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JUNE 1972

five-band solid-state COMMUNICATIONS RECEIVER

this month

More Details? CHECK—OFF Page 94

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June, 1972
volume 5, number 6

offices

Greenville, New Hampshire 03048
Telephone: 603-878-1441

ham radio magazine is
published monthly by
Communications Technology, Inc
Greenville, New Hampshire 03048

Subscription rates, world wide
one year, $6.00, three years, $12.00
Second class postage
paid at Greenville, N. H. 03048
and at additional mailing offices

Foreign subscription agents
United Kingdom
Radio Society of Great Britain
35 Doughty Street, London WC1, England

All European countries
Eskil Persson, SM5CJP, Frotunagrand 1
19400 Upplands Vasby, Sweden

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

Printed by Wellesley Press, Inc
Wellesley, Massachusetts 02181, USA

ham radio is available to the blind
and physically handicapped on magnetic tape
from Science for the Blind
221 Rock Hill Road, Bala Cynwyd
Pennsylvania 19440
Microfilm copies of current
and back issues are available
from University Microfilms
Ann Arbor, Michigan 48103

Postmaster: Please send form 3579 to
ham radio magazine, Greenville
New Hampshire 03048

ham radio magazine

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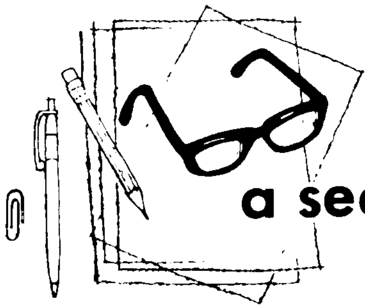


a second look

by jim fisk

Recently, I overheard a contact on 40 meters between two long-time amateurs who felt that amateur radio today just isn't as exciting, inviting and mysterious to today's youth as it had been to them forty years ago. They felt that in today's era of technological miracles, our hobby has less uniqueness and fewer opportunities to offer than it had in years past. Similar feelings have underlined many amateur discussions recently.

A. Prose Walker, W4BW, in speaking at amateur gatherings around the nation, has mentioned that amateur radio up to this day has been exciting and has seen tremendous technical progress and growth. But Mr. Walker maintains that the past has only been a prologue to what is to come.

Along with many others, we at *ham radio* note that the day of the amateur-built receiver may have passed in favor of the vastly superior and less expensive commercial version. However, look to the applications to which this commercial gear can be used for experimentation and growth.

Some oldtimers say that even the thrill of working DX is gone now – anybody with money and a big antenna can work all the DX he wants. Yet today we see the phenomenal growth of QRP as hundreds of old-timers and experienced kilowatt-wielders leave their high-power equipment to marshal three of four watts and chase DX across oceans or across state lines.

Modern solid-state technology and manufacturing techniques have provided us with equipment which has fostered the amateur spirit – perfecting the art of getting the message through in spite of the limitations of equipment or power. Rather than making more "appliance operators," new low-power commercial equipment has presented new challenges and opportunities for fun and better training to help amateurs serve in the public interest.

A recurring theme of Mr. Walker's has been the undreamed of opportunities presented to today's amateurs by satellite communication. Rather than bemoaning the passing of the simple homebrew a-m transmitter, look toward the possibilities of intercontinental communication *when you want it* rather than at the whim of the ionosphere. The amateur's traditional communication expertise, inquisitiveness, patience, resourcefulness and determination must again come to the fore in this present and indescribably exciting field of amateur satellite communication.

Most importantly, though, our present level of sophisticated communications equipment gives us all the ability, and the real *responsibility,* to truly communicate with our fellow amateurs – either through the local fm repeater or on the other side of the world. And if that still isn't exciting, if it isn't challenging, if it isn't rewarding, if it isn't as new and vital as *today,* then maybe we should start the funeral dirge for amateur radio. However, I agree with Mr. Walker – the past is only a prologue to the future.

Jim Fisk, W1DTY
editor

five-band solid-state communications receiver

The A80-10 receiver — a straightforward reproducible design for 80- through 10-meter CW, ssb and a-m reception

M. A. Chapman, K6SDX, 1262 Orkney Lane, Cardiff, California 92007

This receiver, which I call the A80-10, has been designed for simplicity of construction, and uses standard solid-state circuits in a dual-conversion system. You can see from the photographs that an attempt was made to minimize the number of operating controls without compromising performance. So often, the extra knob (or switch) for some special feature is difficult to apply correctly, and many of them cause operator confusion.

The A80-10 receiver provides excellent amateur-band performance in any of the standard operating modes. The across-band sensitivity is less than 1 μV for 10 dB S+N/N ratio. The passband is controlled by a Collins 2.1-kHz mechanical filter, with added skirt improvement provided by an i-f transformer serving double duty as an impedance-matching network.

Frequency drift is negligible. Either of two methods is available to the builder to minimize drift problems — NPO capacitor compensation or the installation of a British *Tempatrimmer,** an adjustable

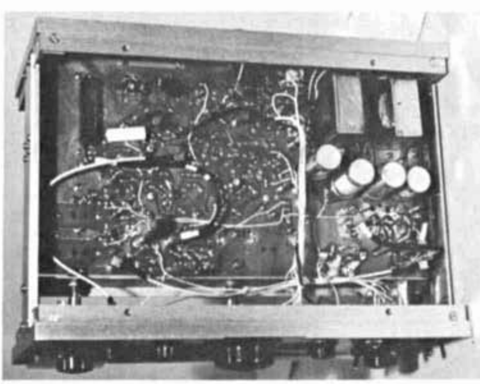
*The Oxley 6.5-pF *Tempatrimmer* is available from British Radio Electronics Limited, 1742 Wisconsin Avenue, N. W., Washington, D. C. 20007. The unit is priced at $13.25; add $.50 for postage and handling.

temperature-compensating device. Both methods satisfy today's stringent stability requirements.

The CW passband is effectively much less than that provided by the mechanical filter. An added op-amp audio filter allows peaking of any audio tone, thereby filtering out unwanted adjacent signals. A few minutes spent learning to operate the upper and lower bfo control with the CW audio filter should allow you to obtain passband selectivity that is adequate in the most dense operating conditions.

The A80-10 receiver has two poor functional features which should be pointed out. First, there are internal birdies at 7.0 and 21.0 MHz. The 7.0-MHz birdie is quite strong and can result in the loss of the bottom 2-kHz of the 40-meter band. Both birdies are second-overtone harmonics from the band-switching oscillator in the converter. The 21.0-MHz spurious is relatively small by comparison, but can be easily recognized. Second, the printed-circuit board, panel, etc., were not designed for a particular commercial cabinet.* All peculiar parts, panels, etc., were developed for this design: *on the plus side*, the size of the PC board and grouping of operating controls lends itself to a variety of cabinets at the builder's option.

