DECEMBER 1983 / $2.50

Season's Greetings from

ham radio magazine

ham radio • December 1983

- auto-dialer
- photovoltaics
- lightning protection
- vertical phased arrays
- time and frequency standards
- PCBs in the ham shack

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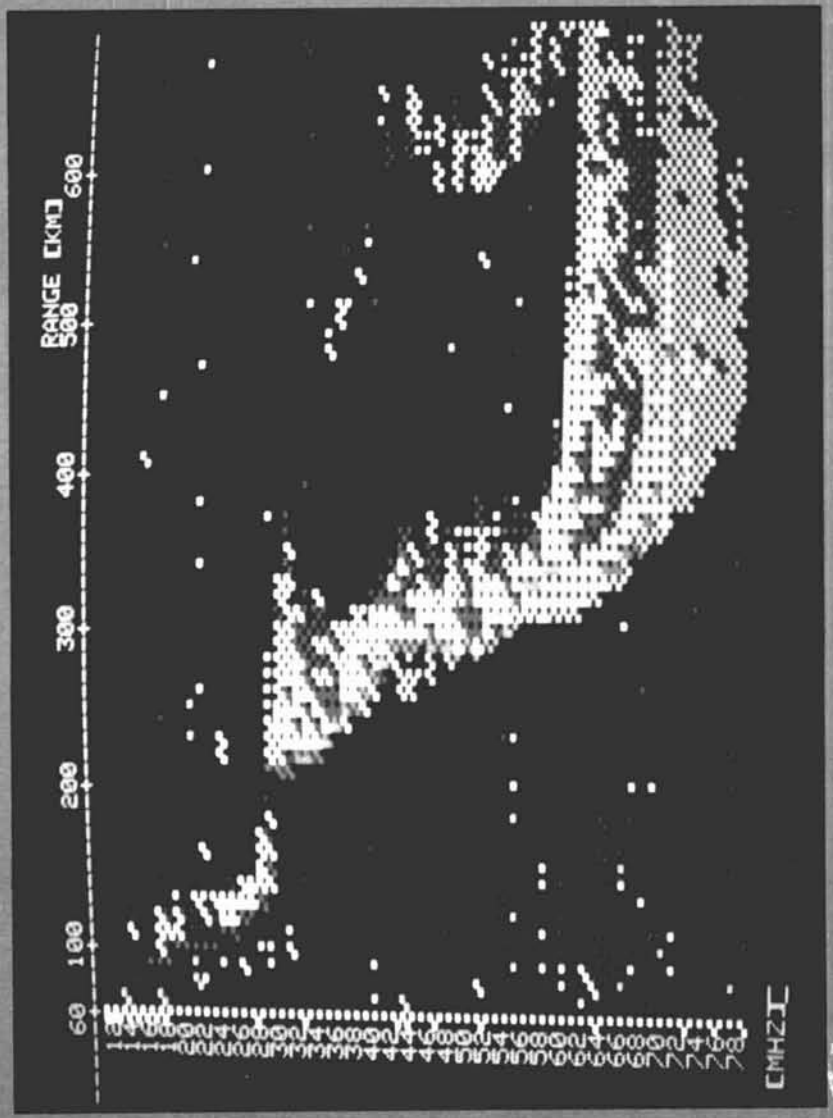
unications technology



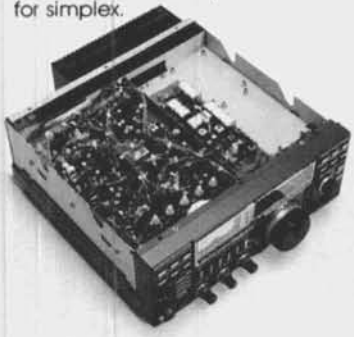
PROBING THE IONOSPHERE: DIGITAL IONOSONDES

IC-271H

Now a 100 Watt, 2 Meter Base!

For the ultimate in two-meter communications, ICOM presents the IC-271H transceiver with a high dynamic range receiver and a 100 watt transmitter. Operating from the IC-PS30, IC-PS15, or the internal IC-PS35 (optional), the IC-271H brings all the advanced functions of the latest CPU controlled radios to your shack.

100 Watts. Now a two-meter base station with 100 watts of internal power! The IC-271H provides all the power required for operation from remote places to repeaters, or for simplex.



IC-PS30
Power Supply

Subaudible Tones. Included as a standard feature are 32 built-in subaudible tones which are easily selected by rotating the main tuning knob. PL tones may be stored into memory.

32 Full-Function Memories. Each tunable memory holds frequency, offset, offset direction, mode and subaudible tone. Each parameter is selected by rotating the main tuning knob in conjunction with the switches on the front panel.

PLL Locked at 10Hz. An extremely low-noise, professional receiver and a good signal-to-noise ratio PLL allows the IC-271H's synthesizer to lock to 10Hz providing receiver performance unparalleled by any other VHF receiver.

Fluorescent Display. ICOM's high-visibility, multicolor display gives easy-to-read display of all information necessary for logging a contact. Frequency, mode, duplex, offset direction, RIT frequency, memory channel and PL tone can be displayed.

Scanning. The IC-271H can scan memories and programmed sections of the band or modes. Mode-S scan can be used to scan only memories with a particular mode or lock out frequencies continuously busy so the receiver will not stop at that memory channel while scanning.

Other Standard Features. To facilitate the operation of the IC-271H, ICOM has incorporated a duplex check switch, all-mode squelch, receive audio tone control, S-meter, center meter, seven-year lithium battery memory backup, accessory connector and microphone.

Optional Features. IC-271H options are: switchable preamplifier, CTCSS encoder/decoder (encoder is standard), computer interface and voice synthesizer.

Size. Only 11¼ inches wide by 4⅛ inches high, the IC-271H is styled to look good and engineered for ease of operation.

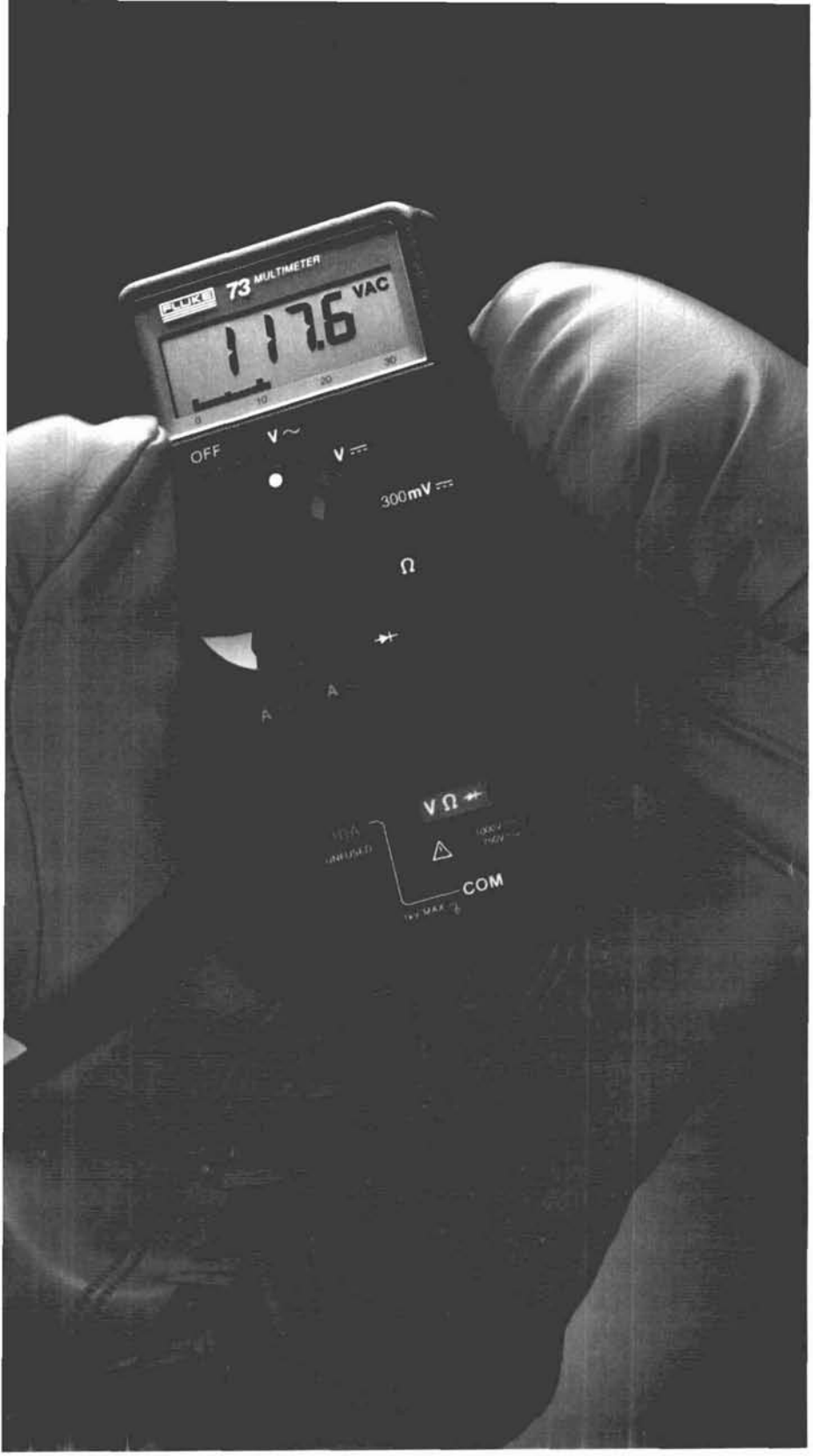
IC-271H
Shown with internal power supply IC-PS35

The IC-271A. The IC-271A with 25 watt output is available and has the same features as the IC-271H, plus an optional IC-PS25 internal power supply to make it a compact, go-anywhere two-meter base station. See the IC-271A(H) and other fine ICOM equipment at your ICOM dealer today.

ICOM
The World System

ICOM America, Inc., 2112-116th Ave NE, Bellevue, WA 98004 **(206)454-8155** / 3331 Towerwood Drive, Suite 307, Dallas, TX 75234 **(214)620-2780**

All stated specifications are approximate and subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions. 271H1083-1



The Digital vs. Analog battle is over.

$85* buys you the new champion. **The new Fluke 70 Series.**

They combine digital and analog displays for an unbeatable two-punch combination.

Now, digital users get the extra resolution of a 3200-count LCD display.

While analog users get an analog bar graph for quick visual checks of continuity, peaking, nulling and trends.

Plus unparalleled operating ease, instant autoranging, 2,000+ hour battery life and a 3-year warranty.

All in one meter.

Choose from three new models. The Fluke 73, the ultimate in simplicity. The feature-packed Fluke 75. Or the deluxe Fluke 77, with its own multipurpose protective holster and unique "Touch Hold" function (patent pending) that captures and holds readings, then beeps to alert you.

Each is Fluke-tough to take a beating. American-made, to boot. And priced to be, quite simply, a knockout.

For your nearest distributor or a free brochure, call toll-free anytime **1-800-227-3800, Ext. 229.** From outside U.S., call 1-402-496-1350 Ext. 229.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

Fluke 73

$85*

Analog/digital display

Volts, ohms, 10A, diode test

Autorange

0.7% basic dc accuracy

2000+ hour battery life

1 year warranty

Fluke 75

$99*

Analog/digital display

Volts, ohms, 10A, mA, diode test

Audible continuity

Autorange/range hold

0.5% basic dc accuracy

2000+ hour battery life

3 year warranty

Fluke 77

$129*

Analog/digital display

Volts, ohms, 10A, mA, diode test

Audible continuity

Touch Hold™ data hold

Autorange/range hold

0.5% basic dc accuracy

2000+ hour battery life

3 year warranty

Multipurpose holster

*Suggested U.S. retail price effective 1 July 1989

FLUKE

142

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TS-930S

"DX-traordinary"... superior dynamic range, auto. antenna tuner, QSK, dual NB, 2 VFO's, general coverage receiver.

A superlative, high-performance, all solid-state HF transceiver, that covers all Amateur HF bands, and incorporates a 150 kHz to 30 MHz general coverage receiver having an excellent dynamic range.

TS-930S FEATURES:

- 160-10 Meters, with 150 kHz-30 MHz general coverage receiver. Covers all Amateur frequencies, plus WARC, on SSB, CW, FSK, and AM. UP conversion digital PLL circuit.
- Excellent receiver dynamic range. Typical two-tone dynamic range, 100 dB (20 meters, 50-kHz spacing, 500 Hz CW bandwidth).
- All solid-state 28 volt operated final amplifier. Lowest IM distortion. Power input 250 W on SSB/CW/FSK, 80 W on AM. SWR/ Power meter.
- Available with AT-930 automatic antenna tuner built-in, or as an option. Covers 80-10 meters, including WARC bands.
- CW full break-in. CMOS logic IC, plus reed relay. Switchable to semi break-in.
- Dual digital VFO's, 10-Hz steps, includes band information.
- Eight memory channels. Stores frequency and band data. Internal battery memory back-up, est. 1 yr. life. (Battery not Kenwood supplied.)
- Dual mode noise blanker. NB-1, with threshold control, for "pulse" noise. NB-2 for "woodpecker."
- SSB IF slope tuning, allows independent adjustment of the low and/or high frequency slopes of the IF passband.
- CW VBT and pitch control. VBT tunes out interfering signals. CW pitch control shifts IF pass-band and beat frequency. "Narrow-Wide" filter switch.
- Tuneable, peak-type audio filter for CW.
- AC power supply built-in.
- Fluorescent tube digital display (100 Hz resolution, modifiable to 10 Hz) with digitalized sub-scale, in 20-kHz steps.
- RF speech processor.
- One year limited warranty.
- SSB monitor circuit.

Optional Accessories:

- AT-930 Auto. antenna tuner.
- SP-930 External speaker with selectable audio filters.
- YG-455C-1 (500 Hz) or YG-455CN-1 (250 Hz) plug-in CW filters for 455 kHz IF.
- YK-88C-1 (500 Hz) CW plug-in filter for 8.83 MHz IF.
- YK-88A-1 (6 kHz) AM plug-in filter for 8.83 MHz IF.
- SO-1 commercial grade TCXO.
- MC-42S UP/DOWN hand mic.
- MC-60A deluxe desk mic.
- MC-80 desk top UP/DOWN mic.
- MC-85 multi-function desk mic.

TS-430S

"Digital DX-terity"... General coverage, Superior dynamic range, 2 VFO's, 8 memories, Scan, Notch, COMPACT!

Combines compact styling with state-of-the-art circuit design and performance.

TS-430S FEATURES:

- 160-10 meters, with 150 kHz-30 MHz general coverage receiver. Covers all Amateur frequencies, plus WARC. UP-conversion digital PLL circuit.
- USB, LSB, CW, AM, and FM (optional) all mode.
- Compact lightweight design. Only 10-5/8 (270) W x 3-3/4 (96) H x 10-7/8 (275) D, inches (mm); only 14.3 lbs. (6.5 kg.).
- Superior receiver dynamic range with Dyna-Mix high sensitivity direct mixing system.
- 10-Hz step dual digital VFO's. Operate independently, include band and mode information. Dial torque adjustable. Step switch for 10-Hz or 100-Hz steps. A=B switch shifts "B" VFO to "A" VFO frequency and mode, or vice versa. VFO LOCK switch. RIT for VFO or memory. UP/DOWN manual scan with optional UP/DOWN microphone.
- Eight memories store frequency, mode, and band data. 8th memory stores RX/TX frequencies independently.
- Lithium battery memory back-up. (Est. 5 yr. life.)
- Memory Scan.
- Programmable automatic band scan width.
- IF shift circuit for minimum QRM.
- Tuneable notch filter, built-in.
- Narrow-wide filter selection on SSB and CW (filter optional).
- Speech processor, built-in.
- All solid state. Input rated 250 W PEP on SSB, 200 W DC on CW, 120 W on FM (optional), 60 W on AM. Operates on 12 VDC or on 120 VAC, or 220/240 VAC with optional PS-430 AC power supply.
- Fluorescent tube digital display indicates frequency to 100 Hz (10 Hz modifiable).
- All-mode squelch circuit, built-in.
- Built-in noise blanker.
- RF attenuator (20 dB).
- VOX circuit, plus semi break-in with side-tone.

Optional accessories:

- PS-430, PS-30 or KPS-21 AC power supplies.
- SP-430 external speaker.
- MB-430 mobile mounting bracket.
- AT-250 automatic antenna tuner, 160-10 m, incl. WARC.
- AT-130 compact antenna tuner, 80-10 m, incl. WARC.
- FM-430 FM unit.
- YK-88C (500 Hz) or YK-88CN (270 Hz) CW filters.
- YK-88SN (1.8 kHz) SSB filter.
- YK-88A (6 kHz) AM filter.
- MC-42S UP/DOWN hand mic.
- MC-55 (8P) mobile mic.
- MC-60A deluxe desk mic.
- MC-80 desk top UP/DOWN mic.
- MC-85 multi-function desk mic.

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ham radio magazine

DECEMBER 1983

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contents

REFLECTIONS

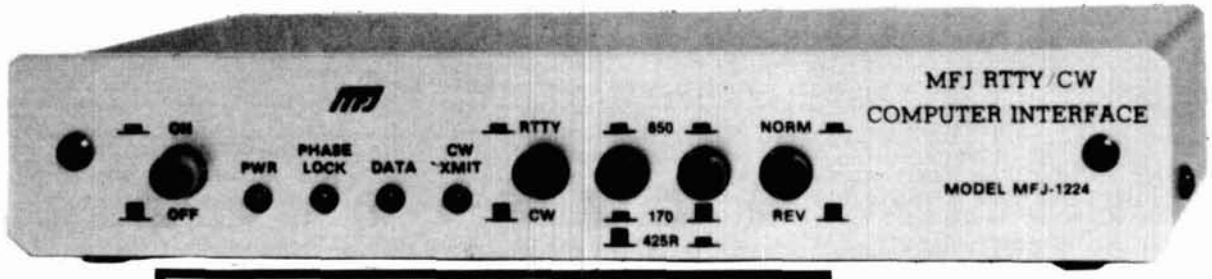
We couldn't think of a nicer way to end the year than with a wish for peace — at least on the airwaves.

Best wishes for a joyous holiday season from the "Skipper" and crew of ham radio magazine.

SHAMMS '83

MFJ RTTY / ASCII / CW COMPUTER INTERFACE

Lets you send and receive computerized RTTY/ASCII/CW. Copies all shifts and all speeds. Copies on both mark and space. Sharp 8 Pole active filter for 170 Hz shift and CW. Plugs between your rig and VIC-20, Apple, TRS-80C, Atari, TI-99, Commodore 64 or most other personal computers. Uses MFJ, Kantronics software and most other RTTY/CW software.



NEW!

MFJ Software plus MFJ Interface
for VIC-20 or Commodore 64
(Software cartridge alone, $49.95. Order MFJ-1250 for VIC-20, MFJ-1251 for Commodore 64)
$129.95

Powerful RTTY/ASCII/CW software for VIC-20, Commodore 64. Developed by MFJ. Cartridge plugs into expansion port. Features split screen display, type ahead buffer, message ports, RTTY/ASCII/CW send and receive plus much more.
Includes cable to interface MFJ-1224 to VIC-20 or Commodore 64.

$99.95
MFJ-1224

This new MFJ-1224 RTTY/ASCII/CW Computer Interface lets you use your personal computer as a computerized full featured RTTY/ASCII/CW station for sending and receiving.

It plugs between your rig and your VIC-20. Apple, TRS-80C, Atari, TI-99, Commodore 64, and most other personal computers.

Powerful MFJ software available for VIC-20 (MFJ-1250, $49.95) and Commodore 64 (MFJ-1251, $49.95). Features split screen display, type ahead buffer, message ports, RTTY/ASCII/CW send and receive plus more.

Uses Kantronics software for Apple, TRS-80C, Atari, TI-99 as well as VIC-20 and Commodore 64.

You can also use most other RTTY/CW software with nearly any personal computer.

A 2 LED tuning indicator system makes tuning fast, easy and positive. You can distinguish between RTTY/CW without even hearing it.

Once tuned in, the interface allows you to copy any shift (170, 425, 850 Hz and all shifts between and beyond) and any speed (5 to 100 WPM on RTTY/CW and up to 300 baud on ASCII).

Copies on both mark and space, not mark only or space only. This greatly improves copy under adverse conditions.

A sharp 8 pole active filter for 170 Hz shift and CW allows good copy under crowded, fading and weak signal conditions.

An automatic noise limiter helps suppress static crashes for better copy.

A Normal/Reverse switch eliminates retuning while stepping thru various RTTY speeds and shifts.

The demodulator will even maintain copy on a slightly drifting signal.

A +250 VDC loop output is available to drive your RTTY machine. Has convenient speaker output jack.

Phase continuous AFSK transmitter tones are generated by a clean, stable Exar 2206 function generator. Standard space tones of 2125 Hz and mark tones of 2295 and 2975 Hz are generated. A set of microphone lines is provided for AFSK out, AFSK ground, PTT out and PTT ground.

FSK keying is provided for transceivers with FSK.

High voltage grid block and direct outputs are provided for CW keying of your transmitter. A CW transmit LED provides visual indication of CW transmission. There is also an external hand key or electronic keyer input jack.

In addition to the Kantronics compatible socket, an exclusive general purpose socket allows interfacing to nearly any personal computer with most appropriate software. The following TTL compatible lines are available: RTTY demod out, CW demod out, CW-ID input, +5 VDC, ground. All signal lines are buffered and can be inverted using an internal DIP switch.

For example, you can use Galfo software with Apple computers, RAK software with VIC-20's, or Clay Abrams software with TRS-80C, N4EU software with TRS-80 III, IV. Some computers with some software may require some external components.

DC voltages are IC regulated to provide stable AFSK tones and RTTY/ASCII/CW reception.

Aluminum cabinet. Brushed aluminum front panel. 8x1¼x6 inches. Uses 12-15 VDC or 110 VAC with optional adapter, MFJ-1312, $9.95.

MFJ-1223, $29.95, RS-232 adapter for MFJ-1224.

RTTY/ASCII/CW Receive Only SWL Computer Interface

$69.95
MFJ-1225

Use your personal computer to receive commercial, military and amateur RTTY/ASCII/CW traffic.

The MFJ-1225 automatically copies all shifts (850, 425, 170 Hz shift and all others) and all speeds.

It plugs between your receiver and VIC-20, Apple, TRS-80C, Atari, TI-99, Commodore 64 and most other personal computers.

Use MFJ-1250 ($49.95) software cartridge for VIC-20 or MFJ-1251 ($49.95) software cartridge for Commodore 64. Use Kantronics software for Apple, TRS-80C, Atari and TI-99.

An automatic noise limiter helps suppress static crashes for better copy, while a simple 2 LED tuning indicator system makes tuning fast, easy and positive.

In addition to the Kantronics compatible socket, a general purpose socket provides RTTY out, RTTY inverted out, CW out, CW inverted out, ground and +5VDC for interfacing to nearly any personal computer with most appropriate software.

Audio in, speaker out jacks. 4½x1¼x4¼ in. 12-15 VDC or 110 VAC with adapter, MFJ-1312, $9.95.

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AN UNPRECEDENTED FCC-AMATEUR ANTI-INTERFERENCE PROJECT was kicked off in Chicago October 19 by the FCC Chicago Field Office. Introduced to about 70 area repeater representatives by the plan's originator, new Chicago Engineer-in-Charge Joe Monie, WBØPAW, the "unconventional approach" program will be conducted strictly on a trial basis to see if such FCC-Amateur cooperation is workable. Though strictly local in scope, the project is being conducted with the knowledge and agreement of appropriate FCC Washington bureaus.

Initial Thrust Of The Experiment Is Against Intentional Interference to area 2-meter repeaters. Several Chicago-area machines have long been plagued by this problem, and the project was initially conceived in response to their specific difficulties. All liaison between FCC and participating Amateurs will be conducted under strict guidelines, with very specific criteria as to what types of information will be acceptable for FCC use in hunting down and eliminating interfering stations.

Reaction To The Proposed Program Was Quite Positive, with some urging that its scope should eventually be expanded to cover other kinds of interference and other bands. If it is successful Monie feels that it could also be adopted by other FCC Field Offices as well. Though at this time the project is not a part of the long-planned Amateur-FCC enforcement program made possible by the Goldwater Communications Act rewrite bill, it could well become a significant aspect of it if the project does prove workable.

A Fringe Benefit Of The FCC-Sponsored Meeting was the reactivation of the long-dormant Illinois Repeater Council. All Illinois repeaters should contact WD9GMZ to register their interest in participating in future IRC activities.

GRENADA'S POLITICAL UPHEAVAL WAS GRAPHICALLY BROUGHT HOME to listening Amateurs by KA2ORK/J3A, a student at St. George's University School of Medicine, who came on shortly after military operations began early October 25. Though Mark was able to confirm no U.S. medical students on the island appeared to be casualties, he reported both artillery and small arms fire plus frequent overflights of helicopter gunships and other military aircraft. Sometimes operating while prone on the floor of his shack to avoid possible stray bullets, he and J37AH provided the only real-time reports of the invasion action.

Interested Amateurs Were Joined By Other Amateur Stations with inputs to various government agencies and news media on 14250, 14303, 21300, 21309, and 21375. Many found themselves featured on TV and radio, as normal news sources were unavailable.

STS-9'S OCTOBER 28 LAUNCH WAS SCRUBBED due to severe erosion of launch vehicle rocket nozzles, with consequent delay in W5LFL's operation from space. Though an alternate date of November 28 seems probable at press time, it's also possible that the nozzle problem or other considerations might further delay the STS-9 launch to February 22.

Unfortunately, Limitations On W5LFL's Operating May Be Much Greater than originally expected. Unless the mission's operating schedule is changed, only nine orbits will have the proper combination of spaceship orientation and W5LFL's free time to put his signal into the U.S. In addition, most of these orbits favor the east coast. Unless there's a further change, he'll be active on orbits 49, 56 (descending), 64, 80, 96, 112, 113, and 129. It's also possible that he may be able to operate during some additional orbits, or that the radiation pattern from the spaceship may permit contacts even when his window antenna is oriented away from the earth. Check the phone numbers in November Presstop for updates, but note that Westlink's number for STS-9 news is now 213-465-1500.

THE 10-YEAR AMATEUR LICENSE BECAME A REALITY OCTOBER 6, when the Commissioners acted favorably on PR Docket 83-337. At the same time they also extended the grace period for station license renewal from one year to two (operator licenses already are five years).

Current Licenses Will Not Automatically Be Extended. Instead 10-year licenses will be phased in with renewals. Just when the new 10-year licenses will actually begin to be issued depends on when new computer programs can be implemented.

TECHNICIANS MAY RUN FOR ARRL OFFICE, League directors decided at their fall meeting in Houston. The previous requirement was for candidates to be General Class or higher.

FCC's Volunteer Exam Program Was Endorsed By The Directors in a unanimous resolution, which also specified, however, that League participation in the program would commence only "...upon governmental authorization for recoupment of VEC expenses..."

220 MHz CONTINUES TO ATTRACT POTENTIAL USERS, with Waterway Communications System, Inc., pushing its FCC Petition for Rule Making (RM-4560) for a dedicated inland waterways band from 216 to 220 MHz. In addition, the FCC's Private Radio Bureau has also issued a "Final Report" on a study by its planning staff on future land-mobile needs that urges "Reallocation of 2 MHz from the 216-225 MHz band to the private land-mobile radio services for narrowband systems using 5 kHz spacing." RM-4560 is being strongly opposed by the Association of Maximum Service Telecasters because of possible channel 13 interference.

The 420-450 MHz Band May Also Be Hearing More Non-Amateur QRM soon. Westlink reports that Hughes Aircraft has a new contract for a military "Position Location and Reporting System" in that band for use by the Army and Marine Corps.

WELZ

SP-600

SP-600 Select 1 of 3 sensors by soft touch switch. Three wide bandwidth sensors cover 1.6-500MHz. **$159.00**
RS-1: 1.6-60MHz 0-2kW RS-2: 1.6-150MHz 0-200W RS-3: 130-500MHz 0-200W

SP-200 Two position antenna switch and indicators. Three power ranges to 1kW, 1.8-160MHz. **$107.00**

SP-400 Three band sensors (2m, 220, 450MHz), 10 percent accuracy, 0-150W CW, LED power range indicators. **$109.00**

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WELZ

SP-250

SWR & POWER METERS

SP-250 Low-profile, economy 2kW wattmeter. 1.6-60MHz bandwidth. 3W SWR sensitivity. Three ranges. A Best Buy! **$75.00**

SP-15M 1.8-150MHz, 200 watt, low-profile wattmeter. VSWR, FWD PWR, REF PWR, 1.5W SWR sensitivity. Great for mobile HF. **$60.00**

SP-45M VHF-UHF to 100 watts. 3W sensitivity for SWR, 10 percent accuracy. All metal shielded construction. **$85.00**

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WELZ

DUMMY LOADS

CT-300
Oil-less aircooled.
1kW peak for 3 min.,
300W avg. DC-250MHz
$68.00

CT-150
Oil-less aircooled.
400W peak for 3 min.,
150W avg. DC-250MHz
$46.00

CT-15A
50W peak, 15W avg.
SO-239 Screw-on dummy
DC-500MHz, VSWR<1:1.2
$12.00

CT-15N
50W peak, 15W avg.,
Type N Dummy Load.
DC-500MHz, VSWR <1:1.1
$21.00

SURGE SUPPRESSOR

CA-35A
Contains replaceable,
chip-type surge
voltage protector.
Low loss, low VSWR.
DC-500MHz, 350V breakdown.
$22.00

COAXIAL SWITCH

CH-20N
Two-way coaxial switch.
SO-239 type connector.
DC-900MHz, 1kW power.
$54.00

TERMINATION POWER METERS

TP-05X
BNC connector,
5W talkie checker.
Field calibratable,
3W avg. Dummy Load,
1W center. 50-500MHz.
$21.00

TP-25A
25 watt version of
TP-05X for mobile use.
Larger Dummy Load.
50-500MHz
$40.00

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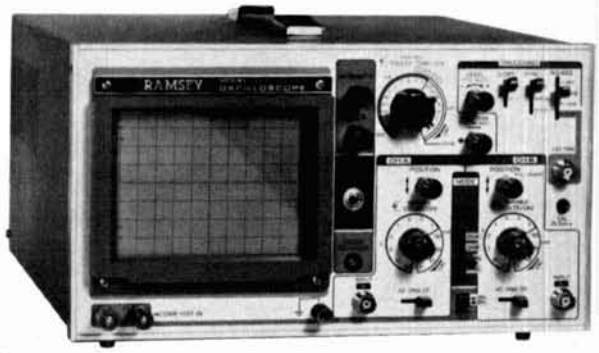


NEW FROM RAMSEY 20 MHz DUAL TRACE OSCILLOSCOPE

Unsurpassed quality at an unbeatable price, the Ramsey oscilloscope compares to others costing hundreds more. Features include a component testing circuit that will allow you to easily test resistors, capacitors, digital circuits and diodes • TV video sync filter • wide bandwidth & high sensitivity • internal graticule • high quality rectangular CRT • front panel trace rotator • Z axis • high sensitivity x-y mode • very low power consumption • regulated power supply • built-in calibrator • rock solid triggering • high quality hook-on probes

$39.95 high quality hook-on probes included

RAMSEY D-1100 VOM-MULTITESTER

Compact and reliable, designed to service a wide variety of equipment. Features include • mirror back scale • double-jeweled precision moving coil • double overload protection • an ideal low cost unit for the beginner or as a spare back-up unit.

$19.95

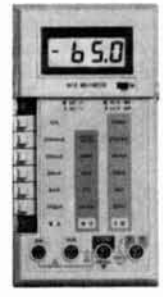
test leads and battery included

RAMSEY D-2100 DIGITAL MULTITESTER

A compact easy to use unit designed to operate like a pro. Featuring • 3½ digit LCD • low BAT. indicator • all range overload protection • overrange indication • auto-polarity • transistor tester • dual-slope integration • vinyl carrying case

$54.95

h_{FE} test leads, battery & vinyl carrying case included



RAMSEY D-3100 DIGITAL MULTIMETER

Reliable, accurate digital measurements at an amazingly low cost • In-line color coded push buttons, speeds range selection • abs plastic tilt stand • recessed input jacks • overload protection on all ranges • 3½ digit LCD display with auto zero, auto polarity & low BAT. indicator

$59.95

test leads and battery included

CT-70 7 DIGIT 525 MHz COUNTER

Lab quality at a breakthrough price. Features • 3 frequency ranges each with pre amp • dual selectable gate times • gate activity indicator • 50mV @ 150 MHz typical sensitivity • wide frequency range • 1 ppm accuracy

$119.95

wired includes AC adapter

CT-70 kit $99.95
BP-4 nicad pack 8.95

CT-90 9 DIGIT 600 MHz COUNTER

The most versatile for less than $300. Features 3 selectable gate times • 9 digits • gate indicator • display hold • 25mV @ 150 MHz typical sensitivity • 10 MHz timebase for WWV calibration • 1 ppm accuracy

$149.95

wired includes AC adapter

CT-90 kit $129.95
OV-1 0.1 ppm Oven Time base 59.95
BP-4 nicad pack 8.95

CT-125 9 DIGIT 1.2 GHz COUNTER

A 9 digit counter that will outperform units costing hundreds more. • gate indicator • 24mV @ 150 MHz typical sensitivity • 9 digit display • 1 ppm accuracy • display hold • dual inputs with preamps

$169.95

wired includes AC adapter

CT-125 kit $149.95
BP-4 nicad pack 8.95

CT-50 8 DIGIT 600 MHz COUNTER

A versatile lab bench counter with optional receive frequency adapter, which turns the CT-50 into a digital readout for most any receiver • 25 mV @ 150 MHz typical sensitivity • 8 digit display • 1 ppm accuracy

$169.95

wired

CT-50 kit $139.95
RA-1 receiver adapter kit 14.95

DM-700 DIGITAL MULTIMETER

Professional quality at a hobbyist price. Features include 26 different ranges and 5 functions • 3½ digit, ½ inch LED display • automatic decimal placement • automatic polarity

$119.95

wired includes AC adapter

DM-700 kit $99.95
MP-1 probe set 4.95

PS-2 AUDIO MULTIPLIER

The PS-2 is handy for high resolution audio resolution measurements, multiplies UP in frequency • great for PL tone measurements • multiplies by 10 or 100 • 0.01Hz resolution & built-in signal preamp/conditioner

$49.95

wired includes AC adapter

PS-2 kit $39.95

PR-2 COUNTER PREAMP

The PR-2 is ideal for measuring weak signals from 10 to 1,000 MHz • flat 25 db gain • BNC connectors • great for sniffing RF • ideal receiver/TV preamp

$44.95

wired includes AC adapter

PR-2 kit $34.95

PS-1B 600 MHz PRESCALER

Extends the range of your present counter to 600 MHz • 2 stage preamp • divide by 10 circuitry • sensitivity: 25mV @ 150 MHz • BNC connectors • drives any counter

$59.95

wired includes AC adapter

PS-1B kit $49.95

ACCESSORIES FOR RAMSEY COUNTERS

Telescopic whip antenna—BNC plug	$ 8.95
High impedance probe, light loading	16.95
Low pass probe, audio use	16.95
Direct probe, general purpose use	13.95
Tilt bail, for CT-70, 90, 125	3.95

master charge — BANKAMERICARD VISA

PHONE ORDERS CALL
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TELEX 466735 RAMSEY CI

TERMS: • satisfaction guaranteed • examine for 10 days; if not pleased return in original form for refund • add 6% for shipping and insurance to a maximum of $10.00 • overseas add 15% for surface mail • COD add $2.50 • orders under $10.00 add $1.50 • NY residents add 7% sales tax • all kits have a 90 day parts warranty. All wired units have 1 year parts and labor warranty.

RAMSEY

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Tell 'em you saw it in HAM RADIO!

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We now have available a bunch of goodies too good to bypass. Items are limited so order today

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Call your Phone Order in Today. TERMS: Satisfaction guaranteed or money refunded. C.O.D. add $2.50. Minimum order $6.00. Orders under $10.00 add $1.50. Add 6% for postage, insurance, handling. Overseas add 15%. N.Y. residents add 7% tax.

MINI KITS - YOU HAVE SEEN THESE BEFORE NOW HERE ARE OLD FAVORITE AND NEW ONES TOO. GREAT FOR THAT AFTERNOON HOBBY.

FM MINI MIKE

A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.

FM-3 Kit **$14.95**
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See music come alive! 3 different lights flicker with music. One light each for high, mid-range and lows. Each individually adjustable and drives up to 300 W. runs on 110 VAC.

Complete kit, ML-1 **$8.95**

Video Modulator Kit

Converts any TV to video monitor. Super stable. Tunable over ch. 4-6. Runs on 5-15V, accepts std. video signal. Best unit on the market! Complete kit, VD-1 **$7.95**

Led Blinky Kit

A great attention getter which alternately *flashes 2 jumbo LEDs*. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts. Complete kit, BL-1 **$2.95**

Super Sleuth

A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2 W rms output, runs on 6 to 15 volts, uses 8-45 ohm speaker. Complete kit, BN-9 **$5.95**

CPO-1

Runs on 3-12 Vdc 1 watt out. 1 KHZ good for CPO, Alarm, Audio Oscillator. Complete kit **$2.95**

FM Wireless Mike Kit

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.

FM-1 kit **$3.95** FM-2 kit **$4.95**

Whisper Light Kit

An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Includes mike, controls up to 300 W, runs on 110 VAC. Complete kit, WL-1 **$6.95**

Tone Decoder

A complete tone decoder on a single PC board. Features 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone, burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts. Complete kit, TD-1 **$5.95**

Universal Timer Kit

Provides the basic parts and PC board required to provide a source of precision timing and pulse generation. Uses 555 timer IC and includes a range of parts for most timing needs.

UT-5 Kit **$5.95**

Mad Blaster Kit

Produces LOUD ear shattering and attention getting siren like sound. Can supply up to 15 watts of obnoxious audio. Runs on 6-15 VDC.

MB-1 Kit **$4.95**

Siren Kit

Produces upward and downward wail characteristic of a police siren. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker.

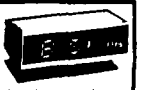
Complete kit, SM-3 **$2.95**

60 Hz Time Base

Runs on 15 VDC, low current (2.5mA), mounts directly on TB-7 kit.

TB-7 Kit **$5.50**
TB-7 Assy **$9.95**

CLOCK KITS



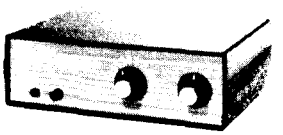
Your old favorites are here again. Over 7,000 Sold to Date. Be one of the gang and order yours today!

Try your hand at building the finest looking clock on the market. Its satin finish anodized aluminum case looks great anywhere, while six .4" LED digits provide a highly readable display. This is a complete kit, no extras needed, and it only takes 1-2 hours to assemble. Your choice of case colors: silver, gold, black (specify).

Clock kit, 12/24 hour, DC-5 **$24.95**
Clock with 10 min. ID timer, 12/24 hour, DC-10 **$29.95**

For wired and tested clocks add $10.00 to kit price.
SPECIFY 12 OR 24 HOUR FORMAT

SATELLITE TV KIT



THE POPULAR SAT-TEC RECEIVER IN KIT-FORM! yours today.

image rejection, fully tunable audio to recover 'hidden' subcarriers, divide by two PLL demodulator for excellent threshold performance, tight tracking AFC to assure drift free reception, and of course, full 24 channel tunable coverage.

Build your satellite TV system around the R2B, close to ten thousand others already have and now it's available in kit form at a new low price. Order today.

NEW, LOWER PRICES!

Featured in a Radio Electronics magazine cover story (May 82), the reliable R2B Sat-tec TV receiver is now operating in thousands of locations. The R2B is easy to build; pre-etched, plated boards with screened component layout assures accurate component placement and the critical IF section and local oscillator are pre-assembled and aligned! All parts are included for the R2B, attractive case, power supply, descriptive operating manual as well as complete assembly instructions. Features of the receiver include: dual conversion design for best

A complete Satellite TV System requires a dish antenna, LNA (low noise amplifier), Receiver and Modulator.

R2B Receiver Kit **$295.00**
R2B Receiver, Wired and Tested **$395.00**
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RM3 RF Modulator **$49.95**
Prices include domestic UPS shipping and insurance.

