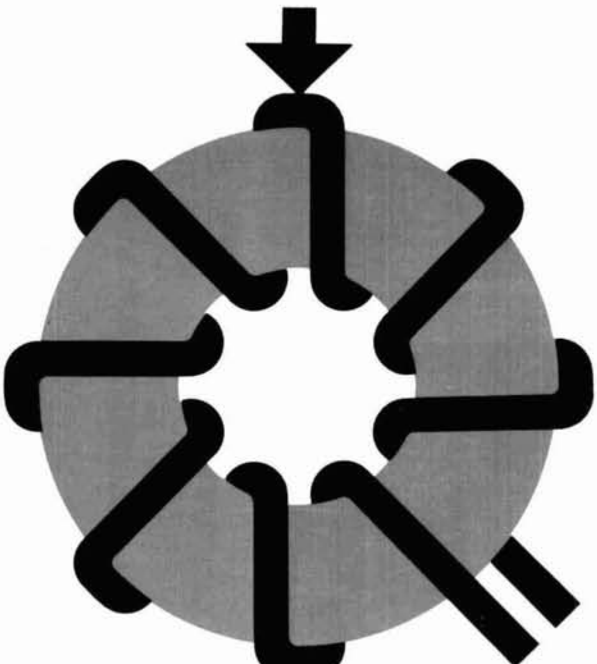
one dollar

ham radio magazine

NOVEMBER 1976

wideband rf autotransformers



Henry Radio has the amplifier you want

Never before has one company manufactured such a broad line of amateur amplifiers, both vacuum tube and solid state, for HF, VHF and UHF; fixed station and mobile; low power and high power. Take your pick from 20 *models...the world's finest line of* amateur amplifiers.

2K-4. . .
THE "WORKHORSE"
The 2K-4 linear amplifier offers engineering, construction and features second to none, and at a price that makes it the best amplifier value ever offered to the amateur. Constructed with a ruggedness guaranteed to provide a long life of reliable service, its heavy duty components allow it to loaf along even at full legal power. If you want to put that strong clear signal on the air that you've probably heard from other 2K users, now is the time. Move up to the 2K-4. Floor console ..$995.00

3K-A COMMERCIAL/MILITARY AMPLIFIER
A high quality linear amplifier designed for commercial and military uses. The 3K-A employs two rugged Eimac 3-500Z grounded grid triodes for superior linearity and provides a conservative three kilowatts PEP input on SSB with efficiencies in the range of 60%. This results in PEP output in excess of 2000 watts. In addition, the 3K-A provides a heavy duty power supply capable of furnishing 2000 watts of continous duty input for either RTTY or CW with 1200 watts output. Price...$1395.00

4K-ULTRA
The 4K-ULTRA is specifically designed for the most demanding commercial and military operation for SSB, CW, FSK or AM. The amplifier features general coverage operation from 3.0 to 30 MHz. Using the magnificent new Eimac 8877 grounded grid triodes, vacuum tune and load condensers, and a vacuum antenna relay, the 4K-ULTRA represents the last word in rugged, reliable, linear high power RF amplification. 100 watts drive delivers 4000 watts PEP input. This amplifier can be supplied modified for operation on frequencies up to about 100MHz. Price...$2950.00

TEMPO 6N2
The Tempo 6N2 brings the same high standards of performance and reliability to the 6 meter and 2 meter bands. Using a pair of advanced design Eimac 8874 tubes, it provides 2,000 watts PEP input on SSB or 1,000 watts input on FM or CW. The 6N2 is complete in one compact cabinet with a self-contained solid state power supply, built-in blower and RF relative power indicator. Price...$895.00

TEMPO 2002
The same fine specs and festures as the 6N2, but for 2 meter operation only. ...$745.00

TEMPO 2006
Like the 2002, but for 6 meter operation. ...$795.00

TEMPO VHF/UHF AMPLIFIERS
Solid state power amplifiers for use in most land mobile applications. Increases the range, clarity, reliability and speed of two-way communications. FCC type accepted also.

LOW BAND VHF AMPLIFIERS (35 to 75 MHz)	
Tempo 100C30	Tempo 100C02
Tempo 100C10	
HIGH BAND VHF AMPLIFIERS (135 to 175 MHz)	
Tempo 130A30	Tempo 80A02
Tempo 130A10	Tempo 50A10
Tempo 130A02	Tempo 50A02
Tempo 80A30	Tempo 30A10
Tempo 80A10	Tempo 30A02
UHF AMPLIFIERS (400 to 512 MHz)	
Tempo 70D30	Tempo 40D01
Tempo 70D10	Tempo 25D02
Tempo 70D02	Tempo 10D02
Tempo 40D10	Tempo 10D01
Tempo 40D02	

TEMPO 100AL10 VHF LINEAR AMPLIFIER
Completely solid state, 144-148 MHz. Power output of 100 watts (nom.) with only 10 watts (nom.) in. Reliable and compact ...$199.00
TEMPO 100AL10/B BASE AMPLIFIER $349.00

please call or write for complete information.

Henry Radio

11240 W. Olympic Blvd., Los Angeles, Calif. 90064 213/477-6701
931 N. Euclid, Anaheim, Calif. 92801 714/772-9200
Butler, Missouri 64730 816/679-3127

Prices subject to change without notice.

if the 4-BTV weighs 39% more... what do others leave out?

HUSTLER® FIXED STATION FOUR BAND VERTICAL

The 4-BTV is longer for greater aperature, larger in diameter for strength and bandwidth, heavier traps for precision and safety factor. Individually, each subassembly weighs more to collectively give you an antenna designed for convenience of assembly and installation, a wide margin in mechanical stability and far superior electrical performance.

- **Lowest SWR**—PLUS!
- Bandwidth at its **broadest!** SWR 1.6 to 1 or better at band edges.
- Hustler exclusive trap covers **"Spritz" extruded** to otherwise unattainable close tolerances assuring accurate and permanent trap resonance.
- Solid one inch **fiberglass trap forms** for optimum electrical and mechanical stability.
- Extra heavy duty aluminum mounting bracket with **low loss—high strength** insulators.
- All sections 1¼" **heavy wall,** high strength aluminum. Length 21'5".
- **Stainless steel clamps** permitting adjustment without damage to the aluminum tubing.
- Guaranteed to be **easiest assembly** of any multi-band vertical.
- Antenna has ⅜"-24 stud at top to accept RM-75 or RM-75-S Hustler resonator for **75 meter operation** when desired.
- Top loading on 75 meters for broader bandwidth and **higher radiation efficiency!**
- Feed with **any length** 50 ohm coax.
- Power capability—**full legal limit** on SSB and CW.
- Ground mount with or without radials; roof mount with radials.

one setting for total band coverage!
40 THROUGH 10 METERS

HUSTLER ANTENNA PRODUCTS—for sixteen years—original designs—created and manufactured by American ingenuity, labor and materials—used by communicators throughout the world.

Hustler designs are patented under one or more of the following assigned to New-Tronics Corporation: 3287732, 3513472, 3419869, 3873985, 3327311, 3599214, 3582951

HUSTLER®

Available from all distributors who recognize the best!

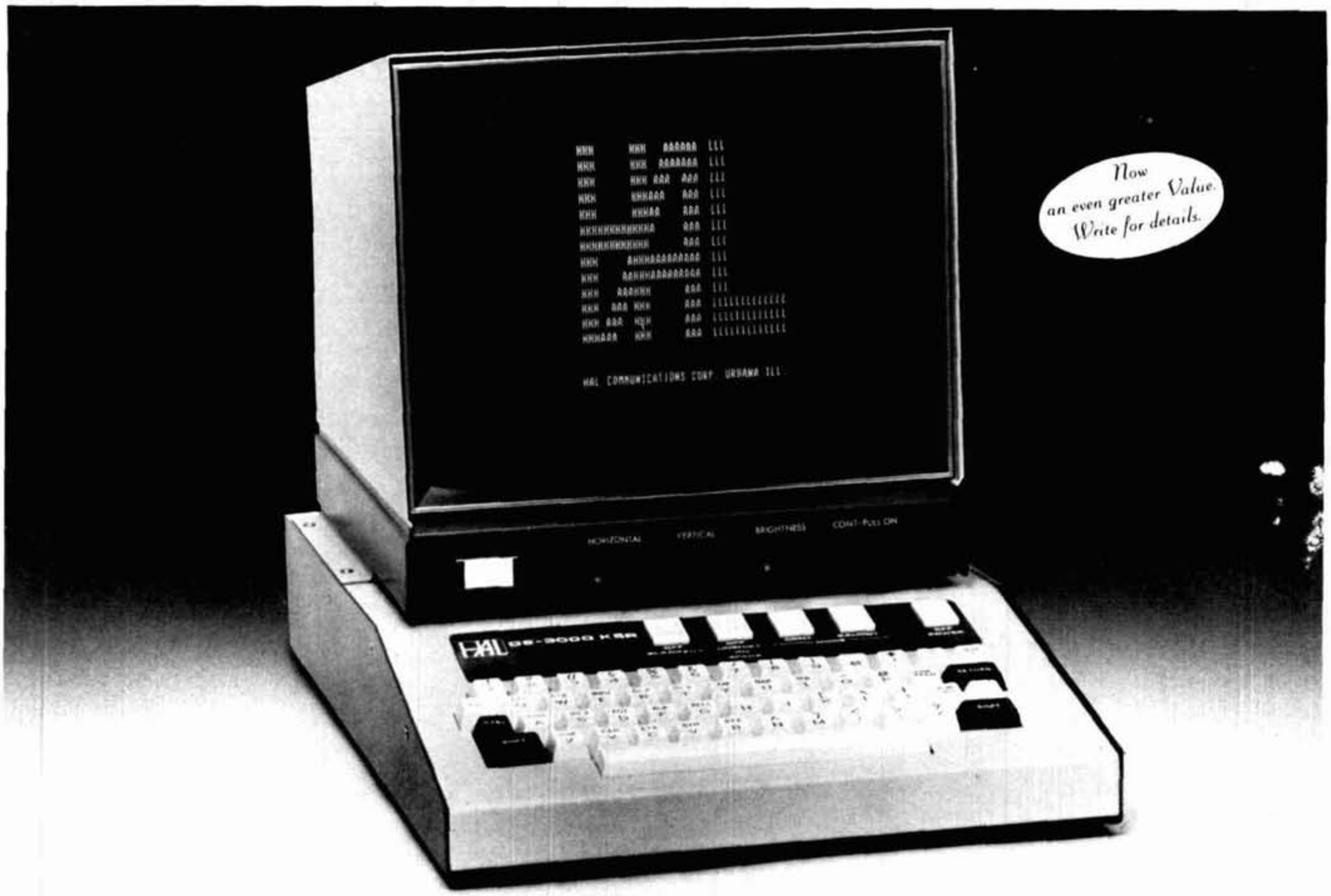
MODEL
4-BTV
15 POUNDS

new·tronics corporation

15800 commerce park drive,
brook park, ohio 44142

Exporter: Roburn Agencies, Inc., New York, N. Y.

Stay tuned for future programs.



The HAL ST-6000 demodulator /keyer and the DS-3000 and DS-4000 KSR/RO series of communications terminals are designed to give you superlative TTY performance today —and in the future. DS series terminals, for example, are re-programmable, assuring you freedom from obsolescence. Sophisticated systems all, these HAL products are attractively priced—for industry, government and serious amateur radio operators.

The HAL ST-6000 operates at standard shifts of 850, 425, and 170 Hz. The tone keyer is crystal-controlled. Loop supply is internal. Active filters allow flexibility in establishing different tone pairs. You can select AM or hard-limiting FM modes of operation to accommodate different operating conditions. An internal monitor scope (shown on model above) allows fast, accurate tuning. The ST-6000 has an outstandingly high dynamic range of operation. Data I/O can be RS-232C, MIL-188C or current loop.

The DS-3000 and DS-4000 series of KSR and RO terminals provide silent, reliable, all-electronic TTY transmission and reception, or read-only (RO) operation of different combinations of codes, including Baudot, ASCII and Morse. The powerful, programmable 8080A microprocessor is included in the circuitry to assure maximum flexibility for your present needs —and for the future. The KSR models offer you full editing capability. The video display is a convenient 16-line format, of 72 characters per line.

These are some of the highlights. The full range of features and specifications for the ST-6000 and the DS series of KSR and RO terminals is covered in comprehensive data sheets available on request. Write for them now—and tune in to the most sophisticated TTY operation you can have today . . . or in the future.

HAL Communications Corp., Box 365, 807 E. Green Street
Urbana, Illinois 61801 • Telephone: (217) 367-7373

More Details? CHECK—OFF Page 126

ham radio magazine

NOVEMBER 1976

volume 9, number 11

ham radio magazine is published monthly by
Communications Technology, Inc
Greenville, New Hampshire 03048
Telephone: 603-878-1441

subscription rates
U.S. and Canada: one year, $10.00
three years, $20.00
Worldwide: one year, $12.00
three years, $24.00

foreign subscription agents
Ham Radio Canada
Box 114, Goderich
Ontario, Canada, N7A 3Y5

Ham Radio Europe
Box 444
194 04 Upplands Vasby, Sweden

Ham Radio France
20 bis, Avenue des Clarions
89000 Auxerre, France

Ham Radio Holland
Postbus 3051
Delft 2200, Holland

Ham Radio Italy
STE, Via Maniago 15
I-20134 Milano, Italy

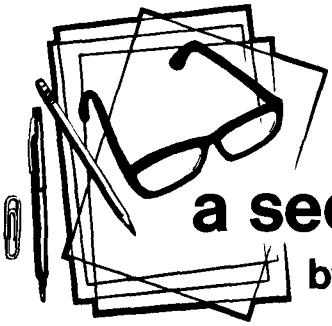
Ham Radio UK
Post Office Box 64, Harrow
Middlesex HA3 6HS, England

Holland Radio, 143 Greenway
Greenside, Johannesburg
Republic of South Africa

Microfilm copies
are available from
University Microfilms
Ann Arbor, Michigan 48103

Second-class postage
paid at Greenville, N.H. 03048
and at additional mailing offices

contents



a second look

by Jim Fisk

Interference on the amateur bands is something that most of us have learned to live with, at least to a certain extent, but in recent months I have noticed an increasing number of bad operating practices cropping up on our bands. Apparently other amateurs have been troubled, too, because I have received a number of letters on the subject. None of these practices is new, but they're more offensive because the bands are much more crowded than they used to be. Deliberate interference, tuning up on net frequencies, playing music, calling CQ without listening first, offensive language, incorrect identification (or no identification at all), using a kilowatt when 100 watts is adequate, talking crosstown on 20 meters instead of using vhf-fm – the list could go on and on.

There's no question that our high-frequency bands are crowded, but deliberate and malicious interference, and discourteous operating tactics, aren't going to relieve the situation, anymore than elbowing your way to the front of the checkout line at the local supermarket is going to get you anything more than a fat lip! In case you hadn't noticed, everything is more crowded today – the population has exploded, the expressways and turnpikes are jammed, homes are being built on smaller and smaller pieces of land, and even on the remotest trail of the high Sierras it's impossible to escape from the inevitable discarded beer can – practically everywhere you go you find a mass of humanity. It follows that we'll have more and more congestion on the amateur bands, but congestion doesn't mean bedlam. Zeroing your kilowatt on a QSO or local net is not going to make them move. Why not join them? They'd probably be glad to have you.

Today, there is a net for almost every range of interest – they aren't restricted to handling traffic. Some of the groups that congregate on the bands are not really nets at all, but simply groups of hams who get together for a common purpose. There are DX nets, the county hunters, the early-morning groups on 75 meters, and various single-frequency gabfests. There are technical nets, satellite operators' nets, EME round tables, vhf nets, and, of course, a multitude of local and intercontinental traffic nets, if traffic handling happens to be your *forte*.

If you don't happen to care for net-type operation, fine; there are a good many amateurs who don't. On the other hand, if there weren't any nets, imagine what the QRM would be like. There are thousands of amateurs who congregate on particular net frequencies. Since they're a member of a net, they just "read the mail" a good deal of the time. If they didn't have the net, they would be calling CQ, fishing for a new county, or active in one of the horrendous DX pileups. So, when you hear a net in operation, don't use it for a tuneup frequency. Whether you know it or not, the most hedonistic of them will stand to handle emergency traffic if asked to do so. They *all* do a service to the amateur community by minimizing interference with channelized communications.

Deliberate interference and incorrect identification are only two of the bad operating practices you will find on any band you listen to. You can also hear any number of stations working cross town on 15 or 20 meters when they should be on 75 or vhf fm. I have often copied W/K stations on 20 meters, running well over S9 in New Hampshire, working their neighbors. With modern linear amplifiers, it's a simple matter to turn off the big box when you don't need it.

Why the big penchant for S9 signal reports, anyway, when you can maintain perfectly adequate QSOs with S6 or S7? You may need your linear for a long-haul DX QSO or for making initial contact, but once communication has been established, 95 percent of the time you can turn your linear off with absolutely no effect on the QSO. Owning a linear is a bit like carrying an umbrella to work every day – there are times when it's a practical necessity, but just because you own one doesn't mean you have to use it all the time.

I've heard a lot of stations go QRT because of interference and poor operating practices. This is not the answer. If you hear an amateur on the air with a bad signal, not identifying properly, causing unnecessary interference, or being generally obnoxious, tactfully tell him about it. Most amateurs are gentlemen and will accept your suggestions with grace.

And, when you go on the air the next time, use operating finesse instead of brute force. Strive to be a first-class operator and encourage your friends to do the same. Let's promote good operating on our bands – discourtesy breeds pandemonium.

Jim Fisk, W1DTY
editor-in-chief

More Details? CHECK—OFF Page 126

presstop

"HAM RADIO HORIZONS," a new Amateur Radio magazine aimed primarily at the newcomer, has been announced by Ham Radio and will be introduced in January. Editorially the new publication will be directed toward the beginning Amateur, with low level technical articles plus general interest features for Amateurs and SWL enthusiasts at all levels. As an attraction to potential Amateurs, some CB and SWL coverage will also be included with the expectation that readers seriously interested in those fields are very good prospects for conversion to Amateur Radio.

Very Broad Market penetration will be a feature of Ham Radio's new publication. Promotion in a variety of non-Amateur Radio media is planned and emphasis will be on wide distribution far beyond the usual radio store outlets. Since it will be written for and by Amateurs, its content will appeal to most Amateurs, old timers as well as Novices, but its primary goal is to attract new Amateurs and encourage their progress up through the Amateur ranks.

Subscriptions To Ham Radio Horizons are now being accepted at $7.00 per year; after January 1st the cost for a one-year subscription will increase to $10.00.

Ham Radio Horizons Already Has a good backlog of technical articles but it is looking for good fiction, humor, and other non-technical contributions. Prospective authors should contact Tom McMullen, W1SL, Managing Editor, Ham Radio Horizons, Greenville, New Hampshire 03048.

FIRST U.S.-BERMUDA TWO METER CONTACT was made by W1NU/VP9 and K1HTV September 14th at 0100Z! Alerted to a potential opening by the AMSAT Net, Vic and hopeful stateside two-meter DXers moved to 144.090 CW and within moments the historic contact began. Vic next worked K1WHS, and before the evening ended 30 more stations, from Maine to Pennsylvania, at least one running only 100 watts to an 11-element beam, had made it across the Atlantic to Bermuda.

FCC LICENSE TIMES continue to improve, with some Amateurs receiving theirs in as little as six weeks while most CB tickets are showing up in just over half that time. Applicants whose licenses don't arrive in a reasonable time might check with their banks — John Johnston said in Hawaii that FCC is getting about 300 rubber checks each week, but very few from Amateurs!

AN UNLICENSED CW OPERATOR can operate an Amateur station under a current interpretation of the rules. However, it must be with a control operator present and the unlicensed operator's transmissions logged and recorded as third party traffic.

A TVI-LESS TELEVISION SET is to be built by Texas Instruments under contract from the FCC, according to FCC Chief Engineer Ray Spence. The experimental set will provide graphic demonstration that TVI is not all the fault of the transmitter. Consumer complaints have shifted recently, however, and audio component systems have now become more of a problem than TV receivers.

PLANNING FOR WARC 79 is still very much in the news. Amateur Radio, as defined by Article 41, will not be discussed at the 1979 Geneva Conference — the proposed agenda includes only Article 5, the international frequency table. We will face problems — our own broadcasters want parts of 40, 75, and 160, and now the Canadian DOT wants to make 1605-4000 kHz all maritime and the CBC wants to shove 40 meters down to 6800-7100 kHz so 7100 and up can be devoted to international broadcast!

Clearly More Supportive Work needs to be done, both with our own government and with other governments friendly to the Amateur Radio Service.

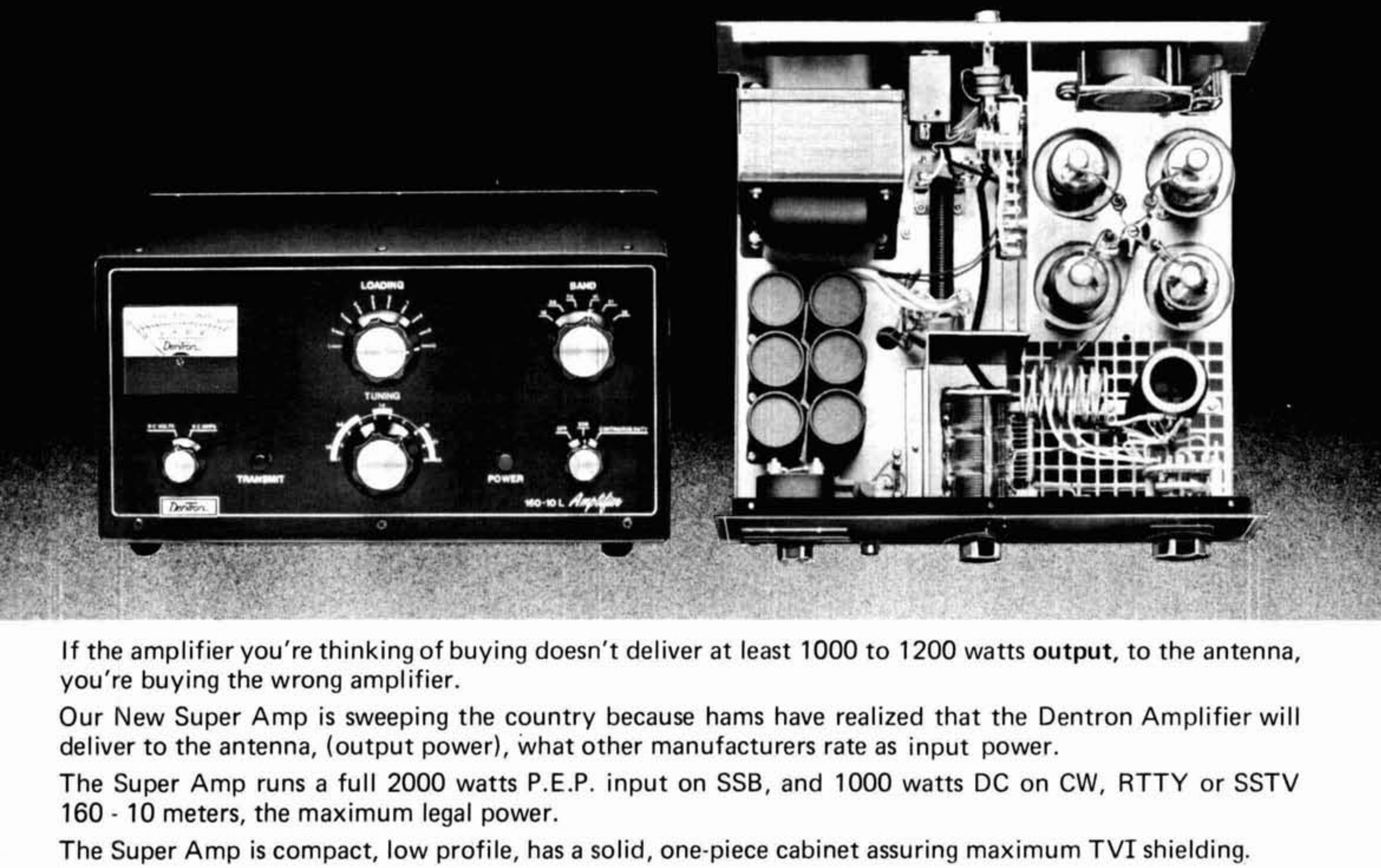
THE "PERSONAL COMMUNICATIONS RESEARCH ASSOCIATION" was formed in Los Angeles in early September by ten legal people who met in Jon Gallo's (WA6PTM) law offices. The non-profit organization, eventually to become the "Personal Communications Research Institute," will be a coordinating body for attorneys who find themselves in legal conflicts involving the personal communications field, primarily Amateur Radio and Citizens Band.

Tower Restrictions, anti-TVI/RFI ordinances, and dealings with various governmental agencies will be the foundation's prime concerns. If funding permits, it would also sponsor major research studies supporting the concept of personal communications.

Long Term Support will be sought from both industry and individuals but start-up costs are being borne by the organizers. All are Amateurs (half with CB licenses) with experience in helping support the concept that Amateur and CB radio is a "reasonable and proper" use of an individual's home.

10,000 MHZ DX RECORD was broken by two U.K. Amateurs in August when G4BRS in Cornwall worked GM3OXX in Edinburgh, a distance of 323 miles (521 km). Despite the much larger U.S. Amateur population, the U.K. and other European countries seem to be much more active on 3 cm and other Amateur microwave bands.

Dentron Proudly Reveals the Secret of the New $499.50 Super Amp



If the amplifier you're thinking of buying doesn't deliver at least 1000 to 1200 watts **output**, to the antenna, you're buying the wrong amplifier.

Our New Super Amp is sweeping the country because hams have realized that the Dentron Amplifier will deliver to the antenna, (output power), what other manufacturers rate as input power.

The Super Amp runs a full 2000 watts P.E.P. input on SSB, and 1000 watts DC on CW, RTTY or SSTV 160 - 10 meters, the maximum legal power.

The Super Amp is compact, low profile, has a solid, one-piece cabinet assuring maximum TVI shielding.

The heart of our amplifier, the power supply, is a continuous duty, self-contained supply built for contest performance.

We mounted the 4 - 811 A's, industrial workhorse tubes, in a cooling chamber featuring the on demand variable cooling system.

The hams at Dentron pride themselves on quality work and we fight to keep prices down. That's why the dynamic Dentron Linear Amplifier beats them all at **$499.50.**

The No-nonsense Amplifier at a No-Nonsense Price $499.50.

DenTron
Radio Co., Inc.
2100 Enterprise Parkway
Twinsburg, Ohio 44087
(216) 425-3173

ANNOUNCING AN EXCITING NEW 2-METER TRANSCEIVER FROM KENWOOD

TR-7400A Specifications

Range: 144.00 MHz to 147.995 MHz
Mode: FM
800 Channels: 5 KHz spaced
Sensitivity: Better than 0.4 uV for 20 dB quieting
Better than 1 uV for 30 dB S/N
Squelch Sensitivity: Better than 0.25 uV
Selectivity: 12 KHz at −6 dB down
40 KHz at −70 dB down
Image Rejection: Better than −70 dB

the TR-7400A

Featuring Kenwood's New and Unique
CONTINUOUS TONE CODED SQUELCH SYSTEM
4 MHz BAND COVERAGE
25 WATT OUTPUT
FULLY SYNTHESIZED

UNIQUE SQUELCH SYSTEM
The TR-7400A may be used on your favorite repeater, no matter what type of squelch system is used. The continuous tone coded squelch (CTCS) may be used for both transmit and receive or for transmit only. Tone burst operation may also be used.

SYNTHESIZED, 800 CHANNELS
The phase-locked loop (PLL) frequency synthesizer in the TR-7400A divides the 4 MHz bandwidth into 400 channels at intervals of 10 KHz. The frequency may be offset 5 KHz higher with the push of a button, thus providing 800 discrete channels.

REPEATER OFFSET
A convenient front panel switch offsets the transmit frequency of the TR-7400A up OR down 600 KHz for standard repeater operation. This offset circuit uses digital technology to provide a highly stable offset frequency without spurious response. A dual color LED indicates the direction of offset from the displayed receive frequency.

OUTSTANDING RECEIVER PERFORMANCE
Large-sized helical resonators with high Q minimize undesirable interference from outside the 2-meter band. The large helical resonators, 2-pole 10.7 MHz monolithic crystal filter, and MOSFET front-end circuitry combine to give outstanding receiver performance.

TONE PAD CAPABILITY
A jack is provided to allow convenient connection of a tone pad to the TR-7400A.

FINAL PROTECTION CIRCUIT
The final transistor in the TR-7400A is protected from antenna impedance mismatch. Excessive reflected power reduces the amount of drive to the final transistor rather than turning off the final stage. This practical feature allows continued safe operation at a reduced power level whether the antenna system becomes opened or shorted.

Spurious Interference: Better than −60 dB
Intermodulation: Better than 66 dB
Receive System: Double conversion
First IF: 10.7 MHz
Second IF: 455 KHz
Audio Output: More than 1.5 Watts (8 ohm load)
RF Output Power: 25 Watts (High)
5-15 Watts (Low-adjustable)
Antenna Impedance: 50 ohms
Frequency Deviation: ±5 KHz
Spurious Response: Better than −60 dB
Tone Pad Input Impedance: 600 ohms
Tone Burst Duration: 0.5 to 1.0 sec.
CTCS Range: 88.5 Hz to 156.7 Hz
Microphone: Dynamic, with PTT switch, 500 ohms
Voltage: 11.5 to 16.0V DC (13.8V DC nominal)
Current Drain: Less than 1A in receive (no input signal)
Current Drain: Less than 8A in transmit
Polarity: Negative ground
Temperature Range: −20 to +50 degrees C
Dimensions: 182 mm (7-3/16") wide
270 mm (10-5/8") deep
74 mm (2-7/8") high
Net Weight: Approximately 2.8 kg (6.2 lbs.)

TRIO-KENWOOD COMMUNICATIONS INC.

If you haven't tried the TS-700A ...you haven't experienced the excitement of 2-meters

TS-700A Specifications

TRANSMIT/RECEIVE FREQUENCY RANGE: 144-148 MHz
MODE: SSB, FM, CW, AM
RF OUTPUT: CW, FM: more than 10W output. AM: more than 3W output. SSB: more than 20W DC input.
ANTENNA IMPEDANCE: 50Ω (unbalanced)
CARRIER SUPPRESSION: Better than 40 dB
SIDE BAND SUPPRESSION: Better than 40 dB
SPURIOUS RADIATION: Less than −60 db
MAX. FREQUENCY DEVIATION (FM): ±5 kHz
REPEATER FREQUENCY SHIFT WIDTH: 600 kHz
TONE BURST TIME: 0.5-1.0 sec.
MODULATION: Balanced modulation for SSB. Variable reactance frequency shift for FM. Low power modulation for AM.
MICROPHONE: Dynamic microphone, 500Ω
AUDIO FREQUENCY RESPONSE: 400-2600 Hz, within −9 db.
RECEIVING SYSTEM: SSB, CW, AM: Single-superheterodyne. FM: Double-superheterodyne.
INTERMEDIATE FREQUENCY: SSB, CW, AM: 10.7 MHz. FM: 1st IF: ... 10.7 MHz. 2nd IF: ... 455 kHz.
RECEIVING SENSITIVITY: SSB, CW: S/N = 10 dB or better at 0.25μV. 20 dB noise quieting = Less than 0.4μV. AM: S/N = 10 dB or better at 1μV.
IMAGE RATIO: Better than 60 dB
IF REJECTION: Better than 60dB
PASS BANDWIDTH: SSB, CW, AM: More than 2.4 kHz at −6 dB. FM: More than 12 kHz at −6 dB.
RECEIVER SELECTIVITY: SSB, CW, AM: Less than 4.8 kHz at −60 dB. FM: Less than 24 kHz at −60 dB.
SQUELCH SENSITIVITY: 0.25μV
AUDIO OUTPUT: More than 2W at 8Ω load (10% distortion)
RECEIVER LOAD IMPEDANCE: 8Ω
FREQUENCY STABILITY: Within ±2 kHz during one hour after one minute of warm-up, and within 150 Hz during any 30 minute period thereafter.
POWER CONSUMPTION: Transmit mode: 95W (AC 120/220V), 4A (DC 13.8V), max. Receive mode (no signal): 45W (AC 120/220V), 0.8A (DC 13.8V).
POWER REQUIREMENTS: AC 120/220V, 50/60 Hz. DC 12-16V (13.8V as reference).
DIMENSIONS: 278 (W) x 124 (H) x 320 (D) mm
WEIGHT: 11 kg
SUGGESTED PRICE: $700.00

Prices subject to change without notice

Experience the excitement of 2 meters. There's more than just FM repeaters, you know. SSB DX, OSCAR Satellite, CW...and do it all with a tunable VFO. Do it all with the Kenwood TS-700A.

- Operates all modes: SSB (upper & lower), FM, AM, and CW
- Completely solid state circuitry provides stable, long lasting, trouble-free operation
- AC and DC capability. Can operate from your car, boat, or as a base station through its built-in power supply
- 4 MHz band coverage (144 to 148 MHz) instead of the usual 2
- Automatically switches transmit frequency 600 KHz for repeater operation ... reverses, too
- Outstanding frequency stability provided through the use of FET-VFO
- Zero center discriminator meter
- Transmit/Receive capability on 44 channels with 11 crystals
- Complete with microphone and built-in speaker

The TS-700A is available at select Kenwood dealers throughout the U.S. For the name of your nearest dealer, please write.

16 EAST ALONDRA/GARDENA, CA 90248

KENWOOD
...pacesetter in amateur radio

wideband rf autotransformers

Design data for broadband impedance transformers using a single core

The use of transmission-line transformers wound on toroidal forms has become very popular in the last few years. These transformers serve many useful purposes, probably the most common being the transformation of balanced to unbalanced circuits and vice versa (baluns) over a relatively wide bandwidth. They were first described by G. Guanella.[1] The basic paper on the subject in this country was written by Ruthroff.[2]

Transmission-line transformers are restricted, however, as to available impedance transformation ratios and circuit configurations. Some of these restrictions can be relaxed by using an autotransformer instead of a transmission-line transformer, for although the construction techniques for the two types of transformers are similar, there are some very subtle differences in their operation, design, and application.

The purposes of this article are to point out the differences between transmission-line transformers and the more conventional autotransformers, and to give some design considerations for autotransformers. Autotransformers have many applications that can't be realized with transmission-line transformers, such as unbalanced-to-unbalanced or balanced-to-balanced impedance transformations, or impedance transformation ratios other than an integer squared. Some impedance transformation ratios that can be obtained with transmission-line transformers by using multiple cores can be obtained with a single core by using an autotransformer.

transmission-line transformers

The distinguishing feature of the transmission-line transformer is that the "winding" is composed of two conductors with equal and opposite currents flowing in each conductor, as in a balanced transmission line. The net magnetizing ampere-turns in the core is zero. Because of this, there is considerable difference in the means by which energy is transformed between the input and output circuits for a transmission-line transformer and an autotransformer.

Quoting from reference 3 in describing a transmission-line transformer, "the inductance of a conductor is directly proportional to the relative permeability of the surrounding medium. A high permeability material placed close to the transmission line conductors acts on the external fringe field present and can magnify the inductance appreciably and thereby provide lower cutoff frequency. There is no influence upon internal magnetic fields nor upon the characteristic impedance of the line. The power transferred from input to output is not coupled through the ferrite material, but rather through the dielectric medium separating the transmission line conductors. This is an important concept for design. Relatively small cross-section ferrite material can perform unsaturated at impressively high power levels. In contrast to this, conventional transformers couple power from primary to secondary entirely through a high permeability core which must be chosen to suitably carry the total power without saturating."

With the autotransformer, the permeability of the core and the number of turns determine the low-frequency response, while the high-frequency response of these transformers is obtained by very close coupling, both capacitively and magnetically, between the windings. This is obtained by the twist.

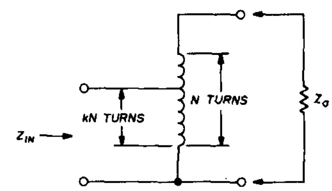


fig. 1. Basic autotransformer circuit used as a step-down device. In this application $Z_{in} = k^2Z_o$ for k between zero and 1, where Z_{in} and Z_o are input and output (load) impedances and k is the tap location, expressed as a fraction of the total number of turns referenced to the common terminal.

autotransformers

The basic autotransformer circuit is given in **fig. 1.** When the transformer is used as an impedance step-down device, the relationship between the load impedance and that presented to the input terminals is given by

$$Z_{in} = k^2 Z_o \quad (1)$$

where Z_o is the load or output impedance
Z_{in} is the impedance presented to the input terminals
k is the location of the tap (stated as a fraction of the total number of turns referenced to the common terminal).

This article was originally published in the February 2, 1976 issue of *Electronic Design*, and is republished here with the permission of the editor.

By John J. Nagle, K4KJ, 12330 Lawyers Road, Herndon, Virginia 22070

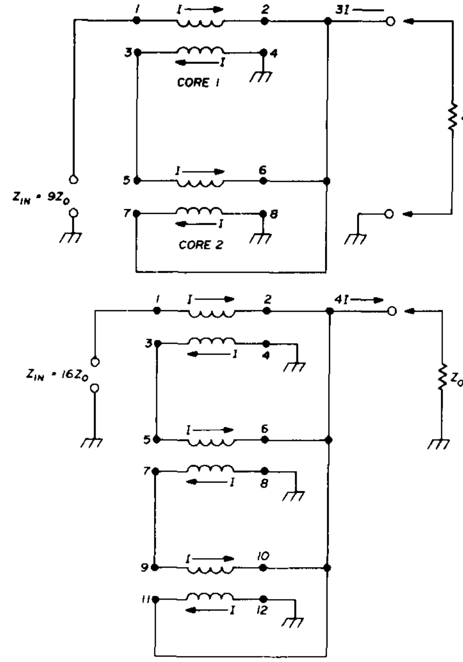


fig. 2. Transmission-line transformers for unbalanced-to-unbalanced loads. A and B are for 9:1 and 16:1 transformation ratios respectively. (Data is from reference 3).

When using transmission-line transformers, it's necessary to have two identical windings. The tap must be placed at the center, giving a four-to-one impedance transformation. This case has been well covered in the literature and will not be considered further. Unfortunately, impedance ratios other than four-to-one are frequently required, and methods of obtaining both integral and nonintegral impedance ratios are not so well known.

unbalanced-to-unbalanced loads

Pitzalis and Couse[3] give circuits for obtaining 9:1 and 16:1 impedance ratios for unbalanced-to-unbalanced loads. These circuits are shown in **figs. 2A** and **2B** respectively. The 9:1 transformer requires two cores, while the 16:1 unit requires three cores; in these circuits, there is one bifilar winding on each core.

Because of the requirement for equal and opposite currents in the windings, transmission-line transformers are restricted to impedance ratios of $(\frac{2}{1})^2, (\frac{3}{1})^2, (\frac{4}{1})^2 \ldots (\frac{n}{1})^2$ where n is an integer. In general, the impedance transformations available with this type of circuit are given by

$$\text{impedance ratio} = (N_c + 1)^2 \qquad (2)$$

where N_c is the number of cores

Impedance transformation ratios other than those obtainable from transmission-line transformers are frequently required, and so the autotransformer must be considered. Krause and Allen[4] have given an interesting method for extending a 4:1 transformation ratio to 6:1. After the usual bifilar winding is wound on the core, a third winding is wound over the original winding, as shown in **fig. 3.** The length of this winding is given by

$$L3 = L\,[\sqrt{R_L/R_S} - 2\,] \qquad (3)$$

where $L3$ is the length of the third winding
R_L is the load resistance
L is the length of the bifilar winding
R_S is the source resistance

If impedance transformations greater than about 6:1 are attempted, bandwidth reductions may occur.

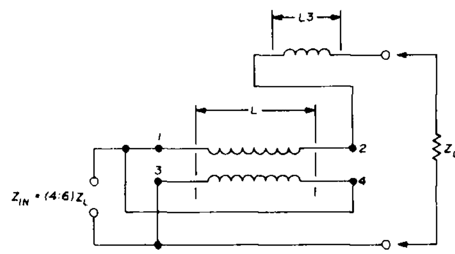


fig. 3. Method for extending the impedance-transformation ratio of an unbalanced-to-unbalanced transformer from 4:1 to about 6:1 (after Krause and Allen, reference 4).

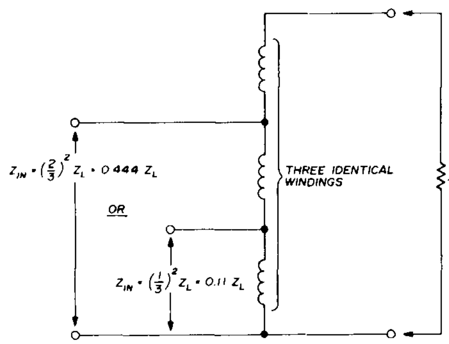


fig. 4. Autotransformer using a trifilar winding gives impedance step-up ratios of 1:9/4 or 1:9, depending on which tap is used.

The addition of this third winding changes the device from a transmission-line transformer to an autotransformer, since the tertiary winding has no conductor to carry an equal and opposite current. Care must be taken to ensure the core does not become saturated by the unbalanced current flow.

The characteristic of transmission-line transformers cited previously is also evident from **fig. 2**; in a true transmission-line transformer, the current flow must be equal and opposite in the two conductors on the core, just as in a transmission line. Many of the devices one sees parading as transmission-line transformers, including some to be described later, are not true transmission-line devices but are simply broadband transformers of the autotransformer variety.

It's possible to obtain transformation ratios of other than 4:1 by autotransformer techniques; these have the further advantage that only one core is needed. If a trifilar winding is made by tightly twisting three separate conductors together to form a single winding and the three conductors connected in series aiding, the circuit of **fig. 4** results. This gives impedance step-up ratios of $1{:}\frac{9}{4}$ or 1:9, depending on which tap is used. This device is of the autotransformer type and is not a transmission-line transformer since the currents are not equal and opposite through the individual conductors, although the construction techniques are similar and the bandwidths obtainable appear to approach those of a transmission-line transformer.

Going one step further and using a quadrifilar winding, impedance step-up ratios of $1:(3/4)^2$, $1:(1/2)^2$, and $1:(1/4)^2$ can be obtained, as shown in **fig. 5**, thereby increasing the flexibility afforded the circuit designer. It's difficult to say how much further the process can be continued, but the possibilities appear limited by the number of wires it's practical to put on a core. It should also be expected that the usable bandwidth will decrease as the number of windings increases.

The type of construction just described has the advantages of accuracy and convenience. As broadband rf transformers of the type described have only a very small number of turns, it's difficult to place a tap accurately. With the transformers to be described, the available transformation ratios depend only on the number of windings put on a core, so that miscounting a turn or two won't cause an error. The total number of turns can be selected to obtain the required inductance. The arrangement is convenient because the taps are placed at the junction of two windings, which is easily accessible. A further advantage is that the impedance transformation ratios available are the square of a rational number instead of the square of an integer, as with transmission-line transformers.

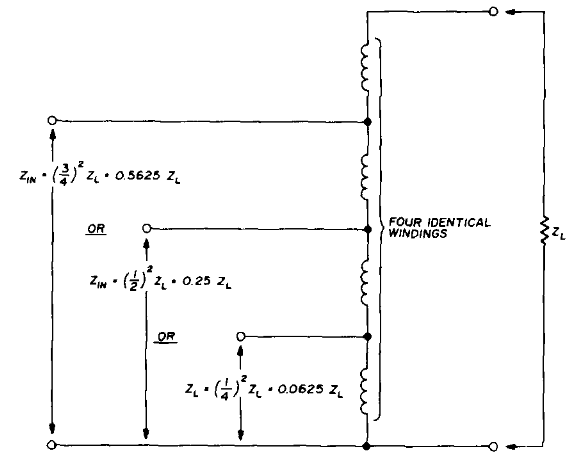


fig. 5. Autotransformer with a quadrifilar winding will give step-up ratios of $1:(3/4)^2$, $1:(1/2)^2$, and $1:(1/4)^2$.

balanced-to-balanced loads

In the preceding material we've assumed the unbalanced-to-unbalanced case. When three or more windings are put on the same core, as in **figs. 6** or **7**, the transformer may also be used for balanced-to-balanced impedance transformations. A three-winding core is shown in **fig. 6** which will give an impedance ratio of 0.111:1; a four-winding core will give an impedance ratio of 0.25:1; see **fig. 7**. An advantage of using an even number of windings is that the center tap may be grounded.

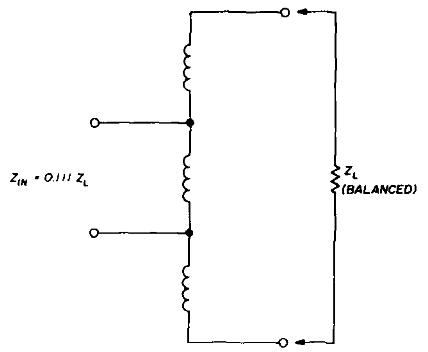


fig. 6. A trifilar-wound transformer that provides a balanced-to-balanced impedance transformation of 0.111:1.

It's desirable to be able to determine early in the design stage whether a given impedance transformation can be obtained with an n-filar winding with taps at the junctions or whether a tapped winding must be used. The following slide-rule algorithm will easily determine this:

Assume it's desired to match a 50-ohm coaxial cable to a 72-ohm load using an autotransformer. Set 50 on the *A* scale of a slide rule opposite 72 on the *B* scale. Now scan the *C* and *D* scales for two integers that line up; notice that 6 on the *C* scale is opposite 5 on the *D* scale (**fig. 8**). This indicates that a hexifilar winding connected across the 72-ohm load, with the 50-ohm cable connected between the fifth and sixth winding, will be required as shown in **fig. 9**. A resistive pad used to obtain the same impedance match would require a loss of 5.7 dB.

The same procedure may be used for balanced lines except that in scanning the *C* and *D* scales of the slide rule, it's necessary to look for integers separated by two or any other even number. For example, let's say we wish to match a 383-ohm balanced line of AWG 18 (1mm) wire spaced ½ inch (12.5mm), such as open-wire TV line, to 200 ohms balanced (200 ohms was chosen since it's the impedance obtained in going from 50-ohm coax through a 4:1 balun).

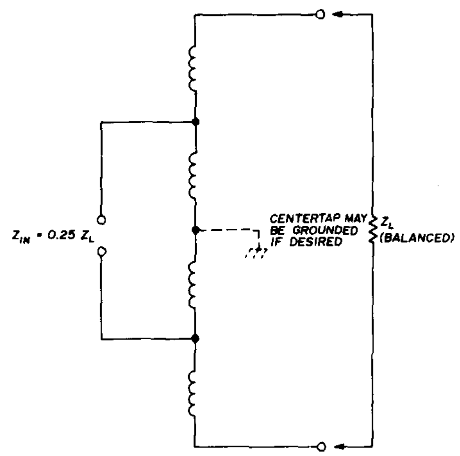


fig. 7. A balanced-to-balanced impedance transformation of 0.25:1 may be obtained with a quadrifilar winding. The center tap may also be grounded.

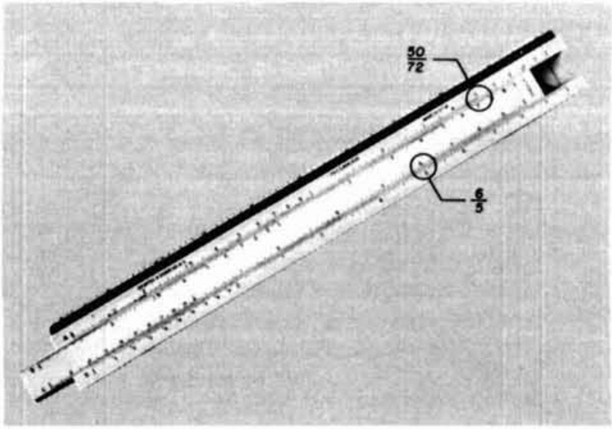


fig. 8. Slide-rule algorithm for determining the turns ratio for matching 50 ohms to a 72-ohm load. Impedance ratios on the A and B scales show that the turns ratio should be 5:6 (C and D scales).

After setting 200 on the *B* scale opposite 383 on the *A* scale, we note that the closest integers separated by two are 7 on the *D* scale opposite 5.05 on the *C* scale (**fig. 10**). Because only integral numbers are allowed, an exact match can't be obtained. It is therefore necessary to move the slide slightly so that 5 and 7 are aligned on the *C* and *D* scales. This puts 200 on the *B* scale opposite 390 on the *A* scale, and will give a vswr of 390/383 = 1.02:1 (this may or may not be acceptable, depending on the application). At any rate, it's the best that can be done with an n-filar winding. If a better match is required, a tapped winding must be used. The circuit is shown in **fig. 11.**

A note of caution is necessary in applying this algorithm. Make certain that the proper side of the *A* and *B* scales is used in setting up the impedance ratio. In the first example above, both impedances were in the decade between 10 and 100, while in the second example both impedances were in the decade between 100 and 1000, so that in both cases the same half of the *A* and *B* scales would be used. If, on the other hand, you re trying to match 75 to 120 ohms (both unbalanced), you should use 75 from the left-hand side of the *A* scale with 120 from the right-hand of the *B* scale and obtain 5.05 over 4 on the *C* and *D* scales. If you mistakenly set 75 on the left-hand *A* scale opposite 120 on the left-hand *B* scale, the result would be 2 over 5 on the *C* and *D* scales, which is incorrect. This is shown in **fig. 12.**

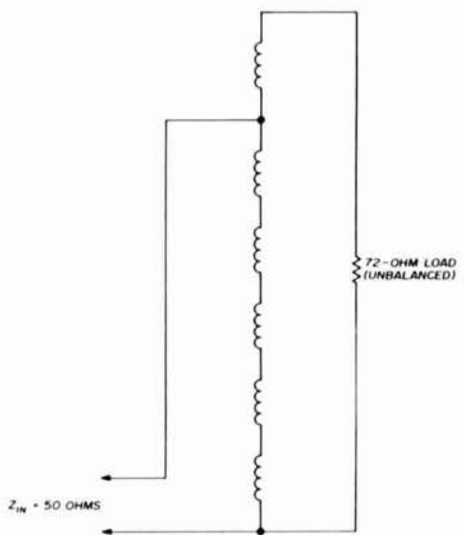


fig. 9. Hexifilar winding on an autotransformer for matching a 72-ohm load to a 50-ohm transmission line. Circuit illustrates the tap placement in the example of fig. 8.

I believe the above algorithm using a slide rule is more convenient to use than trying to calculate an exact turns ratio on a pocket calculator, even a programmable type. A slide rule can tell you at a glance the possible combinations that will give the desired turns ratio and how close it's possible to come if there are no exact ratios.

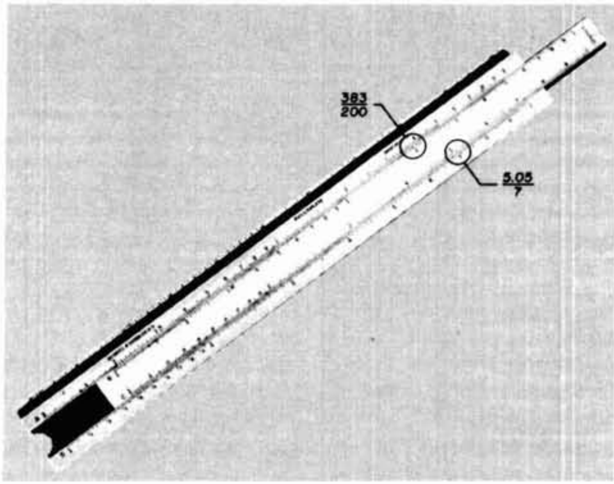


fig. 10. Slide-rule setup shows a turns ratio of 5:7 will match 200 to 383 ohms (approximately), both balanced to ground.

Also the more common four-function calculators won't square nor extract square roots, which you'll need to go from turns ratio to impedance ratios, or vice versa.

core configuration

One of the important parameters in the design of a successful wideband rf transformer is the core shape. Most neophytes in transformer design, including me, begin by using toroids, probably from tradition. Toroids, however, are seldom the best choice. We will, therefore, discuss the subject of core shape briefly; the following material was taken from references 5 and 6.

The factors limiting the high-frequency response of a transformer are leakage inductance and winding capacitance; these factors suggest a winding that has as few turns as possible. On the other hand, the low-frequency response is limited by the available shunt inductance, and this suggests that a large number of turns may be necessary to meet the low-frequency specifications. It is therefore of considerable practical interest to find a core shape that will maximize the shunt inductance while minimizing the leakage inductance and shunt capacity, and to rate various core shapes numerically on this basis.

Such a number is called the form factor and is defined as

$$form\ factor = \frac{l_w l_e}{A_e} \qquad (4)$$

where l_w is length of one complete turn of wire
l_e is effective length of the magnetic circuit
A_e is effective cross sectional area of the core

All the above factors must be in the same units, usually millimeters. The smaller the form-factor number, the more desirable the core for high frequency, broadband transformer use.

In most core manufacturers' literature, the quotient l_e/A_e is given its own symbol, usually C_1, so that

$$form\ factor = l_w C_1 \qquad (5)$$

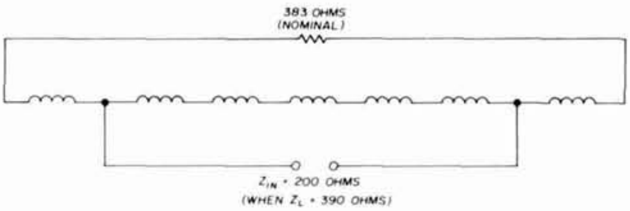


fig. 11. A 7-winding autotransformer for matching a 200- to 383-ohm load.

It's of interest to consider briefly the form factor for a toroid and various ways to minimize it. This will lead to a more optimum core shape. A detailed discussion is given in reference 6, pages 265-267.

The length of a single turn of wire, l_w, for a toroid is given by

$$l_w = d_2 - d_1 + 2h \qquad (6)$$

where d_2 and d_1 are the outer and inner diameters of the core respectively

h is the axial length (height)

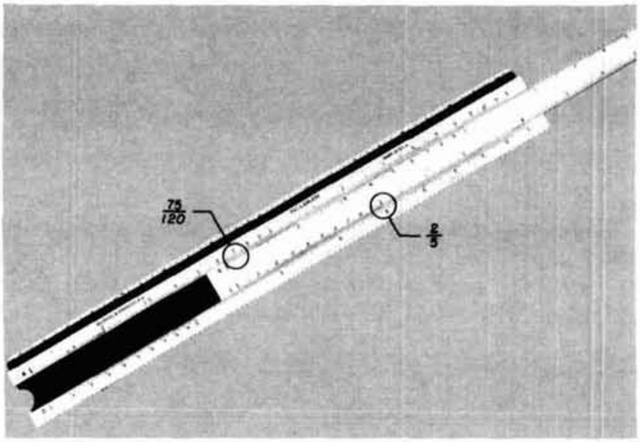


fig. 12. You must watch the slide-rule scale settings carefully or errors will result. This example shows the slide rule set to the wrong half of the A or B scales, which gives an incorrect turns ratio for matching 75 to 120 ohms.

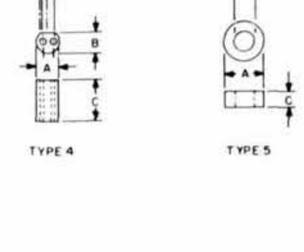
The factor C_1 is given by Snelling[6] as

$$C_1 = \frac{2\pi}{h \log e \frac{d_2}{d_1}} \qquad (7)$$

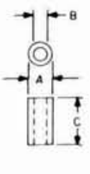
The objective is to minimize the product $l_w C_1$; this can be done by minimizing either or both factors. C_1 can be decreased by either increasing d_2 or decreasing d_1. However, when the ratio $\frac{d_2}{d_1} \gg 1$, increasing d_2 increases l_w far more than a proportional decrease in d_1 so that it's desirable to make d_1 as small as possible. As only a few turns of wire are used for most broadband rf transformers, the inner diameter can usually be reduced to a very few millimeters. This results in a toroidal form quite different in shape from the usual toroid and is more often referred to as a bead.

There is a practical limit, however, as to how far the form factor may be reduced in this manner. Further improvement can be made by placing two toroids edge to edge, as shown in **fig. 13**, and threading turns through

table 1. Form factors for commonly used toroid and balun core sizes.



core shape type	nominal dimensions, in. (mm) A	B	C	D	E	form factor
1	0.525(13.3)	0.295(7.5)	0.407(10.3)	0.225(5.7)	0.150(3.8)	13.0
1	0.277(7.0)	0.160(4.1)	0.244(6.2)	0.114(3.6)	0.071(1.8)	14.3
1	0.136(3.5)	0.079(2.0)	0.093(2.4)	0.057(1.4)	0.034(0.9)	14.0
3	0.250(6.4)	—	0.242(6.1)	0.100(2.5)	0.050(1.3)	9.5
3	0.250(6.4)	—	0.471(12.0)	0.100(2.5)	0.050(1.3)	8.8
4	0.284(7.2)	—	0.218(5.5)	0.104(2.6)	0.052(1.3)	8.8
3	0.220(5.6)	—	0.250(6.4)	0.090(2.3)	0.035(0.9)	7.8
5	0.380(9.7)	—	0.190(4.8)	—	0.197(5.0)	29.0



nominal dimensions, in. (mm) A	B	C	form factor
0.138(3.5)	0.051(1.3)	0.118(3.0)	17.3
0.076(1.9)	0.043(1.1)	0.150(3.8)	24.3
0.138(3.5)	0.051(1.3)	0.236(6.0)	14.9
0.138(3.5)	0.051(1.3)	0.500(12.7)	13.7
0.296(7.5)	0.094(2.4)	0.297(7.5)	14.8
0.200(5.0)	0.062(1.6)	0.250(6.4)	15.2
0.200(5.0)	0.062(1.6)	0.437(11.0)	12.3

the two holes. In practice, a single core would be used having the shape shown in **fig. 14.** This type of core is often referred to as a balun core. A disadvantage of this core shape is that each turn must be threaded through two holes, but since the number of turns is small, this isn't a serious limitation. **Table 1** gives the form factor for various commonly used toroid and balun core sizes. This data was taken from reference 5. From this table, it can be seen that the balun shape has a lower form factor than the toroid.

low-frequency response

The design of wideband autotransformers is similar to that of transmission-line transformers. Although both are relatively straightforward, some compromises must be made from a practical standpoint. For the autotransformer, the desired low-frequency response determines the number of turns and the size of the core. The low-frequency response will be down 3 dB at a frequency, f_1, when the primary reactance is equal to the total shunt resistance. The shunt resistance is the parallel combination of a) the load impedance referred to the primary, b) the parallel equivalent of the generator resistance, and c) the transformer losses expressed as a shunt resistance across the primary. These are shown in **fig. 15.** This will occur when $2\pi f_1 L_p = R_{eq}$ where R_{eq} is the parallel combination of the load, generator and loss resistances referred to the primary. Solving for L_p gives

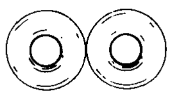


fig. 13. Placing two toroid cores side by side gives a better form factor than a single toroid. The winding is through the two holes.