Receiver performance will be directly proportional to the builder's patience and efforts. Poor wiring and assembly practice will result in disastrous failure. As in any design, compromise and options exist.



Rear view of the pc board.

table 1. Coil-winding data for the A80-10 receiver.

L1,L2	4 μH. 25 turns no. 32 on Miller 4500-2 coil form. Link is 4½ turns no. 32 on cold end. Resonates to 14.2 MHz
L3	40 turns no. 32 on Miller 4500-3 coil form. Link is 10 turns no. 32 on cold end. Resonates to 3.9 MHz
L4	1.2 μH. 10 turns no. 32 on Miller 4500-3 coil form
L5,L6	3.4 μH. 20 turns no. 32 on Miller 4500-3 coil form
L7	1.2 μH. 20 turns no. 32 on Miller 4500-3 coil form
L8	11 turns no. 32 on Miller 4500-2 coil form. Resonates to 24.5 MHz
L9	15 turns no. 32 on Miller 4500-2 coil form. Resonates to 17.5 MHz
L10, L11, L12	11 μH. 40 turns no. 32 on Miller 4500-2 coil form. Link is 10 turns no. 32 on cold end
L13	15 μH. 50 turns no. 32 on Miller 4500-2 coil form

Miller 4500 coil form is a slug-tuned ceramic form, 0.260" diameter. The −2 powdered iron slug (color coded red) is designed for the frequency range from 1 to 20 MHz. The −3 slug (color coded green) is designed for use between 20 and 50 MHz. Miller coil forms are available from the J. W. Miller Company, 5917 South Main Street, Los Angeles 90003.

The builder with a well-stocked parts reservoir will find a major portion of his receiver completed. The guy starting from scratch is up against it. Although there are a nearly infinite number of parts substitutions that can be made, only the gross types will be discussed.

basic design

An overall schematic/block diagram is shown in **fig. 1†**. Briefly, the receiver uses the 3.5- to 4.0-MHz band as the first conversion frequency, mixing with a high-frequency oscillator for a second conversion to 455 kHz. A 2.1-kHz Collins

*A complete set of drawings for the cabinet illustrated in the photographs is available from the author. Please include a large self-addressed, stamped, envelope.

†The power supply circuits, mixer circuit and 100-kHz marker oscillator are essentially the same as those published in the ARRL "Radio Amateur's Handbook," 1970 edition.

filter shapes the passband. The 455-kHz i-f signal is then amplified and beat against an upper or lower sideband oscillator in a product detector. Detected audio is amplified by a single IC to the 1-watt level, suitable for low-power speakers. Higher frequency bands are on a common PC board. **Fig. 10** illustrates the functional arrangement for each section of the receiver. You can use your own judgement as to where to start. I found myself moving back and forth from section to section as components became available.

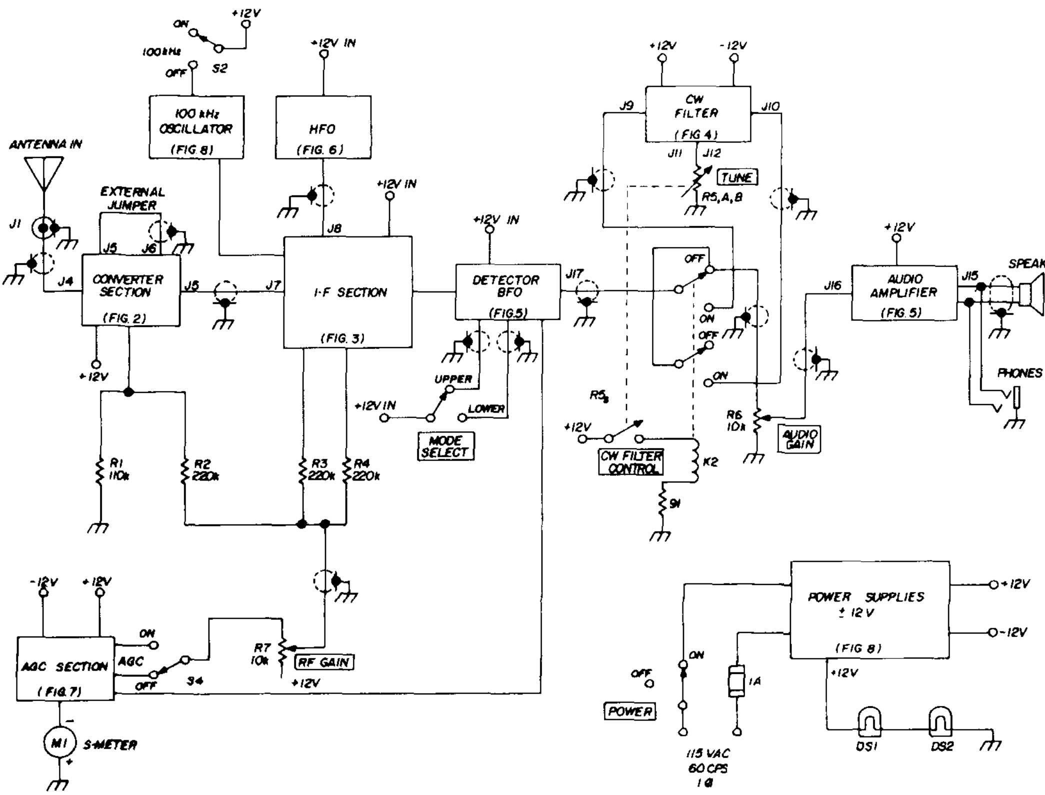


fig. 1. Block diagram of the all-band A80-10 high-performance communications receiver.

tuned with the simple two-stage crystal-converter method. Specific bands are selected from the front panel.

For CW operation, as previously mentioned, a tunable audio filter controls the detected signal. The same knob which is used for tone selection has a built-in switch which activates a relay circuit for in-out control.

construction

As you can see from the photographs, all of the active components are mounted

The serious builder will be able to make an inventory of the items he needs and immediately recognize those items having long procurement times. I would suggest ordering the i-f transformers, filter capacitors and rotary switches immediately, even before the printed-circuit board is available.

The bfo crystal frequencies are determined by the 20-dB points of the Collins mechanical filter. It is important to obtain the filter before ordering the crystals. The bfo and 100-kHz marker crystals are soldered directly to the PC board. Either ceramic or piston-type trimming capacitors may be used in the bfo and 100-kHz circuits.