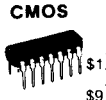
PARTS PARADE

IC SPECIALS

LINEAR

301	$ .35
324	$1.50
380	$1.50
555	$ .45
556	$1.00
565	$1.00
566	$1.00
567	$1.25
741	10/$2.00
1458	$ .50
3900	$ .50
3914	$2.95
8038	$2.95

CMOS



4011	.50
4013	.50
4046	$1.85
4049	.50
4059	$9.00
4511	$2.00
4518	$1.35
5639	$1.75

TTL

74S00	$ .40
7447	$ .65
7475	$ .50
7490	$ .50
74196	$1.35

SPECIAL

11C90	$15.00
10116	$ 1.25
7208	$17.50
7207A	$ 5.50
7216D	$21.00
7107C	$12.50
5314	$ 2.95
5375AB/G	$ 2.95
7001	$ 6.50

FERRITE BEADS

With info and specs **15/$1.00**
6 Hole Balun Beads **5/$1.00**

READOUTS

FND 359 .4" C.C.	$1.00
FND 507/510 .5" C.A.	1.00
MAN 72/HP7730 .33" C.A.	1.00
HP 7651 .43" C.A.	2.00

TRANSISTORS

2N3904 NPN G.P.	15/$1.00
2N3906 PNP G.P.	15/$1.00
2N4403 PNP G.P.	15/$1.00
2N4410 NPN G.P.	15/$1.00
2N4916 FET G.P.	4/$1.00
2N5401 PNP G.P.	5/$1.00
2N6028 G.P.	4/$1.00
2N3771 NPN Silicon	$1.50
2N5179 UHF NPN	3/$2.00
Power Tab NPN 40W	3/$1.00
Power Tab PNP 40W	3/1.00
MPF 102/2N5484	$.50
NPN 3904 Type T+R	50/$2.50
PNP 3906 Type T+R	50/$2.50
2N3055	$.80
2N2646 UJT	3/$2.00

Sockets

8 Pin	10/$2.00
14 Pin	10/$2.00
16 Pin	10/$2.00
24 Pin	4/$2.00
28 Pin	4/$2.00
40 Pin	3/$2.00

Diodes

5.1 V Zener	20/$1.00
1N914 Type	50/$1.00
1KV 2Amp	8/$1.00
100V 1Amp	15/$1.00

25 AMP 100V Bridge **$1.50 each**

Mini-Bridge 50V 1 AMP 2 for $1.00

Resistor Ass't

Assortment of Popular values - ¼ watt. Cut lead for PC mounting. ¼" center, ¼" leads. bag of 300 or more **$1.50**

Switches

Mini toggle SPDT **$1.00**
Red Pushbuttons N.O. **3/$1.00**

Earphones

3" leads, 8 ohm, good for small tone speakers, alarm clocks, etc. 5 for $1.00

Mini 8 ohm Speaker

Approx 2" diam. Round type for radios, mike etc. **3 for $2.00**

Solid State Buzzers

small buzzer 450 Hz, 86 dB sound output on 5-12 vdc at 10-30 mA, TTL compatible **$1.50**

Slug Tuned Coils

Small 3/16" Hex Slugs turned coil, 3 turns. 10 for $1.00

AC Outlet

Panel Mount with Leads **4/$1.00**

CAPACITORS

TANTALUM Dipped Epoxy	ALUMINUM Electrolytic	DISK CERAMIC
1.5 uF 25V 3/$1.00	1000 uF 16V Radial $.50	.01 16V disk 20/$1.00
1.8 uF 25V 3/$1.00	500 uF 25V Axial $.50	1 16V 15/$1.00
.22 uF 25V 3/$1.00	150 uF 16V Axial 5/$1.00	.001 16V 20/$1.00
	10 uF 15V Radial 10/$1.00	100 pF 20/$1.00
		.047 16V 20/$1.00

DC-DC Converter

+5 vdc input prod. -9 vdc @ 30ma
+9 vdc produces -15 vdc @ 35ma **$1.25**

Ceramic IF Filters

Mini- kHz
B.W. SOLD OUT $1.50 ea.

Trimmer Caps

Sprague - 3-40 pf
Stable Polypropylene
.50 ea.

25K 20 Turn Trim Pot **$1.00**
1K 20 Turn Trim Pot **$.50**

Crystal Microphone

Small 1" diameter ¼" thick crystal mike cartridge **$.75**

Mini RG-174 Coax

10 ft. for $1.00

Coax Connector

Chassis mount BNC type **$1.00**

9 Volt Battery Clips

Nice quality clips **5 for $1.00**
¼" Rubber Grommets **10 for $1.00**

Parts Bag

Asst. of chokes, disc caps, tant., resistors, transistors, diodes, MICA caps, etc. sm. bag (100 pc) **$1.00** lg. bag (300 pc) **$2.50**

Connectors

6 pin type gold contacts for mA-1003 car clock module price .75 ea.

Leds

- your choice, please specify
Mini Red, Jumbo Red, High Intensity Red, Illuminator Red **8/$1**
Mini Yellow, Jumbo Yellow, Jumbo Green **6/$1**

Varactors

Motorola MV 2209 30 PF Nominal cap 20-80 PF - Tunable range - .50 each or 3/$1.00

Crystals

3.579545 MHZ	$1.50
10.00000 MHZ	$5.00
5.248800 MHZ	$5.00

AC Adapters

Good for clocks, nicad chargers, all 110 VAC plug one end.

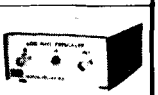
8.5 vdc @ 20 mA	$1.00
16 vac @ 160mA	$2.50
12 vac @ 250mA	$3.00

Audio Prescaler

Make high resolution audio measurments, great for musical instrument tuning, PL tones, etc. Multiplies audio UP in frequency, selectable x10 or x100, gives .01 HZ resolution with 1 sec. gate time! High sensitivity of 25 mv, 1 meg input z and built-in filtering gives great performance. Runs on 9V battery, all CMOS.

PS-2 kit **$29.95**
PS-2 wired **$39.95**

600 MHz PRESCALER



Extend the range of your counter to 600 MHz. Works with all counters. Less than 150 mv sensitivity, specify -10 or -100.

Wired, tested, PS-1B **$59.95**
Kit, PS-1B **$44.95**

30 Watt 2 mtr PWR AMP

Simple Class C power amp features 8 times power gain. 1 W in for 8 out, 2 W in for 15 out, 4W in for 30 out. Max output of 35 W, *incredible value,* complete with all parts, less case and T-R relay.

PA-1, 30 W pwr amp kit **$22.95**
TR-1, RF sensed T-R relay kit **6.95**

MRF-238 transistor as used in PA-1 8-10db gain 150 mhz **$11.95**

RF actuated relay senses RF (1W) and closes DPDT relay. For RF sensed T-R relay. TR-1 Kit **$6.95**

Power Supply Kit

Complete triple regulated power supply provides variable 6 to 18 volts at 200 ma and +5 at 1 Amp. Excellent load regulation, good filtering and small size. Less transformers, requires 6.3 V @ 1 A and 24 VCT.

Complete kit, PS-3LT **$6.95**

OP-AMP Special

BI-FET LF 13741 - Direct pin for pin 741 co[illegible] but 500,000 MEG input z, super low 50 pa input curr[illegible] power drain.

SOLD OUT

50 for only $9.00 **10 for $2.00**

Regulators

78MG	$1.25	7812	$1.00
79MG	$1.25	7815	$1.00
723	$.50	7905	$1.25
309K	$1.15	7912	$1.25
7805	$1.00	7915	$1.25

Shrink Tubing Nubs

Nice precut pces of shrink size 1" x ½" shrink to ¼". Great for splices **50/$1.00**

Mini TO-92 Heat Sinks

Thermalloy Brand **5 for $1.00**
To-220 Heat Sinks **3 for $1.00**

Opto Isolators - 4N28 type **$.50 ea.**
Opto Reflectors - Photo diode + LED **$1.00 ea.**

Molex Pins

Molex already precut in length of 7. Perfect for 14 pin sockets. **20 strips for $1.00**

CDS Photocells

Resistance varies with light, 250 ohms to over 3 meg. **3 for $1.00**

comments

power supply

Dear HR:

WB2UAQ's comment (July, 1983) on the March, 1983, article, "Dual Voltage Power Supply," suggested replacing the LM317 with a 723-type regulator. I did just that (see **fig. 1**).

Paul B. Johnson, VE7DHM
Sooke, British Columbia

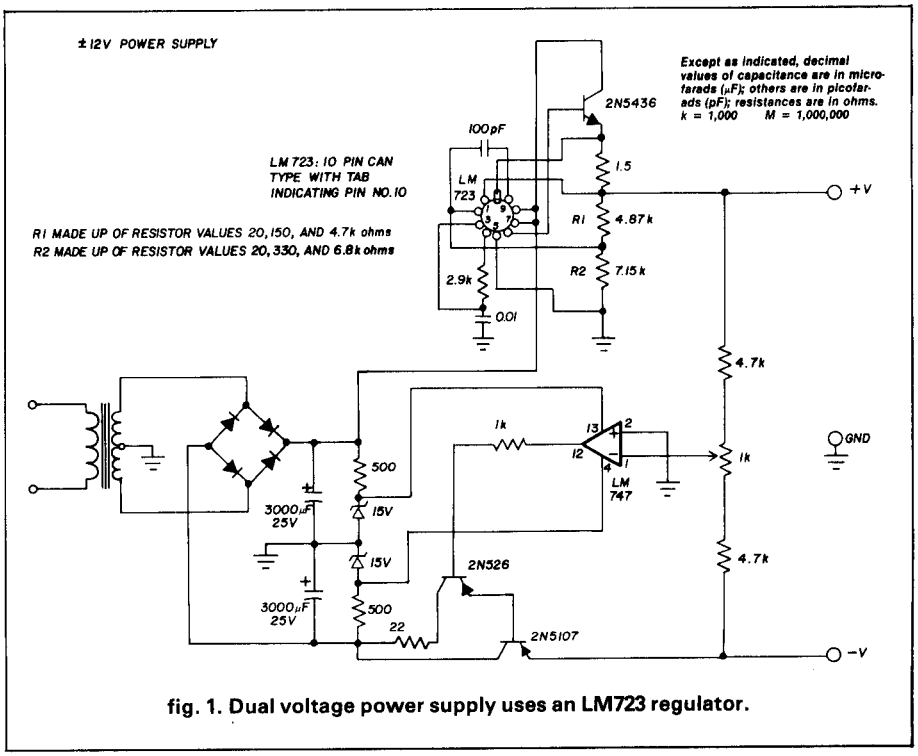


fig. 1. Dual voltage power supply uses an LM723 regulator.

loaded antennas

Dear HR:

Bill Orr's column on loaded antennas (*ham radio*, April, 1983) impressed me because although I generally operate on 20 meters, I'd like to use the 80-meter band and would like to have an antenna that doesn't require a ground.

Using the information on pages 54 and 55 of that issue, I wound the 40 μH loading coils but used No. 14 instead of No. 16 wire and checked the results on a Heath inductance bridge. Although the inductance was just about at the bottom of the scale (the bridge operates at 100 Hz, I believe) the results were accurate to two places.

I could not measure the center inductance but wound 11 turns of No. 14 wire on a 3/8-inch danvas impregnated form I had previously used for RF work.

It's OK to use the inductances *if* you have the equipment to measure them. Perhaps it would be better to indicate the coils not in inductance value, but rather in frequency, using a 10 pF capacitor to resonate with it. (Mine resonated at 14.25 MHz using a Millen meter for measurement.)

My friend WB6AFJ has an LC loaded 80-meter antenna. He's had plenty of trouble with the capacitors burning up. The absence of the capacitor, and the high voltage developed on these coils makes them difficult to manufacture for powers up to the legal limit which he uses now and then, as I do. I tend to shy away from coils as a result, but these — without the loading capacitors — look good.

One thing, however. Using the old compression insulators in which the wires overlap, how does one calculate the full dimensions of the lines? I used small ceramic insulators, and made the wires to full dimension plus about three feet; these I folded back and secured. I like the adjustability of this method. The doubled-back lengths may add a little capacitance on the ends of the wires, and may assist in loading. The antenna has not been dipped as yet; I have to get the noise bridge out and adjust it to specs.

I did not attempt to dip the 1.86 μH coil, but I ought to. I may have to use 52 ohm coaxial; right now I have RG-59 which is 75 ohms instead of 52 ohms.

Someone might want to run a program showing the resonant frequency of the coils mentioned in **fig. 4** (page 54) for benefit of those using the figures and not having other equipment.

Hank B. Plant, W6DKZ
San Jose, California

clean it up

Dear HR:

In his Ham Note, "Low Duty Cycle Transmitter Tune-up," (August, 1983), K4KI recommends using an automatic keyer in the dot mode during transmitter tune-up in order to reduce the duty cycle by approximately 50 percent and thereby save wear and tear on the tubes. But although an editor's note recommending the use of a dummy load at all times was included, we all know not every ham has a dummy load. Those who do have dummy loads don't always use them, and there are times when loading must be done into a radiating antenna, even if only briefly.

Therefore, K4KI's alternatives of either feeding the keyer's audio sidetone through the microphone, or feeding in audio generated by a relay connected in an RC time-constant circuit to make it buzz were both most unfortunate suggestions. Hopefully anyone currently using either of these techniques while loading into anything other than a dummy load will discontinue the practice.

While it is true that a pure sine wave carefully fed into the microphone input of an SSB transmitter can produce, for all practical purposes, a sine wave RF carrier in the output, this should never be attempted casually. The signal should be monitored on an oscilloscope, as the slightest distortion of the input sine wave will result in trash signals in the RF output which may vary from mild to an RF carrier output composed of numerous signals. Add in some flattopping in the finals, and this garbage will extend perhaps several hundred kHz above and below the intended frequency of operation.

Few, if any, audio sidetones are pure sine waves. This is true whether it is electronic keyer sidetone, or the CW sidetone audio now included in all modern transceiver designs. At least one commercial electronic keyer I've seen uses a diode in series with the speaker, clipping one half of the audio waveform and generating a truly unique sidetone signal! Sidetone signals also tend to have an abundance of clicks or chirps, often both. Many of the CB to 10-meter conversions have no provision for operating CW if they are ex-CB SSB transceivers. It is common to feed keyed sidetone audio into them through either the mike or mike input circuit, and the result is spectacular. A number of these are currently loose on 10 meter CW and their signals are characterized by what can only be described as sounding like keyed steam calliopes — numerous carriers, usually accompanied by a bad case of chirps and/or clicks. A fairly clean one will occupy 5 or 10 kHz.

Audio sidetone-generated signals fed into the mike or mike input circuit will invariably generate unsanitary RF output from an SSB transmitter. Sending it into a dummy load is one thing, but radiating this garbage is quite another. Where on-the-air transmitter tuning is unavoidable, only the CW mode utilizing the transmitter's internal CW keying circuit and a keyer set for fast dots is appropriate. Hopefully the internal keying circuitry will provide proper shaping to avoid generating key clicks (approximately 5 ms rise and decay times), and if the dot/space ratio is correct, this will reduce the duty cycle to something less than 50 percent.

Robert G. Wheaton, W5XW
San Antonio, Texas

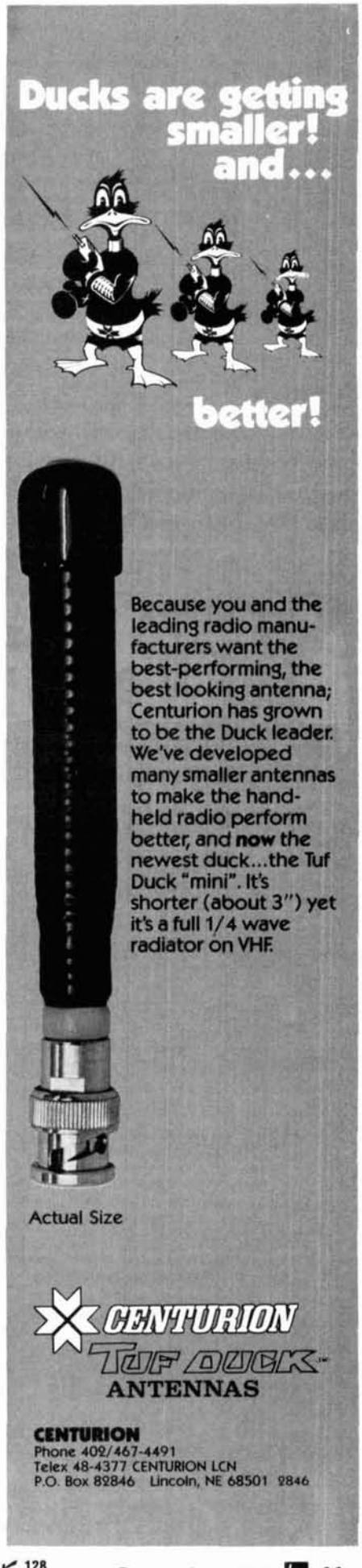
---

short circuit

phased verticals

One line of K2BT's article, "Phased Vertical Arrays: part 4" (October, 1983) was inadvertently omitted. The second-to-last sentence on page 45 should read as follows:

"The calculation procedures are structured and identical for any circuit (except for the differing equations for matrix values), making the method ideal for programmable calculators or small computers."



THE MOST AFFORDABLE REPEATER

ALSO HAS THE MOST IMPRESSIVE PERFORMANCE FEATURES

(AND GIVES THEM TO YOU AS STANDARD EQUIPMENT!)

JUST LOOK AT THESE PRICES!

Band	Kit	Wired/Tested
10M,6M,2M,220	$680	$880
440	$780	$980

Both kit and wired units are complete with all parts, modules, hardware, and crystals.

CALL OR WRITE FOR COMPLETE DETAILS.

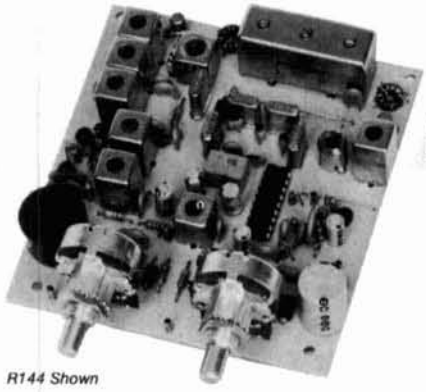
Also available for remote site linking, crossband, and remote base.

FEATURES:

- SENSITIVITY SECOND TO NONE; TYPICALLY 0.15 uV ON VHF, 0.3 uV ON UHF.
- SELECTIVITY THAT CAN'T BE BEAT! BOTH 8 POLE CRYSTAL FILTER & CERAMIC FILTER FOR GREATER THAN 100 dB AT ± 12KHZ. HELICAL RESONATOR FRONT ENDS. SEE R144, R220, AND R451 SPECS IN RECEIVER AD BELOW.
- OTHER GREAT RECEIVER FEATURES: FLUTTER-PROOF SQUELCH, AFC TO COMPENSATE FOR OFF-FREQ TRANSMITTERS, SEPARATE LOCAL SPEAKER AMPLIFIER & CONTROL.
- CLEAN, EASY TUNE TRANSMITTER; UP TO 20 WATTS OUT (UP TO 50W WITH OPTIONAL PA).

HIGH QUALITY MODULES FOR REPEATERS, LINKS, TELEMETRY, ETC.

HIGH-PERFORMANCE RECEIVER MODULES



R144 Shown

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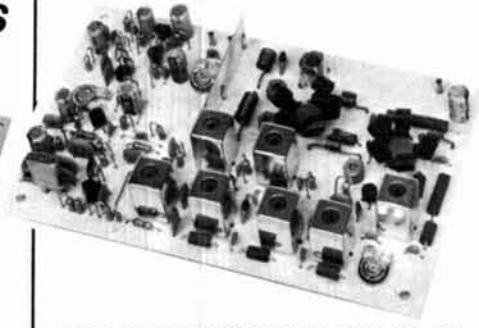

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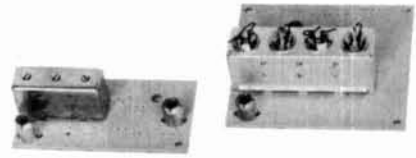

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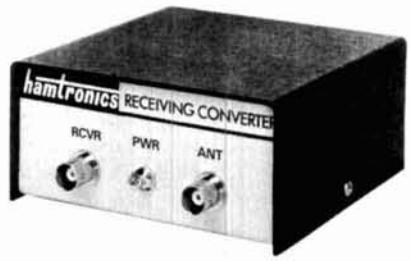

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	Antenna Input Range	Receiver Output
VHF MODELS	28-32	144-148
	50-52	28-30
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Less Case $39	144-146	28-30
Wired $69	145-147	28-30
	144-144.4	27-27.4
	146-148	28-30
	144-148	50-54
	220-222	28-30
	220-224	144-148
	222-226	144-148
	220-224	50-54
	222-224	28-30
UHF MODELS	432-434	28-30
	435-437	28-30
Kit with Case $59	432-436	144-148
Less Case $49	432-436	50-54
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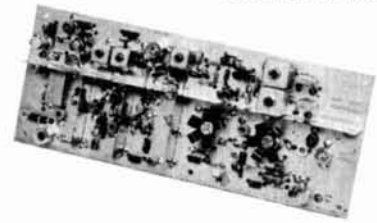
For VHF,	28-30	144-146
Model XV2	28-29	145-146
Kit $79	28-30	50-52
Wired $149	27-27.4	144-144.4
(Specify band)	28-30	220-222*
	50-54	220-224
	144-146	50-52
	50-54	144-148
	144-146	28-30
For UHF,	28-30	432-434
Model XV4	28-30	435-437
Kit $99	50-54	432-436
Wired $169	61.25	439.25
	144-148	432-436*

*Add $20 for 2M input



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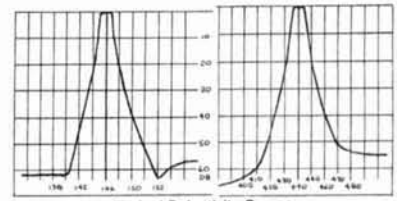

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Note: the front cover illustrates state-of-the-art techniques in the reception and processing of ionospheric sounding returns. The color-enhanced display was recorded by a *Digisonde* installed at Goose Bay, Labrador. It combines in one ionogram both vertical and oblique echo returns where: *yellow* signifies vertical echoes with ordinary polarization; *green*, vertical echoes with extraordinary polarization; *blue*, oblique echoes; *magenta*, automatically identified ordinary F trace; *red*, automatically identified ordinary E trace and extraordinary F trace. (Photo courtesy of Professor Bodo W. Reinisch, Technical Director, Center for Atmospheric Research, University of Lowell, Massachusetts.)

digital ionosondes

A second-generation probe of the ionosphere

HF radar is practically a household word to Radio Amateurs these days with almost everyone familiar with the Russian woodpecker and some with the quieter U.S. equivalent installation in Maine. These are known as Over-The-Horizon Backscatter Radars or OTH-Bs for short. Their purpose is one of long range aircraft detection. Another type of HF radar, known as ionospheric sounder, also operates using the echo principle. The basic differences between these two radars are range and type of object detected. While both radars utilize ionized layers, OTH-Bs use them as a means to an end, while sounders concentrate on the layers themselves. Information provided by the sounders enables communicators to design radio systems, choosing frequencies and times of operation more effectively. It is this latter type of probe that will be discussed.

Sweep-frequency ionospheric sounding equipment was first developed more than 50 years ago,[1] but until recently there was only one type of sounder or ionosonde. It operated in an analog mode, in the 1 to 30 MHz frequency range, by transmitting pulses vertically or obliquely to the D, E, and F ionospheric regions and receiving the weaker returning signals. The round trip time of the signal determined height, while the intensity of the echo could be related to the degree of ionization of the D region(s), where radio wave energy is absorbed while signals propagate through it to the higher reflecting layers. Though extremely useful data became available in the form of ionograms (see **fig. 1**) it still represented a two-dimensional display in a multi-dimensional world. What was needed was instrumentation that determined not only amplitude but also phase, direction of arrival, and polarization of the signal returns.

The next logical step in sounder development took advantage of the high speed capabilities inherent in digital data processing techniques. By combining a general computer with a specialized RF processor, a digital ionosonde was created. It now had the capability of real-time data analysis and display by processing the (complex vector) numerical description of signal returns as they varied with range and frequency.[2] Manipulation of this data provided additional signal parameters including phase, group delay, and doppler spectrum. When combined with an array of receiving antennas, the digital ionosonde was also able to determine signal direction of arrival, wave polarization, and other diffraction pattern information. The significance of this development lies in the fact that a single piece of equipment could now provide all this information, whereas in the past, several different equipment systems — along with elaborate measurements — were necessary. The insight provided enabled ionospheric researchers to re-examine basic concepts in light of this new information.

ionospheric regions and layers

December 12, 1901, marks the date when the first successful reception of transatlantic signals occurred. It also marks the start of inquiries into the mechanism that allowed this radio transmission around the curvature of the earth. A.E. Kennelly from the United States and O. Heaviside (remember the Heaviside layer?) in Great Britain independently conceived of the existence of an ionized region in the upper atmosphere capable of reflecting radio waves back to earth.[3,4,5]

The ionosphere, a term first used by Sir Robert Watson-Watt, was defined as "that part of the atmosphere in which free ions exist in sufficient quantities to affect the propagation of radio waves."[6]

By Rich Rosen, K2RR, Editor-in-Chief, *ham radio*

(However, when Sir Edward Appleton looked into the physics of radio wave propagation in a plasma, he found that the refractive index of the plasma, which controls the propagation of the wave through it by changing the phase velocity of the wave, depends mainly on the electron density of the plasma. The ions, because of their large mass — compared to that of an electron — have little impact on wave propagation. But since charge neutrality requires that the number of ions equal the number of electrons, it could be said that Sir Robert was partially right.) It is accepted as existing from approximately 31 miles (50 km) to as high as several earth radii. There are three commonly-known sections of the atmosphere called the D, E, and F regions occurring at heights of 31 to 56 miles (50 to 90 km), 56 to 87 miles (90 to 140 km) and above 65 miles (120 km), respectively. (The regions are not clearly defined and merge with one another.) These regions can also be divided into smaller layers of ion distributions, with the E region occasionally showing E1, E2, and Es layers while the F region divides into F1, F1 ½, and F2 layers.

The F1 layer has a maximum between 160 and 180 km, exists only in the presence of sunlight, and has a maximum density at local noon. The F2 layer peaks between 200 and 600 km, depending on factors such as time of day, season, phase of solar cycle, neutral winds, ion composition, etc. Due to the low densities at these altitudes, recombination (electron/s + ion = neutral) is very slow; the ionization exists for many hours after sunset. The F1 ½ layer occurs sometimes after eclipse events, but rarely under normal conditions.

The F2 layer is the most important layer for radio communications, since it generally has the largest electron densities and therefore reflects the highest frequencies; it is found at the greatest height, and therefore results in the largest possible 1-hop distance.

Some claims have been made for the existence of two other regions: C and G. The C region is thought to exist at the bottom edge of the D region, approximately 60 kilometers up, and is formed by cosmic rays and is therefore always present (since impinging cosmic rays are always present). The G region appears on ionograms as a little kink during a storm when the critical frequency of the F2 layer is greatly diminished. It's possibly not a distinct region but rather a phenomenon that occurs at special times only.

ionospheric terminology

To understand the role these layers play in communications it's necessary to define a few related terms. For radio communications the most important characteristics of the ionospheric layers are their *critical frequencies* and *virtual heights*. If one were to slowly vary the frequency of a generator that was transmitting pulses vertically (straight up) to the E region, a frequency would be reached where the signal was no longer being reflected down. The highest frequency that reflects back down from the E region is known as the E-region critical frequency or foE for short. Similar terms can be defined for the F1 and F2 layers: foF1 and foF2. Note that the subscript zero in the terms for critical frequencies represents zero distance (surface separation) between a pulse's origin and return location.

Virtual height is the equivalent height of the layer based on length or round trip time and apparent uniform velocity. In actuality, due to the interaction between the radio waves and the electrons, a radio wave is slowed down as it enters ionospheric layers, resulting in non-uniform velocity. Consequently, actual layer height differs from virtual height. Nevertheless, virtual height represents an accepted and useful convention as we shall soon see.

Up to now vertically launched signals have been considered. If the same transmitter drives an antenna that produces a *low* angle (elevation) pattern, additional useful information becomes available. Let us define MUF (2000) E and MUF (4000) F as the highest frequencies which the E or F layer will carry over a 2000, 4000 km path, respectively. These low angle terms when divided by their respective layer critical frequency equal what's known as the M-factor, i.e.

$$M(2000)E = \frac{MUF(2000)E}{foE} \text{ and}$$

$$M(4000)F = \frac{MUF(4000)F}{foF2}$$

Note that the F layer is not often high enough to give a 4000 km 1 hop. Knowledge of these sets of frequencies is one of the beginning steps in determining communication paths and the corresponding operating frequencies. This is where sounders come in.

analog sounders

An early form of an ionosonde was a pulsed radar device in which the frequency was repetitively varied from approximately 1 MHz to 30 MHz (some started even lower, at 0.1 MHz). The equipment was designed to measure the time it took a pulsed radio wave to travel up to the ionosphere and back as a function of frequency. The transmitter and receiver were synchronized either electronically or mechanically while the receiver output was displayed on a CRT. Markers were introduced that interrupted the sweep trace every one third of a millisecond and multiples thereof to provide equivalent height indicators of 50, 100, 150, . . . kilometers. (These are indicated

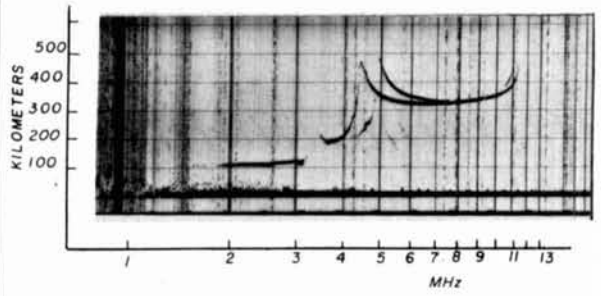

fig. 1. Vertical ionogram generated by an analog sounder on April 23, 1975, over Boulder, Colorado. Sporadic E is evident as well as ordinary and extraordinary wave F_1 and F_2 layers.

as thin horizontal lines in **fig. 1** and in this case are multiples of 100 kilometers or 0.66 milliseconds.) In addition, frequency markers were generated that corresponded to each integer MHz. (Note that the spacing between vertical frequency marker lines is non-uniform and in this case, logarithmic).

A common ionosonde, designed in the mid-1950's for the International Geophysical Year, that operates along these lines is the National Bureau of Standards (NBS) C-4 machine, still used today. It consists of a 10 kW peak pulse transmitter and a wideband receiver. The pulse transmitter uses a 31 to 55 MHz swept CW oscillator that mixes with a 30 MHz pulsed oscillator to provide a 1 to 25 MHz pulsed output. This signal is then amplified in a broadband power amplifier. The receiver uses the same CW (swept) oscillator in a balanced mixer to mix with the incoming echoes down to a fixed 30 MHz IF signal for further amplification and processing. The same antenna in an analog sounder is normally used both for transmitting and receiving and should show a relatively constant resistive impedance over the entire frequency range. Typical antennas utilized are vertically-oriented delta loops, terminated rhombics or log periodics.

A panoramic display of the returning echoes is ac-

ionograms explained

The dark, basically horizontal line on the left side of the ionogram represents the E region (specifically the sporadic E layer — a thin layer at about the same height as the normal E layer which varies, unpredictably). Signals from between 2 and 3 MHz (2nd and 3rd vertical lines) have apparently been reflected from a height starting at 110 and ending at 120 km on this film strip.

The second set of curves on the same ionogram illustrates several important features of ionospheric propagation. The first curve from start to cusp represents the F1 layer, while the next continuous segment from cusp to cusp represents the F2 layer. *The cusps or rapid increase in "height" with small change in frequency corresponds to the previous layer's critical frequency and indicates a maximum layer electron density. Furthermore, a cusp indicates that the electron density profile has a vertical tangent, i.e., that the specific layer has a maximum. The F1 layer often has no discrete maximum; it is merely a ledge on the F2 layer electron density profile — an inflection of the trace, not a cusp. It corresponds to points where the radio wave penetrates the layer. At the critical frequency, the rate of travel of the incident wave is slow, producing the large* virtual *heights.*

The last curve also shows the F1 and F2 layers (though it's hard to see the F1 trace in this case). The reason for the existence of two traces is related to the fact that the transmitted wave splits into two separate waves (ordinary and extraordinary) under the influence of the earth's magnetic field.[7] (This is known as magneto-ionic effects.) This trace separation is important to all communicators because these two waves propagate differently: traveling at different velocities and being absorbed in differing amounts. Depending upon a transmitting station's geographical location, the transmitting antenna's configuration and orientation (polarization and direction) as well as a number of other factors determines which wave is launched and how strongly it is reflected *if at all.*

Note that the following critical frequencies can be picked off the ionogram and are approximately:

foEs = 3.5 MHz	(Sporadic E critical frequency)
foF1 = 4.4 MHz	(Ordinary wave F1 critical frequency)
fxF1 = 5.0 MHz	(Extraordinary wave F1 critical frequency)
foF2 = 11.0 MHz	(Ordinary wave F2 critical frequency)
fxF2 = 11.4 MHz	(Extraordinary wave critical frequency)

complished by applying a voltage to the X plate of the CRT that is a function of the sweeping transmitter frequency. The time base voltage is applied to the Y plates which equates to the virtual height of the layers (round trip time between transmission and reception). The actual receiver output and height pips are applied as blanking pulses to the CRT. In examining the display (see **fig. 1**) two different curved lines (O and X) are seen that rise with increasing frequency to a cusp at the critical frequency of the F layer. This makes sense since higher frequencies are reflected at greater (layer) heights until penetration occurs (see "ionograms explained").

A second type of analog sounder used FMCW, which provided a linear frequency swept transmitted signal. Use of CW gave high average power eliminating the need for high peak powers. It also permitted the use of very narrow receivers (100-200 Hz bandwidth), and was therefore less susceptible to interference from fixed frequency communication signals. The analog output of this FMCW system is a delayed and distorted (by the ionosphere) replica of the transmitted FMCW waveform and not an ionogram. A mathematical operation called a Fourier Transform (or spectral analysis) on the signal determines the delay of each frequency component, which is a measure of the reflection height. This output provides the information which is plotted and recorded as an ionogram. In general the main advantage of using FMCW versus pulse was in its reduced level of interference to itself and other users of the spectrum. However, pulsed systems had an advantage over FMCW types when multichannel receivers or multiple antenna receiving arrays were used. It's easier to switch between multichannel receivers or sample multiple receiving antenna outputs on a pulsed system. By using the positive features of a pulsed system and adding some software controlled equipment for signal enhancement the basic digital ionosonde was created.

digital sounders

A simplified block diagram of one of the few digital ionosondes (**fig. 2**) in the world, the Space Environment Laboratory model,[2] is shown in **fig. 3**. The heart of the system incorporates a 16-bit processor. Data is displayed on a 6-inch (15 cm) XY CRT that

fig. 2. One of the few digital ionosondes in the world, this system developed by the Space Environment Laboratory provides new capabilities — within a single system — to determine ionospheric structure and magneto-ionic effects in general.

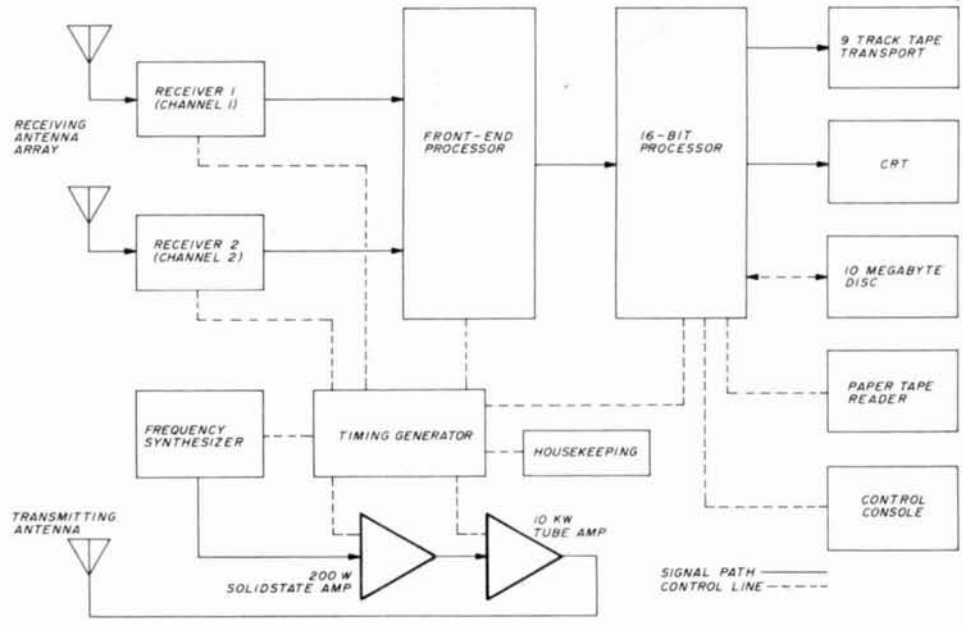

fig. 3. Basic block diagram of the Space Environment Laboratory digital ionosonde.

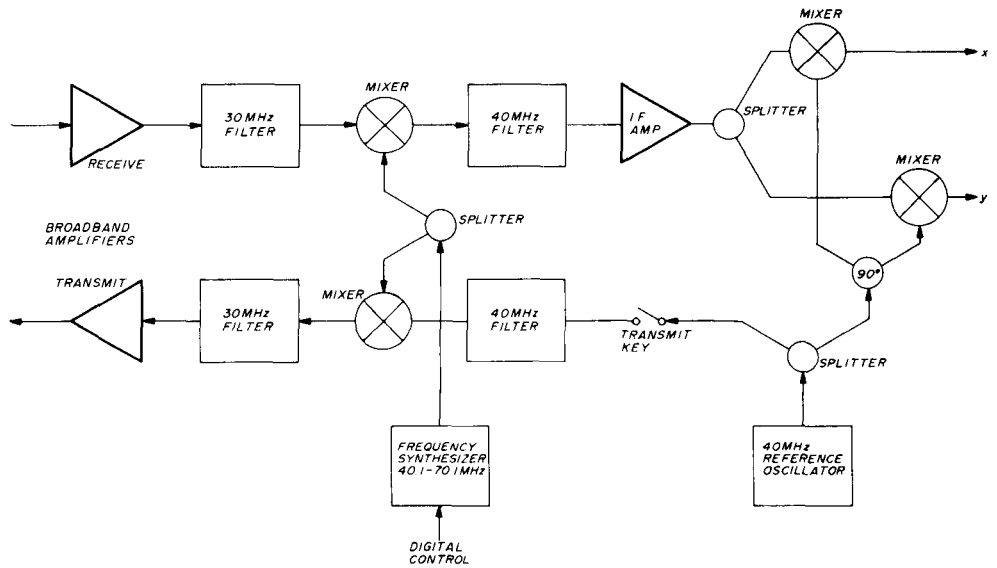

fig. 4. Simplified block diagram of the RF section of the SEL digital ionosonde.

has 1024 × 1024 addressable points. The display appears animated (is refreshed) by direct memory access to the computer's core. This makes rapid changes in the display possible and provides a time sequence presentation of the data. Program loading is provided by a 1600 BPI (byte per inch), 9 track, 3-ips tape transport while a 10 Megabyte disc memory is used for recording data. The operator talks to the system via a graphics display console and hard copy unit.

The RF section of the digital ionosonde has two functions: it generates the transmitted signals and coherently receives the echoes (see **fig. 4**). A symmetrical up/down conversion scheme is used with two oscillators. The first oscillator, a general-purpose synthesizer, generates a frequency between 40.1 and 70 MHz and up converts the receive band of 0.1 — 30 MHz to a 40 MHz IF. The second generator, a fixed-frequency 40 MHz crystal oscillator, mixes with the same synthesizer output to form the transmitted frequency.

In the receive mode the 40 MHz oscillator provides the reference signal while the frequency of operation is selected by the computer which controls the synthesizer.

An important question asked during the design phase was what is the best choice of output signal representation? Previous ionospheric sounding systems have, for the most part, used a logarithmic signal scale. The use of a logarithmic scale, however, is inconvenient for many kinds of digital signal processing. The justification for this choice of signal representation (as opposed to linear, for example) has been that it is otherwise difficult or impossible to achieve the received signal dynamic range any other way. Recent developments in solid-state technology have shown that stable, wideband linear amplifiers with extremely wide dynamic ranges, typically >140 dB in a 30 kHz noise bandwidth *are* achievable. Using these amplifier techniques, passive filters and a well-designed mixer and detector, a linear receiver can be built that is limited only by degree of (digital) quantization and DC stability.

Through careful design, the receiver section exhibits a high degree of linearity with low intermodulation products and achieves a 1 dB compression point of +15 dBm with a third order intercept of +26 dBm with 0 dB RF attenuation thrown in. In addition the receiver gain varies less than ±2 dB from 0.2 to 29 MHz and has a tangential sensitivity of ≤1 μV. An additional benefit of the strong signal handling performance of the receiver is that preselection filters are not required for operation under typical site conditions.

