RFI difficulties. Author Nelson saves the mystery of power line interference — how to locate it, cure it, safely precautions and more. He also gives you valuable tips on how to

**THE COMPLETE IDIOT'S GUIDE TO DX**
by Stuart Gregg, NF4Z
This is the beginner's complete guide to how to work DX. Author Gregg presents in an interesting, conversational style, all of the ins and outs and tricks of the trade.

**HOW TO BUILD HIDDEN, LIMITED SPACE ANTENNAS THAT WORK**
by R. J. Traister
Space problems limiting your signal? It doesn't have to be that way. How to build complete with plenty of projects on how to put out that big signal. Projects include suspended multiband vertical, window antenna, attic dipole, 20m indoor antenna, two meter choxial and much more. Softbound 304 pages. ©1981.

**BRAND NEW 1982 ARRL RADIO AMATEUR'S HANDBOOK**
Order today for delivery by late November. Be one of the first to get your copy. Internationally recognized, universally consulted. It's the all-purpose volume for radio. Jam packed with information, drawings, and illustrations that are useful to the Amateur and professional alike. ©1981.

**1982 U.S. RADIO AMATEUR CALLCBOK**
Ready for shipping 1 Dec.

**1982 FOREIGN CALLBOOK**
If DX is your "thing," then you need a copy of this 1982 Foreign Callbook. Getting a QSL card can be quite a chore without proper names and addresses. Make sure you don't miss it.

**Send This Order To:**
Ham Radio's Bookstore
Greenville, N. H. 03048

<table>
<thead>
<tr>
<th>Catalog #</th>
<th>Title</th>
<th>QTY</th>
<th>Price</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB-US</td>
<td>$18.95</td>
<td>$3.95 shipping = $22.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CB-F</td>
<td>$17.95</td>
<td>$3.05 shipping = $21.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ship To:**
Name __________
Address __________
City __________ State __________ Zip __________

Send your order in today and we'll get your orders out the door. Name and address are required. No credit cards accepted.
World Class Performance
and Features

The FT-ONE is the culmination of an all-out design project by Yaesu's top engineering team. Working without the usual cost constraints, Yaesu's design group is proud to unveil the instrument they "always wanted to design," a revolutionary blend of computer and RF technology.

GENERAL COVERAGE, ALL SOLID STATE

The FT-ONE is a full-coverage all-mode transceiver, equipped for reception on any frequency between 150 kHz and 29.99 MHz, with transmit coverage on all time present and proposed amateur bands. In countries where permitted, the FT-ONE may be programmed to transmit throughout the 1.8-29.99 MHz range.

KEYBOARD FREQUENCY ENTRY

Fully digitally synthesized, the FT-ONE uses a front panel keyboard for initial frequency entry. Frequency change is then accomplished via the tuning dial. Fully stepped tuning, with tuning in either 10 kHz or 100 Hz steps possible. Truly the contestor's dream, the FT-ONE permits extremely fine tuning and instantaneous band change with equal facility.

DUAL VFO SYSTEM

Ten digital VFO's with memory are provided, in conjunction with an A-B selection scheme that allows instant recall of any transmit, receive, or transceive frequency desired. For split-frequency operation, such as on 7 MHz SSB, the operator may select TX on VFO-A and RX on VFO-B, automatically storing the calling and listening frequencies for each pile-up. For net operations, a non-volatile memory board is available as an option, to eliminate the possibility of dumping memory.

FULL CW BREAK-IN

Recent advances in solid-state technology have finally made full CW break-in reliable enough to be incorporated into a Yaesu product. Now you can select traditional semi-break-in (for use with amplifiers not equipped for full break-in) or full high-speed break-in. When using amplifiers so equipped, the output level may be interrupted via a rear panel jack and routed to the break-in sequencing input on your amplifier.

SWITCHING REGULATOR POWER SUPPLY

Extremely compact and lightweight, the switching regulator power supply reduces substantially the space required to produce the operating voltages used in the FT-ONE. Highly efficient and uniquely stable, the switching regulator supply provides superb reliability in a field of design long neglected by amateur manufacturers.

ELITE CLASS PERFORMANCE FEATURES

In addition to the full break-in and superb receiver filters, Yaesu's design team packed the FT-ONE with subtle virtues that others might have overlooked. Rear panel jacks allow the use of both an external receiver and an independent receive antenna, such as a 160 meter Beverage. While scanning, automatic halting on a received signal may be programmed — perfect for watching a band for openings. If you're a DX-peditioner, an optional Curtis 8044 keyboard board is available, so you won't need an external key that only wastes suitcase space. And if your amplifier fan is louder than it should be, there's even a microphone squeal (AMGC) to reduce background noise pickup between words and sentences!