If you like to do your own thing, the PC board layout in **fig. 10** has enough information for taping and etching your

construction sequence

The following sequence is a suggested procedure for building the A80-10 receiver:

1. Install all of the printed-circuit components, rf chokes and smaller filter components to the board.

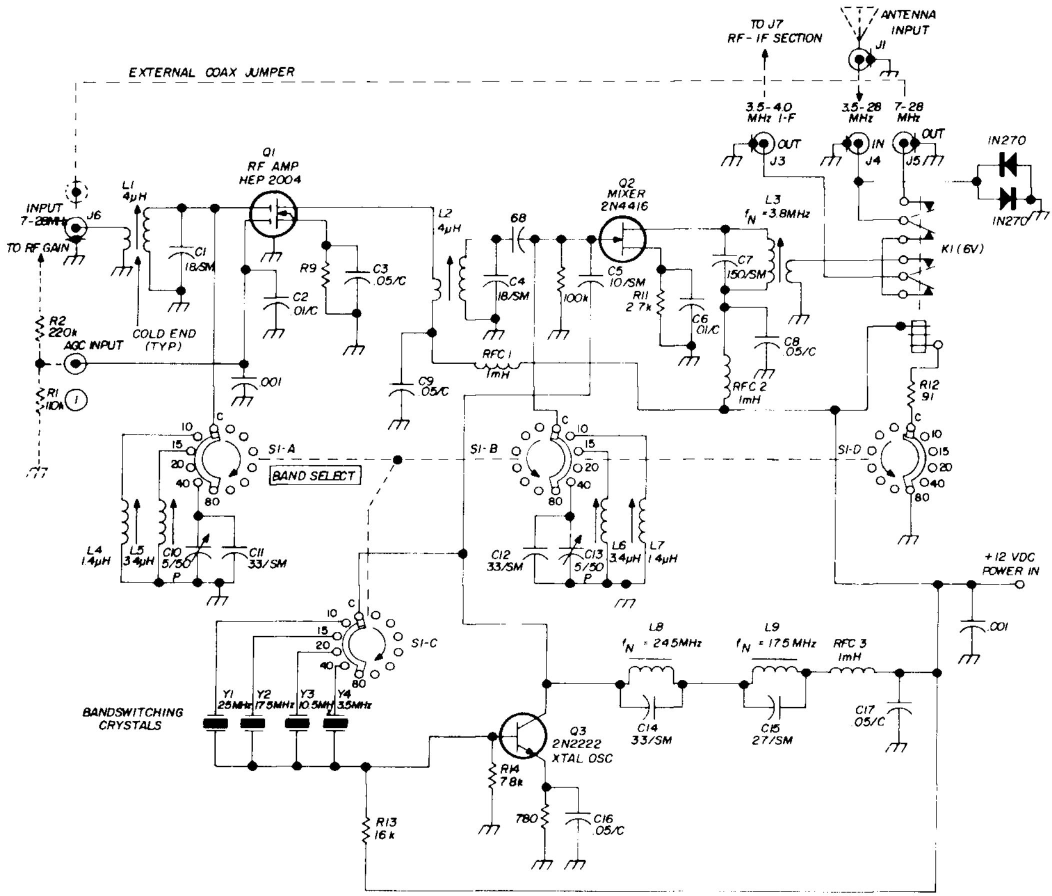


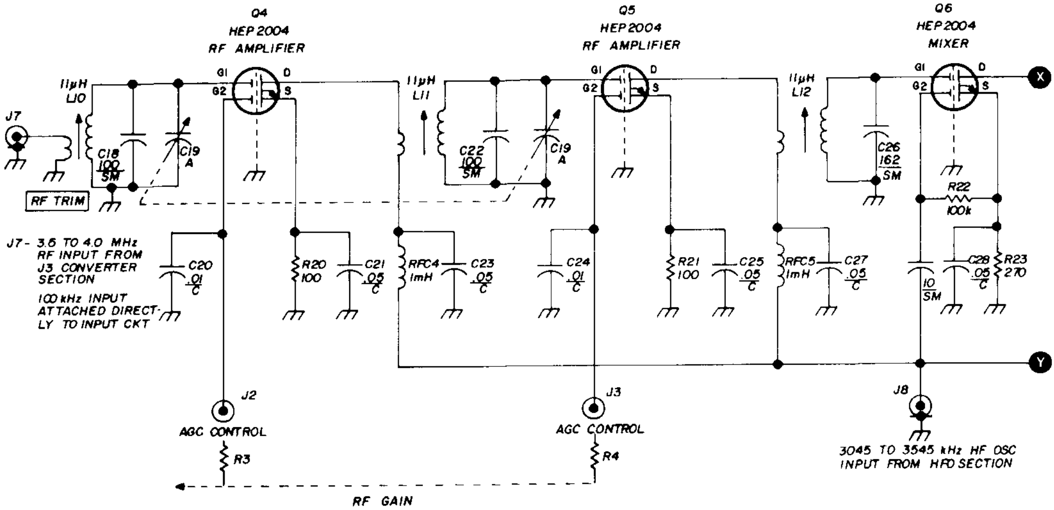
fig. 2. High-frequency converter covers the 40, 20, 15 and 10 meter bands. Complete coil-winding data is given in table 1.

own board, with whatever mechanical arrangements and component substitutions seem appropriate. However, **fig. 13** is a half-scale layout of the PC board used in my receiver. A double-sided board is used, with the same circuit pattern on both sides for stiff ground plane and continuity.

2. Add the dc power straps and agc lines.

3. Install the ICs, transistors and fets (with the exception of the dual-gate mosfets).

4. Add the inductors; each of these coils has been wound several times so the turns ratios are accurate and considerable lati-



tude exists. **Figs. 10** and **15** show the proper orientation of the inductor terminals.

5. Install the trimming capacitors.

6. Add the shields to the rf stage; 0.005 to 0.010-inch copper is suggested. If significantly thicker material is used, soldering to the PC board may be a problem (see **fig. 14**).

7. Add the shield to the converter stage.

8. Install the subpanel, rf peaking capacitor, bandswitch and the two relays.

9. Complete that portion of the wiring which interfaces with the subpanel components and the board.

10. Assemble the power-supply regulator panels and install them on the PC board along with the power transformers, rectifiers and filter capacitors. Add jumper wires to the regulator panels, but do not hookup the dc buses at this time.