Two transmitted output levels can be used: 200 W or 10 kW. The low level transmitter drive output is amplified first by a solid-state class A amplifier to the 200 W level. This can be used directly or can be used to drive a pulsed class A wideband vacuum tube amplifier with a 10 kW output. Since the transmitter outputs are nominally 50 ohms, unbalanced wideband balun transformers must be used to drive typical sounding antennas.

operation

Since the key feature of this system is flexibility — i.e. it is software controlled and not hardware constrained — the digital ionosondes' modes of operation can be greatly modified almost at will. Initially, software has been written to operate the system as a

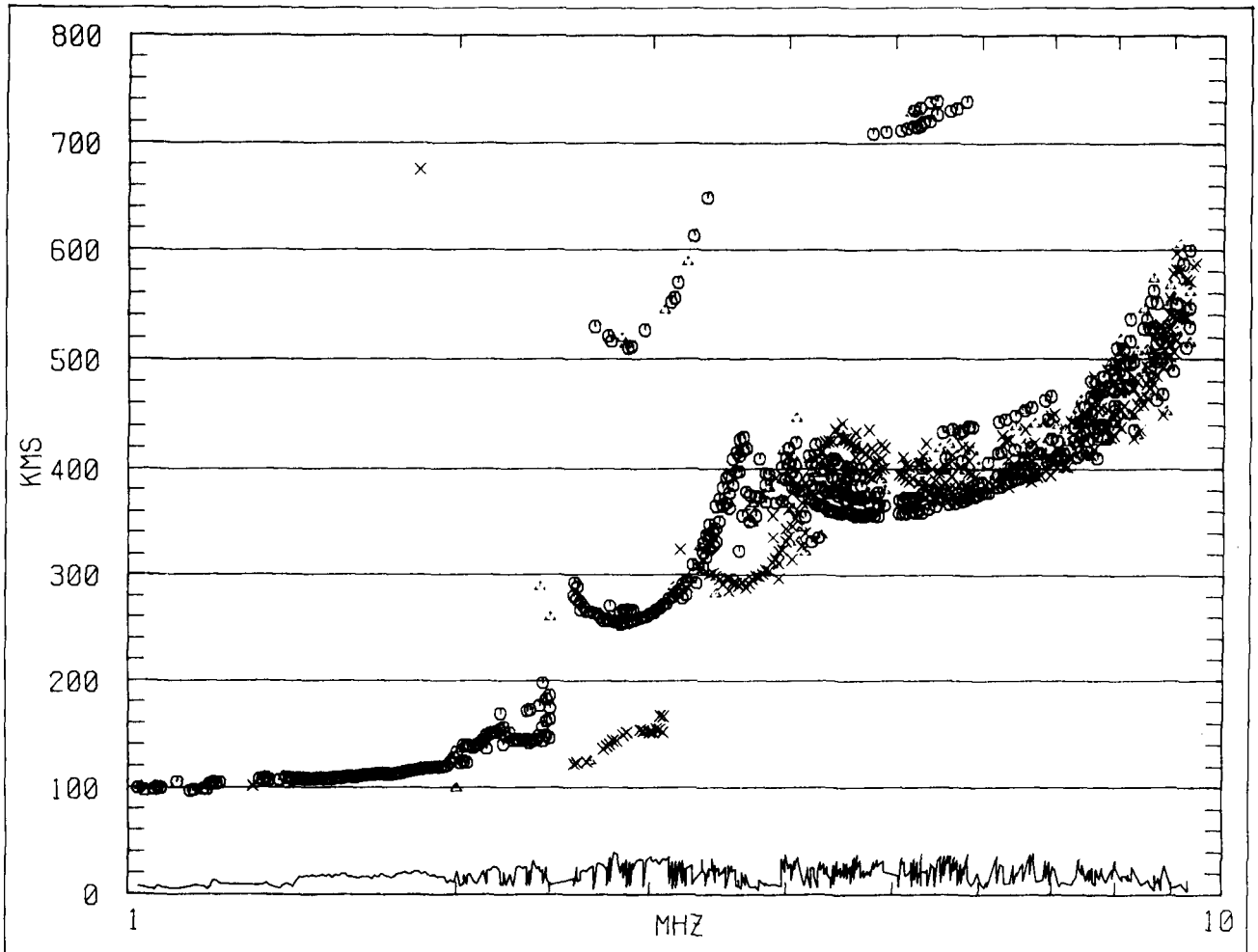

fig. 5. Digital ionosonde generated display depicting sporadic E, F1 and F2 layer ordinary wave returns as well as F1 and F2 layer extraordinary returns. The ordinary wave appears as red "O" symbols and the extraordinary wave as green "X" symbols on the display.

basic vertical pulse sounder, incorporating flexible sweep modes as well as fixed frequency operation (up to ten operator-selected frequencies.) Four pulses are transmitted per frequency, two at f and two at $f + \Delta f$ (Δf is usually chosen at 8 kHz). Four antennas are sampled, using two at a time with two receivers. The amplitude of the "returning signal" is examined (interference is removed) and transferred to the computer. After more processing, the data is recorded on tape and disc and displayed on the system CRT. Of particular interest to users of the standard frequency stations and Radio Amateurs is the frequency deletions of 2.5, 5, 10 MHz and the 160 and 80 meter bands by the system.

Fig. 5 shows a typical graphics display ionogram. The original, in color, shows the Es and F1 and F2 ordinary wave returns plotted as red letter O's while the F1 and F2 extraordinary wave returns are shown as green X's. The additional trace at the top is the second return trip echo (signal transmitted up to the F region, reflected back down, reflected by the earth, returned once again by the same F region. These are also seen on ionograms produced by the conventional analog sounders.)

digital ionosonde programs

In the Space Environment Laboratory Program in Boulder, planning calls for six of the SEL digital ionosonde systems to be built and coordinated as part of an international research program to primarily study the problems of magneto-ionospheric interaction in the Arctic and Antarctic ionospheres. Considerable software development needs to be done in order to take advantage of even a part of the possibilities of the system.

On the east coast, a series of digital ionosondes — the latest version known as Digisonde 256 — has been developed over the last decade by the University of Lowell[8] in cooperation with the Air Force Geophysics Laboratory at Hanscom Air Force Base in Massachusetts. The Digisonde is in use at military and civilian research and geophysical monitoring sta-

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6AK5/EF95	4.26	6005	5.25	8595	39.00
6AL5	2.93	6080	7.50	8624	105.00
6AQ5	2.85	6146	6.50	8643	117.00
6CA7	5.61	6155	75.00	8753	60.00
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acknowledgments

I thank Richard N. Grubb of the Space Environment Laboratory in Boulder, Colorado, for information on the NOAA SEL HF radar system. I also extend my appreciation to Jurgen Buchau of the Ionospheric Physics Division at the Air Force Physics Laboratory, and Bodo W. Reinisch of the University of Lowell, Lowell, Massachusetts, for information on the Digisonde 256 and their constructive comments on the material presented in this article.

references

1. T.R. Gilliland, "Note on a Multifrequency Automatic Recorder of Kennelly-Heaviside Layer Height," *Proceedings of IRE*; June, 1933, Vol. 21, pages 759-760.

2. R.N. Grubb, "The NOAA SEL HF Radar System (Ionospheric Sounder)," *NOAA technical memorandum ERL SEL-55*, Space Environment Laboratory, October, 1979.

3. Charles R. Burrows, "The History of Radio Wave Propagation up to the End of World War I," *Proceedings of the IRE*, May, 1962, page 682.

4. A.E. Kennelly, "On the Elevation of the Electrically-Conducting Strata of the Earth's Atmosphere," *Electronic World and Engineer*, March 15, 1902, Vol. 39, page 473.

5. O. Heaviside, *Encyclopedia Britannica*, 1902, 10th edition.

6. Kenneth Davies, "Ionospheric Radio Propagation," *National Bureau of Standards, Monograph 80*, April, 1965.

7. Rich Rosen, K2RR, "An Interview with Dr. Kenneth Davies," *ham radio*, January, 1983, page 28.

8. B. Klaus, B. Reinisch, "The Universal Digital Ionosonde," *radio science*, Volume 13, Number 3, May/June, 1978.

9. Dr. Bodo W. Reinisch and Huang Xueqin, "Automatic Calculation of Electron Density Profile from Digital Ionograms: Processing of Bottom-Side Ionograms," *radio science*, Volume 18, No. 3, May/June, 1983.

state-of-the-art auto-dialer

It stores 21 telephone numbers, uses only 3 chips, and may save your life

Some time ago I designed a Touch-Tone® auto-dialer because I always had trouble dialing an auto-patch call and driving at the same time. The dialer stored sixteen telephone numbers and was easily programmed from the keypad, but I had to use ten chips to make it work.[1] Now, because of a new chip on the market, I've found it possible to design a much better dialer that mounts directly on the dashboard. The new dialer has only three chips, and the parts were easy to get. To really simplify things, I even designed a printed circuit board. Anyone with a modest junkbox should be able to duplicate my auto-dialer for $50 or less.

features

The dialer has many features that make it attractive for Amateur use:

- It can store twenty-one telephone numbers, eleven of which can be twenty-one digits long.
- All programming and dialing is through a standard Touch-Tone® keypad; no other controls are needed.
- Any one of eight dialing speeds are available.
- Pauses can be programmed, with or without a carrier drop.
- An autopatch access code can be dialed at slow speed, followed by the telephone number at high speed.
- Manual dialing includes automatic PTT (push-to-talk) with a two-second hang-on time.
- PTT is keyed one second before any auto-dialed number starts.
- Audible feedback includes unique tones to distinguish between programming and dialing keystrokes. PTT is inactive during programming.
- Last manually dialed number can be redialed automatically.
- Battery backup retains memory and programming for five to ten years.

By Alan Lefkow, K2MWU, 17 Jacobs Road, Thiells, New York 10984

circuit description

A new CMOS Touch-Tone® auto-dialer chip called the MD-22 is the key to this design. It's available directly from the manufacturer[2] and comes in a 40-pin DIP package. The chip handles all housekeeping and dialing functions, including a standby mode for battery backup, the reading and writing of memory, tone generation, and a PTT output. It's used in conjunction with a standard 256x4 CMOS RAM for maximum number storage. To monitor tones, I added an audio amplifier chip and used an earphone as a loudspeaker.

For proper operation, the central part of the circuit follows the recommendations given in the data sheet for the MD-22. The schematic for the dialer is shown in **fig. 1**. Resistor network RN1 is an 8-bit R-2R ladder array. The network sums eight binary outputs from the MD-22 to produce a stepped approximation of a sine wave. (Most Touch-Tone® generator chips use the same approach, but the summing network is on the chip.) Capacitor C7 filters out the steps to produce a smooth waveform. Trim pot R4 acts as a volume control for amplifier U4, and R5 adjusts the tone output level.

Because of their low voltage drop, germanium diodes are used for CR4 through CR8. Silicon diodes are necessary for CR2 and CR3 because they carry higher current; their voltage drop is compensated for

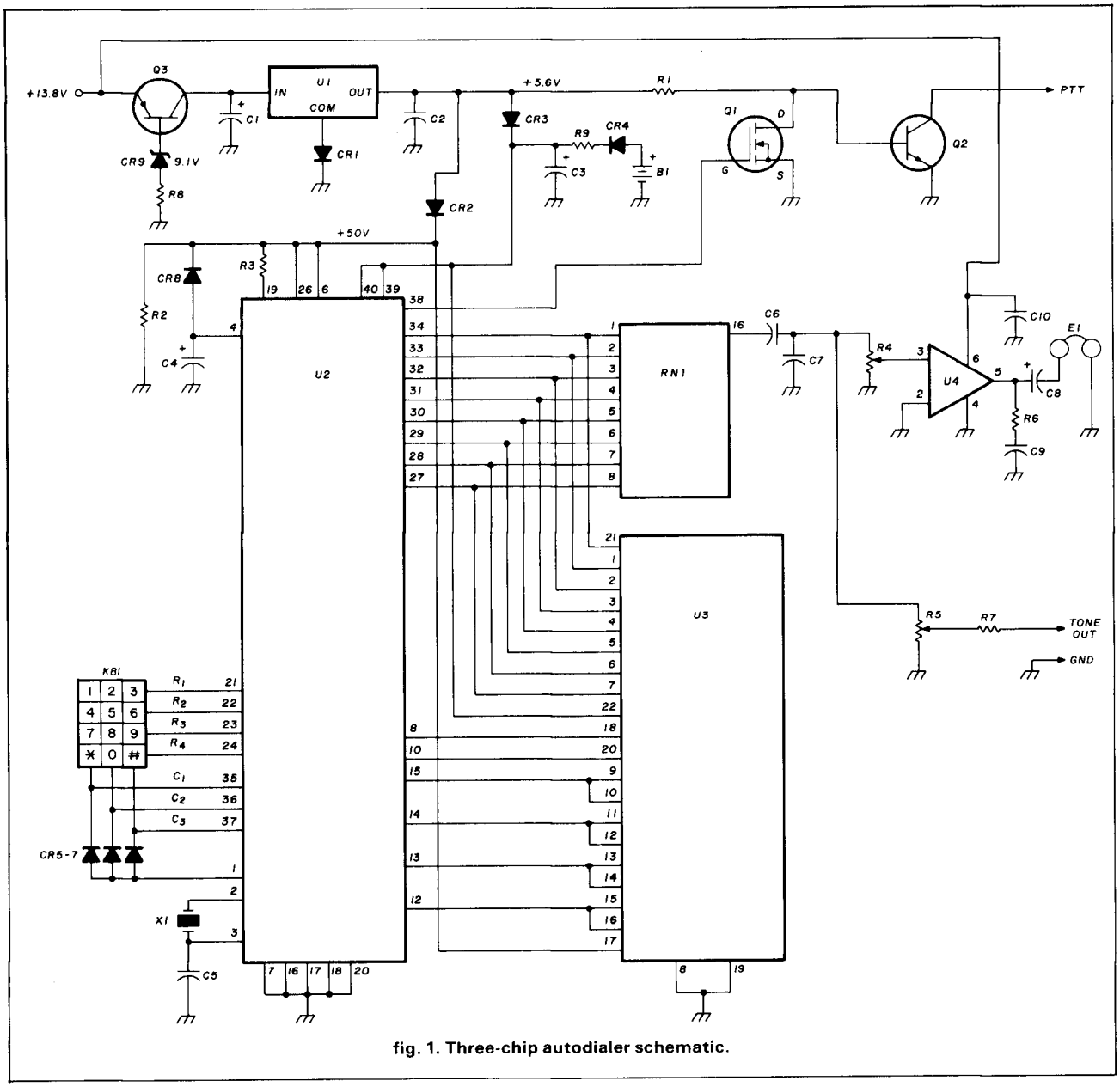
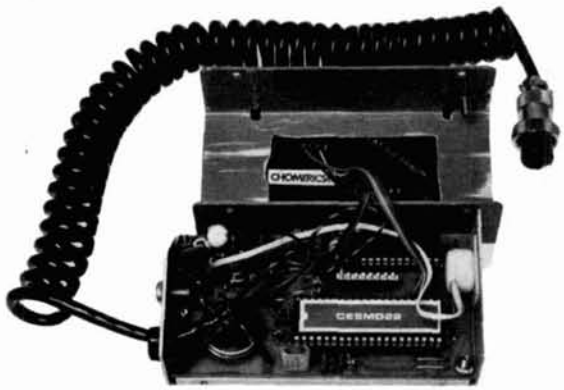


fig. 1. Three-chip autodialer schematic.



Inside view of the finished autodialer. The PC board shown here is an earlier design, slightly larger than the final version shown in *fig. 2*.

by using CR1 to raise the output voltage of regulator U1. This keeps the voltage for the MD-22 in its recommended range of 4.5 to 5.5 volts.

My first try at using the MD-22 pointed out some unexpected problems. The first one concerned the PTT output at pin 38. Most rigs require a switch closure to ground for PTT. Pin 38 goes low when PTT is on, but it must be buffered before connecting it to any rig. That I did with two transistors, using one as an inverter and the other as an open-collector output. Then I discovered that pin 38 remained high when the MD-22 was powered by the backup battery. That kept one transistor turned on and significantly increased the drain on B1.

To eliminate that drain, I followed a recommendation by Reiss[3] and changed the inverting transistor, Q1, to a VMOS FET. In this circuit the VMOS FET behaves much like a bipolar but draws negligible current from U2, which is just what I wanted. With this change, the drain on the battery during backup turned out to be less than 0.1 μA. At that rate, the battery should last five to ten years. When it does have to be replaced, the residual charge on capacitor C3 will provide ample time to replace the battery without any memory loss.

Another problem involved simply shutting off the unit. When power is removed, CR2, CR3, and CR4 switch in battery B1 to preserve memory. I discovered that if the supply voltage to the MD-22 doesn't drop fast enough when power is turned off, memory is erased. This can be a real problem if the autodialer is powered from a rig. The supply voltage doesn't drop abruptly when a rig is turned off because of large filter capacitors in the rig.

The manufacturer of the MD-22 explained the quirk. As the supply voltage falls to zero, there is one point when the backup battery is called upon to deliver current abnormally high for a small watch battery. This causes the backup voltage to the chip to collapse for a moment, and that erases memory.

The problem can be solved in one of several ways. The manufacturer recommended changing B1 to 4.5 volts and shorting R9 to provide higher current capacity. I tried that by adding a 1½ volt calculator battery in series with B1 and it worked, but I still preferred the compactness and simplicity of using a watch battery. That led me to add transistor Q3 with zener diode CR9 wired in series with its base. When the supply voltage drops below the zener voltage, Q3 turns off current to the dialer chip. The sharp knee in the diode's voltage curve switches off Q3 fast enough to prevent the loss of memory no matter how slowly the supply voltage falls. (On some samples of the MD-22 the Q3/CR9 combination may not work; if so, use the 4½ volt battery scheme.)

construction

You can make your own printed circuit board using the pattern in **fig. 2**, or you can order one from the source given in the parts list. Other construction techniques can also be used since parts layout is not critical.

If you use the board, the parts are installed following **fig. 3**. Use insulated wire for jumpers that might

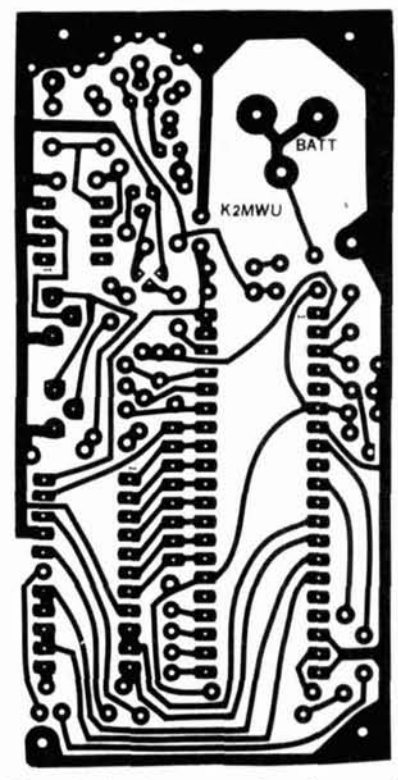


fig. 2. Printed circuit pattern for the autodialer. A drilled and plated PC board is available from the source indicated in the parts list.

parts list

item	*description*
B1	*#2320 lithium watch battery (Radio Shack No. 23-163)*
C1,C4	*2.2 μF dipped tantalum*
C2,C6,C10	*0.1 μF*
C3	*100 μF dipped tantalum*
C5	*22 pF*
C7	*0.0039 μF mylar or polystyrene*
C8	*50 μF electrolytic or dipped tantalum*
C9	*0.05 μF*
CR1-CR3	*1N3600*
CR4-CR8	*1N270*
CR9	*1N757 9.1V Zener diode*
E1	*miniature earphone*
K1	*12-digit Touch-Tone® keypad, matrix switching*
Q1	*VN10KM VMOS FET (Radio Shack No. 276-2070 or similar)*
Q2	*2N2222A*
Q3	*2N3906*
R1,R8	*1K*
R2,R9	*10K*
R3	*5.1K*
R4,R5	*100K miniature trim pot, vertical mounting*
R6	*10 ohm*
R7	*75K or 2.2M (see text)*
RN1	*50K R/2R ladder network (Allen-Bradley No. 316L08503)*
U1	*78L05 5.0V low power regulator*
U2	*MD-22 Touch-Tone® autodialer*
U3	*5101 CMOS RAM*
U4	*LM386 audio amplifier*
X1	*6.0 MHz crystal, HC18/u holder (Jameco Electronics #CY6.00 or similar)*
Case	*LMB No. CR-425, 4-1/4 × 2-1/4 × 1-1/4 inches (L × W × H)*

Except as noted, resistors are 1/4 watt, 5%, and capacitors are disc ceramic.

A drilled and plated printed circuit board is available for $7.50 per board, plus $1.50 for shipping up to 5 boards, from Dynaclad Industries, P.O. Box 296, Meadow Lands, Pennsylvania 15347. The MD-22 (U2) and 50K – R/2R network (RN1) are available for $15.00 and $2.50 respectively, including shipping, from CES Inc., P.O. Box 507, Winter Park, Florida 32790.

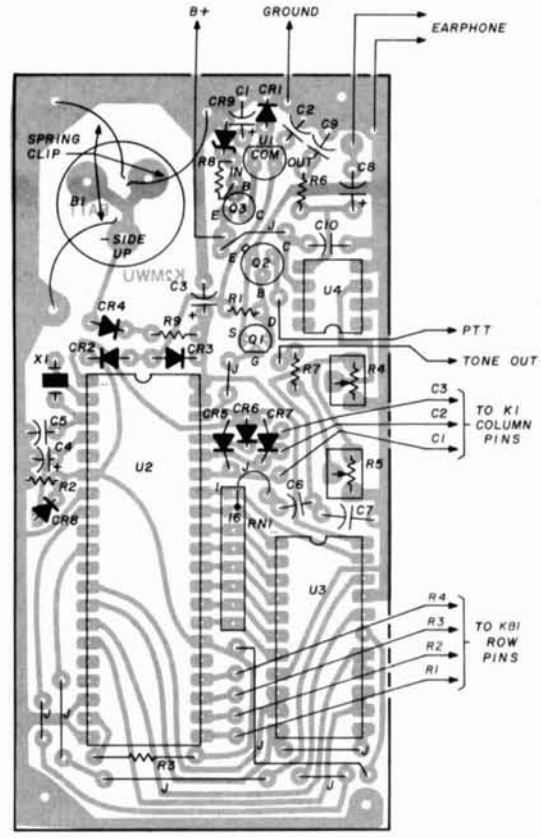


fig. 3. Parts placement for the PC board. All parts mount on the board except the keypad and earphone.

contact other components. And beware of static discharges when handling U2 and U3; they're both CMOS chips.

Most components mount as shown. However, the battery and resistor network require some additional work to install them on the board. The network comes in a 16-pin DIP package but only nine of its pins are used in this circuit. To simplify the PC pattern only one edge of the network is attached to the board. Pins 1 through 8 are soldered in place and bent such that the network is perpendicular to the surface of the board. Pins 9 through 15 are cut off, and pin 16 is connected to the board with a short jumper.

Fig. 4 shows how the battery is held in place using common nickel-plated safety pins fashioned into spring clips. The head and point of three pins are cut off and the pins soldered to the board. Some heat-shrink tubing should cover the portion of the pins closest to the board to keep the edge of the battery from shorting out to them. If desired, eliminating the middle pin at the corner of the board will make it easier to insert and remove the battery.

Another three holes on the board under the battery are used for soldering either eyelets, short pieces of bus wire, or small screws. They should project slightly above the surface of the board to make contact with the "+" side on the battery. The battery will be held against them by the spring clips.

Any standard 12-digit Touch-Tone® keypad that connects a row and column together whenever a key is depressed (called matrix switching) can be used for KB1. I used a discontinued Chomerics keypad purchased on the surplus market. The PC board was sized to fit neatly in the LMB Crown Royal case listed in the parts list. The earphone mounts in the small metal box too; just drill a hole and glue the earphone behind it.

interfacing to your rig

Other than the keypad and earphone, the only connections to the board are for power, ground, PTT and tone output. Power should come from a switched line in your rig that carries 12 - 15 VDC. The cable connecting the dialer to the rig should have a separate ground lead in addition to a shielded lead for the tone output line. Ground the shield at one end only, not at both.

Resistor R7 is used to attenuate the tones from the

dialer to match the requirements of your rig. Its value must be carefully selected. If too small, tones can get through to your rig due to crosstalk, even with R5 turned down to zero. This won't occur if R7 is large enough. When tones just begin to cause over deviation at the maximum setting of R5, R7 is at the right value. Use the # digit to check this because it generates the greatest deviation of any Touch-Tone® pair.

As examples, consider my two FM rigs. Touch-Tone® signals connect to the microphone input in both. In one, the 500 ohm microphone is always connected across the mike input, whether or not the PTT button is depressed. That means the dialer sees a load of 500 ohms. I found that 75K for R7 worked out just right. In my other rig the microphone impedance is 10K. There, the best value for R7 turned out to be 2.2 megohms. If your situation isn't covered by these two examples, experiment with R7, starting with a value that's 150 times the load impedance seen by the dialer.

programming and operation

Table 1 lists all the operations of the dialer and provides room for writing in programmed telephone numbers. Note that a # precedes every programming operation, while a * precedes an auto-dialing operation.

Let's cover manual dialing first. Pressing any key brings up the PTT line and outputs the Touch-Tones®, unless the first digit is a * or #. In that case, the * or # must be pressed *twice* to tell the dialer that no address or programming follows. The first of this double keystroke produces a special tone that's not transmitted, while the second one produces the normal * or # tones. After the last digit, the PTT line stays on for two seconds, at which time a warning tone sounds. (That tone won't be transmitted, either.) Any sequence of digits dialed before the warning tone can be redialed automatically by pressing * #.

Programming a telephone number is also simple. Key in the #, followed by the address, followed by the telephone number. Twenty-one addresses are available, consisting of the digits 1 through 9, and the combinations 01 through 0#, 00 excluded. You have two seconds to go from one digit to another before the warning tone sounds, indicating the end of programming for that number. (The end of the number can also be denoted by keying in # *, as shown on the first line in the table.) During programming, address digits produce special tones to distinguish them from the telephone number digits being stored. If the # is one of the digits to be stored, it must be keyed twice, just as before.

Any one of eight dialing speeds can be programmed from the keypad. Generally, telephone lines will accept the dialer's top speed, but many repeater autopatches need to be accessed at a slower rate. Rather than slow everything down, the dialer can be programmed to dial an access code slowly, and the telephone number fast. That's accomplished with the pause feature.

table 1. Chart of dialer programming instructions and list of addresses (telephone numbers) aids mobile operation.

TO DIAL	TO PROGRAM	DIGITS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
##	LAST NO.	X	X	X	X	X	X	X	X	X	X	X										
*1	#1												## (OPTIONAL END)									
*2	#2																					
*3	#3																					
*4	#4																					
*5	#5																					
*6	#6																					
*7	#7																					
*8	#8																					
*9	#9																					
*01	#01																					
*02	#02																					
*03	#03																					
*04	#04																					
*05	#05																					
*06	#06																					
*07	#07																					
*08	#08																					
*09	#09																					
0	#0*																					
*0#	#0#																					

MANUAL DIALING - IF FIRST DIGIT * OR #, PRESS TWICE

PROGRAMMED PAUSES FOR ACCESS CODES (TAKES ONE DIGIT STORAGE)

#8	3 s.	PTT DROPPED	--
#9	3 s.	PTT DROPPED	UP-SPEED
#0	2 s.	PTT ON	UP-SPEED

PROGRAMMED SPEED:

SPEED	TONE ON	TONE OFF	RATE
##1	80ms.	40ms.	8.3/sec.
##2	80ms.	80ms.	6.3/sec.
##3	160ms.	80ms.	4.2/sec.
##4	160ms.	160ms.	3.1/sec.
##5	300ms.	140ms.	2.3/sec.
##6	300ms.	300ms.	1.7/sec.
##7	600ms.	300ms.	1.1/sec.
##8	600ms.	600ms.	0.8/sec.

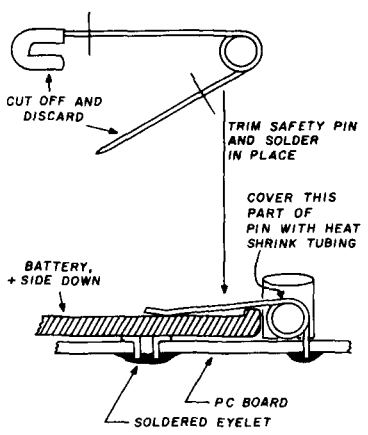


fig. 4. The watch battery is held on the board by spring clips fashioned out of ordinary safety pins.

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As shown in the table, there are three types of pauses that can be progammed anywhere in a stored number. If the up-speed option is selected, the digits before the pause will be dialed at whatever speed the dialer is programmed for, but digits after the pause will go at top speed. The idea is to set the dialing speed slow enough to access the autopatch, and use an up-speed pause to send the rest of the number quickly.

When any number is autodialed, the PTT line is keyed one second before the number starts dialing. This also holds true when dialing resumes after a pause. This compensates for any delays introduced by mechanical switching in your rig or repeater.

Note that of the twenty-one addresses, eleven can store twenty-one digits and the rest, fewer. The table indicates how many may be stored for each. As a reminder, the dialer emits a unique tone when you enter the last digit an address can store. Since the dialer holds so many numbers, I suggest you make a photocopy of **table 1**, fill it in, and keep it near the dialer as a record of what you've programmed.

conclusion

The only real drawback to the MD-22 is the absence of the fourth Touch-Tone® column. For most Amateurs that's not likely to be a problem. The real problem is driving with your eyes on the road and keying in ten digits to make a patch call. That's where the dialer serves its purpose well.

references

1. Alan Lefkow, K2MWU, "A Portable Touch-Tone® Auto-Dialer," *ham radio*, August, 1982, page 12.
2. CES Inc. See parts list.
3. R.A. Reiss, K1HOP, "Low-Power Keyer and Interface," *ham radio*, February, 1983, page 68.

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HOW TO TROUBLESHOOT & REPAIR AMATEUR RADIO EQUIPMENT

by Joseph J. Carr, K4IPV

Not everyone is lucky enough to have someone to teach them the basics of troubleshooting. For many of us the only way to learn was by trial and error. Joe Carr has put in one comprehensive guide, a complete step-by-step program on how to troubleshoot electronic equipment. Chapters include how to use simple test equipment like the voltmeter and ammeter and the more complex kinds of equipment like the oscilloscope. You also get plenty of helpful hints, the kind you can only get from someone who knows how to repair broken gear. Fully illustrated to help insure that you understand what you are doing. ©1980.

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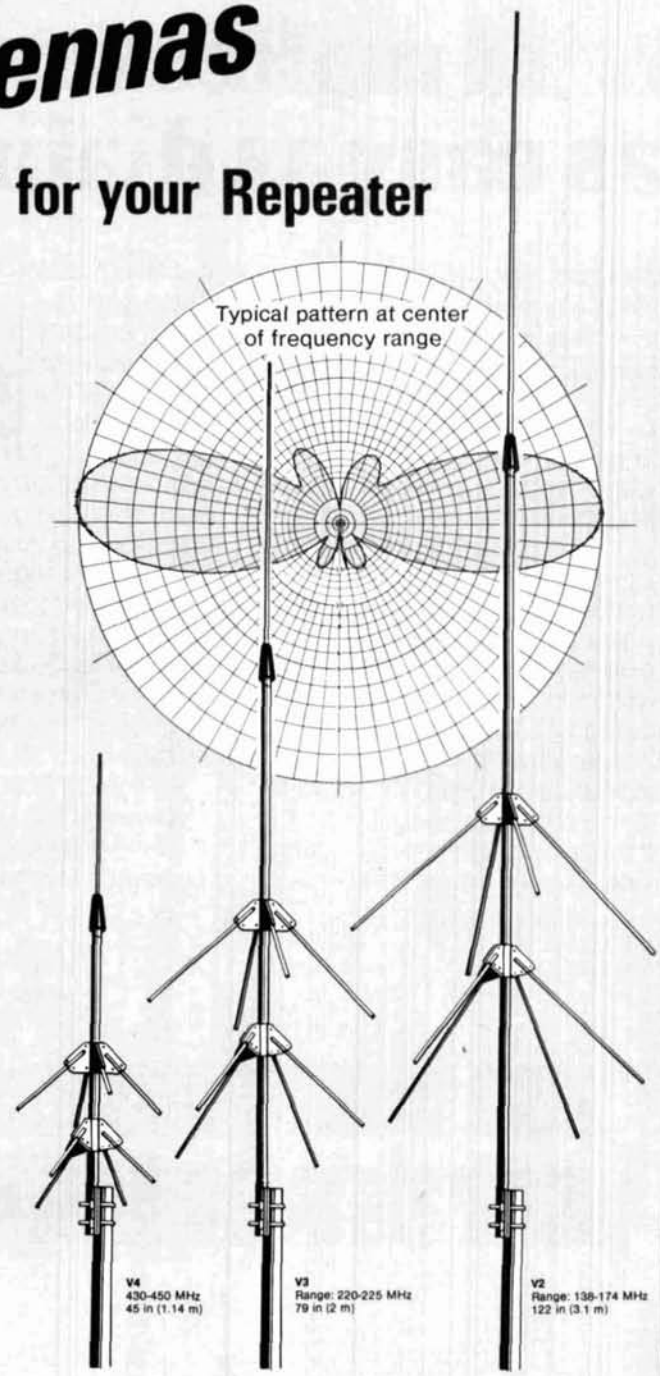

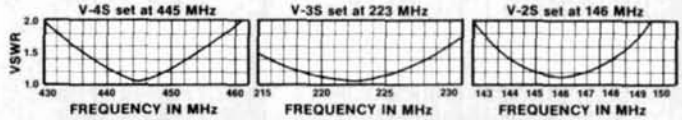

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More Details? CHECK—OFF Page 134

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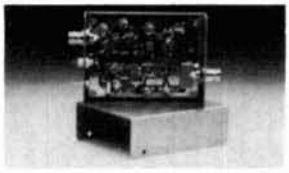

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time and frequency standards: part 2

Multiple-frequency VLF techniques offer extreme accuracy

In part 1 (November) the atomic (non-quartz oscillator) frequency standards by which time and frequency measurements are made were identified; individual VLF comparison techniques used in the precise determination of each were examined. In part 2, the methods by which frequency standard oscillators are compared against precise (usually atomic) house standards such as the rubidium and cesium standards covered in part 1 are discussed, and multiple VLF techniques, typically used in navigation, which allow for time and frequency determinations to submicrosecond accuracies, are described.

comparing frequency standards

Since all aspects of determining time are usually based on the accuracy of an oscillator, let's see first how we can measure the absolute accuracy of oscillators. To be useful, any method for comparing oscillators against an atomic frequency standard must be able to resolve extremely small frequency differences. The following is an examination of five methods for doing this. The first two methods use an oscilloscope, while the last three methods use a period-measuring technique.

Lissajous patterns

Two frequencies can be compared by examining the Lissajous pattern that results from their introduction on an oscilloscope's horizontal and vertical inputs, respectively **(fig. 1)**. If the two frequencies form an integer ratio (a whole number), then the pattern will consist of a number of stationary loops in direct proportion to this ratio (see **fig. 1**).

If the two frequencies are very close to one another, an ellipse results. Slight frequency differences cause this ellipse to roll repeatedly through all orientations from 0° to 360°. If this duration (time of one "roll") is timed, then the difference in frequency is equal to the reciprocal of this time. Consequently, to match the frequency of any oscillator to that of a known standard adjust the oscillator until the ellipse is stationary. This method can be used to provide resolution approaching 1 part in 10^9.

oscilloscope pattern drift

An oscillator can be compared to a frequency standard by externally triggering the oscilloscope from the standard while a pattern of several cycles of the oscillator output is displayed. (**Fig. 2** illustrates this technique.) The ratio of the drift displayed on the oscilloscope is directly proportional to the error frequency of the oscillator under test. Using **fig. 2** as a guide, assume that an oscilloscope is used to check the time base in an HP5345A frequency counter against a time and frequency standard such as the HP5065A[1] Rubidium Vapor Frequency Standard.

If it takes 100 seconds for the pattern of two 10 MHz signals, to drift one cycle, then the error is 1 part in 10^9. Since:

$$\frac{\Delta f}{f} = \frac{0.01}{10^7} = 1 \times 10^{-9}$$

If two 100 kHz signals are being compared and the

By Vaughn D. Martin, 114 Lost Meadows, Cibolo, Texas 78108

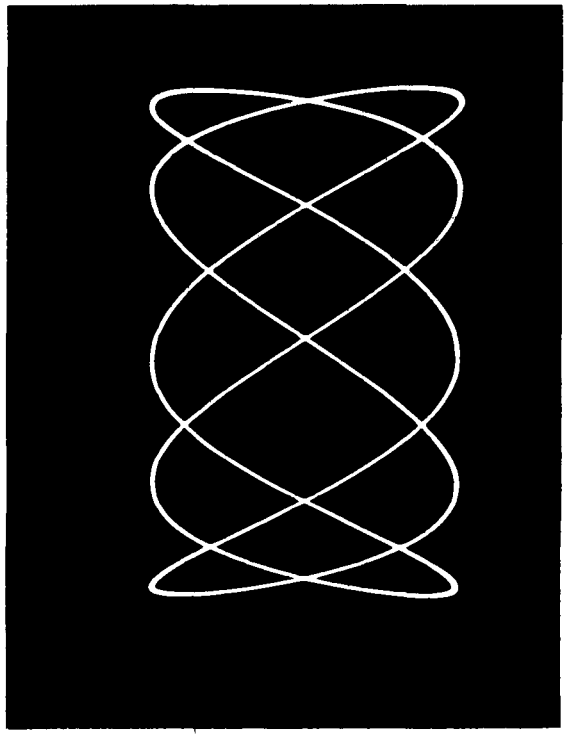

fig. 1. Lissajous oscilloscope pattern.

width of one cycle takes one second, then the frequency error is:

$$\frac{\Delta f}{f} = \frac{1}{100 \times 10^3} = 1 \times 10^{-5}$$

direct frequency comparison with a counter

You may have been wondering, as I used to, how a frequency counter operating on the principle of counting a set number of events during a fixed interval of time (typically one second), could measure a standard crystal oscillator and resolve any minute inaccuracies to a fine degree. After all, a typical frequency counter's timebase itself is far less accurate than the unknown standard crystal oscillator being tested. This "constructive skepticism" goes to the very heart of the issue in that the frequency counter is merely an instrument that takes the difference of two frequencies by having its own internal frequency standard substituted or bypassed by a standard of known accuracy.

As recent as the late 1960's the industry standard frequency was 1 MHz; it is now 10 MHz, with 1 MHz output still available as an option. (This division by ten is easily accomplished by applying the 10 MHz signal to a divide-by-10 IC such as a 74LS90.)

This method substitutes the reference oscillator for the frequency counter's time base to establish the sampling interval or period. Several cycles from the unknown oscillator are counted during this very precisely defined interval. Assume we are measuring a 1 MHz crystal oscillator against a known 1 MHz crystal oscillator standard. The counter's inherent ± count ambiguity limits the precision to 1 part in 10^6 for a one-second interval or sampling period. A ten-second interval or sampling period increases the accuracy to ± 1 count in 10^7. Let us assume we want to resolve the frequency to a very fine degree and have ± 1 count in 10^{11} as our goal. This would take a sampling period of 27.78 hours or 100,000 seconds.

Since this is not practical, another method has been devised to speed this process. The oscillator under test is frequency translated by a factor of 1,000 to a 1 GHz rate. (This can be done with a phase-locked loop.) What results is not only an increase in the fundamental frequency of 1 MHz to 1 GHz but, also an increase in the errors or deviations from 1 MHz by a factor of 1,000. Magnifying these errors by 1,000 also decreases the sampling period required by a factor of 1,000.

Some counters incorporate electronic counter-heterodyne frequency converters which enable the determination of frequency offset, relative aging characteristics, and fractional frequency comparison of deviations (if the measurement interval is kept below 10 seconds).

In modern frequency counters such as the HP5345A time base substitution by an extremely accurate standard can be effected. The same technique used to determine the crystal's accuracy as outlined in the previous section is used. Error is introduced by:

1) least significant digit (LSD) count

2) time base inaccuracy (the quality of the standard used)

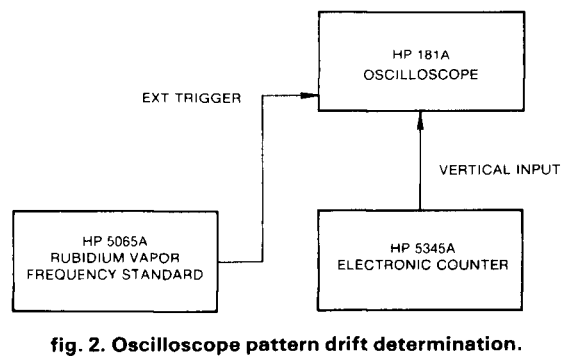

fig. 2. Oscilloscope pattern drift determination.