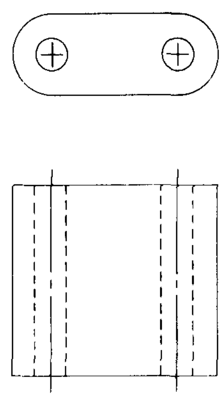
$$L_p = \frac{k^2 R_{eq}}{2\pi f_1} \tag{8}$$

The response will be down 1 dB at a frequency $3f_1$. Most core manufacturers publish a factor, A_L, which gives the inductance per turn (or per turns squared) or per hundred turns. In the megahertz region, A_L varies with frequency so this factor is usually presented as a curve. A_L should be chosen for the lowest frequency of interest. Using this factor and the inductance found from **eq. 8,** the required number of turns can be calculated. If it's not possible to wind the desired number of turns on the selected core, it will be necessary to use a larger core or a core with a higher permeability, thereby requiring fewer turns. Where wide temperature variations are possible, cores with high permeability should be avoided, as these cores also have a higher temperature coefficient than cores with lower permeability, which may cause problems at the temperature extremes.

high-frequency response

The high-frequency response is a different problem. In general, to maintain good high-frequency response, the number of turns should be as small as possible. Thus some juggling is necessary among the number of turns, core permeability, and core size and shape.

fig. 14. A balun core as developed from two toroidal cores placed side by side.



design example

Transformers of this type are not difficult to wind. If you've never tried winding one before, you may have to wind two or three before you get one you like, but keep trying; analyze your deficiencies in light of the above material. When you find the right combination, you'll probably be pleasantly surprised at the performance of the transformer.

We'll close this discussion with a sample design. Let's say we want to transform approximately 5.5 ohms to 50 ohms over a frequency range of 2 to 50 MHz; the maximum power level will be 0 dBm.

The impedance transformation ratio is approximately 9:1, so a trifilar winding is required: $\sqrt{9} = 3$. With the relatively low power requirement, a small core is acceptable. I chose a Fair-Rite Products core no. 2843002802 on the basis that it had the smallest form factor. The number of turns to wind on the core is easily determined: To keep the transformer losses low, the minimum impedance presented to the lowest-impedance tap, with the secondary open circuited, should be approximately five to ten times that presented to the same terminals with the secondary loaded with its rated impedance. Since impedance presented to the lowest-impedance tap will be about 5.5 ohms when the total winding is loaded with 50 ohms, the impedance presented to the lowest-impedance tap with the load open circuited should be about 25 to 55 ohms. This calculation should be made at the lowest rated frequency of the transformer. When made for the lowest

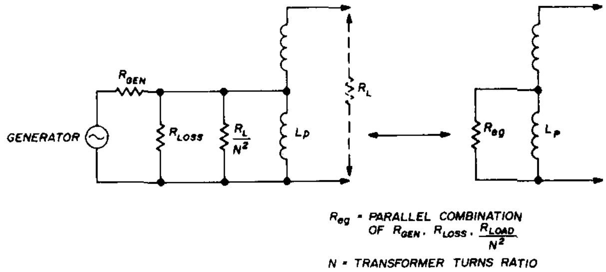
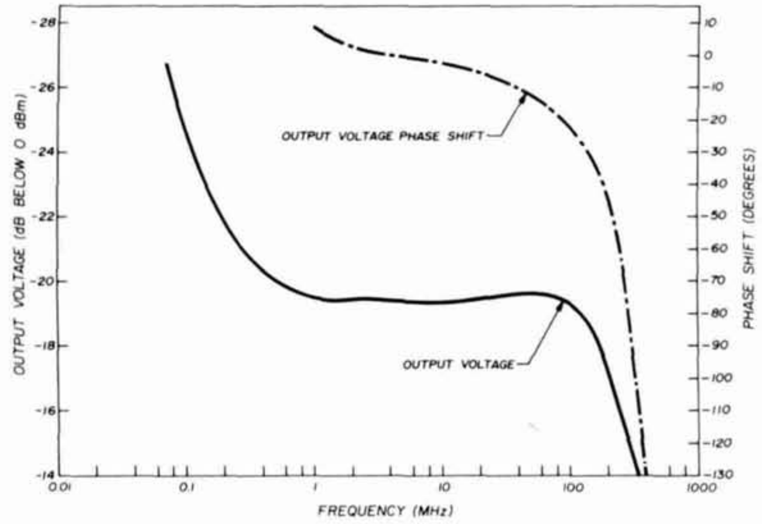


fig. 15. Derivation of the autotranformer primary inductance in terms of the total shunt resistance, which is the parallel combination of a) the load impedance referred to the primary, b) the *parallel equivalent of the generator resistance*, and c) *transformer* losses expressed as shunt resistance across the primary.

fig. 17. Response of the transformer shown in figs. 4 and 16. Load was a 5.6-ohm resistor across the lowest-impedance tap. Transformer input was from a 50-ohm generator. Output voltage in dB below 0 dBm and secondary winding phase shift are shown.



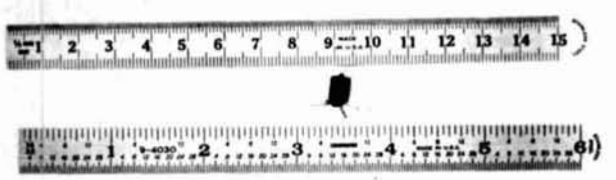
impedance tap, this calculation will determine the number of trifilar turns.

From the core manufacturers' literature for the core used, one turn will give a parallel impedance of about 30 ohms at 2 MHz, so that the transformer will require one (trifilar) turn. The three strands will be connected in *series aiding*. The circuit is shown in **fig. 4** and a photo of the completed transformer is given in **fig. 16. Fig. 17** shows the voltage across a 5.6-ohm resistor connected across the lowest-impedance tap when the transformer is driven from a 50-ohm generator. The measurements were made with a Hewlett-Packard 8405A Vector Voltmeter with a reference channel connected to the transformer input and the slaved channel connected across the load impedance.

The generator output was set to 0 dBm into a 10-dB, 50-ohm resistive attenuator. The left-hand ordinate in **fig. 17** gives the output voltage in dB below 0 dBm. As the transformer has a 3:1 voltage step-down ratio, the output voltage would be expected to be −19.54 dB (−9.54 − 10 dB) below the input to the 10-dB pad (disregarding the impedance change). The right-hand ordinate gives the secondary voltage phase shift in degrees.

From **fig. 17** it can be seen that the output is constant within a few tenths of a dB from 1 to 100 MHz. While this bandwidth is not as great as that obtained with transmission-line transformers, an impedance transformation ratio of 9:1 is obtained with one core and other impedance ratios are conveniently available, making the transformer useful for many applications.

fig. 16. Photo of the transformer design shown in fig. 4. Small size is key to good high-frequency response.



summary

The *n*-filar broadband autotransformer using only a single core gives greater flexibility than is possible with transmission-line devices, thereby achieving greater economy. Furthermore, autotransformers can be used in either balanced-to-balanced or unbalanced-to-unbalanced applications. While the autotransformer as described above may not be a cure-all for a circuit designer's problem, it certainly is a versatile component in his bag of tricks.

Those interested in experimenting with wideband transformers or baluns may obtain an assortment of the various cores shown in **table 1** from Fair-Rite Products Corp.*

*Fair-Rite Products Corporation, Walkill, New York 12589. Price: $10.00 postpaid.

references

1. G. Guanella, "New Method of Impedance Matching in Radio Frequency Circuits," *Brown-Boveri Review,* Vol. 31, 1944, page 327.
2. C.L. Ruthoff, "Some Broad-Band Transformers," *Proceedings of the IRE,* Vol. 47, No. 8, August, 1959, pages 1337-1342.
3. Octavius Pitzalis, Jr. and Thomas P Couse, "Broadband Transformer Design for Transistor Power Amplifiers," *USAECOM Technical Report 2989*, July, 1968. (Available from National Technical Information Service, 5285 Port Royal Rd., Springfield, Virginia 22151; ask for AD-676-816. Price $4.00).
4. H.L. Krause and C.W. Allen, "Designing Toroidal Transformers to Optimize Wideband Performance," *Electronics*, August 16, 1973, pages 113-116.
5. W.A. Martin, "Use of Ferrites for Wide Band Transformers," Application Note published by Fair-Rite Products Corp., Walkill, New York 12589.
6. Snelling, "Soft Ferrites," published in the U.S.A. by the Chemical Rubber Publishing Company, Cleveland, Ohio.

ham radio

Call toll-free 800-647-8660
for products by MFJ ENTERPRISES

(Want MFJ products for Christmas? Mark your choice and show your XYL this ad.)

400% MORE RF POWER
PLUGS BETWEEN YOUR MICROPHONE AND TRANSMITTER

$49.95

LSP-520BX. 30 db dynamic range IC log amp and 3 active filters give clean audio. RF protected. 9 V battery. 3 conductor, ¼" phone jacks for input and output. 2-3/16 x 3-1/4 x 4 inches.

$59.95

LSP-520BX II. Same as LSP-520BX but in a beautiful 2-1/8 x 3-5/8 x 5-9/16 inch Ten-Tec enclosure with uncommitted 4 pin Mic jack, output cable, rotary function switch.

SUPER LOGARITHMIC SPEECH PROCESSOR

Up To 400% More RF Power is yours with this plug-in unit. Simply plug the MFJ Super Logarithmic Speech Processor between your microphone and transmitter and your voice is suddenly transformed from a whisper to a **Dynamic Output.**

Your signal is full of punch with power to slice through QRM and you go from barely readable to "solid copy OM".

$27.95

CWF-2BX Super CW Filter

By far the leader. Over 5000 in use. Razor sharp selectivity. 80 Hz bandwidth, extremely steep skirts. No ringing. Plugs between receiver and phones or connect between audio stage for speaker operation.

• Selectable BW: 80, 110, 180 Hz • 60 dB down one octave from center freq. of 750 Hz for 80 Hz BW • Reduces noise 15 dB • 9 V battery • 2-3/16 x 3-1/4 x 4 in. • CWF-2PC, wired PC board, $18.95 • CWF-2PCK, kit PC board $15.95

$49.95

CMOS-8043 Electronic Keyer

State of the art design uses CURTIS-8043 Keyer-on-a-chip.

• Built-in Key • Dot memory • Iambic operation with external squeeze key • 8 to 50 WPM • Sidetone and speaker • Speed, volume, tone, weight controls • Ultra reliable solid state keying +300 volts max. • 4 position switch for TUNE, OFF, ON, SIDETONE OFF • Uses 4 penlight cells • 2-3/16 x 3-1/4 x 4 inches

$39.95

NEW

MFJ-16010 Antenna Tuner

Now you can operate all band — 160 thru 10 Meters — with a single random wire and run your full transceiver power output — up to 200 watts RF power OUTPUT.

• Small enough to carry in your hip pocket, 2-3/16 x 3-1/4 x 4 inches • Matches low and high impedances by interchanging input and output • SO-239 coaxial connectors • Unique wide range, high performance, 12 position tapped inductor. Uses two stacked toroid cores

$29.95

SBF-2BX SSB Filter

Dramatically improves readability.

• Optimizes your audio to reduce sideband splatter, remove low and high pitched QRM, hiss, static crashes, background noise, 60 and 120 Hz hum • Reduces fatique during contest, DX, and ragchewing • Plugs between phones and receiver or connect between audio stage for speaker operation • Selectable bandwidth IC active audio filter • Uses 9 volt battery • 2-3/16 x 3-1/4 x 4 inches

$27.95

MFJ-200BX Frequency Standard

Provides strong, precise markers every 100, 50, or 25 KHz well into VHF region.

• Exclusive circuitry suppresses all unwanted markers • Markers are **gated** for positive identification. CMOS IC's with transistor output. • No direct connection necessary • Uses 9 volt battery • Adjustable trimmer for zero beating to WWV • Switch selects 100, 50, 25 KHz or OFF • 2-3/16 x 3-1/4 x 4 inches

$49.95

MFJ-1030BX Receiver Preselector

Clearly copy weak unreadable signals (increases signal 3 to 5 "S" units).

• More than 20 dB low noise gain • Separate input and output tuning controls give maximum gain and RF selectivity to significantly reject out-of-band signals and reduce image responses • Dual gate MOS FET for low noise, strong signal handling abilities • Completely stable • Optimized for 10 thru 30 MHz • 9 V battery • 2-1/8 x 3-5/8 x 5-9/16 inches

$27.95

MFJ-40T QRP Transmitter

Work the world with 5 watts on 40 Meter CW.

• No tuning • Matches 50 ohm load • Clean output with low harmonic content • Power amplifier transistor protected against burnout • Switch selects 3 crystals or VFO input • 12 VDC • 2-3/16 x 3-1/4 x 4 inches

MFJ-40V, Companion VFO $27.95

MFJ-12DC, IC Regulated Power Supply, 1 amp, 12 VDC $27.95

$15.95

NEW

CPO-555 Code Oscillator

For the Newcomer to learn the Morse code.
For the Old Timer to polish his fist.
For the Code Instructor to teach his classes.

• Send crisp clear code with plenty of volume for classroom use • Self contained speaker, volume, tone controls, aluminum cabinet • 9 V battery • Top quality U.S. construction • Uses 555 IC timer • 2-3/16 x 3-1/4 x 4 inches

TK-555, Optional Telegraph Key $1.95

OUR OFFER TO YOU

Dear Fellow Ham,

Try any MFJ products and if you are not completely satisfied, return it within 30 days for a full prompt refund (less shipping). Call us today **toll free 800-647-8660** and charge your BankAmericard or Master Charge, or mail your order in today with your check or money order (or use your BAC or MC). Please add $2.00 for shipping and handling. Order now and avoid the Christmas rush.

73, Martin F. Jue, K5FLU

P.S. Solve your XYL's Christmas problem. Mark your choice and show her this ad.

ORDER TODAY. MONEY BACK IF NOT DELIGHTED. ONE YEAR UNCONDITIONAL GUARANTEE.

Order By Mail or Call TOLL FREE 800-647-8660 and Charge It On BANKAMERICARD master charge

MFJ ENTERPRISES P. O. BOX 494
MISSISSIPPI STATE, MISSISSIPPI 39762

audio filters

for improving SSB and CW reception

The FX-60 active filter is put to work as a tunable lowpass filter for ssb and as a narrow bandpass filter for CW applications

Except in more expensive receiver designs, manufacturers have given little attention to the problem of processing detected audio. The usual practice is to roll off the higher-frequency audio signals using shunt capacitance or perhaps include an inductor to introduce reactance at the higher audio frequencies.

This article provides design and construction details for a lowpass filter for single sideband and a narrow bandpass filter for CW reception. The filters are designed around the FX-60 integrated circuit,* which is a cull from the manufacturer's product line but which is perfectly acceptable for the applications described.

*Kinetic Technology, Inc., 3393 De La Cruz Blvd., Santa Clara, California 95050.

improving receiver performance

To detect a single-sideband audio signal from the i-f carrier, some form of mixer is used with a bfo signal. The products resulting from this mixing consist of the audio signals plus an additional number of signals including the bfo frequency, the i-f, and a variety of complex sum and difference frequencies. Many of these signals are within the audible range and are heard as hiss.

The chief advantage of the single-sideband signal is its narrow audio bandwidth. By limiting the audio bandwidth within the transmitter and transmitting only one of the sidebands, we can concentrate the power where it's most effective, resulting in communicable information. The transmitted audio bandwidths will vary from 1.5 kHz to almost 3 kHz; in the process of limiting the transmitted signal bandwidth, normally both the very low frequencies and those above approximately 3 kHz are eliminated from the transmitted signal. The low frequencies are limited by using only nominal coupling capacitors between various audio processing stages and restricting the bandpass with a ceramic-, crystal-, or LC-filter section. Obviously, when the received signal is detected, the high- and low-frequency components contain no intelligence and can be eliminated. While restricting the received audio bandwidth to the useful range of information frequencies, we can improve the receiver overall performance and signal-to-noise ratio.

single-sideband filter

Fig. 1 shows a very simple lowpass filter for use with single-sideband receiver systems. A number of circuits are available in the various amateur handbooks for per-

By M.A. Chapman, K6SDX, 935 Elmview Drive, Encinitas, California 92024

forming this type of audio processing. Normally these circuits employ a series of toroidal-core LC sections in a variety of T or pi arrangements. This is a very effective scheme for single sideband audio filtering; however, to provide the necessary large inductive reactance, the toroids and capacitors are physically quite large, and the performance curves indicate rather poor uniformity.

The circuit illustrated in **fig. 1** uses an inexpensive hybrid active filter, which employs multiloop negative feedback for lowpass transfer functions. Tuning the filter frequency and selecting Q are easily accomplished by adding external resistors. U1, the FX-60 device used for the lowpass audio filtering, is a cull unit available in small quantities from the manufacturer, whose product line includes this device with very rigid parameters (and at a much higher price) under alternative part numbers FS-60, FS-65 and FS-61. The FX-60 will vary in center-frequency tolerance over slightly wider ranges than the prime product-line devices, but in all other respects its performance characteristics are identical.

To minimize loading previous receiver circuit stages, the single-sideband filter circuit of **fig. 1** employs a high-impedance buffer stage, Q1. This stage provides only nominal gain and isolates the filter from previous receiver stages. The lowpass cutoff or rolloff frequency is determined by the two precision resistors at terminals 2 and 10 of U1 (18.2k, 1%). Using the manufacturer's relationship for determining the lowpass rolloff point, we find that

$$f_c = \frac{455(10^5)}{18.2(10^3)} = 2.5\ kHz\ (nominal) \qquad (1)$$

where f_c is the filter cutoff frequency. This relationship results in a sharp rolloff of audio frequencies above 2.5

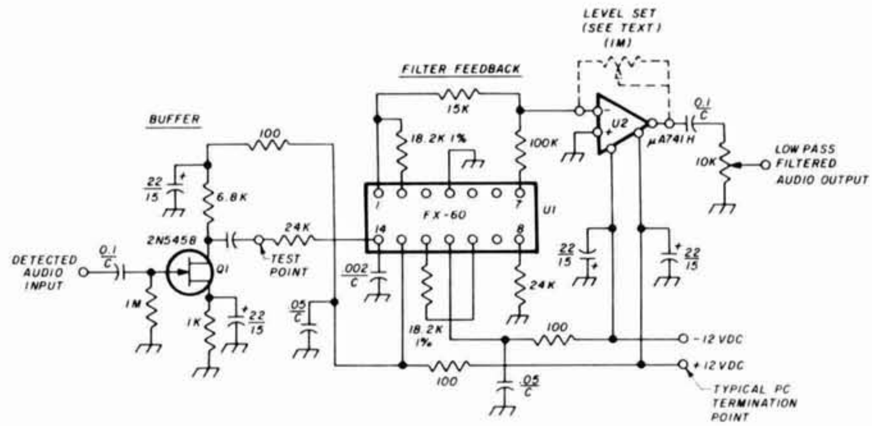
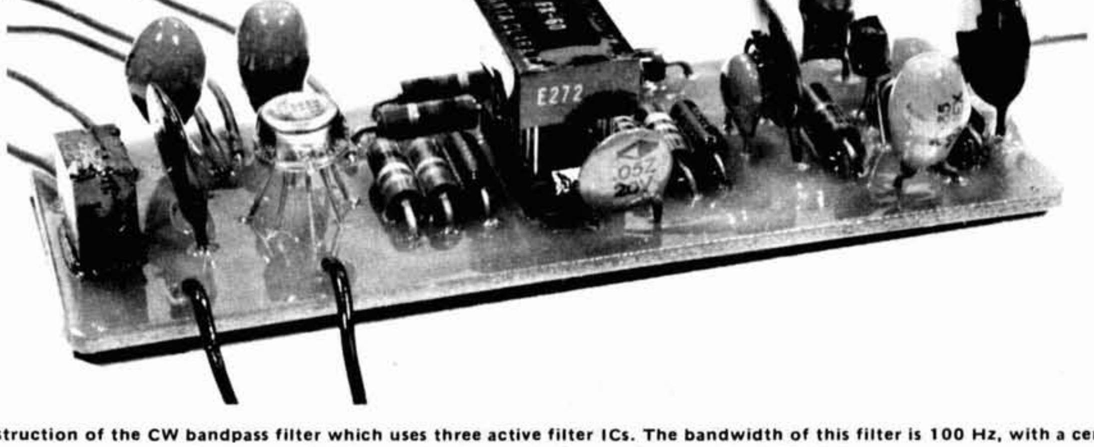


fig. 1. Schematic of the 2.5-kHz detected-audio lowpass filter for single-sideband application.



Construction of the CW bandpass filter which uses three active filter ICs. The bandwidth of this filter is 100 Hz, with a center frequency of 1000 Hz. All other audio frequencies are at least 20 dB down.

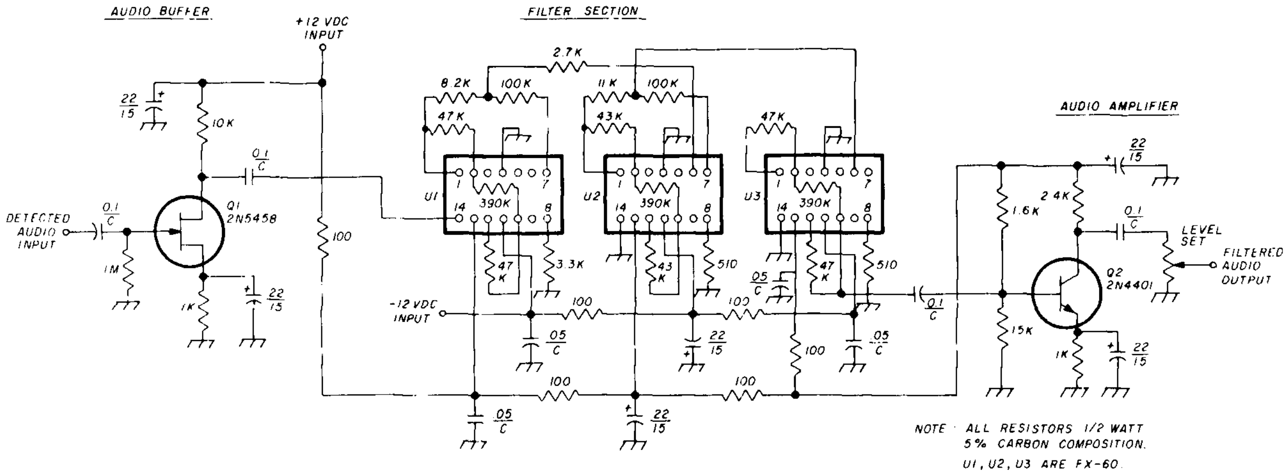


fig. 2. Schematic of the 900-Hz audio bandpass filter for CW. Bandwidth is ≤ 150 Hz with minimum relative attenuation of ≥ 20 dB.

kHz. A relative minimum attenuation of 15 dB is obtained within less than one octave; and as the frequency increases, this relative attenuation continues to increase. The overall gain of the single-sideband filter is achieved by including a simple operational amplifier, U2. The selection of a μA741 device here is based on its internal frequency compensation and stability over the bandwidth of interest.

CW filter

Fig. 2 is a somewhat more sophisticated audio-processing system for CW bandpass use in a receiving system. In CW reception we are normally interested in the audible quanties of the beat note resulting from mixing a bfo signal with an i-f carrier. Normally this beat note is clearest and most distinguishable at frequencies between 800-1000 Hz. Most manufacturers provide a bfo signal injection at approximately 1 kHz above or below the i-f for CW detection. This bfo signal is most often generated by a separate crystal or LC oscillator to maintain frequency stability.

Ideally we would like to pass the detected CW signal through some type of bandpass circuit that would allow only the 1-kHz beat note to be heard and that would discriminate against all other audio frequencies. Techniques for enhancing the CW beat note audio tones are described in several amateur handbooks and are similar to the single-sideband filter in that an LC system is used. These schemes rely on peaking the 1-kHz audio tone with tuned circuits of modest Q. Obviously, to provide tuned circuits at these low-frequency levels the L and C components must be physically large, which creates packing problems. Sharp bandpass filter characteristics are difficult to achieve using this LC filter method. To provide narrow bandpass features at 1-kHz would require that the LC system Q be quite high. Recall that the Q of a tuned circuit is

$$Q = \frac{X_L}{R} \qquad (2)$$

where $X_L = 2\pi L$ and R = reactance of the coil producing the inductance.
Since Q is proportional to L/R and both values are large for inductors usable at the CW beat frequencies, the LC filter is obviously difficult to implement and requires series-tuned circuits to narrow the audio passbnad.

The circuit illustrated in **fig. 2** uses the FX-60 in a multimode bandpass arrangement whose center frequency is ideally 1 kHz with the 100-Hz bandpass. It has a minimum relative attenuation greater than 20 dB for all other detected audio frequencies.

This ideal center frequency and bandpass width can't be achieved without considerable expense. First you'd have to use the FX-60 manufacturer's prime-line device, the FS-61; secondly, all the tuning resistors from pins 2 and 10 of U1, U2, U3 in **fig. 2** would have to be 1% precision resistors. The cost of such a system would be several hundred dollars. However, if you're willing to accept a compromise in the center frequency and a slight increase in bandpass width, a very high-performance CW bandpass filter can be built for one-tenth the cost of the ideal system.

Normally the FX-60 output will fall on the low side of the manufacuter's nominal center frequency, which is the reason it's a cull unit. Using the resistance values indicated in **fig. 2**, the center frequency would be ideally 1 kHz. Because the FX-60 units are on the low side, the actual bandpass center frequency will be between 900-950 Hz. Also because of the variations between units and the tolerance of the 5% carbon composition resistors used for tuning on pins 2 and 10 of U1, U2 and U3, the bandwidth will increase from the ideal (100-Hz) to approximately 150 Hz. As with the single-sideband filter, a high-impedance input buffer (Q1) is used, operating at unity gain. Bandpass signal amplification is achieved using a simple class-A common-emitter amplifier, Q2.

An improvement in bandwidth can be achieved in the CW filter by using matched pairs of resistors from pins 2 and 10 of U1, U2 and U3. How much improvement, of course, depends on the accuracy of your measurements and on your patience in selecting these resistors.

construction

The photos illustrate the construction of both the single-sideband and CW filters. Each is assembled on a single-sided PC board, with all components mounted on the side opposite the etched foil pattern. **Fig. 3** illustrates the relative component placement and all input-output points. Generous use is made of isolation resistors and bypass capacitors for both the plus and minus 12 volt bus lines of the ssb filter unit.

If the lowest practical information bandwidth is approximately 250 Hz, then the 0.1-μF interstage coupling capacitors are more than adequate, considering the high input impedance of successive stages. This same reasoning applies to the power bus decoupling capacitance (22 μF). You can substitute lower-value capacitors freely without serious performance effects assuming, of course, that the power bus ripple content is reasonably low. The feedback control resistor for U2 is shown as a potentiometer; however, after assembly and test, a fixed resistor may be mounted permanently to the board in the space provided.

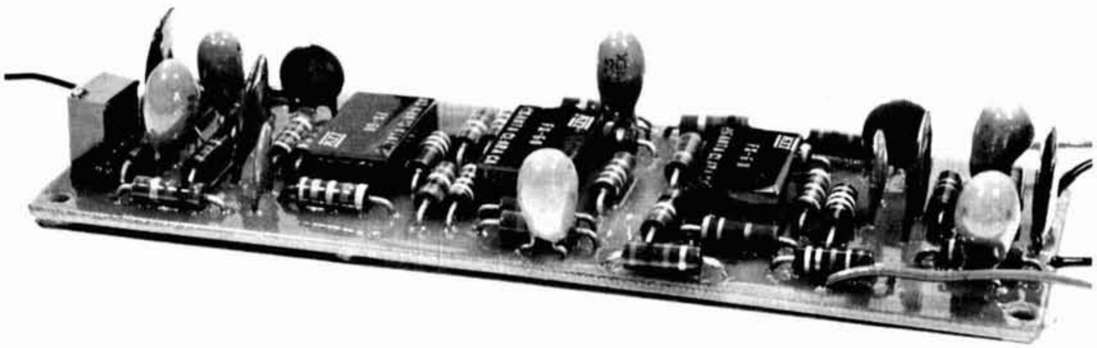
Fig. 4 shows component placement for the PC assembly of the CW filter. Note that the FX-60 is mounted to an IC socket for the single-sideband filter and directly to the board for the CW bandpass unit. I did this purposely to illustrate that either assembly method is acceptable. IC sockets are used to allow easy device removal should they be faulty at the time of initial installation or fail during use. These units are culls, so you can be assured they've been thoroughly tested, thus there's little chance they won't function initially. Because of their conservative design, these devices have an almost indefinite life and a very small possibility of infant mortality.

Resistors were chosen to reduce noise generation and not for power dissipation. Total power dissipation for both filters is in the order of a 100 mW, being concentrated at the output stages of both assemblies. You may substitute ¼ watt or smaller resistors without concern of thermal restrictions.

hints and kinks

Many n-channel depletion-mode, audio-type fets may be used as substitutes for the devices in the Q1 buffer stage. The 2N5458 has a modest I_{DSS} value and if alternative devices are used, they should have the same general ratings. Units such as the 2N5459, which has a higher I_{DSS} value, will require that the source resistor be reduced to approximately 500 ohms and that a lower-value drain load resistor be used. This drain resistance value can be obtained by temporarily connecting a pot in the drain circuit and adjusting the quiescent voltage for approximately 6 volts at Q1 drain termination. Remove the pot and install a resistor with a value closest to that measured on the pot. The CW filter output stage is a simple class-A common-emitter amplifier. Any similar circuit arrangement and device types with which you're familiar can be used, since the circuit is capacitively coupled.

Two important considerations must be kept in mind in the design of the Q2 stage. First, the FX-60 output impedance is in the order of 100 ohms and to develop maximum output voltage to the base of Q2, its input impedance should be 500-1000 ohms minimum.



Construction of the ssb lowpass ssb filter which uses a single KTI FX-60 active filter IC. Operational amplifier (in TO-5 package, left) provides overall gain.

*Undrilled boards are available from the author for $3.00 each postpaid.

Secondly, in the output stage, the ac load consists of the collector resistor and the output coupling capacitor reactance together with the level-set potentiometer in parallel with the signal. If your favorite class-A circuit is used here, some adjustment may be required in the collector resistance and base bias to achieve maximum signal output levels as a result of the added loading.

Never apply power to the FX-60 without the external resistors attached to pins 2 and 10, or the internal circuits will latch and functional properties will be destroyed.

application

Table 1 summarizes the performance of both circuits. Both filters provide considerable voltage gain, which may be used to supplement or replace audio preamplification stages in your receiver. Usual receiver detection systems have audio output levels between 10-100 millivolts, depending on the type of circuits used, with subsequent audio amplification. As shown in **table 1**, the maximum peak-to-peak output-voltage swing is greater than 6 volts, indicating that the filter may be used at any point within the receiver audio system between the detector and final audio amplifier.

The output-level adjustment allows the filters to be used either as unity gain or preamplification gain stages. Where preamplification is not required, the feedback-level set on the single-sideband lowpass filter should be adjusted for about 80% or less of the maximum voltage gain available. Adjustment at levels slightly below maximum will ensure good audio-signal stability, low noise, and minimum distortion.

When the CW filter is used in receivers having crystal bfo oscillators, it is necessary to first assemble the CW filter and test its performance using an external variable audio oscillator to determine the center frequency. This frequency will usually fall between 900-950 Hz.

After determining the bandpass-filter center frequency, a bfo crystal must be used whose frequency corresponds to the receiver i-f and the filter center frequency. As an example, suppose your receiver i-f is 455 kHz and the measured center frequency of your CW bandpass filter is 920 Hz. The correct bfo crystal frequency is then X_f = 455 kHz±920 Hz. You have two choices: 455.92 kHz or 454.08 kHz. Therefore the i-f carrier can be heterodyned from 920 Hz above or below the nominal center i-f to obtain the desired CW audio signal.

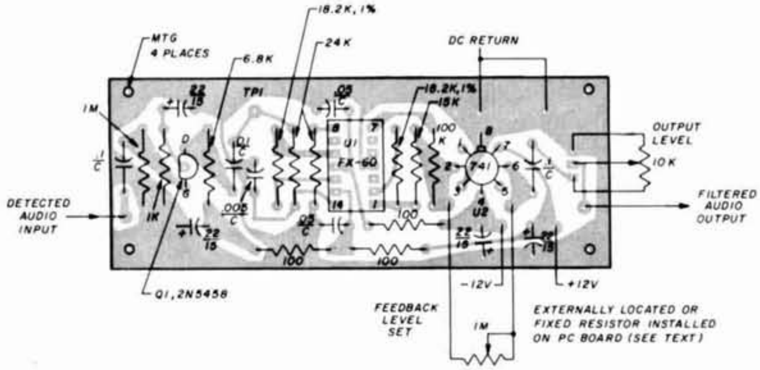


fig. 3. Printed-circuit layout for the single-sideband lowpass filter.

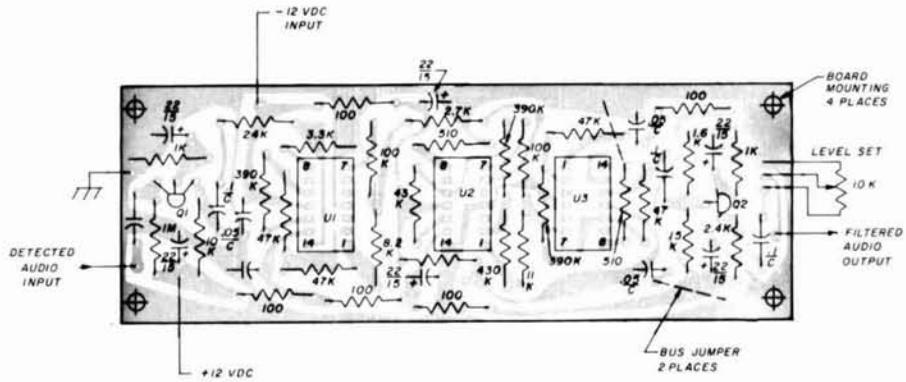
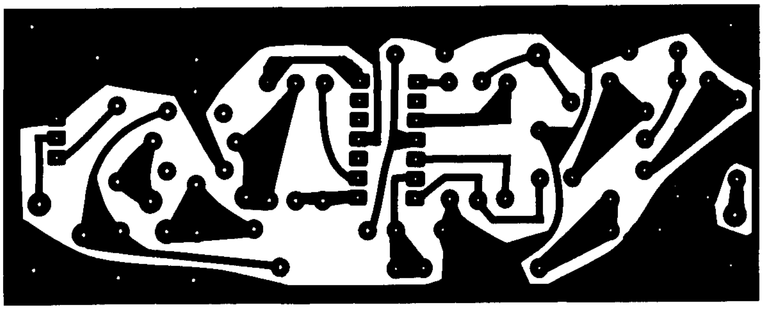


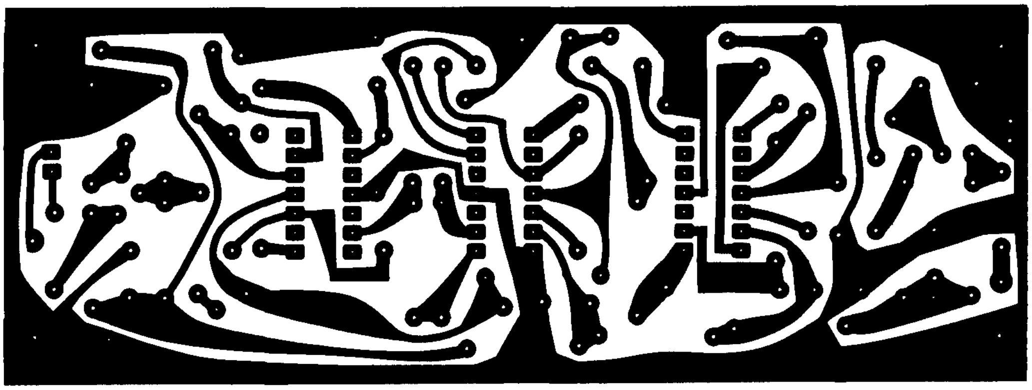
fig. 4. CW filter printed circuit board component assembly.

It is not uncommon for many receiver manufacturers to use a single-sideband crystal bfo frequency for CW reception. This is entirely reasonable, since the i-f pass band might be in the order of 2.5 kHz wide. The upper- or lower-sideband crystal is chosen to beat with the the curves furnished by the FX-60 manufacturer and trimming the resistance values to offset the center-frequency tolerance of the particular FX-60 device being used.

The filters can be wired so that each is selectable by a

fig. 5. Full-size printed-circuit boards for the single-sideband lowpass filter, above, and the CW filter, below.





single-sideband i-f signal at ±20 dB from the i-f center frequency. These bfo frequencies will usually be slightly above 1 kHz; perhaps 1.3 kHz in the nominal case, which is adequate for CW detection. However, these frequencies result in audio tones slightly higher than desired. It is not possible to use the CW filter circuit described here with this type of detection schême. You must either alter your receiver bfo crystal frequency or use resistance values in the tuning of U1, U2 or U3 to move the center frequency up to correspond with the receiver crystal beat frequency. This can be done using

table 1. Performance summary of the receiver audio filters for CW and single-sideband.

parameter	CW filter	lowpass filter
maximum voltage gain (note 1)	⩾30	⩾100 (50 nominal)
center frequency	1 kHz ±10% nominal	not applicable
rolloff frequency	N/A	2.5 kHz ±10% nominal
1st octave relative attenuation	>20 dB	>15 dB
noise (note 2)	<15 mV	<10 mV
maximum peak-to-peak output signal	⩽ 9V	⩽ 10 V

(1) Voltage gain of CW filter may be increased by device and value selection of Q1 stage. Maximum possible Q1 voltage gain ≈ 10; nominal voltage gain of Q2 stage ≈ 10.
(2) Actual noise generation depends on source-voltage ripple content indicated relative to maximum p-p output signal with input grounded.

panel switch, or each filter can be installed as an integral part of your receiver without a switch. For CW, the filters can be cascaded to attenuate high-frequency audio noise. In any event, the filters should be wired to avoid ground loops and oscillation. Isolate the PC-board ground plane from the receiver chassis and allow the dc return to enter the board at only one point.

Long leads carrying the input signal to the filter should be shielded. Ground the shield to the filter PC-board ground plane near the Q1 input and leave the other end of the shield open. The output signal may or may not be shielded, depending on the filter location, its lead length, and signal level. If output shielding is used, the shield should be terminated at the input of the subsequent stage, and the filter output shield should be unterminated. These wiring methods will avoid the possibility of introducing a ground loop and will reduce external noise pickup.

Applications of both filter units with receivers using LC bfos may be optimized by adjusting bfo frequencies to correspond to a) the filter pass band cutoff frequency in the case of the lowpass unit and b) the filter pass band center frequency for CW filter. In most cases this can be accomplished by adjusting the single-sideband bfo frequencies for maximum clarity of the received signal and by adjusting the CW bfo for maximum amplitude of the best tone.

ham radio

200 meters and up

receiving converter for low frequencies

With this two-transistor converter you can explore the fascinating world below the a-m broadcast band

The story of early amateur radio has been told in *200 Meters and Down*, a book authored by Clinton B. DeSoto in 1936 and published by The American Radio Relay League [1] It makes interesting reading and establishes the background for the scientific hobby of amateur radio as we know it today.

More than fifty years have passed since radio amateurs abandoned the very-low frequencies and started to explore the spectrum above the a-m broadcast band. Just what are the longer wavelengths being used for today? The only way to find out is to listen. Considering that the World Administrative Radio Conference will be held in Geneva, Switzerland, in 1979 and that the WARC-79 task group in this country is considering a proposal for an amateur band in the 150-200 kHz region,[2] it seems appropriate that the experimentally inclined amateur should be exploring the low-frequency radio spectrum.

This article presents construction information for a simple solid-state converter that can be used with any good-quality communications receiver to tune the frequency spectrum below the a-m broadcast band.

frequencies available for communications

The FCC permits the use of *nonlicensed* transmitters in certain parts of the medium- and low-frequency radio spectrum. Section 15, paragraph 15:203, permits the use of a 1-watt transmitter and a 50-foot (15.2m) antenna* between 160 and 190 kHz. Paragraph 15:204 permits the use of a 100-mW transmitter and a 10-foot (3m) antenna* in the range 510-1600 kHz, which includes the a-m broadcast band in the United States. Any transmission mode can be used on these frequencies as long as any emissions outside the band edges are suppressed 20 dB below the unmodulated carrier.

background

For the past six years I've been experimenting with these frequencies for communications use, and as of this writing my 189.7-kHz beacon "K" is regularly copied by an amateur in Riverhead, Long Island, New York, some 90 miles distant. My 1575-kHz beacon is copied by

*Antenna length also includes the length of any feed line.

By **Ken Cornell, W2IMB**, 225 Baltimore Avenue, Point Pleasant Beach, New Jersey 08742

another amateur in Lincroft, New Jersey, 18 miles away. Not bad for QRP_p with mini-antennas!

For listening on the medium-, low- and extra-low frequencies, a good receiver is desirable. While there are many usable surplus receivers on the market, they still command a fair price and in many cases require conversion surgery. Converters for vhf and uhf are common, and the same basic heterodyne logic can be applied for the lower frequencies (see **fig. 1**).

The main purpose of this article is to review and update a converter described in reference 3. This converter uses two pnp transistors, one as a mixer and the other as a crystal-controlled local oscillator. It's designed to work with a receiver tuning the 80-meter band and uses a 3500-kHz crystal.

In this case, 10 kHz will appear at 3510 kHz and 500 kHz at 4000 kHz on the receiver dial. A 1-kHz frequency readout or better, depending on the receiver tuning accuracy, can be obtained through the tuning range. The only coil that must be changed is the antenna-to-mixer input coil. This coil and its tuning capacitor must provide a resonant circuit through the converter tuning range.

My Riverhead, Long Island, New York anchor man uses this converter with his Drake R4-A receiver, and his reception reports of experimenters using the 160-190-kHz band are outstanding. My receiver for the lower frequencies is an HRO5TA1. I have all the coils for reception from 50 kHz to 30 kHz. I also use a Central Electronics model DQ Q-Multiplier and a Heath panadaptor as accessories.

My type of experimentation required a receiver that I could use for portable work with a 12-volt battery, so I duplicated this converter and made minor revisions so that it would work with my Yaesu FT-101 transceiver. I was quite pleased with its performance. I am also making some experiments in the 7-10 kHz range, which the HRO doesn't cover, and the converter does a good job there as well.

tuning capacitor

The only complicated construction for this converter, as detailed in reference 3, is the rf tuning capacitor. It calls for two 3-gang variables with the stators wired in parallel. The two capacitors are mounted side-by-side using dial cords for tuning. Such construction could tax the patience of the most experienced amateur.

This problem can be resolved in two ways. One is to obtain a 5-gang surplus variable capacitor.* These capacitors appear to have a total capacitance, with the stators wired in parallel, of 2000 pF. The capacitors I obtained have a 3/8-inch (9.5mm) diameter shaft. I purchased some 3/8-inch (9.5mm) female-to-¼-inch (6.5mm) male shaft reducers from Lafayette Radio (part no. 32-64165) to accommodate a common dial to mount the capacitor behind the panel.

*I obtained mine from Ralph Sanserino, 8422 Crane Circle, Huntington Beach, California 92646. A similar capacitor is offered by Fair Radio Sales, P.O. Box 1105, Lima, Ohio 45802.

The other way is to use the largest variable capacitor you can obtain. If it's the common BC-set type, a rotary switch can be used to shunt fixed capacitors across the variable capacitor to increase its range, otherwise many more coils will be required through the 10 to 500 kHz range. An estimate is that, with a 400-pF variable, you'd need about a dozen coils in this case.

improved converter

I used the converter as is for some time but decided to make some circuit changes to permit more flexibility.

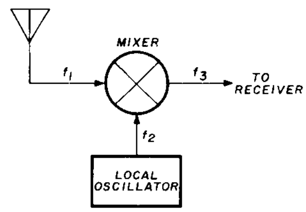


fig. 1. Basic converter heterodyne logic. f_1 **is the desired received-signal frequency,** f_2 **the local-oscillator frequency.** $f_3 = f_1 \pm f_2$, **or** $f_1 \pm f_3 = f_2$.

To achieve this flexibility, I changed the local-oscillator circuit to a Pierce type and used a Motorola HEP-802 fet transistor, which eliminated the need to change the oscillator coil to suit the crystal frequency. The mixer output coil is a plug-in type. The circuit of my revised converter is shown in **fig. 2.**

construction

Because of the large size of the rf tuning capacitor, which is 6 inches long by 3½ inches high by 2½ inches wide (15x9x6.5cm), all thoughts of miniaturization were abandoned. I made a plywood box 10½ inches wide by 8 inches deep by 8½ inches high (27x20x22cm) that contains the converter, which is built on a baseboard. The panel is black plastic, and the cover is hinged for access to the interior and also has a carrying handle. Except for the input tuned circuit, all components are mounted on a small piece of copper-foil board located on the right-hand side of the rf-tuning capacitor, which is centered on the base. Sufficient space is available on the baseboard and panel for mounting coils and switches. The space on the left-hand side of the rf tuning capacitor contains an audio filter for extreme selectivity.

The secret of success with this converter is the antenna-to-mixer input tuned circuit (C2, L1, C3), which is a pi network. It must be resonant at the received-signal frequency for maximum sensitivity. Thus constant peaking of capacitor C2 is necessary as you tune through each L1 coil range.

coils and switching arrangement

The simplest method for mounting L1 is to make it a plug-in coil, or a more complex method is to mount the coil on a suitable base and wire each pie to a rotary switch on the panel. I used a combination of these methods in the converter shown in **fig. 2.**

On a coil-winding machine I wound a series of five pies on a 3/8-inch (9.5mm) diameter dowel.* Each pie contains 50, 100, 150, 200, and 300 turns of 18/42 Litz wire. The winding is continuous and a tap is provided between each pie.

I used a two-gang, eight-position rotary switch wired in the following manner for L1: One gang of the switch was used in the first five positions for this coil. The sixth position was wired to a plug-in coil socket, and the seventh position was wired up through the second gang of the switch to a pair of binding posts. These binding posts permitted the addition of fixed capacitors across the plug in coil, assuring the ultimate in tuning flexibility, especially in the extra-low-frequency ranges.

A suggestion for plug-in coils, if desired, is to mount them on a dual banana plug, a common item available from most radio-part suppliers. These plugs can be stacked, so that you can use one plug with a capacitor connected across the pins, and when plugged into the permanent socket, the plug containing the coil can be plugged into the capacitor plug. This makes for a flexible arrangement to obtain various LC ratios.

checkout

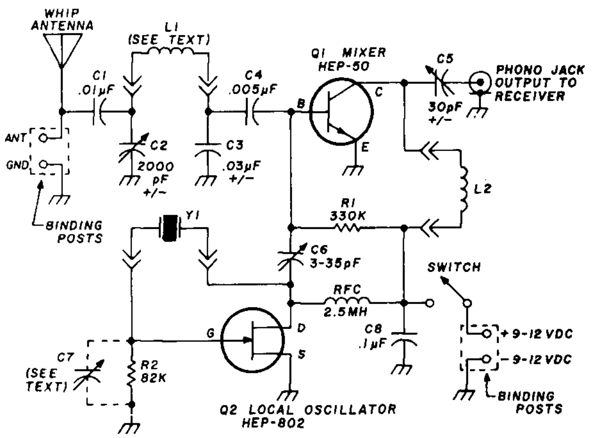
After the converter has been assembled and checked for wiring accuracy, use your vom to check coil continuity and possible short circuits, such as a bad bypass capacitor. Apply power and check the local-oscillator frequency on your receiver for reliable operation. In my case, a sluggish 3500-kHz crystal (FT-243 type) would start oscillating only when I pinched the crystal between my fingers – I later found that if I placed a small value of capacitance between the Q2 gate and ground, the crystal would trigger right off. I used an Arco/Elmenco no. 120 (1-12 pF) and adjusted it for optimum performance (This capacitor is C7 in **fig. 2**).

The number of stations that can be heard on "200 meters and up" are too numerous to list here, but the low end of the a-m broadcast band will provide signal sources to check out the medium frequency portion of the converter. For low frequency, look for WGU-20 on 179 kHz. This is the first of several planned civil defense preparedness stations. It is located in Chase, Maryland, and gives Eastern mid-Atlantic weather reports and accurate time. There is also TUK on Nantucket Island (194 kHz) and SFI in San Francisco on 192 kHz. On extra-low frequency, various Omega navigation stations are scattered around the world (13.6 kHz).

in conclusion

The major problem when using a converter with an auxiliary receiver is fundamental frequency feedthrough. This is because the receiver is trying to do the job it was designed for, and if the converter is not well shielded and an unshielded wire connection between converter and receiver is used, feedthrough can occur if strong stations are in your area. While I have had no serious problem on 80 meters, I believe I'll have to line the inside of my wood cabinet and plastic panel with aluminum foil if I use the converter with a broadcast receiver.

A wave trap can also be used to attenuate an interfering signal. This trap is nothing more than a coil with a variable capacitor across it. The trap is placed in series with the antenna and is located as close as possible to the converter.



C1	0.01 µF (most any type)
C2	2000 pF variable (see text)
C3	0.02 to 0.04 µF disc ceramic (experiment with value for best results)
C4	0.005 µF disc ceramic
C5	Arco/Elmenco 422 trimmer or equal should be adjusted for best performance
C6	Arco/Elmenco 403 trimmer or equal should be adjusted for best performance
C7	see text
C8	0.1 µF disc ceramic
L1	target value for inductances (See text): 5-11 kHz 0.28 H — 50-100 kHz 3.5 mH 10-20 kHz 100 mH — 90-200 kHz 1 mH 18-38 kHz 25 mH — 150-350 kHz 350 µH 30-70 kHz 10 mH — 250-550 kHz 120 µH
L2	80-90 µH for 80 meters. Loop stick for BC band
Q1, Q2	Motorola transistors, but substitutes will work as long as npn tr. is used for Q1 and an fet for Q2
R2	50-100k; 82k nominal
Y1	3500 kHz is used for the 80-meter band but other crystals can be used to suit your heterodyne logic (fig. 1)

fig. 2. Schematic of a medium-, low-, and extra-low-frequency converter for use with an amateur communications receiver.

*The Morris hand-operated coil-winding machine, complete with all gears and cams, is available from Lafayette Radio Electronics, 111 Jericho Turnpike, Syosset, Long Island, New York 11791. Catalog number 32-F-87018.

references

1. Clinton B. DeSoto, *Two-Hundred Meters and Down,* American Radio Relay League, 1936 (reprints are available from the ARRL).
2. "Presstop," *ham radio,* November, 1975, page 6.
3. William H. Fishback, W1IKU, "A VLF Converter for Communications Receivers," *QST*, September, 1968, page 18.

ham radio

electronic bias switch for negatively biased amplifiers

This circuit is designed for the Heath SB-200 but can be adapted to any linear amp using negative bias voltages

Several excellent articles have appeared recently in the amateur literature describing automatic electronic bias switching of linear amplifiers. Bryant[1] published an article in *QST* describing the use of electronic bias switching in the ETO Alpha 77 amplifier. Also included was his adaptation of the circuit for use with the Heath SB-220 linear amplifier. Gonsior[2] published an article in *ham radio* describing his refinements of the Bryant circuit to allow for controlled rise and fall times to create a softer switching action on the bias circuit.

Realizing the importance of electronic bias switching for conservative amplifier operation, I adapted these techniques to the Heath SB-200 linear amplifier, which uses negative rather than positive bias voltages. Amplifier efficiency is enhanced using electronic bias switching, because no power is dissipated under no-signal conditions.

system operation

The Heath SB-200 is designed for linear class-B operation. During the transmit mode the amplifier output tubes, type 572B, are biased with −2 volts on the grids. This bias voltage allows 90 mA of plate current to flow under no rf drive conditions. With 2400 volts on the 572B plates, the quiescent power consumption is nearly 240 watts continuous. Thus the tubes must dissipate this power under no-drive conditions, creating heat that doesn't contribute to amplifying action. If the tubes are completely cut off when no rf drive is present the plate current would be zero. Hence, the power dissipated would be zero under no-signal conditions. This is the purpose of the electronic bias switch.

Fig. 1 is a block diagram of the switch, along with the SB-200 bias circuit. The SB-200 uses negative grid voltage to bias the tubes, whereas the SB-220 uses positive cathode voltage to bias the amplifier for linear operation. The electronic switch senses the presence of rf drive voltage and switches on the class-B bias voltage only when drive is present. With no rf drive, the tubes are cut off by a large negative voltage, and plate current ceases to flow. The electronic switch is very fast and responds to very small rf input voltages. By introducing a small delay into the switch action, a softer on-off action can be created, which results in a softer sound at the receiving end.

Fig. 2 shows the electronic switch circuit used with the SB-200. The circuit is very similar to that described by Gonsior.[2] There are two major differences, however, between this circuit and those published previously. First, negative voltages are controlled in the SB-200 rather than positive bias voltages. Thus, the circuit must be connected in an opposite manner to the previous designs. Second, the circuit must be connected so that the rf input has a good rf path to ground. This is the reason for the 0.001 μF capacitor across the transistors. The negative voltages switched are about −150 Vdc maximum. The transistors were chosen to withstand

By F. E. Hinkle, WA5KPG, I/O Engineering, 9503 Quail Trail, Austin, Texas 78758

these voltages without the need for additional crowbar protection as developed by Bryant.[1] Almost any high-voltage transistors may be substituted if care is used to ensure that the maximum voltage ratings are not exceeded. These transistors are Motorola devices and cost less than $2.00 new. The capacitor across the collector-to-base junction of Q1 is an integrating capacitor in the Miller feedback principle. This capacitor value may be adjusted to reduce the turn-on time of the switch.

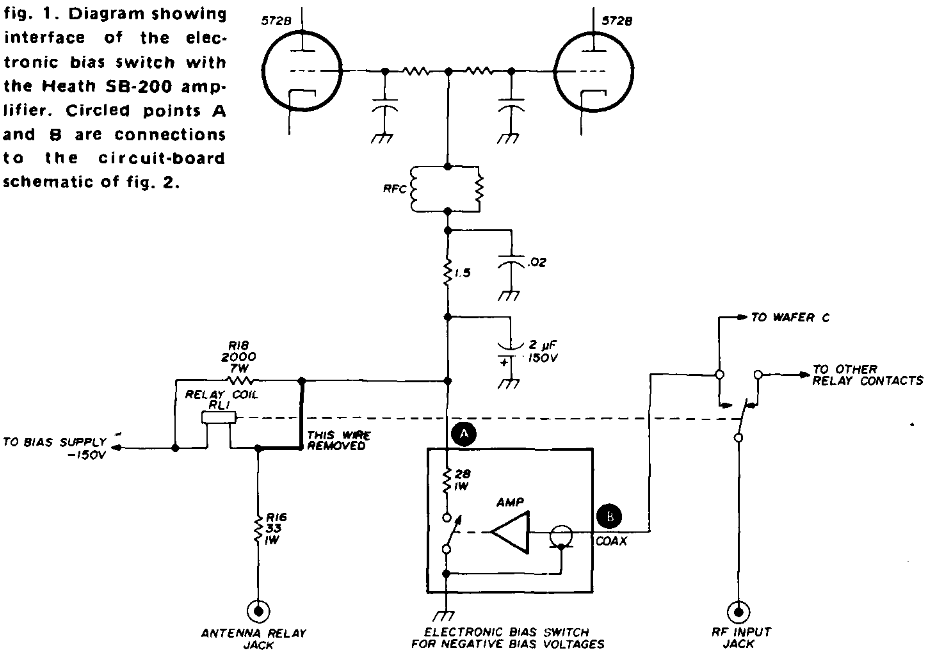
SB-200 modifications

The photo shows the electronic bias switch as installed in an SB-200 amplifier. The location of the circuit board was chosen to permit the use of one of the wires removed during modifications. Using the following procedure, only two wires need be removed from SB-200 terminals and one wire added. No holes were drilled into the chassis, and the original circuit can be reconnected in a matter of minutes.

The circuit of **fig. 2** was built on a small piece of Vector board. The board was then attached to a piece of aluminum strip about 2 inches (51mm) longer than the circuit board and formed as shown in the photo. The aluminum strip was then attached to one of the transformer-mounting screws protruding below the chassis. A new nut was used to fasten the aluminum strip to the bolt. The yellow wire from the rf relay coil was then removed and attached to the pair of 56-ohm resistors as shown in **fig. 2** at *point A*. The removed yellow wire was located on the relay coil terminal nearest the edge of the chassis (lower left corner of the photograph).

The yellow wire in series with the 33-ohm 1-watt resistor located at the *Ant Relay* jack was removed next (see **fig. 1**). A piece of spaghetti tubing was placed over

fig. 1. Diagram showing interface of the electronic bias switch with the Heath SB-200 amplifier. Circled points A and B are connections to the circuit-board schematic of fig. 2.