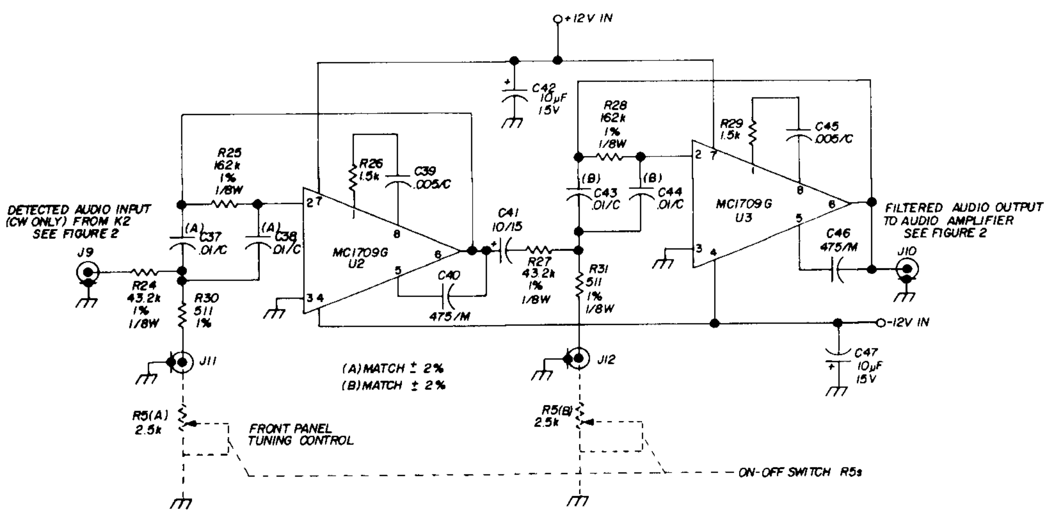


fig. 4. Audio filter provides excellent selectivity for CW communications.

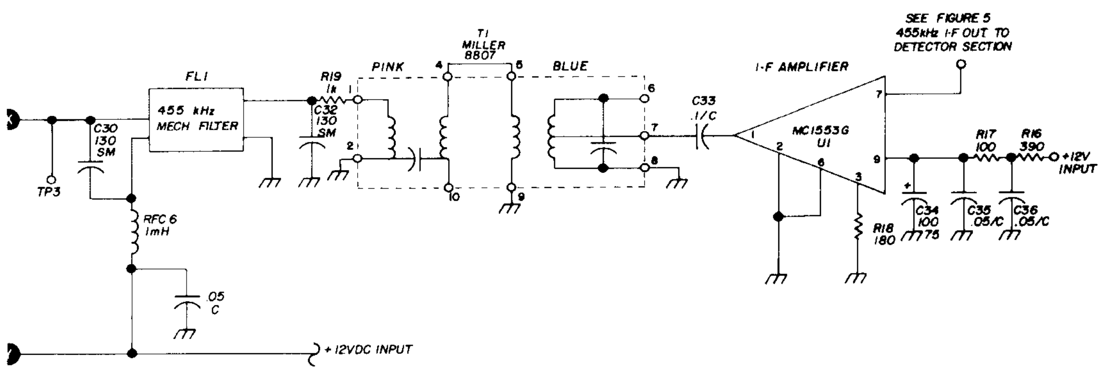


fig. 3. Circuit of the 3.5- to 4.0-MHz rf amplifier and 455-kHz i-f. The Collins mechanical filter provides desired selectivity.

11. Install the assembled printed-circuit board and subpanel into the cabinet. **Fig. 10** shows the brackets and supports which adapt the sub-assembly to the cabinet.

12. Add the front panel components and interwiring except for the S-meter wiring.

construction hints

The rf tuning capacitors and band-switch are all mounted on the same center-line. Use the switch mounting feet as a common point for mounting the PC board; the bushings are mounted on the subpanel as indicated in the cross-section

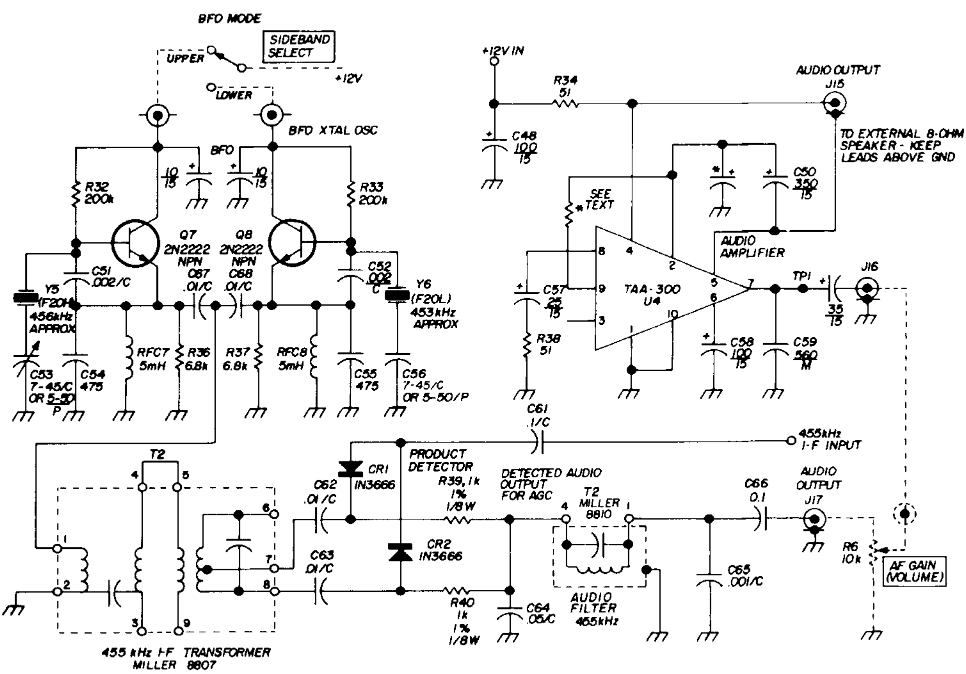


fig. 5. Bfo, product detector and audio amplifier circuits.

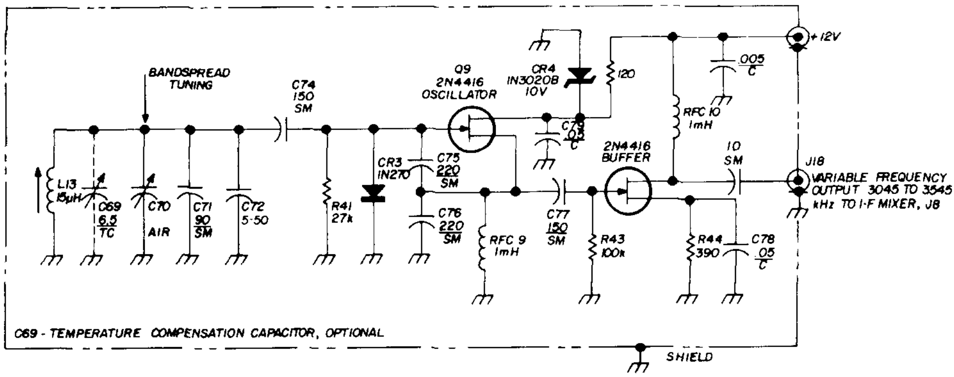


fig. 6. High-frequency oscillator circuit has excellent stability and low drift characteristics.

views in **figs. 11** and **12.** I found that the *feel* of the Centralab PA-2021 rotary switch was poor; there are ball-detent switches similar to the PA-2021 which you may want to use. Both Oak Manufacturing and Centralab have good miniature ball-detent units.