3) trigger error (start of sampling period)

Trigger error for this specific counter is less than 0.3% divided by the number of periods averaged for a 10 mV input sinewave, with noise specified at 40 dB below the signal level. The setup is shown in **fig. 3**. Let's go through a typical measurement and see how the calculations are done. Returning to our basic equation for error sources:

$$error\ max = \pm\ count \pm trigger\ error \pm oscillator\ errors$$

Worst-case conditions for accuracy determination must assume errors as being all in the same direction and cumulative, although in actuality some errors could partially cancel or offset one another.

$$Error\ Max = \pm\ 2\ counts \pm \frac{0.3\%}{5 \times 10^6 *} \pm 1 \times 10^{-11}$$

*5 MHz cesium beam standard

$$= \pm\ 4.61 \times 10^{-9}$$

for a 10 second gate time

$$= \pm\ 4.7 \times 10^{-10}$$

for a 1,000 second gate time

$$= \pm\ 0.46 \times 10^{-11}$$

Note how the accuracy is improved or the maximum error minimized as the sampling period increases, as previously discussed.

frequency comparison with a vector voltmeter

This is the last of the five methods of frequency comparison. A phase-sensitive or vector voltmeter is a special type of AC voltmeter with a high input impedance which minimizes the effects of circuit loading. It possesses some special features, including a filter to suppress harmonics and noise from the input source and a phase-sensitive demodulator. This circuit gives the instrument the ability to accept two input signals and determine how closely the unknown input signal's frequency overlaps or coincides in time with a frequency standard used as a reference input.

If the two signals are exactly in phase and at the same frequency, the phase angle generated is zero. As the frequencies depart from one another, the phase angle increases. In our particular case, the two frequencies, that of the standard or reference and that of the unknown frequency being measured, are so close that the angle will be very small. Therefore, a vector voltmeter is used that produces an output voltage in direct proportion to the meter's reading. This small voltage, which usually comes out the instrument's rear panel through a jack, can be amplified and a hard copy recorded on a chart recorder. This method of measurement can resolve differences in frequency to 1 part in 10^{13} in a matter of several minutes. A typical calculation will illustrate this technique:

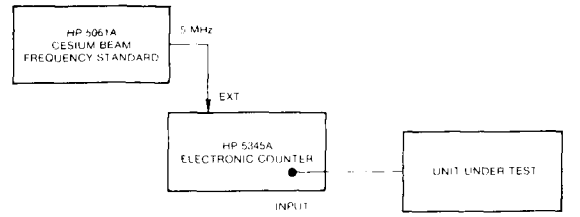

fig. 3. Direct frequency comparison with a counter.

$$\frac{\Delta f}{f} = \frac{\Delta \theta}{360\ t \cdot f}$$

Where:

Δf = frequency difference between the two signal sources (Hz).

f = frequency of the standard source (Hz).

$\Delta \theta$ = phase change in degrees during the measurement time.

t = time, in seconds, during which $\Delta \theta$ was measured.

$\frac{\Delta f}{f}$ = fractional offset of the source being checked.

If our standard and source to be tested both have 10 MHz outputs, and the angle indication of $\Delta \theta$ is 2.5° and the time is 120 seconds, then:

$$\frac{\Delta f}{f} = \frac{2.5°}{360°\ (120\ S)(10 \cdot 10^6\ Hz)}$$

$$= 5.78\ parts\ in\ 10^{12}$$

time comparison systems

Maintaining a consistent local system of time and frequency standards requires that they be compared against one another with a reference being established and maintained. The transfer of time information from one location to another is referred to as "time synchronization," whereas the transfer of data concerning frequency is referred to as "calibration." **Table 1** lists some of the more common methods of accomplishing the transfer of time and frequency data.

Radio broadcasts from frequency and time standard stations are the method most often used to establish the link that maintains this reference. The following is a discussion of both HF and LF/VLF techniques for maintaining local frequency standards

* See **fig. 3**

table 1. A comparison of time and frequency transfer techniques.

TRANSFER TECHNIQUES		STATUS (1)	ACCURACY FREQUENCY SYNCHRONIZATION	ACCURACY FOR DATE TRANSFER	AMBIGUITY (4)	COVERAGE FOR STATED ACCURACY	% OF TIME AVAILABLE	RELIABILITY	RECEIVER COST FOR STATED ACCURACY	COST PER CALIBRATION	NUMBER OF USERS THAT CAN BE SERVED	OPERATOR SKILL REQUIRED FOR STATED ACCURACY	
VLF RADIO	COMMUNICATION/SFB GBR, NBA, WWVL	O	$1\cdot10^{-11}$ (3)	ENVELOPE 500 μs	PHASE ~50 μs	GLOBAL							
	NAVIGATION SYSTEM OMEGA	O/P	$<1\cdot10^{-12}$ (3)	≤ 10 μs■	PROPOSED CODE 1 YR / PHASE ~100 μs	GLOBAL				MODERATE			TIME CODE
LF RADIO	STANDARD FREQ. BROADCAST (WWVB)	O	$1\cdot10^{-12}$ (PHASE 24h) (3)	ENVELOPE ~1 rms	1 YR	USA (WWVB) LIMITED				MODERATE		USA (WWVB) EUROPE OTHERS	
	NAVIGATION SYSTEM LORAN C	O	$1\cdot10^{-12}$ GND (3)	~1 μs(GND) 50 μs(SKY)	50ms / PHASE 10 μs	SPECIAL ♦ AREAS						SPECIAL AREAS	
HF/MF RADIO	STANDARD FREQ. BROADCASTS (WWV)	O	$1\cdot10^{-7}$	1000 μs	1 DAY / 0.5 min	HEMISPHERE		DEPENDS ON CONDITIONS					
	NAVIGATION SYSTEM LORAN A	O	$5\cdot10^{-11}$ (2)	2.5 μs NOT UTC		LIMITED AREAS		DEPENDS ON CONDITIONS				SPECIAL AREAS	
TELEVISION (VHF/SHF RADIO)	PASSIVE LINE 10	O	$1\cdot10^{-11}$ (24h)	~1 μs	1 DAY / ~33ms	NETWORK COVERAGE	LIVE PROGRAMS					USA FOR EXAMPLE	
	ACTIVE LINE 1 (NBS TV TIME SYSTEM)	E	$1\cdot10^{-11}$ (< 30 min)	< 100ns ▲	1 DAY / ~33ms	NETWORK COVERAGE						USA FOR EXAMPLE	
SATELLITES (VHF/UHF/SHF RADIO)	STATIONARY SATELLITES (TRANSPONDER) ONE WAY	E/O	$1\cdot10^{-10}$ (24h)	10 50 μs	DEPENDS ON FORMAT	HEMISPHERE	STATIONARY						
	STATIONARY SATELLITES (TRANSPONDER) TWO WAY	E/O	$1\cdot10^{-12}$ (24h)	~100ns	DEPENDS ON FORMAT	HEMISPHERE				MODERATE			
	ON BOARD CLOCK (ACTIVE) ONE WAY LOW ALTITUDE	O	$\sim1\cdot10^{-10}$ (24h)	0.5 50 μs	DEPENDS ON FORMAT	WORLD	10 15 min PER PASS 2-4 PER DAY	CLOCK NEEDS ADJUSTMENT					
SHF RADIO	MICROWAVE	E/O	$\sim1\cdot10^{-13}$ (PER WEEK)	≤ 100ns	PHASE COMPARISON	LOCAL LINKS							
	VLBI	P	$5\cdot10^{-14}$	~1ns	DEPENDS ON FORMAT	HEMISPHERE	AS NEEDED						
PORTABLE CLOCKS	PHYSICAL TRANSFER	O	$1\cdot10^{-12}$	100ns●	1 DAY	LIMITED BY TRANSPORTATION	AS NEEDED			NONE			
	AIRCRAFT FLYOVER 2 WAY	E	$1\cdot10^{-13}$	≤ 100ns	DEPENDS ON FORMAT	LIMITED BY TRANSPORTATION	AS NEEDED						
PULSARS	OPTICAL SIGNAL — NP 0532	P	$1\cdot10^{-15}$	~10 μs	~33ms	HEMISPHERE	NIGHTTIME						
AC POWER LINE	POWER NETWORK SYSTEM	P	$1\cdot10^{-4}$	~1ms	16.7ms	CONTINENTAL USA				MINIMAL	MINIMAL	CONTINENTAL USA	

GOOD FAIR POOR

NOTES: (1) Status of technique indicated as follows: O–Operational; P–Proposed; E/O–Experimental operational. (2) Estimates of day-to-day measurements within 2000 km(1250 mi) of Loran-A stations. These emissions not coordinated with UTC and manually operated crystal clocks drift. (3) From day-to-day phase measurements e.g., 1 μs per day phase change approximates 1 pt. in 10^{11} in frequency difference. (4) Left-hand designation gives the shortest time interval that cannot be resolved; Right hand number gives basic ambiguity. ♦, by ground wave 1600 km; by sky wave thousands of kilometers depending upon conditions. ■, with proposed time code. ●, closure after 1 day. ▲, within local service area of TV transmitter and path delay known.

traceable to the NBS (National Bureau of Standards).

HF radio reception

HF radio transmission links suffer from propagation delays that are difficult to determine to better than 1 millisecond because of the changing ionosphere which is continually affected by sunspot, diurnal and seasonal variations. In addition, the number of propagational hops is also difficult to determine for distances greater than 2135 miles (3500 km).

Therefore, to use HF timing signals most effectively in the tick phasing adjustment method, to be explained next, these four recommendations should be followed:

- Select the highest frequency that provides consistent reception.
- Make all measurements in the day or night; avoid twilight or transitional hours.
- Observe tick transmissions for a few minutes to judge propagation conditions. Signals must exhibit minimum jitter and fade.
- Make time comparisons using ticks with the earliest arrival time (shortest propagation distance mode).

time comparison by tick phasing adjustment

This technique (**fig. 4**) compares local time against

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The unit was delivered to me in less than one week (coast to coast) from the time I mailed my order. It arrived in perfect working condition and proved to be the easiest piece of equipment I have ever had the pleasure of learning to use.

Since putting the "patch" into service, I have had more compliments than I can count. The audio quality is nothing short of SUPERB!! It is hard to believe that you are not actually conversing on a telephone. The VOX control circuitry is probably the best I have ever had the pleasure to use. Its responsiveness is almost instantaneous and when properly adjusted, yields control that is so fine that no words or syllables are lost. The control circuitry was well thought out; the sequences and operational methods chosen have proven to be easy to master and even easier to use in the field than ever hoped for.

I could go on and on . . . the merits of the equipment are many and each feature is "better than the next". Congratulations on the production of one of the best and most useful pieces of gear to come along in quite a while.

Sincerely yours,

Edmund Schneider, K2RCO

Gentlemen:

I received my Private Patch II via UPS today—exactly one week to the day after mailing in my order to you. That's very fast service.

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Incidentally, no adjustments were needed to the level pots . . . it worked "right out of the box".

Sincerely,

Richard Norton, WB5FRO

Gentlemen:

Patch works great. Much superior to Sampling Interconnects, the (censored) as an example. Excellent product! Keep up the good work!

Michael Chisholm, KA6DAC

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More Details? CHECK—OFF Page 134

time signals transmitted by an HF standards station such as WWV. The local frequency standard, typically a rubidium standard with a 10 MHz output, has this signal divided down to a frequency of 100 kHz and applied to a frequency divider and clock. This instrument further divides this signal to produce a 1 PPS pulse. These pulses are applied to the external sync of an oscilloscope while the vertical input to the scope is driven by an HF receiver that supplies the WWV ticks. This HF receiver is usually a good communications-quality instrument which can be tuned to the required frequencies (2.5, 5.0, 10, 15, and 20 MHz for WWV). It is preferable to use an antenna that is directional and is oriented in a manner favorable to the transmission mode consistently providing the shortest propagation path.

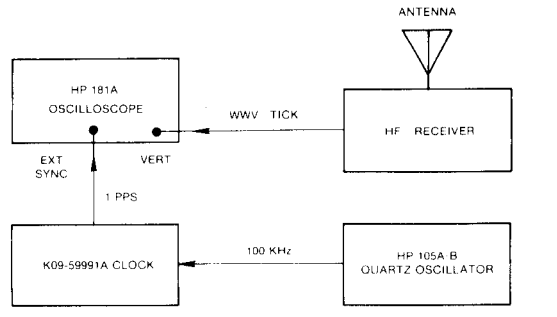

fig. 4. Time comparison by "tick phasing" adjustment.

The clock incorporates time delay thumbwheel switches to control the start of the oscilloscope sweep by delaying it until the WWV "tick" begins the sweep. By successive adjustments of this control, the two ticks are brought to near-coincidence. The WWV tick is a 5 ms pulse of 1 kHz energy.

The operator must be skillful at determining when the tick arrives. A tick-averaging scheme helps in this regard. An oscilloscope with a variable persistence screen permits the operator to view repeated sweeps of WWV displayed together (see **fig. 5**). An alternative tick-averaging method is to make an oscillogram using a scope camera. With either method, time comparison readings are possible once the scope's sweep time has been properly calibrated.

LF and VLF compared to HF signals

Variations in the ionosphere ion and electron density versus height cause propagation time of a signal to change continually, refer to **fig. 6.** This necessitates that the data recorded from stations such as WWV be averaged for days to remove anomalies in the data in order to obtain at best 1 part in 10^8 accuracy — note that WWV signals are stable to 5 parts in 10^{11} as transmitted.

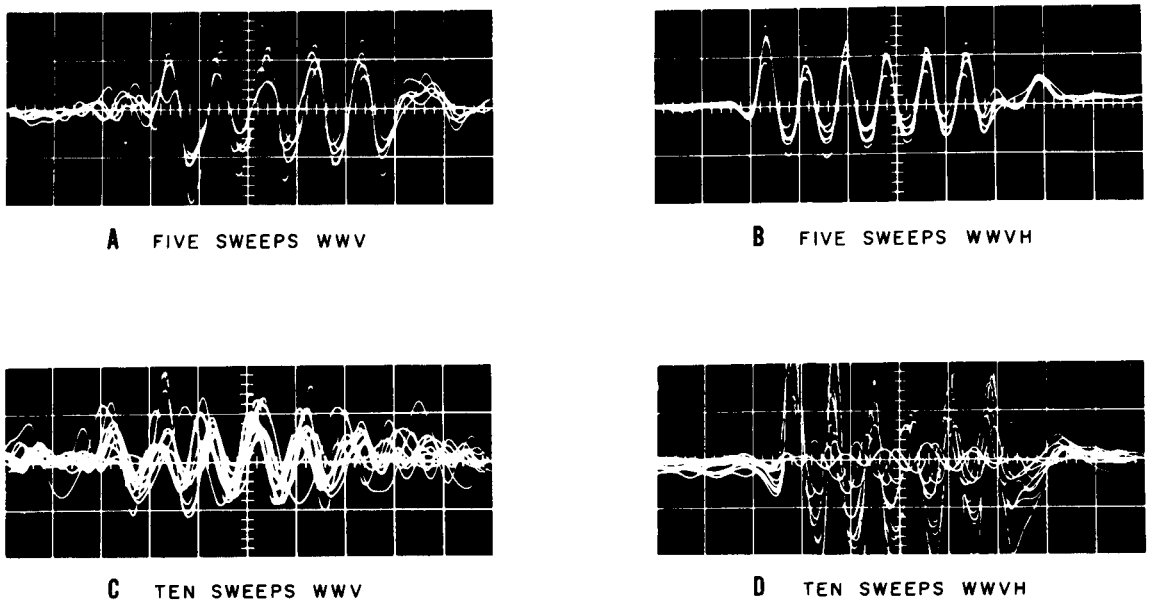

fig. 5. Photographic tick averaging adjustment.

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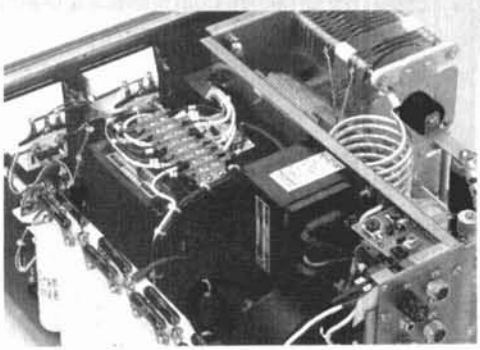

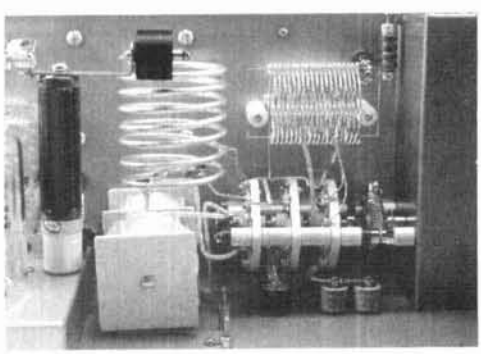

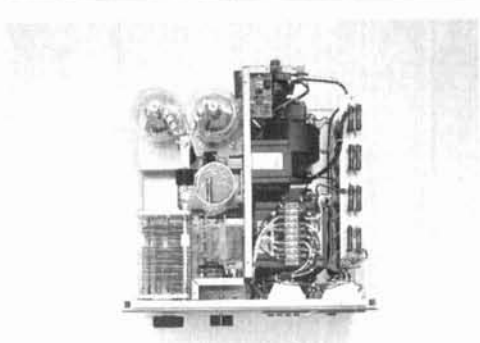

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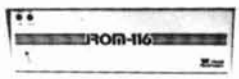

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Low frequency and VLF signals are far more stable than HF signals. This is because, unlike HF signals, they follow the curvature of the earth and follow a "duct" created by the earth's surface and the ionosphere. Since the earth's ionosphere acts as a boundary rather than as a reflector, as it does with HF signals, its variations have a much less pronounced effect. Therefore, for standard frequency transmissions this more phase stable method is used. When precise timekeeping is of paramount importance, most users still rely though upon the HF service provided by WWV. This is because of two factors: First, information bandwidth characteristics have limited to some extent the use of lower frequency signals for time-of-day and time comparison information. Secondly, to realize very high precision in clock synchronization, a fast risetime signal for a time marker is required; unfortunately the LF/VLF antennas used have large time constants which prevent this from being possible or practically realizable.

LORAN-C using cesium beam standards

Now that we have a better appreciation of the characteristics of sky and groundwaves, let's examine a navigation system that is stabilized by cesium beam standards and is one of the most accurate time transfer media available through radio waves.

LORAN-C (*LO*ng *RA*nge *N*avigation) is a navigation system used in some parts of the Northern Hemisphere as a method of time and frequency distribution. Operated by the U.S. Coast Guard, this navigation system uses pulsed transmissions on a carrier frequency of 100 kHz with a 20 kHz bandwidth.

The LORAN-C system has the following advantages and disadvantages, respectively:

1) The transmitters are controlled by cesium standards.

2) Propagation delays of groundwaves still provides ± 0.3 microsecond accuracies.

3) The TOC (time of coincidence), to be explained shortly, is provided in advance by the USNO (United States Naval Observatory).

4) Equipment costs are reasonable.

The disadvantages are:

1) Mixed terrain (sea and land) result in hard-to-predict effects of the propagation delays of skywaves.

2) Local clock time must be very exactly known, as will be shown shortly.

3) Coverage is not yet global.

4) Cycle selection requires a skilled operator.

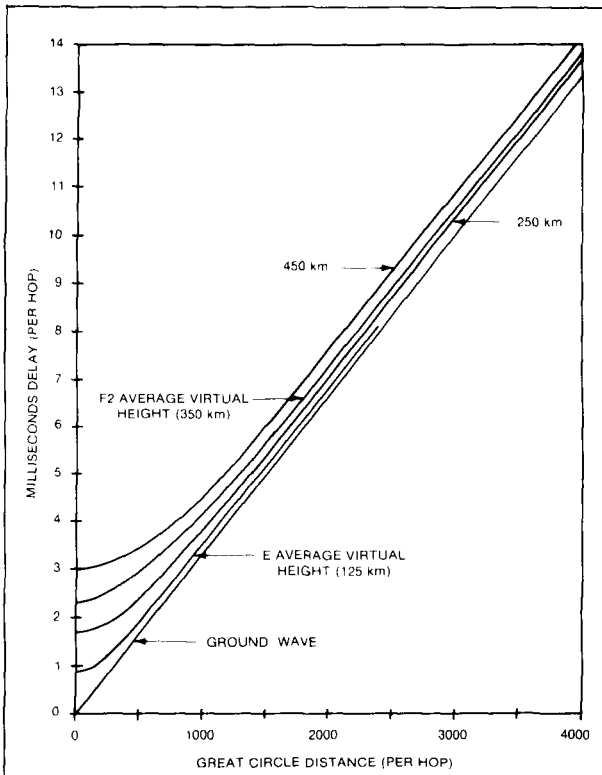

fig. 6. Transmission delay experienced on groundwave, E and F2 layer propagation modes.

time and frequency determination using LORAN-C

This navigation system *does not* broadcast a time code signal. It is therefore necessary to know the time-of-coincidence (TOC) of a LORAN-C signal relative to a UTC (universal coordinated time) second. Each LORAN-C chain transmits a unique format. Within the GRP (Group Recognition Period), which is unique to each chain, the master station transmits precisely spaced groups of nine pulses (**fig. 7**). Each of the slaves transmits eight pulses within the GRP.

There is only one GRP that will provide a TOC every second. And the period between a pulse coinciding with one UTC second and another pulse-UTC second is a function of the repetition rate of the whole chain. Each chain is assigned a different repetition rate and this and other data typical of this chain can be found in USNO documents.

Figure 8 is a typical system to utilize LORAN-C transmissions for time transfer. This system has a 1 PPS signal used to start a time interval counter with the output of the LORAN-C receiver used to stop the interval counter. The output of the LORAN-C receiver is a 1 PPS signal phaselocked to the received signal and in sync with the TOC. By using the count

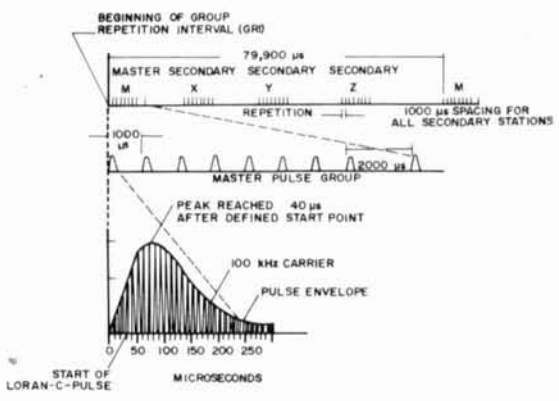

fig. 7. LORAN-C pulse group formats.

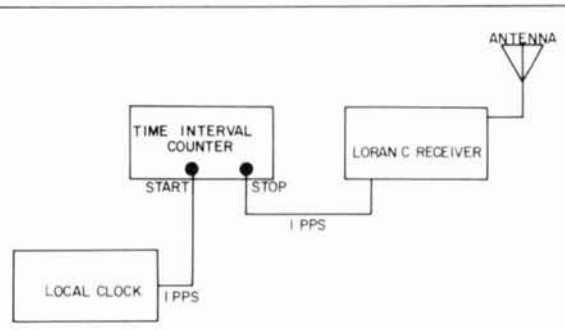

fig. 8. A typical LORAN-C timekeeping system.

on the interval counter in conjunction with USNO published data, you can determine the difference between UTC, USNO, and the local clock.

multiple VLF systems

Single VLF systems, with their less precise clock synchronizations, are unacceptable in highly demanding applications such as LORAN-C and Omega navigation systems. What is required in these instances is submicrosecond accuracies, obtainable only with multiple-frequency VLF techniques which use two or more closely spaced, coherently related, sequentially transmitted signals.

The multiple-carrier VLF techniques function by extracting timing data in the difference frequencies of two carriers. This allows for individual cycle identification of one of the carrier frequencies. Used successfully with WWVL and Omega frequencies, this technique requires signals, transmission media and receiving/comparison equipment that are extremely stable. The system functions by setting coarse time using an HF radio transmission (link) having an accuracy of several milliseconds which serves to resolve any initial frequency ambiguities. The multiple carrier VLF method includes a local calibration signal for simulating the frequency of the received signal to relate the local time scale to that of the transmitter. Agreement between the received and calibrated VLF phases is made systematically, and the local clock phase-shifter adjusted, until all simulated signal phases are identical to the actual received signal phases for a single setting of the phase shifter. This phase relationship remains essentially unchanged (except for clock interruption and phase loss), and the VLF receiver can be turned off and on without affecting the calibration.

The development of precise time and frequency standards, and the design of equipment to perform extremely accurate tests and measurements, is one of the most promising areas in the field of communications. As satellite communications technology advances, an equivalent degree of progress should be evident in this specialized field.

references

1. Vaughn Martin, "Time and Frequency Standards: Part 1," *ham radio,* November, 1983, page 36.

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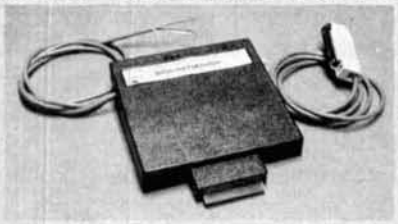

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when hazardous waste comes home — PCBs in the ham shack

What's inside your dummy load? Knowing the answer may be important.

So far we at *ham radio* have been lucky: hazardous waste has usually been a matter of concern for somebody else. Because we didn't live near the Love Canal, or along the 210-mile stretch of North Carolina highway poisoned by a "moonlight dumper," there seemed to be time and room for complacency.

But within recent months, two public wells near ham radio's office — one fifteen miles east, the other fifteen miles west — were added to the EPA list of over 500 contaminated sites eligible to compete for $1.6 billion in "Superfund" money. Even closer to home, reports in the Amateur press have pinpointed dummy loads as a potential source of PCB contamination in the hamshack.

CDC warning

Katherine Hevener, WB8TDA, called attention to the possible hazard in the May 15 issue of *New England Report/Crossbander:*

...According to CDC Public Health Advisor David Forney, the potential danger from the dummy loads could come from a type of transformer oil containing polychlorinated biphenyl (PCB), a substance known to cause liver damage in humans and animals. Fifteen samples of transformer oil will be taken from dummy loads in Houston, Atlanta, St. Louis, Denver, Columbus (Ohio), and Boston. ...Although hams should not panic, Forney urges those concerned to take precautionary measures, such as using dummy loads in well-ventilated rooms, and preventing the possible PCB-contaminated transformer oil from vaporizing.[1]

When we called Forney for an update in early September, he was careful to note that these precautions apply even to *non-leaking* dummy loads — loads without visible defects and functioning without apparent cause for concern — which could release invisible airborne PCBs when they overheat. Consequently, it's important to give your dummy load a rest. *Don't let it overheat*: inhaled PCBs may be as dangerous as PCBs that are ingested or absorbed through the skin. *Follow the rating curve* **(fig. 1)** *for your dummy load;* one should be found in your copy of the owner's manual for the model you have. If you don't have a rating curve, get a copy from the manufacturer.

According to Forney, *leaking dummy loads require immediate attention.* A leaking canister — regardless of however slight the leak — suggests the immediate possibility of direct absorption through the skin, regardless of whether the dummy load is in use or not.

Don't risk handling a leaking dummy load until you know what's in it.

what's inside?

If your dummy load was sold with oil already in it, contact the manufacturer to determine whether or not it was filled with transformer oil containing PCBs. Obviously, if you built your dummy load from a kit and installed your own oil, you know whether it contains mineral oil or transformer oil. If it's mineral oil, there's no cause for concern beyond the knowledge

By Dorothy Rosa Leeds, assistant editor, *ham radio*

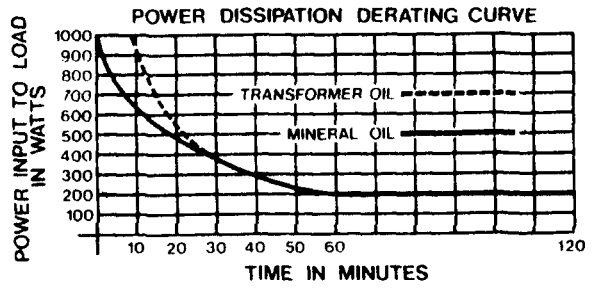

fig. 1. Rating curves for Heathkit Cantenna (Model HN-31A) provide data for dummy load in mineral oil as well as in transformer oil. Since specifications differ, product literature or manufacturer should be consulted for capacity of other dummy loads. (Note: Transformer oils made without PCBs are available: for example, Dow Corning manufactures a silicone-based liquid said to offer excellent dielectric properties, yet be environmentally safe.)

that mineral oil will burn at a comparatively low temperature. PCB oil will not; in fact, it was its excellent thermal and chemical stability, as well as its superior dielectric and insulation qualities that made PCB oil such a resounding commercial success from its introduction in the late 1920s through its decline in the late 1970s.

If your kit-built dummy load contains transformer oil, then identifying its composition may be more difficult. Testing for PCBs, down to the parts-per-million level, can be done in any laboratory with a gas chromatograph and a mass spectrometer, but this testing can be expensive — more than the cost of a new air-cooled or silicone oil-cooled dummy load.

biomagnification

The same qualities that made PCBs a boon to industry have made them an environmental scourge: they simply don't break down into new chemical arrangements. According to a U.S. Navy report, PCBs "biomagnify in the food chain — that is, they accumulate in the tissues of living organisms and as one organism feeds on another, progressively greater concentrations occur as the food chain progresses upward towards man."[2] Current estimates are that 99 percent of Americans carry a measurable amount of PCBs in their fatty tissues.[3] But unfortunately, the human body has no way to break the compound down into its less harmful components.

In structure, PCBs are similar to DDT (see **fig. 2**). Once contaminated by DDT, the human body requires up to fifteen years to rid itself of the chemical, but this can happen only if no additional DDT is absorbed. The federal ban on DDT in 1972 has effectively controlled this hazard, but despite their structural similarity to DDT, PCBs are significantly more dangerous, more prevalent and much more difficult to eliminate both from the body and the environment.

advice from the experts

Throughout their nearly 50 years of manufacture, PCBs were used primarily in electrical transformers — including the familiar "pole pig" sometimes acquired for use as a power supply — and capacitors, heat transfer systems, and hydraulic systems. They were also extensively used as plasticizers in paints, inks, adhesives, sealants, caulking compounds, coatings, and in carbonless copy paper, as well as in fluorescent lamp fixture ballasts and in pesticides and weed-control products.[4]

Suppose you've concluded that your dummy load contains, or may contain, PCB's. What then?

Don't put it out with the trash.

Al Hyer, of the EPA public affairs office in Washington, D.C., told us that the individual owner of any suspect device is solely responsible for its disposal, and urged that concerned Amateurs get professional advice before disposing of any questionable dummy load. He suggested calling your state environmental agency first; if an appropriate response and timely

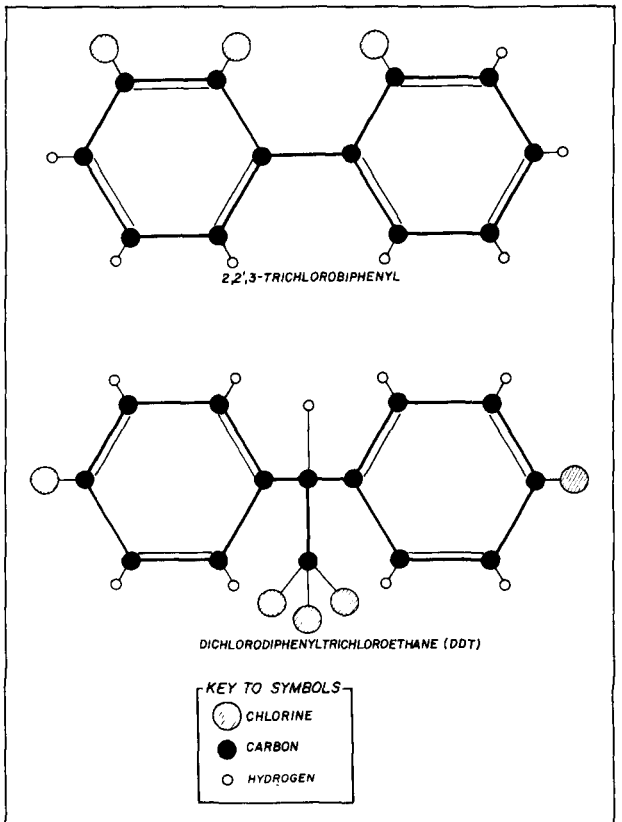

fig. 2. 2, 2', 3 trichlorobiphenyl is one of several PCBs, all resembling DDT in chemical structure.

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assistance are not immediately forthcoming, then the regional office of the EPA should be called (see **table 1**). "Help is available," Hyer said, "and it may not cost a dime."

Another knowledgeable source we contacted was less optimistic about obtaining help from the public sector. Alan Borner, Executive Director of the Environmental Hazards Management Institute, an independent, non-profit educational and consulting firm in Portsmouth, New Hampshire, cited the potential difficulty of calling the attention of a large bureaucratic state agency to a seemingly minor — yet perhaps dangerous — problem. Borner suggested that Amateurs turn to utilities or industries instead of state or federal agencies. "Call the environmental manager for the local public service company," he said. "Try any major chemical corporation or utility. Ask for the national environmental program manager and get his or her advice. These people have been walking through this morass for years."

Public utilities are especially sensitive to PCB questions, Borner noted, because under federal law, owners of potentially hazardous materials are responsible for them. Even though vandals still shoot out transformers for sport, it's the utilities who foot the bill for replacements and any lawsuits that may result.

According to Borner, the number and availability of disposal facilities for PCBs is extremely limited, so disposal, however it is ultimately accomplished, may be complicated by red tape and delay. But if only because PCBs are the only compound specifically singled out for immediate restriction as hazardous in the Toxic Substances Control Act of 1976, their handling and ultimate disposal should be taken seriously.

Another option open to Amateurs seeking to dispose of questionable or contaminated dummy loads is to contact an independent hazardous waste contractor. Some firms will deal only with industrial clients and have minimum quantities they will accept. A few large firms — SCA Chemical Services was one we spoke with — have limited programs designed to help individuals dispose of hazardous materials in a responsible manner. (SCA sponsored a "household cleanup" program on Cape Cod last fall, and other efforts are planned in certain areas of the Northeast.)

There are also smaller firms that will accommodate small quantities of waste as well as industrial quantities. Transformer Service, Inc. (TSI), of Concord, New Hampshire, for example, offers testing and disposal services. Louis LaSalle, TSI's Northeast Sales Manager, told us his firm would assist Amateurs in disposing of contaminated dummy loads. Group rates are negotiable for both testing and disposal services.

table 1. List of administrators designated as "hazardous waste contact persons" at regional offices of the Environmental Protection Agency (as of July 29, 1983).

Region I — Ira Leighton, Environmental Protection Agency, John F. Kennedy Building, Boston, Massachusetts 02203, (617) 223-3468

Region II — Dr. Ernest Regna, Environmental Protection Agency, 26 Federal Plaza, New York, New York 10278, (212) 264-0504/5

Region III — Anthony Donatoni, Environmental Protection Agency, 6th and Walnut Streets, Philadelphia, Pennsylvania 19106, (215) 597-7937

Region IV — Allan Autley, Environmental Protection Agency, 345 Courtland Street N.E., Atlanta, Georgia 30308, (404) 881-3016

Region V — Karl J. Klepitsch, Jr., Environmental Protection Agency, 230 South Dearborn Street, Chicago, Illinois 60604, (312) 886-7435

Region VI — Ms. Pat Hull, Environmental Protection Agency, 1201 Elm Street, First International Building, Dallas, Texas 75207, (214) 767-9736

Region VII — Chet McLaughlin, Environmental Protection Agency, 324 E. 11th Street, Kansas City, Missouri 64106, (816) 374-6534

Region VIII — Jon P. Yeagley, Environmental Protection Agency, 1860 Lincoln Street, Denver, Colorado 80295, (303) 837-2221

Region IX — Laura Yoshii, Environmental Protection Agency, 215 Fremont Street, San Francisco, California 94105, (415) 974-8127

Region X — Tobias A. Hegdahl, Environmental Protection Agency, 1200 6th Avenue, Seattle, Washington 98101, (206) 442-2808

Note: *The EPA operates a special hotline dedicated specifically to questions about PCBs: 1-800-424-9065. Questions about other hazardous wastes should be directed to another EPA hot line: 1-800-424-9346.*

LaSalle cautioned Amateurs to choose their disposal contractor with care, and to insist on receiving documentation confirming appropriate incineration of the waste oil. He confirmed Hyer's and Borner's warning that the owner is responsible for safe disposal: "You can't contract your liability away...anytime the material leaves your premises, you've lost control; be sure you know where it goes," he warned.

don't inhale

According to LaSalle, dummy loads can be shipped; check with your contractor for specific instruction for safe handling and packaging.

In a letter to *ham radio*,[6] Tom Runyon, VE5UK, took the media to task for "overrating" the potential

hazards of PCBs, but at the same time expressed appreciation that the question had been brought to the attention of Amateurs as a group. He gave this advice for distinguishing PCB oil from mineral oil in dummy loads:

1. *The smell of PCBs is somewhat similar to that of moth balls. Ordinary vegetable or mineral transformer oils smell like "oil."*

2. *Pure PCB is heavier than water, and a drop dropped into a bottle of water will sink. Ordinary transformer oil will float on water.*

(We don't recommend that you actually sniff the oil in your dummy load; inhalation, as noted before, may be hazardous. And before you follow any of VE5UK's advice, check with your regional EPA office or other appropriate authority.)

Runyon pointed out what may be an important distinction in any review of this issue: that there's a difference between acute poisoning with PCB's in high concentrations and short or long-term exposure to materials containing PCB's in lesser concentrations. Serious health effects have been documented in episodes involving heavy concentrations of PCB's, but to our knowledge, there is no evidence at this point to confirm the common fear that incidental exposure to low levels of PCBs has any documentable health effects. *We just don't know. Nobody knows.*

Hearing that nobody really knows for sure about the effects — if any — of low-level exposure to PCBs usually causes one of two reactions: either people assume that since nobody knows, there's nothing to be afraid of, or that *because* nobody knows, there's reason to be gravely concerned.

toward solving the problem

Congress was sufficiently concerned about the possibility of serious PCB-induced health hazards and passed The Resource Conservation and Recovery Act of 1976, in which the manufacture of PCBs or products containing PCBs, and the importation of any polychlorinated biphenyls, were declared illegal. No longer could industries or utilities drain the oil from a malfunctioning transformer, perform a repair, and replace the oil. It had to be discarded. *Where and how* became an entirely new problem.

With increased understanding of the importance of responsible disposal of hazardous wastes, industry has turned to two main means of disposal: incineration and detoxification by dehalogenation. (PCB waste in low concentrations may still be buried, but only in approved landfills under close EPA supervision. High-concentration PCB materials may not be buried.)

Incineration is effective only at temperatures in excess of 2300 degrees Fahrenheit; incomplete incineration at lower temperatures has been known to release dioxin (tetrachlorodibenzo-para-dioxin, TCDD), estimated to be approximately 500,000 times more dangerous than PCBs. (Its levels of contamination are measured in the parts-per-trillion, rather than in the more modest parts-per-million used to calculate the levels of PCBs.)

Several state-of-the-art incinerators are in operation now; the Rollins Environmental Services, Inc., facility in Deer Park, Texas, was the first to receive a permit from the EPA to incinerate PCBs in liquid and solid form. Rollins claims an efficiency level of 99.9999.[6] Several major chemical corporations have developed elaborate incineration systems (see **figs. 3, 4**), but the cost remains high — $9 to $12 per gallon, plus fifty cents per gallon for transportation alone.

Industries seeking to develop effective disposal systems face a costly and time-consuming challenge, however, because citizen resistance to incinerators remains intense. No wonder: even with high-efficiency incineration, the possibility of accident or unwanted emissions remains.

At least two experimental incinerators are currently operating at sea, with more in the planning stages, and Sunohio, Inc., has developed five mobile units that process PCB waste on-site.

Unfortunately, we read less about progress in the development of effective means of detoxification and effective solutions to the problem of disposal than we read about accidents involving PCB contamination of people, wildlife, and the environment. The stories *are* shocking. While research has yet to conclusively link inordinately high levels of cancer in certain areas with PCB contamination, studies have documented liver damage, digestive disturbances, jaundice, impotence, swollen limbs, and serious skin problems, including lesions, chloracne,* and pigmentation disturbances. The most notorious episode of PCB poisoning occurred in Japan in 1968, when 1,291 adults and children consumed rice oil contaminated with PCBs. Twenty-four died — nine of malignant neoplasms. In *Laying Waste: The Poisoning of America by Toxic Chemicals*, three-time Pulitzer Prize nominee Michael Brown, who covered the infamous Love Canal story in the *Niagara Gazette*, reports on a study of thirteen women who had ingested the contaminated rice oil during pregancy. Of the thirteen, "nine bore children with impaired liver function and other defects...."[7]

Japan outlawed the production of PCBs in 1972.