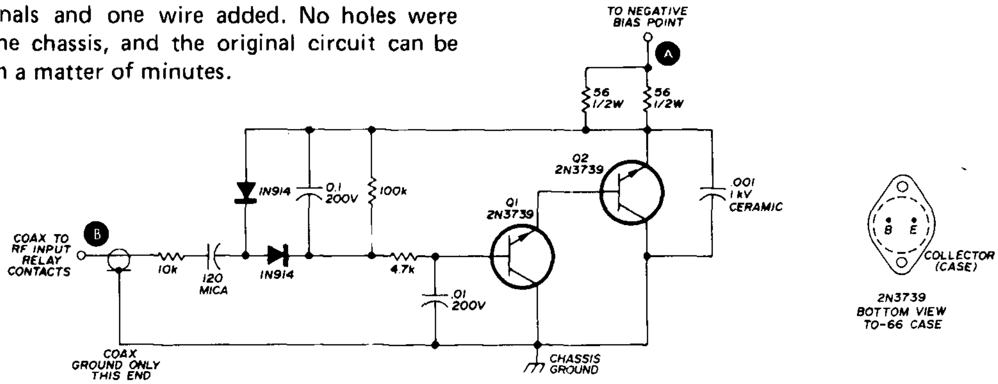
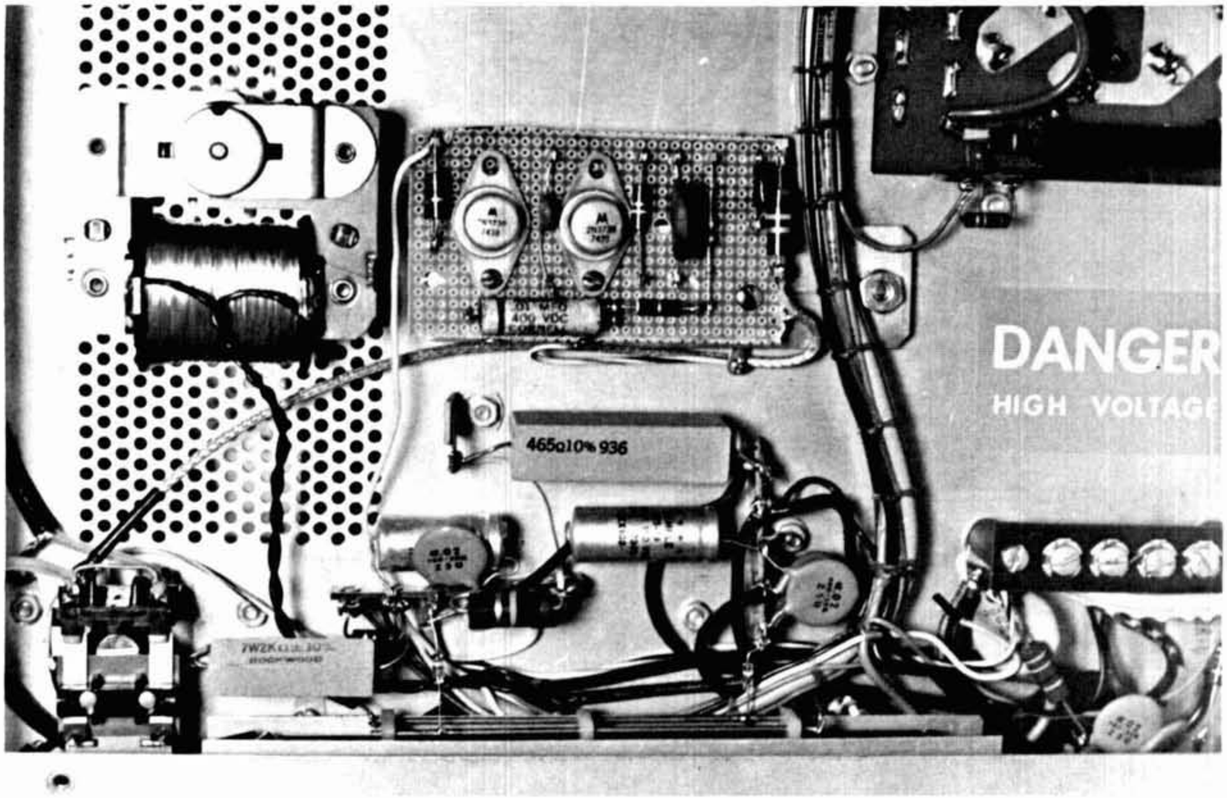


fig. 2. Schematic of the electronic bias switching circuit for the Heath SB-200 amplifier. Components are mounted on a piece of perf board, which fits into an unused space below chassis. No holes need be drilled. Only two wires are removed from terminals in the SB-200 and one wire added to make the modification.



Underchassis view of the SB-200 showing addition of the electronic bias switching circuit. Circuit board is mounted onto an aluminum strip, which is bolted to one of the transfromer mounting studs.

this yellow wire since it isn't needed. A new wire was then soldered onto the terminal from which the second yellow wire was removed. This new wire was then attached to the relay coil terminal just vacated. The *Antenna Relay* jack will now operate the rf relay coil but not the bias circuits.

A small piece of coax was then soldered between the circuit board and the rf relay contacts (*point B,* **figs. 1** and **2**). These contacts will have the *input* rf present on them when the relay is energized. The relay lug to which the coax was connected was the one nearest the top of the photograph, second from the top of the relay. Rf energy should be fed to the circuit board only if the relay is energized. The circuit board ground wire was attached to the aluminum strip but could be attached to any convenient ground lug.

operation

Proper operation of the electronic bias circuit is easily identified. Turn on the amplifier. If there is no rf drive from the transmitter, the amplifier plate current should be zero, indicating that the amplifier is biased to cutoff. Place the transmitter in the *tune* position. With the small amount of rf present at the output, the electronic bias switch will detect the rf and apply class-B bias voltage to the amplifier. The plate current should be 90 mA. As the rf drive is increased the plate current will increase as usual. When rf drive is removed the plate current should again decrease to zero. The amount of rf-drive voltage necessary to enable the bias switch is about 2 volts.

When the transmitter is placed in the ssb mode, with no speech, the plate current will be zero. With speech the plate current will increase in accordance with the rf driving voltage.

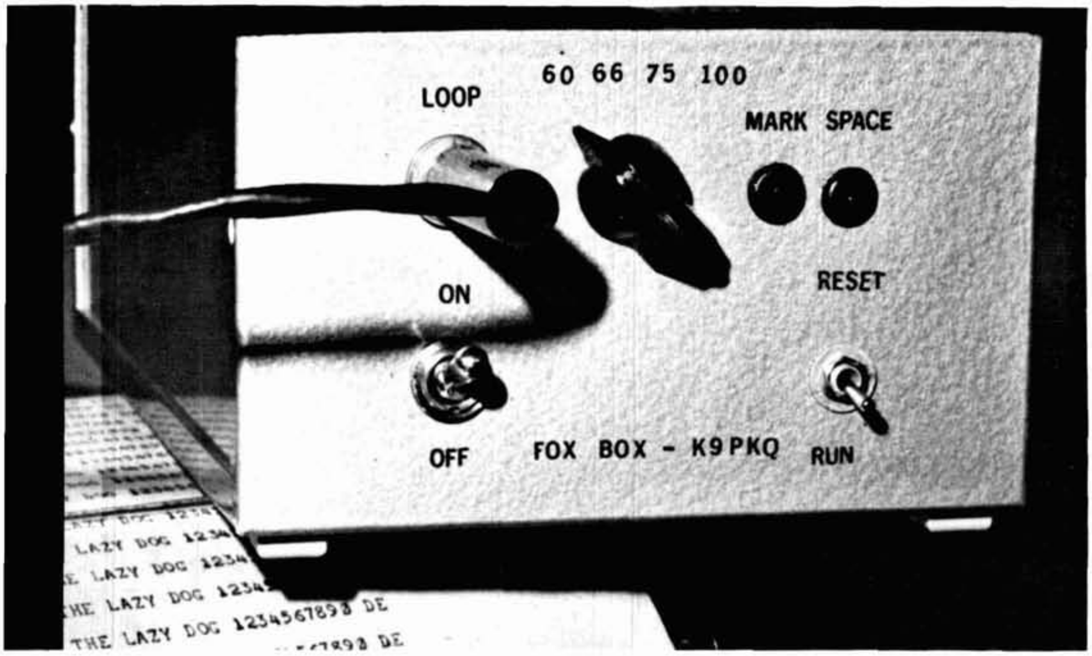
The electronic switch will respond to very small voltage levels, so it's mandatory that the ssb carrier be suppressed sufficiently. If an indication of amplifier plate current is present in ssb mode with no speech, the transmitter balanced modulator should be checked for proper carrier suppression in accordance with the manufacturer's specification.[3]

Although the circuit modification was for the SB-200 linear amplifier, there is no reason why it would not function in other amplifier designs which use negative voltages for biasing. References 1 and 2 should be consulted, however, for more insight into the operation of the bias switch and possible applications to other amplifier designs.

references

1. J. A. Bryant, W4UX, "Electronic Bias Switching for RF Power Amplifiers," *QST*, May, 1974, page 36.
2. M. Gonsior, W6FR, "Electronic Bias Switching for Linear Amplifiers," *ham radio*, March, 1975, page 50.
3. *Heathkit Assembly Manual, SB-200*, Heath Company, Benton Harbor, Michigan.

ham radio



RTTY test-message generator

Tired of fighting the cumbersome old fox box? Here's a compact, lightweight replacement using TTL logic and a mos read-only memory chip

RTTY buffs are familiar with the "fox box", a large, heavy electromechanical machine complete with commutator that generates the test message, "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 1234567890." The disadvantages of this monster are well known, but when it came to testing a TTY machine for each function, the old fox box was a necessity.

This article describes a successor to the fox box that weighs only a couple pounds and is designed for the four popular RTTY speeds of 60, 67, 75 and 100 wpm. It generates "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 1234567890 DE." Someone more ingenious could probably figure out a way to insert a call sign; this feature was not included, because this unit is normally used on a local loop with no requirement for a call sign.

A schematic of the test generator main frame is shown in **fig. 1**. It is designed around the MM5220DF "quick brown fox generator," which is one of a series of preprogrammed read-only memory (*rom*) ICs by National Semiconductor, Inc. All logic in the test generator is TTL except for the MM5220DF IC, which is a mos device. All parts can be easily obtained except the

By Ken Ebneter, K9GSC, and Jim Romelfanger, K9PKQ. Mr. Ebneter may be reached at 117½ 4th Street, Baraboo, Wisconsin 53913; Mr. Romelfanger's address is 822 Wauona Trail, Portage, Wisconsin 53901.

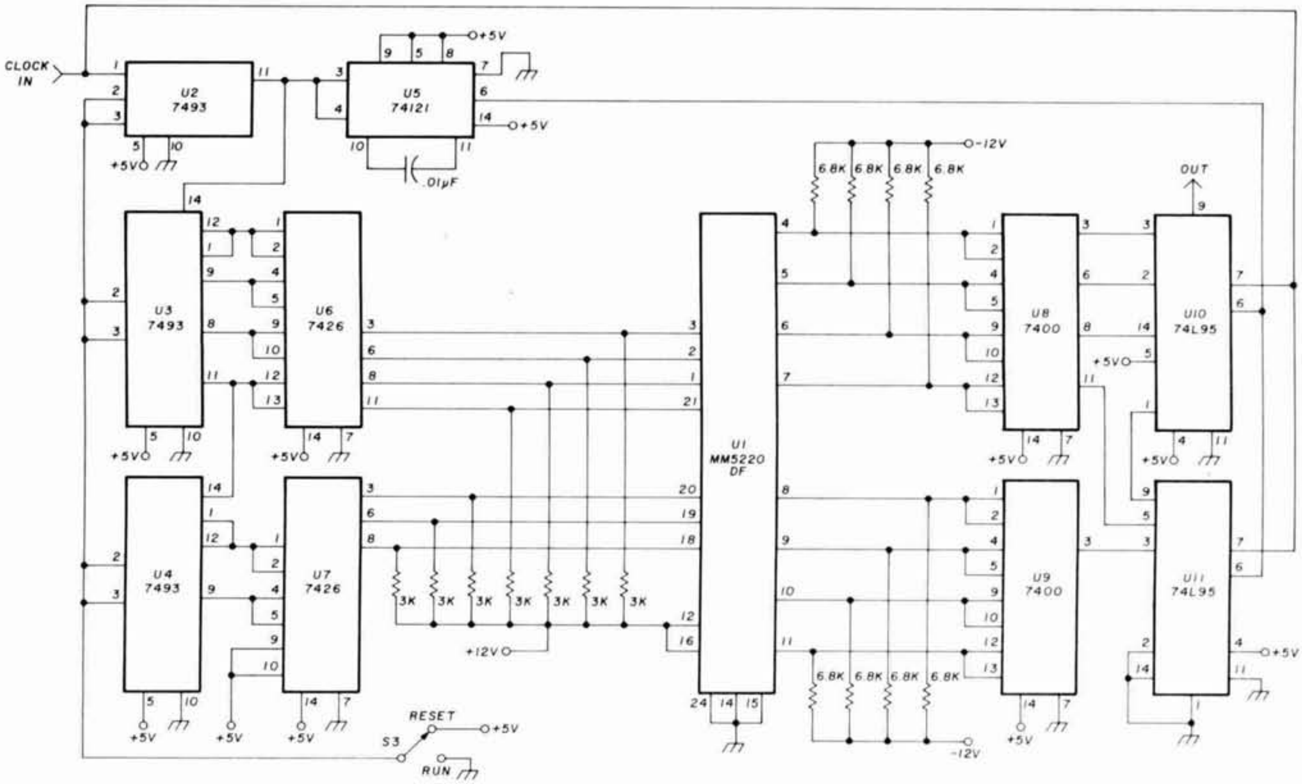


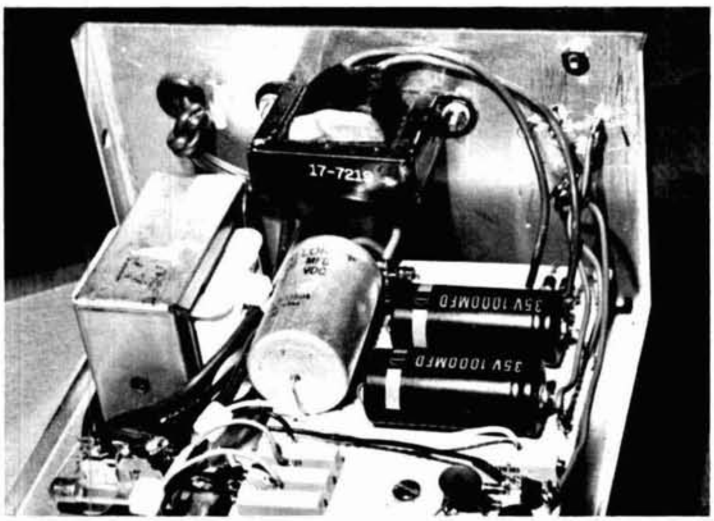
fig. 1. Schematic of the solid-state replacement for the old electromechanical "fox box." Design is based on National Semiconductor's "quick brown fox generator," a mos read-only memory chip. The other devices are TTL ICs.

MM5220DF. This device can probably be obtained from any National Semiconductor distributor or from Taylor Electric Company.*

circuit description

clock. This simple circuit was burgled from the Micro-TO Keyer[1] with some obvious modifications, **fig. 2**. It delivers a very sharp negative-going pulse train, which is TTL compatible. Four series resistors and 10K trimpots set the various baud rates. The clock can be adjusted for the proper speed by connecting a frequency counter to the clock output and setting the four trimpots for the desired baud rate as chosen by rotary switch S2; i.e., 45.45 for 60, 50.0 for 67, 56.88 for 75, and 74.2 for 100 wpm.

View showing power-supply components.



main frame. The clock drives the binary counter chain consisting of U2-U4. U2 is connected as an 8-bit divider. In addition to feeding the remainder of the divider chain, U2 output is also fed to U5, a one-shot that provides a load pulse for output shift register U10, U11. Counters U3, U4 provide the six address lines for the mos IC. The outputs from the counters must first be changed from TTL level (positive logic) to mos-compatible levels (negative logic). This is done by using gates U6, U7 and 3.0k pullup resistors. For each of the 64 different addresses, a different output word will occur, consisting of a Baudot letter or function. The mos output is buffered back to TTL level by gates U8, U9.

Parallel data from the memory is fed to shift registers U10, U11 along with a hard-wired start pulse (space) and

*Taylor Electric Company, Industrial Sales Division, Post Office Drawer 11N, Milwaukee, Wisconsin 53201. (Latest price quote is $18.00).

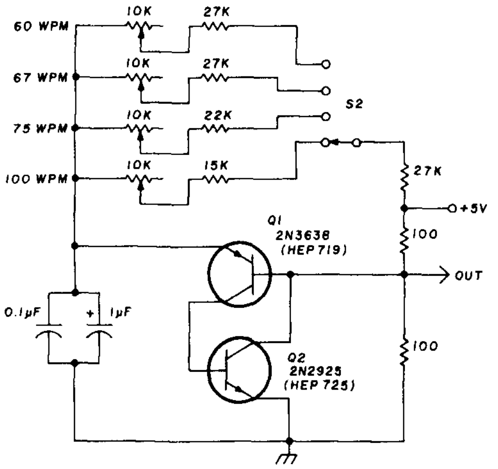


fig. 2. Clock/circuit schematic for the RTTY test-message generator. Desired baud rate is selected by the rotary switch for the four popular RTTY speeds.

two stop pulses (mark) to be run out in serial form by the clock pulses. This action produces a stop pulse slightly longer than normal. The information from the read-only memory is loaded into the shift register by U5 during the time of the hard-wired start pulse.

When *reset/run* switch S3 is in *reset*, the 7493 counters are reset to zero, and the output shift register is allowed to run in a steady mark condition. When S3 is in the *run*, the counters begin to count the 64 different conditions for the address lines of the ROM with the 74121 one-shot loading the shift registers with each new output from the ROM. The first two outputs produce carriage returns, CR, and the final count, 63, produces a letter shift. The counter will return to zero and start a new line until the switch is flipped to *reset* or until the printer runs out of paper. (Actually, the printer won't stop, which could be rough on its platen).

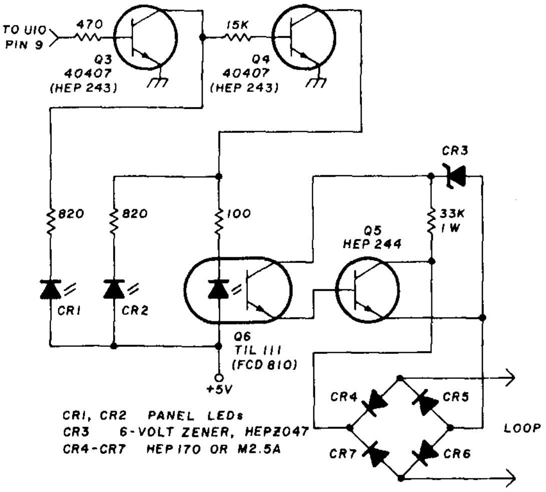


fig. 3. RTTY test-message generator output circuit, which is designed for standard 20- or 60-mil loops running at 100 volts minimum. Bridge voltage is high, so the M2.5A or equivalent diodes should be used.

output. The output circuit (**fig. 3**) is designed for standard 20- or 60-mA loops running at 100 volts minimum. It will not work with the so-called low-voltage loops. The diode bridge allows the loop to be connected with either polarity. Be sure to use diodes such as the M2.5A or equivalent, as the voltage will be high. Zener diode CR3 (5.6 volts) prevents the voltage from avalanching the opto-isolator. The opto-isolator can be an FCD-810, available from HAL.* The LEDs (optional) are for mark-space indication and are mounted on the control panel to indicate whether the system is in standby or run mode.

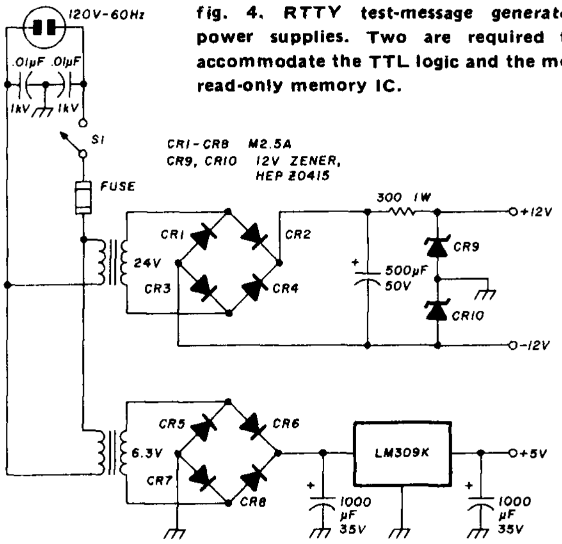


fig. 4. RTTY test-message generator power supplies. Two are required to accommodate the TTL logic and the mos read-only memory IC.

power supplies. Since both TTL and mos ICs are used, two power supplies are required; one for the TTL (plus 5V) and one for the mos logic (plus and minus 12V), **fig. 4.** For the 5-volt supply we used a 6.3-volt filament transformer. At the low-current drain of the TTL chips, the LM309K regulator works fine. However, it might be prudent to use 12 volts ac in the bridge for the 5-volt supply to make the LM309K work a little harder and provide somewhat better regulation.

The 12-volt supply, as shown, was used because it was simple. A center-tapped transformer could have been used but it would have required more components. The MM5220DF seems to be quite happy with the slight amount of ripple obtained with only 500 μF of filter. Use good-quality 12-volt zeners to ensure proper operation of the ROM. In both supply bridges, M2.5A 1kV 2.5A diodes were used because they were available.

*HAL Communications Corporation, Box 365, Urbana, Illinois 61801.

reference

1. Chet Opal, K3CUW, "The Micro-TO Keyer," *QST*, August, 1967, page 17.

ham radio

Since 1969, the year in which TEN-TEC introduced the first solid-state HF transceiver, progress has been rapid. It was in this year that we produced the POWER-MITE which triggered the booming QRPp activity. Two years later, the ARGONAUT followed, demonstrating that Ham Radio can be more than just push-button communication.

Then, in 1972, a break-through — the 100 watt "405" solid state linear amplifier which requires but two watts of rf drive power. And in 1973 the 200 watt TRITON made its debut, with unique and exciting operating advantages made possible by full solid-state technology.

At the moment, there are over 7,500 solid-state TEN-TEC transceivers in service in nearly every Free-world country. We are acknowledged, we think, to be the World's Most Experienced Designer of Fully Solid-State HF Transceivers. And there is no short cut to design perfection.

It is notably significant that TEN-TEC is the only manufacturer that has placed a five-year pro-rata warranty on output transistors — with an unlimited guarantee the first year against failure from any possible cause under normal operating conditions.

You can put your full trust in the integrity of design, quality, craftsmanship and performance to specifications of any TEN-TEC product. Year after year after year . . . See your local TEN-TEC Dealer, or write for full details.

Argonaut

SSB/CW 5 watts input. Fully solid-state.

"405" Linear

100 watts input. Fully solid-state.

Triton IV

SSB/CW 200 watts input. Fully solid-state.

TEN-TEC
SEVIERVILLE, TN. 37862
EXPORT:5715 LINCOLN AVE.
CHICAGO, ILLINOIS, 60646

More Details? CHECK—OFF Page 126

practical considerations in crystal-filter design

Construction and alignment techniques for building crystal filters that approach commercial standards

The principles of crystal-filter operation are well documented in the amateur literature; some excellent sources are found in references 1 through 3. In this article we'll explore the practical aspects of crystal filters, and show how they can be built with available crystals without resorting to sophisticated test equipment.

crystal selection

To the best of my knowledge only two sources of inexpensive high-frequency crystals are available: the surplus market and aviation equipment in which, until the late 1960s, crystals were used in large quantities. Frequency synthesizers have changed this situation, because today a single (or few) crystals control many different frequency channels.

The source of crystals is further narrowed because only those in type FT-243 holders should be used for the filters described here. These holders are sturdy and their construction permits convenient removal of the crystal for grinding. HC-6/U holders can't be easily opened for grinding in the home workshop. Crystals in HC-6/U holders can be used for the filters described here, however, by selecting those that will match the filter design requirements, which are discussed later. In any event, you should have a large quantity of crystals to choose from before beginning this project to ensure finding crystals that will match with satisfactory accuracy.

design example

Let's assume that a number of FT-243 crystals are available of equal nominal frequency. A crystal filter is to be built around these crystals. Whether the filter is to be used in a receiver i-f setup or in a transceiver is another matter. I recommend consulting references 4 and 5 in advance to make sure that the crystal-filter center frequency (which sets the i-f) will lead to a conversion scheme that will be as free as possible from spurious response.

The first step in selecting the four crystals used in the filter is to make sure they're as electrically similar to each other as possible. My standard procedure is to select crystals from the same manufacturer which are designed for the same parallel capacitance of the crystal-oscillator basic circuit. By so doing, I enhance the probability of ending up with crystals that are close relatives rather than distant cousins – a precaution that makes some of the later design steps easier.

activity check

Given the same oscillator circuit, some crystals have higher output than others. Your available crystals should be classified by grouping together those of approximately equal activity. This is easily done by inserting a meter in the collector circuit of the oscillator shown in **fig. 1**. Higher-activity crystals will show higher meter readings.

Next comes the frequency selection of the four crystals to be used in the filter circuit of **fig. 2**. From an electrical standpoint, the best procedure to find the pole-zero spacing is that reported in reference 2. However, the purpose of this article is to make matters as simple as possible, so we'll resort to another method.

crystal-frequency selection

To check the crystal resonant frequency using the circuit of **fig. 1**, the signal from the oscillator is injected into a frequency counter. If a counter isn't available, a communications receiver with a calibrated dial will do. What is recommended in the latter case is to read the crystal oscillator harmonics at as high a frequency as the receiver can cover. If, for example, the receiver goes to 30 MHz and the crystal fundamental frequency is 5.5 MHz, the harmonic at 5.5 x 5 = 27.5 MHz should be used. By so doing, the accuracy of the frequency readout is improved. Keep in mind that all we're concerned

By Jack Perolo, PY2PE1C, Caixa Postal 2390, Sao Paulo, Brazil

with is the *difference* in the resonating frequency of the oscillator-crystal combination when changing from one crystal to another. In other words, it is a secondary matter for this purpose if one crystal resonates at, say, 5,501.600 kHz or at 5,502.300 kHz; what really matters is to establish *exactly* how much higher or lower the resonating frequency is of crystal A vs A'; B vs B'.

Using this technique I have observed that, for a spacing of resonating frequencies of about 1.3 to 1.5 kHz, the resulting filter bandwidth (at −6 dB) is 1.8 to 2.1 kHz. Using a resonant-frequency spacing of 2.0 to 2.2 kHz, a suitable ssb filter can be obtained with a bandwidth at −6 dB of 2.5 to 2.7 kHz.

Referring to **fig. 2**, two matched pairs of crystals are needed for this type of filter. Using the technique just described, choose two crystals of like manufacturer, like nominal parallel capacitance (for the circuit), like activity, and like resonant frequency. The last requirement is the most difficult to achieve. I consider two crystals to be matched when, after meeting the first three requirements, they resonate in the same circuit with a *maximum* difference of 25 Hz. If this criterion can't be obtained with the crystals at hand, then one of the crystals must be ground, as outlined below.

If you're lucky, or have a large selection of crystals to start with, chances are that the four crystals needed for the filter can be obtained simply by proper selection without any grinding at all. If this seems possible, even though the filter bandwidth may end up slightly different from that required, I strongly recommend using the selected crystals to avoid grinding. Crystal grinding is an extremely delicate operation that's bound to cause some disappointment at the beginning.

The crystals must be matched pairs, so always start grinding the crystal of the planned pair that resonates at the *lower* frequency. The grinding operation *increases* the crystal resonant frequency.

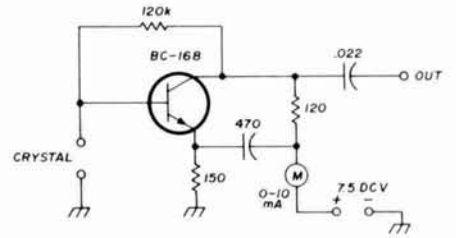
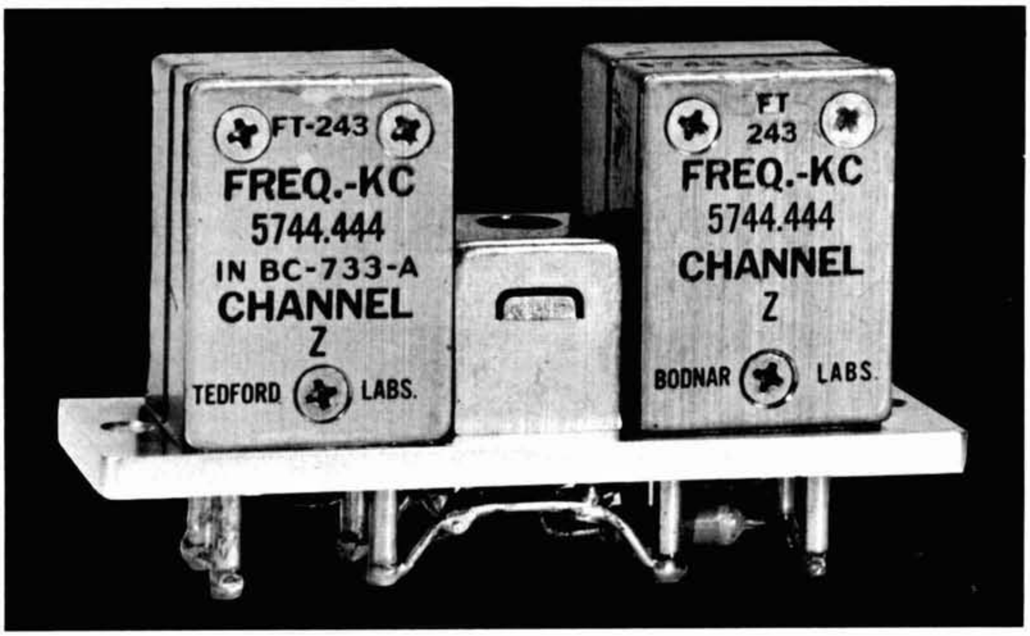


fig. 1. Oscillator circuit recommended for checking crystal activity and resonant frequency when choosing matched crystals for the filter.

Let's pick a numerical example, assuming the following crystals are available to build the filter:

A. 5501.267 kHz
B. 5501.291 kHz
C. 5502.018 kHz
D. 5502.326 kHz
E. 5502.120 kHz
F. 5501.914 kHz

Crystals **A** and **B** differ by only 24 Hz, so they need no further processing. If they were not matched, crystal **A** would be ground to move its resonant frequency closer to that of crystal **B**. If you're shooting for a difference in resonant frequency of 1.5 kHz for example, crystals **D** and **E** are recommended as a starting point. They should



Closeup of the four crystals and coupling coil installed on the aluminum plate. Note matching resistor under plate at right. Crystals and coil can are fastened in place with epoxy cement.

be ground to resonate at (5501.267 + 5501.291 kHz)/2 + 1.500 kHz = 5502.779 kHz ±12 Hz.

grinding procedure

Begin by preparing a scratch-free glass plate about 6 x 6 inches in area by about ¼-inch thick (152 x 152 x 6 mm). Wet the top surface of the glass with water and add a small amount of abrasive powder, 400 mesh or finer (available in hardware stores). Remove the crystal from its holder and, by *gently* applying pressure with one finger, move the crystal in a circular motion on the prepared surface of the glass plate.

It is extremely important that perfect parallelism be maintained between both sides of the crystal. After a few circular strokes, turn the crystal 90 degrees, apply the same number of circular strokes, and continue until the crystal has completed a full turn (360 degrees). Try to maintain the same finger pressure during each 90-degree segment of the grinding operation. Do not turn the crystal over during the grinding operation.

The ground crystal must now be washed in clean water and dried. Lay the crystal on a piece of absorbent material until all moisture evaporates. Next, clean the crystal again in a petroleum-derivative solvent; this operation ensures removal of any residual oil that may have been left on the crystal by your finger. Dry the crystal in open air and reinstall it in its original holder, taking pains to avoid touching the crystal surface with bare fingers. Use a pair of tweezers for this operation.

Check the crystal resonant frequency again, using the same original oscillator circuit and receiver setup. If its frequency is below 5502.779 kHz, the crystal must be ground further. If its frequency is higher than this value, the crystal grinding was too extensive and this crystal is no longer useful for this particular filter. Select another crystal and repeat the process, reducing finger pressure and the number of strokes.

The procedure should be repeated until the crystal resonates at the desired frequency; then the second crystal should be ground until its frequency matches its selected mate. In this process, more abrasive powder should be added if necessary. Two recommendations are in order at this point:

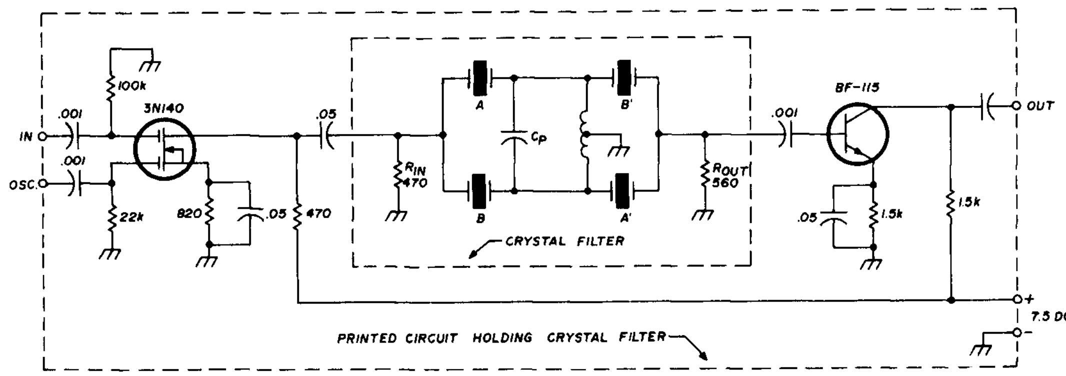


fig. 2. Schematic of the crystal filter using two matched sets of surplus crystals, together with input and output isolating stages. A pair of crystals are considered matched when they resonate in the same circuit with a maximum frequency difference of 25 Hz.

1. As the selected frequency approaches the desired value, a single stroke in the grinding operation can negate hours of work. The idea is to proceed slowly, avoid getting tired, and try to retain a parallel relationship between both sides of the crystal during grinding. You may have to remove and reinstall the crystal into its holder many times before satisfactory results are obtained.

2. If the crystal before grinding resonated at, say, 5502.390 kHz and after grinding its resonant frequency *decreased* to, say, 5501.920 kHz, then the crystal upper and lower surfaces have become out of parallel. You can either discard this crystal and start again from scratch, or if you want to recover the crystal, its thickness should be measured and the crystal should be ground until parallelism has been restored, bearing in mind that grinding causes the crystal frequency to increase.

Grinding a crystal out of parallelism to decrease its frequency is not recommended, as crystal activity will be decreased. Furthermore, the chances of obtaining spurious response from the filter are increased.

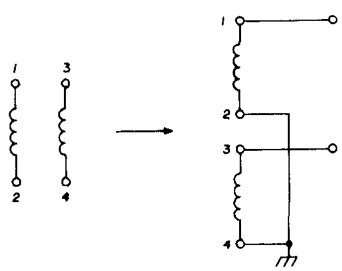


fig. 3. Bifilar-wound coupling coil for the two pairs of crystals used in the filter. For filters in the 5 to 6 MHz range, the coil consists of 7 + 7 turns of no. 28 AWG (0.3mm) enameled wire on a 10.7-MHz i-f transformer with a slug diameter of 3/32 inch (2.4mm).

filter assembly

Matching the four crystals in two pairs is the most time-consuming part of the project. The crystals must be assembled on a subchassis together with the coupling coil. I use an aluminum plate measuring 1 x 3 x 1/8 inches (25 x 76 x 3 mm). The crystals and coil are fastened in place with epoxy cement. The coil must be bifilar wound, with as close coupling as possible. If the coils are wound simultaneously, the connections shown in **fig. 3** should be made to obtain the desired bifilar configuration. To ensure close coupling, the coil should have a slug of the "closed cup" type, or a toroid should be used. Tuning a toroid is more critical, and that's why I prefer the closed-cup variety.

filter alignment

Different precautions must absolutely be taken if the filter is to perform comparable to commercial units. The crystals must have been thoroughly cleaned after the grinding procedure, or else the filter will perform erratically as a function of time.

The input and output leads should be as short and rigid as possible a change in length of the input and/or output leads will cause the filter to have a dramatically different bandpass response. To avoid this problem, I install the filter over a printed circuit board with isolating stages before and after the filter. By so doing, I'm assured that filter alignment will remain steady over the years and remain independent of filter application.

Whatever convenient setup is used, filter alignment can be made using different approaches. Evidently the best is to use a signal generator and a scope with a sweep system so that filter response may be directly displayed on the scope and adjusted accordingly. Since this is a rather sophisticated technique requiring some expensive test equipment, I assume that those who have a scope also know how to use it; consequently no description of this option is given. Instead I'll describe an easier alignment procedure, although it's more time consuming.

The setup of **fig. 4A** is recommended for the filter alignment. If no vfo is available with the required frequency and stability output, a suitable alternative method is shown in **fig. 4B**.

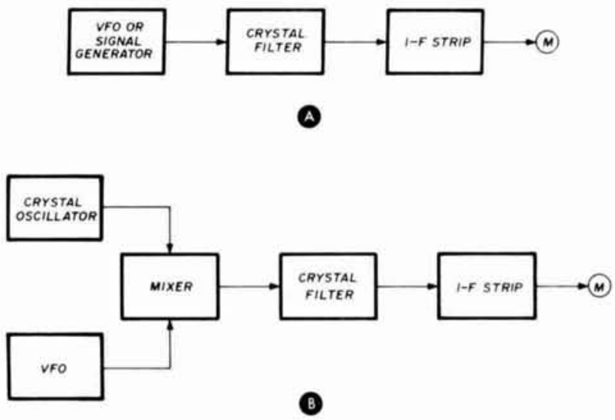
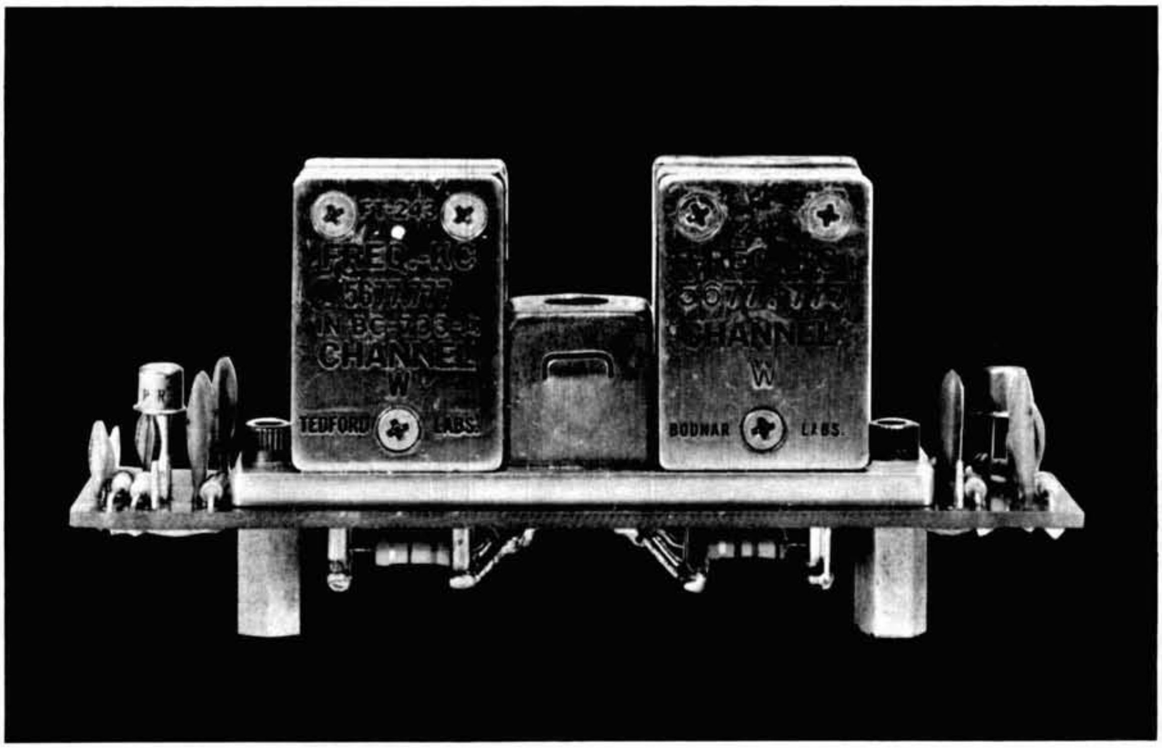


fig. 4. Setup for filter alignment. The setup at A is the recommended arrangement; an alternative method is shown in B. In both cases the vfo should be stable and accurately calibrated.

The approximate center frequency of the filter should be determined, then filter response should be determined by varying the vfo frequency ±3.0 kHz around the center frequency. This operation should be performed at 100- or 200-kHz increments, recording the vfo reading and the corresponding meter reading on paper in each case. If a calibrated vfo isn't available, its frequency can be determined with good accuracy by using the technique previously described for determining the frequencies of the crystals.



Crystal filter installed on a printed circuit board, complete with an isolating stage ahead of i-f (with a 3N140 transistor) and another following it (with a BF115 transistor). Pillars support the whole assembly.

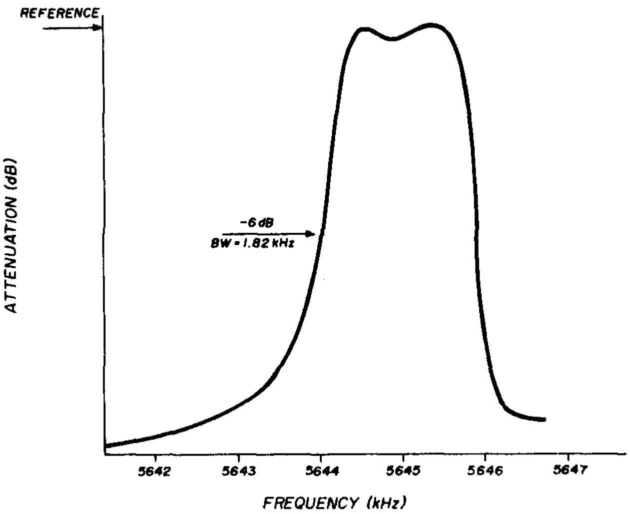


fig. 5. Bandpass characteristics of a 5645-kHz four-crystal filter built by the author using the technique described in the text. Frequency differences in the two matched pairs were 6 and 14 Hz, respectively. Insertion loss of this filter was about 5 dB.

At this point four variables are at hand to achieve a) the least amount of insertion loss, and b) the flattest bandpass response:

1. Value of R_{in}.
2. Value of C_p.
3. Position of the coil slug.
4. Value of R_{out}.

While the value of R_{in} and R_{out} can't be too far from 560 ohms or so, items **2** and **3** may vary considerably from one case to the next. For filters in the 5 to 6 MHz range, I've consistently obtained good results using 7 + 7 turns of no. 28 AWG (0.3mm) enameled wire for the coil. The coil form is a 10.7-MHz i-f transformer with a slug diameter of 3/32 inch (2.4mm). The value of C_p will vary between 27 and 68 pF; 39 to 47 pF is the most common value.

Fig. 5 shows the bandpass characteristics of a 5645-kHz crystal filter built recently using the technique described. The coil used in this filter has 7 + 7 turns, as described; C_p = 39 pF, R_{in} = 470 ohms, and R_{out} = 560 ohms. The passband ripple is below 1 dB and the 60/6 dB shape factor is about 1:2.1. The crystals were originally for 20 pF parallel capacitance and were ground and checked with the oscillator of **fig. 1**. They were considered to be matched when they displayed these operating frequencies:

A	5644.410 kHz	Δf = 6 Hz
A'	5644.416 kHz	
B	5645.627 kHz	Δf = 14 Hz
B'	5645.641 kHz	

The measured bandpass at −6 dB is 1.82 kHz; two spurious responses were recorded 13.3 and 18.3 kHz above the bandpass center frequency. The insertion loss of the filter is about 5 dB.

Several distorted patterns (*all* of which were obtained at one time or another while the filter was being calibrated) are shown in **fig. 6**; all indicate that some adjustment was missing on the filter. It goes without saying that a system with four variables deserves some respect and, unless the alignment problems are properly tackled, no result will be achieved. Consequently only one parameter at a time should be varied to obtain useful conclusions.

ripple, spurious response, and insertion loss

Passband ripple can be adjusted to as low as 0.3 dB, an extremely good figure even by commercial standards. Spurious response generally appears as one or two signals some 10 or 20 kHz removed from the filter center frequency. Both responses generally show the same attenuation, about 40-35 dB below the midband signal.

Insertion loss becomes generally higher by attempting to obtain a ripple-free, perfectly symmetrical bandpass response. At any rate, I do not consider the insertion loss a critical item, as this attenuation can be easily compensated by adding an extra stage of amplification after the filter, whereas other characteristics of the crystal filter cannot be externally compensated.

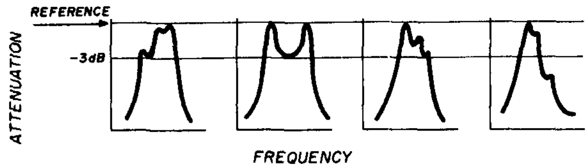


fig. 6. Examples of bandpass response of improperly adjusted filters, indicating that some important step or steps were missing when calibrating or grinding the crystals or when alignment was attempted.

It must be remembered, however, that the filter response may be substantially deteriorated if the i-f strip following the filter is misaligned; I recommend checking the entire i-f response, complete with the filter, to make sure that nothing has gotten out of hand. No shielding of the filter, as shown in the photos, is necessary as long as it is operated away from high-powered stages.

acknowledgement

Thanks go to Maiso, PY2GP, for many of the observations reported and for much guidance on filter construction.

references

1. D. J. Healey, "High-Frequency Crystal Filters for SSB," *QST*, October, 1960, page 35.
2. B. H. Vester, "Surplus Crystal High-Frequency Filters," *QST*, January, 1959, page 24.
3. J. Kosowsky, "High-Frequency Crystal Filter Design Techniques," *Proceedings of the IRE*, February, 1958.
4. J. G. Lee, "Mixer Spurious Frequency Analysis," *CQ*, September, 1965, page 42.
5. J. Perolo, "An Analytical Approach to Mixer Spurious Evaluation," *CQ*, August, 1971, page 24.

ham radio

transmission line calculations

with your pocket calculator

How to use your four-function calculator to design transmission-line matching transformers and matching stubs

As many amateurs have discovered, cut and try transmission-line adjustments can become a frustrating experience. Strange things have been known to happen when you fiddle around with different lengths of coaxial or open-wire line. When you dig out a textbook on transmission-line theory, those hyperbolic functions and associated complexities can be intimidating, to say the least!

In recent years the Smith chart has been *the* engineer's tool, and those of us who were able to meet it on even terms acquired a new and different concept of transmission lines. Unfortunately, Smith charts are not the easiest things for the amateur to acquire, and although its application and use have been described in the amateur magazines,[1,2] its mastery takes a good deal of practical use.

More recently, the computer has appeared on the scene, but few of us have access to its mysteries, so once again the average amateur is left out in the cold. However, a ray of hope has appeared in the shape of the popular hand-held electronic calculator. If you will compromise to the extent of a book of trigonometric tables, the humble four-function calculator can do a pretty good job of coming up with the answers. Where do you locate that matching stub or transformer? If your handy-dandy device is sophisticated enough to do trig functions as well, you won't even need the trig tables!

To begin at the beginning, consider a length of transmission line, of characteristic impedance Z_o, terminated by a mismatched load having a resistive component, R, and a reactive component, X (see **fig. 1**). If you now refer to the Smith chart of **fig. 2**, you will see that it has a scale around its circumference which is labeled "Angle of Reflection Coefficient in Degrees." You will also see that a set of rectangular coordinates has been superimposed on the Smith chart. The locus of all the centers of reactance circles has become the X axis, while all of the centers of resistive circles are located on the Y axis. This allows us to express Smith chart functions in simple trigonometric terms, and eliminates the complex j operator, which the simple pocket calculator cannot handle.

This article will show how, given a complex load of $R + jX$ (or $G + jB$), appropriate points may be computed where either a suitable matching transformer or shunt stubs may be located to match out the transmission line.

By Henry S. Keen, W5TRS, Fox, Arkansas 72051

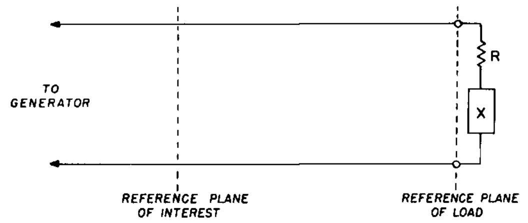


fig. 1. Transmission line terminated with a complex load. Design of matching transformers or matching stubs, and their proper location, may be determined with a Smith chart, or by using the simple four-function calculator, as discussed in the text.

In addition, a general relationship will be given, with which the impedance (or admittance) resulting from looking at a known complex load through a given length of transmission line may be determined.

It may also be determined from the Smith chart that as you back off from the load, moving toward the generator (transmitter), that the angle of the reflection coefficient will be *reduced* as you recede toward the generator.

There are two general methods of matching a mismatched transmission line to eliminate standing waves. The first is to insert a matching transformer (usually a quarter wavelength of line, of a different characteristic impedance than the line to be matched). The second, which is more adaptable to coaxial lines, is to install a shunt stub at the proper spot on the line.

The location for a matching transformer, if you are using open-wire lines, is quite simple as you only have to run a neon lamp along the line to locate a voltage minimum or maximum. These are points where the reactive component is zero. If plotted on a Smith chart, this impedance would fall upon the "real" diameter, which is marked as the Y axis in **fig. 2.** At this point you would cut the line and insert a matching transformer having a transformation ratio equal to the square root of

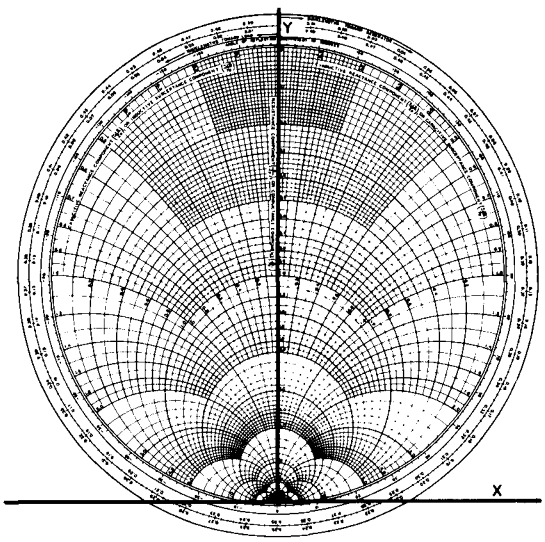


fig. 2. Smith chart with superimposed rectangular coordinates (see text).

the vswr. Whether its characteristic impedance would be higher or lower than the main transmission line depends upon whether you had chosen a minimum or a maximum voltage point.

With coaxial lines, however, you cannot detect voltage maximums and minimums as you move a neon lamp along the line, so all points have to be computed, based upon knowledge of the complex impedance of the load. Bridges for measuring such complex quantities have been fairly well covered in the literature, and need not be discussed here.[3,4]

transformer location

Starting with the load impedance of $R_o + jX_o$ you must first normalize the load by dividing both the resistance and reactance of the load by the characteristic impedance of the line. Thus, $30 + j60$, normalized to 50 ohms, for example, would be $30/50 + j60/50 = 0.6 + j1.2$.

Secondly, you must find the angle of the reflection coefficient, θ, using the relationship

$$\tan \theta = \frac{2X}{R^2 + X^2 - 1} \qquad (1)$$

In this usage, whenever X is positive, θ also is positive, and when X is negative, θ is negative, as on the Smith chart. When the denominator is positive, θ lies between zero and 90°, and when the denominator is negative, θ lies between 90° and 180°.

In the case of our assumed impedance of $0.6 + j1.2$, for example;

$$\tan \theta = \frac{2(1.2)}{0.36 + 1.44 - 1} = 3$$

Therefore $\qquad \theta = 71°34'$

Inasmuch as the length of line included affects both the incident and the reflected wave, the transformer should be located 35°47′ (half of 71°34′) back from the load. Such accuracy as represented by the 47′ is unnecessary for any amateur operation, but it's nice to know that you can figure it that closely (assuming, of course, that you accurately measure the load impedance). This is a point of low impedance (0°). If you wanted to locate the transformer at a high impedance point, it would be located an additional 90° back from the load.

The vswr represented by this load may be calculated by first finding the reflection coefficient, Γ from the following expression:

$$\Gamma = \frac{2X}{[(1 + R)^2 + X^2] \sin \theta} \qquad (2)$$

Solving **eq. 2** for the example above

$$\Gamma = \frac{2(1.2)}{[(1 + 0.6)^2 + 1.2^2] \sin 71°34'}$$

$$= 0.63245$$

The corresponding vswr is

$$vswr = \frac{1 + 0.63425}{1 - 0.63425} = 4.44$$

Therefore, the transformation ratio would be $\sqrt{4.44}$ or about *2:1*.

When coaxial transmission line is used, you rarely have the chance to select the characteristic impedance of a matching transformer, so the matching must usually be accomplished by means of shunt stubs, which can be calculated in the following manner: Convert the complex admittance $R_o + jX_o$ to the admittance form, as follows, using the normalized resistance and reactance

$$Conductance,\ G_o = \frac{R_o}{R_o^2 + X_o^2} \qquad \textbf{(3)}$$

$$Susceptance,\ B_o = \frac{X_o}{R_o^2 + X_o^2} \qquad \textbf{(4)}$$

In transferring from impedance to admittance, the sign changes, so that $R_o + jX_o$ becomes $G_o - jB_o$ (and $R_o - jX_o$ becomes $G_o + jB_o$). This is because inductance is considered a positive reactance, while inductive susceptance is negative.

stub matching

1. Using the admittance counterpart of **eq. 1** find θ from the expression

$$\tan\theta = \frac{2B_o}{G_o^2 + B_o^2 - 1} \qquad \textbf{(5)}$$

2. Using the admittance counterpart of **eq. 2**, find Γ from the expression

$$\Gamma = \frac{2B_o}{[(1 + G_o)^2 + B_o^2]\sin\Phi} \qquad \textbf{(6)}$$

3. The admittance must move down the transmission line to a point where $G_1 = 1.0$, at which point the new value for B may be found from

$$B_1 = \pm\frac{2\Gamma}{\sqrt{1 - \Gamma^2}} \qquad \textbf{(7)}$$

Substitution of this new value of susceptance, B_1, with $G=1$ in **eq. 5** will give the value of θ at the location for the stub. If B_1 should be positive, the added stub will be negative (inductive). You can choose either type of stub, but the widest bandwidth will be obtained when you choose the point closest to the load.

As an example, let's return to our original assumed load impedance which normalized to $0.6 + j1.2$.

From **eq. 3** $$G_o = \frac{0.6}{0.6^2 + 1.2^2} = \frac{0.6}{1.8}$$

$$= 0.333$$

$$B_o = \frac{1.2}{0.6^2 + 1.2^2} = \frac{1.2}{1.8}$$

$$= 0.667$$

Therefore, the admittance equivalent is 0.333 − j0.667

From **eq. 5** $$\tan\theta_o = \frac{2(-0.667)}{0.333^2 + 0.667^2 - 1}$$

$$= \frac{-1.333}{-0.444} = 3.000$$

from which we deduce that θ_o is negative (B_o is negative) and that θ_o is between −90° and −180° (denominator is negative).

$$\arctan 3.000 = 71°34'$$

The value of θ_o is therefore $-180° + 71°34' = -108°26'$

The reflection coefficient, Γ, has not changed from previous calculations and is still 0.63245. When this value is used in **eq. 7**

$$B_1 = \pm\frac{2(0.63245)}{\sqrt{1 - 0.63245^2}}$$

$$= \frac{1.2649}{\sqrt{0.600}} = 1.633$$

Therefore, the nearest point to the load, where a shunt stub could be located, is where $Y_1 = 1.0 + j1.633$. Consider clockwise rotation on the Smith chart from −108°26′, so applying **eq. 5** again, using these figures,

$$\tan\theta = \frac{2(1.633)}{(1.0)^2 + (1.633)^2 - 1}$$

$$= 1.2247$$

$$\theta = 50°46'$$

Therefore, the total distance will be $(180° - 108°26') + (180° - 50°46') = 200°48'$ This will require a length of line half that, or $100°24'$ *(0.2789 wavelength)*.

Since B_1 is positive, the stub must be inductive and present a shunt susceptance equal to -1.633. The stub length is determined from

$$\cot^{-1} 1.633 = 31°29'\ (0.08745\ wavelength)$$

The characteristic impedance of the stub is assumed to be the same as the main transmission line.

If you had wanted to use a capacitive stub (or a shunt capacitor), you'd have chosen B_1 to be -1.633, which would have placed the new value of θ_1 as $-50°46'$, and would have called for a length of 0.4247 wavelength between the load and the shunt susceptance.

general relationship

When a given normalized complex admittance, Y_L, is to be translated a distance θ (in electrical degrees) down a line of admittance Y_o, the classical formula is

$$Y_1 = \frac{Y_L + j\tan\theta}{1 + jY_L\tan\theta} \qquad \textbf{(8)}$$

This relationship looks innocent enough, but when Y_L is complex to begin with, then you must, after expanding and combining terms, also rationalize the denominator. There are numerous pitfalls which can trip up the unwary (when I used this expression, I always checked the results on a Smith chart just to be sure).

However, the same translation of a complex admittance can be accomplished in the following manner:

Given: $Y_L = G_L + jB_L$ $(or\ Z_L = R_L + jX_L)$

to extend the transmission line by θ degrees and find Y_1 (or X_1)

1. From **eq. 5**, find θ_o (or use **eq. 1** for Z)

2. From **eq. 6** or **eq. 2** find Γ

3. Subtract the quantity 2θ from θ_o, giving θ_1

4. Find $X_1 \doteq \Gamma \sin \theta_1$ and $Y_1 = 1 - \Gamma \cos \theta_1$ **(9)**

5. Calculate

$$G_1 = \frac{2Y_1}{X_1^2 + Y_1^2} - 1 \quad (or\ R_1) \qquad \textbf{(10)}$$

$$B_1 = \frac{(1 + G_1)\,X_1}{Y_1} \quad (or\ X_1) \qquad \textbf{(11)}$$

substitute R_1 *for* G_1

I feel that this process is not as messy as **eq. 8**, in addition to being compatible with the pocket calculator, particularly those which have trigonometric capability. It may be that some or all of these steps might be programmed on the more sophisticated HP-25 or HP-65 calculator, which would make the process a breeze.

Another application of these relationships might be to translate the impedance of an antenna, as measured through a length of coaxial cable, *back* up to the antenna itself. In such an application, the length of the coaxial line in electrical degrees must be accurately known for each frequency of measurement.