ONE YEAR FACTORY WARRANTY

Because of the level of attention to design detail, parts selection, and factory quality control, your FT-ONE is backed by a one-year factory warranty for the original purchaser at retail. Prompt and meticulous attention to your warranty needs will be provided by our Ohio And California Service Centers. In addition, all units sold in the United States will be inspected and tested after clearing Customs, and will include a Service Manual in the purchase price.

GAIN/INTERCEPT OPTIMIZED RECEIVER FRONT END

Utilizing up-conversion with a first IF of 73 MHz, the FT-ONE RF amplifier stage uses push-pull power transistors configured to produce a typical output intercept of +40 dBm. The first mixer utilizes a diode ring module followed by a low noise post amp, for optimum noise figure consistent with modern day intercept requirements. The result is a receiver with a typical two-tone dynamic range well in excess of 95 dB (14 MHz, CW bandwidth). Additional gain tailoring is provided via a PIN diode attenuator controlled from the front panel.

FILTERS READY FOR COMPETITION

Three filter bandwidths are available for CW operation (two for FSK), using optional 600 Hz or 200 Hz crystal filters. Filter insertion losses are equalized for constant IF gain. Both IF Shift and Variable Bandwidth are provided, and two CW filters may be cascaded, for competition-grade selectivity. For SSB work, the Variable Bandwidth feature eliminates the need for costly 1.5 kHz or 1 kHz filters, as any intermediate bandwidth may easily be programmed using the standard, cascaded SSB filters. To top it all off, a high-performance audio peak and notch filter is standard equipment.

EXPANDED OPERATING DISPLAYS

Digital displays for the VFO Frequency, memory channel, and RIT offset are provided for quick frequency identification. The large front panel meter provides easy viewing of transceiver operating parameters, including final transistor collector current, input DC voltage, FM discriminator center tuning, speech processor compression level, and forward/reflective relative power.

NOT AVAILABLE AS OPTIONS

It's hard to believe that other manufacturers still insist on making such essential items as a noise blanker or speech processor extra-cost options. We find that these are less expensive to incorporate and more reliable in operation when installed on our assembly line. No AC power supply is available as an option for the FT-ONE, either, it's equipped for operation from 100/110/127/200/220/234 volts AC or 13.5 volts DC. And it goes without saying that there will not be an external VFO offered for the FT-ONE — we're confident that ten VFO's are quite enough!

Experience the FT-ONE in your Authorized Yaesu Dealer's showroom today. This may be the last Amateur transceiver you will ever own.

Warranty policy available upon request. SASE, please. Specifications subject to change without notice or obligation.
A Bold Adventure In Engineering!

YAESU THE radio.

YAESU ELECTRONICS CORPORATION, 6851 Walthall Way, Paramount, CA 90723 • (213) 633-4007
Eastern Service Ctr., 9812 Princeton-Glendale Rd., Cincinnati, OH 45246 • (513) 874-3100
EIMAC's 4CW300,000G Power Tetrode.  
A new generation of high-performance power tubes.

EIMAC's 4CW300,000G combines all the desired features transmitter designers look for: high peak plate current, low grid emission, low internal capacitances and low internal inductance. This is the first of a new generation of high performance power tubes for LF, HF, VHF and pulse service.

Laserfab pyrolytic graphite grids
The control grid and screen structures of the 4CW300,000G are precision-cut by a laser beam. Each element is monolithic and combines extremely low coefficient of expansion with low structural inductance. These features permit the 4CW300,000G to have a very high transconductance — $10^8$ micromhos — and allow efficient, high-frequency operation.

Rugged mesh filament
The EIMAC mesh filament provides exceptionally high peak plate current and permits low plate voltage operation. This leads to power supply economy, making the 4CW300,000G the economic choice for 300 KW AM broadcast service or long-pulse switch service, each of which demands a reserve of peak emission.

Improved anode structure
EIMAC's multi-phase cooling technique provides high plate dissipation to extract heat evenly and quickly from the anode, contributing to long tube life and operating economy.

EIMAC expertise
EIMAC's expertise in electron ballistics pyrolytic grid production, thermodynamics and circuit techniques combine to bring tomorrow's tubes for today's transmitter designs. More information is available from Varian EIMAC. Or the nearest Varian Electron Device Group sales office.

Electron Device Group
Varian EIMAC
Application Engineering Department
301 Industrial Way
San Carlos, CA 94070
Telephone: 415-592-1221, ext. 218

Varian AG
Steinhauserstrasse
CH-6300 Zug, Switzerland
Telephone: (042) 23 25 75
Telex: 78 841