According to EPA estimates, there are 9,131 *abandoned* waste disposal sites. 440 million pounds of

*While chloracne is not life-threatening, it is disfiguring; its treatment — drainage and surgery — is said to be painful.

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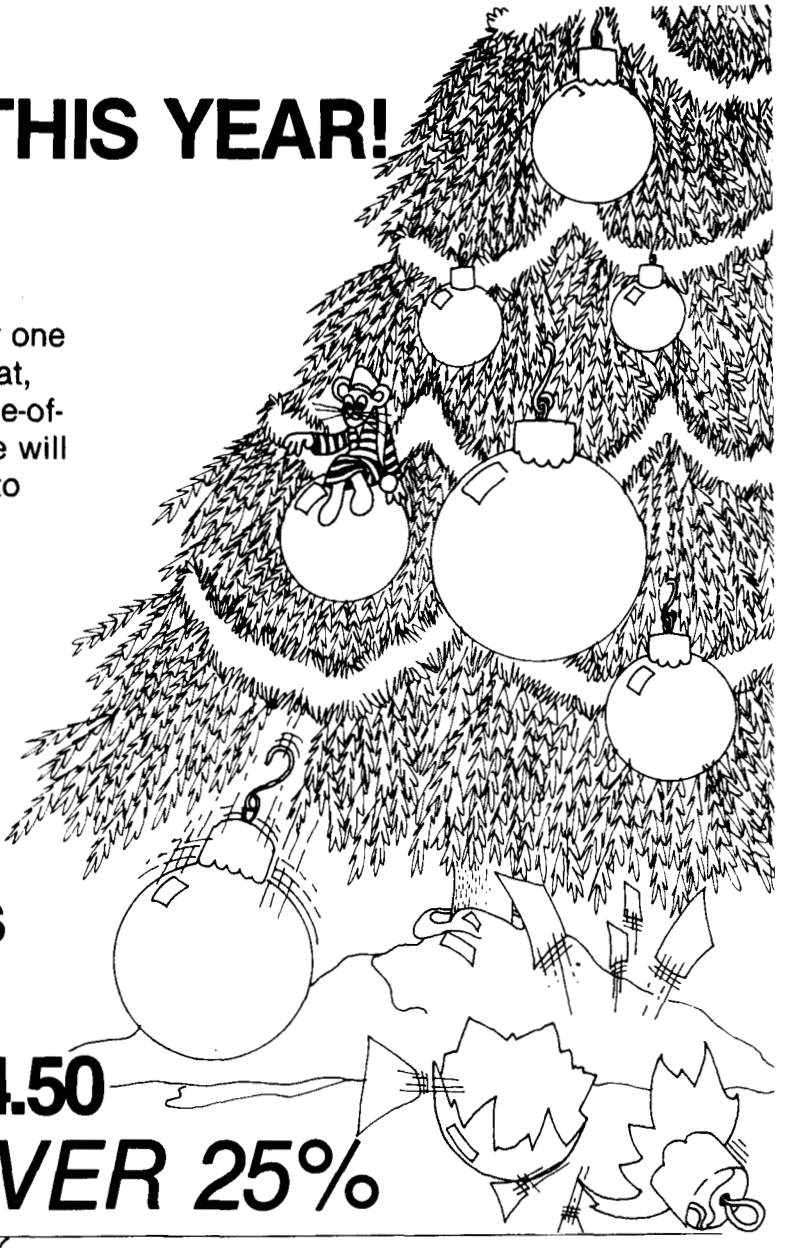

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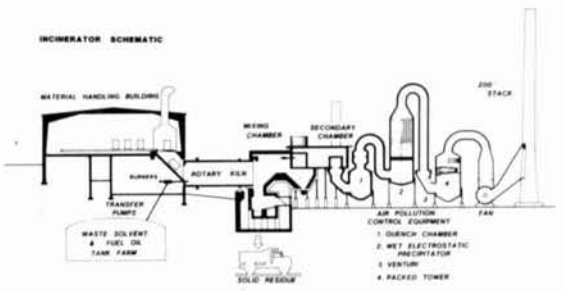

fig. 3. 3M Company's state-of-the-art incinerator at Cottage Grove, Minnesota, processes 500 55-gallon drums of hazardous waste daily. Constructed in 1971 at a cost of $4.6 million, and updated as technological improvements became available, the facility treats only 3M waste.

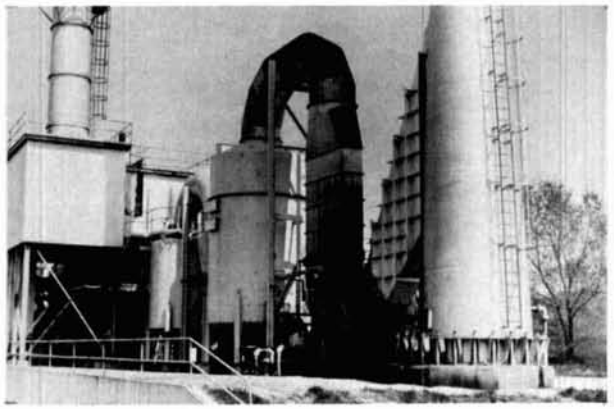

fig. 4. 3M incinerator air pollution control train includes a series of water showers designed to remove gas and particulate matter from air stream before it passes through 500-horsepower fan at base of stack, which measures 5 feet in diameter, 200 feet in height.

PCBs await disposal, and 750 million pounds remain in use or storage, with 40,000 of the 20 million transformers in use by utilities today containing Askarel, a fluid composed of 60 to 100% PCBs.[8] Of the 200 or more varieties of PCBs made, most can be identified by name; tradenames include Aroclor, Pydraul, Therminol. Pyroclor, Santotherm, Pyralene, Pyranol, Inerteen, Asbestol, Chlorextol, Diachlor, Dykanol, Elemex, Hyvol, NO-Flamol, Saf-T-Kuhl, Clorinol, Clorphen, and Eucarel.[8]

Because the number of approved incinerators is limited, and because the issue of incineration is controversial, industry has turned to detoxification as an alternative. In 1980, Goodyear Tire & Rubber announced the development of a method of breaking down PCBs into sodium chloride and sludge.

Only recently have the EPA, FDA, and Department of Agriculture ordered removal of equipment containing PCBs from food and feed preparation and storage areas. Currently under EPA study is a proposal to eliminate equipment containing PCBs from public buildings. (In 1976, 95 percent of all oil-filled capacitors manufactured in the United States were made with PCB oil.) PCBs are still very much with us.

By the time serious health implications were first suspected — in the early 1970s — the annual rate of PCB production in the United States had reached 34,000 tons (30,844 metric tons). But it was too late to reverse the worldwide spread; by 1970, traces of the compound had been found in almost every American river and even at the Arctic Circle, in the bodies of nonmigatory bears. Commercial and sport fishing, and duck hunting on many waterways has been seriously disrupted or destroyed by PCB contamination.

With the banning of PCB production in the United States, it would seem that at least one part of the problem has been solved. But the question of how to handle what we have already remains; the fact is that we as individuals, families, and as a nation, generate more household and industrial waste than we can effectively dispose of.

So the next time you sit down to operate, cast a wary eye on your dummy load. It may be a small piece of a very large puzzle.

references

1. Kitty Hevener, WB8TDA, *New England Report/Crossbander*, Volume 5, No. 5, May 15, 1983.
2. "Polychlorinated Biphenyls," *OPNAV Notice 6240*, Department of the Navy, Office of the Chief of Naval Operations, Washington, D.C., 20350. June 29, 1981.
3. John Bransford and Arthur J. Palotta, "Industry Wrestles with the PCB Problem," *Hazardous Materials Waste Management*, July-August, 1983, page 23.
4. "Polychlorinated Biphenyls and Polybrominated Biphenyls," Volume 18, *International Agency for Research on Cancer (IARC) Monographs on the Evaluation of the Carcinogenic Risks of Chemicals to Humans*, World Health Organization, October, 1978. Available from WHO Publications Center, 49 Sheridan Avenue, Albany, New York 12210.
5. Tom Runyon, VE5UK, *ham radio*, September, 1980, p. 66.
6. Rollins Environmental Services, Inc., advertisement in *Hazardous Materials Waste Management*, July-August, 1983, page 11.
7. Michael Brown, *Laying Waste: The Poisoning of America by Toxic Chemicals*, Pantheon Books (a division of Random House), 1979, pages 246-247.
8. "Polychlorinated Biphenyls," *OPNAV Notice 6240*, June 29, 1981.

bibliography

Culhane, John, "PCBs: The Poison That Won't Go Away," *Readers Digest*, December, 1980.

Fischbein, Alf, M.D. et al, "Dermatological Findings in Capacitor Manufacturing Workers Exposed To Dielectric Fluids Containing Polychlorinated Biphenyls (PCBs)," *Archives of Environmental Health*, Volume 37, Number 2, March/April, 1982.

"Polychlorinated Biphenyls and Polybrominated Biphenyls," Volume 18, *International Agency for Research on Cancer (IARC) Monographs on the Evaluation of the Carcinogenic Risks of Chemicals to Humans*, World Health Organization, October, 1978. Available from WHO Publications Center, 49 Sheridan Avenue, Albany, New York 12210.

Morgan, Robert E., WB5AOH, letter, *QST*, June, 1976, page 59.

Reiger, George, "The Poisons We Eat," *Field and Stream*, May, 1983.

Smith, A.B., et al, "Metabolic and Health Consequences of Occupational Exposure to Polychlorinated Biphenyls," *British Journal of Industrial Medicine*, November, 1982.

Stellman, Jean M., Ph.D., *Work is Dangerous to Your Health: A Handbook of Health Hazards in the Workplace*, Vintage Books, a division of Random House.

Environmental Protection Agency — Hazardous Waste and Consolidated Permit Regulations, Federal Register, Part II, May 19, 1980.

"PCBs: Good Works from Goodyear," *Newsweek*, September 1, 1980.

ham radio

CDC confirms PCBs in dummy loads

As this issue went to press, the CDC had reportedly found at least one PCB-contaminated dummy load in its study of samples taken from Amateur equipment in six cities (see page 42).

The contaminated dummy load belonged to Richard P. Beebe, K1PAD, ARRL section manager for eastern Massachusetts. Of the 15 samples taken from the Boston area, Beebe's was the only one found to contain PCBs.

Beebe told *ham radio* that he had been advised by the CDC to undergo a blood test in order to determine whether he had experienced any negative health effects as a result of exposure to the material.

According to CDC epidemiologist Paul Stehr, the CDC study will continue, as leads in which potential problems were identified are followed up and owners of questionable dummy loads notified.

Katherine Hevener, WB8TDA

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photovoltaic cells: a progress report

Seminar covers PV basics, "breeder" concept, and Amateur Radio applications

In November, 1982, 400 people participated in what has been termed the "largest publicly held seminar" on photovoltaics in the world. The gathering, presented by ENCON and SOLAREX in Dearborn, Michigan, provided the latest information on this subject to a group consisting of Radio Amateurs, corporate engineers and building contractors. The following article discusses the important features presented at the seminar.

Early photovoltaic cells were manufactured solely for space applications, and between 1958 and 1973 cost $500 to produce one (peak) watt. At this rate, the early cells would have had to operate for 40 years to pay back the energy expended in their manufacture alone; in order to compete with conventional electrical power generation, the cost of the cells would have to decrease dramatically. By 1977 the cost of solar cells had dropped to $20 per peak watt, with a calculated energy payback of less than six and a half years. Today, costs are lower than $10 per peak watt, with an energy payback of less than three and a half years. Both the cost and energy payback are continuing to decrease.

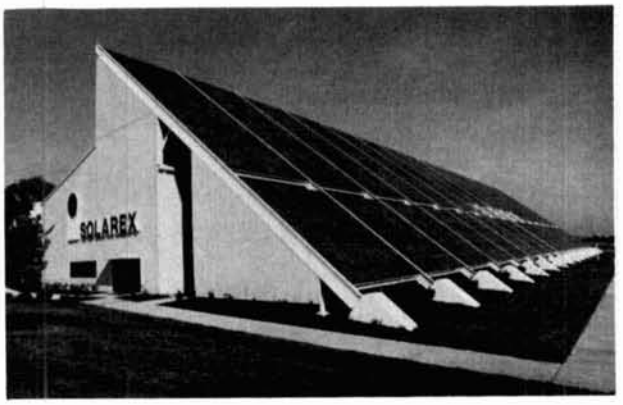

fig. 1. "Breeder concept" structure uses solar energy to provide power for production of solar cells.

What this indicates is that the technology, productivity, and energy consumption problems are being resolved, and that the solutions to the remaining issues are in hand. It is believed that by the time photovoltaic demand rises to the 100 megawatt level, costs will drop below $4 per watt and the energy payback will be reduced to less than one year.

photovoltaic cell material

Historically, several materials have been used for experimentation in photovoltaic devices: gallium arsenide, cadmium sulphide, and silicon, among others. Silicon has been chosen for widespread use and is the logical material since it is the second most abundant element on earth, is low in cost when used in a relatively low purity form and provides high photovoltaic efficiency. One key to lowering costs of solar cells has been the development of semicrystalline silicon — a form of polycrystalline silicon developed specifically for photovoltaic applications.

Semicrystalline silicon is fabricated using a procedure known as Ubiquitious Crystallization Process (UCP), in which the silicon takes on the shape of the mold in which it is crystallized. One common configuration* is that of square wafers, which lends itself to high density packing in a solar panel. Perhaps most importantly, UCP uses inexpensive, low-purity raw silicon. This means that the expensive, highly pure and energy-demanding raw material used in the conventional single crystal process can be bypassed.

the breeder concept

One way to decrease the price of a product is to increase its productivity. One successful means of increasing productivity, called the breeder concept method, incorporates a large industrial structure completely powered by the sun. With its sloping, south-facing roof, the building features a 28,000 square foot (2600 square meter) array of SOLAREX semicrystalline silicon solar cell panels (see **fig. 1**).

By Paul J. DeNapoli, WD8AHO, ENCON Corp., 27600 Schoolcraft, Livonia, Michigan 48150

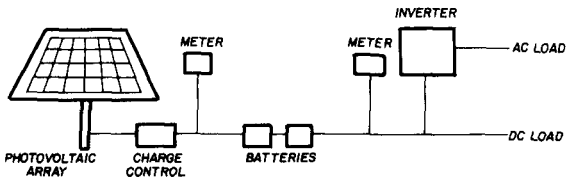

fig. 2. Block diagram of an electrical generation system based on a photovoltaic source.

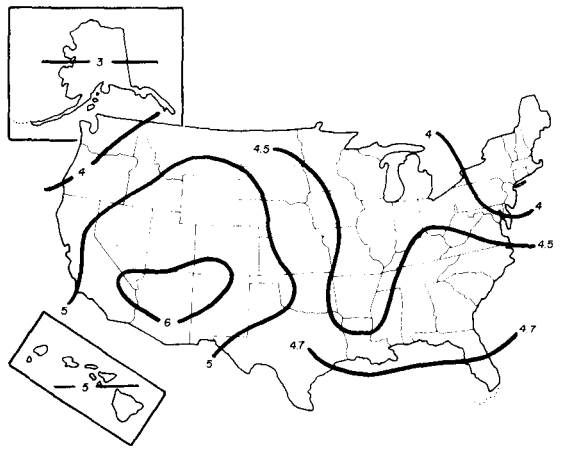

fig. 3. Average peak sun hours per day throughout the U.S. ("Guide to Solar Electricity," Solarex technical staff report, Solarex Corporation, 1335 Piccard, Rockville, Maryland 20850.)

The 200 kW rooftop photovoltaic array converts sunlight directly into electricity to provide power for the facility's production lines, which produce photovoltaic cells and panels. So the facility actually uses power provided by the solar cells on its roof to manufacture, or "breed," more solar cells. It derives all of its electric power, including power for lights, air conditioning, and production equipment, from the more than 3000 semicrystalline panels mounted on its roof. Its photovoltaic system, aided by solar thermal energy and thermal storage, also provides for all facility heating requirements, elminating the need for oil or gas heating. The 200 kW array produces an average of 800 kWh per day of energy coupled with a 2.5 MWh battery storage system. This storage capacity provides steady, uninterrupted power of 60 kW in the unlikely event of four dark days in succession.

powering an Amateur station

A complete system sufficient to power an Amateur Radio station under ordinary circumstances or during times of crisis would consist of photovoltaic panels, charge-controlling devices, and deep-cycle renewable energy batteries, (see **fig. 2**). A typical "barefoot" installation allowing for three hours of operation per day (one hour transmit, two hours receive) would require an average of four peak hours of sun in an area such as Michigan (see **fig. 3**), where ENCON and SOLAREX test facilities are maintained.

The transmitter load in this case would be 15 amperes for one hour or 15 ampere-hours. The receiver load would be 0.6 amperes for two hours or 1.2 ampere-hours. The combined load requirement would be 16.2 amperes, or more simply, 17 ampere-hours.

It's usual to factor in a system loss term of 20%, which raises our design requirements to a total of 20.4 ampere-hours. Referring to **fig. 3** and dividing 20.4 by 4 (average peak sun hours) provides our design goal of 5.1 amperes. Examining the industrial literature shows that the SX-100** PV panel produces 1.9 amperes at 17.0 volts or 32 watts under these conditions. Use of three of these panels meets our requirements *(1.9 × 3 = 5.7 amperes)* conservatively. **Fig. 4** has been included to assist readers in designing installations according to their own specific requirements.

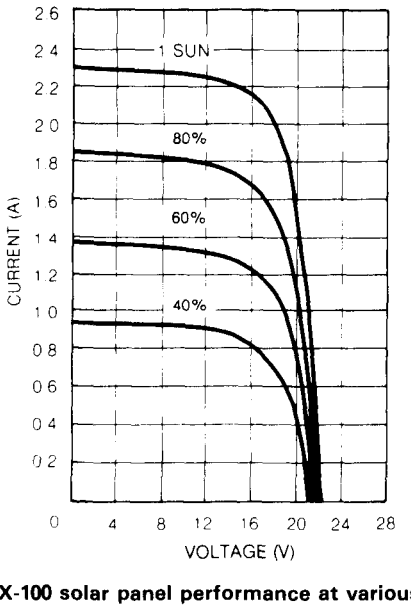

fig. 4. SX-100 solar panel performance at various light intensities, T = 25°C. (Courtesy of Solarex Corporation.)

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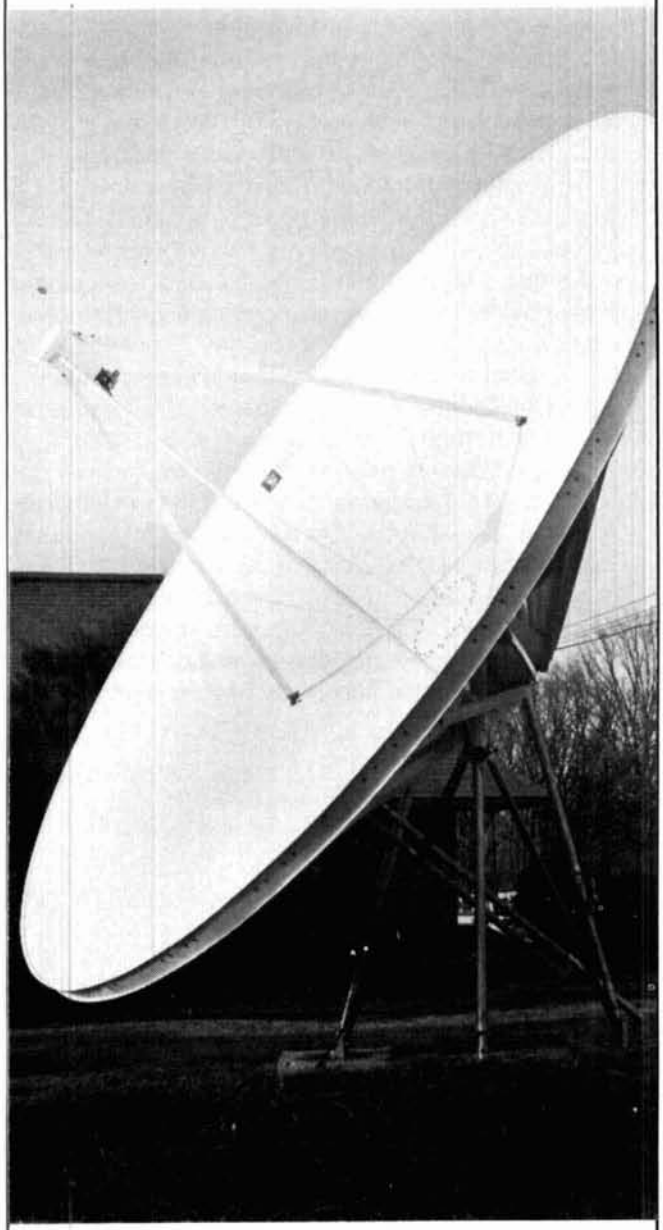

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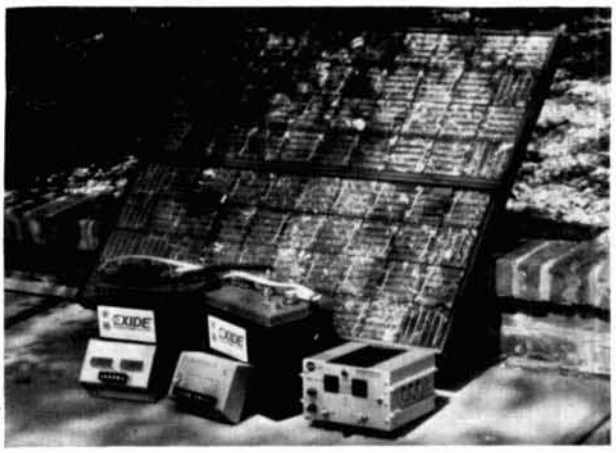

fig. 5. A typical "barefoot" ham station can be powered by a two-PV panel array with two 6 VDC 185 ampere-hour batteries as backup.

battery calculations

For battery (or storage) calculations, use a NO SUN day number for added reliability.

$$20.4\ ampere\text{-}hour\ load \times 7\ (No\ SUN\ days) = 143\ ampere\text{-}hours$$

$$143\ ampere\text{-}hours \times 2\ (50\%\ battery\ drain) = 286\ ampere\text{-}hours$$

Four 6 VDC 185 ampere-hour batteries will supply 370 ampere-hour capability at double the voltage or 12 volts DC (series-parallel configuration).

A list of materials for this system would include 3 SX-100 panels, 4 Exide 6 volt DC batteries, 1 charge controller, 1 mounting hardware kit, and 1 meter package and cable.

Due to SSB characteristics, a transmitter will never really see the full ampere output in transmitting. A system containing 2 SX-100 panels and 2 batteries with accessories can be utilized in a very energy-efficient manner for normal and emergency operations, (see **fig. 5**).

when will the price come down?

PV's have been dropping in price for twenty years. The pricing structure of photovoltaics is now at an affordable level, but without consumer support, we'll never see another decrease because of the elementary laws of supply and demand. A prime example of how consumer-supported products decrease in price are calculators and personal computers. The same principles apply to photovoltaics: until the Amateur Radio community chooses to support PV products, the industry will be slow to meet its ultimate goal of supplying reliable, cost-effective, primary and emergency power for communication, residential and commercial needs.

ham radio

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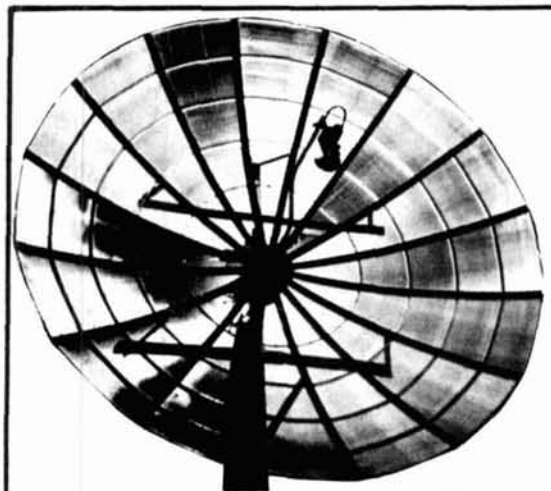

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vertical phased arrays: part 5

ABCD matrix parameters simplify network calculations

The most recent article of this series[1] discussed the application of lumped-constant circuits to the drive networks for all-driven element phased arrays. Design equations were presented for the most commonly used four-terminal networks. The design process and general procedures that must be followed for any drive network were reviewed, using typical arrays as examples.

Not discussed in part 4 was how the input/output calculations might be done. Those familiar with complex algebra and the use of a Smith chart can do these calculations one circuit branch at a time with these relatively simple networks. But it is a tedious process at best, prone to human error and cumulative errors resulting from rounding off in chain calculations. And one of Murphy's Laws asserts that errors are always committed at the *beginning* of the longest chain of calculations!

There is an alternative to this drudgery: matrix algebra. Using it allows us to determine the input conditions that result when any load is connected to a network. We do not have to calculate each circuit branch individually; all we need to know is the circuit type. There is even a built-in method of checking accuracy which aids in eliminating arithmetical errors and the entry of incorrect signs.

Matrix algebra has been used for solving problems of networks, transmission lines, and filters since the late 1940s because of its convenience in rapid circuit analysis and synthesis. With the advent of computers the use of matrices has increased, and it is possible that many readers have been using matrix methods without recognizing them as such, since the methods have often been incorporated into scientific computer programs as special process calls or library functions.

If matrix methods have been neglected in Amateur literature, it is not for lack of suitable applications. Perhaps the method has seemed too esoteric to be applied to such mundane problems as matching antennas to transmission lines, or that the jargon associated with it has frightened experimenters away; perhaps Amateurs have simply not been sufficiently exposed to this powerful mathematical tool.

four-terminal network matrices

Mathematical analyses using matrices require only the algebra of alternating current theory: a + jb. Because four-terminal networks happen to have properties which are natural to matrices and because the recurring structure of matrix operations makes them well suited for performance on programmable calculators or small computers, it makes sense for the Amateur to apply matrix algebra to network design.

By Forrest Gehrke, K2BT, 75 Crestview, Mountain Lakes, New Jersey 07046

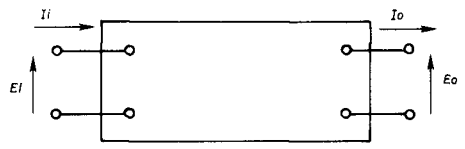


fig. 1. Four-terminal network showing reference directions for voltage and current. Subscripts *i* and *o* imply 'in' and 'out', respectively.

As with many other mathematical concepts, the application of matrix methods does not necessarily require a complete understanding of the underlying theory. It is in this context — i.e., in explanation of the *use* of matrices — that I address this subject. (For those who may wish to explore matrix algebra in depth, a brief bibliography is supplied at the end of this article.)[2]

Some fundamentals, such as the assumptions and restrictions and the notation employed, must be understood. Before all else, it should be emphasized that we are dealing only with alternating current *steady* state. (Matrix methods can be applied to transient and pulsed states, but that is outside the realm of this discussion.)

Four-terminal networks are a special form of a general network having a pair of input terminals and a pair of output terminals. Pictured in **fig. 1** is a box with the two pairs of terminals showing the reference directions for voltage and current. We may not know what is in the box, but we will suppose it to consist of any number of circuit branches and impedances with the following restrictions applying:

1. All impedances may be complex, but are linear and constant (time-invariant).

2. The network is passive, i.e., the only generators must be external sources (no dependent or internal sources), represented by E_i or E_o operating alone, or both simultaneously.

Despite not knowing the exact circuit inside the box, enough information can be deduced from measurements (amplitude *and* phase) made at the four terminals to produce a simple Tee or π circuit which is equivalent to it at any one frequency. We do this by defining a set of matrix parameters as follows:

$$A = (E_i/E_o) \qquad \text{with } I_o = 0 \qquad \textbf{(1)}$$

Voltage E_i is applied to the input terminals and voltage E_o is measured at the output terminals with no load connected to the output.

$$B = (E_i/I_o) \qquad \text{with } E_o = 0 \qquad \textbf{(2)}$$

Voltage E_i is applied to the input terminals and the short circuited output current I_o is measured.

$$C = (I_i/E_o) \qquad \text{with } I_o = 0 \qquad \textbf{(3)}$$

Applying a voltage to the input terminals, measure input current I_i and output voltage E_o with no output load connected.

$$D = (I_i/I_o) \qquad \text{with } E_o = 0 \qquad \textbf{(4)}$$

Applying a voltage to the input terminals, measure input current I_i and measure the short-circuited output current I_o.

The coefficients A, B, C, D are called general network parameters. Two relationships exist between inputs and outputs of a four-terminal network involving these parameters:

$$E_i = AE_o + BI_o \qquad \textbf{(5a)}$$

$$I_i = CE_o + DI_o \qquad \textbf{(5b)}$$

A and D are dimensionless transfer ratios, but B and C have the dimensions of impedance and admittance, respectively. In addition, a specific relationship exists between the network parameters because of reciprocity:

$$AD - BC = 1 \qquad \textbf{(6)}$$

If we know any three of the four parameters, we can calculate the fourth. On the other hand, if we believe we know all four, this relationship gives us a means of verification, for if calculations using **eq. 6** do not hold, there must be an error.

The matrix used to describe four terminal networks is known as a square or network matrix. The network matrix is always portrayed this way:

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} \qquad \textbf{(7)}$$

If the network contains no resistances, i.e., is lossless, A and D are real numbers and B and C are pure imaginary numbers (B and C carry the 'j' operator).*

Several kinds of matrix parameters such as S, H, and ABCD, have been developed for solving particular problems. Though one system is sometimes preferred over the other, it is possible to convert any of these parameter types to any other type, and to use *any* type of matrix parameter in the calculations discussed herein.

**Complex algebra, real* and *imaginary*, are mathematician's terms. For people working with electronics, these terms may unfortunately convey meanings which are not intended literally. The algebra, although different, *is not complicated*; the reactances resulting from inductances and capacitances *are neither unreal nor imaginary in effects*. However, the terms have been with us a long time and are here to stay.

Matrices may be manipulated — added, multiplied, inverted, reversed, partitioned — in many ways, but only according to special rules of procedure and order. For example, when four-terminal networks are cascaded, the effect may be calculated using matrix multiplication. If the individual matrix of each component network is known, the product is a new matrix of ABCD parameters for the overall network chain, allowing calculation of input/output relationships directly, end-to-end. If there is no need to determine the intermediate voltages and currents of the component networks, this is the way to go. (The order of this matrix multiplication is important. Obviously, there will be a great difference in results if the position of a 75-ohm 1/4 wave transformer followed by any length of 50-ohm line, is reversed!)

A four-terminal network is reversible if the A parameter is equal to the D parameter at all frequencies. This is another special case of the network matrix; we may reverse the connections to such a network without causing any change. Physically, a length of coaxial transmission line, a symmetrical Tee or π circuit are examples of such networks. The matrix of reversible networks appears like this:

$$\begin{bmatrix} A & B \\ C & A \end{bmatrix}$$

with $A = \pm \sqrt{1 + BC}$

When designing four-terminal networks, it is often necessary to express the current and voltage at the input side as a linear transformation of the current and voltage on the output side. For instance, with phased arrays we usually know what is wanted on the output side. What we need to know is the current and voltage required on the input side to produce those specific output conditions. Rearranging **eq. 5**, we can state several useful relationships. If each equation is divided by I_o we have:

$$E_i/I_o = (AE_o/I_o) + B$$

and

$$I_i/I_o = (CE_o/I_o) + D$$

E_o/I_o describes an external load which I will call Z_a. (I have chosen to use the subscript 'a' to avoid confusion with the commonly used 'o' which refers to a transmission line characteristic impedance.)

If the first of the above equations is divided by the second, and Z_a substituted for E_o/I_o, we obtain:

$$E_i/I_i = Z_{in} = (AZ_a + B)/(CZ_a + D) \quad \textbf{(8)}$$

which defines the input impedance of the network in terms of the output load Z_a and the parameters of a network.

This leads to additional useful relationships:

$$E_o/E_i = Z_a/(AZ_a + B) \quad \textbf{(9)}$$

$$I_o/E_i = 1/(AZ_a + B) \quad \textbf{(10)}$$

$$I_o/I_i = 1/(CZ_a + D) \quad \textbf{(11)}$$

$$I_i = I_o(CZ_a + D) \quad \textbf{(12)}$$

$$E_i = I_o(AZ_a + B) \quad \textbf{(13)}$$

If we know the input impedance and want to calculate the load impedance:

$$Z_a = (DZ_{in} - B)/(A - CZ_{in}) \quad \textbf{(14)}$$

If the matrices of the fundamental types of four-terminal networks are known, along with the input or output impedance, all other network characteristics can be computed. Notice the recurrence of the terms $AZ_a + B$ and $CZ_a + D$ in the above relationships. If we program only these two calculations, we have substantially reduced the tedium of network calculations. (Most scientific calculators include the functions rectangular-to-polar and polar-to-rectangular, which takes care of most of the rest of the computations.*) Notice also that the ABCD parameters define the network operating characteristics, independent of the type of network. Therefore, if a length of coax and a π circuit or a Tee circuit have identical parameter values, the circuits will be exactly equivalent (even though the equations for calculating the parameters are different for each of these network types). Though not *all* types of networks may be transformed from one form to another, it is true often enough not to ignore the possibility. If true, use it to simplify your design.

Part 4 showed the basic building block four-terminal networks most useful to design of the drive networks for phased arrays. Presented in **table 1** are the parameter equations for each of those circuits, using the same notation. Note that this discussion is confined to the lossless case, since for low band frequencies losses are usually negligible. In the more general case, the procedure is still valid with loss terms introduced. However, it's not needed in this discussion.

using the ABCD parameters

Example calculations, which usually improve understanding, also help illustrate the versatility of matrix methods. I will first show the relatively simple case of a quarter-wave transformer and then proceed to design a real network for a 2-element array.

*For those familiar with Hewlett-Packard calculators and RPN, an SASE to the author will bring a 98-step program developed for the HP-19C which can calculate **eqs. 8** through **13** using complex algebra. Translation for other programmable H-P calculators should not be difficult.

The electrical length of a quarter-wave transformer is 90 degrees. If we are not interested in circuit components values, we do not need to know the frequency. What is required is the angular length and the characteristic impedance of the circuit. "Electrical length" (in any units of length) is always defined as the length under *matched* load conditions. But this does not imply that the current or voltage phase displacement at other than matched conditions is necessarily equal to the electrical length of the circuit.[3] The quarter-wave transformer is an exception; this consequently accounts for its great utility. As long as the load is a *pure* resistance, the current and voltage phase displacement is 90 degrees even though not matched. If our transformer is made from a 50-ohm transmission line, it has the following ABCD parameters:

$$A = \cos 90^\circ + j0 = 0 + j0$$

$$B = 0 + j50 \sin 90^\circ = 0 + j50$$

$$C = 0 + \left(\frac{j \sin 90^\circ}{50}\right) = 0 + j0.02$$

$$D = \cos 90^\circ + j0 = 0 + j0$$

Assume that the load is a pure resistance of $35 + j0$:

$$AZ_a + B = 0 + j50$$

$$CZ_a + D = 0 + j0.7$$

and $Z_{in} = (AZ_a + B)/(CZ_a + D)$
$= 71.4285 + j0$ ohms

Though we already know the current phase displacement, we can also determine the current amplitude ratio, a factor often required in antenna array calculations:

$$I_o/I_1 = 1/(CZ_a + D) = 1.4285 \angle -90^\circ$$

Assuming the load current, I_o, to be $1 + j0$, the input voltage is $E_i = I_o (AZ_a + B) = 50 \angle 90^\circ$, another value often needed in array network design.

In short, with **eqs. 8** through **13**, (in some cases assuming values for output current or voltage), we can find any of the input conditions using the ABCD parameters of the circuit.

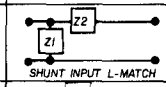
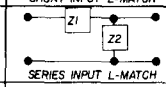
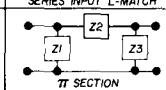
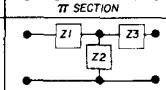
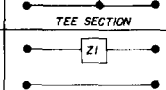
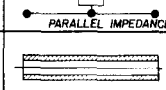
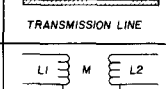
Suppose we had chosen a π network for our quarter-wave transformer. If we use a reversible π circuit designed to be coax-equivalent we know that[1]

$$X_1 = X_3 = -(Z_o \sin\theta)/(1 - \cos\theta)$$

and $X_2 = Z_o \sin\theta$

where Z_o and θ is defined the same way as it is for coax. As already indicated, the ABCD parameters define the circuit characteristics. Since the circuit characteristics are supposed to be the same, we should expect to find the parameter values to be identical even though calculated differently.

Table 1. Four-terminal network block diagrams and associated matrix forms.

No.	NETWORK	MATRIX = $\begin{bmatrix} A & B \\ C & D \end{bmatrix}$
1	 SHUNT INPUT L-MATCH	$\begin{bmatrix} 1 & Z2 \\ 1/Z1 & (Z1-Z2)/Z1 \end{bmatrix}$
2	 SERIES INPUT L-MATCH	$\begin{bmatrix} (Z1+Z2)/Z2 & Z1 \\ 1/Z2 & 1 \end{bmatrix}$
3	 π SECTION	$\begin{bmatrix} \frac{(Z2+Z3)}{Z3} & Z2 \\ \frac{(Z1+Z2+Z3)}{Z1\,Z3} & \frac{(Z1+Z2)}{Z1} \end{bmatrix}$
4	 TEE SECTION	$\begin{bmatrix} \frac{(Z1+Z2)}{Z2} & \frac{(Z1Z2+Z1Z3+Z2Z3)}{Z2} \\ \frac{1}{Z2} & \frac{(Z2+Z3)}{Z2} \end{bmatrix}$
5	 SERIES IMPEDANCE	$\begin{bmatrix} 1 & Z1 \\ 0 & 1 \end{bmatrix}$
6	 PARALLEL IMPEDANCE	$\begin{bmatrix} 1 & 0 \\ \frac{1}{Z1} & 1 \end{bmatrix}$
7	 TRANSMISSION LINE	$\begin{bmatrix} \cos\theta & jZo\sin\theta \\ j\frac{\sin\theta}{Zo} & \cos\theta \end{bmatrix}$
8A, 8B	 COUPLED CIRCUITS	$\begin{bmatrix} \frac{L1}{M} & \frac{j\omega(L1L2-M^2)}{M} \\ \frac{-1}{\omega M} & \frac{L2}{M} \end{bmatrix}$ (A) $\begin{bmatrix} \frac{1}{k}\sqrt{\frac{L1}{L2}} & j\omega\sqrt{L1\,L2}\frac{(1-k^2)}{k} \\ \frac{1}{j\omega k\sqrt{L1\,L2}} & \frac{1}{k}\sqrt{\frac{L2}{L1}} \end{bmatrix}$ (B)

$$A = \frac{0 + j\,50 \sin 90^\circ - j\,\frac{50 \sin 90^\circ}{1 - \cos 90^\circ}}{0 - j\,\frac{50 \sin 90^\circ}{1 - \cos 90^\circ}} = 0 + j0$$

$$B = 0 + j50 \sin 90^\circ = 0 + j50$$

$$C = \frac{0 - j\,\frac{50 \sin 90^\circ}{1 - \cos 90^\circ} + j\,50 \sin 90^\circ - j\,\frac{50 \sin 90^\circ}{1 - \cos 90^\circ}}{\left(0 - j\,\frac{50 \sin 90^\circ}{1 - \cos 90^\circ}\right)\left(0 - j\,\frac{50 \sin 90^\circ}{1 - \cos 90^\circ}\right)} = 0 + j0.02$$

$$D = \frac{0 + j\,50 \sin 90^\circ - j\,\frac{50 \sin 90^\circ}{1 - \cos 90^\circ}}{0 - j\,\frac{50 \sin 90^\circ}{1 - \cos 90^\circ}} = 0 + j0$$

Since the ABCD (parameter) values are identical, all other circuit relationships will be identical also. A similar parameter computation can be carried out with the coax-equivalent Tee circuit where[1]

$$X_2 = -Z_o/\sin\theta \text{ and } X_1 = X_3 = Z_o\frac{(1-\cos\theta)}{\sin\theta}$$

Again the ABCD parameter values will be identical to the first two cases, though their computation requires yet another set of equations from **table 1**.