When moving *toward* the load, instead of away from it, as was done in the foregoing discussion, twice the electrical length of the line through which measurements are taken must be *added* to the calculated angle of the reflection coefficient. Integral half wavelengths (180°) of line, which result in a complete revolution on the Smith chart, would of course be discarded. Therefore, if you neglect losses in the transmission line, the electrical characteristics of the antenna might be determined to a fair degree of accuracy without disturbing the electromagnetic field around it. The use of a carefully measured and known length of coaxial line for this purpose would be most helpful. A standard test line should be of considerable value to the antenna experimenter as a primary piece of test equipment.

references

1. Gerald Hall, K1PLP, "Smith-Chart Calculations for the Radio Amateur," *QST*, January, 1966, page 22; February, 1966, page 30.

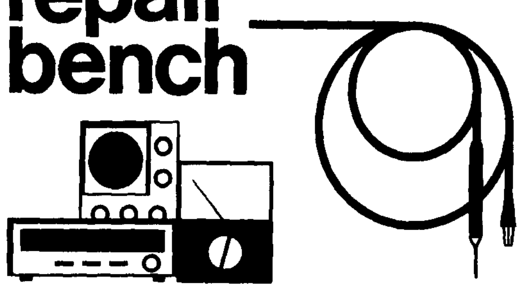
2. James Fisk, W1DTY, "How to Use the Smith Chart," *ham radio*, November, 1970, page 16.

3. William Wildenhein, W8YFB, "Low-Cost RX Impedance Bridge," *ham radio*, May, 1973, page 6.

4. Jerry Sevick, W2FMI, "Simple RF Bridges," *QST*, April, 1975, page 11.

ham radio

repair bench



Hank Olson, W6GXN

power-supply servicing

Probably the most common service job in electronic equipment involves the power supply. The power supply in amateur equipment is usually connected to the 110- or 220-volt ac line through switches, fuses, or circuit breakers. This connection is a significant interface between your equipment and the real (and imperfect) world. If your power supply is not connected to a source of perfect sine-wave power, then you can expect problems, especially if the supply is used to power solid-state equipment. In this month's column we discuss a number of power supplies and voltage regulators and how to troubleshoot problems that may develop – what to look for, how to isolate faults, and how to make repairs.

line-voltage transients

The most common power-supply problems don't occur from plugging the supply into a source of the wrong line voltage; such errors usually result in an open primary fuse or open circuit breaker, which is easily fixed. A more important problem occurs from line-originated transients, which cause the input voltage to depart from a pure sine wave. A line-voltage transient can be a positive high-voltage spike riding on the most-positive excursion of the 60-Hz sine wave (**fig. 1**). The duration of this spike is very short, so it doesn't contain enough energy to open a fuse or trip a circuit breaker. However, it can appear on the power-transformer secondary winding (if the transformer has sufficiently high frequency response) and result in overvoltage on one or more of the rectifiers.

Overvoltage occurs when the rectifier peak inverse voltage (PIV) exceeds the rectifier rating. In tube rectifiers this is called flashback; in modern silicon rectifiers it's usually called *destruction*! Some silicon rectifiers (more expensive types) are made to recover from low-duty-cycle overvoltage; these are the "avalanche-protected" variety. Because they're more expensive, you probably won't find them in your commercial amateur equipment. Some of the principal makers of these avalanche-protected diodes are Semcor, Unitrode, and Varo. What you're most likely to find in your commercial gear is the 1N4001-1N4007 series or something similar, which are *not* protected and which are worth about 5 cents each in OEM quantities. If they fail, you may not find these rectifiers in your equipment except for their wire ends; the package will have disintegrated into small black granules rattling around in the bottom of the equipment case.

If the above seems overstated, it was because I wanted to make a point: by far, *the most common fault in power supplies is rectifier failure.* In modern circuitry using silicon rectifiers, the diodes will most often be shorted; the only open-circuited rectifiers I've seen are those resulting from package fracture or disintegration.

typical circuits

To troubleshoot power supplies, we must first know what circuits might be encountered. In **fig. 2** are seven common rectifier-filter configurations, all using capacitor-input filters. The first is the simple half-wave rectifier, which is the least expensive, but which produces 60-Hz ripple (making filtering more difficult). The second is the full-wave rectifier, which requires a center-tapped transformer. The third is the full-wave bridge, which requires no center tap but which requires four rectifiers. The conventional voltage doubler is shown next, followed by the cascade voltage doubler. The full-wave, full-wave bridge, and conventional voltage doubler all produce dc output with 120-Hz ripple. The cascade voltage doubler produces 60-Hz ripple very much like the simple half-wave circuit.

The last two circuits of **fig. 2** are variations on the full-wave bridge. The circuit in **fig. 2F** produces both positive and negative voltages (as in power supplies used

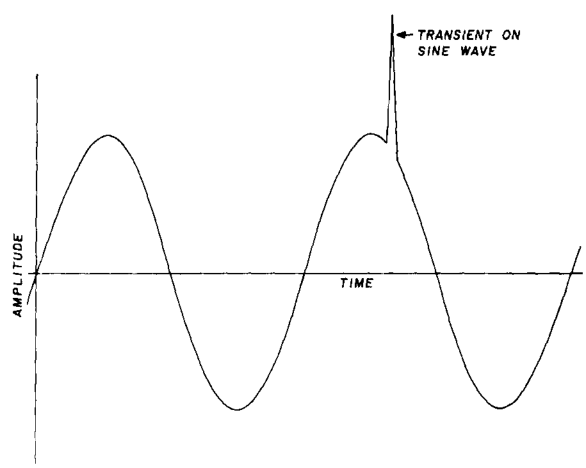


fig. 1. Representation of a 60-Hz line-voltage wavetrain with a transient spike, which can cause overvoltage on power-supply rectifiers.

By **Hank Olson, W6GXN,** Post Office Box 339, Menlo Park, California 94025

for operational amplifiers). Looking at this circuit carefully, we see that it boils down to simply a positive and a negative full-wave rectifier operating from the same center-tapped transformer. The other full-wave bridge, **fig. 2G,** is the dual-voltage version. It produces *half* the dc output at the transformer center tap as produced at the plus terminal of the bridge. This supply is similar to that of **fig. 2F** but with a different point grounded.

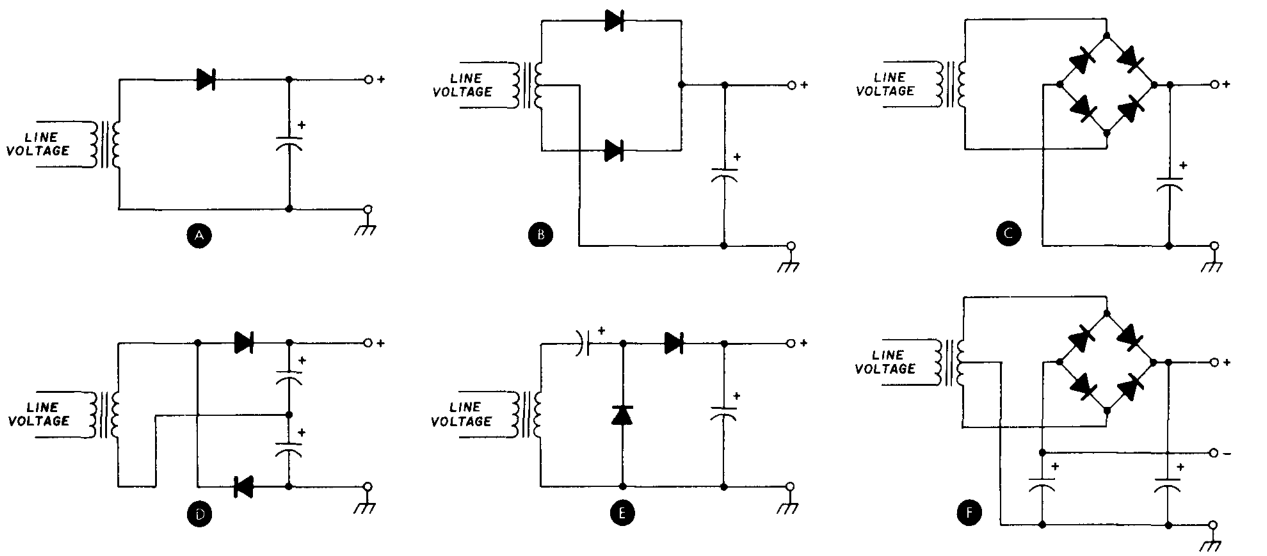
Seven rectifier-filter circuits with typical component values, together with plots of voltage and current output, are shown in **fig. 3**. The graph of **fig. 3H** shows that wide variations occur in the output of the different circuits even though the same transformer and filter-capacitor values are used. Although choke-input filtering is not too common in modern commercially built amateur gear, it's possible to use such filtering with the full-wave and full-wave bridge rectifiers. Typical examples are shown in **figs. 3F** and **3G.**

voltage regulators

Following the rectifier-filter section there will frequently be no signal regulator, because many circuits in commercial electronic equipment are not very sensitive to voltage variations. In a typical receiver, for instance, the only stage that may use regulated +Vcc is the local oscillator. In even the best and most expensive designs, the audio output stages are operated from unregulated +Vcc.

Power supplies that do have a central regulator, however, generally use some sort of series circuit, much like those in **fig. 4. Figs. 4A** and **4B** show the positive and negative versions. The negative regulator works in exactly the same way as the positive regulator and will be more common in older designs that used germanium power transistors. The only differences between the designs are that, in troubleshooting the positive regulator, one measures positive voltages to common; in the negative regulator, one measures negative voltages to common. The other major difference, when fixing older germanium designs, is that the base-emitter forward voltage is closer to 0.3 volts whereas it's about 0.6 volt for silicon transistor designs.

Perhaps the simplest series regulator design is the emitter-follower, shown in **fig. 5A.** In this case no separate feedback of the output voltage to the control section is used, but it is assumed that the base-emitter voltage is more or less constant. The base is held at constant voltage by the zener diode, and ripple at the base is reduced by the filter formed by R1, C1. The next most-complex series regulator is shown in **fig. 5B,** where feedback is used from the output. A fraction of the output voltage is fed to Q2 base. The difference between this voltage and the zener diode voltage (plus the emitter-base forward drop of Q2) is amplified to control Q1 base. The third most-complex regulator uses a differential amplifier as a control circuit with one side refer-



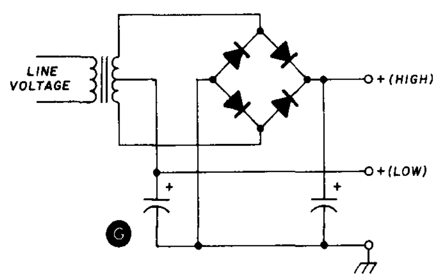


fig. 2. Typical power-supply circuits. A, B, and C depict half-wave, full-wave, and bridge rectifiers using capacitive-input filters. A conventional voltage doubler in D and a cascade voltage doubler in E. Variations of the bridge are shown in F and G, the former producing both positive and negative voltage and the latter producing half the dc output at the +low terminal as produced at the +high terminal.

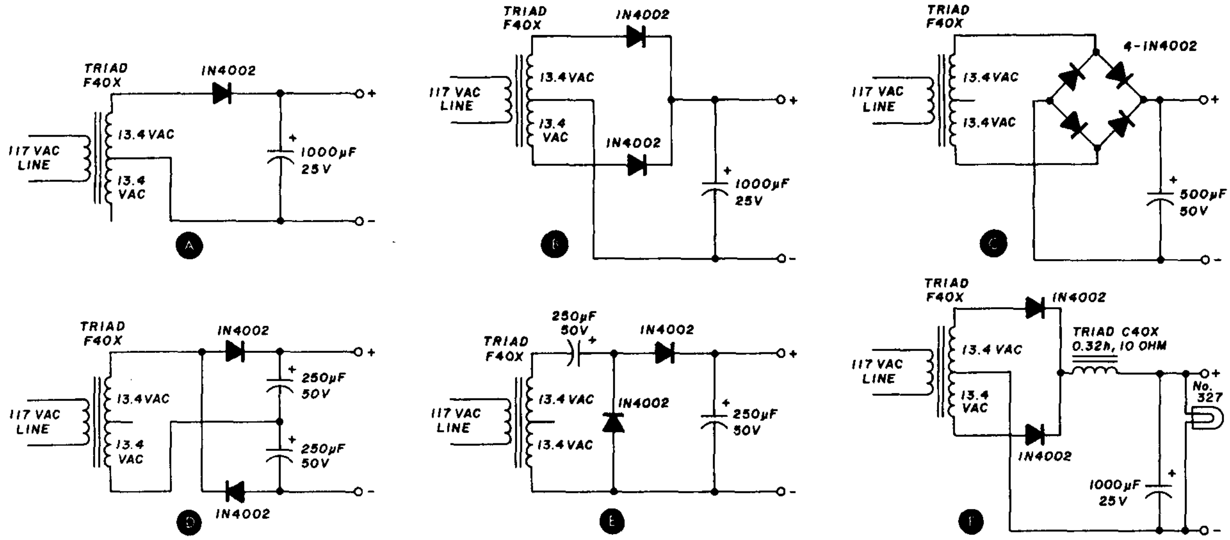
enced to a zener and the other to a fraction of the output voltage. This circuit is shown in **fig. 5C**; note that a second zener is usually used to provide coarse regulated voltage to the differential pair.

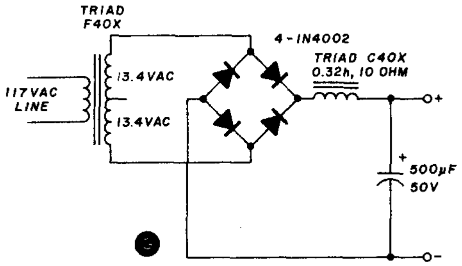
IC op amp regulators

At this point it is advantageous to substitute an operational amplifier for the differential pair. Many

Q1 base in a negative direction. This action prevents further current being passed by Q1. If Q2 were a germanium transistor *R2 would have to be about 3 ohms to* allow current limiting at 100 mA, again because of the lower base-emitter forward drop of germanium transistors.

In the next generation of linear ICs the voltage-reference and current-limiting functions and even a small





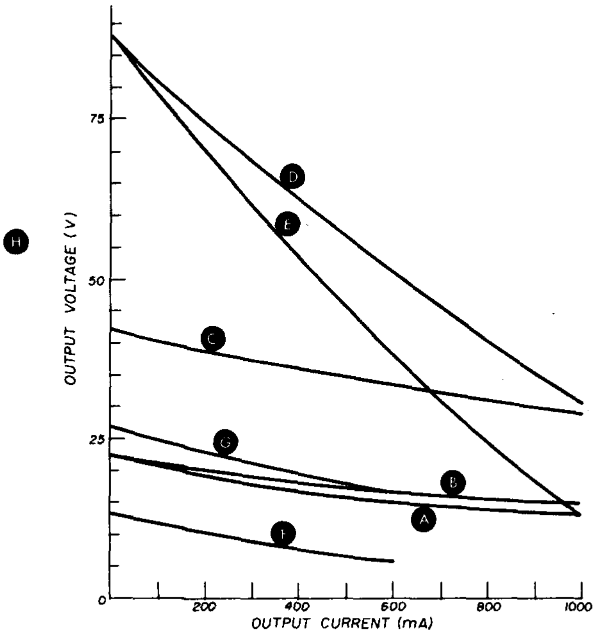


fig. 3. Rectifier-filter circuits with typical component values. A through E are respectively a half-wave rectifier, full-wave rectifier, bridge rectifier, voltage doubler, and cascade voltage doubler. Full-wave and bridge rectifiers are shown in F and G, using choke-input filters. Response curves of these systems are shown in H. The curves for the choke-input systems were terminated at 600 mA because of the choke current rating.

commercial regulators that were designed shortly after monolithic IC amplifiers became available are of the form shown in **fig. 6.**

In **fig. 7** are actual circuits of the regulators discussed above. Note that in **fig. 7D** a current limiter has been added consisting of Q2, R1, and R2. (Compare with **fig. 6**). This feature can be added to most regulators and is certainly worthwhile. When 100 mA is drawn, 0.6 volt is developed across R2, causing Q2 to conduct, which pulls

series-pass transistor were integrated into the regulator chip. National's LM300, Fairchild's µA723, and Motorola's MC1460 are representative of this first generation of IC regulators. In their small TO-5 packages these regulators could handle currents of only 10 mA or so, depending on the input-output voltage and the adequacy of the heat sink. These ICs can be used with external power transistors to provide regulators with *amperes* of current capability. **Fig. 8** shows circuits using these ICs with external transistors as combined regulators. The LM300 has since been replaced by the improved version, LM305, and the MC1460 has also been replaced by the MC1469. The μA723 and LM305 are widely second-sourced, so you may find them with any number of brand names.

Finally, in the second generation of IC regulators, manufacturers have succeeded in putting even the power transistors onto the chip. Such regulators are typified by the Fairchild μA7800 and National LM340 series of three terminal regulators, in power packages. These ICs have fixed output voltages; you simply buy the voltage type desired. The negative three-terminal regulators, μA7900 and LM320 series, operate in similar fashion. Of course, since there is no user control of output voltage or current limiting on any particular three-terminal regulator, there is also nothing to repair once the input, output, and ground connections are checked for proper connections and voltages; IC replacement is the only remaining option. The use of three-terminal regulator ICs is shown in **fig. 9.** Note that a small capacitor is necessary between input and common for stability.

troubleshooting and repair

Preliminary checks. Now that we've covered at least a fair number of rectifier-filter and regulator circuits most likely to be encountered, let's move on to fixing them. It is perhaps superfluous advice, but your first check should be to see if line voltage is actually entering the equipment under repair. Line cords, especially the molded variety, are frequently open (and occasionally not plugged in). Next, fuses and breakers should be checked; even if they appear OK, check them with an ohmmeter. Apparently good fuses can occasionally open in a way that will be missed by a visual check. If new fuses immediately blow, then you must resist the temptation to use much-larger-than-normal fuses to "get things going." Such overriding of the fuse function, even for "a short time during servicing," will usually cause severe damage to some component that may be hard to replace – such as a specially made power transformer.

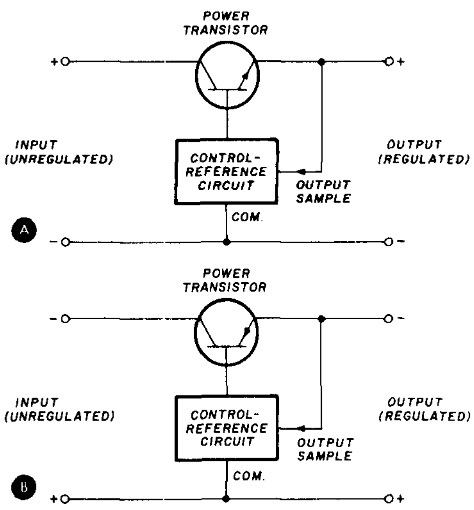


fig. 4. Series regulators. Positive and negative versions are shown in A and B. The negative regulator is more common in older designs using germanium power transistors.

Rectifiers. The next step is to check the rectifier diodes using an ohmmeter; as mentioned before, these are the most likely candidates for failure. It is easiest to disconnect one lead of each rectifier before applying the ohmmeter test, otherwise the dc resistance of the power transformer secondary can confuse the issue. If a bad rectifier is found, replace it with a new part or equivalent. The Motorola "HEP Cross Reference Guide and Catalog" is the best of the several replacement handbooks in this area, in my experience. My advice is to replace all the diodes in a full-wave or a full-wave bridge rectifier (unless you have an *exact* replacement) if only one rectifier diode is shorted. In this way, the original balance of diodes is maintained. The required PIV in the replacement diodes should be twice that of the originals to ensure reasonable reliability.

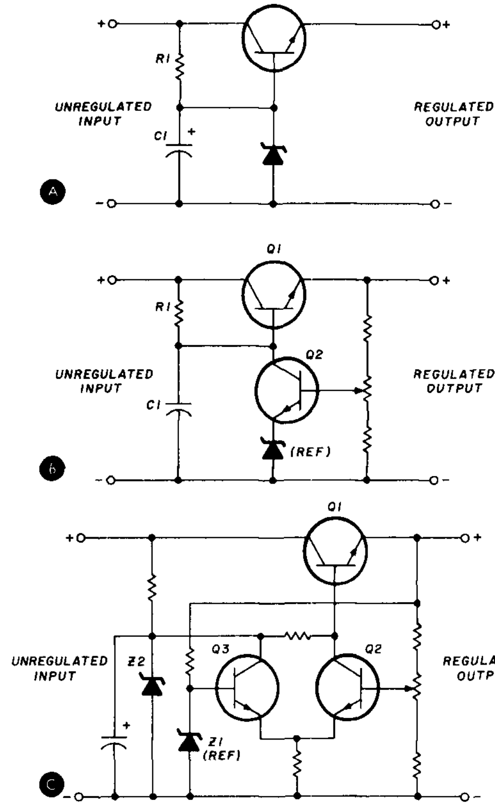


fig. 5. Simple emitter-follower series regulator, A, in which base-emitter voltage is held constant by a zener. In B, a fraction of the output voltage is fed back to Q2, a dc amplifier, to control the base of Q1. The series regulator in C uses a differential amplifier, Q2, Q3, as part of the control circuit.

Such diodes are very inexpensive. As an example, consider a full-wave rectifier with capacitor input and an output voltage (unloaded) of 15 volts. You could get away with using a nominal 50-volt PIV diode such as the 1N4001 and still have a 10-percent margin of PIV before breakdown. A 1N4001 costs 32 cents (1976 Allied

Radio Catalog), and a 1N4002 costs 33 cents. The difference is *one cent* in price, but this one cent buys you *double* the PIV (100 volts). It certainly is a worthwhile penny spent! Diodes (up to about 15 amps) are so cheap because of wide consumer use – it's ridiculous to pinch pennies on PIV.

Transient suppressors. After replacing rectifier diodes in a power supply, should a repetition of the failure occur in a few weeks or months, it may be wise to add something to suppress line transients. A 0.01-μF 1kV disc capacitor across the transformer secondary will do a lot to suppress short-duration spikes for example. An even more effective spike reducer is a thyrite varistor of the correct voltage. Disc and rod varistors are rated in voltage (for both ac and dc) by their manufacturers. These components may also be connected across the transformer secondary. Such thyrite varistors are made by General Electric, National Lead, and Automatic Electric.

The varistors have the advantage of *dissipating* the transient as opposed to the capacitor, which integrates the transient energy into a lower voltage, longer impulse. In power supplies using choke-input filters, a thyrite varistor may be used as in **fig. 10** to prevent the choke-field collapse voltage from exceeding the rectifier diode PIV when the power supply is turned off.

Load circuitry. After the rectifiers have been given a clean bill of health, disconnect the regulator output from the circuit that it is designed to power. A failure in the circuitry that loads the regulator can give the appearance of a regulator failure, especially if the regulator has built-in current limiting. If low output voltage still occurs, the regulator input voltage should be checked. If the regulator input voltage is low, disconnect the rectifier-filter output from the regulator input. This allows the rectifier-filter to operate unloaded, and its output voltage should increase at least to nominal voltage when turned on. We have now three different system blocks where an apparent power-supply problem can occur: rectifier-filter, regulator, and load circuitry. By disconnecting these blocks from each other in steps, the faulty section can be isolated and fixed.

filter capacitors

If the trouble is in the rectifier-filter section, the most

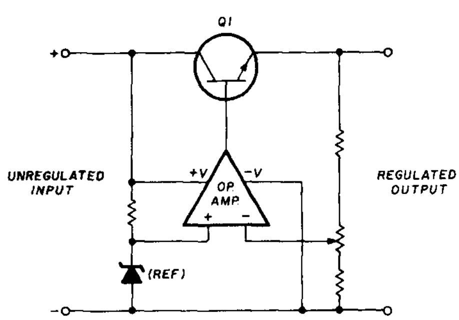


fig. 6. Series regulator using an op amp IC. Circuit is typical of many commercial designs that appeared after monolithic IC op amps became available.

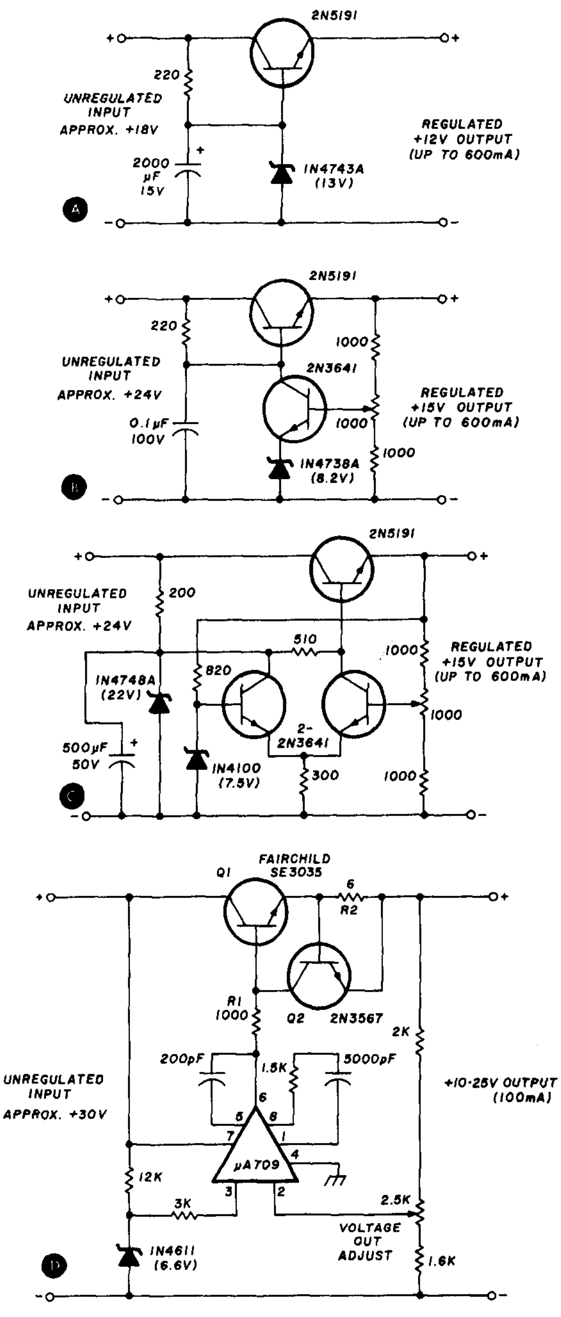


fig. 7. Series regulator circuits of figs. 5 and 6 using typical components. The emitter-follower version is shown in A; simple series regulator, B; series regulator using differential dc amplifier, C; and a series regulator using an IC op amp as a differential amplifier, D. The current limiter consisting of Q2, R1, R2 in D is a simple and worthwhile addition that can be included in most regulators.

probable failure (after rectifier diodes) is an electrolytic filter capacitor. The failure of electrolytic capacitors can either be a short or open circuit. A shorted electrolytic can be easily found with an ohmmeter; the only indication of an open electrolytic is its failure to smooth out ripple. Such an open-circuit failure will cause the dc voltage to decrease to a value lower than the peak ac voltage, as read on most meters.

An oscilloscope readily shows an open filter capaci-

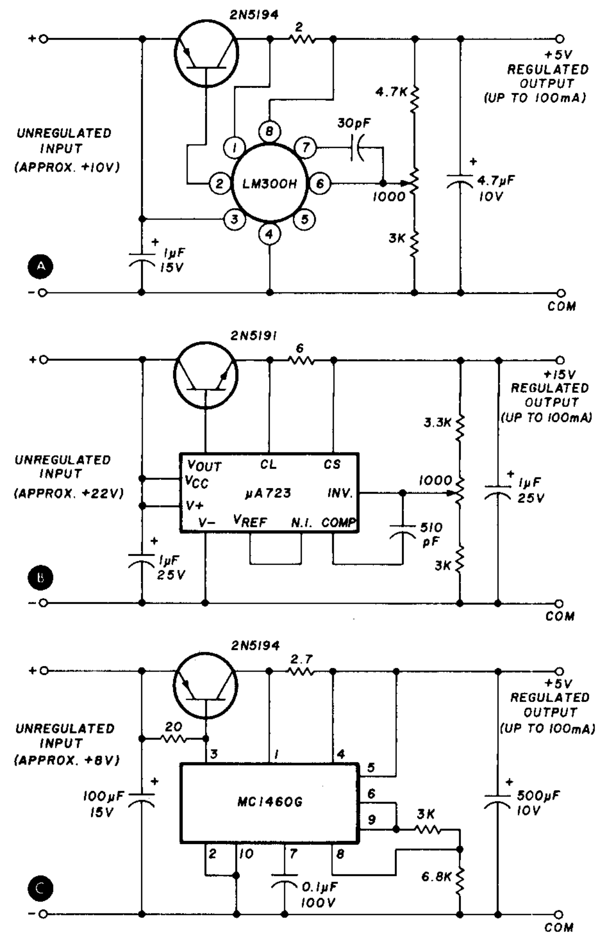


fig. 8. Series regulators using ICs especially designed for the purpose. All use external power transistors as part of the regulator circuit. The regulator in A uses the National LM300H or its improved version, the LM305H. In B the Fairchild µA723 is used. C shows another version using a Motorola 1460G, which has since been replaced by the MC1469. The National and Fairchild devices have become widely second-sourced and appear under a variety of brand names.

tor, because the increased ripple can be seen immediately. Bridging a new (correct value) electrolytic across the suspected open capacitor is a simple way to check this problem. What causes most electrolytic open failures is excessive ac. This current causes heat and subsequent drying of the capacitor electrolyte. If you have a supply in which electrolytes consistently dry up, probably no thought had been given to limiting ac current in the capacitor in the original design. This was a rare problem when we had only tubes and selenium rectifiers because of their high equivalent series forward resistance. But the modern silicon rectifier diode has extremely low equivalent forward resistance and immense peak current capability. A typical 1N4001 rectifier, rated at 1 amp, has a peak current rating of 30 amps!

With essentially no limit to the peak current our modern rectifiers will handle, the only limitations on ac in the filter capacitor, in a capacitor-input rectifier-filter system, are the leakage inductance and secondary resistance of the power transformer (plus the equivalent series resistance of the electrolytic itself). By using a clamp-on ac ammeter on the filter-capacitor lead you can easily see the magnitude of this current. The solution is either to use a capacitor of higher current rating (expensive and relatively bulky) or to add a small resistor, as in **fig. 11.** One-ohm, half-watt resistors are common and inexpensive for this purpose. For dc to 500 mA, this protective resistor will decrease the output less than 0.5 volt, which will usually be tolerated by the circuitry (regulator or load) that follows the rectifier filter. For larger-current supplies, a smaller resistance made from nichrome or constantin wire should be used. Note that the *exact* resistance and its stability are unimportant here as long as the resistance limits the ac current to a value the filter capacitor can accept according to its ratings.

magnetic components

The only other components in the power supply are the power transformer and perhaps a filter choke. These components usually fail from long-time overload or just plain old age and will have been "cooked." Obvious evidence of their demise includes strong odor, charred paper insulation, darkened insulation on formvar winding wire, and leaking insulation oil from sealed units.

Ohmmeter checks for winding continuity and leakage paths to the frame are called for here. Also ac voltage measurements across the power transformer secondary are appropriate. If all seems well in the rectifier-filter section, then the supply may be loaded using appropriate power resistors or light bulbs to determine if failure occurs only under load. The transformer alone may also be checked under resistive loads in the same way.

regulators

If you have problems in the regulator section, fixing becomes more varied and interesting. It can be very

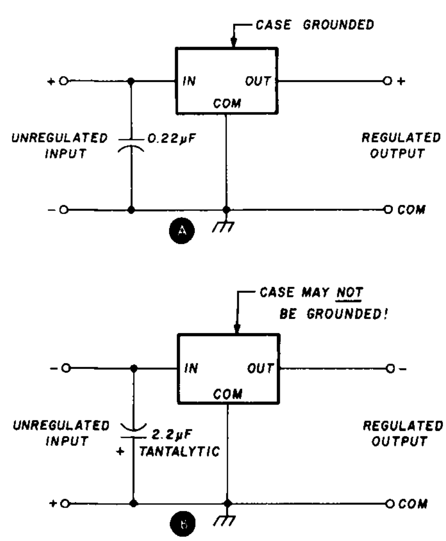


fig. 9. Using a three-terminal device as a positive regulator, A, and as a negative regulator, B, the power transistor is included within the chip. The IC for A can be a National LM340 or Fairchild µA7800; for B is can be a National LM320 or Fairchild µA7900. The capacitor between input and common is used for stability.

simple if the regulator is one of the three-terminal types, in which case the regulator is simply replaced. Regulator failures in my experience fall in this order of probability: series-pass power transistor, regulator IC, small transistors, and small electrolytics. Since the regulator is a feedback system, voltage measurements are often misleading. Unlike open-loop circuits, feedback systems usually completely tie themselves into knots when any part of them goes wrong.

The easiest way to fix a regulator is to check (or replace) the most likely parts (as above), one at a time, until success is achieved. Two voltage measurements can be helpful – sometimes: measurement across the current-sense resistor and across the reference. In **fig. 7D** this would be across the 6-ohm resistor for current-limiting; any voltage here in excess of 0.6 volts indicates that the regulator is current limiting. Also in **fig. 7D**, a check across the zener (1N4611) will show if the regulator has any reference voltage to which it can compare the output voltage.

Reference-zener failure doesn't occur often in good commercial designs, but a number of companies use inexpensive plastic transistors as reference diodes. The reverse breakdown voltage of the emitter-base junction of a silicon transistor is used for a zener in the 4-10 volt range. These "reference diodes" are inexpensive for the manufacturer but nasty to replace, because the repairman has no idea of their exact breakdown voltage before failure. My practice is to use a good zener with a sharp knee to replace these so-called references. The 1N4099 at 6.8 volts is my favorite at least as a first cut.

mysterious part labeling

When fixing commercially made power supplies you may encounter that annoying facet of protectivism called "in-house-numbering." For example, Motorola makes an MC1466L for Lambda to use in their modular power supplies but gives it a Lambda special number. There is *no way* you can find out from the IC manufacturer what the part is – short of industrial espionage. All

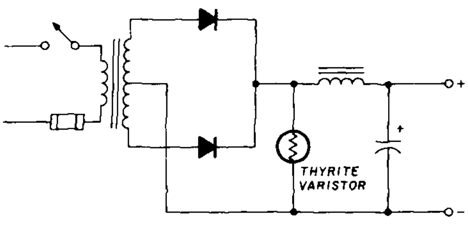


fig. 10. Choke-input circuit with a thyrite varistor added to protect rectifiers against overvoltage when the choke field collapses.

IC manufacturers do this for large O.E.M. customers. However, the IC manufacturer usually puts his trademark on the IC or transistor so that at least you have a clue.

There is almost zero probability that an in-house semiconductor is a specially-made device because of the cost factor; almost always it will be a standard part but re-marked. The circuit and pinning of the device to be replaced should be compared with the information in the semiconductor manufacturer's data book, then usually you can infer what the part is. In modular power supplies the Fairchild μA723 and National LM305 are by far the most common regulator ICs.

The main producers of regulator ICs are Fairchild, National, Motorola, Silicon General, Raytheon, Teledyne, Signetics, and RCA (that is, all the big linear houses). These companies' trademarks are easily recognized and their data books are commonly available. Occasionally you may be able to obtain an in-house number equivalent by calling the O.E.M. or his field engineering office. When replacing the regulator IC I always *carefully* unsolder the package using a desoldering tool (vacuum type) then *install an IC socket.* This allows a new IC to be tried without further weakening the circuit-board traces and pads.

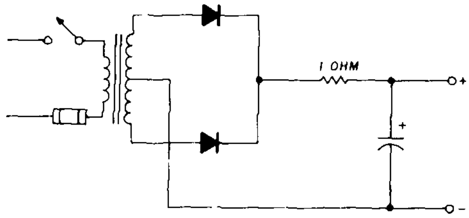


fig. 11. Capacitor-input filter with a 1-ohm resistor added to limit electrolytic-capacitor current.

heat sinks

One last point on power supplies is the subject of heat sinks. Very often commercial designs at the low-price end have inadequate heat sinks for power semiconductors. Occasionally you'll even find power semiconductors "heat sink" mounted to a steel chassis or bracket. This, of course, saves the O.E.M. money but provides *poor* heat conductivity. A simple retrofit of an aluminum or copper plate can often prevent persistent semiconductor failures due to overheating. Another pitfall is the *application* of modular power supplies, especially the molded-in-epoxy block types. These modules are frequently designed to be operated with good thermal contact to a large aluminum chassis or other good heat dissipator. Floating them on a fiberglass circuit board in a stagnant air location is a sure way for them to fail.

conclusion

We have touched on a number of types of power supplies and the ways in which they can be separated into sections, the section at fault isolated, and finally that section repaired. There are many other regulator forms: shunt regulators, switching regulators, and even regulators that rely on ferro-resonance in transformers and other clever magnetic tricks. These other regulators are not so common that space can be devoted to them here; but they, too, can be fixed using the same general principles: separate, isolate, repair.

ham radio

The station of many faces...

SSB or CW

Wide Selectivity or Narrow

DX Chasing or Traffic Handling

160 thru 10

Ham Bands or MARS

Drake C-Line

Both the R-4C and T-4XC cover extra 500 kHz ranges throughout the hf spectrum. Additional crystals, which are front panel selectable, provide new bands as they are needed such as those discussed for 10, 18, and 24 MHz.

The excellent performance of the system makes weak signal DXing on 160 meters a pleasure.

Both units employ the famous Drake PTO for super stability and 1kHz direct dial readout. Calibration remains the same when switching between modes.

With the proper use of the passband tuning, notch filter, and eight-pole cyrstal lattice filter (ssb supplied, five others for am, cw, and RTTY available as accessories), R-4C gives outstanding results in severe QRM as compared to fixed selectivity Systems.

Complete transceive capability using either PTO is provided, with spot signal for zero beating.

Also consider the Drake L-4B Linear Amplifier — full power 2kW PEP ssb and 1000 W-dc cw, full rated for RTTY, offering full operator convenience with front panel by-pass switch and built-in precision high power wattmeter.

C-LINE ACCESSORIES

• Standard Crystals for T-4XC or R-4C • Accessory I-f Filters • Ac Power Supply • Matching Speaker • Antenna Matching Networks • Rf Wattmeters • Linear Amplifier • Desk Top or Hand Held Ceramic Microphones • Noise Blanker

To receive a FREE Drake Full Line Catalog, please send name and date of this publication to:

R. L. DRAKE COMPANY DRAKE®

540 Richard St., Miamisburg, Ohio 45342
Phone: (513) 866-2421 • Telex: 288-017

Western Sales and Service Center, 2020 Western Street, Las Vegas, Nevada 89102 • 702/382-9470

More Details? CHECK—OFF Page 126

binaural synthesizer-filter with tone-tag modulation

A narrowband tone-marking system that quickly locates binaural crossover and provides a characteristic tonal quality to CW signals

Back in the thirties, before the explosion of electronic-component availability and refinements, amateur radio was more relaxed. You could tune across the phone bands and hear anything from a rock-crusher with broadcast-band quality eating up 20 "kilocycles" of bandwidth to a self-excited oscillator modulated by a loop-coupled telephone mike. CW was more often effected by a straight key than a bug. And since voltage regulators were not yet generally available, many CW signals chirped, thumped, clicked or yooped – some were pure raspberry (filter capacitors were expensive). Added to this charm was brass-pounder rhythms such as the "Banana Boat Roll" and "Lake Erie" swing and many, many more – most with generous amounts of syncopation thrown in. Individuality there was.

Today the phone bands are sideband-tight and log compressed. Almost all CW signals are chirpless dc, with or without crystal control. And, with a few exceptions,[1] electronic keyers coldly subtract character from keying. Clearly the effect of signal quality in days gone by was not all bad by any means. You could often copy a DX station precisely because he had the sound of a buzz saw or maybe a peanut-whistle chirp. He was different, and it helped. Although some purists frowned on those raunchy sounds, they were less piercing to the ear (probably less damaging physiologically) and much more pleasant to copy.

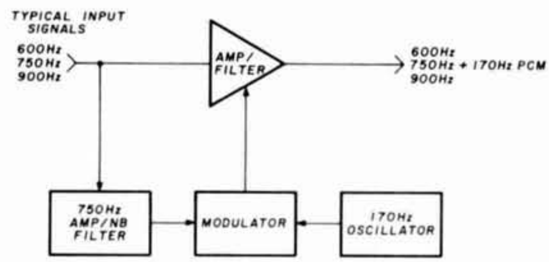


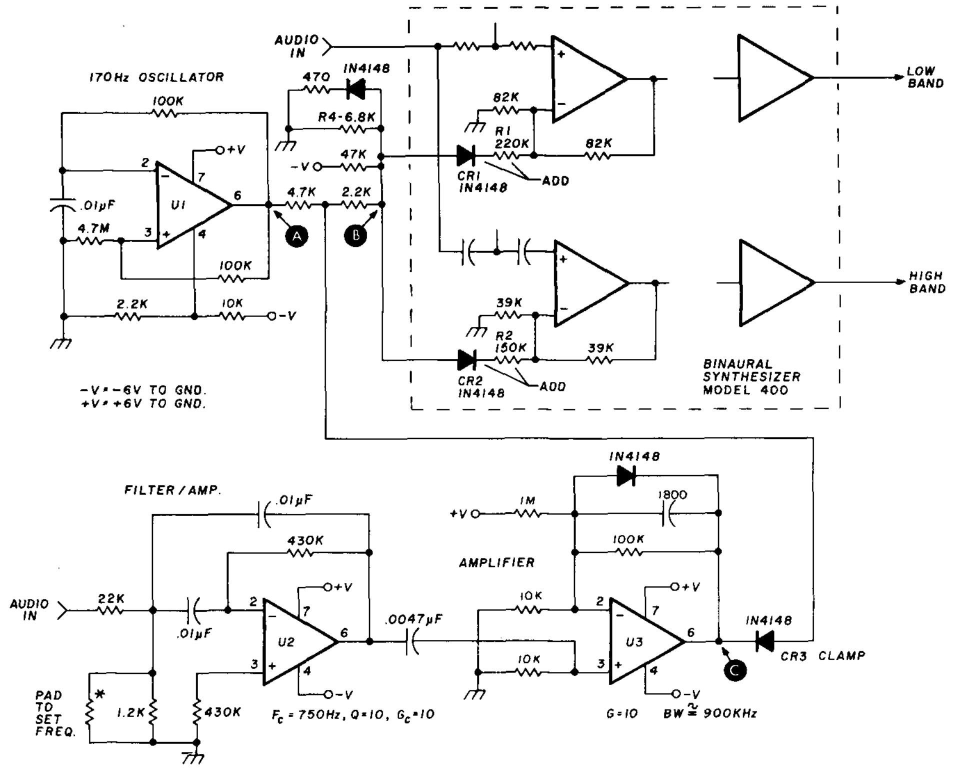
fig. 1. Block diagram of the basic Tone-Tag modulation system for enhancing reception of CW signals.

system description

Because of technological progress much of the old

By Don E. Hildreth, W6NRW, Post Office Box 3, Sunnyvale, California 94088

character of CW signals is gone forever; but perhaps today's technology can restore some of it. Of course you could make all signals sound like a buzz saw simply by cutting some of the power supply filter out of your receiver. You'd lose the piercing CW notes, but all signals would still sound alike. Tone-Tag™ is my answer to resistors R1 and R2 (**fig. 2**) between ground and open at a selected rate not only creates amplitude modulation, but it does so at the binaural crossover frequency. Every effort was made to obtain a modulated tone without superimposing startup delays or transients on the basic desired signal.



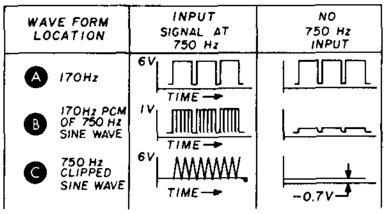


fig. 2. Circuit details of the basic Tone-Tag modulation scheme. Reducing resistance between an operational amplifier minus port to ground not only increased gain, but the gain is increased most near the filter cutoff frequency. The binaural synthesizer (dashed box) appeared in reference 2.

part of the problem. I use it to accomplish two major objectives:

1. Tone modulate a selected signal without changing adjacent signals.

2. Provide a tuning aid to determine quickly and precisely the location of the 750-Hz crossover point in my binaural synthesizer for CW.[2]

You'll note that the first objective can be accomplished whether or not you use a binaural synthesizer. You can apply the Tone-Tag principle to any system. The general idea is shown in **fig. 1. Fig. 2** shows circuit details. Although there are many ways to effect modulation, this method takes advantage of a basic characteristic of the VCVS active filter class. In this case, reducing resistance from a minus op-amp port to ground not only increases gain, but the gain is increased most around the filter cutoff frequency. Therefore, switching

circuit

A tone-modulating oscillator, U1, runs at approximately 170 Hz (this frequency is between the 4th and 5th subharmonics of the 750-Hz listening frequency to avoid harmonic beat notes). Under no-signal conditions, the modulating oscillator's assymetrical square wave is inhibited by clamp CR3. The clamp is held in conduction by a quiescent -0.7 volt output from op amp U3. Divider R3, R4 inhibits modulator diodes CR1, CR2 when strong signals pass through the system above and below 750 Hz. When a nominal 750-Hz signal appears, it is amplified and filtered by U2, a narrow-band filter, then fed to amplifier U3. Positive half cycles appearing at U3 output periodically open the clamp CR3, which allows samples of the 170-Hz oscillator to do its work on the modulation diodes. In this way, only those signals in the filter passband near crossover are modulated — a method that is as effective as it is simple. **Fig. 3** shows a complete system including a 300-Hz input filter with adjustable skirts.

The 741 IC op amp or its equivalent will work in all circuits shown, but a 308 or 301A with a 3-pF frequency-compensation capacitor between pins 1 and 8 will provide more margin for the U2 circuit in **fig. 2.** Carbon-film resistors are rated better than carbon composition for the active filters, but 5%, ¼-watt carbon resistors are usually sufficient. It's better to use capacitors with a tolerance of 10% or better, unless you wish to spend some time with a bridge. I've had good results with 50- or 100-volt 10% mylar film capacitors (James Electronics and others).

function on input audio signals as low as 10 mV rms; therefore, considerable dynamic-range flexibility is provided. Hopefully your receiver, in addition to its other good features, has a well-designed i-f amplifier and detector (mixer for CW); for although an audio processor can help a marginal i-f system, it will do much better with one that provides a good single-signal response and one that does not generate copious quantities of spurs. An excellent bandwidth to work with this system is around 1 kHz with a 6-60 dB shape factor of 2.

operating procedures

With your receiver bfo set around 750 Hz above or below its i-f passband center and with binaural skirts *up*, simply tune a desired CW station to binaural center. At this point, coincident with equal energy in your right and left speakers or phones, the received signal will pick up a gentle tone modulation. At the same time, signals to the right and left (higher or lower beat note) will remain pure dc. Under heavy interference you may turn the skirt-control to drop the wideband skirts, leaving the tone-modulated signal unchanged. Usually, however, it seems better to leave the skirts — or floor — reasonably well up and enjoy three modes of selectivity: binaural, Tone-Tag, and the "ear-brain" filter.[4] Frequency response with typical skirt control positions is shown in **fig. 4.**

What about using this system for receiving phone signals? To me they sound better than with a monaural audio system. The stations you hear seem to occupy a wide band of space in front of you; but of course, Tone-Tag just doesn't come into the picture. Under interference or high noise, you can drop the flat skirts 10 dB

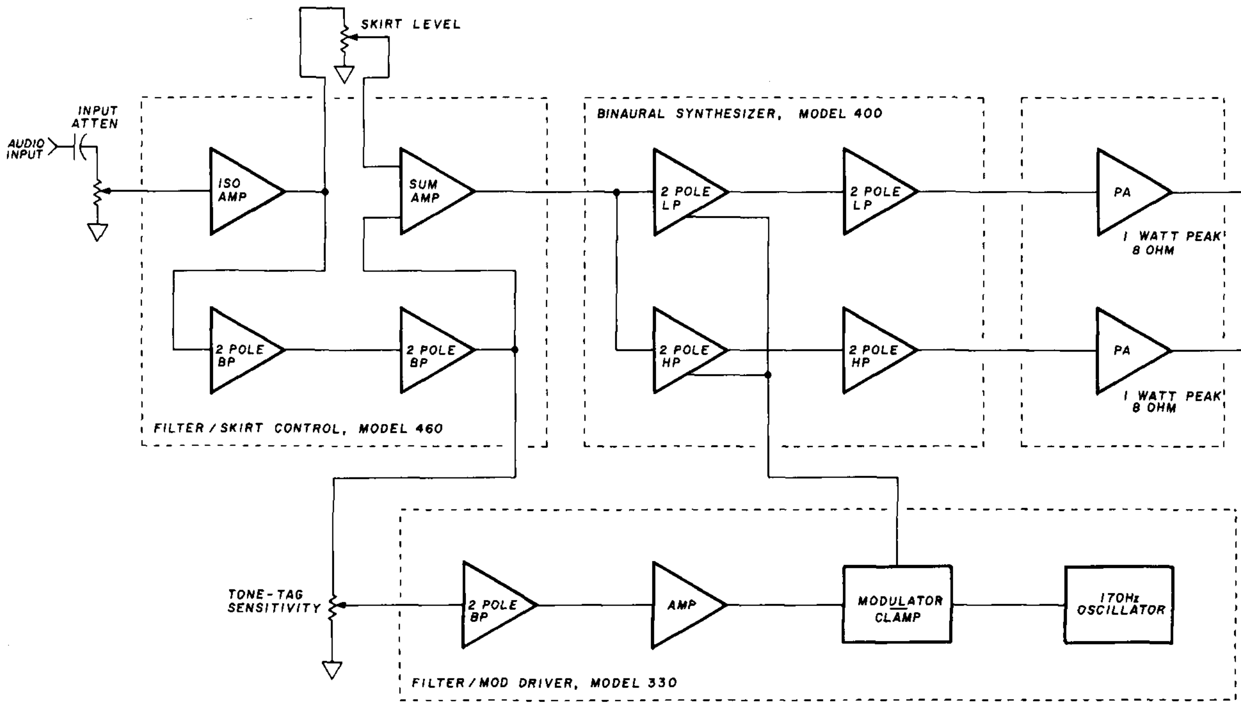


fig. 3. Complete Model 1100 system including Tone-Tag, binaural synthesizer, and 4-pole, 300-Hz input filter.

input requirements

Since distortion in the driving receiver and early stages of this system can reduce effective binaural action, very linear operation is desirable. This can be assured by keeping signals out of the final low- and high-pass active filter stages to a level of *not more* than 5 or 6 volts p-p. This level will also avoid interaction between signal levels and the modulation function.

As a distortion-effect example, if a receiver produces a condition where the second or third harmonics of a hypothetical 500-Hz signal are down only 10 or 20 dB, then the effect of the excellent binaural separation built into the system is largely compromised. A similar case is true for intermodulation distortion, and we have enough of these problems with our nonlinear ears. When you consider that the maximum physiological binaural potential tends to be only about 7 dB,[3] it's best to stay very linear (operate well below saturation) and don't listen with more than comfortable volume.

Available gain in the Tone-Tag system will allow it to or so to improve copy. With music, leave the skirts up and enjoy simulated stereo.

conclusions

With Tone-Tag, one of the desirable factors of old, lost through technological improvement, has been returned — at *your* choice of application. Now you can apply tone modulation *and* binaural action to any CW signal you select. This provides a much wider field than before. And while it is true you won't have much luck binaurally separating or modulating just one of several signals within a few Hz of each other, these cases are not too frequent. On balance, we are ahead.

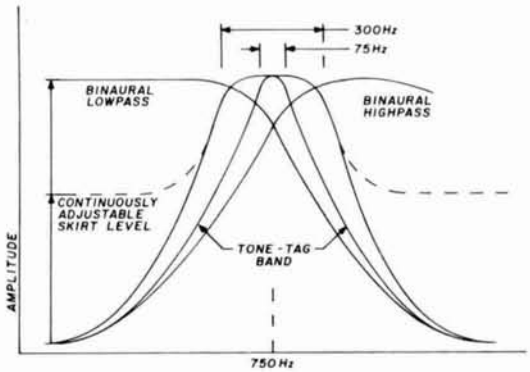


fig. 4. Frequency response of the binaural bandpass filter and Tone-Tag modulation system. The 75-Hz Tone-Tag filter is cascaded with the 300-Hz input filter, which provides skirts equivalent to those from a 6-pole filter in addition to enhancement from the binaural filters.

A narrowband filter is used as a part of this system; but in this case it's not in the direct signal path so it doesn't ring and ping with noise and signal alike. This system helps the selective process without interfering with our fantastic ear-brain filter.

Considerable experimentation was applied in choosing a tone-modulated frequency. Brainwave rates were even tried. "Alpha" sounds fine as long as keying rates are slow; but for all-around use, the frequency shown seemed best to me.

acknowledgement

I wish to thank Dick Turrin, W2IMU, for providing a copy of reference 4 and for some very interesting references indicating potential s/n improvements when comparing monaural with binaural listening.

references

1. Jim Pollock, WB2DFA, "A Digital Morse Code Synthesizer," *QST*, February, 1976, page 37.
2. Don E. Hildreth, W6NRW, "Synthesizer for Binaural CW Reception," *ham radio*, November, 1975, pages 46-48.
3. J.C. Steinberg and W.B. Snow, "Physical Factors," *Bell System Technical Journal*, Vol. 13, No. 2, fig. 3, page 252, 1934, Reprinted in part in *Reference Data for Radio Engineers*, 5th Edition, page 35-22.
4. Dick Turrin, W2IMU, "Simple Super Selectivity, (Technical Correspondence), *QST*, January, 1967, page 48.

ham radio

calculating line-of-sight distance to the horizon

Users of the vhf/uhf spectrum often want to know the line-of-sight distance from the top of some particular object to the horizon. The distance is given by the following formula:

$$D = \sqrt{2Rh + h^2} \quad (1)$$

where

D = line-of-sight distance from the observing point to the horizon

R = radius of the earth to the average terrain surrounding the observing point

h = height of the observing point above the average terrain

You may use any units of measure you like as long as you are consistent throughout the equation.

Eq. 1 does not take into consideration variations in terrain between the observer and the horizon, which of course can alter the actual distance that he will see, nor does it consider the characteristics of propagation (refraction, multipath), which often affect transmission range.

The value of R is not critical, however, regardless of latitude or altitude above sea level. The following approximations, though based on mid latitudes, will give excellent results regardless of where you live.

$$R \approx 20{,}890{,}400 \text{ feet}$$

or

$$R \approx 6{,}367{,}400 \text{ meters}$$

The really important factor is the height of the observing point above the average terrain, and this figure should be as accurate as possible.*

While the distance formula is quite simple, it is not always easy to remember the radius of the earth. For those who use the English system of measurements, the following is an excellent approximation:

$$D\,(miles) = \sqrt{1.5h}\,(feet) \quad (2)$$

*Excellent topographical charts are avilable that show contour lines depicting elevation in feet above mean sea level for just about any community in the country. These charts are avilable at nominal cost from the U.S. Geological Survey, Denver, Colorado 80225, or Washington, D.C. 20242. A folder describing topographical maps and symbols is available on request from the USGS. **Editor**

Note that the height is in *feet* and the answer is in *miles.* This approximation is so close that the distance error does not exceed a tenth of a mile until you rise to well over 60,000 feet in altitude. (This also makes it useful in finding the distance to the horizon from an airplane). You may find it interesting to prove to yourself just why this approximation is valid.

Conversely, if you want to know how high you must be to see a certain distance, **Eq. 2** is rewritten as:

$$h = \frac{2D^2}{3} \quad (3)$$

Once again, remember that distance is in miles and height is in feet.

If you use the metric system of measurements, the following is an excellent approximation for line-of-sight distance to the horizon in *kilometers* when the height is in *meters:*

$$D\,(kilometers) = \sqrt{12.7h}\,(meters) \quad (4)$$

To see how high you must be to see a certain distance, this may be rewritten as

$$h\,(meters) = \frac{D^2}{12.7}\,(kilometers) \quad (5)$$

Table 1 will give you an idea of what the formulas reveal for both metric and English measurements. You may be surprised that, even at fairly high altitudes, the horizon really is not very far away. As a friend of mine said recently, "Not only is the earth round but it is very, very round."

table 1. Distance to the horizon as a function of observing height, English and metric measurement systems.

observing height, h (ft)	distance, D (mi)	observing height, h (m)	distance D (km)
1000	39	300	62
2000	55	600	87
3000	67	900	107
4000	77	1200	124
5000	87	1500	138
6000	95	1800	151
7000	102	2100	164
8000	110	2400	175
9000	116	2700	185
10000	122	3000	195
11000	128	3300	205
12000	134	3600	214
13000	140	3900	223
14000	145	4200	231
15000	150	4500	239

ham radio

By William D. Johnston, WB5CBC, 1808 Pomona Drive, Las Cruces, New Mexico 88001

We thought you might be interested in a 2-meter, synthesized, VHF–FM transceiver featuring 800 frequencies in 5KHz steps, variable RF output from 1 to 25 watts, 4 front panel selectable splits, a discriminator meter, and a price tag below five hundred dollars.

TRANSMITTER SPECIFICATIONS

Frequency Range: 144 to 148MHz. **Front Panel Frequency Splits:** Simplex, +0.6MHz, —0.6MHz, +1MHz, —1MHz. **Frequencies:** 800 (5KHz separation). **Modulation:** 16F3 ±5KHz for 100% at 1,000Hz. **RF Power Output:** 1-25 Watts, variable. **Frequency Stability:** Within ±0.001% from —20°C. to +60°C. **Hum & Noise:** Better than — 30dB 2/3 rated system deviation at 1,000Hz. **Antenna Impedance:** 50 Ohms. **Switching:** Solid-state type. **Spurious & Harmonic:** At least 60dB below rated carrier power. **Microphone:** Turner, low impedance. **Audio Frequency Response:** 300Hz to 3,000Hz, referred to +1, —8dB of 6dB/Octave de-emphasis curve. **Audio Distortion:** Less than 7% at 1,000Hz, 2/3 system deviation. **Frequency Display:** 6 digit, 7 segment HP LED. **Optional Accessory:** Plug in touch-tone encoder – $50.