To make maximum room available for adding the jumper wires between the converter components and the bandswitch, remove all the excess contacts. This will minimize coupling problems as well. Referring to **fig. 10,** the shields between stages in the i-f and converter sections are just high enough to clear the ends of the inductors; a small bead of solder is run along the bottom of the shield as shown in **fig. 14.**

To provide for maximum slug adjustment in the inductors, the coils should be wound as shown in **fig. 15.** Complete winding data is given in **table 1.**

In my receiver I used no. 20 solid,

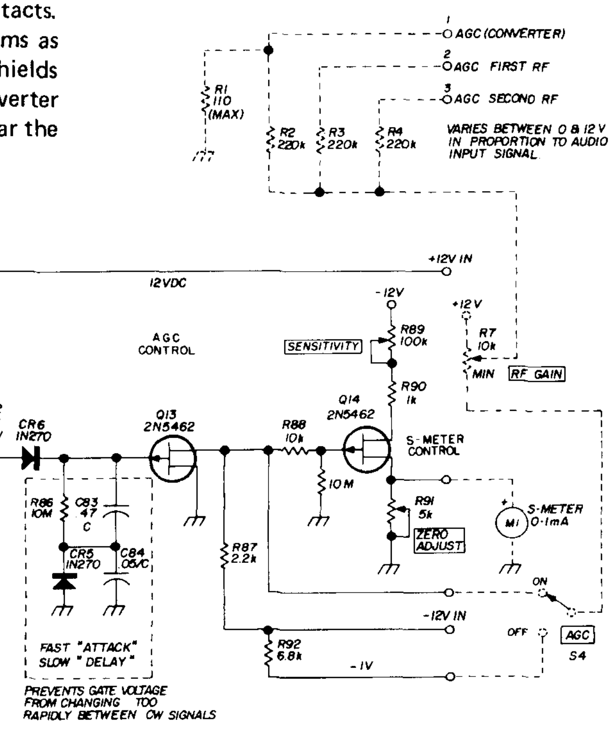


fig. 7. Complete agc circuit for the A80-10 communications receiver. The high-impedance fet S-meter circuit provides minimum load on the agc line.

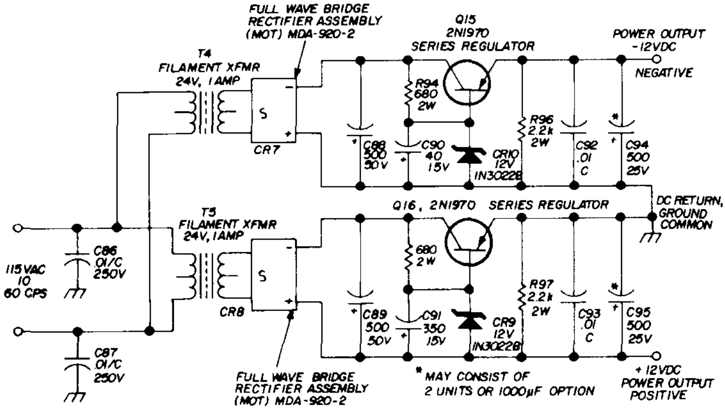


fig. 8. Regulated power supply for the receiver provides plus and minus 12 Vdc.

tinned wire for the jumpers from the tuning inductors to the printed-circuit board, bandswitch and resonating capacitors. For all other wiring I used no. 24; miniature coaxial cable was used for shielded leads.

If you look at **fig. 10** you will see that there is an offset between the integrated-circuit terminal centerline and the printed-circuit pads. The ICs should be installed as shown in **fig. 16**. The IC lead offset provides stress relief for the leads as well as allowing larger pad sizes to simplify etching the board. Note that the ICs are all installed from the back side of the board.

I tried HP2800 hot-carrier diodes in the detector, agc rectifier and agc attack circuits without significant improvement. These diodes provide low forward voltage drop and high leakage; however, the use of 1N270, 1N191, 1N914, 1N100 or 1N3600 diodes in these circuits provides almost equivalent performance. Don't be hesitant about using any good germanium device in the detector and agc attack circuits. Almost any good silicon rectifier will work well in the high-frequency oscillator circuit.

semiconductors

Transistor types used in the A80-10 receiver were standardized wherever possible. For example, all small-signal bipolar stages are handled by the 2N2222, an npn high-speed switching transistor. However, any general-purpose npn transistor may be used so long as it has comparable current gain (h_{FE} = 50 minimum) and adequate voltage ratings.

In the agc circuit, transistor Q11 is operated class A, but saturates with strong signals. Transistor Q12 operates almost entirely in class B to accentuate positive pulses and provide a wider gate voltage swing on Q13. Some adjustments in bias values may be necessary if substitute transistors are used in these stages.