For the specific quarter-wavelength example we did not have to perform all these calculations to find the input impedance. We know all we need to know from the quarter-wavelength relationship,

$$Z_o = \sqrt{Z_{in}Z_a}$$

but when examining a new procedure it is always reassuring to be able to verify it with a more familiar one. Even for this example, we would not be able to calculate voltage or current input conditions quite so easily if the load were reactive. Best of all, matrix methods are applicable to any circuit without restrictions placed on electrical length. To illustrate this point, let's design a no-compromise feed network for a 2-element vertical phased array. Assuming directional switchability is desired, physical symmetry will dictate equal length element feeders. However, these need only be long enough to meet at a central switching point in the array. At a design frequency of 3.8 MHz, the array in this example has the following characteristics:

Equal amplitude current drive with a 90° phase displacement between elements. The elements are quarter-wave spaced and quarter-wave resonant.

From part 3 of this series[4] the driving-point impedances are:

$$Z_1 = 21.4 - j15 \text{ for element 1}$$

$$Z_2 = 51.4 + j15 \text{ for element 3}$$

Note: These impedances are for elements with an extensive ground plane.

At 3.8 MHz the element spacing is 64.71 feet. Allowing for some variation in placement of the switching relays and feed network, each feeder is arbitrarily cut to 34 feet. Assuming a line characteristic impedance, Z_o, of 50 ohms and velocity factor of 0.66 the electrical length of the feeders is 71.65°. The drive network will be matched to a 50-ohm line.

For a matched array we must first determine the resistance loads each network chain presents to the shack line. Assuming 1 ampere flowing into each element, the total power going to the array is the sum of I^2R inputs, or

$$21.4 \bullet 1^2 + (51.4) \bullet 1^2 = 72.8 \text{ watts}$$

table 2. Input conditions and ABCD parameters at each circuit junction with 1 ampere flowing into each element.

element 1		element 2	
Z_1	= 21.4 − j15	Z_2	= 51.4 + j15
E_1	= 26.134 /−35.028°	E_2	= 53.544 /−73.731°
I_1	= 1 /0°	I_2	= 1 /−90°
71.65° coax		**71.65° coax**	
A	= 0.3148 + j0	A	= 0.3148 + j0
B	= 0 + j47.458	B	= 0 + j47.458
C	= 0 + j0.01898	C	= 0 + j0.01898
D	= 0.3148 + j0	D	= 0.3148 + j0
$AZ_z + B$	= 6.7372 + j42.7351	$AZ_a + B$	= 16.1819 + j52.1798
$CZ_a + D$	= 0.5995 + j0.4062	$CZ_a + D$	= 0.0300 + j0.9757
Z_1	= 40.7999 + j43.6326	Z_2	= 54.9379 − j14.9217
E_1	= 43.2629 /81.0410°	E_2	= 54.6314 /−17.2296°
I_1	= 0.7242 /34.1195°	I_2	= 0.9761 /−1.7656°
shunt L-match (leading)		**shunt L-match (lagging)**	
A	= 1 + j0	A	= 1 + j0
B	= 0 − j116.2630	B	= 0 + j45.0951
C	= 0 − j0.01047	C	= 0 + j0.0079
D	= −0.21678 + j0	D	= 0.64378 + j0
$AZ_a + B$	= 40.7999 − j72.6303	$AZ_a + B$	= 53.9379 + j30.1733
$CZ_a + D$	= 0.2398 − j0.4270	$CZ_a + D$	= 0.7616 + j0.4260
Z_1	= 170.0934 + j0	Z_2	= 70.8171 + j0
E_1	= 60.3324 /−26.5554°	E_2	= 60.3324 /27.4573°
I_1	= 0.3547 /−26.5554°	I_2	= 0.8519 /27.4573°
pi circuit (lag 54.0126°)			
A	= 0.5876 + j0		
B	= 0 + j137.6306		
C	= 0 + j0.004757		
D	= 0.5876 + j0		
$AZ_a + B$	= 99.9479 + j137.6303		
$CZ_a + D$	= 0.5876 + j0.8091		
Z_1	= 170.0934 + j0		
E_1	= 60.3324 /27.4572°		
I_1	= 0.3547 /27.4572°		

The voltage at the common connection of the array for matched conditions, i.e., a 50 ohm load, is $E = \sqrt{RW} = \sqrt{(50)(72.8)} = 60.3324$ volts. Since the element networks will be transformed individually to pure resistances whose paralleled value is 50 ohms, we must find the individual values. Going back to the resistive components of each driving-point impedance (and knowing the array's impressed voltage amplitude when correctly driven), we can determine what these resistive loads must be. Using the relationship $R = E^2/W$, these transformed loads are respectively:

$$(60.3324)^2/21.4 = 170.0935 \text{ ohms, element 1*}$$

$$(60.3324)^2/51.4 = 70.8171 \text{ ohms, element 2}$$

*Check whether these resistances when paralleled equal 50 ohms.

As recommended in part 4, the simplest network often results if the drive network for the −90° phased element establishes the voltage amplitude and phase for the array common connection. Proceeding on that basis we will design the network for element 2 first. We need to transform the driving-point impedance of this element to the input end of its coax feeder and to determine the input voltage and current that must exist there. **Table 2** lists the input conditions for each element at each junction point and the ABCD parameters for each circuit. For simplicity, 1 ampere is assumed to be flowing into each element.

The design procedure for the lumped-constant part of the network transforms element 2 driving-point impedance, as seen at the input to its coax feeder, to the resistive load required, using a lagging phase shunt L-match. (The design equations for all discussed circuits are found in part 4.) This fixes the voltage amplitude and phase required for the array. Element 1 driving-point impedance, as seen at the input to its coax feeder, is transformed, with a leading phase shunt L-match, to the resistive load required for this chain. At the input to this L-match, the voltage amplitude is correct but the phase displacement has overshot the objective. (L-match circuits can be designed to produce either a specific resistive input or a specific phase displacement — not both.) The solution is to add a lagging π coax-equivalent circuit with a characteristic impedance of 170.0935 ohms and an electrical length equal to the difference between the phase angle existing at the input to this L-match (−26.5554°) and the angle required at the common connection point (27.4572°). This difference, i.e., the total angular displacement between these two vectors, is 54.0126°. This phase correction circuit can be thought of as though we had somehow magically obtained approximately 26 feet of coax delay line having a characteristic impedance of 170 ohms. When doing chained network calculations, don't forget that Z_a (output load) for the circuit being computed is the *input* impedance of the preceding junction (looking towards the load). For example, when transforming the element driving-point impedance to the input end of its feeder, then the output load, Z_a, is the element's driving-point impedance. But when computing input/output relations for the succeeding L-match circuit, Z_a is now the impedance seen at the input end of the transmission line feeder, and so on.

final 2-element network design

The resulting design for the feed network of this array requires three inductances and four capacitances as seen in **fig. 2**. The component values are quite realizable. Evaluation of network designs is admittedly somewhat subjective. It is conditioned by the number of individual network circuits required, circuit component values (e.g., at 3.8 MHz lossless air core series arm inductances greater than 10 μH become physically large; shunt arm capacitance values less than 50 pF require more rigorous assessment of the unavoidable stray circuit capacitances). Should awkward values of components result from a particular design, it is often possible that using a different element to establish the voltage amplitude and phase at the array common connection point results in more physically realizable components.

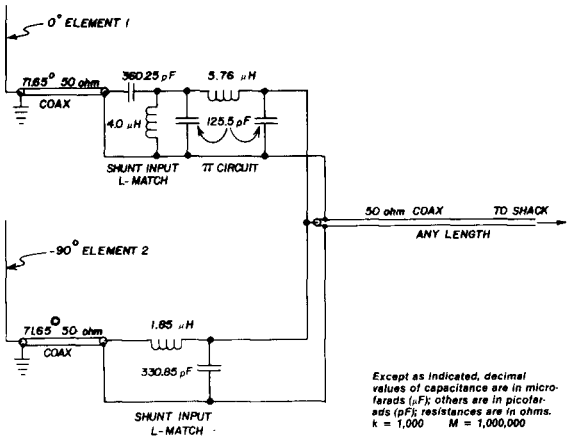


fig. 2. Feed network schematic for quarter-wave spaced two-element vertical array.

In a concluding article of this series I will discuss practical array and feed network construction and measurements.

This information, gleaned during the various phases of the development of my vertical phased arrays, should help the reader convert the theory presented on these pages into an actual physical structure — an antenna array that works the way it was designed to work.

references

1. Forrest Gehrke, K2BT, "Vertical Phased Arrays, part 4," *ham radio*, October, 1983, page 34.
2. Frank Ayres, *Matrices*, (Shaum's Outline Series), McGraw-Hill Book Company; Noble and Daniel, *Applied Linear Algebra*, Prentice-Hall Inc.; L.A. Pipes, *Applied Mathematics for Engineers and Physicists*, McGraw-Hill Co.
3. Forrest Gehrke, K2BT, "Vertical Phased Arrays: part 1," *ham radio*, May, 1983, page 18.
4. Forrest Gehrke, K2BT, "Vertical Phased Arrays: part 3," *ham radio*, July, 1983, page 26.

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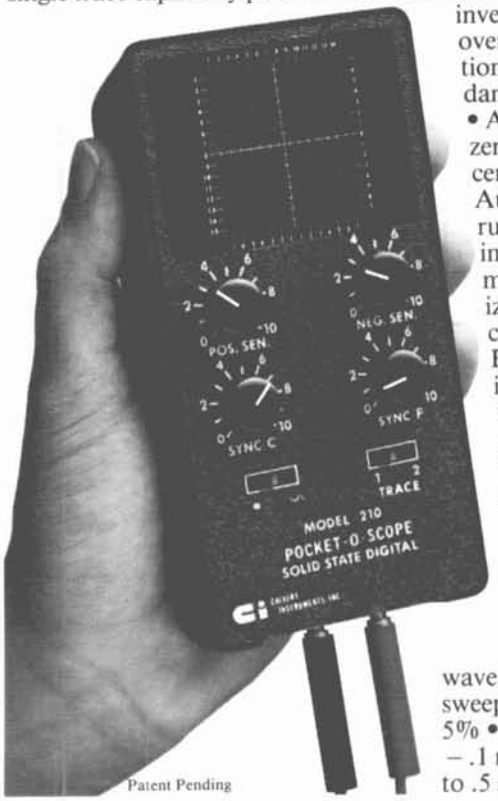

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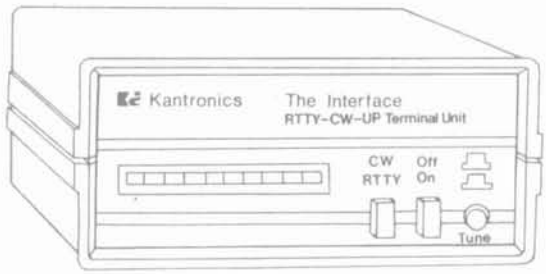

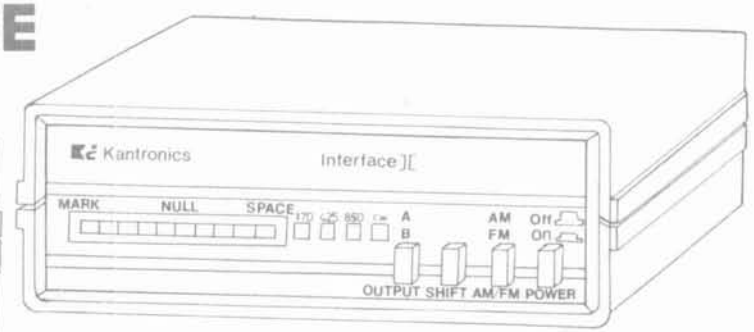

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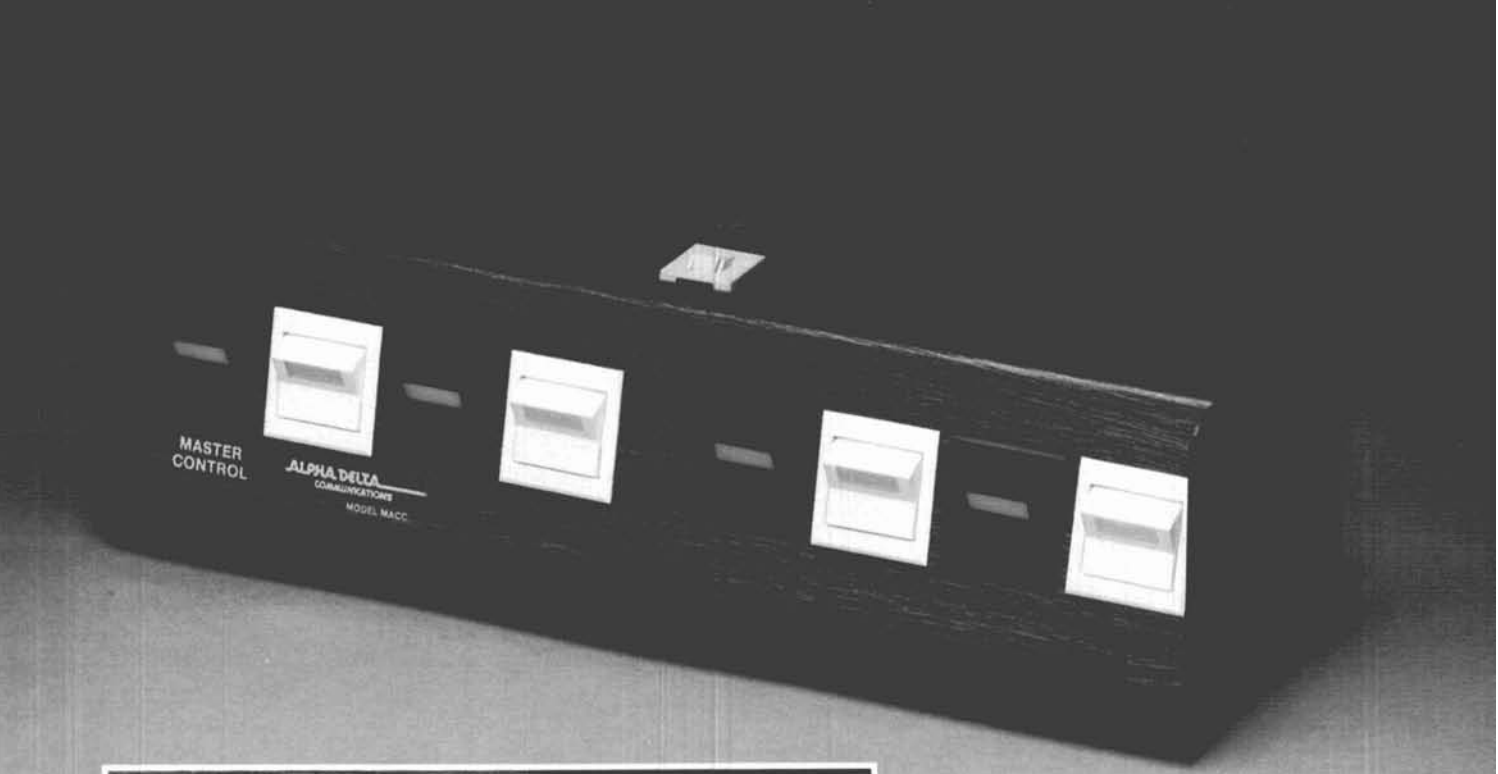

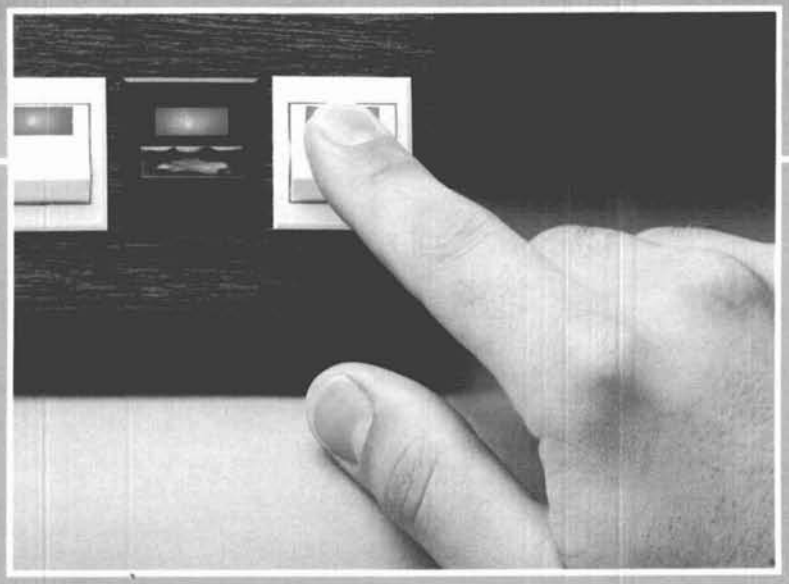

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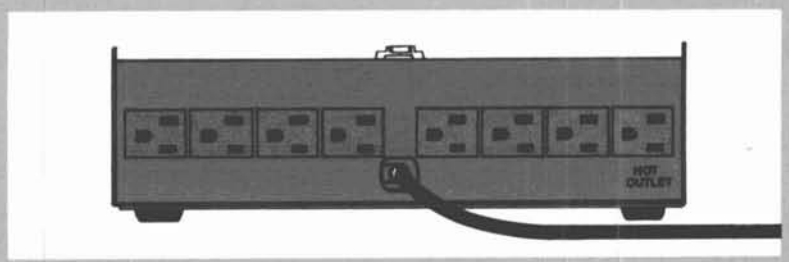

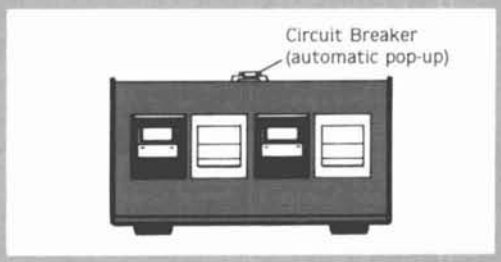

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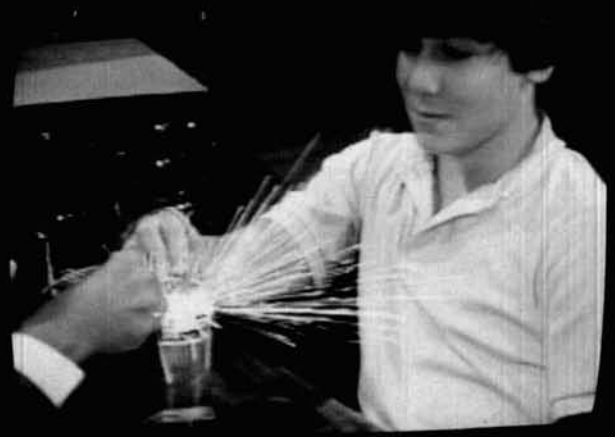

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lightning and electrical transient protection

A variety of devices safeguard delicate electronic circuitry

It's a summer afternoon; the air feels heavy, dense. Towering gray-black cumulonimbus clouds advance across the sky. Suddenly lightning knifes from cloud to ground, filling the air with thunder. Bolts leap from cloud to cloud, cloud to ground, and from top to bottom within individual clouds. Rain pours down and then, almost as abruptly as it began, the thunderstorm disappears.

Snug at home, a ham fires up his rig to keep a schedule on 20 meters. He's running a few minutes late, but that's better than operating in the middle of an electrical storm. To his dismay, he discovers that his radio can't transceive any more. It sits dead, emitting a quiet hiss on every band.

Unknown to our ham, his rig gave up the ghost five minutes before he turned on the power. The FET in the receiver front-end had its gate destroyed by a lightning-induced static discharge.

Every year, hundreds of hams have the same unfortunate, unnecessary experience. *All* radio equipment can be protected, easily and inexpensively, but before we can give our rigs complete protection, we must first understand the causes and nature of static discharges.

Thunderstorms develop when warm, moist air is forced to rise. This may be triggered by the meeting of warm and cold air masses, which is especially common in the Midwest and along the Gulf Coast and Eastern seaboard. Or it may be induced by terrain, as frequently happens in the mountainous West. Thunderstorms are most likely to occur in those areas favored by frontal development or terrain or both, as shown in **fig. 1**.

For whatever reason, rising air begins cloud formation at *lifting condensation level* where its temperature drops below the dew point. The larger the temperature differential between the surrounding atmosphere and the rising column of air, the greater the speed and violence of development.

An average cumulonimbus cell will reach upward 6 miles (9.7 km) and develop vertical air drafts with velocities of 15 feet per second. Violent cells may rise to 60,000 feet and create intense drafts with speeds over 200 feet per second.

After the formation of ice crystals, a charge separation occurs within the cloud. The top of the cloud becomes positive; the underside, negative. The reasons for this separation are varied: frictional contact, melting, freezing, inductive charge transfer, water drop breakup, ion attachment. These mechanisms may operate independently or together and turn the cloud into a giant static electricity generator.

The development of extreme potential differences within the cloud leads to atmospheric breakdown and electrical conduction. Lightning strokes begin within the cloud and often between clouds. While nine out of ten discharges during thunderstorms are of this type, it's that remaining ten percent that are of primary concern to us.

lightning development

Development of a ground stroke follows a definite sequence: first, a faintly luminous tendril descends from the cloud base. This is the *stepped leader*. A stepped leader moves downward in jerky spurts of 150 feet (45.7 meters) at speeds of 75 miles (120 km) per second. It may branch out, with a new fork occurring at one of its hesitation points. When this leader is within 100 feet (30.5 meters) of the ground, the local electrical field becomes strong enough to initiate discharge from the ground. This *ground streamer* moves upward in a forked pattern. With the connection of the stepped leader and ground streamer, a heavy current (typically 20,000 amperes)

By Bradley Wells, KR7L, 5053 37th Avenue SW, Seattle, Washington 98126

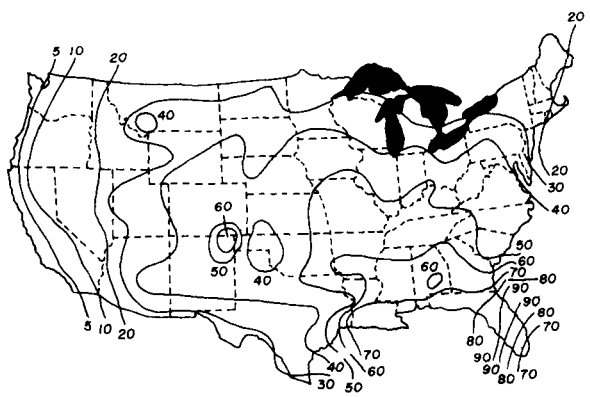

fig. 1. The mean number of thunderstorm days in the United States is related to both mountainous terrain and seasonal weather patterns. (Adapted with permission from *Understanding Lightning* by Martin Uman, copyright 1971, BEK Technical Publications, 1700 Painters Run Road, Pittsburgh, Pennsylvania 15243.)

flows from the ground to the cloud at a speed of 60,000 miles (97,000 km) per second. This *return stroke* produces the lightning flash that we observe.

Approximately 50 milliseconds after the return stroke, another tendril of luminosity descends from the cloud base. This is the *dart leader*, and it traverses the same channel followed by the return stroke. Its ground contact triggers a second return stroke of slightly less power than the first. Most cloud-to-ground discharges consist of three or four return strokes, each successively penetrating farther into the cloud to tap new charge accumulations.

The quantity of energy in an average lightning stroke can approach 1,000,000,000 joules. It transfers some 10 coulombs of charge across a potential difference of 100 million volts. This release of energy in less than 300 *microseconds* is equivalent to many megawatts of power. While lightning strokes are normally measured in thousands of feet, horizontal strokes up to 100 miles (161 km) in length have been observed. Similarly, voltages also vary, and potential differences of as high as one billion volts have been recorded. The sudden energy release of these lightning strokes can generate intense electrostatic and electromagnetic fields miles away from their origin.

lightning protection

Several steps are involved in protecting electronic equipment from lightning-induced static discharge. The first rule is to bond all metal objects to a ground system in order to provide a low resistance, high capacity reservoir for soaking up static charges. Pay particular attention to your tower since it will act just like a giant lightning rod: clean and lubricate all joints with conductive grease, then tie the tower to your ground system with heavy copper or aluminum wire. *Simply having the tower base in the earth is no guarantee of a good electical ground.* (Commercial radio towers use wide copper straps run in several directions for some distance to secure a good ground.) Properly grounded, a tower located close to the house can provide a degree of protection for the dwelling and occupants against lightning damage.

The often-repeated suggestion to disconnect antennas during a storm is still good advice. The problem, however, is that the operator may not be home to make this disconnection, or that the storm may be several miles away and out of sight. (see "10 GHz Weather Radar", *ham radio*, September, p. 61, for discussion of a method for detecting nearby thunderstorm activity.) Generally, by the time a ham thinks to unhook the coax, the damage is done.

other hazards

Several other sources of static electricity are common and may severely damage equipment. High winds, especially under conditions of very low humidity, can cause static in much the same manner as does dragging your feet over a carpet. Blowing powder snow may also cause static build-up on exposed metal surfaces.

Conventional lightning arrestors offer little protection for modern equipment because most of us operate with solid-state rigs; older tube-type radios were far more forgiving of static buildup than transistors or field-effect devices. Many tubes could actually arc over with minimal damage to either the tube or related components — but not modern transistors or, in particular, FETs. MOSFETs, particularly those without gate protection, can be irrevocably damaged by simply picking them up. Solid-state devices cannot tolerate any type of overvoltage on their base or gates, for even a microsecond, without sustaining damage. This damage may be total, in which case the receiver is dead; or it may be partial, leaving the operator thinking that propagation just isn't what it used to be.

Air gap lightning arrestors fail to protect equipment because the characteristics that determine their firing ability vary with both the air pressure and humidity of the environment. Under optimal conditons their response time is far too slow; even when these devices do fire, they retain a high enough voltage across the gap to damage sensitive equipment. Normally, 3 to 5 kilovolts is required to trigger the spark gap and when operating will still leave a 50-80 volt potential at the antenna terminal.

What we need is a device that will fire within nanoseconds and clip off high voltage spikes effectively. Two such devices are shown in **fig. 2.** Unlike conventional air gaps, these lightning protectors util-

fig. 2. While designed for indoor use, both Alpha Delta *Transi-Trap* and Drake Surge Shunt may be installed outdoors if appropriate weather-proof shielding is provided.

ize a hermetically sealed tube filled with Krypton 85, a gas of known breakdown characteristics. Since these devices are sealed, they remain unaffected by changes in humidity or atmospheric pressure. The tube design is such that their firing properties remain constant under all conditions. The gas conducts very effectively and reduces the voltage to values safe for solid-state devices. The typical firing speed is 100 nanoseconds and conduction begins at 750 volts for transient pulses.

Unlike old-style lightning arrestors, both of these mechanisms shunt the static electricity directly to ground rather than to the receiver chassis. Bypassing the receiver in this manner prevents the chassis potential from being raised to several thousand volts above ground level.

powerline transients

Receivers and transceivers can also be ruined by the effects of voltage transients coming in through the back end via the AC mains. Just as lightning can induce currents in the antenna system, it can also induce voltages in nearby power lines. These transients, running up to thousands of volts, can damage power supplies and internal components.

A lightning return stroke generates an intense RF field over a range of frequencies from kilohertz to Gigahertz. Most of the energy is centered around a frequency of 5 kHz, which makes long power lines very effective antennas. Since a lightning strike can generate electric fields of 60-80 volts per meter at distances of a mile or more, voltage transients of kilovolt magnitude can easily show up on power lines.

A second type of transient is created by a short circuit in the power distribution system. This may happen any number of times during the year, depending on where you live and how well the local power company maintains the system. The clearing of a short circuit is effected by blowing a fuse or, more commonly, by tripping a circuit breaker. This abrupt termination of current induces a high voltage transient on the power lines from the collapsing magnetic field of the power distribution transformers. Spikes of up to 6000 volts for periods of 5 to 10 microseconds are not uncommon, as shown in **fig. 3**.

Another source of voltage transients is inductive load switching of motors associated with furnaces, washing machines, and other appliances. When the current flow through motor windings is terminated, the magnetic field collapses and induces a reverse voltage of such magnitude that it may jump across the switch contacts to the power mains. Once an arc is established across the switch contacts, current flow continues to oscillate back and forth until there is insufficient energy to maintain the arc.

The problem of protecting your equipment against these transient voltages is further complicated by mode of transmission to the equipment. These

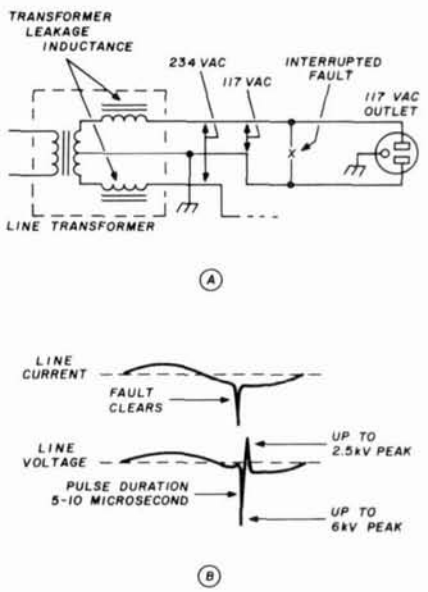

fig. 3. High voltage transients can occur on household 117 volt lines when a short circuit is cleared. (3A) shows circuit condition conducive to transient generation; (3B), current and voltage waveforms of spike. (Adapted from *QST*, February, 1982.)

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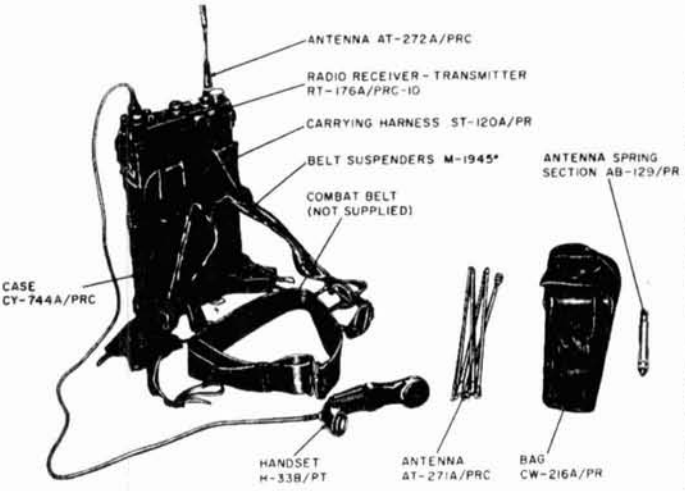

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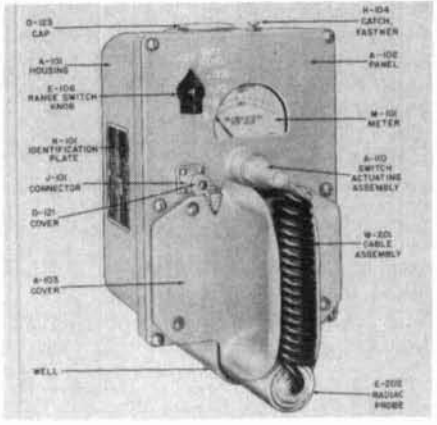

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PDR-27 phones $7.00 — Approx. 100 page Instr. Book $10.00
Hi Sensitivity GM tube $10.00 — Low Sensitivity GM tube $5.00
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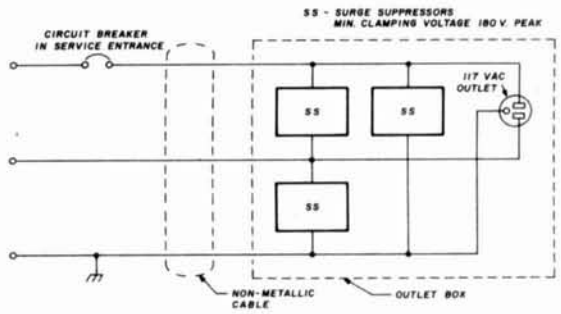

fig. 4. Three metal oxide varistors (MOV's) in a wall outlet provide maximum transient protection against the effects of both differential and common mode coupling within the house wiring.

fig. 5. Specially-designed terminal strips available from Drake and other manufacturers offer protection from power line spikes and transients.

pulses can exist between individual lines or between lines and ground in the house wiring. A further complication is the inherent capacitance of the house wiring which allows these transients to move from one wire to another.

transient protection devices

Several devices that will protect equipment from these damaging voltage transients are available. The General Electric Home Lightning Protector, for example, is built to protect electrical devices within the home from lightning-induced voltage transients. Designed for mounting in either the service entrance box or the weatherhead for the incoming AC mains, it intercepts the transients before they enter the house wiring.

The metal-oxide varistor (MOV), also manufactured by General Electric, exhibits a resistance that is inversely proportional to the applied voltage. It is a non-polarized device for installation between wires or from wires to ground as shown in **fig. 4**. MOVs are built to respond to transients in nanoseconds and have clamping voltages ranging from 10 to 1500 volts. Most have continuous power ratings of 1/2 to 5 watts with peak dissipation of over 600 joules of energy. These may be installed in service entrances or within the equipment itself.

General Semiconductor Industries manufactures the TransZorb, a semiconductor device with a large PN junction for transient protection. TransZorbs are capable of handling very high power levels for short periods of time (100,000 watts for 100 nanoseconds).

Both TransZorbs and MOVs look like oversized disc ceramic capacitors and may be installed with the electronic equipment or more easily at the back of an AC receptacle (after switching off the circuit breaker at the service panel).

Alpha Delta, Drake, and others sell terminal strips with built-in protective devices (**fig. 5**). These may be purchased in various configurations depending upon the number of outlets desired. Radio Shack markets the Voltage Spike Protector for single-plug protection. It resembles an oversize AC plug and contains a GE MOV wired across the AC line. It can clamp a 435 volt, 50 ampere, 20 micro-second surge and is the least expensive of the commercially made units.

A list of manufacturers and distributors of lightning protection devices is provided in **table 1**. Unfortunately, none of these devices will protect your valuable equipment against a direct lightning strike. The

table 1. List of manufacturers of distributors of surge and transient protection devices.

Alpha Delta Communications
P.O. Box 571
Centerville, Ohio 45459

R.L. Drake Company
540 Richard Street
Miamisburg, Ohio 45342

Electro Protection Devices, Inc.
P.O. Box 673
Waltham, Massachusetts 02254

Electronic Specialists, Inc.
171 South Main Street
Natick, Massachusetts 10760

Encomm, Inc.
2000 Avenue G, Suite 800
Plano, Texas 75074

General Electric Company
Semiconductor Division
West Genesee Street
Auburn, New York 13021

General Semiconductor Industries
P.O. Box 3078
Tempe, Arizona 85281

Telex/Hy-Gain
9600 Aldrich Avenue South
Minneapolis, Minnesota 55420

Kalglo Electronics
6584 Ruch Road East
Bethlehem, Pennsylvania 18017

MFJ Enterprises, Inc.
921 Louisville Road
Starkville, Mississippi 39759

Newark Electronics
500 North Pulaski Road
Chicago, Illinois 60624

Poly Phaser
P.O. Box 2001
Kissimmee, Florida 32741

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1111 West Walnut
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XF-9B-01	LSB	2.4 kHz	8	95.90
XF-9B-02	USB	2.4 kHz	8	95.90
XF-9B-10	SSB	2.4 kHz	10	125.65
XF-9C	AM	3.75 kHz	8	77.40
XF-9D	AM	5.0 kHz	8	77.40
XF-9E	FM	12.0 kHz	8	77.40
XF-9M	CW	500 Hz	4	54.10
XF-9NB	CW	500 Hz	8	95.90
XF-9P	CW	250 Hz	8	131.20
*XF910	IF noise	15 kHz	2	17.15

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XF107-C	WBFM	30 kHz	8	67.30
XF107-D	WBFM	36 kHz	8	67.30
XF107-E	Pix/Data	40 kHz	8	67.30
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old rule is still the best: during an overhead electrical storm, disconnect all antennas and unplug all equipment. And don't forget that the potential for static damage exists at any time; take appropriate protective measures. Much static damage is not immediately apparent, and it would be a shame to discover that your poor reception is not due to the decline in the sunspot cycle.

bibliography

Battan, L.J., *The Nature of Violent Storms,* Doubleday and Co., Inc., 1961.

Byers, R.R. and Braham, R.R., Jr., *The Thunderstorms,* U.S. Government Printing Office, 1949.

Logan, Devere E., W1HEO, "Lightning Protection," *Ham Radio Horizons,* September, 1980, page 12.

Maon, B.J., *Clouds, Rain and Rainmaking,* Cambridge University Press, 1962.

Schonland, B.F.J., *The Flight of Thunderbolts,* Second Edition, Clarendon Press, 1964.

Stuart, Ken, W3VVN, and Collick, Gene, W8LEQ, "Protect Your Equipment From Damaging Power-line Transients," *QST,* February, 1982, page 35.

Tyrell, Don R., W8AD, "Lightning Protection: A New Era," *CQ,* April, 1982, page 22.

Uman, M.A., *Lightning,* McGraw-Hill, 1969.

Uman, Martin A., *Understanding Lightning,* Bek Technical Publications, 1971.

White, T.E., K3WBH, "A Primer of Lightning Protection," *CQ,* July, 1981, page 42.

Zaks, Rodnay, *Don't (Or how to Care for Your Computer),* SYBEX, Inc., 1981.

Transient Voltage Suppression Manual, General Electric Company, 1978.

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ham radio TECHNIQUES

Bill Orr W6SAI

intermodulation distortion

Ham radio equipment has come a long way in the last ten years. All you have to do is to pick up a ten-year-old copy of *ham radio* and compare the articles and advertisements of yesterday with those of today.

One of the interesting developments that has taken place during this decade is the gradual improvement in linearity and the reduction of intermodulation distortion. These improvements are particularly noticeable in some of the new transceivers and exciters available today. But before I discuss the improvements, it would be a good idea to review the fundamentals of intermodulation distortion (IMD) and its importance in HF communications.

Intermodulation distortion is a particularly unpleasant form of nonlinearity that should be of interest to those operators using linear amplifiers (either in their exciters or as an auxiliary unit). IMD occurs in a nonlinear device driven by a complex signal having more than one frequency.[1,2]

As speech is made up of a multitude of frequencies, and the perfect linear amplifier has yet to be built, IMD is of concern to every Amateur interested in voice or multiplex transmission.

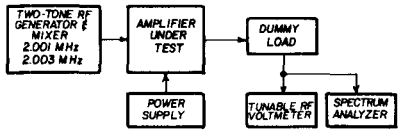

fig. 1. Intermodulation distortion analyzer. A two-tone RF generator with excellent IMD characteristics (third-order distortion products better than 70 dB down from one tone of a two-tone signal) drives the amplifier under test. A portion of the output signal is observed on a spectrum analyzer and measured by a tunable RF voltmeter. The test may take place at any frequency within the operating range of the amplifier. 2 MHz and 30 MHz are common test frequencies.

A linear amplifier is an amplifier in which the output signal is an *exact* replica of the input signal. If the output signal does not duplicate the input signal, intermodulation distortion is created. IMD shows up on the air as a "roughening" of the signal accompanied by broad sidebands ("splatter"). Some Amateurs who are acutely sensitive to IMD can actually hear it as a growl on the low-frequency portions of voice transmissions and, in years past, could accurately identify the manufacturer of an SSB transmitter by merely listening to the signal on the air!

Intermodulation distortion may be examined and the amplifier tested by use of a distortion analyzer (**fig. 1**). An input signal consisting of two sine waves of equal amplitude (for example, 2.001 MHz and 2.003 MHz) is applied to the amplifier. The distortion products in a nonlinear stage appear as spurious signals within the passband of the amplifier and also at the harmonic frequencies, and the intermodulation distortion, as additional signals! In the example in **fig. 2**, the IMD products are located 2 kHz apart and occupy the span of 1995 kHz to 2009 kHz, or more. Thus, a signal that should be only 2 kHz wide is now 14 kHz wide, thanks to intermodulation distortion (**fig. 2**). The situation can be worse than this as a greater degree of distortion produces additional spurious signals on each side of the two desired signals.

IMD is independent of the operating frequency. If a 20-meter linear amplifier were tested for IMD at 14.200 MHz using a two-tone test signal whose tones were 2 kHz apart, IMD products would form a spectrum of signals, 2 kHz apart centered around 14.200 MHz. Photos of this type of distortion have appeared from time to time in product reviews.

the IMD rating

Intermodulation distortion is expressed in relation to the output level of an amplifier. The standard method of specifying the magnitude of the distortion products is to specify the reduction in decibels of one distortion product from one tone of a two-equal-tone signal. For example, if an amplifier (or tube or transistor) under a particular set of operating conditions has third-order distortion products of −30 dB, this means that the products have an amplitude 30 dB below one of the two test tones. It is *not* correct to compare one distortion product to the sum of the two tones; that is to say, the PEP value of the signal. If this is done, the resulting distortion figure is 6 dB "better" than the correct example (−30 dB rather than −24 dB). Unfortunately many product reviews and amplifier specifications take advantage of this "one-upmanship" because the better figure looks nicer in the advertisement!