RECEIVER SPECIFICATIONS

Frequencies: 143 to 148.995MHz. **Usable Sensitivity (12dB sinad):** 0.35uV @ 50% audio. **Quieting Sensitivity (20dB):** 0.5uV minimum. **Squelch Threshold Sensitivity:** 0.25uV minimum. **Squelch Limit Sensitivity:** 2.0uV or less. **Modulation Acceptance Bandwidth:** ±7.5KHz minimum. **Adjacent Channel Selectivity:** 70dB minimum. **Spurious Response Attenuation:** 70dB minimum. **Intermodulation Attenuation:** 60dB minimum. **Local Oscillator Frequency Stability:** ±10 parts per million. **Audio Output Power:** 4.0 Watts into a 4 Ohm load @ less than 10% distortion. **Audio Frequency Response:** +2dB to —8dB from the standard 6dB per Octave de-emphasis from 300Hz to 3,000Hz. **Hum & Noise:** —50dB squelched and —30dB unsquelched. **Chassis Size:** 7⅛"W x 2⅝"H x 10"D.

SO, WE BUILT ONE FOR YOU.

Face plate also available in black.

The S 225 by AMCOMM®

An American Communications Corporation.

730 WEST McNAB ROAD · FORT LAUDERDALE, FLORIDA 33309.

Wilson Electronics Corp.

HAND HELDS

220

REQUENCY RANGE 220 - 225 MHz

- 6 Channel Operation
- Individual Trimmers on all TX/RX Crystals
- All Crystals Plug In
- 12 KHz Ceramic Filter
- 10.7 and 455 KC IF
- .3 Microvolt Sensitivity for 20 dB Quieting
- Weight: 1 lb. 14 oz. less Battery
- Battery Indicator
- Size: 8 7/8 x 1 3/4 x 2 7/8
- Switchable 1 & 2.5 Watts Output @ 12 VDC
- Current Drain: RX 14 MA, TX 500 MA
- Microswitch Mike Button
- Unbreakable Lexan® Case

JSES SAME ACCESSORIES AS 1405

INCLUDES

1. 2202 SM
2. Flex Antenna
3. 223.50 Simplex Installed

~~$239.95~~

XMAS SPECIAL $219.95

450

FREQUENCY RANGE 420 - 450 MHz

- 6 Channel Operation
- Individual Trimmers on all TX/RX Crystals
- All Crystals Plug In
- 12 KHz Ceramic Filter
- 21.4 and 455 KC IF
- .3 Microvolt Sensitivity for 20 dB Quieting
- Weight: 1 lb. 14 oz. less Battery
- Battery Indicator
- Size: 8 7/8 x 1 3/4 x 2 7/8
- Switchable 1 & 1.8 Watts Output @ 12 VDC
- Current Drain: RX 14 MA, TX 500 MA
- Microswitch Mike Button
- Unbreakable Lexan® Case

USES SAME ACCESSORIES AS 1405

INCLUDES

1. 4502 SM
2. Flex Antenna
3. 446.00 Simplex Installed

~~$279.95~~

XMAS SPECIAL $269.95

ACCESSORY SPECIALS

	DESCRIPTION	SPECIAL PRICE
BC1	BATTERY CHARGER	$34.95
BP1	10 EA. AA GOULD NICAD BATTERIES	14.95
BT1	EXTRA BATTERY TRAY	6.00
LC1	LEATHER CASE 1402	12.95
LC2	LEATHER CASE 1405, 2202, 4502	12.95
SM1	SPEAKER MIKE FOR EARLY MODEL 1402 9 PIN CONNECTOR	24.95
SM2	SPEAKER MIKE FOR ALL NEW HAND HELDS WITH ROUND 6 PIN CONNECTOR	24.95
TE-1	SUB-AUDIBLE TONE ENCODER INSTALLED	34.95
TTP	TOUCH-TONE PAD	49.95
	INSTALLATION AT TIME OF RADIO PURCHASE	FREE
	INSTALLATION AT LATER DATE, ADD	15.00
XF-1	10.7 KC MONOLITHIC XTAL FILTER	9.95
CRYSTALS	TX or RX (Common Frequency Only)	3.75

BC-1 BATTERY CHARGER

XMAS SPECIAL

"FACTORY DIRECT ONLY"

XMAS SPECIAL

Shown With Optional Touch-Tone Pad

1402SM HAND HELD 2.5 WATT TRANSCEIVER

144-148 MHz

~~$164.95~~

XMAS SPECIAL $159.95

1405SM HAND HELD 5 WATT TRANSCEIVER

144-148 MHz

~~$239.95~~

XMAS SPECIAL $229.95

FEATURES

1402 SM

- 6 Channel Operation
- Individual Trimmers on all TX/RX Crystals
- All Crystals Plug In
- 12 KHz Ceramic Filter
- 10.7 IF and 455 KC IF
- .3 Microvolt Sensitivity for 20 dB Quieting
- Weight: 1 lb. 14 oz. less Battery
- S-Meter/Battery Indicator
- Size: 8 7/8 x 1 7/8 x 2 7/8
- 2.5 Watts Minimum Output @ 12 VDC
- Current Drain RX 14 MA TX 500 MA
- Microswitch Mike Button
- High Impact Plastic Case

1405 SM

- 6 Channel Operation
- Individual Trimmers on all TX/RX Crystals
- All Crystals Plug In
- 12 KHz Ceramic Filter
- 10.7 and 455 KC IF
- .3 Microvolt Sensitivity for 20 dB Quieting
- Weight: 1 lb. 14 oz. less Battery
- Battery Indicator
- Size: 8 7/8 x 1 3/4 x 2 7/8
- Switchable 1 & 5 Watts Minimum Output @ 12 VDC
- Current Drain: RX 14 MA TX 400 MA (1w) 900 MA (5W)
- Microswitch Mike Button
- Unbreakable Lexan® Case

OVER 35,000 XTALS IN STOCK

SPECIAL ON EACH RADIO INCLUDES:

Flex Antenna
52/52 Simplex Xtal

90 Day Warranty

10 Day Money Back Guarantee

Can be Modified for MARS or CAP

OVER 2000 UNITS IN STOCK FOR XMAS SALE

XMAS SPECIAL DIRECT SALE ORDER BLANK

TO: WILSON ELECTRONICS CORP., 4288 S. POLARIS AVE., LAS VEGAS, NEVADA 89103
(702) 739-1931

___ 1402SM @ $159.95
___ 1405SM @ $229.95
___ 2202SM @ $219.95
___ 4502SM @ $269.95
___ BC1 @ $34.95
___ BP1 @ $14.95
___ BT1 @ $6.00
___ LC1 @ $12.95
___ LC2 @ $12.95
___ SM1 @ $24.95
___ SM2 @ $24.95
___ TE1 @ $34.95
(SPECIFY FREQUENCY ________)

___ TTP @ $49.95
___ XF1 @ $9.95
___ TX or RX XTALS @ $3.75 ea. Common Frequencies Only.
___ FACTORY XTAL INSTALLATION/ NETTING @ $7.50/Radio
___ MARS or CAP XTALS @ $10.00 ea.

EQUIP TRANSCEIVER AS FOLLOWS:

XTALS	TX	RX	XTALS	TX	RX
A.	52	52	G.		
B.			H.		
C.			I.		
D.			J.		
E.			K.		
F.			L.		

ENCLOSED IS ________ ☐ CHECK ☐ MONEY ORDER ☐ MASTER CHARGE ☐ BANKAMERICARD

CARD # ________

EXPIRATION DATE ________

NAME ________

ADDRESS ________

CITY ________

STATE ________ ZIP ________

SIGNATURE ________

SHIPPING & HANDLING PREPAID FOR XMAS SPECIAL
NEVADA RESIDENTS ADD SALES TAX

HR VALID ONLY NOV. 1 THRU DEC. 31, 1976

microcomputer interfacing: a software UART

This month we return to the subject of the substitution of software for hardware, i.e., the substitution of machine-level routines and subroutines for specific digital hardware devices that store, manipulate, transmit, or receive digital information. The hardware device we'll discuss is the universal asynchronous receiver/transmitter, or UART – a 40-pin integrated-circuit chip that contains an independent 8-bit asynchronous receiver and an independent 8-bit asynchronous transmitter. Data rates range from dc to 60,000 bits per second. The receiver and transmitter sections of the chip can be programmed for 5, 6, 7, or 8 data bits; 1 or 2 stop bits; even or odd parity; and parity or no parity. The chip also contains a variety of flags. For further details, we refer you to manufacturer's literature or to references 1 through 3.

UART interface

An interface circuit for a simplified software UART is shown in **fig. 1**. Because of the nature of the specific application, which we'll discuss at the end of this column, there was no need for special flag bits or error checking. As a consequence, the interface circuit consists of a single three-state input buffer gate (SN74126), a single output-data latch (SN7474), two input device-select pulses, and one output device-select pulse. With appropriate modifications of the device-select pulses, this circuit can be used with almost any microprocessor chip. In our case, a 8080A-based microcomputer operating at 750 kHz was used. This system generates and detects, in combination with operating software, asynchronous serial ASCII-coded, 5-volt, TTL data. For teleprinter operation, additional hardware is required to convert the 5-volt logic levels to 20 mA current loop operation.[4]

By Paul E. Field, David G. Larsen, WB4HYJ, Peter R. Rony, and Jonathan A. Titus

Dr. Field is guest author of this month's column. Dr. Field and Mr. Larsen, Department of Chemistry, and Dr. Rony, Department of Chemical Engineering, are with the Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Mr. Titus is President of Tychon, Inc., Blacksburg, Virginia.

The transmit subroutine, shown in **table 1**, for the software UART occupies 20-25 successive program steps in memory once the appropriate PUSH, POP, and RET instructions have been included. Also required is a 9.09 millisecond time-delay subroutine, which corresponds to an asynchronous serial ASCII data transmission rate of 110 Baud, i.e., teleprinter speed. The program in **table 1** is described as follows:

Register L is used as the bit counter for the 11-bit ASCII word, and is set initially to octal 013. The seven data bits plus the parity bit, which is bit 8, are assumed to be present in the accumulator. At LO = 146, the accumulator is ORed to itself to clear the carry bit, which is shown on the far left in **fig. 2**. In **fig. 2** the least-significant data bit is bit 1. At address LO = 147, a RAL instruction is performed to rotate the start bit to bit position DO in the accumulator. **Fig. 3** should pro-

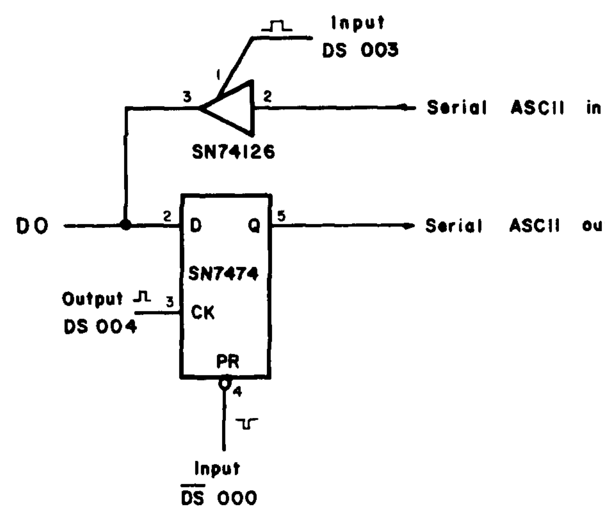


fig. 1. Interface circuit between an 8080A-based microcomputer and a TTL asynchronous serial ASCII input-output device.

vide assistance in understanding the four different rotate instructions in the 8080A microprocessor instruction set.[5]

At LO = 150, the start bit is output to the SN7474 data latch, which is shown in **fig. 1**. The program then goes into a 9.09 ms time delay subroutine, after which bit 1 is rotated into the DO accumulator position and the carry bit is set to logic 1. Bit 1 is output to the SN7474 latch, the ASCII word bit counter in register L is decremented, and program control is returned to the time delay subroutine, which is called at LO = 152. The loop from LO =152 to LO = 164 is executed a total of eleven times, after which register L becomes zero and the JNZ instruction at LO = 162 is ignored. A software UART transmit subroutine possesses a flexibility equivalent to the original 40-pin UART chip. With appropriate modifications to the program or the original accumulator data, you can transmit 5, 6, 7, or 8 data bits; 1 or 2 stop bits; even or odd parity; and parity or no parity.

table 1. Microcomputer subroutine that demonstrates the asynchronous serial transmission of an eleven-bit ASCII word at a teletype speed of 110 Baud.

LO memory address	instruction byte	mnemonic	description
•	•	•	
•	•	•	
•	Accumulator contains 8-bit ASCII word. Bit 8 is the parity bit, which can be set for even or odd parity, or no parity.		
144	056	MVI L	Set ASCII word bit counter to 013
145	013	013	
146	267	ORA A	Set carry bit to logic 0
147	027	RAL	Rotate carry bit to D0 in accumulator
150	323	OUT	Output carry bit to SN7474 latch
151	004	004	
152	315	CALL	Call 9.09 ms time delay subroutine
153	<B2>	<B2>	LO address byte of time delay subroutine
154	<B3>	<B3>	HI address byte of time delay subroutine
155	037	RAR	Rotate bit in ASCII word to DO in accumulator
156	067	STC	Set carry bit to logic 1
157	323	OUT	Output bit to SN7474 latch
160	004	004	
161	055	DCR L	Decrement bit counter by 1
162	302	JNZ	If bit counter has value of zero, ignore this instruction. If all of the bits in the 11-bit ASCII word have not yet been transmitted, jump to address LO = 152 above.
163	152	152	LO address byte
164	<B3>	<B3>	HI address byte
•			
•			
•	At this point, the 8-bit ASCII word contained in the accumulator has been transmitted. Two stop bits have been added at the end of the eight bits and a single start bit, at logic 0, has been added at the beginning of the eight bits.		
•			

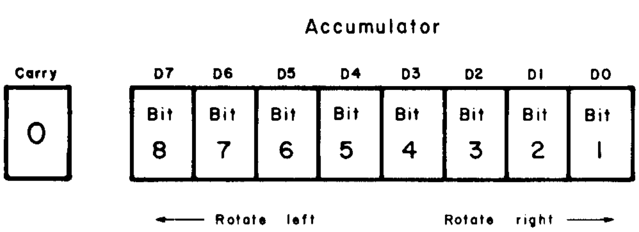


fig. 2. Schematic of the accumulator contents after the ORA A instruction in the software UART transmit subroutine in table 1. The carry bit is the start bit, which is at logic 0.

The time-delay subroutine can be modified so that you can transmit at data rates from 60 to 9600 Baud for a 750-kHz clock rate and higher for 2-MHz and 4-MHz 8080A clock rates.

The conversion from one data transmission rate to another is easily accomplished with the aid of appropriate software time delay subroutines, which replace RC time-constant circuits. An additional advantage that accrues from the use of software is the potential to perform code conversions. For example, 5-level Baudot KSR machines are in widespread use and can still be obtained for under $50. It is not too difficult to develop software that converts ASCII to Baudot and thus produce an inexpensive hard-copy terminal for the laboratory scientist or engineer, amateur, or computer buff.

The software UART receive subroutine requires 50 instructions and will not be repeated here.* The basic programming concepts associated with the receive subroutine are illustrated in **fig. 4**, which represents an eleven-bit asynchronous series ASCII word that is being detected by the 8080A-based microcomputer with the aid of the SN74126 three-state buffer gate shown in **fig. 1**. The program repeatedly tests the "serial ASCII in" line in **fig. 1** for a logic 0 state. Once a logic 0 state, which corresponds to a start bit, is detected, the program goes into a 4.54-ms wait loop. Upon leaving the wait loop, the program again inputs the logic 0 into bit

*Copies of the transmit and receive subroutines and a description of a "smart" remote-data entry station are available from Prof. Paul Field, Department of Chemistry, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 20461.

position DO in the accumulator, thus testing the validity of the start bit. The start bit is rotated to the carry bit, and the program then enters a 9.09-ms wait loop, after which it inputs bit 1 into position DO in the accumulator. Register H is used as the SAVE register, which stores can also be generated from software with the aid of a second SN7474 latch.

The software UART routines described above by Dr. Paul Field of VPI & SU were in a "smart" remote data entry station that was tied through a 20-mA current

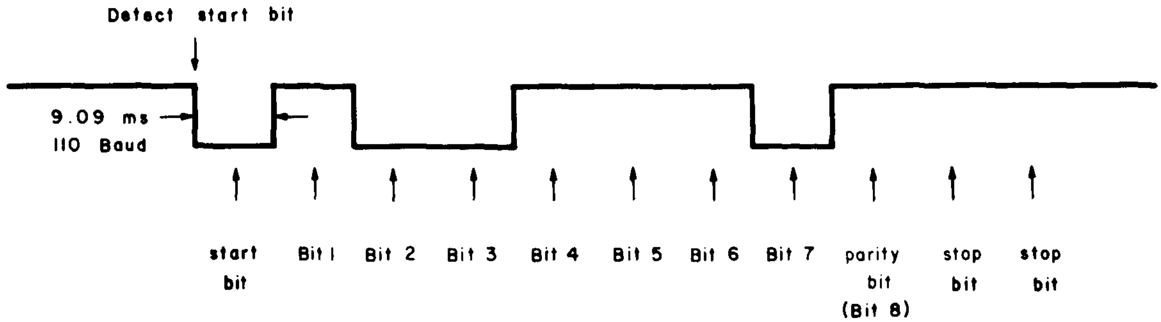


fig. 4. Schematic of an eleven-bit asynchronous serial ASCII word being received by the 8080A-based microcomputer. Each bit has a time duration of 9.09 ms. The logic state of each bit is detected at the middle of the bit.

the growing ASCII data word. The SAVE register is rotated one position, and the 9.09-ms wait loop is again entered, after which bit 2, which is a logic 0 in **fig. 4**, is input into bit position DO in the accumulator. The input of successive data and parity bits continues until the entire 8-bit data word is entered into the SAVE register. The two stop bits are also detected. With appropriate modifications, the program can detect parity or framing errors or an overrun condition. A data ready flag signal

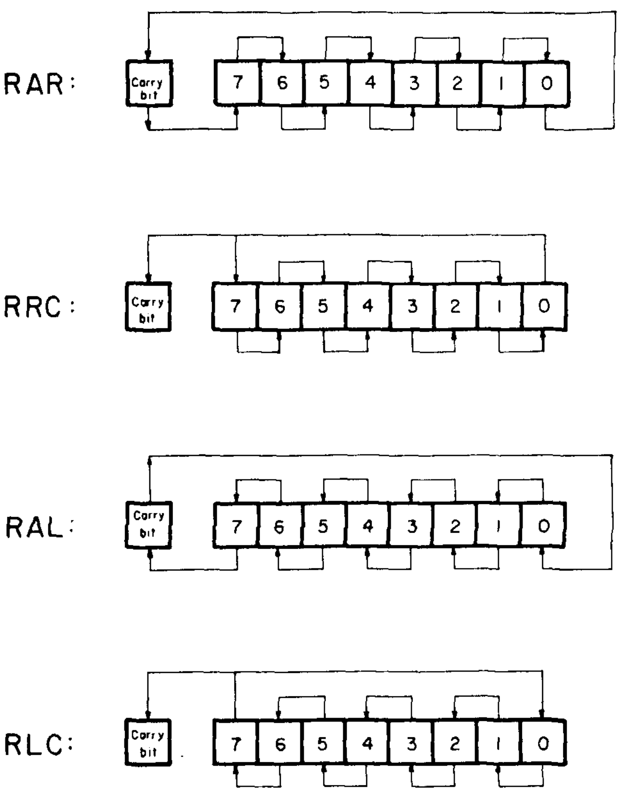


fig. 3. The four rotate instructions in the 8080A microprocessor instruction set.

loop to a PDP 8/L minicomputer in a physical chemistry laboratory. The data entry station intercepted the 20-mA teletype current loop tied to the minicomputer. The remote data entry station permitted students to load data into memory and then transmit it as a block to the minicomputer, which analyzed the data and provided a printout. With the aid of the 20-mA current loop operated in the full duplex mode, ten or more remote data entry stations could be tied to the minicomputer.

This column provides a good demonstration of the software-hardware tradeoffs that can be accomplished using microcomputers. Similar, and perhaps more comprehensive, routines have already been written for all the popular microprocessor chips, such as the 16-bit PACE or the 8-bit 6800. The faster and less expensive microcomputers become, the more likely that all moderate-speed digital functions will be executed through software. The theme of software replacing hardware is an important one, and we'll return to it many times in the future.

references

1. *Bugbook IIA, Interfacing and Scientific Data Communication Experiments Using the Universal Asynchronous Receiver/Transmitter (UART) and 20 mA Current Loops,* E & L Instruments, Inc., Derby, Connecticut, 1975. (Available from Ham Radio Books, Greenville, New Hampshire 03048. Price $4.95; Order no. BB-2A).

2. D.G. Larsen and P.R. Rony, "Computer Interfacing: INWAS, Interfacing with Asynchronous Serial," *American Laboratory*, 6 (9), 83, 1975.

3. D.G. Larsen and P.R. Rony, "Computer Interfacing: The Universal Asynchronous Receiver/Transmitter (UART)," *American Laboratory,* 7 (2), 113, 1975.

4. P.R. Rony, D.G. Larsen, and J.A. Titus, "Computer Interfacing: Half Duplex and Full Duplex Current Loops," *American Laboratory,* 7 (6), 78, 1975.

5. *Bugbook III, Microcomputer Interfacing Experiments Using the Mark 80 Microcomputer, and 8080 System*, E & L Instruments, Inc., Derby, Connecticut, 1975. (Available from Ham Radio Books, Greenville, New Hampshire 03048. Price $14.95; Order no. BB-3.)

ham radio

DIGITAL DATA RECORDER

for Computer or Teletype Use
Up to 4800 Baud

Uses the industry standard tape saturation (NRZ) method to beat all FSK systems ten to one. No modems or FSK decoders required. Loads 8K of memory in 17 seconds. This recorder enables you to back up your computer by loading and dumping programs and data fast as you go, thus enabling you to get by with less memory. Great for small business bookkeeping. Imagine! A year's books on one cassette.

Can be software controlled. Comes complete with a software program used to test the units in production (8080). Manual includes software control hook up data and programs for 8080 and 6800.

$149^95

SPECIFICATIONS — MODEL CC7:

A. Recording Mode: Tape saturation binary (NRZ). This is not an FSK or Home type recorder. No voice capability. No Modem. Runs at 2400 baud or less Asynchronous and 4800 baud Synchronous. Runs at 3.1"/sec. Speed mechanically regulated ± .5% or better.

B. Two channels (1) Clock, (2) Data. Or two data channels providing four (4) tracks on the cassette. Can also be used for Bi-Phase, Manchester, etc.

C. Inputs: Two (2). Will accept TTY, TTL or RS 232 digital.

D. Outputs: Two (2). Board changeable from TTY, RS232 or TTL digital.

E. Erase: Erases while recording one track at a time. Record new data on one track and preserve three or record on two and preserve two.

F. Compatibility: Will interface any computer using a UART or ACIA board. (Altair, Sphere, IMSAI, M6800, etc.)

G. Other Data: 110-220 V - (50-60) Hz; 3 Watts total; UL listed; three wire line cord; on/off switch; audio, meter and light operation monitors. Remote control of motor optional. Four foot, seven conductor remoting cable provided.

H. Warrantee: 90 days. All units tested at 300 and 2400 baud before shipment. Test cassette with 8080 software program included.

Also available — MODEL CC7A with variable motor speed which is electronically regulated. Runs 4800 baud Synchronous or Asynchronous. Recommended for quantity users who require tape interchangeability. Comes with speed calibration tape to set exact speed against 60 cycle line.

$169.95

NEW — 8080 I/O BOARD with ROM

Permanent Relief from "Bootstrap Chafing"
This is our new "turnkey" board. Turn on your Altair or Imsai and go (No Bootstrapping). Controls one terminal (CRT or TTY) and one or two cassettes with all programs in ROM. Enables you to turn on and just type in what you want done. Loads, Dumps, Examines, Modifies from the keyboard in Hex. Loads Octal. For the cassettes, it is a fully software controlled Load and Dump at the touch of a key. Even loads MITS Basic. Ends "Bootstrap Chafe" forever. Uses 512 bytes of ROM, one UART for the terminal and one USART for the Cassettes. Our orders are backing up on this one. #2SIO (R)

Kit form $140.00

Fully assembled and tested $170.00

Fill out form and send check or money

Mailing Label — PRINT

NATIONAL MULTIPLEX CORPORATION
3474 Rand Avenue, Box 288
South Plainfield, New Jersey 07080 **201-561-3600**
SHIP TO:

....

....

....

CARD NO. .... ZIP ....
EXPIRATION DATE ....

...... Data Recorder CC-7 @ $149.95
...... Data Recorder CC-7A @ $169.95
Please enclose $2.00 Shipping & Handling on each Recorder or I/O Board.
...... Operating & Technical Manual (Schematics) Includes Software & Hookups for 8080, 6800, and I/O. $2.00
N. J. Residents add 5% Sales Tax

More Details? CHECK—OFF Page 126

The one You've Been Waiting for!

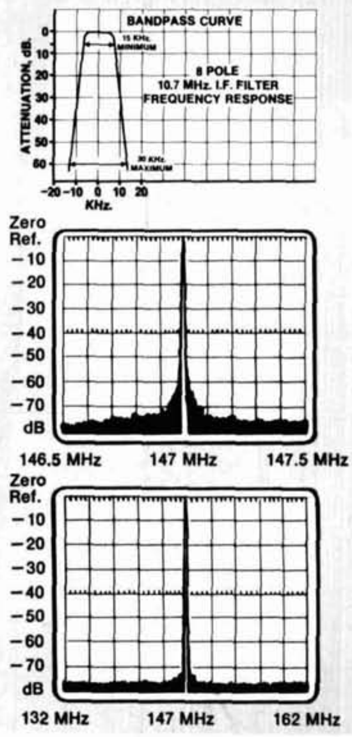
Shown with optional Micoder

Just look at these photos and specifications. The HW-2036 gives you the kind of 2-meter performance you WANT!

HW-2036 SPECIFICATIONS

Receiver: Sensitivity: 0.5 μV for 12 dB SINAD (or 15 dB of Quieting). Squelch Threshold: 0.3 μV or less. Audio Output: 1.5 watts at 10% T.H.D. typically 2 watts. (5 kHz deviation). Image Rejection: –45 dB or greater. Spurious Rejection: –50 dB or greater. IF Rejection: –80 dB or greater. Internally Generated Spurious: Below 1 μV equivalent. Bandwidth: 6 dB at 15 kHz min. and 60 dB at 30 kHz max. Modulation Acceptance: 7.5 kHz, min. Transmitter: Power Output: 10 watts min. at 25°C and 13.8 VDC, into a 50 Ω load. Harmonic & Spurious Output: –70 dB within 20 MHz of carrier; –50 dB elsewhere, –40 dB harmonics. Modulation: FM, 0 to 7.5 kHz, adjustable. Duty Cycle: 100% with infinite VSWR. Tone Encoder: 3 tones, 70 to 200 Hz, approx. ±700 kHz deviation. Transmitter Offset: 0 (simplex), –600 kHz, +600 kHz with crystals supplied. Provision for one additional offset crystal. General: Frequency Coverage: Any 2 MHz segment from 143.5 to 148.5 MHz. Both receiver and transmitter must be aligned for the same 2 MHz segment. Frequency Increments: 5 kHz. Frequency Stability: ±.0015%. Operating Temperature Range: 15° to 125° F. (–10° to 50° C). Operating Voltage Range: 12.6 to 16 VDC (13.8 VDC nominal). Current Consumption: RX: 700 mA max. squelched. TX: 2.6 A max. at 13.8 volts. Dimensions: 2¾" high x 8¼" wide x 9⅞" deep. Weight: 6.25 lbs.

Actual spectrum analyzer photos of HW-2036 operating at 147 MHz. Spurs within 20 MHz of carrier are down a full 70 dB.



Heathkit Synthesized 2-meter Transceiver!

The new Heathkit 2-meter frequency-synthesized transceiver combines state-of-the-art technology with operating ease, convenience and versatility in an easy-to-build kit that's about HALF THE COST of comparable synthesized transceivers. It's the one to buy and build for real 2-meter PERFORMANCE!

Operation is easier than ever! The front panel lever switches select any frequency in any 2 MHz segment of the 143.5 to 148.5 operating frequency range. You select the last four digits, three with lever switches which display the frequency directly and the last with a 0/5 kHz toggle switch which makes ALL 2-meter frequencies in the band available. If you inadvertently dial up an out-of-band frequency, the transmitter simply will not key.

And the signal is solid! The HW-2036 puts out a minimum 10 watts at 25° C and 13.8 VDC. And it operates into an infinite VSWR without failure. The transmitter output is extremely clean, with spurious output greater than 70 dB below carrier. True FM circuitry means you transmit and receive with excellent audio quality too.

The receiver is hot! Sensitivity is an outstanding 0.5 μV for 12 dB SINAD. An 8-pole IF crystal filter provides an ideally shaped bandpass for excellent adjacent channel rejection and its superb selectivity makes it the one to have for crowded signal areas.

Complete operating versatility! A built-in continuous tone encoder with three customer-adjusted tones selectable on the front panel accesses most repeaters. The HW-2036 provides all the offset capability you'll ever need — built-in simplex, plus and minus 600 kHz offsets, and an Aux. position that lets you add a crystal for any other frequency. And, if you order the HW-2036 with the Heathkit Micoder microphone/auto patch encoder, you'll be able to make phone calls through repeaters equipped with auto patch input! (And save $19.95 in the bargain!) The HW-2036 operates mobile from your vehicle's 12 VDC battery, or you can use the optional HWA-2036-3 AC power supply for fixed station operation.

The HW-2036 is our best 2-meter transceiver! Check it out for yourself and you'll see it's the one to have for years of reliable 2-meter communications!

Our HW-2021 hand-held 2-meter transceiver is the one to have if you're working portable. It gives you a full 1-watt output plus 5 receive and 5 transmit channels and flexible simplex/offset. It's hand-held, battery-operated, and there's an optional auto patch encoder to add telephone versatility at low cost. Crystal-controlled, with better than 0.05% frequency stability. Sensitivity is 0.5 μV for 12 dB SINAD.

The HW-2036 and HW-2021 are two of the finest 2-meter transceivers around. Use 'em both for complete 2-meter versatility! Read more about them, and all the other superb Heathkit Amateur Radio products in the new Heathkit Catalog. Send coupon below!

Heath Company, Dept. 122-23 Benton Harbor, Michigan 49022

FREE!

New Heathkit Catalog

Nearly 400 fun-to-build, practical and money-saving electronic kits! Send coupon today!

HEATH
Schlumberger

Heath Company, Dept. 122-23
Benton Harbor, Michigan 49022

Please send me my FREE Heathkit catalog. I am not on your mailing list.

Name ____________________

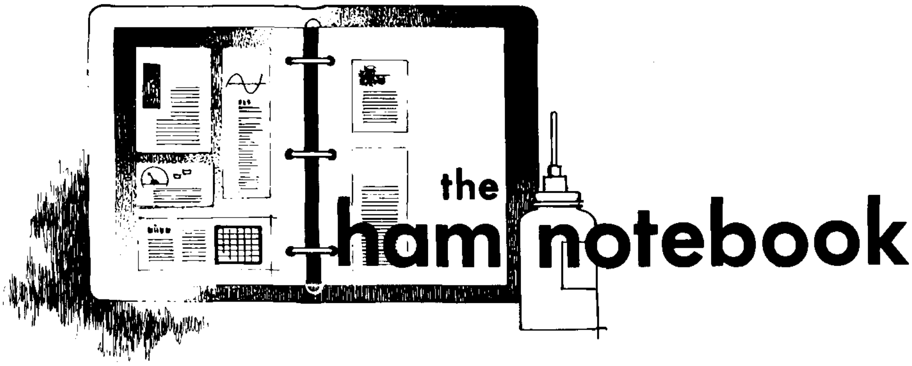
Address ____________________

City ____________________

State ____________ Zip ____________

AM-338

Prices & specifications subject to change without notice.



ten-minute timer

The SN74121 works well as an astable multivibrator although it was designed for monostable operation. In the circuit of **fig. 1**, U1 generates pulses at 4-second intervals. U2 and U3 divide the pulse train by 144 which results in a period of 576 seconds (9 minutes, 36 seconds). U4 is then turned on and produces a positive output pulse of 20 seconds duration. Transistor Q1 actuates a keyer or other signalling device such as a sidetone oscillator, lamp or LED.

The LED connected to pin 1 of U1 flashes a few milliseconds at the beginning of each 4-second period and makes it easy to adjust the time interval in comparison with WWV. The timing adjustment is made with trimpot R1. The timing range may be extended by changing R1 to 5 kilohms and R2 to 45k.

It is possible to reset the counter (see dashed circuitry), but this requires an additional switch. At my station, I identify at the beginning of a QSO, and again when the ten-minute alarm flashes — then I am in synchronization with the timer.

The timing tolerance over the full period is within about ±5 seconds. However, this requires good quality capacitors at C4 and C5 and a stable power supply.

Herbert Seeger, DJ9RP

audio mixer

I recently came up with a system which materially improved my ssb "talk power" and am offering it here to the amateur fraternity. I had been using an Astatic D-104 microphone with relatively little success in the DX pileups. Friends told me the audio sounded "thin" so I bought an Electrovoice EV-674 dynamic. Reports with the EV-674 indicated I sounded smooth but muffled, as if talking into a barrel. It occurred to me that the best features of each microphone could be combined with an audio mixer. Radio Shack sells a well-made, four channel transistorized mixer for $13.95.

I use two of the channels and mix the D104 with the EV-674 in the proper ratio. My ssb signal now has audio punch and quality. I also get through the pileups sooner. The "W6KNE Equalizer" should help provide good audio for everyone, particularly those operators whose natural voice does not come across strong and with "punch."

Gary Legel, W6KNE

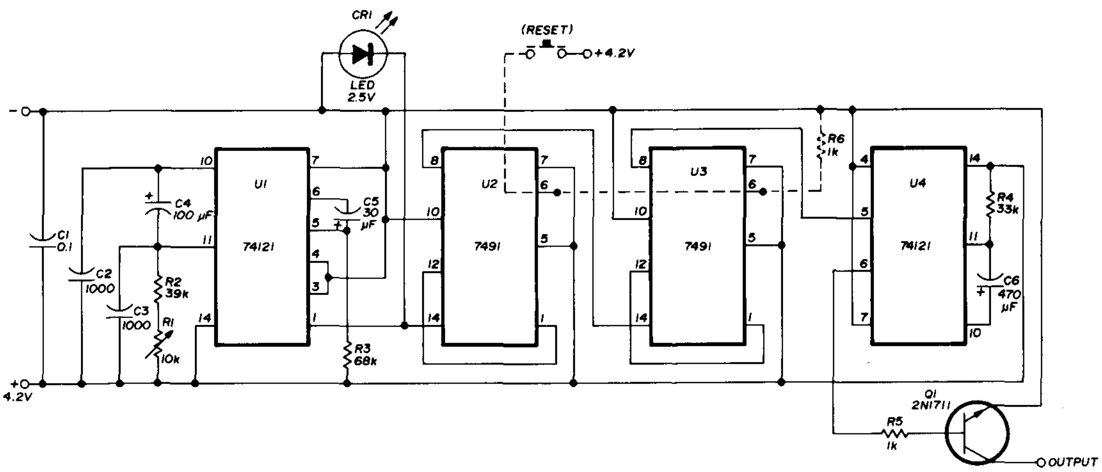


fig. 1. Ten-minute timer uses 74121 (U1) as an astable multivibrator, generating pulses a 4-second intervals. U2 and U3 divide the pulse train by 144 which results in a period of 576 seconds (9 minutes, 36 seconds).

New! SOTA

"STATE - OF - THE - ART"

SSB TRANSCEIVERS

$395.00

MADE IN U.S.A.
SIZE: 3½ x 7 x 8½

MOBILE MONOBANDERS

MODEL 160	1.8 – 2.0 MHz.	LSB
MODEL 80	3.5 – 4.0 MHz.	LSB
MODEL 40	7.0 – 7.3 MHz.	LSB
MODEL 20	14.0 – 14.35 MHz.	USB

COMPLETELY SOLID STATE • Mosfet mixers for excellent I.M. and cross modulation performance. J-Fet oscillators for stability. I.C.'s used in digital frequency counter, balanced modulator, receiver I.F. amplifier, and audio output for functional simplicity. No relays.

DIGITAL DIAL • Frequency can be read at a glance. 0.3 inch L.E.D. displays are easily visible. Frequency counter offers 100 Hz. accuracy.

SPEECH COMPRESSOR • Increases average output power approximately 6 db. Level set by mic control.

NOISE BLANKER • Noise pulses are blanked ahead of the crystal filter for optimum reduction of interference.

100 WATTS INPUT • P.E.P. or C.W. 50 watts output (minimum).

BROADBAND OUTPUT • Infinite VSWR protection. Multiple pi-section low-pass filter for minimum spurious output.

RECEIVER FRONT END DESIGN • AGC controlled pin diode R.F. attenuator for low distortion large signal handling capabilities. Triple tuned preselector offers superior R.F. selectivity.

QUALITY CONSTRUCTION • Utilizing glass epoxy P.C. boards and commercial grade components. All electrical connections soldered for reliability. P.C. boards accessible for easy servicing.

STANDARD ACCESSORIES • Mobile mounting bracket and power connector with 8 foot battery cable are supplied with unit.

WARRANTY • Full one year warranty on all parts and workmanship with exception to damage incurred by abuse. Our customer service offers one week turnaround time on repairs.

SPECIFICATIONS

GENERAL

MODES: S.S.B. and C.W. with Sidetone
POWER REQUIREMENTS: 12-14 volts D.C. negative ground only. 12 amps maximum. Reverse polarity protection.
WEIGHT: 5.4 lbs.

RECEIVER

SENSITIVITY: Less than 0.5 microvolt for 15 db. signal-plus-noise/noise ratio.
SELECTIVITY: 2.1 KHz @ -6 db., 3.8 KHz @ -60 db.
IMAGE REJECTION: Better than 60 db.
AUDIO OUTPUT: 2 Watts at less than 5% distortion into 4 ohm load.

TRANSMITTER

POWER INPUT: 100 watts P.E.P. or C.W., nominal.
POWER OUTPUT: 50 Watts P.E.P. or C.W., minimum.
OUTPUT IMPEDANCE: 52 ohms, nominal.
UNWANTED SIDEBAND: –40 db or better.
CARRIER SUPPRESSION: –60 db or better.
THIRD ORDER DISTORTION: –30 db. or better.
SPURIOUS OUTPUTS: –30 db or better.
AUDIO RESPONSE: 400 to 2,500 Hz., ± 2 db.
MIC INPUT: High impedance dynamic or crystal microphone.
EXTERNAL AMPLIFIER CONTROL: Open collector to 100 volts @ 1 amp., maximum.

OPTIONAL ACCESSORIES:

MODEL MMB-1
Plug-in mobile mounting bracket making all connections to the transceiver at once, providing quick and easy installation or removal from the car.
Price $45.00

MODEL PS-1
Matching A.C. power supply with built-in speaker. Supplies 13.8 VDC regulated at 12 amps. maximum. 110/220 VAC, 50-60 Hz. Price $125.00

ORDERING INFORMATION:
All Prices F.O.B factory plus shipping. California residents add 6% sales tax. To order now, send a deposit ($25.00 minimum) to secure a delivery position. Fully refundable at any time. Payment in full required prior to shipment.

SOTA Industries

308 ENCINAL STREET
SANTA CRUZ, CA. 95060
TELEPHONE: (408) 426-8161

More Details? CHECK—OFF Page 126

Whether you go for fat coils, skinny coils, switch flickers or automatics, Swan has the mobile antenna that's exactly right for your needs. So top off your mobile rig with a Swan antenna. Every time you press the mike button you'll know you're delivering the biggest signal your rig is capable of. Without compromise.

Mobile 45. This switch-adjustable 5-band antenna features a Swan Hi-Q coil and positive-stop, 8-position switch with gold-plated contacts. Select 10, 15, 20, 40 or 75 meters and go to work knowing this rugged antenna won't let you down. **$114.95**

742 Automatic. Just resonate this triband on 20, 40 and 75 meters. Bandwidth approximately 100 KC on each band. Now you can work any frequency in those bandwidths on all three bands and never touch the antenna. Handles 500 watts P.E.P.. . . . . . . **$79.95**

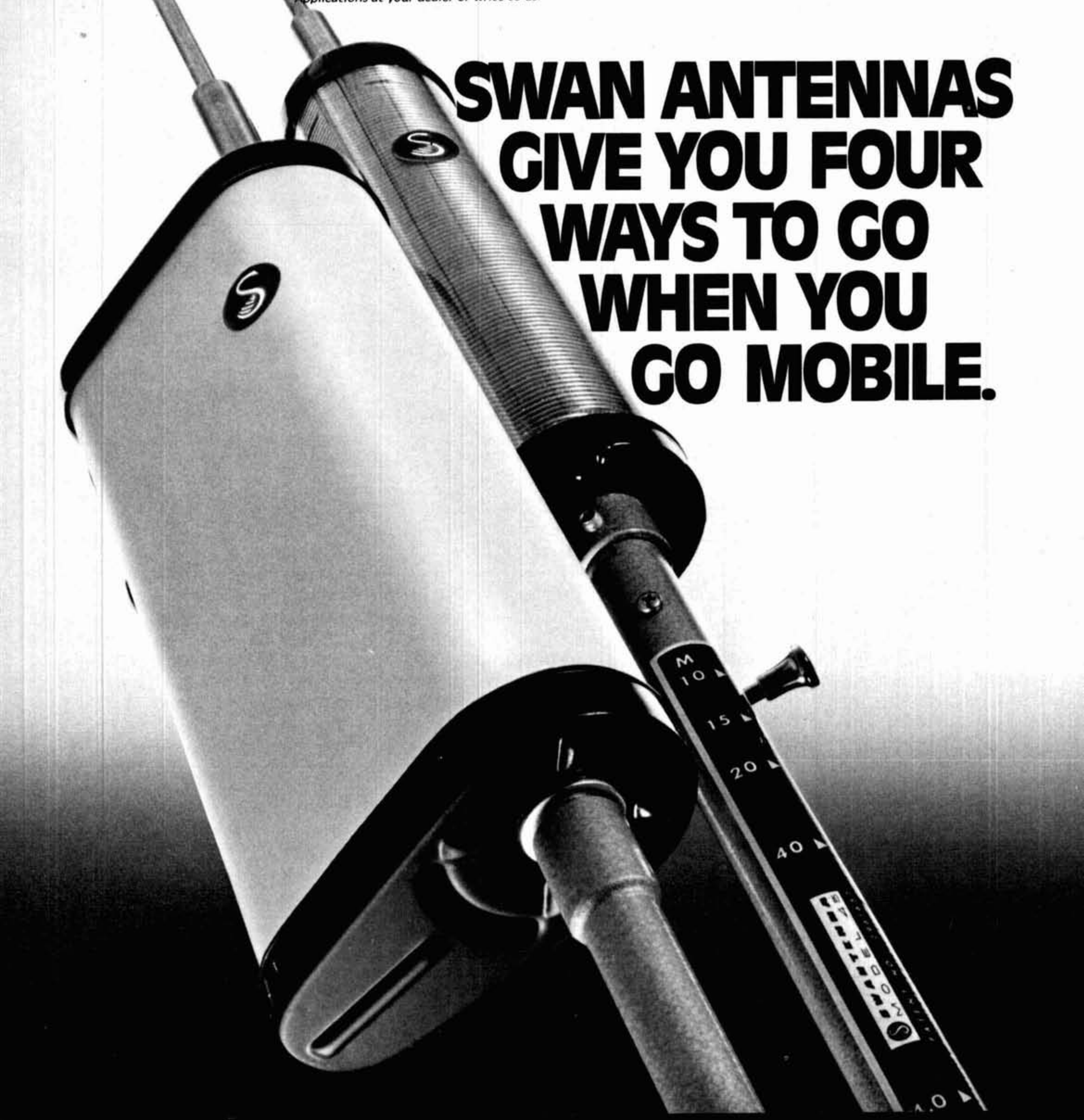
(Prices F.O.B. Oceanside, CA)
Buy Swan antennas with your Swan credit card. Applications at your dealer or write to us.

Series 35 Slim-Line. Neat, low-drag coils in slimline antennas are the ticket when you're operating single-band at 500 watts P.E.P. or less. Interchangeable coils for 15, 20, 40 and 75 meters. **$30.95** to **$37.75**

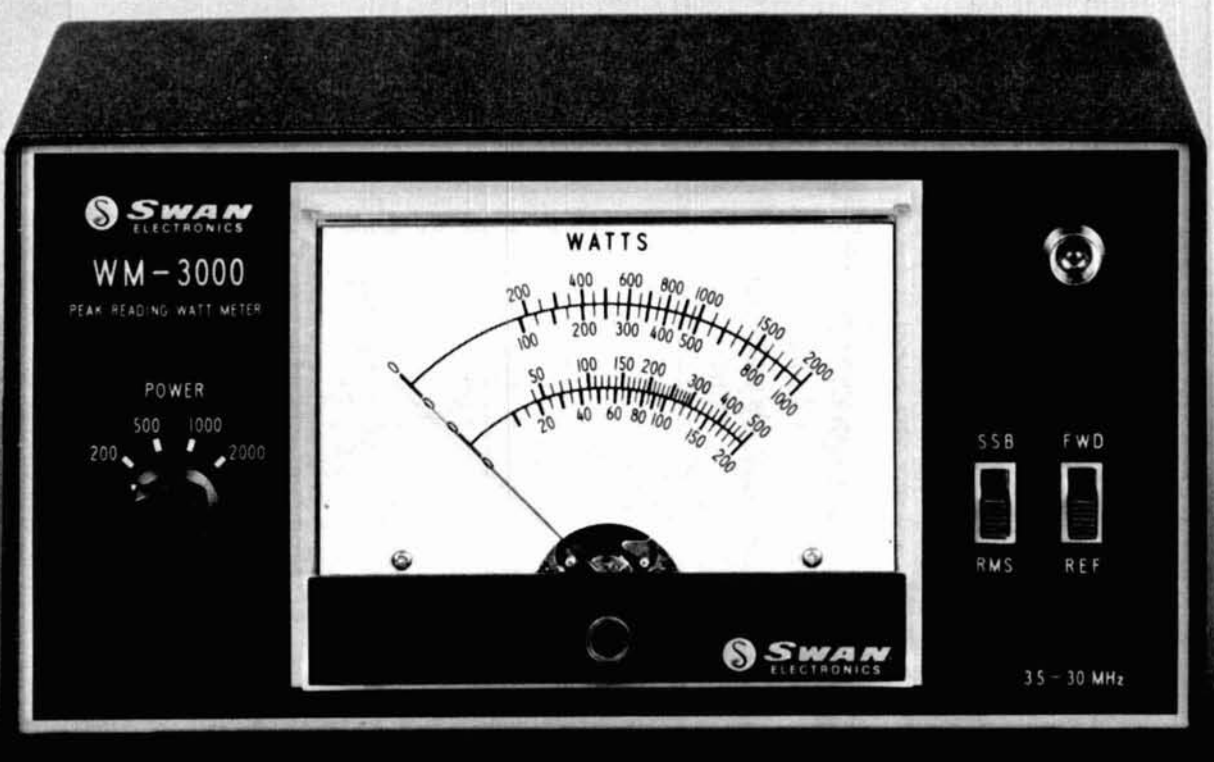
Series 36 Hi-Q. The most efficient single-band antennas you can buy. Rated at 1000 watts P.E.P. Interchangeable coils for 15, 20, 40 and 75 meters. These rugged, durable antennas include base, coil and whip. **$39.50** to **$47.95**

Dealers throughout the world or order direct from

SWAN® ELECTRONICS
A subsidiary of Cubic Corporation
305 Airport Road, Oceanside, CA 92054
(714) 757-7525



SWAN ANTENNAS GIVE YOU FOUR WAYS TO GO WHEN YOU GO MOBILE.


SWAN ELECTRONICS
WM-3000
PEAK READING WATT METER
POWER
200
500
1000
2000
WATTS
SSB
RMS
FWD
REF
SWAN ELECTRONICS
3.5 - 30 MHz

NEW products

new touch-tone encoders for variety of applications

Looking for a *Touch-Tone* encoder? Need 12 or 16 buttons for mobile, hand-held or desk-mounting applications? If so, Pipo Communications may have exactly what you've been looking for in their recently announced PP-1 (12-button) and PP-2 (16-button) *Touch-Tone* encoders.

The PP-1 measures just 3/8x2x2-11/16 inches (9.5x50.8x68mm) and the PP-2 measures 3/8x2-3/8x2-11/16 inches (9.5x60.3x68mm). Both pads are self-contained and feature positive touch control; that is, the keys depress. There are no "potted" parts, so servicing is easy, and the units are immune to rf interference. They possess low distortion at high output levels while drawing current only when the buttons are depressed. The output level is easily adjustable from the front of either pad.

Each unit is supplied with instructions for hook-up and use, schematic diagram, drilling template and all necessary mounting hardware.

These *Touch-Tone* encoders are capable of operating at any temperature between zero and 140 degrees F., at any voltage between 4.5 and 16 volts dc, and draw between 7.5 and 20 mA in use.

The PP-1 is priced at $55.00, and the PP-2 at $58.00. (California residents please add 6% sales tax.)

For additional information, write Pipo Communications, Box 3435, Hollywood, California 90028; telephone (213) 852-1515, or use *check-off* on page 126.

new catalog from Heathkit

Heathkit has just announced its colorful new fall 1976 catalog, a free 96-page release describing nearly 400 electronic kits for virtually every do-it-yourself interest. Heathkit product categories include amateur radio, hi-fi components, color TV, test instruments, digital clocks and weather instruments, radio control equipment, marine, aircraft and auto accessories, and many more.

Some of the interesting new products described in the fall catalog are: a new electronic TV game for Heath solid-state TV owners, a combination digital clock/indoor-outdoor thermometer, a portable power megaphone/yelp alert, professional-quality harmonic and IM distortion analyzers, a shirt-pocket-size color alignment generator, and a touch-control light switch.

Heath Company is the world's largest manufacturer of electronic products in kit form. Their step-by-step instruction manuals can be followed easily by anyone, and are world-famous for clarity, precision and accuracy.

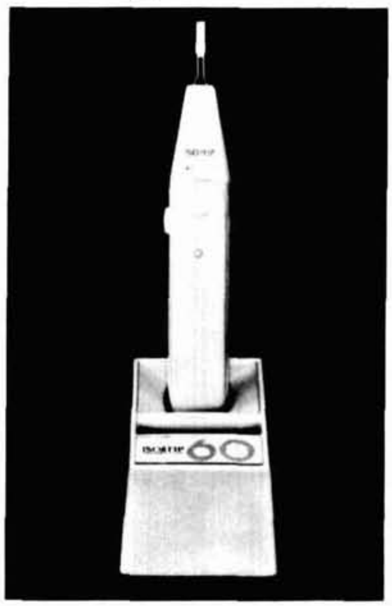
For your new, free, catalog write Heath Company, Department 350-04, Benton Harbor, Michigan 49022; telephone (616) 982-3417, or use *check-off* on page 126.

alphanumeric printer kit

Southwest Technical Products Corporation recently announced its new low-cost alpha-numeric printer kit. The PR-40 is a 5x7 dot matrix impact printer capable of printing the 64-character upper case ASCII set with 40 characters/line at a print rate of 75 lines/minute on standard 3-7/8 inches (9.84cm) wide rolls of adding machine paper. One complete line is printed at a time from an internal 40-character line buffer memory. Printing takes place either upon the receipt of a carriage return, or automatically, whenever the line buffer memory is filled.

The PR-40 printer is available in kit form only and includes the assembled print mechanism, chassis, circuit boards, components, 120/240-volt ac, 50/60 Hz power supply, assembly instructions, one ribbon and one roll of paper. The price is $250, postpaid, in the United States. Delivery is approximately 30 days. For more information write Southwest Technical Products Corporation, 219 West Rhapsody, San Antonio, Texas 78216; telephone (512) 344-0241, or use *check-off* on page 126.

rechargable cordless soldering iron



Wahl Clipper Corporation recently introduced its new *Iso-Tip 60* Cordless Soldering Iron. The low voltage, battery-operated, ground-free unit is the first that can be recharged from "dead" to "full" in one hour. With the *Iso-Tip 60*, the user can enjoy virtually uninterrupted service from a single unit, making cordless soldering practical for heavy-use applications.

The *Iso-Tip 60* Cordless Soldering Iron has the capacity for up to 125 or more electronic joints on a single charge. It can, however, be kept at a constant "full" charge simply by resting it in the recharge stand when not in use. The iron is equipped to accept a very fast charge when its battery is down and then switch to a trickle rate for maintenance purpose. An LED indicator shows when the unit is fully charged.

Standard kit no. 7800 from Wahl includes an *Iso-Tip 60* Cordless Soldering Iron, a recharging stand, a fine tip, a chisel tip and an instruction booklet. Any of the 16 Wahl snap-in soldering tips are usable with the new iron.

For further information contact Ross Advertising, Inc., 5901 N. Prospect Road, Peoria, Illinois 61614, or use *check-off* on page 126.

KSR-type terminals from Info-Tech

Info-Tech, Incorporated, a manufacturer of digital electronic systems for the amateur radio market and for light computer use, recently announced two new KSR-type terminals featuring low price and versatility. One terminal features 16 lines of 32 characters and the other, 16 lines of 64 characters; both with RS-232 compatibility.

The new terminals interface with all popular micro-computer kits and any video monitor.

Detailed technical information and prices may be obtained from Info-Tech, Incorporated, 20 Worthington Drive, St. Louis, Missouri 63043; telephone (314) 576-5489 or use *check-off* on page 126.

ultra low noise jfets

National Semiconductor Corporation announces a new series of ultra low noise junction field-effect transistors. In the past, special selection by the manufacturer was required to provide ultra low noise parts, a factor contributing to their relatively high price and limited availability.

The new series of National jfets is specifically produced for ultra low noise audio and video applications, including particle detectors, vidicon and I-R sensor preamplifiers, and audio and video tape amplifiers. The series includes three metal-can devices (NF5101, NF5102 and NF5103) and three TO-92 epoxy devices (PF5101, PF5102 and PF5103).

Key specifications for the new fets include a typical noise figure of 1.5 dB at 10 Hz, and a common-source transconductance of 4000 micromhos minimum with a drain current of 0.5 milliamperes. Another feature of the new series is tight control of the gate-source cutoff voltage. The NF5101 and PF5101 have a gate-source cutoff voltage range of 0.5 to 1.0 volts; the NF5102 and PF5102 have a gate-source cutoff voltage range of 0.8 to 1.4 volt and the NF5103 and PF5103 have a gate-source cutoff voltage range of 1.3 to 2.5 volts.

Unit prices range from about $1.00 for the plastic version and $2.50 for the metal package. For further information, including electrical and performance characteristics of these devices, write to National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, California 95051 or use *check-off* on page 126.

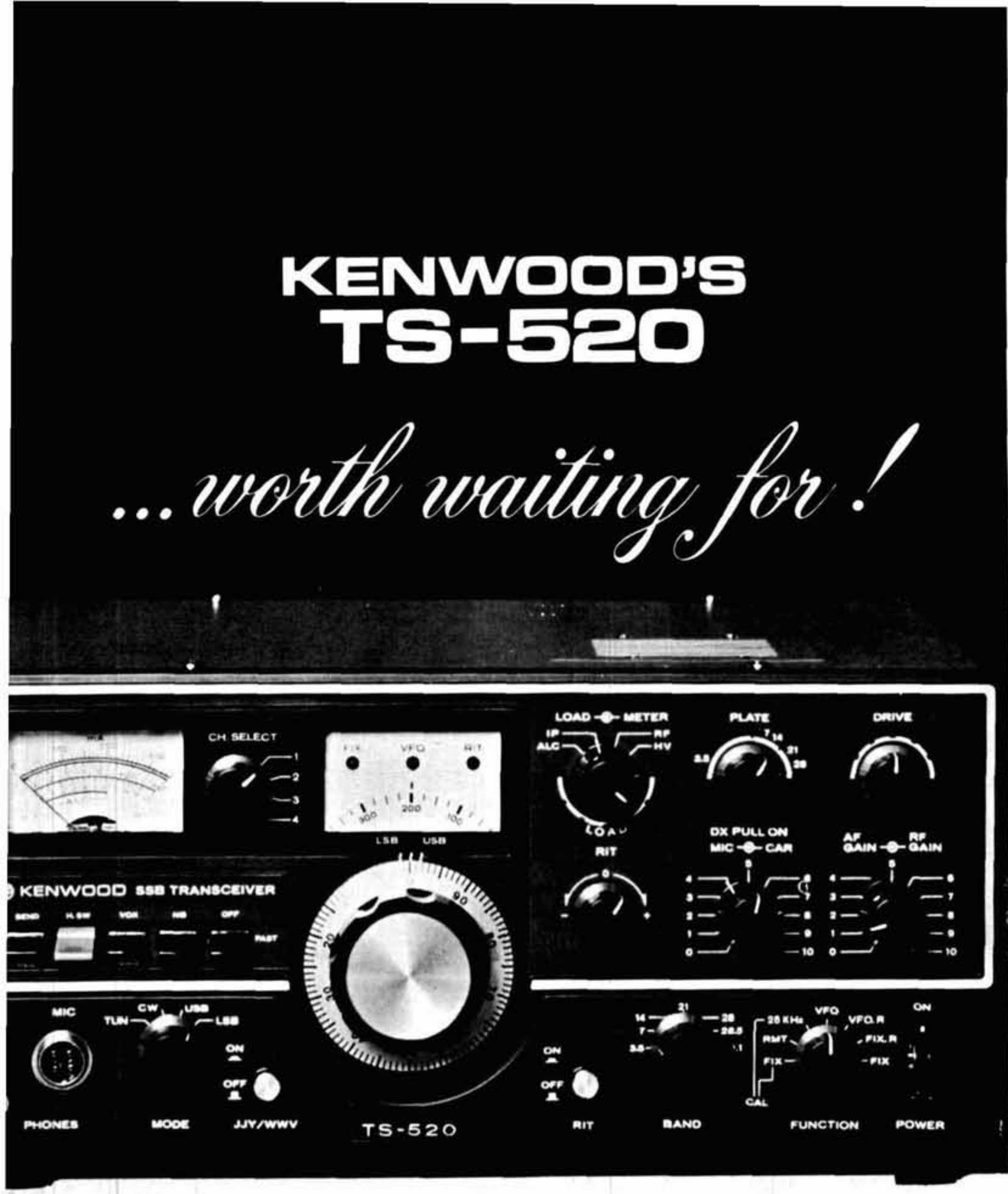
Allied Electronics catalog

Off press and ready for mailing is Allied Electronic's *1977 Engineering Manual and Purchasing Guide*. The guide is filled with a wide selection of industrial-type electronic parts, components, supplies, and equipment which keep amateurs, engineers, technicians, and hobbyists requesting Allied's guide year after year. And, new in this year's guide is the introduction of metric measurements on many electronic parts and components.