The 2N5462 p-channel depletion-mode fet used in several stages is a

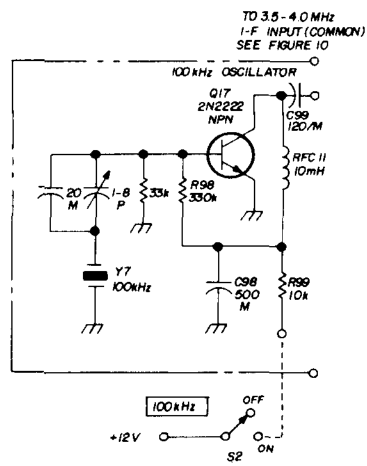
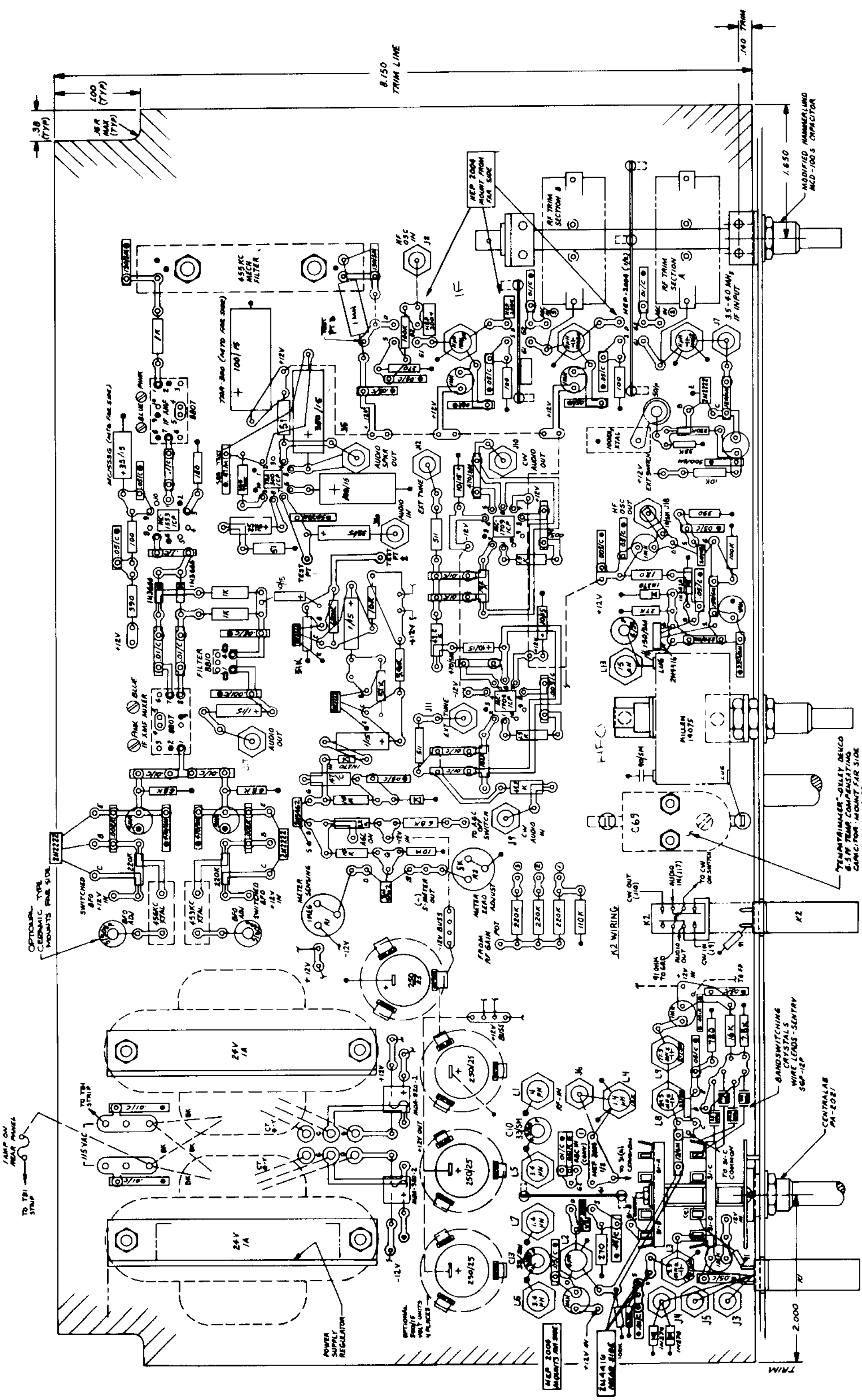


fig. 9. Circuit for the 100-kHz marker oscillator.


8.150
TRIM LINE
TRIM
455 KC MECH FILTER
MODIFIED HAMMERLUND MCD-100S CAPACITOR
35-40 MHz IF INPUT
MILLEN 19075
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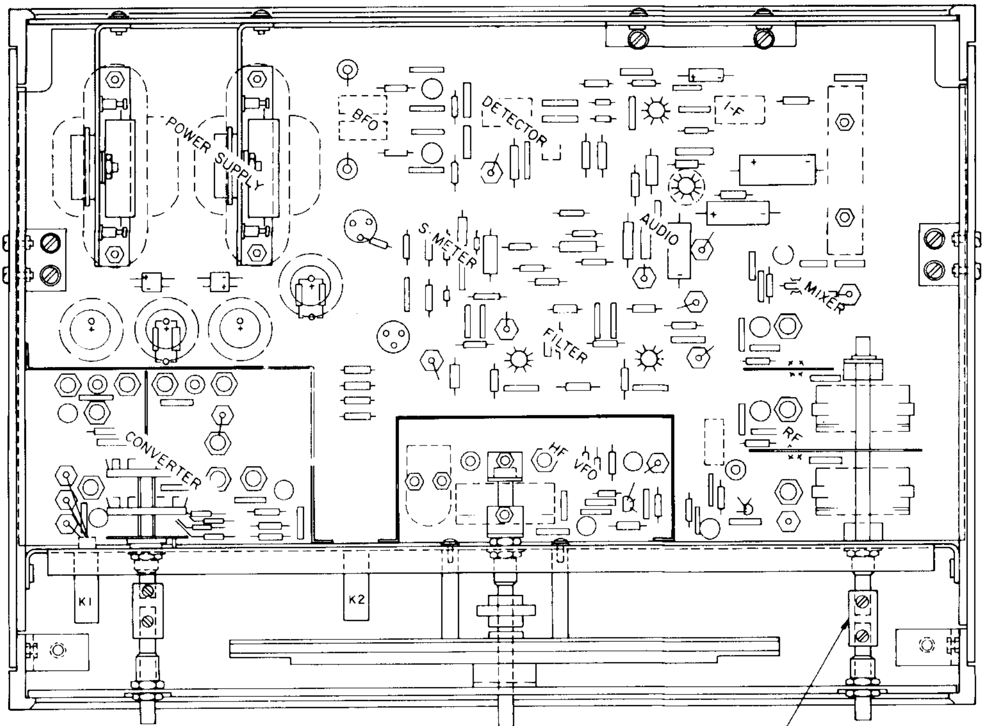
POWER SUPPLY REGULATOR
24V 1A
115 VAC