IMD then and now

Has any improvement been made in the intermodulation distortion level of today's exciters and amplifiers, as compared to those products in 1973? I think there's been worthwhile improvement as new devices and circuit techniques have been developed.

Many early exciters used the so-called television "sweep tubes" as linear amplifiers. The popular 6LQ6 tube is a good example. This pint-size "bottle" could squeeze out up to 125 watts PEP at a plate potential of only 800 volts. It was an inexpensive and effective amplifier tube that attained wide acceptance in yesterday's equipment. Unfortunately, the third-order IMD products of the 6LQ6 when run in this fashion were only 18 dB below one tone of the two-tone power level. And if the signal from this amplifier were run through a second amplifier stage to bring it up to the legal Amateur power-input level,

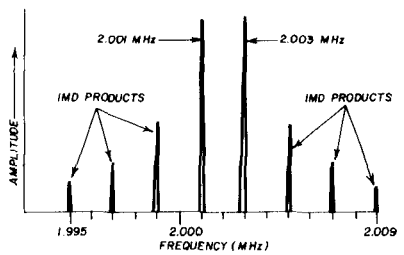

fig. 2. Two-tone IMD test signal has a 2 kHz spacing between the tones. In this representative case, the IMD products form an additional band of frequencies, spaced 2 kHz apart, centered on the test frequency. In this example, the third-, fifth- and seventh-order products are shown. The signal is 14 kHz wide. Higher-order products produced under severe distortion widen the signal even more than shown in this example.

the IMD products would be brought up by 10 dB or so in addition to the wanted signal. The result would be a broad, fuzzy-sounding signal having about 15 watts of splatter power in the third-order distortion products. It may not sound like much, but 15 watts of unwanted splatter on top of the signal you're trying to listen to can be intolerable.

The equally popular 6146 (6146B) was designed for RF services (as opposed to the 6LQ6), and it had much more appealing IMD ratings. At 800 volts and 60 watts power output, the IMD products were 24 dB below one tone of a two-tone test signal. That's 6 dB better than the 6LQ6, a worthwhile improvement.

The Collins Radio Company, now a division of Rockwell, pioneered the use of RF feedback to improve the linearity of an amplifier. It s use in the famous S-line transmitters provided an IMD level of better than −30 dB compared to one tone of a two-tone test signal.

And there the matter rested for a while. Perceptive Amateurs could pick out the S-line transmitter on the air, as it sounded immeasurably better than other equipment that did not incorporate RF feedback. However, as solid-state amplifiers came into general use, they were able to duplicate the IMD level set by the S-line as they, too, used fairly linear devices and an RF feedback loop. Thus, over the years, the "30-dB level" became an unofficial standard for measuring the excellence (or lack thereof) of IMD in Amateur equipment.

IMD today

Things are looking up. While IMD levels of −50 to −60 dB may be common in deluxe commercial and military gear, such levels are prohibitively expensive and too complicated for the competitive Amateur market. Despite this, improvements in intermodulation distortion in ham gear are here to stay. New solid-state devices skirt the −35 dB level with RF feedback, and at least one Amateur transceiver* has reached this favorable level using the common 6146B tube.

This is a far cry from the old sweep-tube "distortion generator." An IMD level of −35 dB sounds *clean* to the ear, even when the equipment is being run next door. Undoubtedly, significant improvements in IMD reduction will come about in the next few years, and I look forward confidently to an IMD level of −40 dB before the end of this decade.

Unfortunately, the good IMD rating of an exciter can be ruined quickly

*The Yaesu FT-102 HF transceiver boasts three 6146s in the ouput stage. Excellent linearity (better than −35 dB) is achieved by combining a relatively high resting plate current level with RF feedback.

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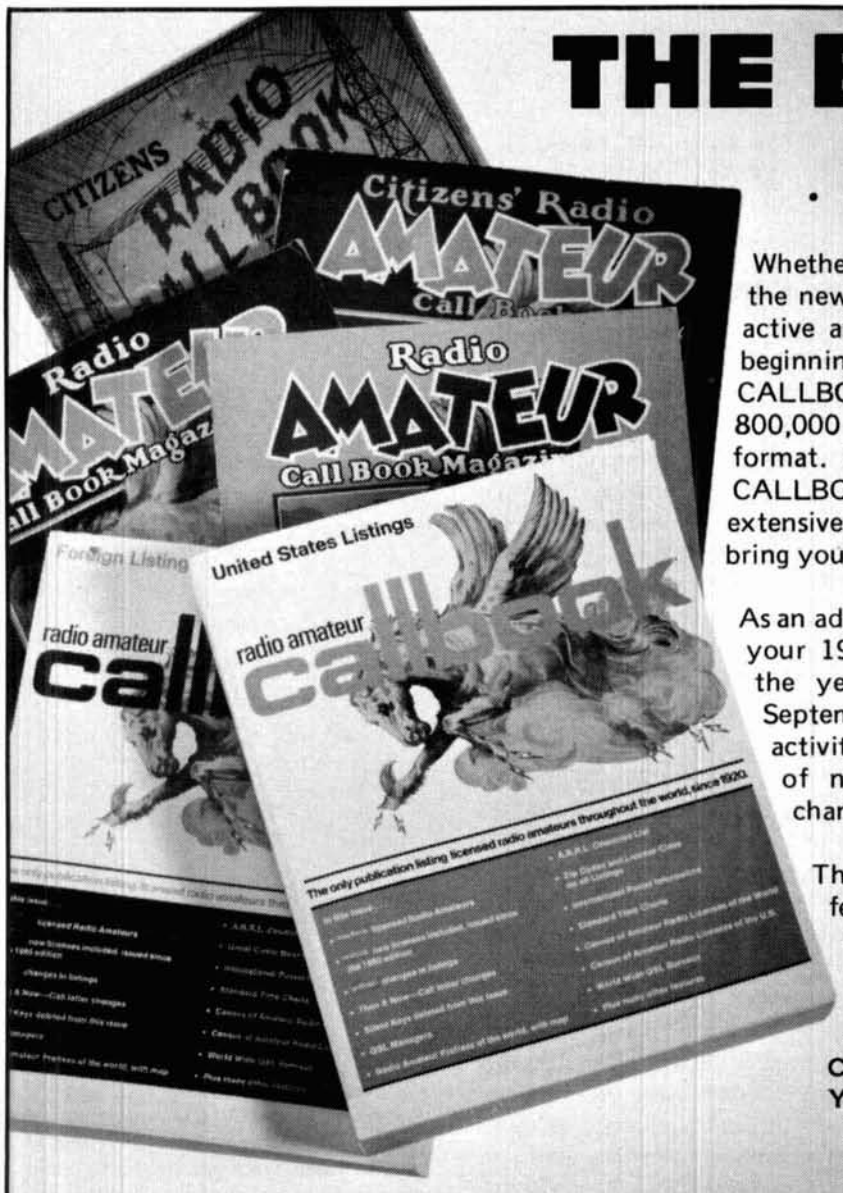

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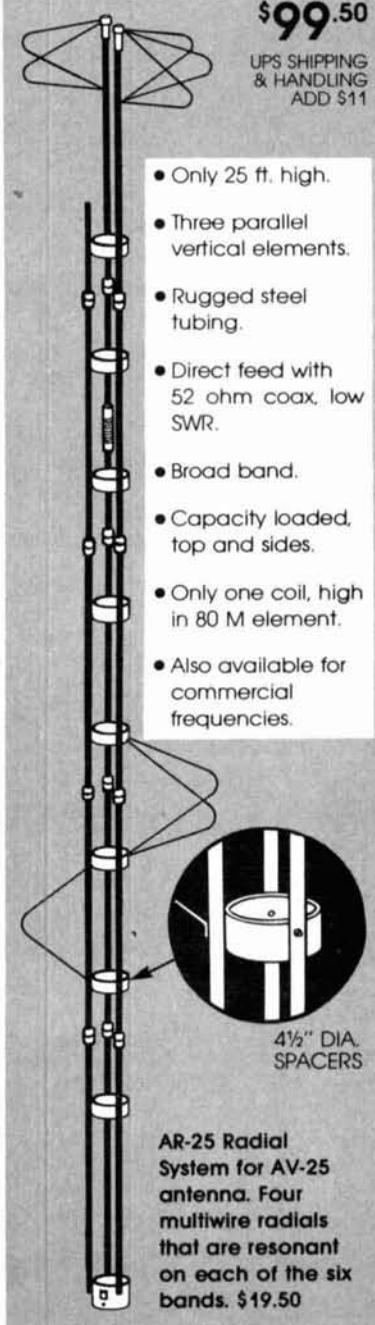

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by the careless operator who operates with "all knobs to the right." You hear plenty of these lids on the air today; will they be gone by 1990? I doubt it.

HF communication lives!

Remember the days when communications specialists predicted the demise of HF radio for long-distance communications? Why put up with static, fading, and interference on an unreliable HF circuit when you can do so much better with a reliable satellite link? In effect, HF radio was dead and buried by new communications techniques in the microwave satellite range. But times change! An article in the June, 1983, *Defense Systems Review* magazine[3] says it this way:

"Ten years ago it was thought that HF long distance communications for fleet operations would soon pass its heyday because of the capabilities of satellite communications. But the real vulnerability of satellite communications to antisatellite attack and potential propagation disruption with a nuclear detonation combined with the improved real-time propagation measurement capability give HF communications a new lease on life. The fact that HF communication is relatively inexpensive, flexible, and its assets are in place should give rise to increased interest to improve HF architecture and capabilities, relatively neglected for far too long."

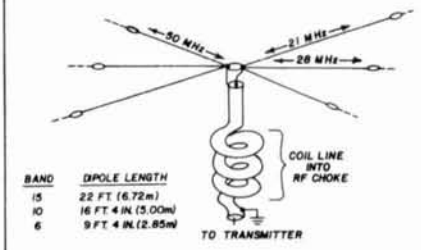
Well, hurrah! The ionosphere has been rediscovered for long-distance communications as "a satellite that doesn't fall down." Spearheaded by the U.S. Navy (who started using HF communications in approximately 1911), communicators are starting to re-examine the HF spectrum as an alternative to satellite circuits.

CW lives, too!

Did you see the full-page in the September issue of *ham radio*, placed by the Central Intelligence Agency, offering openings for electronics technicians and communications and radio operators *with Morse Code ability preferred*? I wonder what the CIA thinks of FCC pressure to dilute Amateur Radio with no-code licensees?

a simple antenna for 21-28-50 MHz

Some new triband transceivers on the market cover only the 21-, 28-, and 50-MHz bands. A simple triband antenna for these ranges is shown in **fig. 3**. These dipoles are paralleled at the feedpoint and fed with a coaxial line. The dipoles are trimmed a bit to provide the lowest SWR figure at your chosen point in each band. A simple transmatch placed at the station end of the line may ease loading problems.



BAND	DIPOLE LENGTH
15	22 FT. (6.72m)
10	16 FT. 4 IN. (5.00m)
6	9 FT. 4 IN. (2.85m)

fig. 3. Triband dipole for 15, 10, and 6 meters. Separate the tips of the dipole at each end as far as possible. Transmission line is made into a coil below feedpoint to isolate outer surface of line from field of antenna. For RG-58/U line, use four turns wrapped into a coil about six inches (30 cm) in diameter.

moonbounce revisited!

Another printing of the *Moonbounce Notes* is at hand. Send four first-class stamps (or four IRCs) to me at EIMAC, 301 Industrial Way, San Carlos, California 94070 and I'll send this interesting information to you.

references

1. Robert I. Sutherland, W6UOV, and William I. Orr, W6SAI, "Rating Tubes for Linear Amplifier Service," *ham radio*, March, 1971, page 50.
2. William I. Orr, W6SAI, "Intermodulation Distortion in Linear Amplifiers," *QST*, September, 1963. (For a reprint of this article, write author and request bulletin AS-21. Include two first-class stamps).
3. "High Frequency Transmissions Enjoy A Renewed Life," *Defense Systems Review*, June, 1983, published by Cosgriff-Martin & Cutter, Inc., Box 2828, Santa Clara, California 95055.

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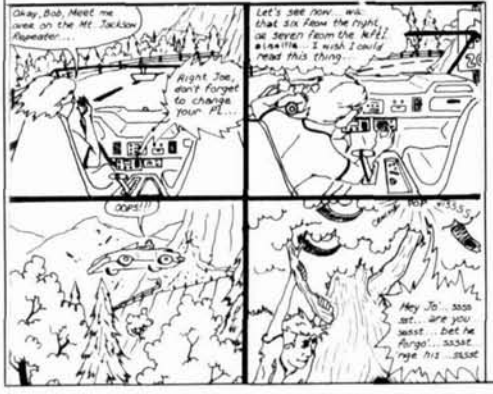

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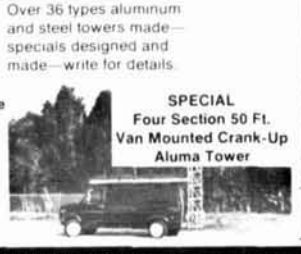

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2-meter weather converter

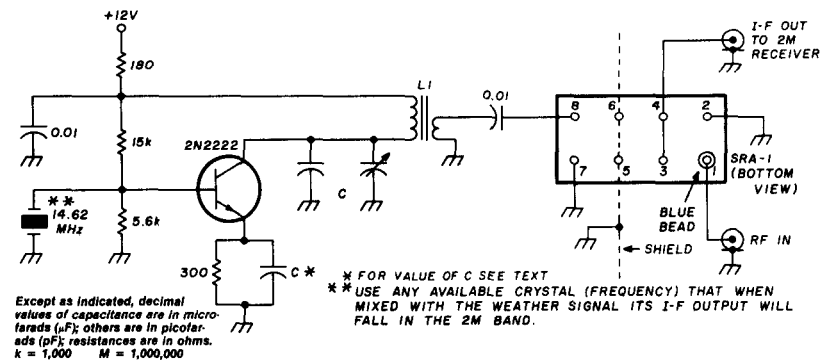

fig. 1. Weather converter consists of a 14.62 MHz local oscillator and a $10 double-balanced mixer.

Because I sometimes enjoy listening to the VHF public service bands and the NOAA weather broadcasts at 162 MHz, I designed and built a simple converter to convert these frequencies to 2-meter FM for reception on my transceiver.

The 162.40 MHz signal mixes with a 16 MHz local oscillator to produce a signal at 146.40 MHz. A typical converter has four stages: the RF amplifier, mixer, output filter, and local oscillator. Because a mixer is a multiplying device, it produces a signal at both the sum and difference of the input and the local oscillator frequencies. Conversely, for given intermediate and local oscillator frequencies, two input frequencies may be received. Tuned RF stages eliminate all but the desired frequencies.

I chose a passive double balanced mixer (DBM) for this converter. It is an integrated component with a frequency response from DC to 500 MHz. I used a Mini Circuits Lab SRA-1 ($9.95, in small quantities) that requires oscillator injection of about +7 dBm (5 mW) and has an inherent input impedance of 50 ohms. If IF feedthrough is about −45 dB and conversion loss is 6 dB, it is ideal for mixers when close frequencies are used.

By Ladimer S. Nagurney, WA3EEC, 73 Blackberry Lane, Amherst, Massachusetts 01002

The schematic diagram shown in **fig. 1** is the complete circuit. The local oscillator uses a 2N2222 that delivers about +10 dBm. The primary of L1 is selected to have a reactance of about 200 ohms at the crystal frequency. For example, at 15 MHz L1 is 20 turns on a T50-2 toroidal core. The secondary is 4 turns. The combination of the fixed and variable capacitors at the collector should resonate with L1. The emitter bypass capacitor should be about the same value but need not be adjustable. For 15 MHz, a 20 pF fixed and 7-45 pF variable capacitor were used in the collector and a 39 pF fixed value capacitor was used in the emitter. I used a 14.62 MHz crystal from my junkbox and tuned my transceiver to 147.78 MHz in order to receive 162.40 MHz.

The whole circuit was built on a small piece of PC board and mounted in a minibox. No pattern was etched on the board. The DBM was mounted by drilling a grid of eight holes at one end. A shield of PC material was used to separate the local oscillator from the IF and RF. The holes for the ungrounded pins of the DBM were drilled larger for clearance. A blue bead indicates pin 1 of the DBM.

The local oscillator was built using isolated pad

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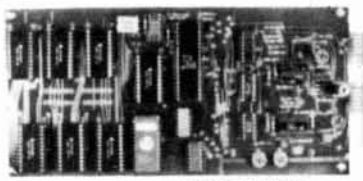

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techniques. An approximately 3/4-square inch piece of PC board was divided into four equal pads with a hacksaw to cut the foil. This was placed upon the groundplane on the same side as the side on which the DBM pins protrude. It is secured by the resistor and capacitor leads soldered between the various pads and ground. The local oscillator was tested before the DBM was installed by attaching a 47-ohm resistor to the output capacitor as a load and using an oscilloscope to observe the signal. The output was clearly heard on my communications receiver.

The IF output of the mixer utilizes the excellent selectivity capabilities of the front end of a typical 2 meter Amateur transceiver. Since the input of the transceiver is matched to 50 ohms, no additional impedance matching was necessary.

Note no RF filtering is used at the input. Because I could find no interfering signals near 133.16 MHz, I just connected the antenna directly to the input. If one wanted to eliminate this image, a highpass filter with a cutoff below 150 MHz could easily be added. Similarly, a lowpass filter could be used to eliminate the higher image if one wanted to copy a signal below the transceiver frequency.

Even though the mixer exhibits some loss, I found it to be acceptable for local listening. As soon as power was applied, the Providence NOAA weather station was received with full quieting occurring. Either a 162 MHz preamp before or a 2-meter preamp after the converter could be used to eliminate conversion losses.

If one were to choose a common repeater frequency for the IF, a receiver tuned to the weather channel could copy it because of the reciprocity of the mixer.

A note of caution: although DBMs are rugged, they will usually not withstand transmitter power levels. Also, the RF filtering in this simple converter is such that one might put out *several* signals if the unit were used for transmitting.

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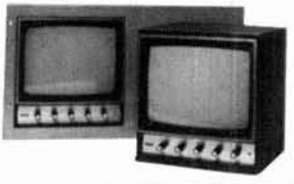

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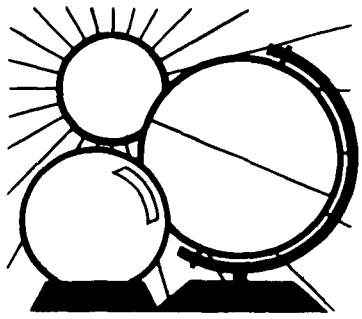

DX FORECASTER

Garth Stonehocker, KØRYW

ray tracing

If Santa were to bring you a ray tracer DX machine for Christmas, you'd have the ultimate DX forecaster right in your home.

Ray tracing between transmitter and receiver locations *is* possible; see this column in the October issue for a diagram showing a trans-equatorial ray path (signal) traced through the ionosphere to give one-long-hop propagation.

Another example of ray tracing technique is to search the ionosphere between your transmitter and the DX QTH, varying the take-off angle, bearing and frequency. (A computer could quickly determine the best path to use and specify these three corresponding parameters.) Ray tracing procedure consists of the following steps:

1. Determine the electron (ion) density at heights above the earth along the ray (signal) path using ionosonde, rocket, or satellite measurements.

2. Generate ionospheric contours using the electron density versus height data.

3. Trace the ray (path) through these contours starting from the transmitted signal. The changing refractive indices along the path determine a new ray direction.

4. Follow the ray as it bends from one point to the next until it emerges from the ionosphere at an angle heading down to earth toward the receiver.

All these steps are depicted in the diagram.

Ray tracing is not commonly done because of the limited availability of electron density profiles around the world. Even if the profiles were available, a substantial computer would be needed for ionosonde data conversion and the electron density profiles storage. However, Radio Amateurs are now using more sophisticated computers, and ionospheric measurements can be made with SSB equipment; maybe someday you *will* be able to get a ray tracing machine for Christmas.

last-minute forecast

December is one of the winter DX season months exhibiting low thunderstorm QRN and low probability of geomagnetic disturbances or at least long quiet periods in between disturbances. However, this year in the 11-year sunspot cycle may see a few more disturbances than in other years. Expect disturbances around December 4, 14, 17, 22, and 27. If WWV is broadcasting a radio flux greater than 140, good trans-equatorial openings might occur on 10-30 meters. If the flux is lower than 140, expect disturbances to last longer and fades to occur on the lower bands on higher latitude east-west paths.

An annular eclipse of the sun is to begin at 0941 UT in northeast North America, traveling across Iceland to England, Southern Europe, North Africa and ending in Southwest Asia at 1520 UT. The full moon is on the 20th and perigee on the 22nd. Winter solstice is on the 22nd at 1030 UT.

The Geminid meteor shower, which peaks on December 13 and 14, provides the richest and most reliable display of the year, with rates of 60 to 70 meteors per hour (determined mainly by radio, because of the poor weather in December). Also, a smaller portion of the shower (15 to 20 per hour) will be observed on December 22.

band-by-band summary

Ten, fifteen, twenty, and thirty meters will have DX openings from most areas of the world during daylight and into the evening almost every day. Long skip and one-long-hop trans-equatorial openings will occur in the early evening hours. These openings should occur during periods of disturbed geomagnetic field. Otherwise watch for high solar flux days for ten and fifteen meter openings.

Thirty, forty, eighty, and one-sixty meters are the night DXer's bands. Excellent extended periods of long skip, shorter than on the higher bands, will occur. Low noise and quiet geomagnetic conditions generally result in pleasant operating this time of year. Happy Holidays, and lots of DX during the coming New Year!

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DECEMBER

GMT	PST	WESTERN USA N	NE	E	SE	S	SW	W	NW	MST	MID USA N	NE	E	SE	S	SW	W	NW	CST	EST	EASTERN USA N	NE	E	SE	S	SW	W	NW
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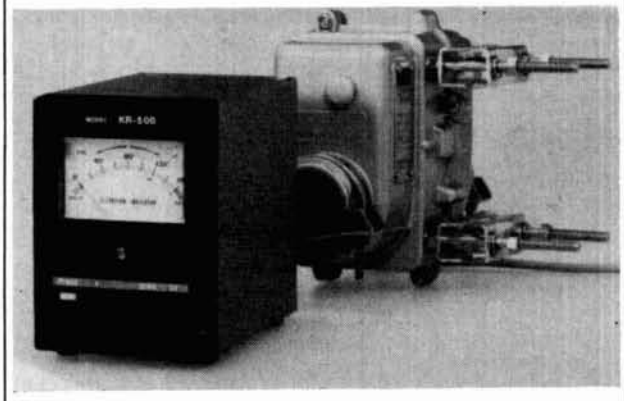

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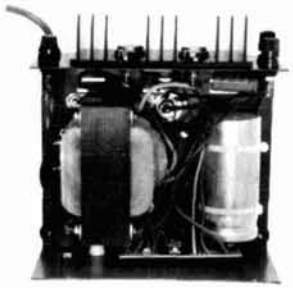

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MODEL VS-50M

RM-A Series

MODEL RM-35A

19" X 5¼ RACK MOUNT POWER SUPPLIES

Model	Continuous Duty (AMPS)	ICS* (AMPS)	Size (IN) HXWXD	Shipping Wt. (lbs.)
RM-35A	25	35	5¼ × 19 × 12½	38
RM-50A	37	50	5¼ × 19 × 12½	50

RS-A SERIES

MODEL RS-7A

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W X D	Shipping Wt (lbs)
RS-4A	3	4	3¾ x 6½ x 9	5
RS-7A	5	7	3¾ x 6½ x 9	9
RS-7B	5	7	4 × 7½ × 10¾	10
RS-10A	7.5	10	4 x 7½ x 10¾	11
RS-12A	9	12	4½ x 8 x 9	13
RS-20A	16	20	5 x 9 x 10½	18
RS-35A	25	35	5 x 11 x 11	27
RS-50A	37	50	6 x 13¾ x 11	46

RS-M SERIES

MODEL RS-35M

- Switchable volt and Amp meter

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt (lbs)
RS-12M	9	12	4½ x 8 x 9	13
RS-20M	16	20	5 x 9 x 10½	18
RS-35M	25	35	5 x 11 x 11	27
RS-50M	37	50	6 x 13¾ x 11	46

VS-M SERIES

MODEL VS-20M

- Seperate Volt and Amp Meters
- Output Voltage adjustable from 2-15 volts
- Current limit adjustable from 1.5 amps to Full Load

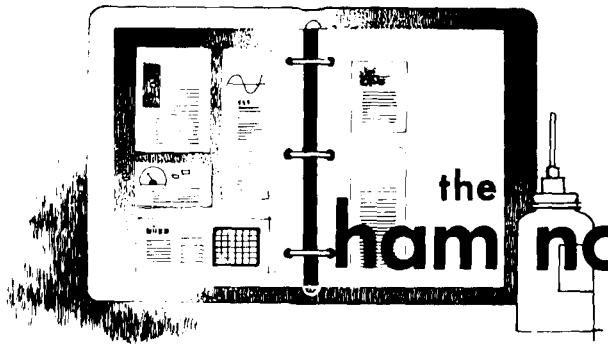
MODEL	Continuous Duty (Amps) @13.8VDC@10VDC@5VDC	ICS* (Amps) @13.8V	Size (IN) H x W x D	Shipping Wt (lbs)
VS-20M	16 9 4	20	5 x 9 x 10½	20
VS-35M	25 15 7	35	5 x 11 x 11	29
VS-50M	37 22 10	50	6 x 13¾ x 11	46

RS-S SERIES

MODEL RS-12S

- Built in speaker

MODEL	Continous Duty (Amps)	ICS* Amps	Size (IN) H x W x D	Shipping Wt (lbs)
RS-7S	5	7	4 x 7½ x 10¾	10
RS-10S	7.5	10	4 x 7½ x 10¾	12
RS-10L(For LTR)	7.5	10	4 × 9 × 13	13
RS-12S	9	12	4½ x 8 x 9	13
RS-20S	16	20	5 x 9 x 10½	18



KWM 380 external control circuit

This unit will control external antenna switches or solid-state (relay-actuated) amplifiers from the megahertz BCD output signals from the KWM 380. It was built in an evening with wire wrapping techniques using IC sockets, parts, and boards available at any Radio Shack or similar electronics outlet.

The KWM 380 (**fig. 1**) powers the circuit and provides BCD information for both the ones and ten digits. When operation is below 10 MHz, both of the "tens" BCD outputs, representing 10 and 20 MHz, are high.

The two 4028 IC's are BCD to decimal decoders. One handles the "ones" input information from the 380; the other handles the "tens" input information. The output from these IC's labeled U3 and U4 go to common QUAD AND gates U1 and U2 which are 74LS08's. When both inputs of any one of the AND GATES are high, the output goes high. This output goes through a 4.7k resistor to the base of a 2N2222 transistor. When the base goes high, the transistor acts as a switch and completes the circuit to ground for the small relay which in turn actuates an antenna switch (or amplifier bandswitch).

U1 and U2 pin 14 is at +5 volts, and pin 7 is at ground. U1a and U1b have one input each tied to the decimal 3 output of BCD decoder U4. This is because the KWM 380 causes both interface pins 12 and 13 to go high (10's and 20's MHz info) when the radio is tuned to any MHz band below 10.000. Thus U1a, which closes the 3.5 MHz relay, reads 33 MHz from the decoders, and U1b reads 37 MHz to close the 7 MHz relay. U3 and U4 pin 16 is at +5 volts,

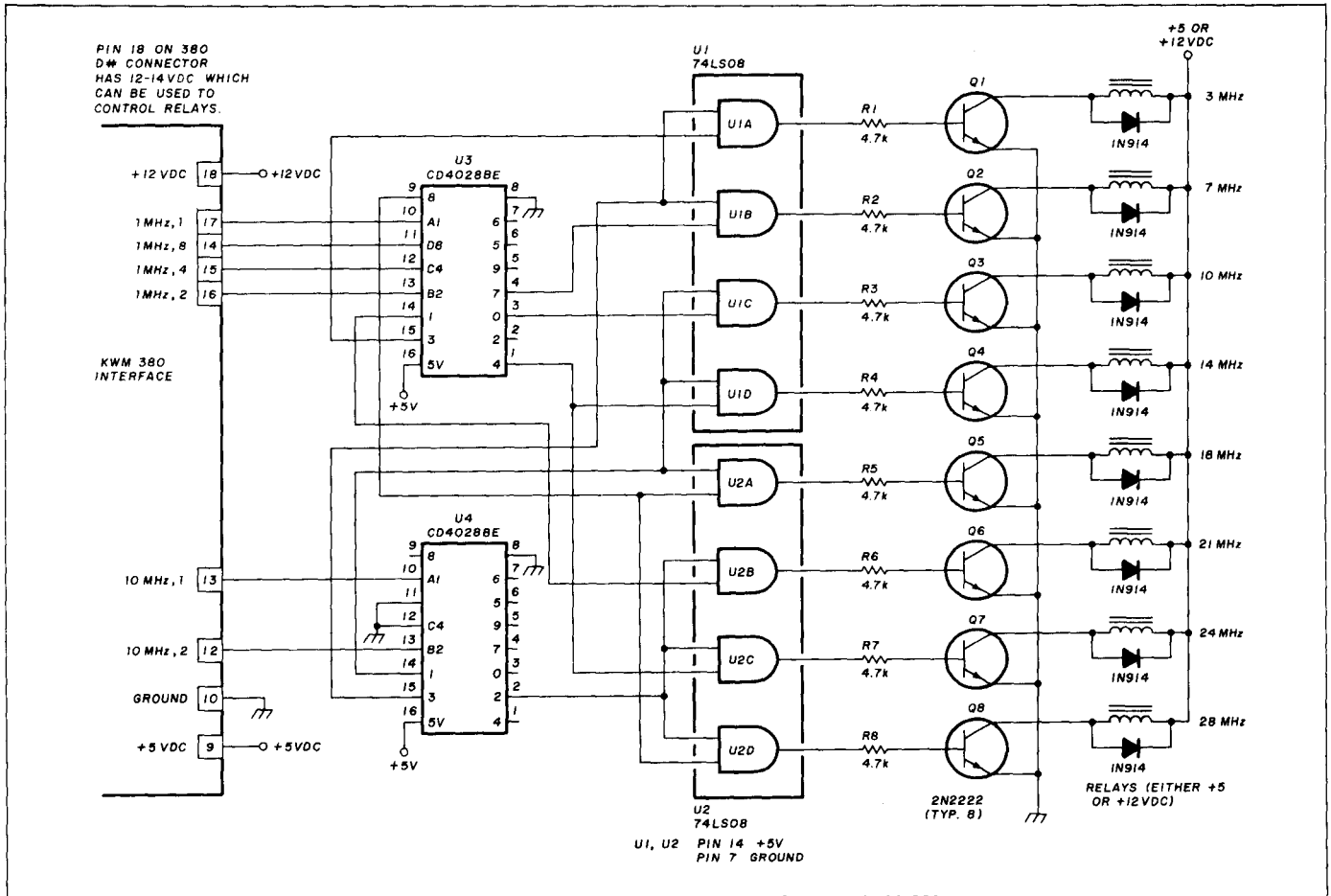


fig. 1. External control circuit schematic for the KWM-380.

and pin 8 is grounded. Unused BCD inputs U4 pins 11 and 12 must be grounded to prevent instability.

I recommend that the cable from the KWM 380 to the control unit be shielded to prevent EMI. The control circuit can be expanded to as many as 29 AND GATES if necessary to control the bandswitching systems required by some commercial solid-state amplifiers. Bypass capacitors of 0.1 and 0.01 μF should be added to the 5-volt and 12-volt lines to help reduce RF problems that might occur under high power conditions.

Bill Levy, WA2RUD

turns per inch from wire size

Here's a nice little way of computing the approximate number of turns per inch of enameled wire (of a tightly-wound single-layer coil) if you know the wire gauge.

$$TPI = \left(\left[\frac{G^3}{415} \right] + 5 \right)$$

where G is the wire gauge.

It's easy to put into a computer.

Dennis Mitchell, K8UR

regulator problem solved

For years I had been building 12 volt DC power supplies using the LM-340-K-12 and other three-legged devices without any apparent problems. But suddenly I started having problems, and blew out a dozen of the devices, which the manufacturer swears is well protected and easy to use.

I checked the input voltage to the regulator carefully; it was well below safe limits. The bypass capacitors were soldered close to the input and output leads, and I'd used a heatsink while soldering to the pins, but the things still blew out.

I wrote to several manufacturers and finally received an answer. Most of the circuits shown in the handbooks and brochures don't show a safety diode placed across the unit from output to input. It seems that when the voltage is removed from the input, the output capacitor discharges through the regulator and damages it. The solution, suggested in **fig. 1**, seems to solve the problem.

Ed Marriner, W6XM

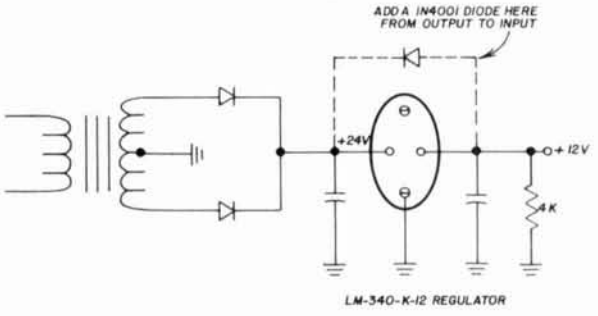


fig. 1. Including a diode across the regulator keeps it from "blowing."

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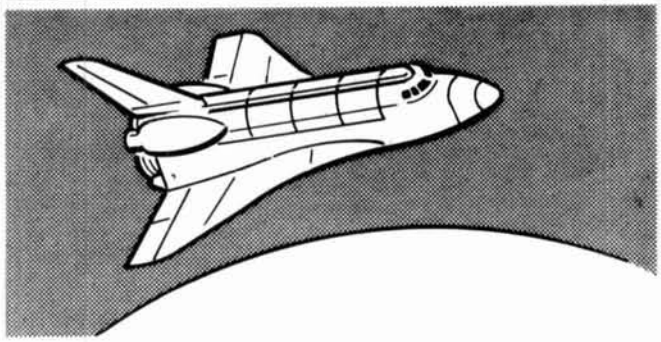

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Fluke Model 8026 True RMS Multimeter

My first experience with Fluke equipment came while I was stationed at Letterkenny Army Depot in Pennsylvania. Letterkenny is the prime repair center for the Nike-Hercules and Hawk/Improved Hawk Missile Systems. Our repair and overhaul was a soup-to-nuts mission in that besides rebuilding the actual missiles themselves, we also overhauled all of the electronics systems.

As a member of the Production Engineering Department, I was directly involved in the establishment of the overhaul lines and was responsible for the selection and recommendation of test and production equipment. A number of overhaul steps required specific pieces of test equipment to ensure that all test procedures were done in accordance with manufacturers' specifications. This entailed establishing test and overhaul equipment lists that duplicated exactly what the systems' manufacturers used. This is where I first came into contact with Fluke equipment, which was specified because of its high degree of design accuracy and dependability in a production environment.

When the Fluke Model 8026B Multimeter came in to *ham radio* for review, I was quite interested to see how the unit compared to my memory of Fluke lab grade (read *very expensive*) test equipment. Needless to say, I wasn't disappointed. The Fluke Model 8026B is a handy, easy-to-use, digital multimeter. It is designed to test the following parameters:

DC voltage	100 μV - 1000 V
AC voltage	100 μV - 750 V
DC current	1 μA - 2000 mA
AC current	1 μA - 2000 mA
Resistance	0.1 ohm - 20 megohm
Diode test	
Conductance	0.1 ns - 200 ns 0.001 ms - 2 ms s = siemens = 1/ohm
Continuity	

It will also give true RMS AC measurement for signals up to 10 kHz. Each range has full auto-polarity operating, overrange indication and is protected from overloads. To ensure that measurements are accurate and noise free, the Model 8026B utilizes a dual slope integration measurement technique.

The unit measures 7.1 × 3.4 × 1.8 inches (180 × 86 × 45 mm) and weighs just 13 ounces (369 grams). With an alkaline 9 volt battery, the unit is rated at 200 hours of continuous operation. An optional AC power supply is available. The unit fits comfortably into your hand and the case is made of a high impact plastic.

operation

The unit is designed around a Fluke custom LSI chip. The chip contains a dual slope a/d converter and a driver for the LCD display. When an input signal is applied, it is routed through the range switch or to one of four signal conditioners as determined by the function switch setting. The conditioners are designed to scale and convert the input to an acceptable −0.2 to +0.2 VDC that is presented to the a/d converter.

Tuning for the Model 8026 is derived from a precision quartz crystal whose frequency is a multiple of 60 Hz. This allows the conditioned DC input to be measured over an integral number of power line cycles.

Of significant interest is the 103-page owner's manual. It is well written and full of information and goes far beyond owners' manuals found in many other units. Full documentation includes specifications, operating and maintenance instructions, a discussion of its theory of operation, a list of replaceable parts, accessory information, and a schematic.

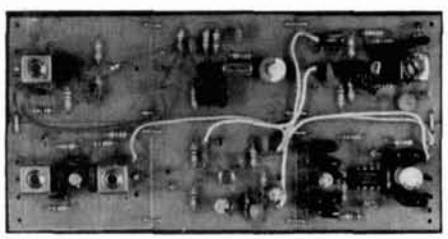
As you would expect from a company such as Fluke, calibration is a simple process and can be obtained from any Fluke Technical Service Center for a small fee. With all that Fluke has provided, it is hard to believe that I was reviewing a hand-held multimeter. The price of $219.99 may be a little expensive for the average ham. However, for the ham who wants only the very best or for the service technician who depends upon his equipment to perform without problems, I would highly recommend this or any other Fluke unit. For more information contact the John H. Fluke Mfg. Co., PO Box C9090, Everett, WA 98206. R.S.#302

N1ACH

NEW products

hobby kits

"Hobby Kits" are a new line of custom-designed electronic products from Morning Distributing. Designed with the ham or electronic hobbyist in mind, they allow construction of equipment ranging from a simple intercom or



phone amplifier to projects as complex as a state-of-the-art multi-band, multi-mode transceiver. Using this simple approach, beginners will be able to learn as they build. For engineers, it will allow them tremendous flexibility in equipment design. Modules are typically 1.5 to 2 inches long and 1.5 inches wide. All Hobby Kit modules other than the power supply are designed to work from 12-14 VDC. Boards are all predrilled and tinned. The kits come with all parts and instructions necessary. The photo above shows a monoband QRP transceiver built with six Hobby Kit modules for a total cost of about $35. A complete manual showing all diagrams and board layouts including suggested circuit systems design and hookups is available for $2.00 from Morning Distributing Company, P.O. Box 717, Hialeah, Florida 33011. RS#301

automatic antenna tuner

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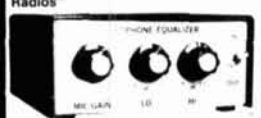

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RF Products are 100% field repairable should a problem arise. A large diameter metal plate is used in the base mount to ensure complete capacitive coupling between the antenna and vehicle. Seven other styles of Magnum units are available for other radios. Three choices of RF connectors are available; BNC, UHF and slug. Call, write, check off bingo card for more information.

✓ 189

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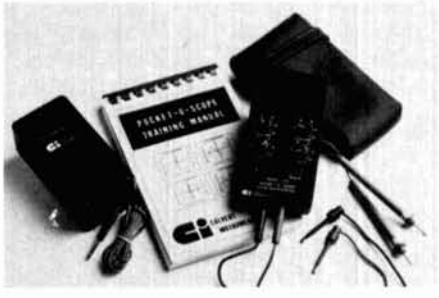
✓ 136

430S high-frequency transceiver in size, color, and general appearance, it is functionally compatible with any HF transceiver of 200 watts PEP or less. Used with the TS-430S, its ABC (Automatic Band Change) system handles all switching from band to band; if the transceiver is other than the TS-430S, manual switching from band to band is required. The unit covers 160-10 meters, including the three WARC bands, has a front panel SWR/power meter, features four separate antenna terminals, and comes complete with a built-in AC power supply.

Additional information is available from Trio-Kenwood Communications, 1111 West Walnut Street, Compton, California 90220.

pocket oscilloscope

Calvert Instruments has developed a 4-ounce, pocket-size solid-state digital LED oscilloscope that provides the same functions as oscilloscopes more than twenty times its size, yet performs with only four solid-state controls. Focus and brightness on the 210-point, high-intensity illuminated screen are electronically self-controlled. The trace is always in sharp focus. Zero position and full-screen sweep are maintained automatically. The zero-reference, or cross-over line, is always centered. Full-



trace minimum on the screen is automatically maintained, and the automatic internal circuitry assures a properly positioned wave form.