The 1977 edition of the guide is 212 pages full of high-quality electronic parts and equipment from Allied and other leading manufacturers. Choose from a wide variety of new products, in addition to the traditional items which have set the standard for Allied's previous guides. You'll find wire, cable, solid-state devices, test equipment, resistors, trimmers and potentiometers, transformers, switches, timers, connectors, relays, tools, capacitors, new solar energy products, test equipment and even a microcomputer, plus many other electronic parts too numerous to list. Allied offers bulk pricing for quantity buyers, and six nationwide stocking locations assure prompt delivery of ordered merchandise.

There's no need to rely on a friend or business associate for access to Allied's 1977 guide. Write today for your own copy. Send $1.00, to help cover postage and handling, to Allied Electronics, Dept. 77, 401 East 8th Street, Fort Worth, Texas 76102.

More Details? CHECK—OFF Page 126



Why wait any longer for a rig that offers top performance, dependability and versatility . . . the TS-520 has proven itself in the shacks of thousands of discriminating amateurs, in field day sites, in DX and contest stations, and in countless mobile installations.

Superb craftsmanship is evident throughout . . . in its engineering concepts as well as its construction and styling . . . craftsmanship that is a Kenwood hallmark.

Maybe the Kenwood TS-520 is the one you have been waiting for.

Kenwood offers accessories guaranteed to add to the pleasure of owning the TS-520. The TV-502 transverter puts you on 2-meters the easy way. (It's completely compatibile with the TS-520.) Simply plug it in and you're on the air. Two more units designed to match the TS-520 are the VFO-520 external VFO and the model SP-520 external speaker. All with Kenwood quality built in.

TS-520 Specifications

MODES: USB, LSB, CW
POWER: 200 watts PEP input on SSB, 160 watts DC input on CW
ANTENNA IMPEDANCE: 50-75 Ohms, unbalanced
CARRIER SUPPRESSION: Better than −45 dB
UNWANTED SIDEBAND SUPPRESSION: Better than −40 dB
HARMONIC RADIATION: Better than −40 dB
AF RESPONSE: 400 to 2600 Hz (−6 dB)
AUDIO INPUT SENSITIVITY: 0.25μV for 10 dB (S+N)/N
SELECTIVITY: SSB 2.4 kHz (−6 dB), 4.4 kHz (−60 dB), CW 0.5 kHz (−6 dB), 1.5 kHz (−60 dB) (with accessory filter)
FREQUENCY STABILITY: 100 Hz per 30 minutes after warmup
IMAGE RATIO: Better than 50 dB
IF REJECTION: Better than 50 dB
TUBE & SEMICONDUCTOR COMPLEMENT: 3 tubes (2 x 6146B, 12BY7A), 1 IC, 18 FET, 44 transistors, 84 diodes
DIMENSIONS: 13.1" W x 5.9" H x 13.2" D
WEIGHT: 35.2 lbs.
SUGGESTED PRICE: $629.00

VFO-520

Provides high stability with precision gearing. Function switch provides any combination with the TS-520. Both are equipped with VFO indicators showing at a glance which VFO is being used. Connects with a single cable and obtains its power from the TS-520. Suggested price: $115.00.

SP-520

Although the TS-520 has a built-in speaker, the addition of the SP-520 provides improved tonal quality. A perfect match in both design and performance. Suggested price: $22.95.

TV-502

TRANSMITTING/RECEIVING FREQUENCY: 144-145.7 MHz, 145.0-146.0 MHz (option).
INPUT/OUTPUT IF FREQUENCY: 28.0-29.7 MHz
TYPE OF EMISSION: SSB (A3J), CW (A1)
RATED OUTPUT: 8W (AC operation)
ANTENNA INPUT/OUTPUT IMPEDANCE: 50Ω
UNWANTED RADIATION: Less than −60 dB
RECEIVING SENSITIVITY: More than 1μV at S/N 10 dB
IMAGE RATIO: More than 60 dB
IF REJECTION: More than 60 dB
FREQUENCY STABILITY: Less than ±2.5 kHz during 1-60 min after power switch is ON and within 150 Hz (per 30 min) thereafter.
POWER CONSUMPTION: AC 220/120V, Transmission 50W max., Reception 12W max. DC 13.8V, Transmission 2A max., Reception 0.4A max.
POWER REQUIREMENT: AC 220/120V, DC 12-16V (standard voltage 13.8V)
SEMI-CONDUCTOR: FET 5, Transistor 15, Diode 10
DIMENSIONS: 6⅝" W x 6" H x 13¼" D
WEIGHT: 11.5 lbs.
SUGGESTED PRICE: $249.00

CW-520
500 Hz CW Crystal Filter: $45.00.

Prices subject to change without notice

KENWOOD
. . . pacesetter in amateur radio

TRIO-KENWOOD COMMUNICATIONS INC. 116 EAST ALONDRA/GARDENA, CA 90248

7400N TTL

SN7400N*	16	SN7459A	25		
SN7401N	16	SN7460N	22	SN74154N*	1.00
SN7402N	21	SN7470N	45	SN74155N	99
SN7403N	16	SN7472N	39	SN74156N	99
SN7404N*	18	SN7473N*	37	SN74157N	99
SN7405N	24	SN7474N*	32	SN74160N	1.25
SN7406N	20	SN7475N*	50	SN74161N	99
SN7407N	29	SN7476N*	32	SN74163N*	99
SN7408N	25	SN7479N*	5.00	SN74164N	1.10
SN7409N	25	SN7480N	50	SN74165N	1.10
SN7410N*	18	SN7482N	98	SN74166N	1.25
SN7411N	30	SN7483N	70	SN74167N	5.50
SN7412N	33	SN7485N	89	SN74170N	2.10
SN7413N	45	SN7486N	39	SN74172N	8.95
SN7414N	70	SN7488N	3.50	SN74173N	1.50
SN7416N	35	SN7489N	2.25	SN74174N	1.25
SN7417N	35	SN7490N*	45	SN74175N	99
SN7420N	21	SN7491N	75	SN74176N	90
SN7421N	33	SN7492N	49	SN74177N	90
SN7422N*	49	SN7493N*	49	SN74180N	99
SN7423N	37	SN7494N	79	SN74181N	2.49
SN7425N	29	SN7495N	79	SN74182N	95
SN7426N	29	SN7496N	89	SN74184N	1.95
SN7427N	37	SN7497N*	4.00	SN74185N	2.20
SN7429N	42	SN74100N*	1.00	SN74186N*	5.00
SN7430N	26	SN74107N	39	SN74187N	6.00
SN7432N	31	SN74121N*	39	SN74188N	3.95
SN7437N	27	SN74122N	39	SN74190N	1.19
SN7438N	27	SN74123N*	70	SN74191N	1.25
SN7439N	25	SN74125N	60	SN74192N*	89
SN7440N	15	SN74126N	60	SN74193N*	89
SN7441N	89	SN74132N	1.09	SN74194N	1.25
SN7442N	59	SN74136N	95	SN74195N	75
SN7443N	75	SN74141N	1.15	SN74196N	1.25
SN7444N	75	SN74142N*	4.00	SN74197N	75
SN7445N	75	SN74143N*	4.50	SN74198N	1.75
SN7446N	81	SN74144N*	4.50	SN74199N	1.75
SN7447N*	69	SN74145N	1.15	SN74200N	5.59
SN7448N	79	SN74147N	2.35	SN74279N*	90
SN7450N	26	SN74148N	2.00	SN74251N	1.79
SN7451N	27	SN74150N	1.00	SN74284N	6.00
SN7453N	27	SN74151N	79	SN74285N	6.00
SN7454N	20	SN74153N	89	SN74367N	75

MANY OTHERS AVAILABLE ON REQUEST
20% Discount for 100 Combined 7400's

CMOS

CD4000	25			74C04N	75
CD4001	25			74C10N	65
CD4002	25	CD4035	1.85	74C20N	65
CD4006	2.50	CD4040	2.45	74C30N	65
CD4007	25	CD4042	1.90	74C42N	2.15
CD4009	59	CD4044	1.50	74C73N	1.50
CD4010	59	CD4046	2.51	74C74	1.15
CD4011	25	CD4047	2.75	74C90N	3.00
CD4012	25	CD4049	79	74C95N	2.00
CD4013	47	CD4050	79	74C107N	1.25
CD4016	56	CD4051	2.95	74C151	2.90
CD4017	1.35	CD4053	2.95	74C154	4.00
CD4019	55	CD4060	3.25	74C157	2.15
CD4020	1.49	CD4066	1.75	74C160	3.25
CD4022	1.25	CD4069	45	74C161	3.25
CD4023	25	CD4071	45	74C163	3.00
CD4024	1.50	CD4081	45	74C164	3.25
CD4025	25	CD4511	2.50	74C173	2.60
CD4027	69	CD4518	2.50	74C193	2.75
CD4028	1.65	CD4566	3.00	74C195	2.75
CD4029	2.90	74C00N	39	MC4044*	4.50
CD4030	65	74C02N	55	MC14016*	56

LINEAR

LM300H	80			LM1310N	2.95
LM301H	35			LM1351N	1.65
LM301CN	35			LM1414N	1.75
LM302H	75			LM1458C	65
LM304H	1.00	LM370N	1.15	LM1496N	95
LM305H	95	LM373N	3.25	LM1556V	1.85
LM307CN	35	LM377N	4.00	LM2111N	1.95
LM308H	1.00	LM380N	1.39	LM2901N	2.95
LM308CN	1.00	LM390CN	1.05	LM3065N	69
LM309H	1.10	LM381N	1.79	LM3900N	55
LM309K	99	LM382N	1.79	LM3905N	60
LM310CN	1.15	NE501K	8.00	LM3909*	1.25
LM311H	90	NE510A	6.00	LM5556N	1.85
LM311N	90	NE531H	3.00	MC5558V	1.00
LM318CN	1.50	NE536T	6.00	LM7525N	90
LM319N	1.30	NE540L	6.00	LM7535N	1.25
LM320K-5	1.35	NE550N	79	8038B*	4.95
LM320K-5.2	1.35	NE555V*	45	LM75450	49
LM320K-12	1.35	NE560B*	5.00	75451CN	39
LM320K-15	1.35	NE561B*	5.00	75452CN	39
LM320T-5*	1.75	NE562B*	5.00	75453CN	39
LM320T-5.2	1.75	NE565H*	1.25	75454CN	39
LM320T-8*	1.75	NE565N*	1.75	75491CN	79
LM320T-12*	1.75	NE566CN*	1.25	75492CN	89
LM320T-15	1.75	NE567H*	1.95	75494CN	89
LM320T-18*	1.75	NE567V*	1.50	**RCA LINEAR**	
LM320T-24	1.75	LM703CN	45	CA3013	2.15
LM323K-5*	9.95	LM709H	29	CA3032	2.56
LM324N	1.80	LM709N	29	CA3035	2.48
LM339N	1.70	LM710N	79	CA3039	1.35
LM340K-5	1.95	LM711N	39	CA3046	1.30
LM340K-6	1.95	LM723H	55	CA3059	3.25
LM340K-8	1.95	LM723H	55	CA3060	3.25
LM340K-12	1.95	LM733N	1.00	CA3080	85
LM340K-15	1.95	LM739N	1.00	CA3081	2.00
LM340K-18	1.95	LM741CH	35	CA3082	2.00
LM340K-24	1.95	LM741CN	35	CA3083	1.60
LM340T-5	1.75	LM74114N	39	CA3086	85
LM340T-6	1.75	LM747H	79	CA3089	3.75
LM340T-8*	1.75	LM747N	79	CA3091	10.20
LM340T-12	1.75	LM748H	39	CA3123	2.15
LM340T-15	1.75	LM748N	39	CA3130	1.39
LM340T-18*	1.75	LM1303N	90	CA3140	1.25
LM340T-24	1.75	LM1304N	1.19	CA3600	1.75
LM350N	1.00	LM1305N	1.40	RC4194	5.95
LM351CN	65	LM1307N	85	RC4195	3.25

74LS00 TTL

74LS00	39			74LS139	1.95
74LS02	39			74LS151	1.55
74LS03	39	74LS74	65	74LS153	1.89
74LS04	45	74LS75	79	74LS157	1.55
74LS05	45	74LS76	65	74LS162	2.25
74LS08	39	74LS83	2.19	74LS163	2.25
74LS10	39	74LS85	2.49	74LS164	2.25
74LS13	79	74LS86	65	74LS175	1.95
74LS14	2.19	74LS90	1.25	74LS181	3.69
74LS20	39	74LS92	1.25	74LS190	2.85
74LS26	49	74LS93	1.25	74LS191	2.85
74LS27	45	74LS95	2.19	74LS192	2.85
74LS28	49	74LS96	1.89	74LS193	2.85
74LS30	39	74LS107	65	74LS194	2.25
74LS32	45	74LS109	.65	74LS195	2.25
74LS40	49	74LS112	65	74LS257	1.89
74LS51	39	74LS132	1.55	74LS260	55
74LS55	.39	74LS136	65	74LS279	79
74LS73	65	74LS138	1.89	74LS670	5.95

DATA HANDBOOKS

7400 Pin-out & Description of 5400/7400 ICS $2.95
CMOS Pin-out & Description of 4000 Series ICS $2.95
Linear Pin-out & Functional Description $2.95
ALL THREE HANDBOOKS $6.95

100 PER STRIP MOLEX PINS

Intended for use as an inexpensive substitute for IC sockets. Also perfect for use as board connectors and in subassemblies.

SPECIAL — 100/1.49 — 1000/12.00

CONSUMER ELECTRONICS

PONG — SINGLE GAME $55.00
SUPER PONG — 4 GAMES IN ONE $79.95

GAMES INCLUDED IN SUPER PONG ARE:

- PONG
- CATCH
- SUPER PONG
- HANDBALL

FEATURES OF PONG AND SUPER PONG

- Incremental speed on volleys increases excitement.
- Playing field adjusts to any size screen.
- Game appears in color or in black & white, depending on television set.
- Unmistakable "PONG" sound accompanies each volley.
- Digital scoring flashes on the screen between each point.
- 2 player challenge or Solitaire.
- Hooks up simply to any model television set, the screen actually becomes the playing field.
- English and other techniques can be used to make any member of the family a Pong champion.
- Battery operated by 4 size "D" flashlight batteries included with the Unit.

AC Adaptor (Eliminates Batteries) $9.95

DISCRETE LEDS

125" dia.
XC209Red 10/$1
XC209Green 4/$1
XC209Yellow 7/$1
XC209Orange 4/$1

.190" dia.
XC111Red 10/$1
XC111Green 4/$1
XC111Yellow 4/$1
XC111Orange 4/$1

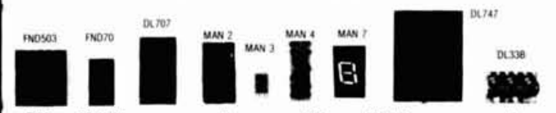
.200" dia.
XC22Red 10/$1
XC22Green 4/$1
XC22Yellow 4/$1
XC22Orange 4/$1
SSL-22RT 4/$1

.185" dia.
XC526Red 10/$1
XC526Green 4/$1
XC526Yellow 4/$1
XC526Orange 4/$1
XC526Clear 4/$1

.200" dia.
XC556Red 10/$1
XC556Green 7/$1
XC556Yellow 7/$1
XC556Orange 7/$1
XC556Clear 7/$1

.085" dia.
MV50
.085" dia. Micro red LED
6/$1

DISPLAY LEDS



TYPE	POLARITY	HT		TYPE	POLARITY	HT	
MAN 1	Common Anode	270	2.95	MAN 3620	Common Anode-orange	300	1.75
MAN 2	5 x 7 Dot Matrix	300	4.95	MAN 3640	Common Cathode-orange	300	1.75
MAN 3	Common Cathode	125	.39	MAN 4710	Common Anode-Red	400	1.95
MAN 4	Common Cathode	187	1.95	DL701	Common Anode-red	300	1.85
MAN 7	Common Anode	300	1.25	DL707	Common Anode	300	1.50
MAN 7G	Common Anode-green	300	1.95	DL 728	Common Cathode	500	2.95
MAN 7Y	Common Anode-yellow	300	1.95	DL 747	Common Anode	600	2.25
MAN 52	Common Anode-green	300	1.75	DL 750	Common Cathode	600	2.49
MAN 64	Common Anode-red	400	1.75	DL 338	Common Cathode	110	99
MAN 72	Common Anode	300	1.25	FND70	Common Cathode	250	75
MAN 74	Common Cathode	300	1.50	FND503	Common Cathode	500	1.29
MAN 82	Common Anode-yellow	300	1.75	FND507	Common Anode	500	1.29
MAN 84	Common Cathode-yellow	300	1.75				

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.17	16	15	24 pin	$.38	37	36
14 pin	20	19	18	28 pin	45	44	43
16 pin	22	21	20	36 pin	60	59	58
18 pin	29	28	27	40 pin	63	62	61
22 pin	37	36	35				

SOLDERTAIL STANDARD (TIN)

14 pin	$.27	25	24	28 pin	$.99	90	81
16 pin	30	27	25	36 pin	1.39	1.26	1.15
18 pin	35	32	30	40 pin	1.59	1.45	1.30
24 pin	49	45	42				

SOLDERTAIL STANDARD (GOLD)

8 pin	$.30	27	24	24 pin	$.70	63	57
14 pin	35	32	29	28 pin	1.10	1.00	90
16 pin	38	35	32	36 pin	1.75	1.40	1.26
18 pin	52	47	43	40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

10 pin	$.45	41	37	24 pin	$1.05	95	85
14 pin	39	38	37	28 pin	1.40	1.25	1.10
16 pin	43	42	41	36 pin	1.59	1.45	1.30
18 pin	75	68	62	40 pin	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea.	10 OHM 27 OHM	12 OHM 33 OHM	15 OHM 39 OHM	18 OHM 47 OHM	22 OHM 56 OHM	1/4 WATT 5% — 50 PCS.
ASST. 2	5 ea.	68 OHM 180 OHM	82 OHM 220 OHM	100 OHM 270 OHM	120 OHM 330 OHM	150 OHM 390 OHM	1/4 WATT 5% — 50 PCS.
ASST. 3	5 ea.	470 OHM 1.2K	560 OHM 1.5K	680 OHM 1.8K	820 OHM 2.2K	1K 2.7K	1/4 WATT 5% — 50 PCS.
ASST. 4	5 ea.	3.3K 8.2K	3.9K 10K	4.7K 12K	5.6K 15K	6.8K 18K	1/4 WATT 5% — 50 PCS.
ASST. 5	5 ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	1/4 WATT 5% — 50 PCS.
ASST. 6	5 ea.	150K 390K	180K 470K	220K 560K	270K 680K	330K 820K	1/4 WATT 5% — 50 PCS.
ASST. 7	5 ea.	1M 2.7M	1.2M 3.3M	1.5M 3.9M	1.8M 4.7M	2.2M 5.6M	1/4 WATT 5% — 50 PCS.
ASST. 8R		All Seven Resistor Assortment					$10.95 ea.

5-25 PCS .05 ea 30-95 PCS .04 ea 100-495 PCS .03 ea 500-995 .0275 ea

SINGLE TURN 3/8" CERMET POTENTIOMETER

- Resistance Tolerance ± 20%
- High Power — 0.5 Watt at 70°C
- Wide Operating Temp. Range −55°C to +125°C

$.89

STANDARD RESISTANCE VALUES
50Ω 100Ω 500Ω 1K 2K 5K 10K 20K 50K 100K 200K 500K 1 MEG

All Advertised Prices Good For This Month Only — November
Satisfaction Guaranteed. $5.00 Min. Order. U.S. Funds.
California Residents — Add 6% Sales Tax — Data Sheets 25¢ each
Send a 24¢ Stamp (postage) for a Free 1977 Catalog

NOW OPEN SATURDAYS

JAMES

1021 HOWARD AVE., SAN CARLOS, CA. 94070
PHONE ORDERS WELCOME — (415) 592-8097

MINIATURE TOGGLE

DPDT				MT	1	2-9	10-29	30-99
	ON	OFF	ON	221	2.95	2.55	1.87	1.70
	ON	NONE	ON	223	2.95	2.15	1.58	1.43
	ON	OFF	ON	121	2.35	1.95	1.43	1.30
	ON	NONE	ON	123	2.05	1.65	1.21	1.10

PUSH BUTTON

SPDT — SERIES PB, PB1
Maintained Action Switch — Push To Make Contact And Push Again To Reverse Action
Momentary Action Switch — Normally Open or Normally Closed

PB-123 $1.75
PB-126 $1.75

5 AMP RATINGS

THUMBWHEEL SWITCHES

THUMBWHEEL SWITCH ONLY

Part No.	Description	Price
SF 12	Single Pole 10 Position	$2.50
SR 12	Decimal	3.00
SF 21	10 Position BCD only	2.50
SR 21		3.00

Ordering: Order desired switch or switches and add necessary accessories for your particular application.

SF - Front Mount SR - Rear Mount

SERIES SF Front Mount Assembly — SERIES SR Rear Mount Assembly

ACCESSORIES

Part No.	Description	Price	Part No.	Description	Price
SF EP	End Plate (Pair)	.50	SR EP	End Plates (pair)	$.50
SF DP	Divider Plate (each)	.40	SR DP	Divider Plate (each)	.40
SF BB	Blank Body (each)	.40	SR BB	Blank Body (each)	.40
SF HB	Half Body (each)	.40	SR HB	Half Body (each)	.40

DIP SWITCH

These switches feature seven SPST slide switches in a molded dip. They are ideally suited for microprocessor applications.

$1.95

CLIPLITE !! 4/$1.00

NEW LED MOUNTING SYSTEM

- CLIPLITE mounts from the front of the Panel in a .250 hole on 3/8" centers. Panel thickness from 1/16" to 1/8".
- CLIPLITE equalizes and increases the brightness of commonly used wide beam LEDS.
- CLIPLITE is to be used with XC556 LEDS.
- Specify colors—red, green, amber, or yellow when ordering.

ZENERS—DIODES—RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
IN746	3.3	400m	4/1.00	1N4005*	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006*	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007*	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	8/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25M	20/1.00
1N5232	5.6	500m	28	1N4734	5.6	1w	28
1N5234	6.2	500m	28	1N4735	6.2	1w	28
1N5235	6.8	500m	28	1N4736	6.8	1w	28
1N5236	7.5	500m	28	1N4738	8.2	1w	28
1N456	25	40m	6/1.00	1N4742	12	1w	28
1N458	150	7m	6/1.00	1N4744	15	1w	28
IN485A	180	10m	5/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	IN1185	150 PIV	35 AMP	1.70
1N4003	200 PIV	1 AMP	12/1.00	IN1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	50
MDA 980-1	25A @ 50V	FW BRIDGE REC	1.95
MDA 980-3	25A@ 200V	FW BRIDGE REC	1.95

TRANSISTORS

MPS A05	5/$1.00			PN4249	4/$1.00
MPS A06	5/$1.00			PN4250	4/$1.00
2N2219A	3/$1.00	PN3567	3/$1.00	2N4400	4/$1.00
2N2221	4/$1.00	PN3568	4/$1.00	2N4401	4/$1.00
2N2222A	5/$1.00	PN3569	4/$1.00	2N4402	4/$1.00
2N2369	5/$1.00	2N3704	5/$1.00	2N4403	4/$1.00
2N2369A	4/$1.00	2N3705	5/$1.00	2N4409	5/$1.00
FN2415	5/$1.00	2N3706	5/$1.00	2N5086	4/$1.00
2N2484	4/$1.00	2N3707	5/$1.00	2N5087	4/$1.00
2N2906A	4/$1.00	2N3711	5/$1.00	2N5088	4/$1.00
2N2907A	5/$1.00	2N3724	$.65	2N5089	4/$1.00
2N2925	5/$1.00	2N3725	$1.00	2N5129	5/$1.00
2N3053	2/$1.00	2N3903	5/$1.00	2N5138	5/$1.00
2N3055	$.89	2N3904	4/$1.00	2N5139	5/$1.00
MJE3055	$1.00	2N3905	4/$1.00	2N5209	5/$1.00
MJE2955	$1.25	2N3906	4/$1.00	2N5951	5/$1.00
2N3392	5/$1.00	2N4013	3/$1.00	C106B1SCR	2/$1.00
2N3398	5/$1.00	2N4014	3/$1.00	2N5432	$2.00
		2N4123	10/$1.00	40673	1.75ea.

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	05	04	03	001μF	05	04	035
22 pf	05	04	03	0047μF	05	04	035
47 pf	05	04	03	01μF	05	04	035
100 pf	05	04	03	022μF	06	05	04
220 pf	05	04	03	047μF	06	05	04
470 pf	05	04	035	1μF	12	09	075

100 VOLT MYLAR FILM CAPACITORS

.001mf	12	10	07	.022mf	13	11	08
.0022	12	10	07	.047mf	21	17	13
.0047mf	12	10	07	.1mf	27	23	17
.01mf	12	10	07	.22mf	33	27	22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

.1/35V	28	23	17	1.5/35V	30	26	21
.15/35V	28	23	17	2.2/25V	31	27	22
.22/35V	28	23	17	3.3/25V	31	27	22
.33/35V	28	23	17	4.7/25V	32	28	23
.47/35V	28	23	17	6.8/25V	36	31	25
.68/35V	28	23	17	10/25V	40	35	29
1.0/35V	28	23	17	15/25V	63	50	40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	15	13	10	.47/25V	15	13	10
1.0/50V	16	14	11	.47/50V	16	14	11
3.3/50V	15	13	10	1.0/16V	15	13	10
4.7/25V	16	14	12	1.0/25V	16	14	11
10/25V	15	13	10	1.0/50V	16	14	11
10/50V	16	14	12	4.7/16V	15	13	10
22/25V	17	15	12	4.7/25V	15	13	10
22/50V	24	20	18	4.7/50V	16	14	11
47/25V	19	17	15	10/16V	14	12	09
47/50V	25	21	19	10/25V	15	13	10
100/25V	24	20	18	10/50V	16	14	12
100/50V	35	30	28	47/50V	24	21	19
220/25V	32	28	25	100/16V	19	15	14
220/50V	45	41	38	100/25V	24	20	18
470/25V	33	29	27	100/50V	35	30	28
1000/16V	55	50	45	220/16V	23	17	16
2200/16V	70	62	55	470/25V	31	28	26

More Details? CHECK—OFF Page 126

FAIRCHILD ANNOUNCES THE FAIRCHILD

SOLID STATE TECHNOLOGY KIT

- FOR THE EXPERIMENTER WITH TASTE FOR "STATE OF THE ART" PRODUCTS
- COMPLETE SPECIFICATIONS ARE PRINTED ON THE BACK OF EACH TECHNOLOGY KIT

FTK0020

CARD FRONT

FTK0020

CARD BACK

FTK0106

CARD FRONT

DIGITS

FTK0001	0.5" High Common Cathode Digit	$1.00
FTK0002	0.5" High Common Anode Digit	1.00
FTK0003	.357" High Common Cathode Digit	.75
FTK0004	0.8" High Common Cathode Digit	2.00
FTK0005	0.8" High Common Anode Digit	2.00

0.8" HIGH DISPLAY ARRAYS

FTK0010	12 Hour, 3½ Digit Clock Display	7.00
FTK0011	24 Hour, 4 Digit Clock Display	8.00

LED LAMPS

FTK0020	10 Red LED Lamps	1.00
FTK0021	5 Mixed Colored LED Lamps	1.00
FTK0022	10 LED Mounting Clips	1.00
FTK0023	5 Three Piece LED Mounting Adapters	1.00

PHOTO TRANSISTORS

FTK0030	5 Flat Lens Photo Transistors	1.00
FTK0031	5 Round Lens Photo Transistors	1.00
FTK0032	3 Flat Lens Photo Darlingtons	1.00
FTK0033	3 Round Lens Photo Darlingtons	1.00

PHOTO ARRAYS

FTK0040	9-Element Tape Reader Array	16.00
FTK0041	12-Element Card Reader Array	24.00
FTK0042	Reflective Opto Coupler	4.00

COUPLERS

FTK0050	3 General Purpose Opto Couplers	1.00
FTK0051	Darlington Opto Coupler	1.00

MOS CLOCK CIRCUITS

FTK0400	Digital Clock/Calendar Circuit (FCM7001)	7.00
FTK0401	Digital Clock/Calendar with BCD Outputs (FCM7002)	7.00
FTK0402	Direct Drive Digital Clock Circuit with AC Output (FCM3817A)	5.00
FTK0403	Direct Drive Digital Clock Circuit with DC Output (FCM3817D)	5.00
FTK0405	Direct Drive Digital Clock/Calendar Circuit (FCM7015)	6.00

KITS

FTK0106	Automobile Clock Kit	40.00

- THESE PRODUCTS ARE PACKAGED FOR OUTSTANDING WALL DISPLAY APPEARANCE
- FULL FAIRCHILD PRODUCT LINE TO FOLLOW
- DEALER'S AND WHOLESALER'S INQUIRIES INVITED—PRICE LIST AVAILABLE.
- BUY WITH PRIDE THE PRODUCTS BUILT BY THE INDUSTRY'S LEADER — FAIRCHILD

Satisfaction Guaranteed. $5.00 Min. Order. U.S. Funds.
California Residents – Add 6% Sales Tax
Send a 24c Stamp (postage) for a FREE 1977 Catalog.

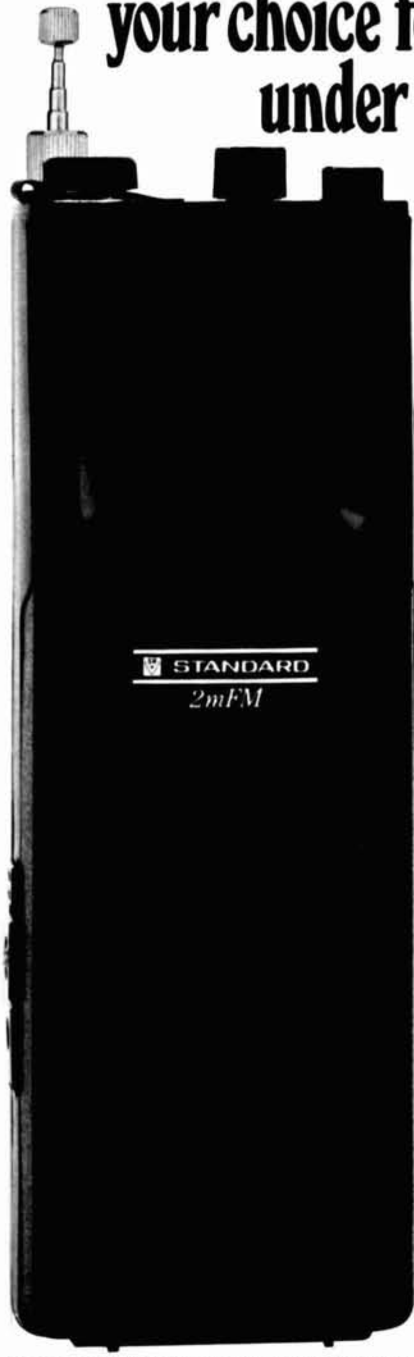
JAMES

NOW OPEN SATURDAYS

1021 HOWARD STREET
SAN CARLOS, CA 94070
PHONE ORDERS – (415) 592-8097

More Details? CHECK–OFF Page 126

Performance... your choice for under $299*



Standard's 146-A Handheld outclasses them all! A deluxe 2 meter FM transceiver • Full 5 channel capability, 2 channels included • Compact size 1 x 3 x 9 inches • Separate internal mike • Built-in meter to monitor battery condition • Provision for Private Channel (CTCSS), external mike or speaker mike.

Since no two radio applications are exactly alike Standard makes the rugged HORIZON "2" 25 watt, 2 meter FM transceiver for HAM, CAP, and MARS. The HORIZON "2" is also available for under *$299. Both of these rugged radios offer you exceptional quality and outstanding performance at a price that's right.

Standard Communications
P.O. Box 92151 • Los Angeles • Ca. • 90009

GREGORY ELECTRONICS
The FM Used Equipment People.

FE53: W 9", H 4", D 16"

150-170MHz MOBILE UNITS

GENERAL ELECTRIC T.P.L.

Transistorized Progress Line, FE53JA6, Front Mount, 150-174 MHz, 12 volt, 35 watts, fully solid state receive, 4 tubes in transmitter, fully narrow band, complete with accessories, shipping weight 50 lbs.

Regular ~~$168~~

NEW LOW PRICE $118.

(Schematic available on request)

GREGORY ELECTRONICS CORP.
245 Rt. 46, Saddle Brook, N.J. 07662
Phone: (201) 489-9000

PORTA-PAK

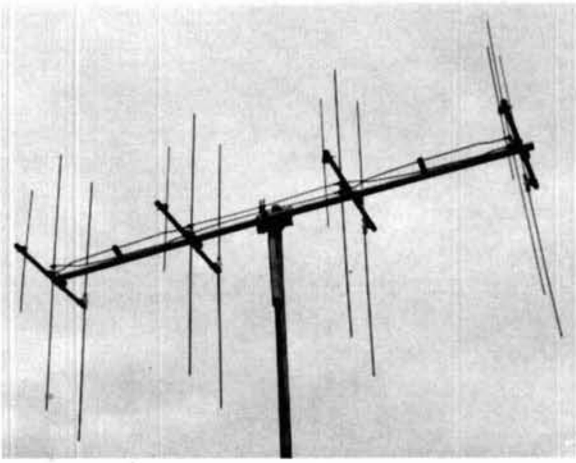
MODELS IN STOCK INCLUDE:
BTL BTH MT 25 MT15
GENAVE: ALL MODELS
ICOM 230 AND 22A MIDLAND
REGENCY HR6 HR2B
MICRO-COM LINE
HEATHKIT HW 202
STANDARD

BEAUTY IS NOT ONLY SKIN DEEP. YOU GET MUCH MORE THAN GOOD LOOKS WITH A PORTA-PAK. THE PORTA-PAK IS A TOTALLY PORTABLE PERFORMANCE PACKAGE THAT WILL KEEP YOU IN TOUCH WITH WHAT IS HAPPENING WHETHER YOUR COMMUNICATIONS NEED IS BUSINESS OR PLEASURE, THE PORTA-PAK WILL SATISFY YOUR NEEDS. DELUXE PORTA-PAK HAS 4.5 AMP HR. SUPER PORTA-PAK HAS 9 AMP HR. PORTA-PAK INCLUDES THE CASE, BATTERY, AND CHARGER. GEL-CELL IS THE POWER SOURCE. GC-1245 IN STOCK FOR SAME DAY SHIPMENT: DELUXE $67.50 + $1.75 SHIPPING. THE SUPER, $88.00 + $2.75. GEL-CELL BATTERY ONLY $29.20 + $1.75. RUBBER DUCKIE ANTENNAS $7.00. L.E.D. BATTERY CONDITION INDICATOR $5.00.

PORTA-PAK, INC.
P.O. BOX 67
SOMERS, WI. 53171

More Details? CHECK—OFF Page 126

VHF DX

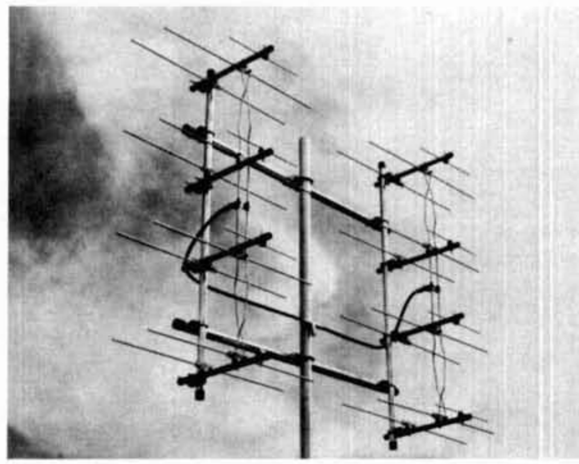


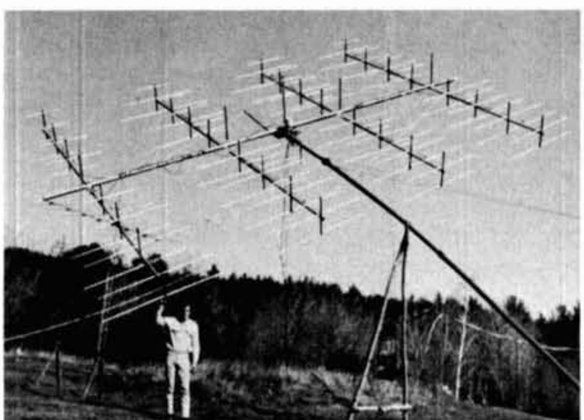
FM —

Enjoy the thrill of dependable long distance contacts on simplex or thru remote repeaters. The 20 element co-linear DX-Array offers a precise pattern with large capture area. This vertically polarized, horizontally stacked array provides a narrow beamwidth for the discriminating FM user. Wide impedance and gain bandwidths make the DX-Array a natural choice for the serious FM'er. A vertical polarization bracket, model DX-VPB, is required (support boom and mast not supplied). Seek out new horizons with DX-Array!

SSB/CW —

Discover reliability in long-haul communications with VHF SSB and CW. The Cush Craft DX-Array also gives low angle, high gain performance for many exotic propagation modes — tropo, aurora, sporadic-E, and meteor scatter. Horizontally polarized DX-Arrays may be used singly or combined in pairs (twice Effective Radiated Power) or quads (4 x ERP). Each DXK stacking kit is complete with stacking frame and phasing harness (vertical mast not supplied). This year has seen some spectacular VHF band openings — Don't miss the next one!





Dave Olean, K1WHS, with his 160 Element DX-Array and Polar Mount EME System

EME —

Many VHF experimenters have found excitement in conquering the formidable Earth-Moon-Earth (EME) path. 2-meter moonbouncers have achieved outstanding success using eight stacked DX-Arrays. Impedance and gain characteristics of this antenna permit stacking without the critical detuning problems inherent in large arrays of Yagis. Enlarging system size will yield a more uniform gain increase with DX-Arrays than with many other large antennas. The physical configuration alleviates mounting and phasing/tuning problems. EME enthusiasts are setting new records — So can you!

DX-ARRAY LEADS THE WAY!

	144 MHz.		*220 MHz.*		*432 MHz.*	
Description:	Model:	Price:	Model:	Price:	Model:	Price:
20 Element DX-Array	DX-120	$39.50	DX-220	$32.50	DX-420	$29.50
Frame & Harness (40 E.)	DXK-140	$52.50	DXK-240	$49.50	DXK-440	$36.50
Frame & Harness (80 El.)	DXK-180	$100.00	DXK-280	$85.00	DXK-480	$70.00
1-1 52-ohm Balun	DX-1BN	$10.95	DX-2BN	$10.95	DX-4BN	$10.95
Vert. Pol. Bracket (20 El.)	DX-VPB	$8.95	DX-VPB	$8.95	DX-VPB	$8.95

IN STOCK WITH DISTRIBUTORS WORLDWIDE

cushcraft
CORPORATION
P.O. BOX 4680, MANCHESTER, N.H. 03108

More Details? CHECK—OFF Page 126

TS-1 MICROMINIATURE ENCODER-DECODER

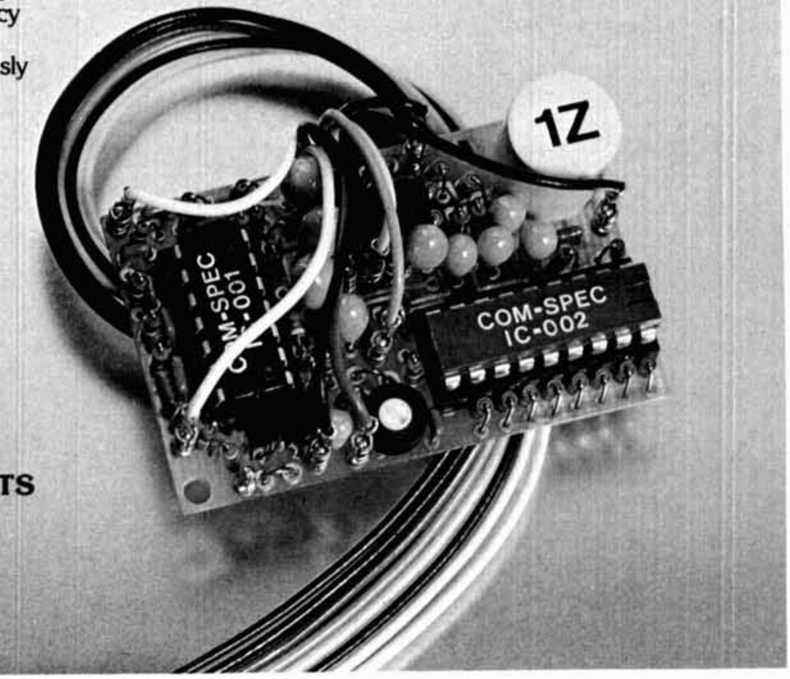
- ☐ Available in all EIA standard tones 67.0Hz-203.5Hz
- ☐ Microminiature in size, 1.25x2.0x.65" high
- ☐ Hi-pass tone rejection filter on board
- ☐ Powered by 6-16vdc, unregulated, at 3-9ma.
- ☐ Decode sensitivity better than 10mvRMS, bandwidth, ±2Hz max., limited
- ☐ Low distortion adjustable sinewave output
- ☐ Frequency accuracy, ±.25Hz, frequency stability ±.1Hz
- ☐ Encodes continuously and simultaneously during decode, independent of mike hang-up
- ☐ Totally immune to RF

Wired and tested, complete with K-1 element

$59.95

K-1 field replaceable, plug-in, frequency determining elements

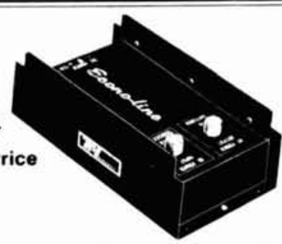
$3.00 each



COMMUNICATIONS SPECIALISTS
P.O. BOX 153
BREA, CALIFORNIA 92621
(714) 998-3021

---

talk power by **TPL** *Econo-line*



- Quality for an Economy Price
- Solid State Construction
- Linear Switch (FM/SSB)
- Broad Band

Model	Input	Output	Typical	Frequency	Price
702	10W-20W	50W-90W	10W in/70W out	143-149MHz	$139.00
702B	1W- 5W	60W-80W	1W in/70W out	143-149MHz	$169.00

Now get TPL COMMUNICATIONS quality and reliability at an economy price. The solid state construction, featuring magnetically coupled transistors and a floating ground, gives you an electronically protected amplifier that should last and last.

The Linear Bias Switch allows you to operate on either FM or SSB. The 702 and 702B are exceptionally well suited for 2-meter SSB. Typical power output levels as high as 100W PEP can be achieved with the proper drive.

The broad band frequency range means that your amplifier is immediately ready to use. No tuning is required for the entire 2-meter band and adjacent MARS channels on TPL's new *Econo-line*.

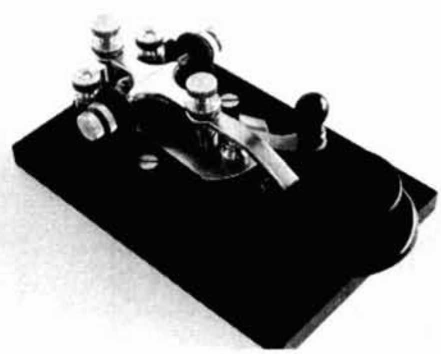
See these great new additions to the TPL COMMUNICATIONS product line at your favorite radio dealer.

Call or write for prices and information on TPL's complete line of amateur and commercial amplifiers.

TPL *COMMUNICATIONS INC.*
1324 W. 135TH ST., GARDENA, CA 90247 • (213) 538 - 9814

Canada: A.C. Simmonds & Sons Ltd., 285 Yorkland Blvd., Willowdale, Ontario M2J 1S8
Export: EMEC Inc., 2350 South 30th Avenue, Hallandale, Fla. 33009

GOLD PLATED
BI-CENTENNIAL SPECIAL TELEGRAPH KEY



Our standard Nye Viking Speed-X® Model 114-310-004 with all gold plated hardware and key arm on a standard black crackle base mounted on a black plastic sub-base.

A truly beautiful key for the man who has everything. A fine gift for those special occasions.

Model 114-310-104 G.P.

$50.00 PREPAID IN U.S.A.

ORDER THRU YOUR FAVORITE DEALER OR DIRECT TO

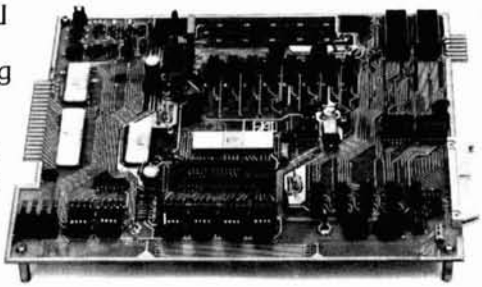
Nye Viking

WM. M. NYE COMPANY, INC.
1614 - 130th N.E.
Bellevue, WA. 98005

More Details? CHECK—OFF Page 126


ME-3 microminiature tone encoder
Compatible with all sub-audible tone systems such as: Private Line, Channel Guard, Quiet Channel, etc.
• Powered by 6-16vdc, unregulated
• Microminiature in size to fit inside all mobile units and most portable units
• Field replaceable, plug-in, frequency determining elements
• Excellent frequency accuracy and temperature stability
• Output level adjustment potentiometer
• Low distortion sinewave output
• Available in all EIA tone frequencies, 67.0 Hz-203.5 Hz
• Complete immunity to RF
• Reverse polarity protection built-in
$29.95 each
Wired and tested, complete with K-1 element
communications specialists
P. O. BOX 153
BREA, CALIFORNIA 92621
(714) 998-3021
K-1 FIELD REPLACEABLE, PLUG-IN, FREQUENCY DETERMINING ELEMENTS
$3.00 each

If you want a microcomputer with all of these standard features...



- 8080 MPU (The one with growing software support)
- 1024 Byte ROM (With maximum capacity of 4K Bytes)
- 1024 Byte RAM (With maximum capacity of 2K Bytes)
- TTY Serial I/O
- EIA Serial I/O
- 3 parallel I/O's
- ASCII/Baudot terminal compatibility with TTY machines or video units
- Monitor having load, dump, display, insert and go functions
- Complete with card connectors
- Comprehensive User's Manual, plus Intel 8080 User's Manual
- Completely factory assembled and tested — not a kit
- Optional accessories: keyboard/video display, audio cassette modem interface, power supply, ROM programmer, and attractive cabinetry... plus more options to follow.

The HAL MCEM-8080. $375

...then let us send you our card.

HAL Communications Corp. has been a leader in digital communications for over half a decade. The MCEM-8080 microcomputer shows just how far this leadership has taken us... and how far it can take you in your applications. That's why we'd like to send you our card — one PC board that we feel is the best-valued, most complete microcomputer you can buy. For details on the MCEM-8080, write today. We'll also include comprehensive information on the HAL DS-3000 KSR microprocessor-based terminal, the terminal that gives you multi-code compatibility, flexibility for future changes, editing, and a convenient, large video display format.

HAL

HAL Communications Corp.
Box 365, 807 E. Green Street, Urbana, Illinois 61801
Telephone (217) 367-7373

432 AMPS
AND
TRANSMITTING CONVERTERS

WRITE OR CALL

ARCOS
AMATEUR RADIO COMPONENT SERVICE
35 HIGHLAND DRIVE
P. O. BOX 546
EAST GREENBUSH, N. Y. 12061
518-477-4990

TROPICAL HAMBOREE

JANUARY 22-23, 1977
(MIAMI BAYFRONT AUDITORIUM)
MIAMI, FLORIDA

ADVANCE REGISTRATION
$2.00

FOR SPECIAL HOTEL RATES AND MORE INFORMATION WRITE:

DADE RADIO CLUB
P. O. Box 73, B.A.
Miami, Florida 33152

ANTENNA SUPERMARKET, *PO Box 1682, Dept. H, Largo, Fla. 33540*

DIPOLE AND WIRE ANTENNA KITS, complete with HI-Q BALUN, 100′ rope, copper antenna wire and insulators.

80/40/15 parallel dipole	$36.95	160 short, 130′ length	$36.95
40/20/15 parallel dipole	$30.95	80 short, 63′ length	$31.95
80/40 trap dipole	$41.95	40 short, 33′ length	$28.95
40/20 trap dipole	$36.95	Single band models from	$24.95

VERTICALS — complete with Universal Mounting Base, Folds to 5′ for Easy Transport, Hvy. Duty Aluminum Tubing.

20/15 trap, 13′ hgt.	$29.95	160 compact 23′ hgt.	$44.95
40/20/15 trap 22′ hgt.	44.95	80 compact 20′ hgt.	39.95
80/40/20 trap 30′ hgt.	69.95	40 compact 15′ hgt.	34.95
80/40/15 trap 20′ hgt.	59.95	20/15/10 full size vertical	29.95
10 meter cov. for above add	9.95		

NEW
Apartment / Portable apt. roof or patio, camper, trailer, motor home. All bands 80 10, folds to 5′ easily. 13′ height. 80 40-20 15-10 **$49.95**

TO ORDER — Include $1.95 shipping ($2.95 West Coast)
24 hour shipment. 30 day guarantee.
For Info: 1st Class Stamp.

Include Interbank # and Expiration date on Credit Card orders.

More Details? CHECK—OFF Page 126

HERE'S A HOT NUMBER

800-325-3636

(Toll Free)

CALL

HAM RADIO CENTER

ST. LOUIS

FOR NEW AND USED AMATEUR RADIO EQUIPMENT

MASTER-CHARGE BANKAMERICARD

TRADE ON NEW OR USED

Hours 9 A.M. - 5 P.M. (Central) **Closed Sun. & Mon.**

THE HAM-KEY

NOW 5 MODELS

- Iambic circuit for squeeze keying.
- Self completing dots & dashes.
- Dot memory.
- Battery operated with provision for external power.
- Built-in side-tone monitor.
- Speed, Volume, tone & weight controls.
- Grid-block or direct keying.
- Use with external paddle such as HK-1.

NEW

MODEL HK-5
ELECTRONIC KEYER

$69.95

MODEL HK-1

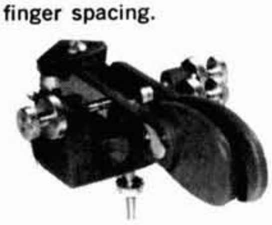
$29.95

- Dual lever squeeze paddle.
- Use with HK-5 or any electronic keyer.
- Heavy base with non-slip rubber feet.
- Paddles reversible for wide or close finger spacing.

MODEL HK-3

$16.95

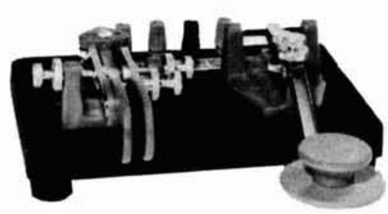
- Deluxe straight key.
- Heavy base, no need to attach to desk.
- Velvet smooth action.



MODEL HK-2

$19.95

- Same as HK-1, less base for those who wish to incorporate in their own Keyer.



MODEL HK-4

$44.95

- Combination HK-1 & HK-3 on same base.

Available from your local dealer or order direct.

HAM RADIO CENTER, INC.

8340-42 OLIVE BLVD. • P. O. BOX 28271 • ST. LOUIS, MO. 63132

More Details? CHECK—OFF Page 126

More Details? CHECK–OFF Page 126

More Details? CHECK—OFF Page 126

Your Next Purchase.

ELECTRONIC KEYER
MODEL 10B

Reed relay output (1 amp, 250V, 20VA). 10-30 WPM @ 6V-DC supply, 12 MA drain. 15-45 WPM @ 9V-DC supply, 15 MA drain. 3 MA idle current drain. Fixed spacing. Dots 1:1, Dash 1:3. Self-completing Dot/Dash. Manual dash in tune position. (Batteries not included.) Use the Model 10B Keyer with your paddle or our Model 11B matching paddle.

MODEL 10BWA KEYER with Sidetone assembled	$39.95
MODEL 10BW assembled	$29.95
MODEL 10BK (Kit)	$23.95
200-2K PC BOARD KIT	$14.95
200-3K SIDETONE KIT	$ 5.95
Ship. Wt. 1 Lb., add	$ 1.00

(PA RES. ADD 6% SALES TAX)

PADDLE
MODEL 11B

Dit/Dah travel adjustment. No mechanical switches. No bearings to fail. Paddle assembly weight is 1.5 pounds. Reversible Dit and Dah connections. Rubber feet. Damping on paddle operator lever. Feather glide paddle movement.

MODEL 11BW assembled	$11.95
MODEL 11BK (Kit)	$ 8.95
Ship. Wt. 2 Lb., add	$ 1.35

(PA RES. ADD 6% SALES TAX)

CW TRANSMITTER
MODEL 50

15 watts input. Full break-in keying. All solid state. Crystal control. 160, 80 or 40M plug-in coil. Zener regulated chirpless keying. Has built-in 120 Vac power supply. OPTIONS: Built-in keyer and/or sidetone. Paddle Model 11B is compatible with built-in keyer option.

MODEL 50K (Kit)		$49.95
MODEL 50W (Wired)		$69.95
Add-on options:		
SIDETONE	200-21 Kit	$ 5.95
	200-21 Wired	$ 8.95
KEYER	200-22 Kit	$13.95
	200-22 Wired	$18.95
Ship. Wt. 4 Lb., add		$ 2.10

(PA RES. ADD 6% SALES TAX)

(All units come with 40M plug-in coil unless otherwise specified. (Additional coil kits $3.95 each postpaid.)

ELECTRONIC KEYER WITH PADDLE

MORSE-1835
MODEL 12

C-MOS circuitry. Solid state output switch. (250V, 1 AMP MAX.) 8-45 WPM. Fixed spacing. Dot 1:1, Dash 1:3. Self-completing Dot/Dash. No on/off switch required. Sidetone has 2-inch speaker. Paddle travel adjustment. Rubber feet. 4 penlight batteries (not included).

MODEL 12 assembled	$49.95
Ship. Wt. 2 Lb., add	$ 1.35

(PA RES. ADD 6% SALES TAX)

SPEECH PROCESSOR
MODEL 60A

200K/500 OHM inputs. PTT on connector. Instantaneous attack and release. 2, 9V-DC batteries (not included). 1.5 MA drain. Frequency is ±-1/2 db., 300-3000 Hz. Process gain control has an in/out switch. The process threshold is: 1.5 MV-RMS (HI-Z). 400 micro V-RMS (LO-Z). Output voltage 100 MV-RMS nom.

MODEL 60AW assembled	$29.95
MODEL 60AK (Kit)	$23.95
Ship. Wt. 1 Lb., add	$ 1.00

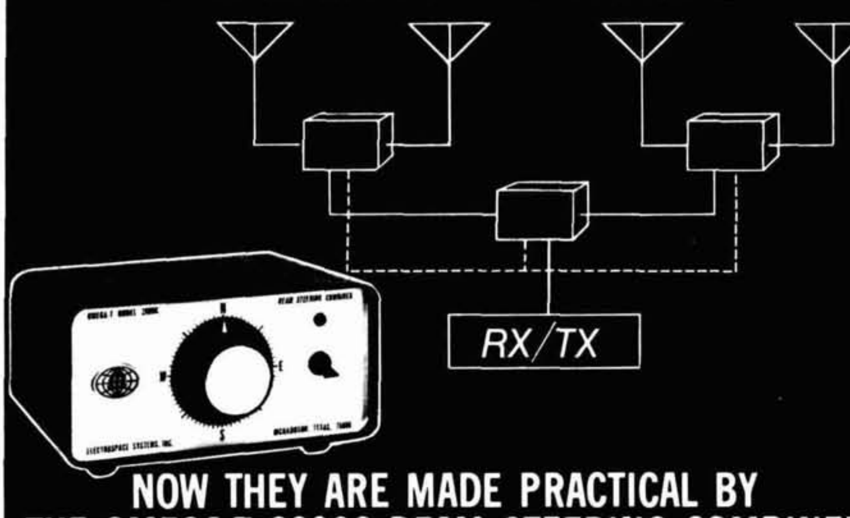
(PA RES. ADD 6% SALES TAX)

THE WORLD AT YOUR FINGERTIPS!

SEND FOR CATALOG & DEALER LIST.
ORDER FROM DEALER OR DIRECT.
FOR U.P.S., C.O.D SHIPMENTS—ADD 85¢

MATRIC
RD-1 • BOX 185A • FRANKLIN, PA. 16323
TELEPHONE (814) 432-3647

STEERABLE PHASED ARRAYS
2 ELEMENTS OR 4 ELEMENTS



NOW THEY ARE MADE PRACTICAL BY THE OMEGA-T 2000C BEAM STEERING COMBINER

Broadband, 1.8-30MHz. Can be used with any type antennas - verticals, dipoles, beams.

Write for details or see your dealer.

ELECTROSPACE SYSTEMS, INC.
P.O. BOX 1359, RICHARDSON, TEXAS 75080, (214) 231-9303

We're Fighting Inflation No Price Rise for '76

FOR FREQUENCY STABILITY
Depend on JAN Crystals. Our large stock of quartz crystal materials and components assures Fast Delivery from us!

TWO METER — Crystals for — CITIZENS BAND
MONITOR RECEIVERS — MARINE RADIO

CRYSTAL SPECIALS

Frequency Standards
100 KHz (HC 13/U) $4.50
1000 KHz (HC 6/U) 4.50

Almost all CB sets, TR or Rec $2.50
(CB Synthesizer Crystal on request)
Amateur Band in FT-243 .... ea. $1.50
.... 4/$5.00
80-Meter- ..... $3.00 (160-meter not avail.)

For 1st class mail, add 20¢ per crystal. For Airmail, add 25¢. Send check or money order. No dealers, please.