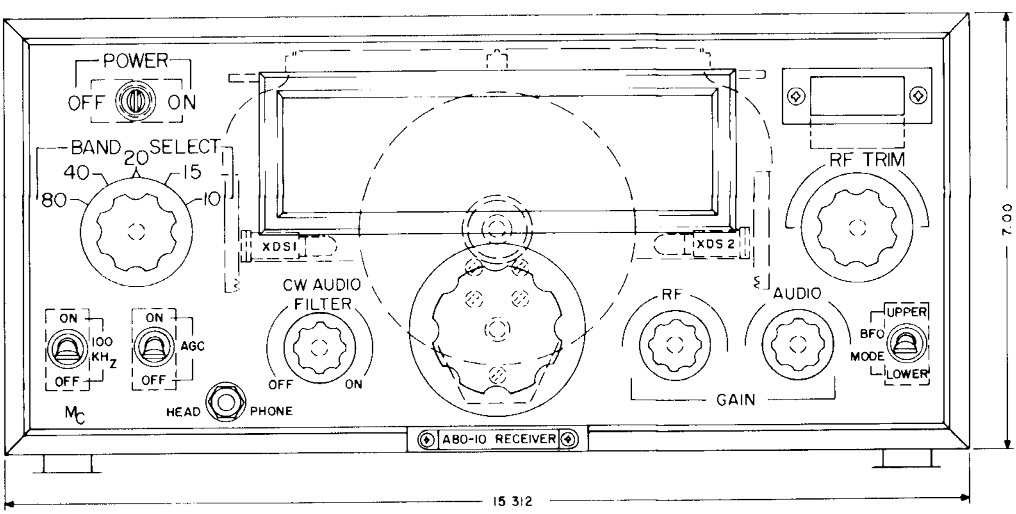
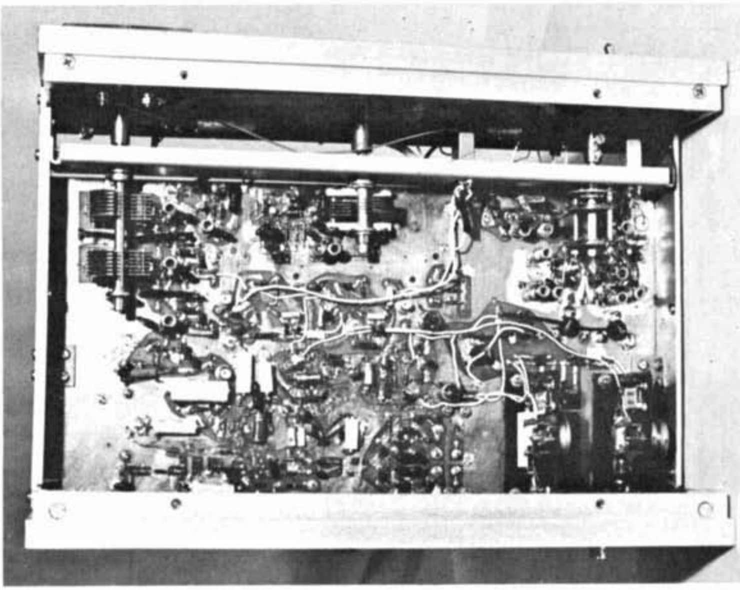


fig. 10. The complete parts layout for the A80-10 is shown on the facing page, the printed-circuit layout is shown in fig. 13 and the construction and panel layout of the receiver is shown above.

general-purpose type. The 2N5463 or 2N4360 are acceptable substitutes. Since large variations in gate voltage vs drain current between different devices will cause the maximum agc voltage swing to vary considerably, it's a good idea to have several transistors to select from. Adjust

diodes are installed across the antenna input circuits for over-voltage protection.[1, 2]

A Motorola MC-1553G wideband linear amplifier IC was selected for use in the A80-10. The MC-1552G may be used with somewhat reduced gain and sensi-



Top view of pc board with converter and hfo covers removed. The i-f is along the left, the hfo is in the middle.

the 2.2k agc drain resistor slightly (between 1.5k and 3k) to maximize the agc voltage swing.

The 2N4416 n-channel fet used in the rf amplifier and mixer stages provides exceptionally good noise figure. Alternate types, which work well in these circuits, are the 2N3823, 2N5459, MPF-102, MPF-105 and MPF-108. However, the 2N3823 is the best choice for low mixer noise and maximum vfo output voltage.

The HEP-2004 dual-gate mosfet is used in the vhf amplifier and mixer circuits. The MFE-3006, MFE-3007, MFE-3008, MPF-120, MPF-121 and MPF-122 are superior substitutes since wider gain variations can be expected from the HEP-2004. However, there is sufficient i-f gain to offset this, and the cost of the HEP-2004 is much less than the recommended substitutes. Protective

tivity. I experimented with some similar ICs manufactured by RCA, but they all required an additional buffer stage to obtain equivalent results. The cost of the MC-1553G is relatively high, but well worth the investment because of the circuit simplicity it provides.

Although I used the Motorola MC1709C operational amplifier in the audio filter, a variety of suppliers makes this same device, including Fairchild (W5B77092IX), Philco (PA70931), Raytheon (RM4709) and Texas Instruments (SN52709L). In a recent issue of *ham radio,* WA1JSM discussed some additional design features of this device, as well as applications.[3]

The Amperex TAA-300 audio amplifier IC used in the audio power amplifier stage provides 1-watt into an 8-ohm load. This device requires a heat sink. You may want to obtain a copy of the Amperex data sheet on this device since there are considerable variations in external capacitors and feedback resistors for various operating requirements.[4]

In some installations, to prevent instability, you may have to connect a capacitor (47 pF minimum) from pin 2 of the TAA-300 to ground. The printed circuit board indicates this component location. However, motorboating may result if this capacitor is installed prior to test and found not to be required. Some devices may require an additional capacitor (100 to 500 μF) from pin 4 to ground to prevent low-frequency oscillation.

test and alignment

Before applying any power, double check all your wiring connections, checking for continuity and short circuits. Check all transistors, capacitors and ICs for correct orientation. Without the power-supply regulator section connected to the circuit, you should obtain the following resistance readings from the plus and minus 12-volt lines to ground:

+12V bus approximately 50 ohms
-12V bus approximately 400 ohms

These measurements are made with the dual-gate-mosfet transistors installed in the board.

Apply ac power to the unloaded power supplies. The output voltage should be between 11.2 and 12.2 volts. Variations in zener-diode tolerances cause wide variation in output voltages. If the power supply voltages are within tolerance, connect the ±12-volt outputs from the regulator circuit to the corresponding bus points on the printed-circuit board.

Apply a 5- to 15-mV, 1000-Hz audio signal to TP-1. If the speaker is disconnected, install a 10-ohm resistor across the two output leads; connect a scope across the resistor — the audio signal will be displayed on the scope if everything is working properly. Of course, if the speaker is connected, you will hear the 1000-Hz tone.

Disconnect the speaker and install a 10-ohm resistor in its place. To properly test the agc circuit all of the rf stages must be tested and aligned. For preliminary agc alignment, however, apply a 25- to 50-mV audio signal to the base of Q11; varying this input voltage should cause a corresponding variation in negative voltage at the drain of Q13. If all is going well, a zero audio level applied to the base of Q11 should result in a corresponding Q13 drain voltage of -1 V; increasing the audio signal level to 25 or 50 mV should cause the Q13 drain voltage to change proportionately to -6 or -9 volts.

If the Q13 drain voltage swing is not as large as indicated, then something is wrong. Since Q11 is operating in class A, the collector voltage should be about 6 V, and the output signal should be nice and clean except when overdriven — then the output should start saturating a little. If Q12 is operating correctly the collector voltage should be about 1 or 2 volts with no signal, and 6 to 10 volts with a high input and some saturation may be apparent; i. e., the output could consist of square waves at about 6 to 10 volts positive.

The gate voltage on Q13 should be slightly less than the collector voltage of Q12, and vary in direct proportion. With this much gate voltage swing the drain current should cause the previously indicated voltage variations across the 2.2k resistor. I had to play a little with this circuit since there are so many variables between different fets that under some circumstances Q12 can operate in class A. Just a few volts on the gate of Q13 will provide a significantly large agc voltage. The circuit in **fig. 7** gives a little larger gate voltage swing under touchy CW conditions where the large agc voltage will save your eardrums.