The Pocket-O-Scope digital display visually reveals the value of the incoming signal during a precise real-time and/or degree envelope of the signal cycle. Every signal received is displayed as a series of lighted LED dots on the screen. These LED dots are for the "Digital Dot Envelope" and represent the digital value of

the signal rather than the analog value seen on conventional scopes. The Pocket-O-Scope's digital display provides a definite value for amplitude and its intra-relationship with real time/degrees. No judgment is required.

The Pocket-O-Scope, including carrying case, AC adapter, standard and high voltage probes and 200-page training manual, is being introduced for under $250. The scope only with standard probes will be available for $179.95.

For further information, contact Calvert Instruments, 19851 Ingersoll Drive, Cleveland, Ohio 44116. RS#303

remote base intertie

The RB-1 from Heil, Ltd., allows the easy interconnection of two transceivers for remote base operation. With the RB-1, a 220 MHz rig can be intertied with a 146 MHz rig so that the operator of a 220 MHz hand-held unit can control the 146 MHz "base" rig, which can be connected to large amplifiers, antenna systems, etc. This allows the HT to communicate over greater distances.

Very simple to connect and operate, the RB-1 has only two 8-pin microphone type connectors on the back panel to connect the squelch of rig A to the PTT Line of rig B, along with proper logic and audio coupling. With the front panel switch off, both rigs operate normally. The RB-1 can also be used as a repeater control.

The size of the unit is 4-1/4 × 4-1/8 × 1-7/8 inches; the price is $49.95.

For further information, contact Heil, Ltd., Marissa, Illinois 62257. RS#304

amplifier and power supply

The SCA-100 is a 100 watt, 406-512 MHz amplifier that can be used in either repeater or base station applications. With a unique high efficiency cooling design that combines a high volume forced air system and deep fin heatsink, failures due to transistor overheating are virtually eliminated.

The Circular Advantage

For OSCAR 10 and Russian Satellite Communications

2M-14C

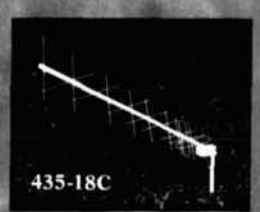
KLM's Circular Polarized antennas have been specifically designed to optimize OSCAR 10 and Russian satellite operation. Quality workmanship and superior design, yield virtually perfect circular patterns over the satellite operational bandwidth. Enjoy less Multi-Path Distortion, less Flutter, Fade, and better S/N Ratios, with comparable performance on transmit.

Both the 2M-14C and 435-18C sport virtually unbreakable 3/16" rod parasitic elements anchored thru the boom, folded dipole driven elements produce excellent physical and electrical symmetry for years of constant performance.

Specifications: (2M-14C)

BANDWIDTH:	144–150 MHz	BOOM LENGTH:	12'9"
GAIN:	11 dBdc	VSWR:	1.2:1
BEAMWIDTH:	48°	WINDLOAD:	1.25 sq. ft.
FEED IMP:	50 ohm unbal.	WT. (LBS):	7.5
BALUN:	4:1,2KW	ELLIPTICITY:	3 dB Max.
CIRCULARITY SWITCHER:			INCLUDED

The 435-18C is a star performer, an optional CS-2 circularity switcher puts left, and right-hand circular control in your shack, and doubles as a two port divider/impedance transformer for single feed line convenience.



Specifications: (435-18C)

BANDWIDTH:	420–450 MHz	GAIN:	12 dBdc
BOOM LENGTH:	7.3 ft.	VSWR:	1.5:1
BEAMWIDTH:	44°	FEED IMP:	50 ohm unbal.
WT. (LBS):	4.5	BALUN:	2–4:1. 1KW
MAST DIA:	Cen–Rear/1½"	ELLIPTICITY:	3dB MAX.
CIRCULARITY SWITCHER			(CS-2) OPTIONAL

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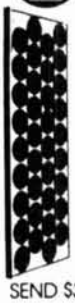

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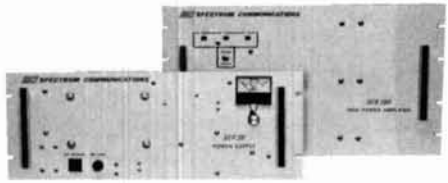
The SCA-100 also features automatic high VSWR shutdown designed to self-test the antenna circuit in order to prevent damage to the amplifier should the antenna system fail. Other standard features include power supply failure



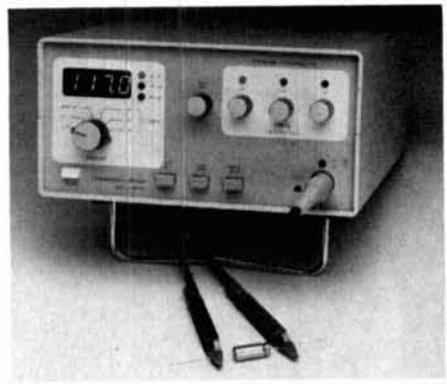
bypass to ensure continuous operation, over-temperature protection in case of cooling system failure and extremely tight RF shielding.

The SCP-30, the matching power supply for the SCA-100 amplifier, is designed to operate at 25 amps continuous, 13.8 VDC. Its features include ferro-resonant power transformer, over-current protection, optional power main failure switch to battery power and heavy-duty construction.

For further information, call Spectrum Communications Corp., 1055 West Germantown Pike, Norristown, Pennsylvania 19401-9616. RS#305

autoranging L/C meter

An instrument that allows accurate measurement and sorting of inductors and capacitors is available from Cambridge Technology. Although less than $1000, the Model 520 Com-



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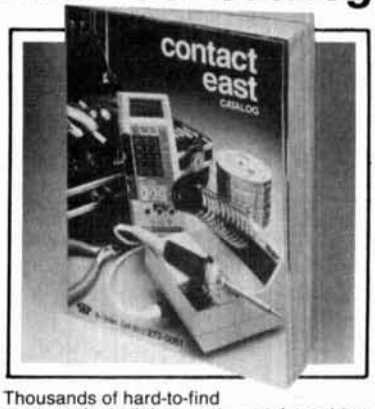

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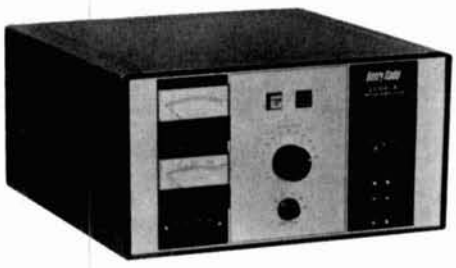
parator> <Bridge measures component dissipation and is accurate to 0.25 percent of reading. A built-in comparator allows simultaneous sorting for high and low tolerances, and dissipation limits. The limits are easily set with 10-turn controls and dual-color LEDs that indicate whether the component parameters fall within the ranges set.

The Model 520 may be easily calibrated by the user without any standard components, and has an internally adjustable, 0 to 10 VDC, capacitor bias voltage. Measurement frequencies of 120 Hz or 1 kHz are automatically selected. The instrument autoranges over unusually large measurement range from 199.9 pF/μH full scale to 1999 μF/H full scale. A range-hold feature permits fast, repetitive, true 4-terminal measurements. A full refund within thirty days is available if the instrument is found unsatisfactory for any reason. The Comparator> <Bridge sells for $785.00.

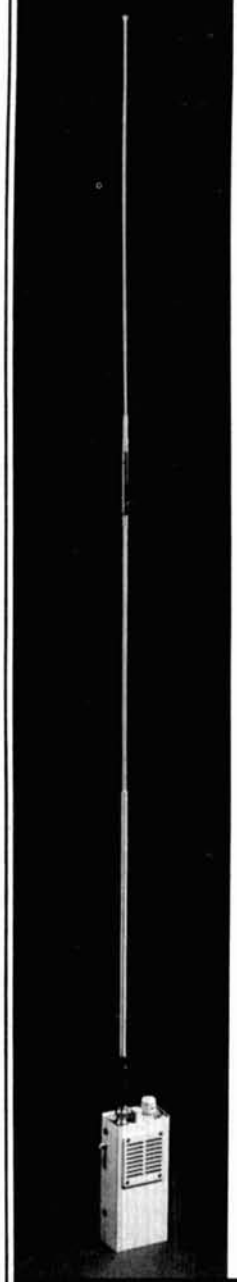
For more information, contact Cambridge Technology, Inc., 2464 Massachusetts Avenue, Cambridge, Massachusetts 02140. RS#306

new amplifier

Several new amplifiers are available from Henry Radio. The 2002A, a new version of the popular 2002 2-meter amplifier, uses the new Eimac 3CX800A7 power triode. The RF chassis



uses a 1/4-wavelength stripline design for a simple, straightforward, and reliable design. Like its predecessor, the 2002A offers 2000 watts input for SSB and 1000 watts input for CW. Because the tube provides more than 15 dB of gain, only about 25 watts drive is required for full output. The 2904A will be identical to the 2002A except that it is set up for the 430 to 450 MHz band, using a 1/2-wavelength stripline.



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The MX-15 is a 15-meter band SSB/CW hand-held transceiver. It measures only 1½'' (D) × 2⅝'' (H) and offers 300mW for SSB and CW operation. A single-conversion receiver employing a MOS/FET front-end offers clear and sensitive reception. As a base or portable station, the MX-15 offers an unlimited challenge in QRP operation. Additional accessories are available to extend your operation.

The **MX-15** comes with full 90 day warranty and is available from factory direct or **HENRY RADIO** **(800) 421-6631**

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- **Standard Frequency crystal of your choice**
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▪ SP-15 Telescoping antenna	$19.50
▪ 2M2 DC-DC Converter set	$17.50
▪ PR-1 Mobile Rack Kit	$23.50
▪ VX-15 External VXO (one crystal supplied)	$53.50
▪ PL-15 10W Linear amplifier	$89.50

Photo shown MX-15, VX-15, PL-15, SP-15, MS-1 and PR-1

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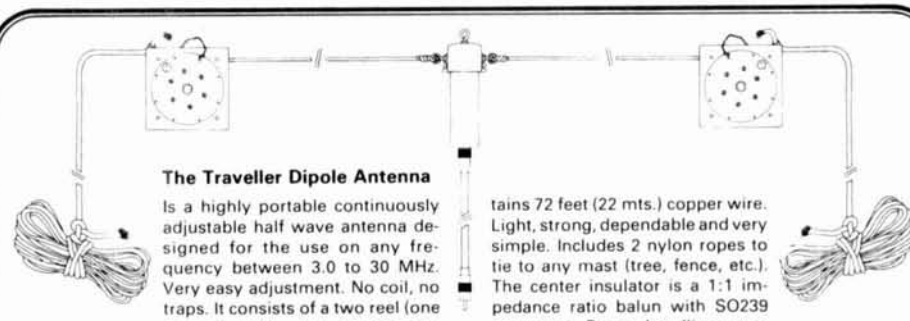

The Traveller Dipole Antenna

Is a highly portable continuously adjustable half wave antenna designed for the use on any frequency between 3.0 to 30 MHz. Very easy adjustment. No coil, no traps. It consists of a two reel (one at each end) - two housing assembly, both built of aviation grade aluminum. Each reel contains 72 feet (22 mts.) copper wire. Light, strong, dependable and very simple. Includes 2 nylon ropes to tie to any mast (tree, fence, etc.). The center insulator is a 1:1 impedance ratio balun with SO239 connector. Power handling capabilities - 2KW PEP or 1KW 100% amplitude modulate.

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NEW products

The 1002A, a 2-meter amplifier, follows the same design as the 2002A, but uses an 8874 tube for one-half the power specifications. The 1002A is rated at 600 watts PEP output and 300 watts continuous carrier output. It employs the same stripline design as the 2-02A. The 1004A, a half-power version of the 2004A, also uses the 8874. The 1004A will cover the 430 to 450 MHz band using 1/2- wavelength stripline design.

For further information, contact Henry Radio, 2050 South Bundy Drive, Los Angeles, California 90025. RS#307

HF transceiver

The new IC-745, a full feature HF transceiver and general coverage receiver, is now available from ICOM. Operational modes are SSB, CW, RTTY, AM (receive only) and FM (optional).

The unit offers the user the capability of a general coverage receiver, between 100 kHz and 30 MHz, and all of the HF ham bands from

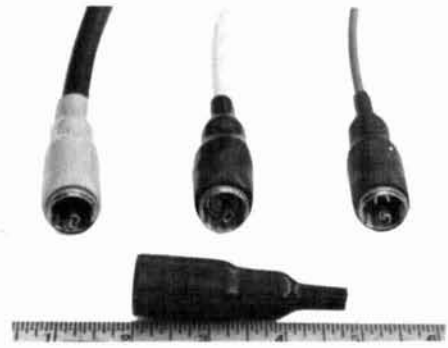
1.8 to 30.0 MHz including the new WARC bands at 10 MHz, 18 MHz, and 24 MHz. Ham band selection can be activated by simply touching the band button and rotating the main tuning knob. Other innovative standard features found in the IC-745 include 16 tunable memory channels, passband tuning, continuously adjustable AGC, 100 percent duty cycle-rated transmitter, and 12 volt DC operation.

A multi-purpose scanner allows the user to search the 16-memory channel frequencies or scan between two programmed frequencies. The 16 tunable memory channels have the capacity to store not only the desired frequency, but also the desired mode of operation. The frequency called up from memory can be changed by simply adjusting the frequency dial. Installation of the optional IC-PS35 internal power supply makes the IC-745 self-contained.

For further information, contact ICOM America, Inc., at 2112 116th Ave. N.E., Bellevue, Washington 98004. RS#308

new boots

Kilo-Tec announces a new custom weather boot for use with RG-8X, RG-59, RG-58, and RG-213 coaxial cables and PL-259/SO-239 combinations. Designed to keep connections

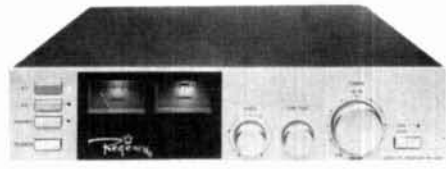


clean and dry and to keep moisture out of coax cables, the boots are manufactured with a flexible vinyl material that resists moisture and breakdown from the sun's rays. Three models are available: model KTB-58 for RG-58 cables; model KTB-8 for RG-8 cables; and model KTB-8X for RG-8X or RG-59. Custom weather boots can be made for other types of cables and connectors.

For further details, contact Kilo-Tec, P.O. Box 1001, Oak View, California 93022. RS#309

satellite TV receiver

The new Regency satellite receiver links your television set to its outdoor satellite antenna, or "dish." The Model SR 3000 receiver/downconverter combination is capable of receiving programming from a choice of satellites which include some 90 channels covering entertainment, sports, news, religious, and educational media. Its features include automatic Chaparral Polarotor control, detent tuning with AFC, pre-



set and variable audio control, signal strength and center tuning meters, audio and video fine tuning controls, and a rugged weather sealed downconverter.

The suggested retail price on the Regency SR 3000 is $549.95. For further information, contact Regency Electronics, 7707 Records Street, Indianapolis, Indiana 46226. RS#310

two-meter linear amplifier

The LA2060, *Daiwa's new medium power* two meter linear amplifier, can take the output of a typical handheld transceiver and boost it to as much as 60 watts with any FM, SSB, or CW input from 0.5 to 3 watts acceptable. Equipped with RF activated transmit/receive switching (manual override option included), the unit features automatic protection circuitry and relative output metering. An input cable with BNC plugs is provided. The LA2060 requires 12 VDC at 12 amps maximum.

For details, contact MCM Communications, 858 E. Congress Park Drive, Centerville, Ohio 45459. RS#311

digital multi-multimeter™

The new AEMC digital multi-multimeter™ functions as a highly accurate voltage, current, and resistance tester designed for safe and precise testing of both sensitive electronic circuitry and high capacity power distribution net-

works. Its wide measuring capabilities include 24 ranges covering the following spans: 100 micro-volts DC to 1000 volts DC; 10 milli-volts AC to 1000 volts AC; 1 micro-amp DC to 10 amps DC; 10 milli-amps AC to 10 amps AC; and 0.1 ohms to 2 megohms. An extra large LDC digital display (0.7 inch) allows for easy reading. Two models of the multi-multimeter™ are available: Model 2010, the average sensing conversion type, and Model 2011, which is true RMS.

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1412 1412G	144	160	30	199 239
2210 2210G	220	130	10	225 265
2212 2212G	220	130	30	199 239
4410 4410G	440	100	10	225 265
4412 4412G	440	100	30	199 239

1. Models with G suffix have GaAs FET preamps. Non-G suffix units have no preamp.
2. Covers full amateur band. Specify 10 MHz Bandwidth for 420-450 MHz Amplifier.

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compact amplifier

After nine years of manufacturing electronic inspection systems, Ham Industries, Inc., has expanded its product base to include several newly developed products designed for the Radio Amateur.

The first product to be released in the PA-25, a compact 25-watt amplifier for the 2-meter band that boosts the output power from a handheld transceiver by a factor of *six*. The device weighs only eight ounces and can be attached directly to a handheld unit or permanently mounted to the automobile dashboard. An adapter cord allows plugging directly into the car cigarette lighter; a separate power supply can also be used.

For more information, contact Ham Industries, Inc., 835 Highland Road, Macedonia, Ohio 44056. RS#313

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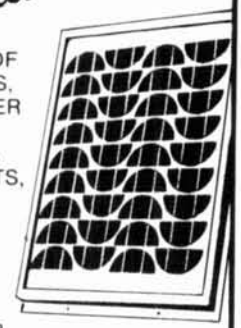

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FB Ratio 9/14/21/28	12.4/21.8/22.3/20.1	0/21.7/22.3/20.2
Power	1KW CW	1KW CW
VSWR 7.0 - 7.1	2.0:1 or better adjustable	
7.1 - 7.25	2.0:1 or better adjustable	
14.0 - 14.5 21.0 - 21.45 28.0 - 29.0	1.5:1 or better	
Boom Length m/ft.	6.0/19.8	4.0/13.2
Max. Element Length m/ft.	9.25/30.5	9.25/30.5
Weight kg/lb	18.0/39.6	14.6/32.1
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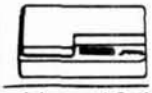

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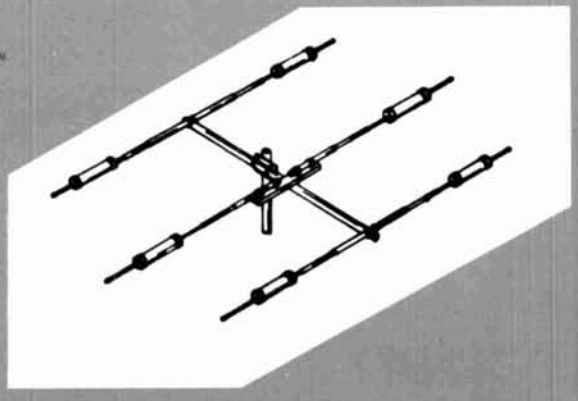

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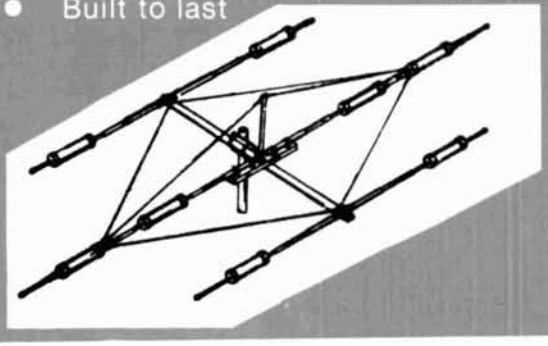

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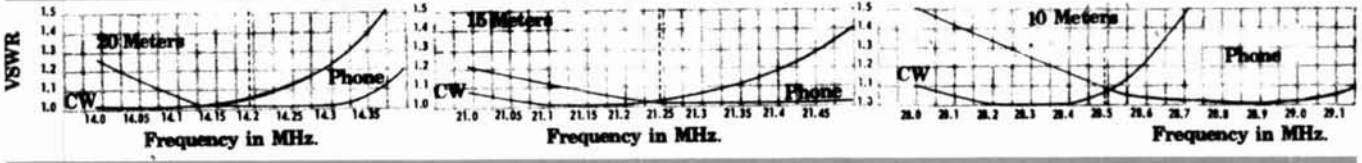

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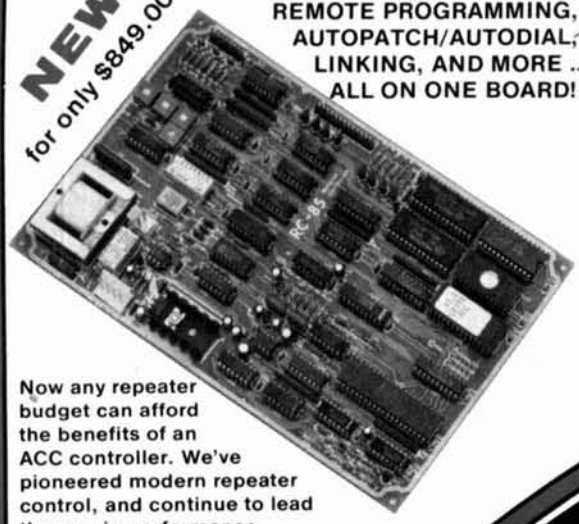

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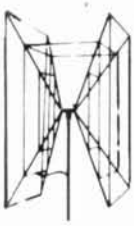

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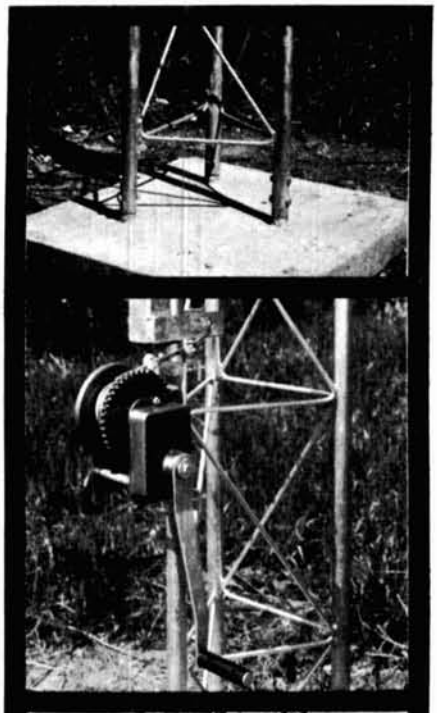

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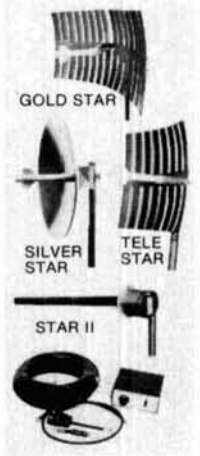

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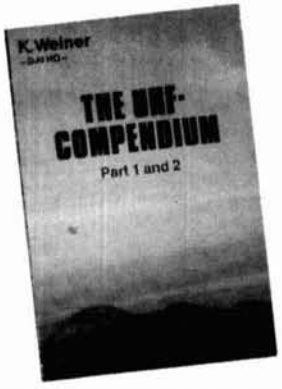

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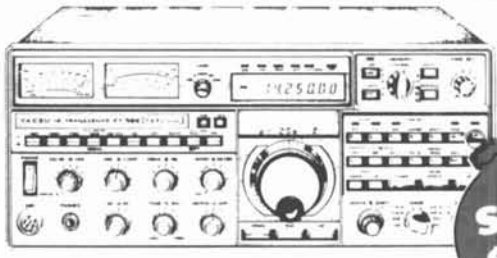

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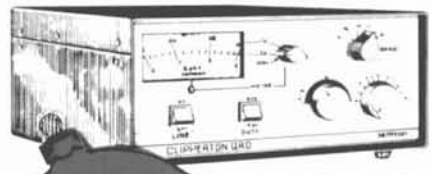

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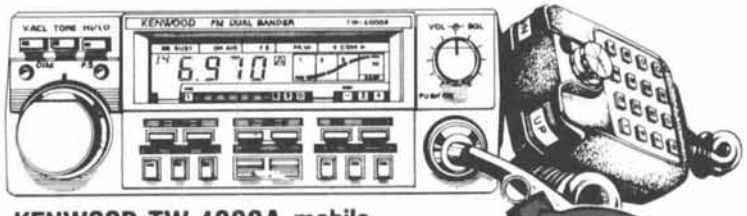

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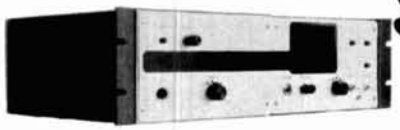

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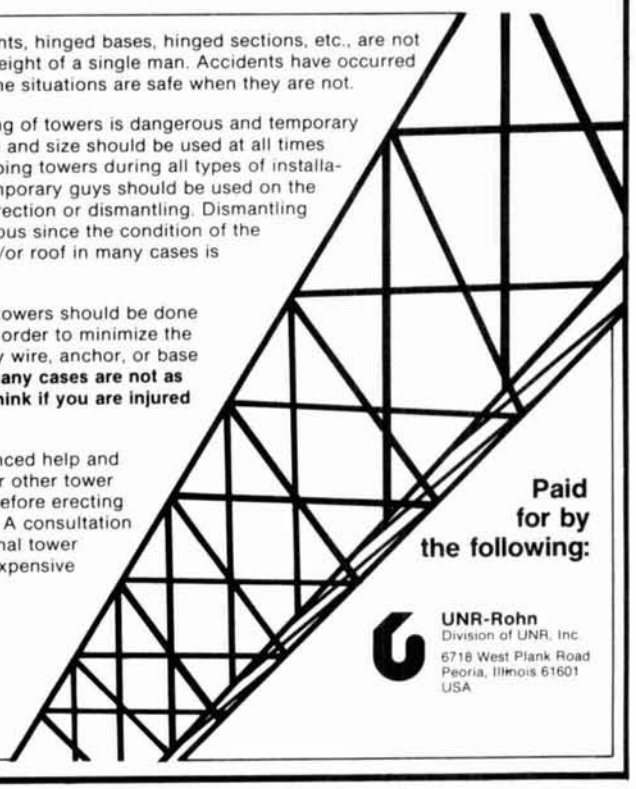

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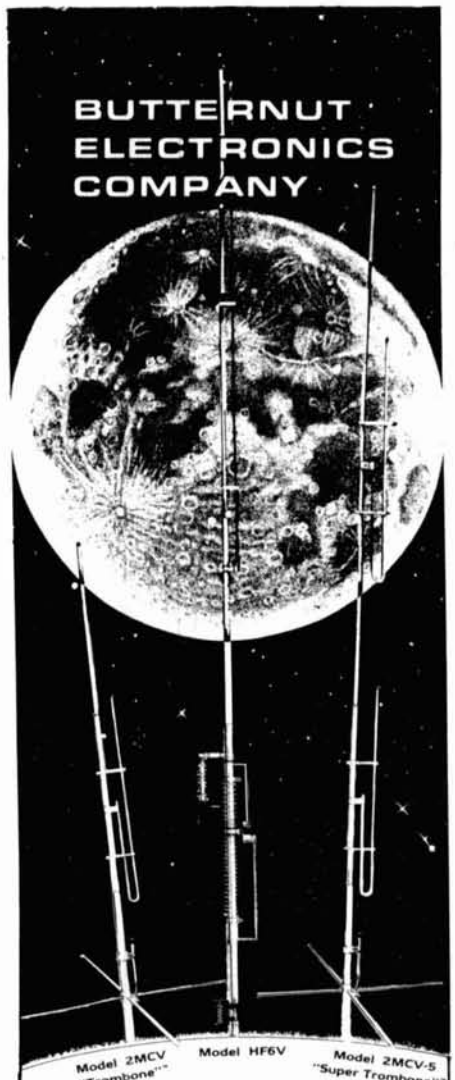

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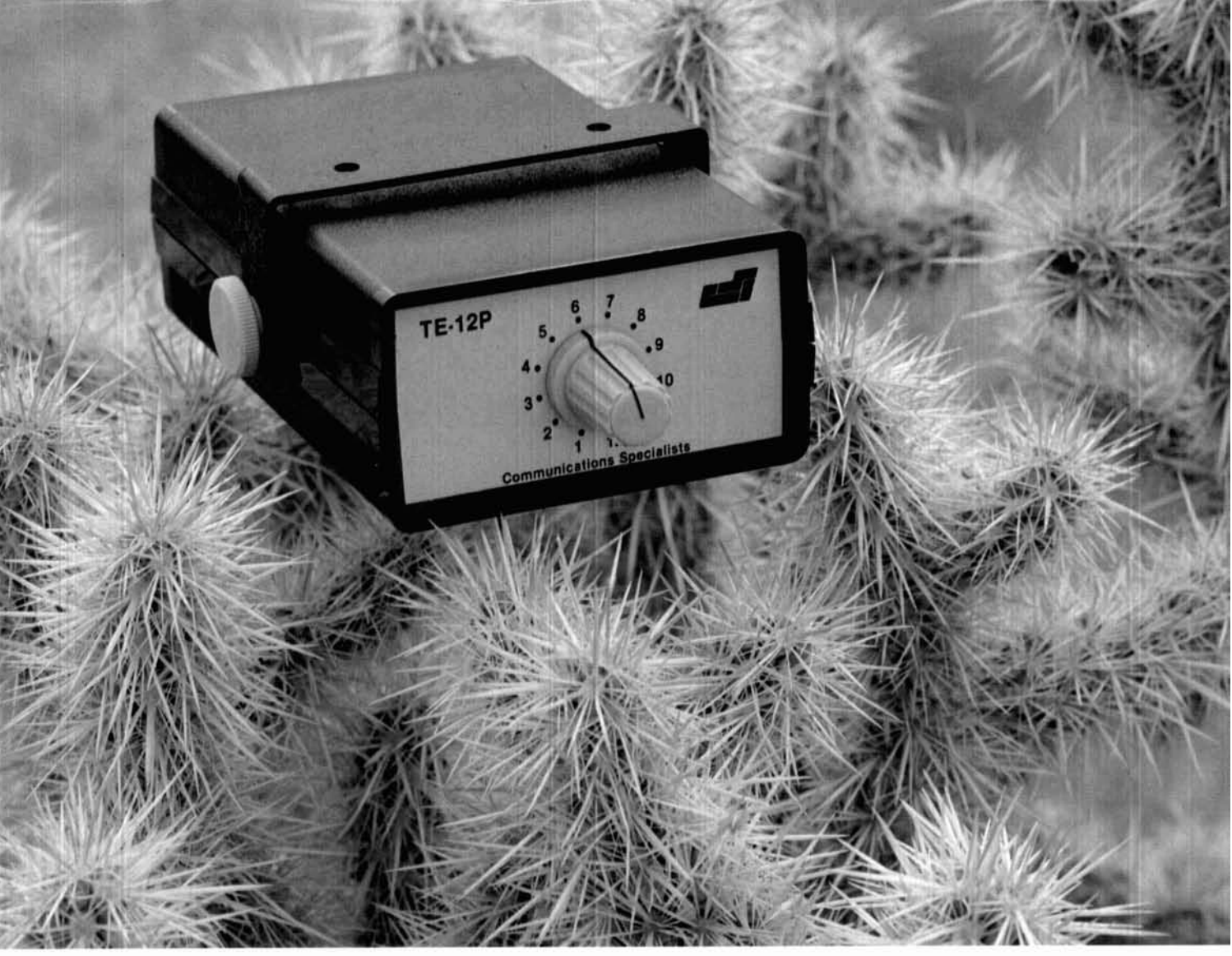
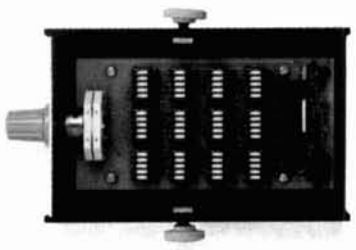


Stuck with a problem?

Our TE-12P Encoder might be just the solution to pull you out of a sticky situation. Need a different CTCSS tone for each channel in a multi-channel Public Safety System? How about customer access to multiple repeater sites on the same channel? Or use it to generate any of the twelve tones for EMS use. Also, it can be used to access Amateur repeaters or just as a piece of versatile test equipment. Any of the CTCSS tones may be accessed with the TE-12PA, any of the audible frequencies with the TE-12PB. Just set a dip switch, no test equipment is required. As usual, we're a stickler for 1day delivery with a full 1 year warranty.

- Output level flat to within 1.5db over entire range selected.
- Immune to RF.
- Powered by 6-30vdc, unregulated at 8 ma.
- Low impedance, low distortion, adjustable sinewave output, 5v peak-to-peak.
- Instant start-up.



TE-12PA

67.0 XZ	85.4 YA	103.5 1A	127.3 3A	156.7 5A	192.8 7A
71.9 XA	88.5 YB	107.2 1B	131.8 3B	162.2 5B	203.5 M1
74.4 WA	91.5 ZZ	110.9 2Z	136.5 4Z	167.9 6Z	
77.0 XB	94.8 ZA	114.8 2A	141.3 4A	173.8 6A	
79.7 SP	97.4 ZB	118.8 2B	146.2 4B	179.9 6B	
82.5 YZ	100.0 1Z	123.0 3Z	151.4 5Z	186.2 7Z	

- Frequency accuracy, ±.1 Hz maximum −40°C to +85°C
- Frequencies to 250 Hz available on special order.
- Continuous tone

TE-12PB

TEST-TONES:	TOUCH-TONES:		BURST TONES:			
600	697	1209	1600	1850	2150	2400
1000	770	1336	1650	1900	2200	2450
1500	852	1477	1700	1950	2250	2500
2175	941	1633	1750	2000	2300	2550
2805			1800	2100	2350	

- Frequency accuracy, ±1 Hz maximum −40°C to +85°C
- Tone length approximately 300 ms. May be lengthened, shortened or eliminated by changing value of resistor

$89.95

130

COMMUNICATIONS SPECIALISTS

426 West Taft Avenue, Orange, California 92667
(800) 854-0547/California: (714) 998-3021

MasterCard VISA

MEET THE NEW YAESU FT-102

The FT-102 is factory equipped for operation on all present and proposed Amateur HF bands. An extra AUX band position is available for special applications. Equipped for SSB, CW, and AM (RX), the FT-102 may be activated on FM and AM (TX) via the optional AM/FM-102 Module.

The all-new receiver front end utilizes a low-distortion RF preamplifier that may be by-passed via a front panel switch when not needed. Maximum receiver performance is yours with this impressive lineup of standard features: IF Notch Filter, Audio Peak Filter, Variable IF Bandwidth Control, IF Shift, Variable Pulse Width Noise Blanker, Independent SSB and CW Audio Channels with Optimized Audio Bandwidth, and Front Panel Audio Tone Control. Wide/Narrow filter selection is independent of the Mode switch.

The celebrated transmitter section is powered by three 6146B final tubes, for more consistent power output and very low distortion. An RF Speech Processor, Mic Amp Audio Tone Control, VOX, and an IF Monitor round out the transmitter lineup.

Futuristic panel design and careful human engineering are the hallmarks of the FT-102. Convenient pop-out controls below the meters may be retracted when not in use, thus avoiding inadvertant mistuning. Abundant relay contacts, rear panel phono jacks for PTT, microphone/patch input, and other essential interface connections make the FT-102 extremely simple to incorporate into your station.

SPECIFICATIONS

TRANSMITTER

Power Input: (1.8-25 MHz) (28-29.9 MHz)

SSB, CW	240W DC	160W DC
AM	80W DC	80W DC
FM		160W DC

RECEIVER

Image Rejection:
Better than 70dB from 1.8-21.5 MHz
Better than 50dB from 24.5-29.9 MHz

IF rejection:
Better than 70 dB

Selectivity (−6 dB/ −60 dB):
SSB, CW, AM; 2.7/4.8 kHz (with no optional filters)
Width adjusts continuously from 2.7 kHz to 500 Hz (−6 dB)

Spurious Radiation: Better than −40 dB

SP-102

The SP-102 External Speaker/Audio Filter features a large, high-fidelity speaker with selectable low- and high-cut audio filters. The front panel A-B switch allows selection of two receiver inputs for maximum versatility. Also available is the SP-102P Speaker/Patch.

FV-102DM

The FV-102DM Synthesized External VFO tunes in 10 Hz steps. Keyboard entry of frequencies, UP/DOWN scanning, and 12 memories make the FV-102DM a "must" for serious DX or contest work.

FC-102

The FC-102 Antenna Coupler is capable of handling 1.2KW of transmitter power, with an in-line wattmeter, separate SWR meter, and A-B input/output selection expanding your station's capability. The optional FAS-1-4R allows remote selection of up to four antennas via one coaxial cable connected to the FC-102.

See your Authorized Yaesu Dealer today for a hands-on demonstration of the rig that everybody's talking about. It's the FT-102, The Transceiver of Champions!

Price And Specifications Subject To Change Without Notice or Obligation 1082R ✓ 214

YAESU **ELECTRONICS CORPORATION** 6851 Walthall Way, Paramount, CA 90723 (213) 633-4007
CINCINNATI SERVICE CENTER 9070 Gold Park Drive, Hamilton, OH 45011 (513) 874-3100

"Comm-packed."

BIG performance... small size... smaller price!!!

TR-2500

The TR-2500 is a compact 2 meter FM handheld transceiver featuring an LCD readout, 10 channel memory, lithium battery memory back-up, memory scan, programmable automatic band-scan, Hi/Lo power switch and built-in sub-tone encoder.

TR-2500 FEATURES:

- **Extremely compact size and light weight**
  Measures 66 (2-5/8) W x 168 (6-5/8) H x 40 (1-5/8) D, mm (inches). Weighs 540 grams (1.2 lbs) with Ni-Cd pack.
- **LCD digital frequency readout**
  Shows frequencies and memory channels, four "Arrow" indicators.
- **Ten channel memory**
  Nine memories for simplex or ±600 kHz offset. "M0" memory for non-standard split frequency repeaters.
- **Lithium battery memory back-up**
  (Estimated 5 year life.) Maintains memory when Ni-Cd pack is fully discharged or removed.

- **HI/LOW power selection**
  2.5 watts or 300 mw.
- **Memory scan**
  Scans only channels in which frequency data is stored.
- **Programmable automatic band scan**
  Upper and lower frequency limits and scan steps of 5-kHz and larger.
- **UP/DOWN manual scan**
- **Built-in tuneable sub-tone encoder**
  Tuneable (variable resistor) to desired CTCSS tone.
- **Built-in 16-key autopatch encoder**
- **"SLIDE-LOC" battery pack**
- **Repeater reverse switch**
- **Keyboard frequency selection**
- **Extended frequency coverage**
  Covers 143.900 to 148.995 MHz in 5-kHz steps.
- **Optional power source**
  Using optional MS-1 mobile or ST-2 AC charger/power supply, radio may be operated while charging. (Automatic drop-in connections.)

Actual size

- **High impact plastic case**
- **Battery status indicator**
- **Two lock switches**
  Prevent accidental frequency change and accidental transmission.

Standard accessories include:

- Flexible antenna with BNC connector
- 400 mAH Ni-Cd battery pack
- AC charger

Optional accessories:

- ST-2 Base station power supply/charger (approx. 1 hr.)
- MS-1 13.8 VDC mobile stand/charger/power supply

TR-3500

70 CM FM Handheld

- 440-449.995 MHz in 5-kHz steps
- TX OFFSET switch keyboard programmable ±5 kHz to ±9.995 MHz
- 1.5 W/300 mW HI/LOW power switch
- Auto. squelch position on squelch control
- Tone switch for TU-35B optional programmable CTCSS encoder
- Other features include 10 memories, lithium battery memory back-up, programmable automatic band scan, memory scan, UP/DOWN manual scan, repeater reverse, 16-key autopatch, keyboard frequency selection, slide-lock battery.

- VB-2530 2-M 25 W RF power amp., w/cables, mtg. brkt. (TR-2500 only)
- TU-1 Programmable CTCSS encoder (TR-2500 only)
- TU-35B Programmable CTCSS encoder (mounts inside TR-3500 only)
- PB-25 Extra 400 mAH Ni-Cd battery
- PB-25H Heavy-duty 490 mAH Ni-Cd battery
- DC-25 13.8 VDC adapter.
- BT-1 Battery case for manganese/alkaline AA cells
- SMC-25 Speaker-microphone
- LH-2 Deluxe leather case
- BH-2A Belt hook
- RA-3 m 3/8λ telescoping antenna (for TR-2500).
- WS-1 Wrist strap
- EP-1 Earphone

More information on the TR-2500 and TR-3500 is available from all authorized dealers of Trio-Kenwood Communications, 1111 West Walnut Street, Compton, California 90220.

KENWOOD

...pacesetter in amateur radio

Specifications and prices are subject to change without notice or obligation