JAN CRYSTALS
Div. of
Bob Whan & Son Electronics, Inc.
2400 Crystal Dr.,
Ft. Myers, Fla. 33901
All Phones: (813) 936-2397
Send 10¢ for new catalog

More Details? CHECK—OFF Page 126

vhf engineering

THE WORLD'S MOST COMPLETE LINE OF VHF-FM KITS AND EQUIPMENT

RECEIVERS

RX28C	28-35 MHz FM receiver with 2 pole 10.7 MHz crystal filter	59.95
RX50C Kit	30-60 MHz rcvr w/2 pole 10.7 MHz crystal filter	59.95
RX144C Kit	140-170 MHz rcvr w/2 pole 10.7 MHz crystal filter	69.95
RX144C W/T.	same as above – factory wired and tested	114.95
RX220C Kit	210-240 MHz rcvr w/2 pole 10.7 MHz crystal filter	69.95
RX220C W/T	same as above – factory wired and tested	114.95
RX432C Kit	432 MHz rcvr w/2 pole 10.7 MHz crystal filter	79.95
RXCF	accessory filter for above receiver kits gives 70 dB adjacent channel rejection	8.50
RF28 Kit	10 meter RF front end 10.7 MHz output	12.50
RF50 Kit	6 meter RF front end 10.7 MHz output	12.50
RF144D Kit	2 meter RF front end 10.7 MHz output	17.50
RF220D Kit	220 MHz RF front end 10.7 MHz output	17.50
RF432 Kit	432 MHz RF front end 10.7 MHz output	27.50
IF 10.7F Kit	10.7 MHz IF module includes 2 pole crystal filter	27.50
FM455 Kit	455 KHz IF stage plus FM detector	17.50
AS2 Kit	audio and squelch board	15.00

TRANSMITTERS

TX144B Kit	transmitter exciter – 1 watt – 2 meters	$ 29.95
TX144B W/T.	same as above – factory wired and tested	49.95
TX220B Kit	transmitter exciter – 1 watt – 220 MHz	29.95
TX220B W/T.	same as above – factory wired and tested	49.95
TX432B Kit.	transmitter exciter 432 MHz	39.95
TX432B W/T	same as above - factory wired and tested	59.95
TX150 Kit	300 milliwatt, complete 2 meter transmitter, less crystal and mike	19.95

POWER AMPLIFIERS

PA2501H Kit	2 meter power amp – kit 1 w in – 25w out with solid state switching, case, connectors	59.95
PA2501H W/T	same as above – factory wired and tested	74.95
PA4010H Kit	2 meter power amp – 10w in – 40w out – relay switching	59.95
PA4010H W/T	same as above – factory wired and tested	74.95
PA144/15 Kit	2 meter power amp – 1w in – 15w out – less case, connectors and switching	39.95
PA144/25 Kit	similar to PA144/15 kit except 25w out	49.95
PA220/15 Kit	similar to PA144/15 for 220 MHz	39.95
PA432/10 Kit	power amp – similar to PA144/15 except 10w and 432 MHz	49.95
PA140/10	10w in – 140w out – 2 meter amp – factory wired and tested	179.95
PA140/30	30w in – 140w out – 2 meter amp – factory wired and tested	159.95

POWER SUPPLIES

PS15C Kit	15 amp – 12 volt regulated power supply w/case, w/fold-back current limiting and overvoltage protection	79.95
PS15C W/T	same as above – factory wired and tested	94.95
PS25C Kit	25 amp – 12 volt regulated power supply w/case, w/fold-back current limiting and overvoltage protection	129.95
PS25C W/T	same as above – factory wired and tested	149.95
O.V.P.	adds over voltage protection to your power supplies, 15 VDC max	9.95
PS3A Kit	12 volt – power supply regulator card with fold back current limiting	8.95
PS3012	new commercial duty 30 amp 12 VDC regulated power supply w/case, w/foldback current limiting and over voltage protection, wired and tested	239.95

REPEATERS

RPT28 Kit	repeater – 10 meter	TBA
RPT28	repeater – 10 meter, wired & tested	TBA
RPT50 Kit	repeater – 6 meter	TBA
RPT50	repeater – 6 meter, wired & tested	TBA
RPT144 Kit	repeater – 2 meter – 15w – complete (less crystals)	465.95
RPT220 Kit	repeater – 220 MHz – 15w – complete (less crystals)	465.95
RPT432 Kit	repeater – 10 watt – 432 MHz (less crystals)	515.95
RPT144	repeater – 15 watt – 2 meter – factory wired and tested	695.95
RPT220	repeater – 15 watt – 220 MHz – factory wired and tested	695.95
RPT432	repeater – 10 watt – 432 MHz – factory wired and tested	749.95
DPLX144	2 meter, 600 KHz spaced duplexer, wired and tuned to frequency	399.95
DPLX220	220 MHz duplexer, wired and tuned to frequency	399.95

TRANSCEIVERS

TRX 144 Kit	case and all components to build 15 watt 10 channel scanning 2 meter transceiver (less mike and crystals)	219.95
TRX 220 Kit	same as above except for 220 MHz	219.95
TRX 432 Kit	same as above except 10 watt and 432MHz	254.95

SYNTHESIZERS

SYN II Kit	2 meter synthesizer, transmit offsets programmable from 100 KHz - 10 MHz, (Mars offsets with optional adapters)	169.95
SYN II	same as above, wired and tested	239.95

WALKIE TALKIES

HT 144B Kit.	2 meter, 2w, 4 channel, hand held receiver with crystals for 146.52 simplex	129.95
NICAD	battery pack, 12 VDC, ½ amp	29.95
NICAD	battery charger	5.95
Rubber Duck	2 meter, with male BNC connector	8.95

OTHER PRODUCTS BY VHF ENGINEERING

CD1 Kit	10 channel receive xtal deck w/ diode switching	6.95
CD2 Kit	10 channel xmit deck w/switch and trimmers	14.95
CD-3 Kit	UHF version of CD-1 deck, needed for 432 multi-channel operations	12.95
COR2 Kit	complete COR with 3 second and 3 minute timers	19.95
SC3 Kit	10 channel auto-scan adapter for RX with priority	19.95
Crystals	we stock most repeater and simplex pairs from 146.0-147.0 (each)	5.00
CWID Kit	159 bit, field programmable, code identifier with built-in squelch tail and ID timers	39.95
CWID	wired and tested, not programmed	54.95
CWID	wired and tested, programmed	59.95
Microphone	2,000 ohm dynamic mike with P.T.T. and coil cord	9.95

master charge

VHF ENGINEERING

DIVISION OF BROWNIAN ELECTRONICS CORP.

320 WATER ST. / BINGHAMTON, N.Y. 13901 / Phone 607-723-9574

BANKAMERICARD

More Details? CHECK–OFF Page 126

More Details? CHECK–OFF Page 126

ALPHA POWER

IS IN THREE CLASSES BY ITSELF

ALPHA 77D
IS 'THE ULTIMATE'

- Runs cold and whisper-quiet at maximum legal power, any mode, with **N**o **T**ime **L**imit [NTL] and lots of reserve.
- Tunes 10-160 meters (3-30 MHz continuous).
- Full vacuum relay QSK (CW break-in) standard.
- Basic design proven in toughest commercial and amateur service since 1970.
- 1/3 the size of any amplifier of comparable power; easy to handle & ship.

ALPHA 77D is the standard of excellence around the world.
$2995 U.S.; built on order. Contact ETO for schedule.

ALPHA 374
IS SUPER CONVENIENT

- The smallest and lightest of all true [NTL] kilowatts at only 0.9 cubic ft. and 52 pounds.
- No-tune-up operation 10-80 meters, thanks to factory-pretuned bandpass filters, yet built-in controls allow manual antenna matching and amplifier 'tweaking' when necessary for maximum efficiency and power output.
- Thoroughly proven performance and durability through more than two years' worldwide contest, DX, FSK, SSTV, and general use. $1395 U.S.; prompt delivery from factory stock.

ALPHA 76
SETS THE VALUE STANDARD

- An honest, rock-crusher [NTL] kilowatt in all modes, like the **ALPHA 374.** You can lock the key at a full d-c kilowatt and leave town . . . if you have a very husky dummy load!
- Full coverage 10-160 meters - no other [NTL] kilowatt linear (except a **'77D**) covers 160.
- Standard 45 pound plug-in transformer (1.5 KVA CCS) itself outweighs some so-called 'kilowatt' amplifiers. (The only way we know to make any true [NTL] kilowatt lighter than the '76 is to use special tape-wound Hipersil® transformers like those standard in the **ALPHA 77D** and **'374**, and optional in the '76.)

$895 U.S.; factory stock.

Every **ALPHA** HF Linear Amplifier has a combination of quality and convenience features that's available in no other true kilowatt d-c, 2+ KW PEP linear amplifier: • modern, rugged ceramic grounded-grid triode tubes; • silver-plated copper tubing main tank coils; • a 1.5 KVA CCS (or larger) plug-in transformer; • full-cabinet, ducted air cooling; • self-contained desk-top convenience; and a full year of free factory service for any defect. NEW! Expert **factory** demonstration, advice, sales, and service is conveniently available in the Midwest and in Southern California. Write or phone ETO direct for full information, illustrated brochure, and personal service.

ETO

EHRHORN TECHNOLOGICAL OPERATIONS, INC.

BROOKSVILLE, FLORIDA 33512 (904) 796-1428

More Details? CHECK—OFF Page 126

the BRIMSTONE 144

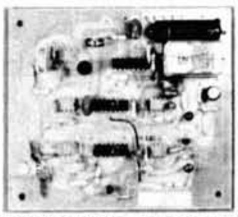
2 METER FM TRANSCEIVER

THE FIRST AND STILL THE ONLY 2 METER TRANSCEIVER THAT OFFERS IT ALL!

Size 9½" x 10½" ' 3¼"

- No crystals to buy.
- Complete band average 143 to 149.99 MHZ, 142 MHZ optional.
- Independent transmit/receive frequency control, yet simplex with the flip of a switch.
- Autopatch, tone burst and sub-audible tone capability by simply plugging in the desired module.
- Very low transmitter spurious output. Some manufacturers have demonstrated their inability to eliminate unwanted spurious outputs. The Brimstone has demonstrated that non-harmonic spurious output at least — 70Dd below the rated power output is possible when the radio is properly designed and constructed.
- The Brimstone 144 is designed for an unprecedented degree of component accessibility and plug-in modularity.
- The only amateur 2 meter FM transceiver with a TWO YEAR WARRANTY.

We have changed our company name to TEC-KAN, Inc. and at this time we are offering a special Fall Sale Price on the Brimstone 144. Check with your dealer on the Fall Special and ask for the 6 page full color brochure.



REPEATER AND AUTOPATCH CONTROL MODULE RPT CM-4

If you are planning a repeater and need a control circuit, we have just what you need! Complete control of repeater as well as the autopatch. Local or remote control. If you are using telephone line control for your repeater the RPT CM is ideal because it uses an opti-coupler for complete line isolation and low voltage, low current control.

If you are using the TKI SCAP-3D, you can call your autopatch line number and the RPT CM will automatically answer and connect you allowing you to send tones over the phone to turn the repeater on or off, or access the autopatch and communicate through the repeater over the autopatch phone line.

When calling the repeater on the autopatch line, you have 20 seconds to either access the autopatch or turn the repeater off or on. If the proper codes are not sent within 20 seconds the RPT CM automatically disconnects.

If you call the autopatch number, hang up, wait 30 seconds and call the number again, the repeater transmitter will be keyed and a tone sent each time the phone rings, thus signaling a mobile operator to access the autopatch. If there is no one available to access the patch, it will automatically disconnect after 30 seconds of ringing.

It also features a COR "Hold" circuit, which is adjustable from 1 to 5 seconds, and automatic "time out" timer, that resets each time the receiver COR drops. No need to wait for the repeater to drop out to reset the timer.

If you are planning a repeater, all you need is a good transmitter and receiver and the TKI RPT CM Control Module.

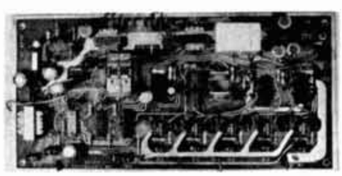
Price $79.95

HANDI-TALKIE SCANNER KIT SK1402

Six Channel Cmos Scanner Kit has provisions to include Mostek Touch-Tone Encoder Chip. Features dwell and normal operation. "Dwell" mode monitors each channel that has a signal on it for 8 seconds. "Normal" monitors in conventional manner. Manual operation locks out the scanner.

Includes LED channel indicators, schematic and installation instructions. Designed for Wilson 1402SM Talkie.

Scanner Kit Model SK1402	$49.95
Includes Touch-Tone Encoder Chip Model SK1402TE	$58.95
Digi-Tran Pad, when ordered with Scanner Kit	$7.50



Size 9 $^{5}/_{16}$ x 4 $^{5}/_{16}$

AUTOPATCH SCAP-3D FEATURES

- 3 Digit access, single digit disconnect.
- 4 sec. time limit on access.
- Anti-falsing tone decoders.
- AGC with 30 Db dynamic range on all inputs and outputs.
- 3 digit on-off control of repeater or other devices.
- Remote inhibit or disconnect of autopatch as well as remote "off" function.
- Monitor amplifier allows monitoring all signals going into and out of the repeater.
- Adjustable level controls on all inputs and outputs.
- Jumpers on circuit board and frequency control pots on tone decoders allow field programming of access codes.
- Adjustable time out function. Patch will automatically disconnect in 30 to 90 seconds after it is accessed if no carrier is received.
- 90 days warranty.
- High quality tantalum and polyester capacitors used in tone decoder circuits to provide reliable low drift performance.
- Rugged G10 glass epoxy circuit board.
- High output level allows transmitter to be modulated through a dedicated phone line.
- Provisions for connecting LEDS for status indication at the local control point.
- **Reverse polarity protection on supply line.**
- Easily connected and adjusted.

Price $199.95

TEC-KAN, Inc.
2916 ARNOLD AVE.
BUILDING NO. 317
SALINA, KANSAS 67401
Tel. 913-823-2235

More Details? CHECK—OFF Page 126

CALL TOLL FREE 800-521-4414
SAVE $80,000.00 IN CRYSTALS
LISTEN TO 16,000 DIFFERENT FREQUENCIES WITH NO CRYSTALS
FREE NO OBLIGATION 7 DAY TRIAL




BEARCAT 101
16 channels
30-50 MHz
146-174 MHz
416-512 MHz
CE's Price – $296.95

TENNELEC
MCP 1
16 channels
31.18 – 51.655 MHz
151.18 – 171.655 MHz
451.18 – 471.655 MHz
CE's Price – $339.95

Regency
WHAMO-10
10 channels
30-50 MHz
146-174 MHz
440-512 MHz
CE's Price – $278.95

SBE
OPTISCAN
10 channels
30-50 MHz
150-170 or 140-160 MHz
450-470 MHz
490-510 MHz
CE's Price – $296.95

master charge THE INTERBANK CARD

your BANKAMERICARD welcome here

Toll free U.S.A. 24 hour order & information line 800-521-4414. Outside U.S.A. & Michigan 24 hour phone 313-994-4441. Certified check or charge card on mail orders for immediate shipment. Dealer inquiries invited. Michigan residents add tax. Foreign orders invited. Call toll free or write for your free complete catalog & specifications. Satisfaction guaranteed or your money back. For engineering advice, call after 6:00 P.M. E.S.T.

COMMUNICATIONS ELECTRONICS™
P.O. BOX 1002 DEPT. 3
ANN ARBOR, MICHIGAN 48106

CALL TOLL FREE
800-521-4414
or
313-994-4441

PRESTO!
Your counter becomes a digital display!

Like magic, Hufco's Digi-Dial Adaptor turns any frequency counter into an absolutely accurate digital display! Inexpensively! With continual display of both transmit and receive frequencies — as fast as you turn your transceiver dial!

With the Digi-Dial Adaptor your counter easily adapts to Yaesu, Tempo, Drake C Line, Collins, Kenwood and other transceivers. (Tell us which other brand you have. We'll tell you if the adaptor fits.)

Operation requires only a connecting cable to the transceiver VFO plug. Translates VFO output to 2 through 2.5 mHz. No internal connection or modifications necessary! Complete instructions included.

No frequency counter? Get both the Digi-Dial Adaptor and a frequency counter from Hufco. We have counters starting as low as $45.95!

DIGI-DIAL ADAPTOR
39.95 kit form
$49.95 assembled

Quick! Order yours today!

Please rush me:
☐ Digi-Dial Adaptor $39.95 kit form - $49.95 assembled
Check or money order enclosed.
☐ Complete data on Hufco frequency counters

Name ____________
Address ____________
City/State/Zip ____________

Hufco Box 357, Dept. 70, Provo, Utah 84601 801/375-8566

NEW from NRI Home training in AMATEUR RADIO

NRI, leader in Communications, Television, Electronics and TV-Radio home training, now offers the first in Amateur Radio courses, designed to prepare you for the FCC Amateur License you want or need.

Don't lose your favorite frequency

The FCC has said "either-or" on licensing, but to pass Advanced and Extra Class exams, you need the technical guidance as offered by NRI. NRI Advanced Amateur Radio is for the ham who already has a General, Conditional or Tech Class ticket. Basic Amateur Radio is for the beginner and includes transmitter, 3-band receiver, code practice equipment. Three training plans offered. Get all the facts. Mail coupon. No obligation. No salesman will call on you. NATIONAL RADIO INSTITUTE, Washington, D.C. 20016.

MAIL NOW

NATIONAL RADIO INSTITUTE 46-076
Washington, D.C. 20016
Please send me information on Amateur Radio training.
Name ____________ Age ____
Address ____________
City ____________ State ____ Zip ____
ACCREDITED MEMBER NATIONAL HOME STUDY COUNCIL

More Details? CHECK–OFF Page 126

SIMPLY THE BEST

THAT'S RIGHT. AT SPECTRONICS YOU GET SIMPLY THE BEST IN EQUIPMENT SERVICE AND VALUE. THIS MONTH WE'RE FEATURING THE ICOM LINE OF QUALITY EQUIPMENT WITH A RADIO FOR EVERY VHF NEED.

IC230

PLL Synthesized for stable, clean operation. Repeater and simplex at your finger tips with 10 watts of power.

IC22S

Forget about ever buying crystals again! 22 channel capability on a receiver that really pulls in the weak ones. Priced right for every budget.

IC215

The FM Grabber. 3 watts of fun with 5 channels of crystals supplied. Now you can take it with you.

EXTRA SPECIAL THIS MONTH . . . ICOM SSB

IC202

2 meter SSB. 3 watts PEP that will astound you with it's range and sensitivity. A whole new world of 2 meter fun.

IC502

6 meter SSB that's a real handful. When the band opens a whole continent is at your call.

Call, write or stop by and see for yourself how easy it is to step up to simply the best. And don't forget to ask for our free catalog so you can shop with confidence for all your amateur needs.

ATTN: MOTOROLA FANS

NEXT MONTH we'll feature a huge Motorola Goodies List just for You.

SPECTRONICS, INC.

1009 GARFIELD
OAK PARK, IL. 60304
312-848-6777
TELEX 72:8310

HOURS

STORE HOURS:
Mon-Thurs 9:30-6:00, Fri. 9:30-8:00
Sat. 9:30-3:00, Closed Sun. & Holidays.

More Details? CHECK—OFF Page 126

a revolutionary concept in kit building...

THE PROGRAMMABLE CLOCK KIT! $27.95

SYSTEM 5000 is the first full-feature timepiece available in programmable form. After the circuit has been assembled and tested, all that is necessary is to add the appropriate switches and jumpers to easily program the system for the desired functions. The system may be expanded or reprogrammed at any time.

This represents a revolutionary concept in adaptability and flexibility. Build an Alarm/Clock/Calendar or a full feature Desk or Radio Station clock. Use the DUPLICATE TIME REGISTER to monitor GMT, another time zone, or as an elapsed timer. Add the optional relay to control AC or DC accessories. The possibilities are limited only by your imagination.

features

TIME OF DAY REGISTER • DUPLICATE TIME REGISTER • FOUR YEAR CALENDAR - month/day or day/month format • ALARM WITH SPEAKER TONE OUTPUT • ADDITIONAL ALARM – use for "his and hers" alarm or activate an accessory at a preset time • 10 MINUTE SNOOZE & "ID" REMINDER • 3 FUNCTION ALARM OUTPUT SELECT – tone, relay, or relay then tone • ONE HOUR DOWN COUNTER • BRIGHT FLUORESCENT DISPLAY – .5" blue or green digits with AM/PM • AUTOMATIC DISPLAY DIMMING • POWER FAILURE INDICATION • 12 & 24 HOUR DISPLAY • BLINKING OR STEADY COLON • SIMPLE FORWARD AND REVERSE TIME SETTING • DIRECT DRIVE ELIMINATES RFI • SINGLE 9 VOLT BATTERY BACKUP • DISPLAY SECONDS CONTROL • HOLD AND RESET CONTROLS • 50/60 HZ OPERATION • 700 WATT RELAY OUTPUT OPTIONAL

SYSTEM 5000 includes all components, 2 time setting switches, and complete assembly and programming manuals. Switches for additional functions and relay are not included but are available as options. Case not included. Specify blue or green display.

RELAY OPTION – $4.00
Includes 700 watt relay and all interface components. Will control AC or DC accessories such as appliances, stereos, etc.

SWITCH OPTION – $3.75
Contains 4 black SPST pushbuttons, 2 black DPDT pushbuttons, and 2 black SPST slide switches. *Programs all major features.*

add a new dimension to time itself...
SERIES 2000 Decorator Clocks

A bright Fluorescent display provides easy to read numbers that brighten and dim automatically according to the light. The clear Acrylic tube with Acrylic or Hardwood end blocks gives these clocks a unique look of simple elegance. AM/PM & power failure indication. Seconds display button. 3½" x 3½" x 5¾". 50/60 HZ

Specify blue or green display, 12 or 24 hour time, and choice of Hardwood – Walnut, Zebrawood, or Rosewood.

FACTORY ASSEMBLED – 1 YEAR WARRANTY

EC-2001	Solid Acrylic "Time Capsule"	$59.95
EC-2002	Acrylic & Hardwood	$49.95

COMPLETE KITS – 90 DAY WARRANTY

EC-2001-K	Solid Acrylic	NEW!	$34.95
EC-2002-K	Acrylic & Hardwood	SPECIAL!	$29.95

Send your check or money order today for fast delivery. Add $1.00 per clock to cover shipping and insurance. Money back guarantee on all products if not fully satisfied. N.J. residents add 5% sales tax. Use your Master Charge or BankAmericard. Phone orders accepted.

digital concepts

DIGITAL CONCEPTS CORPORATION
249 Route 46, Saddle Brook, N.J. 07662
201/845-7101

ANNOUNCING

The Midwest's Newest Amateur Radio Dealer

MID COM ELECTRONICS, INC.

2506 S. BRENTWOOD BOULEVARD
ST. LOUIS, MISSOURI 63144

Phone (314) 961-9990

AMATEUR RADIO SALES AND SERVICE

We Stock:

Atlas
Collins
Drake
Hustler
Hy-Gain
Icom
Info-Tech
Kenwood
Mosley
Regency
Standard

PLUS MANY OTHER LINES

master charge
Your BankAmericard welcome here

REMOTE CONTROLLED ANTENNA SWITCH

- The SW-5 is a heavy-duty remote controlled RF switch. Handles 4 kW PEP with negligible insertion loss and SWR below 30 MHz. Housed in rugged, weather-proof enclosure.
- Safe, low-voltage operation from 26 VDC supply in control unit.
- Indicator lights show at a glance which antenna is in use.
- Requires six-wire control cable. Ham-M cable satisfactory to 150 feet.
- Models from 3 to 9 positions. Optional connectors and special switching systems are available.
- Five position Model SW-5, **$87.50**
(Shipping $3.00 in USA — IA res. add 3%)

ANTENNA MART
Box 1010 ISU Station
Ames, IA 50010
Phone: 515-292-7114

More Details? CHECK–OFF Page 126

BIG HELP FOR SMALL BUCKS.

Design Mate 1 Circuit Designer 790 solderless breadboarding tie-points; adjustable 5-15VDC 1%-regulated supply; 0-15VDC meter. **$54.95***

Used to be, filling your bench with really good test equipment meant emptying your wallet. Because you had to pay a price for quality and versatility. A high price.

Not anymore. CSC's ingenious new Design Mate™ line of test equipment combines performance high enough for most lab applications with the kind of versatility and economy everyone can afford. Thanks to a number of new design concepts and manufacturing techniques.

Proof? Check the specs and prices, then visit your CSC dealer for a demonstration. Or write for our catalog and distributor list.

Design Mate 2 Wide-Range Function Generator 1Hz-100KHz sine, square, triangle waves with low distortion, 100mV-10V P-P output. **$69.95***

Design Mate 3 Precision R/C Bridge Fast, easy measurements of resistance (10 ohms-10 meg) and capacitance (10pF-1uF) within 5%-of-dial accuracy. **$59.95***

CONTINENTAL SPECIALTIES CORPORATION

CSC

EASY DOES IT

44 Kendall Street, Box 1942
New Haven, CT 06509 • 203-624-3103 TWX: 710-465-1227
West Coast office: Box 7809, San Francisco, CA
94119 • 415-421-8872 TWX: 910-372-7992

*Manufacturer's suggested list
Prices and specifications subject to change without notice

More Details? CHECK—OFF Page 126

INTRODUCING THE

ALL MODE LINEAR AMPLIFIER FOR 2 METERS

For use with the many new all-mode 2 meter transceivers, typified by the Kenwood TS-700A.

SPECIALTY COMMUNICATIONS SYSTEMS MODEL 2M10-70L

SCS's AMPS ARE BUILT FOR ALL MODES OF OPERATION!

Want more power on FM? You've got it with the SM10-70L. Want more power on SSB? Just flip the switch on the 2M10-70L and you've got it.

A *TRUE* 70 WATT P.E.P. OUTPUT with 10 watts input.

WITH LOWER INPUT POWER, THE 2M10-70L GIVES APPROXIMATELY A 10 dB GAIN.

SCS's ALL MODE LINEAR AMPS ARE FULL CAPACITY PRODUCTS!

Not economy lines. The Model 2M10-70L is the finest linear amplifier for 2 meters that can be purchased. Components are of the highest quality.

- All solid state—microstripline design.
- Broadband—requires no tuning across band.
- Variable T-R delay for SSB/CW operation.
- Full VSWR and reverse voltage protection.
- Under 1 dB insertion loss in receive or bypass mode.
- Harmonics levels typically -40 dB or better.
- Measures only 7.1 x 10.2 x 16.5 cm. Wt. 1 kg.
- One year warranty on entire unit.

$139.95

If not available at your dealer, tell him to get up to date, and call the SCS factory for name of your nearest SCS dealer.

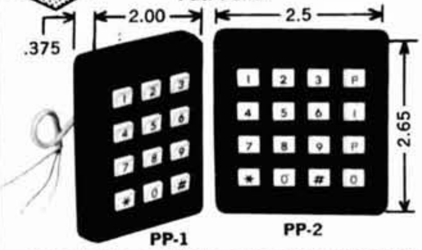
SCS SPECIALTY COMMUNICATIONS SYSTEMS, INC.

8160 Miramar Road, San Diego, CA 92126 • Louis N. Anciaux • WB6NMT

TROUBLE FREE

TOUCH-TONE ENCODER

Pat. Pend.



- **POSITIVE TOUCH (KEYS DEPRESS)**
- **MOBILE • HANDHELD • DESK-MOUNT**
- **NO POTTED PARTS (SERVICEABLE)**
- **MIL. SPEC. COMPONENTS**
- **SELF-CONTAINED • NO RFI**
- **LOW DISTORTION, HI OUTPUT**
- **LEVEL ADJUSTMENT ACCESSABLE FROM FRONT**

Supplied with: Instructions, schematic, template, hardware. Operating voltage: 4.5-16V. **PP-1=$55.00, PP-2=$58.00, PP-1A=$68.00** PP-1A, designed for Standard Communications handhelds. (Calif. Res. add 6% Sales Tax). One day installation available from Pipo. New MK5086 by Mostek.

Available at: Channel Radio and Electronics, Santa Barbara, California.

Mail Order To: **Pipo Communications**

P.O. Box 3435
Hollywood, California 90028
(213) 852-1515

LEARN RADIO CODE

$9.95

Album contains three 12" LP's 2½ hr. instruction

THE EASY WAY!

Based on modern psychological techniques — This course will take you beyond 13 w.p.m. in LESS THAN HALF THE TIME!

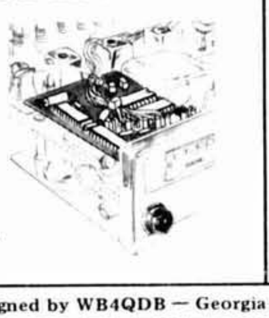
- No Books To Read
- No Visual Gimmicks To Distract You
- Just Listen And Learn

Available in Cassette also for only $10.95.

EPSILON RECORDS

508 East Washington St., Arcola, IL 61910

HW-202 SCANNER

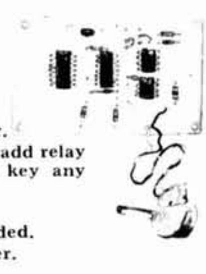


*No holes to drill. Easy installation.
*Doesn't interfere with tone encoder.
*Mounts neatly over power board, completely inside radio.
*Six bright L.E.D.'s visible through semi-transparent meter panel.
*Stops scanning when either signal is heard or manual selection is made.
*Built-in squelch addition eliminates all noise when scanner is scanning.
*Designed especially for your HW-202.
*Assembled.

ONLY
$25.95 ppd.

NEW ELECTRONIC KEYER

LOWEST PRICE EVER



*3-50 WPM.
*Self-completing dots and dashes.
*Has speed control.
*Has automatic weight control.
*Built-in side tone to drive small speaker.
*Use directly with grid block keying or add relay (not included) as per instructions to key any transmitter.
*Use 3 penlight cells.
*Solder plated board. Instructions included.
*Just add your key, batteries and speaker.

Kit — $12.97 ppd.
Assembled — $16.97 ppd.

Designed by WB4QDB — Georgia Residents Include 3% Sales Tax

SANDLIN ELECTRONICS ENGINEERING

P. O. Box 4909 / Martinez, Georgia 30907 / Telephone (404) 863-5852

More Details? CHECK—OFF Page 126

Whatever Santa Says . . . Will be Sharper, Clearer and VALUE PACKED! With the Incredible

This Holiday Season look for value, look for performance. Then buy the Worlds Finest Amateur Transceiver. GENAVE!

GTX-1 or GTX-1T HAND-HELD 2-Meter FM Transceiver

CHECK THESE FEATURES:

- All Metal Case
- American Made
- Accepts standard plug-in crystals
- Features 10.7 MHz crystal filter
- Trimmer caps on TX and RX crystals
- 2.5 watts output
- Battery holder accepts AA regular, alkaline or nicad cells
- Mini Handheld measures 8" high x 2.625 wide x 1.281 deep
- Rubber ducky antenna. Wrist safety-carrying-strap included
- 6 Channels
- Factory-direct to You

Accessories Available:

- Nicad Battery Pack
- Charger for GTX-1 battery pack
- Leather carrying case
- TE III Tone Encoder for auto patch

GTX-200-T

2-meter FM, 100 channel combinations, 30 watts with factory installed tone encoder (Incl. 146.94 MHz) **$249.95**

GTX-200

2-meter FM, 100 channel combinations, 30 watts (Incl. 146.94 MHz) **$199.95**

GTX-10-S

2-meter FM, 10 channels, 10 watts (Xtals not included) **$149.95**

GTX-2

2-meter FM, 10 channels, 30 watts with pushbutton frequency selector (Incl. 146.94 MHz) **$189.95**

GTX-I GTX-IT

2-meter FM, 6-channel, 3.5 watts Hand-Held ***$249.95**

Same as GTX-1, plus factory installed Tone Encoder ***$299.95**

*(Bat. not incl.)

TONE ENCODER PAD Plug in installation on most amateur transceivers

TE-II **$49.95** TE-I **$59.95**

HURRY!

Use This Handy Order Form

Genave

4141 Kingman Dr., Indianapolis, IN 46226
Phone-in orders accepted (317+546-1111)

NAME ______

ADDRESS ______ CITY ______

STATE & ZIP ______ AMATEUR CALL ______

☐ GTX-200-T	$249.95
☐ GTX-200	$199.95
☐ GTX-10-S	$149.95
☐ GTX-2	$189.95
☐ GTX-1	$249.95
☐ GTX-IT	$299.95
☐ Ringo Ranger ARX-2 6db 2-M Base Antenna	$29.95
☐ Lambda/4 2-M and 6-M Trunk Antenna	$29.95
☐ TE-I Tone Encoder Pad	$59.95
☐ TE-II Tone Encoder Pad	$49.95
☐ PS-I AC Power Supply for use with all makes of transceivers 14 VDC—6 amp	$69.95

and the following **standard** crystals @ $4.50 each ______ $______
Non-standard crystals @ $6.50 each: ______ $______

Payment by:
☐ Certified Check/Money Order ☐ Personal Check
☐ C.O.D. Include 20% Down

Note: Orders accompanied by personal checks will require about two weeks to process.
20% Down Payment Enclosed. Charge Balance To:

☐ BankAmericard #______ Expires ______
☐ Master Charge #______ Expires ______
☐ Interbank #______ Expires ______

IN residents add 4% sales tax:
CA residents add 6% sales tax: } $______

HR *All orders shipped post-paid within continental U.S.*

ACCESSORIES FOR GTX-1 and GTX-1T

☐ **PSI-18** Optional Nicad battery pack	$29.95
☐ **PS-2** Charger for GTX-1(T) battery pack	$39.95
☐ **GLC-1** Leather carrying case	$12.95
☐ **TE-III** Tone Encoder (for use with GTX-1)	$49.95

Add $4 per Radio for Shipping, Handling, and Crystal Netting.

More Details? CHECK—OFF Page 126

EBC-144 Jr.

The Ultimate In Versatility.

ONLY THE EBC-144 JR. HAS:

- ★ All Repeater Offsets
- ★ More than 20 Watts of R.F.
- ★ Better than .35 μV Sensitivity
- ★ Dynamic Microphone
- ★ Full Coverage 143.3 to 148.5 MHz
- ★ Two Frequency Monitoring
- ★ More than 4 Watts of Audio
- ★ Lighted Front Panel
- ★ Selectivity with 10 Poles of Crystal Filtering

AVAILABLE NOW FOR ONLY **$529.95**
For your EBC-144 Jr. send $529.95. . .
. . . we'll pay the shipping.

Need to be Convinced? . . . Write:
15 River Street, New Rochelle, N.Y. 10801 (914) 235-9400

emergency beacon corp.
(A Public Corporation)

This is easy- anyone can solder- WITH KESTER SOLDER

KESTER SOLDER

Handymen! Hobbyists! DO-IT-YOURSELFERS!

Let Kester Solder aid you in your home repairs or hobbies. For that household item that needs repairing — a radio, TV, model train, jewelry, appliances, minor electrical repairs, plumbing, etc. — Save money — repair it yourself. Soldering with Kester is a simple, inexpensive way to permanently join two metals.

When you Solder go "First Class" — use Kester Solder.

For valuable soldering information send self-addressed stamped envelope to Kester for a FREE Copy of "Soldering Simplified".

KESTER SOLDER
Litton 4201 WRIGHTWOOD AVENUE/CHICAGO, ILLINOIS 60639

IF WE WERE YOU

MODEL 6154 TERMALINE®

I'D BUY FROM US

YOUR INQUIRY OR ORDER WILL GET OUR PROMPT ATTENTION

AUTHORIZED

BIRD DISTRIBUTOR

WEBSTER COMMUNICATIONS
115 BELLARMINE
ROCHESTER, MI 48063
313-375-0420

More Details? CHECK–OFF Page 126

SWAN METERS HELP YOU GIVE IT YOUR ALL

SWR Bridge for 21.95

Our little dual meter SWR bridge indicates relative forward power and SWR simultaneously.

The unit is capable of handling up to 1000 watts and will indicate 1:1 to infinity VSWR from 3.5 MHz to 150 MHz on 100 microampere meters. Ideal for mobile or home operation with low in-line insertion loss.

Use your Swan credit card. Applications at your dealer or write to Swan.

SWAN® ELECTRONICS
A subsidiary of Cubic Corporation
305 Airport Rd. Oceanside, CA
92054 (714)
757-7525

(Prices FOB Oceanside, CA)

CLOCKS

6 digit AUTOMOTIVE CLOCK KIT complete with a CRYSTAL TIMEBASE accurate to .01 percent. 12 volts d.c. operation — built in noise suppression and voltage spike protection. Readouts blank when ignition is off — draws 25 mA in standby mode. Has .3 in. readouts. Use it in your car or for all applications where a battery-operated clock is needed. Approximate size 3" x 3.5" x 1.75"

WITH BLACK PLASTIC CASE	$34.95 ppd.
WITHOUT CASE	$29.95 ppd.
ASSEMBLED AND TESTED	$45.95 ppd.

CMOS CRYSTAL TIMEBASE KITS with .01 percent accuracy. 5-15 v.d.c. operation. Draws only 3 mA at 12 volts. Single I.C. — very small size — the P.C. board is 7/8" x 1-5/8". Choose a main output of 50 or 100 Hz., 60 Hz., 500 or 1000 Hz., or 1 Hz. Several related frequencies are also available on each board, in addition to the main ones listed above. Be sure to specify the Frequency you want. All kits are $10.95 ppd.

Flyer available —

NEXUS TRADING CO.

Box 3357 San Leandro, Ca 94578

COMMUNICATION ENGINEER

We can turn your interests in amateur radio into full time career involvement. Heath is a company with interest and committment to ham radio. For 25 years, our professional staff has maintained the close ties we feel with amateur radio through products and their service to the ham community. This is a committment of all the hams at Heath including the President.

If you would like to share our excitement and involvement, we would like to hear from you. The successful candidate will have a BSEE or MSEE and a minimum of 3 years experience in the design of communication equipment. You will have an opportunity to take on total responsibility of new receivers, transmitters, and accessories from initial concept to showing at professional ham-fests. Of course we would like you to be a licensed operator.

We are located on the shore of Lake Michigan and enjoy a relaxed lifestyle in an area full of lakes and forests. Heath offers competitive salary, excellent benefits and good prospects for advancement.

Come grow with us, join the hams at Heath. Send your resume, in confidence to:

HEATH COMPANY
Personnel Dept.
Benton Harbor, Mich. 49022

HEATHKIT®

An Equal Opportunity Employer M/F

More Details? CHECK—OFF Page 126

More Details? CHECK—OFF Page 126

More Details? CHECK—OFF Page 126

flea market

RATES Non-commercial ads 10¢ per word; commercial ads 40¢ 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). Repeat insertions of hamfest ads pay the non-commercial rate.

COPY No special layout or arrangements available. Material should be typewritten or clearly printed and must include full name and address. We reserve the right to reject unsuitable copy. **Ham Radio** can not 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.

NEW ADJUSTABLE THREE OUTPUT REGULATED POWER SUPPLY, plus 900 parts worth $400.00 list. Solid state TV recorder electronic unit. Schematics, parts cross reference. Free brochure. $17.95 plus $3.50 S&H, USA. Master Charge, BankAmericard. Satisfaction guaranteed. Madison Electronics Company, Incorporated, Box 369, D77, Madison, Alabama 35758.

STOP don't junk that television set. ASE manufactures the world's most complete line of television picture tubes. Over 1700 types. Most types immediate delivery. Tubes for Old or New TV's, black & white and color. 2 year factory warranty. Lowest prices anywhere. Allied Sales & Engineering, Inc., Dept. 22, Pimento, IN 47866. Telephone 812-495-6555.

TELETYPE EQUIPMENT for beginners and experienced operators. RTTY machines, parts, supplies. Beginner's special: Model 15 Printer and demodulator $139.00. Dozen black ribbons $6.50; case 40 rolls 11/16 perf. tape $17.50 FOB. Atlantic Surplus Sales, 3730 Nautilus Ave., Brooklyn, N. Y. 11224. Tel: (212) 372-0349

VARIABLE CONDENSORS, Johnson 154-3, 19-488pt, 2KV, used, excellent condition, $12 each or 3 for $30, postpaid. KP4DSD, Box 297, Sabana Seca, P. R. 00749.

WANTED BADLY, used but in A1 operation Hallicrafters model HA-10, LF/MF tuner — write or call Ralph Klein W9DKH, 1106 Manitou St., Manitowoc, WI zip 54220. Telephone area code (414) 684-5203 - stating price wanted.

VERY in-ter-est-ing! Next 4 big issues $1. "The Ham Trader," Sycamore, IL 60178.

AN/URM-120 INLINE WATTMETER, like Sierra 164, 3 elements, 2-1000MHz, 4 power ranges $150. Tektronix 317 scope, 10 MHz, $300. AN/USM-140D (HP-170A copy) with dual trace wide band plug-in, $325. AN/USM-44A (like HP-608D) 10-420 MHz, piston attenuator $400. AN/URM-25D signal generator 10kHz-50MHz, decade attenuator, less accessories $175. Bird 8890 load, 2.5 kw, $150. All instruments in good condition with manuals. James Walter, 2697 Nickel, San Pablo, Ca. 94806.

SYNTHESIZER. See Ham Radio, July 76, pg. 20-23, figures 21 to 24. Kit for $115, assembled and tested, $140. Power supply to run from 117 volts additional $15.00. CTD, P. O. Box 708, Cambridge, MA 02139.

SAVE! Bomar FM, xtals $4.00 ppd. Dentron. Hustler, CushCraft, W. M. Nye, Ameco. Used gear. Complete catalog - write Ferris Radio, 308 E. Harry, Hazel Park, Mich. 48030.

RECONDITIONED TEST EQUIPMENT for sale. Catalog $.50. Walter, 2697 Nickel, San Pablo, Ca. 94806.

FREQUENCY COUNTER BOARDS, Jan. 76 Ham Radio includes 500 MHz prescaler circuitry and LED board with instructions, $15.00. QST March 76 speech compressor, $10.00. Both projects come with parts source listing. Double sided glass epoxy, drilled and plated. CSJ Electronics, 5807 Brookview Drive, Lincoln, NE 68506.

MOBILE IGNITION SHIELDING provides more range with no noise. Available most engines. Many other suppression accessories. Literature, Estes Engineering, 930 Marine Dr., Port Angeles, WA 93862.

NEW ELECTRONIC SURPLUS for amateurs and industry. Forward SASE for bargain list. Electronics Warehouse, 805 North Hazelwood Avenue, Youngstown, Ohio 44509.

LOOKING FOR USED GEAR? Buyers & Sellers radio brokerage has the equipment you want at the right prices. Call our Ham Gear Hotline 617-536-8777 Monday-Friday, 9-9.

NEW TELEVISION CAMERAS, color video recorders, ridiculous prices! Haas Enterprises, 6017 Majorca Ct., San Jose, California 95120. (408) 997-0132.

GOVERNMENT SURPLUS Communication Equipment, FREE catalog. Colonel Russell, 9410 Walhampton, Louisville, KY 40222.

BUY — SELL — TRADE. Write for free mailer. Give name, address and call letters. Complete stock of major brands, new and reconditioned equipment. Call for best deals. We buy Collins, Drake, Swan, etc. SSB & FM. Associated Radio, 8012 Conser, Overland Park, Ks. 66204. 913-381-5901.

FREE Electronics Surplus Catalog. Electronic Specialties, 1659 Wetmore, Tucson, AZ 85705.

SIGNAL/ONE REPAIRS. High SWR protection. K6BE/5. 505-522-3705.

HOMEBREWERS: Stamp brings list of high quality components. CPO Surplus, Box 189, Braintree, Mass. 02184.

TWO COLLINS 426T-1 POWER SUPPLIES — Physically perfect, electrically unknown, $75.00 each. Heathkit IM-104, $80.00; Superior TV-50A sig. gen., $30.00; Knight KG670 R/C tester, $25.00. WB5MMM, 513 Saturn, Altus, Okla. 73521.

COMPLETE LINE KLM, CushCraft, Covercraft dust covers, SCS amplifiers, Regency, Triex Towers. Call or write Radios Unlimited, 86 Balch Ave., Piscataway, N. J. 08854. 201-752-4307.

FOR SALE: Heath Apache, Mohawk and SB-10. Good condition. $225 package deal only. Prefer New England sale. Ronald Herman, 13 Simpson Road, Windham, N. H. 03087.

500 MHz PRESCALER ÷10 or ÷100 $59.95. Free information. CBS Enterprise, P. O. Box 1356, Cocoa Beach, Fla. 32931.

NAMEBADGES $1.25 — Name and call sign $1.75. Engraved plastic with pin or clutches. Black, white, red, blue. Include payment with order. Special prices on club badges and hamfest plaques. Donan Engraving, 1660 Marlowe Avenue, Lakewood, Ohio 44107.

DIRECT CONVERSION RECEIVER KITS for AM or CW. Write WB9MBH, 3132 North Lowell Avenue, Chicago, Illinois 60641.

WANTED: Collins 51J4/R388, R390A, 51S1, 651S1; HRO500, R1051. Tektronix 545, 547, etc. Condition not important, but price is! Send condition and price to ship. H. Kolesnik, WBØRVG, 10727 E. Dorado P., Englewood, Colo. 80110.

FERRITE BEADS: Ferroxcube beads w/specification and application sheet — 10 @ $1.00 postpaid. Includes latest catalog. CPO Surplus, Box 189, Braintree, Mass. 02184.

SALE: Send SASE for big list of lifetime collection of electronic goodies. John Rogers, 1927 W. Barry, Chicago, Ill. 60657.

YAESU EQUIPMENT OWNERS — Present or Prospective — Join the five-year-old, 2000-member, 40-country, International Fox-Tango Club. Members receive valuable monthly Newsletter, money-saving purchasing service, technical committee consultation, free ads, FT net, more. Back issues of Newsletter available from 1972. To join, send $5 for calendar year (includes all 1976 issues of Newsletter) or $1 creditable towards dues, for complete information and sample Newsletter. Milton Lowens, WA2AOQ/4, 248 Lake Dora Drive, W. Palm Beach, Fl. 33411.

HA5 VFO 80-2M (all xtals) $45.00, TX62 6-2M AM/CW, 75W, $75.00. (W6RQZ) 1330 Curtis, Berkeley, Ca. 94702. (415) 526-7345.

TELL YOUR FRIENDS about Ham Radio Magazine!

flea market

HOOSIER ELECTRONICS — Your Ham Headquarters in the heart of the Midwest. Factory-authorized dealers for Kenwood, Collins, Drake, ICOM, Ten-Tec, Regency, Atlas, Tempo, Swan, Alpha, Standard, Hy-Gain, Mosley, Antenna Specialists, Dentron, CushCraft, CDE, and others. For the best deal around on HF or VHF gear, see us first or see us last, but see us before you buy! Write or call today for our low quote and become one of our many happy and satisfied customers. Hoosier Electronics, P. O. Box 2001, Terre Haute, Indiana 47802. (812) 238-1456.

RUBBER STAMP, name/call/QTH $2.50 ppd. (CA residents add tax). LWM Press, Box 22161, San Diego, CA 92122.

BIND Ham Radio into books yourself. No messy gluing. Illustrated instructions. Send $2.50 to Teeter, Dept. 1011, 6123 West Hills Road, Fort Wayne, IN 46804.

FIGHT TVI with the RSO Low Pass Filter. For brochure write: Taylor Communications Manufacturing Company, Box 126, Agincourt, Ontario, Canada. MIS 3B4.

WANTED, low priced transceiver. Need not be working. State price and condition. Bob, WA2YGJ, Apt. 25, 11 Arthur St., Binghamton, N. Y. 13905.

PORTA-PAK the accessory that makes your mobile really portable. $67.50 and $88.00. Dealer inquiries invited. P. O. Box 67, Somers, Wisc. 53171.

LARSEN ANTENNAS (our specialty) 2,432 magnetic, trunk-lip 5/8 $33.00, 5/8 ground plane $45.00. BankAmericard and Mastercharge accepted. 201-962-4695. Narwid Electronics, 61 Bellot Road, Ringwood, NJ 07456.

NEW CANADIAN MAGAZINE. "Electronics Work Shop". $5.00 yearly, sample $1.00. ETCOB, Box 741, Montreal, H3C 2V2.

BUILD THIS COLOR TV CAMERA FOR ABOUT $400. Plus list of deflection yokes, focus coils and ampex spare boards — all in flyer 976A4. Copy free on request. Denson Electronic Corp., P. O. Box 85, Rockville, Conn. 06066.

SWAN, 1200X, linear amplifier, new, in sealed carton, $250. Russell, 19680 Mountville Dr., Maple Hts., Oh. 44137.

WANTED: Harvey-Wells Bandmaster Deluxe with VFO. Give condition and lowest acceptable price. Rittman, P. O. Box 7461, Las Vegas, Nevada 89101.

QRP TRANSMATCH for HW7, Ten-Tec, and others. Send stamp for details to Peter Meacham Associates, 19 Loretta Road, Waltham, Mass. 02154.

NOVICES, OTHERS: Get un-used 5¢ Radio Amateur Stamp — Info free — S.A.S.E. please. Postals ignored. W6LM, Box 308, Wrightwood, Calif. 92397.

TRAVEL-PAK QSL KIT — Send call and 25¢; receive your call sample kit in return. Samco, Box 203, Wynantskill, N. Y. 12198.

FOR SALE: Burroughs L-2000 with A-562 paper tape punch and A-581 paper tape reader. Excellent condition. John Crosby, K4GBL, 308 Residence Avenue, Albany, GA 31707. Phone: (912) 883-4420.

ARTS ON 7103 KHZ DAILY 1300Z to 1900Z for emergency or routine traffic. Amateur Radio Telegraph Society, 2730 South Tabor Avenue, Silver City, New Mexico 88061.

SYNTHESIZER, see Ham Radio, July 76, pg. 20-23, figures 21-24. Kit for $115. Assembled and tested, $140. Power supply to run from 117V additional $15. CTD, P. O. Box 708, Cambridge, MA 02139.

WANTED: Car telephones and mobile telephone parts, heads, cables, etc. Greg Hyman, 87 Yonkers Ave., Yonkers, N. Y. 10701. 914-476-4330.

TECH MANUALS for Govt. surplus gear — $6.50 each: SP-600JX, URM-25D, OS-8A/U, PRC-8, 9, 10. Thousands more available. Send 50¢ (coin) for 22-page list. W3IHD, 7218 Roanne Drive, Washington, D. C. 20021.

MANUALS for most ham gear, 1939/70. List $1.00. Send SASE (or 25¢) for one specific model quote. Hobby Industry, WØJJK, Box H864, Council Bluffs, Iowa 51501.

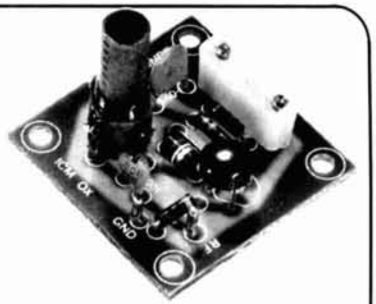
SELLING — Good Clegg 22ER MK11, 2 meter transceiver. AC-DC operation. VFO extra. New final amplifier manual $143. Unused Astatic D104 mike, G stand dynamic 100A mike $27. Unused Bolex 8mm turret cinema camera xvar 2.5 and Lytar 2.5 lens, leather case, manual $62. Shipping prepaid. If interested make offer. George Konnick, Apt. C5, 1750 West Main Street, Riverhead, New York 11901.

More Details? CHECK—OFF Page 126

for the experimenter!

INTERNATIONAL CRYSTALS & KITS

OSCILLATORS • RF MIXER • RF AMPLIFIER • POWER AMPLIFIER



OX OSCILLATOR

Crystal controlled transistor type. 3 to 20 MHz, OX-Lo, Cat. No. 035100. 20 to 60 MHz, OX-Hi, Cat. No. 035101

Specify when ordering.

$3.95 ea.

MXX-1 TRANSISTOR RF MIXER

A single tuned circuit intended for signal conversion in the 30 to 170 MHz range. Harmonics of the OX or OF-1 oscillator are used for injection in the 60 to 179 MHz range. 3 to 20 MHz, Lo Kit, Cat. No. 035105. 20 to 170 MHz, Hi Kit, Cat. No. 035106

Specify when ordering.

$4.50 ea.

PAX-1 TRANSISTOR RF POWER AMP

A single tuned output amplifier designed to follow the OX or OF-1 oscillator. Outputs up to 200 mw, depending on frequency and voltage. Amplifier can be amplitude modulated. 3 to 30 MHz, Cat. No. 035104

Specify when ordering.

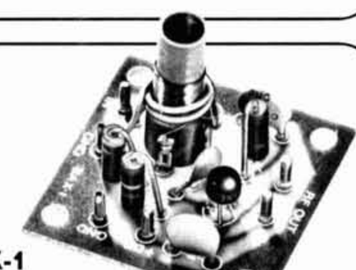
$4.75 ea.

OF-1 OSCILLATOR

Resistor/capacitor circuit provides osc over a range of freq with the desired crystal. 2 to 22 MHz, OF-1 LO, Cat. No. 035108. 18 to 60 MHz, OF-1 HI, Cat. No. 035109

Specify when ordering.

$3.25 ea.



SAX-1 TRANSISTOR RF AMP

A small signal amplifier to drive the MXX-1 Mixer. Single tuned input and link output. 3 to 20 MHz, Lo Kit, Cat. No. 035102. 20 to 170 MHz, Hi Kit, Cat. No. 035103.

Specify when ordering.

$4.50 ea.

BAX-1 BROADBAND AMP

General purpose amplifier which may be used as a tuned or untuned unit in RF and audio applications. 20 Hz to 150 MHz with 6 to 30 db gain. Cat No. 035107

Specify when ordering

$4.75 ea.

.02% Calibration Tolerance

EXPERIMENTER CRYSTALS

(HC 6/U Holder)

Cat. No.	Specifications	
031080	3 to 20 MHz — for use in OX OSC Lo *Specify when ordering*	$4.95 ea.
031081	20 to 60 MHz — For use in OX OSC Hi *Specify when ordering*	$4.95 ea.
031300	3 to 20 MHz — For use in OF-1L OSC *Specify when ordering*	$4.25 ea.
031310	20 to 60 MHz — For use in OF-1H OSC *Specify when ordering.*	$4.25 ea.

Shipping and postage (inside U.S., Canada and Mexico only) will be prepaid by International. Prices quoted for U.S., Canada and Mexico orders only. Orders for shipment to other countries will be quoted on request. Address orders to: M/S Dept., P.O. Box 32497, Oklahoma City, Oklahoma 73132.

ICM

International Crystal Mfg. Co., Inc.
10 North Lee
Oklahoma City, Oklahoma 73102

More Details? CHECK—OFF Page 126

flea market

THE PERFECT GIFT FOR A HAM — His/her callsign cut into solid redwood. Type one: just the call, approximately 18″ x 5½″, $7.50. Type two: the call plus any handle, seven letters or less, approximately 18″ x 9½″, $12.50. Callsigns Ltd., P. O. Box 101, Hurley, N. Y. 12443. N. Y. State residents add sales tax.

FOR SALE: Many rare issues of Ham Radio, 73 and QST. SASE for listing and prices. W. J. Schuch, P. O. Box 815, Destin, Fla. 32541.

SIDESWIPER only **$13.** Airmailed USA. Kungsimport, Box 257, Kungsbacka, Sweden.

FOR SALE: SB220 linear, pick-up deal $370. SX111 receiver $90. William Karl, W2EGX, 24 Mill Street, Cooperstown, N. Y. 13326.

MOTOROLA HT220, HT200, Pageboy, and other popular 2M FM transceiver (Standard, Regency, etc.) service and modifications performed at reasonable rates. WA4FRV (804) 320-4439 evenings.

B&K TEST EQUIPMENT. 15% discount. Free shipping. Free catalog. Spacetron, Box 84J, Broadview, IL 60153.

CANADIAN JUMBO SURPLUS and Parts Catalogs. Bargains Galore. Send $1. ETCO-HR, Box 741, Montreal "A" H3c 2V2.

125-Hz CHYSTAL FILTER for Drake R-4C receivers. Ideal for DX and contest work, $125.00. Sherwood Engineering, Inc., Dept. G, 1268 So. Ogden St., Denver, CO 80210.

RTTY — NS-1A PLL TU (HR 8/76). Wired/tested $29.95 ppd. Board $4.75 ppd. SASE for info. Nat Stinnette Electronics, Tavares, FL 32778.

"GRINCH" offers parts, service, calibration and custom or prototype fabrication. Send S.A.S.E. for data: "GRINCH", 307 Jane Road, Cinnaminson, N. J. 08077.

TELETYPEWRITER PARTS, gears, manuals, supplies, tape, toroids. SASE list. Typetronics, Box 8873, Ft. Lauderdale, Fl. 33310. Buy parts, late machines.

FOR SALE: High power equipment — Two 833A tubes with sockets, $30. Two type 6156 tubes, $30. Two Taylor T300 in small cabinet with 1 KW supply (RF heater) $50. Transformer 6500VCT 3KVA, 2-872s, fil trans, chokes and filters, $75. Thratrons, high power controls, overload relays, $5 ea. Filter capacitors: 25.6UF 2kv, $10. 16MF, 650VAC PF $5. Panel meters, cheap. Equipment: Hewlett-Packard digital 521A, 521CR, 522B. Berkeley 5556, Computor Measurements Corp. 200B, $50 each. Mike Mitchell, 3564 Glenwood Ave., Toledo, Ohio 43610. Tel. 1-419-4761 or 1-419-536-4073.

QSL'S — BROWNIE W3CJI — 3035B Lehigh. Allentown, Pa. 18103. Samples with cut catalog 50¢.

WANTED: Wavetek Model 460 or equal crystal controlled T.V. sweep generator. Neil Van Gaalen, Box 578, Glenwood Springs, Co. 81601.

EXCLUSIVELY HAM TELETYPE 21st year, RTTY Journal, articles, news, DX, VHF, classified ads. Sample 35¢. $3.50 per year. Box 837, Royal Oak, Michigan 48068.

OSCAR 7, SSB-CW TRANSMIT CONVERTERS. For 28 or 50 MHz input at 20 mw. 432 MHz output at 1 watt. Solid state, for 12 volt supply. 35 watt solid state amplifier available for this converter. Units designed and built by WØENC. Write for information. UHF-VHF Communications, 53 St. Andrew, Rapid City, S. D. 57701.

CIRCUIT BOARDS. Artwork, negatives, etching. SASE for details. Karl Raup, WB4OXG, Box 8013, Orlando, Fla. 32806.

FREE! Over 100 electronics items. "Electronics Sourcebook" tells how, where to obtain free samples, manuals, publications. Write Technical Publications, 1405 Richland, Metairie, La. 70001.

VARIABLE AND TRIMMER CAPACITORS — Millen, Johnson, Hammarlund, Erie, Arco. In stock for immediate shipment, write for free price list "A". D & V Radio Parts, 12805 W. Sarle Rd., R#2, Freeland, Mich. 48623.

Coming Events

NEW YORK: The Kings County Repeater Association, will hold an indoor flea market on Sunday, December 19, 1976 from 9 a.m. to 4 p.m. Located at 910 Union St., Brooklyn, N. Y. (at Grand Army Plaza). Sellers $3, buyers $1. Children free. Refreshments available. Talk in on 146.43 and 146.52.

SPECIALS FROM MHz electronics

Fairchild VHF Prescaler Chips

11C01FC	High Speed Dual 5-4 Input no/nor	15.40
11C05DC	1 GHz Counter Divide by 4	74.35
11C05DM	1 GHz Counter Divide by 4	110.50
11C06DC	UHF Prescaler 750 MHz D Type flip/flop	12.30
11C24DC	Dual TTL VCM same as MC4024P	2.60
11C44DC	Phase Freq. Detector same as MC4044P	2.60
11C58DC	ECL VCM	4.53
11C70DC	600 MHz flip/flop with reset	12.30
11C83DC	1 GHz 248/256 Prescaler	29.20
11C90DC	650 MHz Prescaler Divide by 10/11	16.00
11C90DM	same as above except Mil. version	24.00
11C91DC	605 MHz Prescaler Divide by 5/6	16.00
11C91DM	same as above except Mil. version	24.00
95H90DC	350 MHz Prescaler Divide by 10/11	9.50
95H90DM	same as above except Mil. version	16.50
95H91DC	350 MHz Prescaler Divide by 5/6	9.50
95H91DM	same as above except Mil. version	16.50

Batteries

NI-CAD's AA cells 1.25 volts at 500 mahr.	$0.49 or 10/$3.95
Gel-Cell 12 volts at 1.5 Amp Hr. #GC-1215	$19.95

Crystals

1.000000 MHz	4.95
5.000000 MHz	4.95
10.000000 MHz	4.95
3579.545 KC	2.95

JUST ARRIVED! These radios have just been pulled out of service. Set up for approx. 150 MHz. Clean. All tubes included. No accessories. Prices FOB Phoenix.

Motorola U43 GGT	$49.95
GE TPL	$99.95
GE MT-33	$39.95

Motorola MC14410CP CMOS tone Generator uses 1 MHz Crystal to produce standard dual frequency telephone dialing signal. Directly compatible with our 12 key Chomeric pads. Kit includes the following.

1 MC14410CP
1 Touch Tone Pad
1 1 MHz Crystal
1 Printed Circuit Board (From Ham Radio Sept. 1975)
And all other parts for assembly.

$19.95

Fairchild 95H90DC Prescaler divide by 10 to 350 MHz. Will take any 35 MHz Counter to 350 MHz. Kit includes the following.

1 95H90DC
1 2N5179
2 UG-88/u BNC's
1 Printed Circuit Board
And all other parts for assembly.

$29.95

Fairchild 11C90DC Prescaler divide by 10 to 650 MHz. Will take any 65 MHz Counter to 650 MHz or with a 82S90 it will divide by 10/100 to 650 MHz. This will take a 6.5 MHz counter to 650 MHz. Kit includes the following.

1 11C90DC
1 2N5179
2 UG-88/U
1 MC7805CP
1 Bridge
1 Printed Circuit Board and all other parts for assembly.
82S90 add $5.70 to total.

$59.95

10.7 MHz Narrow Band Crystal Filter $7.95
Bandwidth 13 kHz
Type 2194F
Input & Output Impedance 2700 ohms.
Two Filters in series gives steeper sides & a 30dB Bandwidth of ± 15 kHz.

Johanson Trimmer Capacitors

.6 to 6 pf.	$1.95
.8 to 10 pf.	$1.95
1 to 14 pf.	$1.95
1 to 20 pf.	$1.95

Ferrite Beads
12 for .99 or 120 for 9.99

FET's

2N3070	1.50	2N5460	.90	MFE3002	3.35
2N3436	2.25	2N5465	1.35	MPF102	.45
2N3458	1.30	2N5565	5.45	MPF121	1.50
2N3821	1.60	3N126	3.00	MPF4391	.80
2N3822	1.50	MFE2000	.90	U1282	2.50
2N4351	2.85	MFE2001	1.00	MMF5	5.00
2N4416	1.05	MFE2008	4.20	40673	1.39
2N4875	1.75	MFE2009	4.80	40674	1.49

TUBES

2E26	4.00	DX415	25.00	7377	40.00
3B28	4.00	572B/T160L	25.00	7984	4.95
4X150A	15.00	811A	7.95	8072	32.00
4X150G	18.00	931A	11.95	8156	3.95
4CX250B	24.00	5849	32.00	8908	9.95
4X250F	25.00	6146A	4.75	8950	5.50
4CX250K	27.00	6146B/8298A	5.75		
4CX350A/8321	35.00	6907	35.00		

TRANSFORMERS

F-22A	6.3vct at 20 amps	$7.91
F-21A	6.3vct at 10 amps	5.77
F-18X	6.3vct at 6 amps	3.56
F-93X	6.5v to 40v at 750 ma.	3.53
F-92A	6.5v to 40v at 1 amp	4.59
F-91X	6.5v to 40v at 300 ma.	2.72
N-51X	Isolation 115vac at 35va.	2.80
Model D-2	6.5v at 3.3 amps 6.5v at 3.3 amps	4.95
C-912-034	22vct at 200 ma. 11v at 250 ma.	1.49
BE-12433-001	30v at 15 ma.	.49
C-404-024	18vct at 400 ma.	1.49
BGH-9	6.3vct at 10 amps 115 vac at 100va Isolation	6.95

Erie High Voltage Power Supply

TSK-209-000

Input 24vdc
output #1 100 vdc − 12.95
#2 400 vdc +
#3 15000 vdc
Size: 3½″ x 2″ x 2¾″

This power supply was used in a CRT Terminals

METERS

General Electric DC Volts 0-80 vdc Catalogue #50-152011 10.44

RF TRANSISTORS

2N1561	15.00	2N3866 JAN TX	4.85	2N5590	6.30
2N1562	15.00	2N3924	3.20	2N5591	10.35
2N1692	15.00	2N3925	6.00	2N5635	4.95
2N1693	15.00	2N3927	11.50	2N5636	11.95
2N2631	4.20	2N3948	2.00	2N5637	20.70
2N2857	1.80	2N3950	26.25	2N5643	20.70
2N2876	12.35	2N3961	6.60	2N5641	4.90
2N2880	25.00	2N4072	1.70	2N5643	20.70
2N2927	7.00	2N4073	2.00	2N5764	27.00
2N2947	17.25	2N4135	2.00	2N5841	11.00
2N2948	15.50	2N4427	1.24	2N5842/MM1607	19.50
2N2949	3.90	2N4430	20.00	2N5849/MM1622	19.50
2N2950	5.00	2N4440	8.60	2N5862	50.00
2N3287	4.30	2N4957	6.30	2N5942	49.50
2N3300	1.05	2N5070	13.80	2N5922	10.00
2N3302	1.05	2N5090	6.90	2N6080	5.45
2N3307	10.50	2N5108	3.90	2N6081	8.60
2N3309	3.90	2N5109	1.55	2N6082	11.25
2N3375/MM3375	7.00	2N5177/MRF5177	20.00	2N6083	12.95
2N3553	1.80	2N5179	.68	2N6084	14.95
2N3571	4.10	2N5180	.83	2N6094	5.75
2N3818	6.00	2N5184		2N6095	10.35
2N3824	3.20	2N5216	47.50	2N6096	19.35
2N3866	1.09	2N5583	5.60	2N6097	28.00
2N3866 JAN	4.14	2N5589	4.60	2N6166	85.00

RF TRANSISTORS

MRF207	2.00	Kertron KB6008	5.50	MM3002	1.65
MRF208	10.20	Amperex BLY90	22.50	MM3009	1.80
MRF209	12.35	Amperex A209	8.60	MM3375	7.00
MRF237	1.85	MSC 2001	20.00	MM3904	1.50
MRF238	8.55	MSC 3000	20.00	MM3906	1.43
MRF450	16.55	MSC 3001	20.00	MM4000	1.24
MRF453	19.55	MSC 3005	20.00	MM4001	1.39
MRF504	6.75	MSC 80205	20.00	MM4003	1.85
MRF509	5.50	MSC 80206	20.00	MM4036	1.60
MRF511	8.60	MSC 80255	20.00	MM4044	3.00
MRF620	27.00	Fairchild SE7056	3.00	MM4545	3.00
MRF621	30.50	MM1051	2.00	MM8006/2N5842	2.15
MRF8004	1.90	MM1500	32.20	MM1552	50.00
HEPS3013/75	2.95	MM1550	10.00	MM1553	56.50
HEPS3014/76	4.95	MM1601	5.50	HEPS5026	2.48
HEPS3002	11.03	MM1602	7.50	MSC 80256	20.00
HEPS3003	29.88	MM1607/2N5842	8.65	CTC D1-28	20.00
HEPS3005	9.55	MM1614	2.75	CTC D10-28	20.00
HEPS3006	19.90	MM1620	17.50	CTC E1-28	20.00
HEPS3007	24.95	MM1622/2N5849	19.50		
HEPS3008	2.18	MM1661	15.00		
HEPS3010	11.34	MM1669	17.50		
RCA TA7994	50.00	MM1943	3.00		
RCA 40290	2.48	MM2605	3.00		
Kertron K2126	5.50	MM2608	5.00		

MHz electronics

2543 N. 32nd STREET
PHOENIX, ARIZONA 85008
PH. 602-957-0786

C.O.D.
OR
master charge

More Details? CHECK—OFF Page 126

flea market

NOW YOU ALL COME, YOU HEAR. Where? Why ARRL Hudson Division Convention, November 13 and 14, Playboy Resort and Country Club at Great Gorge, McAfee, New Jersey. Many exhibits, giant indoor flea market, FCC and ARRL forums, FCC exams, special YL programs, technical sessions and a Saturday night banquet with Jean Shepherd, K2ORS, world traveler, columnist and famed radio and TV personality as the speaker. For information write to Al Piddington, WA2FAK, 4 Acorn Drive, East Northport, N. Y. 11733.

27 NOVEMBER 1976 (9 PM to 1 AM local time) The twenty-fourth annual 10 Meter Ground Wave Contest sponsored by the Breeze Shooters, Inc., of Pa. All modes permissible. Points are determined on a distance and input power basis with separate awards for leaders in four circular zones centered on the Point in downtown Pittsburgh. Mobiles and Novice/Technician also compete for separate awards. Logs must be postmarked by December 6. Logs and rules available from Richard Evanuik, WA3LUM, 311 Evergreen Ave., Pittsburgh, Pa. 15209.

VINTAGE RADIO. First Southwest Vintage Radio & Phonograph Convention, 5th, 6th, and 7th of November at the Ramada Inn-Dallas East in Dallas, Texas. Forums on collecting of antique and vintage radios, restoration of antique radios, Classic Radios (McMurdo-Silver Scott) antique phonographs, and general Q&A. The usual banquet, swap sessions, and an auction will also be held. Of special interest will be a contest for various equipment submitted by convention registrants. Three prizes will be awarded in each division. In addition a "Best of Show" award will also be made. The categories are as follows: 1. Crystal Sets; 2. TRF Receivers (pre-1930); 3. Regenerative Receivers (pre-1930); 4. Super heterodyne Receivers (pre-1930); 5. Components and Assemblies; 6. Loudspeakers (horn, etc); 7. Homebrew and Kit receivers (pre-1930); 8. AC Table receivers (post-1930); 9. AC Console receivers (post-1930); 10. Classic Receivers (Mc Murdo-Silver, etc.); 11. Ham gear (pre-1940); 12. Phonographs, outside horn; 13. Phonographs, inside horn; 14. Telephone/Telegraph. For more information and pre-registration packet please contact CONVENTION SVRPS, P. O. Box 19406, Dallas, Texas 75219.

"ICELANDIC RADIOAMATEURS" (I.R.A.), was founded thirty years ago. To celebrate, the society has issued "The Icelandic Radioamateur Award" (IRAA). The requirements for the IRAA have been based on the I.T.U. zonal system in order that all radioamateurs may stand an equal chance in obtaining the award, regardless of geographical position. Rules and requirements for the Icelandic Radioamateur Award are available from I.R.A., P. O. Box 1058, Reykjavik, Iceland or from HAM RADIO Magazine. Our club station, TF3IRA, will be operated occasionally throughout this year with the special callsign TF3ØIRA beginning with operation from Pjorsardalur area, near Mt. Hekla.

S O W P CHRISTMAS QSO PARTY. The Society of Wireless Pioneers will conduct a membership on-the-air QSO Party on the weekend of December 18 and 19, 1976. The Party will cover the full 48-hour GMT period and will be the first "voice" Party scheduled by the Society. The purpose of the affair will be to give members an opportunity to meet one another and to pass along their season's greetings, etc. There will be no formal exchange requirements and no need to submit logs. All members with a phone capability are encouraged to participate. The call will be CQ SOWP. While there will be no certificates awarded, everyone who takes part will be a winner by having an opportunity to renew old friendships, establish new ones and to continue a comaraderie developed over the years. Suggested frequencies for the affair are 25 kHz (±) 5 kHz up from the low end of the general class phone portion of each amateur band.

Stolen Equipment

STOLEN from auto on Aug. 29, 1976. In Tallman, N. Y. area. Heath SB-650 freq. counter. Drake MN-2000 matching network. Serial No. 6485. Please contact Cliff Cooley Jr., 4 Camp Hill Rd., Pomona, N. Y. 10970 (WN2GHL) or contact Town of Ramapo Police, Spring Valley, N. Y.

REGENCY HR-2B; Serial #49-02817. Stolen from automobile. Microphone cable is hardwired to set (instead of conventional cable-jack). Kristen N. Johnson, WA1TJP, 86 Alton Rd., Quincy, Mass. 02169.

More Details? CHECK—OFF Page 126

Learn to service Communications/ CB equipment at home with NRI's Complete Communications Course

Career opportunities are opening up fast for the man trained in communications.

The field of communications is bursting out all over. In Citizens Band alone, class "D" licenses grew from 1 to over 2.6 million in 1975, and the FCC projects about 15 million U.S. CB'ers by 1979. That means countless careers in design, installation and maintenance. Start training now, the NRI way, to get your FCC license and qualify for one of these openings.

Learn on your own 400-channel, digitally-synthesized VHF Transceiver.

The NRI Complete Communications Course teaches you to service and adjust all types of two-way radio equipment (including CB), using the one unit that is best equipped to train you for CB, Commercial, and Amateur communications: a digitally-synthesized 400-channel VHF transceiver and AC power supply. This 2-meter transceiver gives you "Power-On" training. Then we help you get your FCC Amateur License with special instructions so you can go on the air.

The complete program includes 48 lessons, 9 special reference texts, and 10 training kits. Also included are: your own electronics Discovery Lab, a new Antenna Applications Lab, an Optical Transmission System, CMOS Digital Frequency Counter, and TVOM. The course covers AM and FM Transmission Systems; Radar Principles; Marine, Aircraft, and Digital Electronics; and Mobile Communications. You must earn your first class radio telephone FCC license or you get your money back.

CB Specialist Course now available

NRI now offers a special course in CB Servicing. You get 37 lessons, 8 reference texts, your own CB Transceiver, AC power supply and multimeter . . . for hands-on training. Also included are 14 coaching units to make it easy to get your commercial radio telephone FCC license—enabling you to test, install and service communications equipment.

Over a million men have enrolled with NRI

Send for the free NRI catalog and discover why more than a million men like yourself have chosen the NRI way the right way to get ahead. Read how you learn from bite-size lessons, progressing at your own speed to your FCC license and then into the communications field of your choice. There's no obligation and no salesman will call.

Send coupon now for FREE NRI catalog

If coupon is missing, write to: NRI Schools, McGraw-Hill Continuing Education Center, 3939 Wisconsin Avenue, Washington, D.C. 20016

Rush the free catalog of my choice (select only one, please). No salesman will call.

- ☐ Complete Communications Electronics with CB • FCC Licenses • Aircraft, Mobile, Marine Electronics
- ☐ CB Specialists Course
- ☐ Amateur Radio Basic and Advanced
- ☐ Industrial and Business Electronics Digital Computer Electronics • Electronic Technology • Basic Electronics
- ☐ TV/Audio Servicing Choose from 5 courses
- ☐ Appliance Servicing Homeowner & Professional Repairs
- ☐ Automotive Mechanics Master Automotive Technician • Tune-Up and Basic Repairs
- ☐ Auto Air Conditioning
- ☐ Air Conditioning & Refrigeration Basic Air Conditioning Servicing • Master Course in Air Conditioning, Refrigeration & Heating

NRI SCHOOLS
McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue,
Washington, D.C. 20016

[redacted]

APPROVED UNDER GI BILL if taken for career purposes.
☐ Check box for details

Name ______________________ Age ______
(Please Print)

Street ______________________

City/State/Zip ______________________

Accredited Member National Home Study Council

More Details? CHECK—OFF Page 126

DON & BOB'S SUPER BUYS

HY GAIN TH6DXX	$192.00
TH3MK3 3 ELEMENT BEAM, 20, 15, 10	$160.00
MOSLEY CLASSIC 33	$179.00
HY GAIN 204BA	$144.00
HY GAIN 402BA	$160.00
BN86	$15.95
CDE HAM-II ROTOR	$129.00
CDE BIG TALK ROTOR + 100 FT. OF CABLE	$100.00
KLM (MODEL KR400) ROTOR + 100 FT. OF CABLE	$100.00
18HT HY TOWER	$218.00
ROHN 25G TOWER & ACCESSORIES	Call or Write
BELDEN 8214 RG-8/U FOAM COAX	23¢/FT.
BELDEN 8237 RG-8/U	19¢/FT.
BELDEN 8 WIRE ROTOR CABLE #8448	14¢/FT.
BELDEN 8210, 72 OHM KW TWINLEAD $19 PER 100 FT.	
AMPHENOL PL-259	59¢
CALL FOR QUOTES — TS-520, TS-820, TS-700A, 210X.	
TEMPO 2020 & MULTI 2700	Call or Write
BOOKS	
SWAN-SILTRONIX SWR-1	$18.95
ELECTRA BEARCAT 101	$319.00
RAYTHEON 811A, SEALED BOXES	$15 per pair
ETO AMPLIFIERS	Call for Quote

ALL PRICES FOB HOUSTON. CALL TODAY FOR ITEMS NOT LISTED

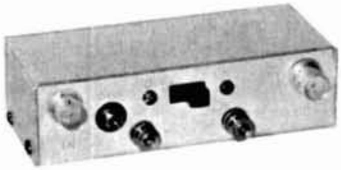
OUR STAFF: W5GJ, K5AAD, W5MBB, WA5ZNY, WA5UUK, WB5JIS, K5QHQ, W5HVU, WA5TGU, W5AB, K5BGB

MADISON ELECTRONICS SUPPLY, INC.

1508 McKINNEY AVENUE, HOUSTON, TEXAS 77002

713/658-0268 CALL US! Nites 713/497-5683

PRE-AMP



HIGH GAIN · LOW NOISE

35dB power gain, 2.5-3.0 dB N.F. at 150 MHz 2 stage, R.F. protected, dual-gate MOSFETS. Manual gain control and provision for AGC. 4⅜" x 1⅞" x 1⅜" aluminum case with power switch and choice of BNC or RCA phono connectors (be sure to specify). Available factory tuned to the frequency of your choice from 5 MHz to 250 MHz with approximately 3% bandwidth. Up to 10% B.W. available on special order.

N. Y. State residents add sales tax.

Model 201 price: 5-250 MHz $29.95

Vanguard Labs

196-23 JAMAICA AVE.
HOLLIS, N. Y. 11423

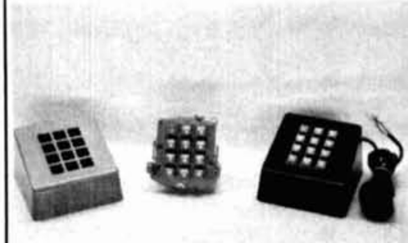
VHF TRANSVERTERS

- *50, 144 & 220MHZ models*
- *1 watt min. output*
- *Compatible with HF SSB equipt*

$129.50

VHF Signal Co.
2246 Beech St.
Laurel, DE 19956 (302) 846-2691

12 Button touch-tone pads calibrated and guaranteed 90 days (abuse excluded) with diagram **$14.00**
Attractive plastic mounting box with brackets **$4.75**
Complete working system ready to connect to your transmitter **$24.95**



TELEPHONE EQUIPMENT COMPANY
Post Office Box 596, Leesburg, Florida 32748
(904) 728-2730

Radio Amateurs Reference Library of Maps and Atlas

WORLD PREFIX MAP — Full color, 40" x 28", shows prefixes on each country . . . DX zones, time zones, cities, cross referenced tables **$1.25**

RADIO AMATEURS GREAT CIRCLE CHART OF THE WORLD — from the center of the United States! Full color, 30" x 25", listing Great Circle bearings in degrees for six major U.S. cities; Boston, Washington, D.C., Miami, Seattle, San Francisco & Los Angeles. **$1.25**

RADIO AMATEURS MAP OF NORTH AMERICA! Full color, 30" x 25" — includes Central America and the Caribbean to the equator, showing call areas, zone boundaries, prefixes and time zones, FCC frequency chart, plus useful information on each of the 50 United States and other Countries **$1.25**

WORLD ATLAS — Only atlas compiled for radio amateurs. Packed with world-wide information — includes 11 maps, in 4 colors with zone boundaries and country prefixes on each map. Also includes a polar projection map of the world plus a map of the Antarctica — a complete set of maps of the world. 20 pages. Size 8¾" x 12" **$2.50**

Complete reference library of maps — set of 4 as listed above **$3.75**

See your favorite dealer or order direct.

Mail orders please include 75¢ per order for postage and handling.

WRITE FOR FREE BROCHURE!

RADIO AMATEUR **callbook** INC.
Dept. E 925 Sherwood Drive
Lake Bluff, Ill. 60044

More Details? CHECK—OFF Page 126

- Advance Registration $12.50 per person; with Hotel Sahara Late Show and two drinks $23.00 per person or with Hotel Sahara Congo Dinner Show (entree Cornish Hen), no drinks $30.00 per person. Tax and Gratuity included.
- Totie Fields and Bert Convy are scheduled entertainers in Hotel Sahara's Congo Room.
- Advance Registration must be received by SAROC on or before January 1, 1977.

The NATION'S TWELFTH ANNUAL LAS VEGAS PRESTIGE CONVENTION

SAROC™

HOTEL SAHARA'S CONVENTION SPACE CENTER

January 6-9, 1977

- SAROC Registration includes: registration tickets, admission to technical sessions, Friday cocktail party hosted by T. P. L. Communications and TRI-EX Tower Corp. with SAROC ; Saturday cocktail party hosted by Ham Radio Magazine with SAROC ; Hotel Sahara Buffet Brunch on Sunday, Tax and Gratuity.
- Hotel Sahara room rate for SAROC registered delegates $17.00 per night plus room tax, single or double occupancy.
- Hotel Sahara room reservation request card will be sent to SAROC registered delegate.

Send your check or money order to SAROC , P. O. Box 945, Boulder City, NV 89005

More Details? CHECK—OFF Page 126

More Details? CHECK—OFF Page 126

More Details? CHECK—OFF Page 126

HAM MART

Ham Radio's guide to help you find your loc

Alabama

LONG'S ELECTRONICS
3521 TENTH AVE. NORTH
BIRMINGHAM, AL 35234
800-633-3410
Call us Toll Free to place your order

California

COMMTECH ENTERPRISES
13754 VICTORY BLVD.
VAN NUYS, CA 91401
213-988-2212
Headquarters for Yaesu, Kenwood, Drake, Icom, Collins, Atlas.

HAM RADIO OUTLET
999 HOWARD AVENUE
BURLINGAME, CA 94010
415-342-5757
Northern California's largest new and used ham inventory.

HENRY RADIO
931 N. EUCLID AVE.
ANAHEIM, CA 92801
714-772-9200
The world's largest distributor of Amateur Radio equipment.

HENRY RADIO CO., INC.
11240 W. OLYMPIC BLVD.
LOS ANGELES, CA 90064
213-477-6701
The world's largest distributor of Amateur Radio equipment

M-TRON
2811 TELEGRAPH AVENUE
OAKLAND, CA 94609
415-763-6262
We service what we sell.

QUEMENT ELECTRONICS
1000 SO. BASCOM AVENUE
SAN JOSE, CA 95128
408-998-5900
Serving the world's Radio Amateurs since 1933.

Colorado

C W ELECTRONIC SALES CO.
1401 BLAKE ST.
DENVER, CO 80202
303-573-1386
Rocky Mountain area's complete ham radio distributor.

Florida

GRICE ELECTRONICS
320 EAST GREGORY
PENSACOLA, FL 32502
904-434-2481
Your Gulf Coast Drake & Kenwood dealer.

Illinois

ERICKSON COMMUNICATIONS, INC.
5935 NORTH MILWAUKEE AVE.
CHICAGO, IL 60646
312-631-5181
Headquarters for all your Amateur Radio needs.

KLAUS RADIO, INC.
8400 NORTH PIONEER PARKWAY
PEORIA, IL 61614
309-691-4840
Let us quote your Amateur needs.

SPECTRONICS, INC.
1009 GARFIELD STREET
OAK PARK, IL 60304
312-848-6777
Chicagoland's Amateur Radio leader.

Indiana

HOOSIER ELECTRONICS
P. O. BOX 2001
TERRE HAUTE, IN 47802
812-238-1456
Ham Headquarters of the Midwest. Store in Meadow Shopping Center.

Kansas

ASSOCIATED RADIO
8012 CONSER P.O.B. 4327
OVERLAND PARK, KS 66204
913-381-5901
Amateur Radio's Top Dealer.
Buy — Sell — Trade.

Kentucky

COHOON AMATEUR SUPPLY
HIGHWAY 475
TRENTON, KY 42286
502-886-4535
Ten-Tec dealer — Call 24 hours for best deal

Maryland

COMM CENTER, INC.
9624 FT. MEADE ROAD
LAUREL PLAZA RT. 198
LAUREL, MD 20810
301-792-0600
New & Used Amateur Equipment.
All Inquiries Invited.

Massachusetts

TUFTS RADIO ELECTRONICS
386 MAIN STREET
MEDFORD, MA 02155
617-395-8280
New England's friendliest ham store.

Michigan

AUDIOLAND
36633 SOUTH GRATIOT
MT. CLEMENS, MI 48043
313-791-1400
All major brands, new/used equipment & accessories.

PURCHASE RADIO SUPPLY
327 E. HOOVER
ANN ARBOR, MI 48104
313-668-8696 or 668-8262
We still sell Ham parts!

RADIO SUPPLY & ENGINEERING
1203 WEST 14 MILE ROAD
CLAWSON, MI 48017
313-435-5660
10001 Chalmers, Detroit, MI 48213, 313-371-9050.

Minnesota

ELECTRONIC CENTER, INC.
127 THIRD AVENUE NORTH
MINNEAPOLIS, MN 55401
612-371-5240
ECI is still your best buy.

Missouri

HAM RADIO CENTER, INC.
8342 OLIVE BLVD.
P. O. BOX 28271
ST. LOUIS, MO 63132
800-325-3636
Call toll free.

MIDCOM ELECTRONICS, INC.
2506 SO. BRENTWOOD BLVD.
ST. LOUIS, MO 63144
314-961-9990
At Midcom you can try before you buy!

Dealers - You should be here too! Contact Ham Radio today for complete details.

New Hampshire

EVANS RADIO, INC.
BOX 893, RT. 3A BOW JUNCTION
CONCORD, NH 03301
603-224-9961
Icom & Yaesu dealer.
We service what we sell.

New Jersey

ATKINSON & SMITH, INC.
17 LEWIS ST.
EATONTOWN, NJ 07724
201-542-2447
Ham supplies since "55".

New Mexico

JIM'S TV AND ELECTRONICS
805 N. FIRST
GRANTS, NM 87020
505-287-8148
Stocking Icom. BAC & MC.
Open 6 Days.

New York

ADIRONDACK RADIO SUPPLY, INC.
185 W. MAIN STREET
AMSTERDAM, NY 12010
518-842-8350
Yaesu dealer for the Northeast.

CFP COMMUNICATIONS
211 NORTH MAIN STREET
HORSEHEADS, NY 14845
607-739-0187
Jim Beckett, WA2KTJ, Manager
Dave Flinn, W2CFP, Owner

GRAND CENTRAL RADIO
124 EAST 44 STREET
NEW YORK, NY 10017
212-682-3869
Drake, Atlas, Ten-Tec, Midland,
Hy-Gain, Mosley in stock

HARRISON
"HAM HEADQUARTERS, USA"
ROUTE 110 & SMITH STREET
FARMINGDALE, L. I., N. Y. 11735
516-293-7990
Since 1925 . . . Service, Satisfaction,
Savings. Try Us!

Ohio

UNIVERSAL SERVICE
114 N. THIRD STREET
COLUMBUS, OH 43215
614-221-2335
Give U.S. a try when ready to buy.

Oklahoma

RADIO STORE, INC.
2102 SOUTHWEST 59th ST.
(AT 59th & S. PENNSYLVANIA)
OKLAHOMA CITY, OK 73119
405-682-2929
New and used equipment —
parts and supply.

Oregon

OREGON HAM SALES
409 WEST FIRST AVENUE
ALBANY, OR 97321
503-926-4591
Yaesu dealer for the Northwest.

Pennsylvania

ARTCO ELECTRONICS
302 WYOMING AVE.
KINGSTON, PA 18704
717-288-8585
The largest variety of crystals
in N. E. Penn.

ELECTRONIC EXCHANGE
136 N. MAIN STREET
SOUDERTON, PA 18964
215-723-1200
New & Used Amateur Radio
sales and service.

"HAM" BUERGER, INC.
68 N. YORK ROAD
WILLOW GROVE, PA 19090
215-659-5900
Communications specialists.
Sales and service.

HAMTRONICS, INC.
4033 BROWNSVILLE ROAD
TREVOSE, PA 19047
215-357-1400
Same location for 25 years.

South Dakota

BURGHARDT AMATEUR CENTER
124 FIRST AVE. N.W. P.O. BOX 73
WATERTOWN, SD 57201
605-886-7314
America's most reliable Amateur
Radio Dealer — Nationwide!

Texas

ALTEC COMMUNICATIONS
1800 S. GREEN STREET
LONGVIEW, TX 75601
214-757-2831
Specializing in ham equipment for
the Ark-La-Tex.

HARDIN ELECTRONICS
5635 E. ROSEDALE
FT. WORTH, TX 76112
817-461-9761
You bet Ft. Worth has a ham store!

TECO ELECTRONICS SUPER STORE
1717 S. JUPITER ROAD
GARLAND, TX 75040
800-527-4642
Call Toll Free for Service Today!

Virginia

ARCADE ELECTRONICS
7048 COLUMBIA PIKE
ANNANDALE, VA 22003
703-256-4610
Serving Maryland, D.C., and Virginia
area since 1962.

Washington

AMATEUR RADIO SUPPLY CO.
6213 13TH AVE. SO.
SEATTLE, WA 98108
206-767-3222
Amateur center of the
Northwest.

Wisconsin

AMATEUR
ELECTRONIC SUPPLY, INC.
4828 WEST FOND du LAC AVENUE
MILWAUKEE, WI 53216
414-442-4200
Open Mon & Fri 9-9, Tues, Wed,
Thurs, 9-5:30, Sat, 9-3.

More Details? CHECK—OFF Page 126

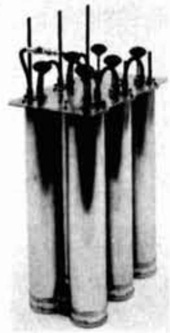
More Details? CHECK—OFF Page 126

More Details? CHECK—OFF Page 126

NORTH SHORE

RF TECHNOLOGY

DUPLEXER & CAVITY KITS...



Now available for you fully assembled and tuned!

- UPGRADE YOUR REPEATER WITH A RF TECHNOLOGY DUPLEXER.
- ALL DUPLEXERS AND CAVITIES ARE TEMPERATURE COMPENSATED WITH INVAR® AND MEET ALL COMMERCIAL STANDARDS
- ONLY TOP QUALITY MATERIALS GO INTO OUR PRODUCTS.
- BOTH KITS & ASSEMBLED DUPLEXERS AND CAVITIES ARE AVAILABLE TO YOU AT A SAVINGS TO YOU.

Mod. 62-3...6 cav., 2 mtr., insertion loss 0.6 db with isolation 100 db typical; pwr. 350 w. Kit $349 ea.-Assembled $439.

Mod. 4220-3...4 cav. 220 MHz insertion loss 0.6 db with 80 db isolation typical; pwr. 350 w. Kit $249 ea. - Assembled $329.

Mod. 4440-3...4 cav. 440 MHz, insertion loss 0.6 db with 80 db isolation typical; pwr. 350 w. Kits $249 ea. - Assembled $329.

Mod. 30 Cavity Kits: 2 mtr. $65 ea., 220 MHz $65 ea., 440 MHz $65 ea.,; 6 mtr. $115 ea. Add $15 for Assembled Kit.

Also available: 6 mtr., 4 cav. Kit $399-Assembled $499, 2 mtr. 4 cav. Kit $249-Assembled $329, 440 MHz TV Repeater Duplexer

Only hand tools are necessary to assemble Kits!

Send your order to: Distributor: **TUFTS RADIO**, 386 Main St., Medford, Mass. 02155. Phone (617) 395-8280.

(Prices F.O.B. Medford, Mass. All units can be shipped U.P.S.-C.O.D. orders require $50 deposit. —Mass. residents add 5% sales tax.)

JAMES MILLEN

MANUFACTURING COMPANY, INC.

Transmitting Variables • R. F. Chokes
Receiving Variables • Couplings
Sockets • Plugs
Grid Dip Meters • Transmatches
RF Switches • And Much More

ONE OF THE GREAT LINES IN STOCK AT

G.R. WHITEHOUSE & CO.
15 Newbury Drive Amherst N.H. 03031

SEND FIRST CLASS STAMP FOR FLYER

CMOS KEYER

Assembled PCB, built-in sidetone, 5-50 wpm, operates on 5-12 VDC, instant start with jam proof spacing, grid block and cathode keying, 2.3 x 3.5 inches.

$24.95 ppd.

Ask about our Memory Keyer

DGM ELECTRONICS
787 BRIAR LANE, BELOIT, WIS. 53511

$79.95 LIMITED TIME SPECIAL

B & K Model 280 Digital Multimeter

Regularly ~~$99.95~~

- 15% Discount on all other B & K items.
- FREE shipping in continental U.S.
- FREE 40 page catalog.

SPACETRON
BOX 84-N • BROADVIEW, ILL. 60153

VHF/UHF CONVERTERS PREAMPS

Ten meters through 432 MHz. A post card will bring our full 1976 Catalog.

JANEL laboratories
3312 S.E. VAN BUREN BLVD.
CORVALLIS, OREGON 97330
Telephone: 503-757-1134

FREE CATALOG

HARD-TO-FIND PRECISION TOOLS

Lists more than 2800 items pliers, tweezers, wire strippers, vacuum systems, relay tools, optical equipment, tool kits and cases. Also includes ten pages of useful "Tool Tips" to aid in tool selection.

JENSEN TOOLS AND ALLOYS
4117 N. 44th Street, Phoenix, Ariz. 85018

FREQUENCY COUNTER

$89.95 Kit

6Digit 7 Segment LED Readout
Crystal Timebase (.001%)
Read Khz./Mhz. to over 30 Mhz.
Input Sensitivity 100 mv. @ 1 Megohm

Add $2.00 Shipping—Allow to 4 weeks delivery.

DELUXE 150 MHZ. COUNTER

$139.95 6 Digit Kit

100 mv. Sensitivity @ 150 Mhz.
Input Impedance 1 Megohm
Crystal Timebase (.001%)
Pushbutton Switches Select Hz/Khz/Mhz
For 8 Digit add $12.00

Add $3.00 Shipping—Allow to 5 weeks delivery.

DIGITAL CAPACITANCE COUNTER

$69.95 Kit

4 Digit LED Readout
Ranges to over 1000 Mfd.
±1% (±1 Pfd. below 100 Pfd.)

Add $2.00 Shipping—Allow to 4 weeks delivery.

Calif. Residents add 6% Sales Tax

SEND CHECK OR MONEY ORDER TO

LIN CORPORATION
15311 S. Broadway, Gardena, Ca. 90248
(213) 532-8809

BOOKS BY PHONE

CALL TOLL FREE

800-258-5353

Almost all popular Amateur Radio Books available for immediate shipment.

HAM RADIO
GREENVILLE, NH 03048

More Details? CHECK—OFF Page 126

More Details? CHECK—OFF Page 126

ORLANDOHAMCATION 77 ORLANDOHAMCATION 77

Presents

The SOUTHEASTERN ARRL CONVENTION

and

The Greatest ORLANDO HAMFEST ever!!

AT ORLANDO FLORIDA'S SHERATON'S TWIN TOWERS HOTEL & CONVENTION COMPLEX

*FEBRUARY 12 & 13 1977 **

ADVANCE REGISTRATION $3, AT DOOR $4

SWAPFEST TABLES $5 PER DAY

For Hamfest information write; HAMFEST SECRETARY, GEORGIA DENMAN K4ZXS, 405 ENKA WAY, ORLANDO FLA. 32811.

FOR HOTEL RESERVATIONS AND INFORMATION WRITE TO; SHERATON TWIN TOWERS, HOTEL, 5780 MAJOR BLVD. ORLANDO FLORIDA 32805. Rooms single $28, double $36 per day.

***SWAPFEST TABLES WILL BE AVAILABLE FRIDAY FEB. 11 AT 6PM SWAP AREA WILL BE OPEN FRIDAY NIGHT, No additional charge for Friday night required .**

ORLANDOHAMCATION 77 ORLANDOHAMCATION 77 ORLANDOHAMCAT!

ORLANDOHAMCATION 77 ORLANDOHAMCATION 77 ORLANDOH

ORLANDO HAMCATION 77 ORLANDO HAMCATION 77 ORLANDO HAMCATION 77

YOU CAN COUNT ON THE DAVIS FREQUENCY COUNTER FOR:

- **500 MHz**
- **± .0002% ACCURACY**
- **UNBEATABLY LOW COST**

FEATURES:
- 8 Digit Display
- Large .3" LED Readouts
- Automatic Dp. Placement
- Resolution to 1 Hz
- High Input Sensitivity
- Automatic Input Limiting
- Input Diode Protected
- Selectable Gate Times, 1 ms. and 1 sec. Provision for 10 sec.
- High Stability 10 MHz Crystal Time Base
- Plug-in Time Base
- Plug-in Prescaler
- All Metal Cabinet with High Quality Components

Kits include all parts, drilled and plated PC boards, cabinet, switches, hardware and a complete instruction manual including calibrating instructions.

All parts guaranteed for 90 days. Factory Service available for $25.

Factory assembled units are tested and calibrated to specifications, and are fully guaranteed for 1 year.

PRICES:

500 MHz kit	$249.95
500 MHz factory assembled	$349.95
Instruction & Calibration Manual (refundable with purchase)	$3.00

DAVIS ELECTRONICS
636 SHERIDAN DRIVE, TONAWANDA, NEW YORK 14150
(716) 874-5848

CUSTOM "AMATEUR RADIO" T-SHIRTS FOR YOU, GIFT FOR A FRIEND, OR FOR CLUBS!

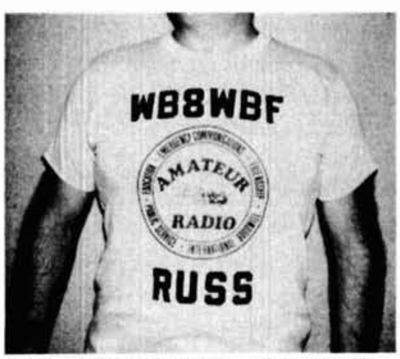
Your call and name printed in bold, 2 inch high black letters on these sky blue, made in USA, 50% polyester/50% cotton T-shirts that resist shrinkage. The center design is a unique, copyrighted commemorative to Amateur Radio, featuring the basis and purpose of the Service. The printing won't wash out, because it is flexible plastic that is impregnated into the fabric!

You get it all for only $5.95 plus 75¢ postage and handling per shirt. (Michigan residents add 24¢ Sales Tax per shirt.) When ordering, specify (1) mailing address, (2) call letters, (3) first name, and (4) shirt size. (S, M, L, XL)

Write about specials for clubs, groups, businesses, etc. Send check or money order with shirt order to:

Freestyle, P. O. Box 606
Walled Lake, Michigan 48088

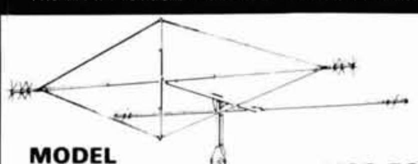
CHRISTMAS SPECIAL $5.95



Guaranteed delivery by Christmas on orders received by December 5.

WANT SOMETHING REALLY SMALL AND EFFICIENT?

Then you want the antenna that's known around the world for it's small size and superior performance . . . The Mini-Products Multiband HYBRID QUAD



MODEL HQ-1 **$109.50**

- ELEMENT LENGTH - 11 ft.
- BOOM LENGTH - 54 INCHES
- WEIGHT - 15 POUNDS
- WIND SURVIVAL - 75 MPH
- BANDS COVERED - 6, 10, 15 & 20
- 1200 WATTS P.E.P.
- FEED LINE - 50 OHMS

If not stocked by your dealer order direct. We pay shipping in USA. Send for free catalog of other models and more data.

Mini-Products, Inc.
1001 W. 18th St. Erie, Pa. 16502

COMPARING KEYERS ?

Check these features :
- operates on 110 VAC or 12 VDC no batteries to change
- not a kit, wired and tested
- your choice of dot and/or dash memory

*m-one introductory price **$49.00**

MONOLITH ELECTRONICS
box 2952 sta. A, Champaign, Ill. 61820

More Details? CHECK—OFF Page 126

Poly Pak's EXCLUSIVE BARREL KITS

Avg. Ship. Wt. 6 ozs.

100'S OF BARRELS PURCHASED!

For the first time anywhere, Poly Pak merchandisers introduce a new way in buying the economical way. Raw stock from the "barrel". Remember the "good ole days"? They're back again. The same way merchandisers throughout the United States buy from various factories . . . their over-runs in barrels. Poly Pak has done the same. Therefore you are getting the same type of material as the RE-TESTERS DO!

TEST 'EM YOURSELF 'N SAVE!

Buy 10 BARREL KITS AND CHOOSE THE **11TH KIT Free**

$1.98 YOUR CHOICE OF ANY KIT

KIT			
#1—SN7400 DIP IC'S	Cat.No.11H2415,untested	☐ 75 for	$1.98
#2—LINEAR OP AMPS	Cat.No.11H2416,untested	☐ 75 for	$1.98
#3—1N4148/914 DIODES	Cat.No.11H2418,untested	☐ 100 for	$1.98
#4—"4000" RECTIFIERS	Cat.No.11H2417,untested	☐ 100 for	$1.98
#7—VOLUME CONTROLS	Cat.No.11H2421,100% good	☐ 40 for	$1.98
#8—SUBMINI IF XFMRS	Cat.No.11H2422,100% good	☐ 100 for	$1.98
#11—POWER TAB TRANS	Cat.No.11H2425,untested,npn	☐ 40 for	$1.98
#12—POWER TAB TRANS	Cat.No.11H2426,untested,pnp	☐ 40 for	$1.98
#14—PRECISION RESISTORS	Cat.No.11H2428,marked-no mark	☐ 200 for	$1.98
#15—MOS FET TRANSISTORS	Cat.No.11H2429	☐ 60 for	$1.98
#19—DIPPED MYLARS	Cat.No.11H2597,100% good	☐ 60 for	$1.98
#20—LONG LEAD DISCS	Cat.No.11H2598,100% good	☐ 150 for	$1.98
#26—PLASTIC TRANSISTORS	Cat.No.11H2604,untested	☐ 100 for	$1.98
#30—PRE-FORMED RESISTORS	Cat.No.11H2608,100% good	☐ 250 for	$1.98
#32—TRANS WITH HOLE	Cat.No.11H2610,untested	☐ 50 for	$1.98
#35—NEON LAMPS	Cat.No.11H2613,100% good	☐ 30 for	$1.98
#37—1-AMP BULLET RECT	Cat.No.11H2615,untested	☐ 100 for	$1.98
#39—2N3055 TRANSISTORS	Cat.No.11H2617,100% good	☐ 15 for	$1.98
#40—HI-POWER PNP TRANS	Cat.No.11H2618,100% good	☐ 20 for	$1.98
#53—JUMBO RESISTOR PAK	Cat.No.11H2721,100% good	☐ 100 pc.	$1.98
#54—8 DIGIT READOUTS	Cat.No 11H2722	☐ 7 for	$1.98
#58—SLIDE SWITCHES	Cat.No.11H2726,100% good	☐ 30 for	$1.98
#61—POLYSTYRENE CAPS	Cat.No.11H2729,100% good	☐ 100 for	$1.98
#65—MIXED READOUTS	Cat.No.11H2733,untested	☐ 15 for	$1.98
#68—2 WATTERS	Cat.No.11H2735,100% good	☐ 100 for	$1.98
#71—CAPACITOR SPECIAL	Cat.No.11H2738,100% good	☐ 100 for	$1.98
#73—TRANSISTOR ELECTROS	Cat.No.11H2747,	☐ 50 for	$1.98
#76—1 WATT ZENERS	Cat.No 11H2741,untested	☐ 100 for	$1.98
#83—LM340T VOLT REG	Cat.No.11H2635,untested	☐ 15 for	$1.98
#86—HOBBY LEDS	Cat.No.11H2859,untested	☐ 40 for	$1.98
#87—NATIONAL IC BONANZA	Cat.No 11H2860,untested	☐ 100 for	$1.98
#88—LITRONICS LED READOUT	Cat.No.11H2861,all mixed	☐ 10 for	$1.98
#91—SILVER MICAS	Cat.No.11H3018,variety	☐ 100 for	$1.98
#92—3 AMP EPOXY RECT	Cat.No.11H3204,untested	☐ 100 for	$1.98
#93—HALF WATTERS	Cat.No.11H3046,100% good	☐ 200 for	$1.98
#99—PHOTO ELECTRIC CELLS	Cat.No.11H3052,100% good	☐ 10 for	$1.98
#104—SLIDE VOL CONTROLS	Cat.No.11H3057,100% good	☐ 10 for	$1.98
#109—TERMINAL STRIPS	Cat.No.11H3136,wide asst	☐ 150 for	$1.98
#110—SUPPRESSOR DIODES	Cat.No.11H3137,untested	☐ 50 for	$1.98
#112—MICRO MINI LEDS	Cat.No.11H3139,variety	☐ 40 for	$1.98
#115—MOLEX SOCKETS	Cat.No.11H3144,100% good	☐ 200 for	$1.98
#119—PRECISION RESISTORS	Cat.No.11H3205,100% good	☐ 100 for	$1.98
#121—MINI MAGNETS	Cat.No.11H3168	☐ 100 for	$1.98
#126—UPRIGHT ELECTROS	Cat.No.11H3226,100% good	☐ 40 for	$1.98
#127—AXIAL ELECTROS	Cat.No.11H3227,asst	☐ 40 for	$1.98
#128—MINI DIP IC'S	Cat.No.11H3245,untested	☐ 75 for	$1.98
#130—CRYSTALS	Cat.No.11H3250,many in 8mc	☐ 12 for	$1.98
#131—TANTALUM ELECTROS	Cat.No.11H3255,mixed	☐ 30 for	$1.98
#133—C-MOS IC'S	Cat.No.11H3257,untested	☐ 60 for	$1.98
#138—PANEL SWITCHES	Cat.No.11H3268,by Oak	☐ 30 for	$1.98
#140—LAMPS, INDICATORS	Cat.No.11H3297,many types	☐ 20 for	$1.98
#141—10 WATT ZENERS	Cat.No.11H3298,good yield	☐ 15 for	$1.98
#144—RCA PHONO PLUGS	Cat.No.11H3293,100% good	☐ 40 for	$1.98
#149—ROCKER SWITCHES	Cat.No.11H3302	☐ 25 for	$1.98
#158—MAGNIFIED MAN-3s	Cat.No.11H3325,lens rejects	☐ 12 for	$1.98
#159—MODULAR SWITCHES	Cat.No.11H3150,Centralab	☐ 25 for	$1.98
#160—LM309KC V. REG	Cat.No.11H3330,untested	☐ 15 for	$1.98
#161—PLASTIC TRANSISTORS	Cat.No.11H3343,100% material	☐ 25 for	$1.98
#163—MINI TRIMPOTS	Cat.No.11H3345,for p.c.	☐ 30 for	$1.98
#172—25 AMP ACRS	Cat.No.11H3355,100% material	☐ 3-pcs.	$1.98
#173—25 AMP TRIACS	Cat.No.11H3356,100% material	☐ 3-pcs.	$1.98
#184—¼-WATT METAL FILM	Cat.No.11H3413,100% material	☐ 150 for	$1.98

DELTROL TUBULAR SOLENOID ☐ $1.49

Cat. No. 11H3394

It's new! Different! 1st Time we've seen these popular tubular soletnoids at this price. Designed for maximum FULL, in minimum space. Features 12VDC @ 450 mils, 32 ohm coil, continuous duty, only ¾ x ¾", with ½" threaded bushing for panel mtg, ⅛" stroke, up to 17 oz. pull. All metal frame, black slotted plunger, with pointed end for precision smooth recoil action. With wire connections. Wt. 3 ozs.

- Space saver ¾ x ¾"
- Powerful 17-oz. pull
- Unique panel mtg.
- Weighs only 2 oz.
- 12 VDC

"Fast Charge" $1.69 AA NICADS 3 for $4.50

Most commonly used nicad battery: 1.2VDC 500 mils. Fast charge, only requires 5 hours, others 12 to 24 hours. Cat. No. 11H3453

FILAMENT TRANSFORMER PANIC ☐

- ALL 110 VAC INPUT
- STANDARD MOUNTING

Cat.No.	Output	Amps	Wt.	Sale	3 for
☐11H2768	6.3V	2.	6-ozs.	$2.95	$8.00
☐11H2266	12. V	.5	8-ozs.	1.95	5.00
☐11H2474	12. V	1.	1-lb.	2.95	8.00
☐11H3448	12. V	2.	2-lbs.	3.50	9.00
☐11H2773	48. VCT	2.	2-lbs.	2.95	8.00

The Revolutionary PowerDIP SOLID STATE 5V DC RELAYS

Cat. No. 11H3397

- Operates directly from C-MOS (μa control sensitivity)
- TTL/DTL Compatible (7 milliamp control current)
- Switches up to 4 amps without heat sinking
- Fits standard 16-pin DIP sockets.

3 FOR $18

$6.50 ☐

Terms: Add postage Rated: net 30
Phone: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield.
MIN. ORDER — $6.00 (Plus Postage)

C.O.D.'s MAY BE PHONED

Send for FREE Fall-Winter **CATALOG**

POLY PAKS

P.O. BOX 942H LYNNFIELD, MASS. 01940

POWER PLUS PERFORMANCE

depend on BLACK CAT® Linear Amplifiers

The Black Cat® JB 2000 10/80 linear amplifier delivers the power you need and rugged performance you can count on. Designed and built with the same quality craftsmanship and pride that backs every Black Cat® product, the JB 2000 10/80 lets you stay up as long as you like, whenever you like.

Containing a 120VAC — 240VAC, Solid State self contained power supply, with a power input of 2000 watts PEP SSB, the JB 2000 10/80 linear amplifier greatly increases your signal. Whether building a new station or renovating an old, the Black Cat® JB 2000 10/80 is the perfect addition to any ham operator's equipment roster.

Also included in the Black Cat® line of durable and dependable ham accessories is the test equipment to insure that you stay on the air: the JB 1000 Dummy Load, JB 1000 SM Oscilloscope/RF Wattmeter/SWR Bridge, and JB 2000 SW Power Meter/SWR Bridge.

For complete information on all Black Cat® products, contact your nearest Black Cat® dealer, or write:

WAWASEE ELECTRONICS

"HOME OF BLACK CAT® PRODUCTS"

Wawasee Electronics Co., Inc.
P.O. Box 36 • Syracuse, Indiana 46567
Phone: (219) 457-3191

Advertisers check-off

... for literature, in a hurry — we'll rush your name to the companies whose names you **"check-off"**

Place your check mark in the space between name and number. Ex: Ham Radio ✓ 234

INDEX

Adva ___ 265
Aldelco ___ 347
Alkan *
Amcomm ___ 500
Amsat ___ 202
Antenna Mart ___ 009
Supermarket ___ 404
Aptron ___ 380
Arcos *
Atlas ___ 198
Atronics ___ 382
Barber ___ 383
Barry *
Budwig ___ 233
Bullet ___ 328
CBS ___ 501
CFP ___ 022
CHM ___ 464
Cal-Com ___ 282
Chaney's ___ 488
Clegg ___ 027
Comm. Engineering ___ 489
Comm. Spec. ___ 330
Cont. Spec. ___ 348
Computer Room ___ 502
Curtis ___ 034
Cush Craft ___ 035
D-D ___ 269
DGM ___ 458
Data Signal ___ 270
Davis ___ 332
Dentron ___ 259
Digital ___ 503
Direct Tech. *
Disc-Cap ___ 449
Drake ___ 039
Dynamic ___ 041
E. T. O. Inc. *
Elect. Dist. ___ 044
Electrospace ___ 407
ELPROCON ___ 301
Epsilon ___ 046
E. B. C. ___ 504
Erickson ___ 047
Fair ___ 048
59+ ___ 429
Freestyle *
Genave ___ 168
Gilfer ___ 207
Gray ___ 055
Gregory ___ 201
Hal ___ 057
Hal-Tronix ___ 254
HamLine ___ 466
Ham Radio ___ 150
Ham Center ___ 491
Hamtronics ___ 246
Heath ___ 060
Heights ___ 061
Henry ___ 062
Hildreth ___ 283
Hosfelt ___ 390
Hufco ___ 403
Hy-Gain ___ 064
Icom ___ 065
Info-Tech ___ 351
Int'l. Xtal ___ 066
James ___ 333
Jan ___ 067
Janel ___ 068
Jensen ___ 293
Kensco ___ 394
Kenwood *
Kester Solder ___ 492
Larsen ___ 078
Leader ___ 412
Lin ___ 451
Lyle ___ 373
M & D ___ 494
MFJ ___ 082
MHz ___ 415
Madison ___ 431
Matric ___ 084
Maximilian ___ 438
Memtrix ___ 505
MidCom ___ 479
Midland ___ 086
Mini-Products ___ 395
Monolith *
National Multi ___ 396
N. R. I. ___ 397
National Semi ___ 323
New-Tronics ___ 171
Nexus ___ 454
Northshore RF ___ 296
NuData ___ 455
Wm. M. Nye ___ 214
Optoelectronics ___ 352
Orlando Hamfest *
Palomar ___ 093
Partridge ___ 439
Pipo ___ 481
Poly Paks ___ 096
Porta-Pak ___ 274
RP ___ 098
Callbook ___ 100
Regency ___ 102
SST ___ 375
Sandlin ___ 471
SAROC *
SOTA ___ 506
Southwest Tech. ___ 263
Space ___ 105
Spacetron *
Spec. Comm. Sys. ___ 318
Spectronics ___ 191
Spec. Comm. ___ 366
Spec. Int. ___ 108
Standard ___ 109
Swan ___ 111
TPL ___ 240
Tec-Kan ___ 507
Tele. Equip. ___ 496
Telrex ___ 377
Ten Tec *
Hamboree *
Tufts ___ 321
VHF Eng. ___ 121
VHF Signal ___ 497
Vanguard *
Varian ___ 043
Wahl ___ 508
Wawasee ___ 498
Webster Comm. ___ 423
Webster Radio ___ 255
Weinschenker ___ 122
Whitehouse ___ 378
Wilson ___ 123
Wire Concepts ___ 476
Yaesu ___ 127

*Please contact this advertiser directly.

Limit 15 inquiries per request.

November 1976

Please use before December 31, 1976

Tear off and mail to
HAM RADIO MAGAZINE — "check off"
Greenville, N. H. 03048

NAME ____________________

CALL ____________________

STREET ____________________

CITY ____________________

STATE ______________ ZIP ______________

Advertisers index

More Details? CHECK—OFF Page 126

YAESU Deluxe "101" Series.
The Ultimate Station Combination

FR-101-Digital Readout Receiver

■ Total Coverage: 160 thru 2 Meters with optional 6 and 2 Meter converters ■ Provision for all mode reception; SSB, CW, AM, RTTY, and FM with optional filters and FM detector ■ Complete transceive capability with all 101 series equipment ■ Reliable, plug-in circuit boards ■ Selectable fast or slow AGC ■ Built-in, threshold adjustable, noise blanker ■ Better than 1 KHz readout on all bands ■ Fixed channel, crystal-controlled operation ■ ±5 KHz clarifier ■ Built-in calibrator 25 or 100 KHz (selectable) ■ Indicator lights for internal VFO and clarifier ■ Built-in AC and 12V DC power supply

FL - 101 Transmitter

- 160 thru 10 Meter coverage with 2 auxiliary bands
- All mode operation: SSB, CW, AM and FSK
- 240 Watts PEP
- Reliable, plug-in circuit boards
- Built-in AC supply
- Built-in, fully adjustable VOX
- Automatic break-in CW operation with sidetone
- Indicator light for internal VFO operation
- Provision for optional RF speech processor
- Built-in final cooling fan

YAESU
The radio.

Yaesu Musen USA Inc., 7625 E. Rosecrans, #29, Paramount, CA 90723 ○ (213) 633-4007
Yaesu Musen USA Inc., Eastern Service Ctr., 613 Redna Ter., Cincinnati, OH 45215 ○ (513) 772-1500

Collins' Generation 4 FM transmitters and EIMAC make beautiful music together.

Nine new FM transmitters from Collins—ranging in power from one to 40 kilowatts—use EIMAC tubes in the PA stages. Collins' combination of the Phase 4 FM exciter and EIMAC tubes provide enhanced performance for today's new generation of radio audiophiles, plus proven reliability for the station engineer.

Make sure your new FM transmitter employs EIMAC power tubes. The transmission of fine sound, brilliant tonality, and low harmonic distortion require the very best of power tubes in the critical high power stages. This means EIMAC, of course.

For full information on power tubes for any service, any power level, contact Varian, EIMAC Division, 301 Industrial Way, San Carlos, California 94070. Or any of the more than 30 Varian Electron Device Group Sales Offices throughout the world.

varian