Another agc circuit which works well if the beta of the transistors is high is shown in **fig. 17.** Note that the value of the coupling capacitors between stages is unimportant so long as you use a minimum value of 0.1 μF. If higher values are used as suggested in **fig. 7**, there is an improvement in low-frequency response. Diode CR6 can be any device exhibiting low forward voltage drop and moderate to high leakage such as the 1N914 or 1N191. Other circuits you might want to try are shown in Bill Orr's "Radio Handbook."[5]

s-meter

The 1970 ARRL "Radio Amateur's Handbook" suggests a typical S-meter

Adjustment of the S-meter circuit is quite simple since the sensitivity can be set for any preferred rf reference level. The meter responds to the decay agc feature so it does not hang up on a-m signals.

high-frequency oscillator

If this circuit is properly wired, and

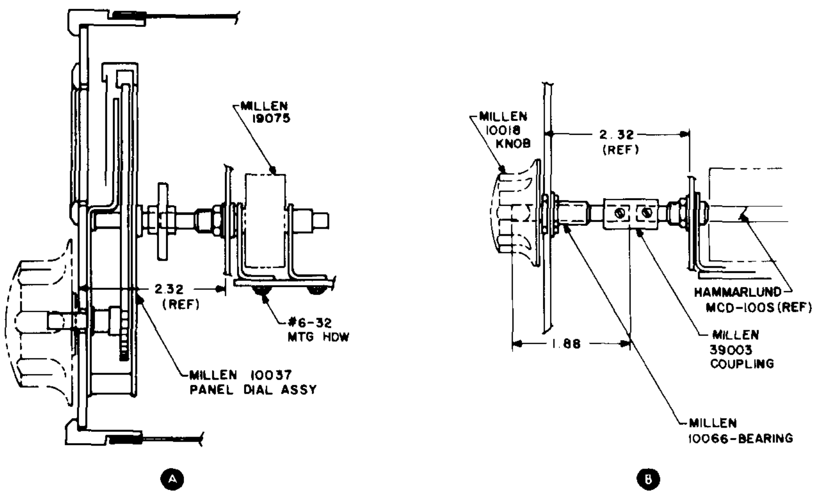


fig. 12. Construction details of the main tuning dial (A) and the rf trimming capacitor (B).

circuit for receivers which use negative agc lines. However, the input impedance of the circuit is so low it severely loads the agc line. The fet S-meter circuit I used in the A80-10 (see **fig. 7**) is similar to the ARRL circuit, but does not load the agc line.

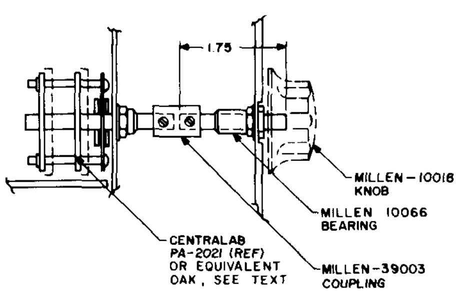


fig. 11. Construction details of the band-selection switch.

the coil is properly wound, there is absolutely no way that it will not work (see **fig. 6**). To align the oscillator, first set the bandspread capacitor to the center position. Grid dip the coil to the same approximate frequency (3.25 MHz) and apply power. Signal output should be from 1 to 3 volts peak, depending on the transistor used in the circuit.

The oscillator may be built without the *tempatrimmer* if you wish. If the *tempatrimmer* is not used, the 100-pF silver-mica capacitor should be an NPO type to compensate for temperature drift. The voltage of the zener diode is unimportant – 8, 9 or 10 volts is satisfactory. If you use an 8- or 9-volt zener, *slightly increase the series resistance.*

The L/C ratios used in the oscillator will allow you to adjust the oscillator from 350 to 500 kHz on five bands. This means that if you are particularly interested in a certain segment of the bands, by properly selecting the converter crystals and adjusting the L/C combination, bandspread of a particular band segment can be adjusted to suit your interest.

Let's assume that you are interested in a straightforward 500-kHz bandspread as results will provide temperature drift levels less than 25 Hz hour.

Probably the easiest i-f section to build and align is the one shown in **fig. 3**. The coils are easily wound with an error latitude of one or two turns. The coil/capacitor assembly is shown quite clearly in **fig. 10.** Put the trimmer capacitor (C19) in the half-mesh position, grid dip

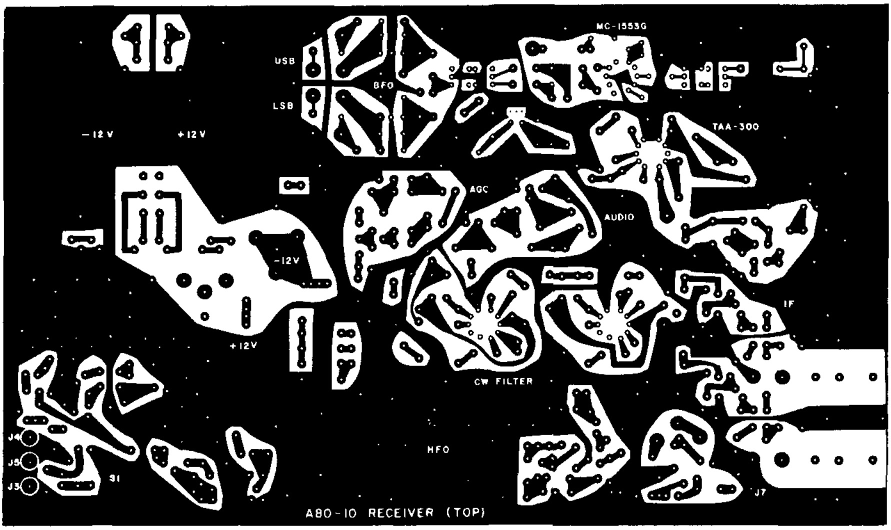


fig. 13. Printed-circuit board layout for the A80-10 communications receiver. Full-size templates are available for 25c from ham radio. Printed-circuit boards with critical component holes drilled are available from Spectrum Research Laboratory.*

illustrated. Not too much trial and error is required to obtain low end frequency output at 3045 kHz with maximum capacitance and minimum slug; then tune to the other end of the scale, setting the inductor slug to a frequency slightly lower, and then backing off the capacitor. Returning to the low end and trimming both inductance and capacitance should get the oscillator into the required tuning range (3045 to 3545 kHz) within 4 or 5 tries.

Let the receiver operate for 72 hours, retrim the tuning components, and then coil-dope the L13 slug and capacitors into position. Adjustment and installation of the *tempatrimmer* is best accomplished using the manufacturer's instructions; the the inductor slugs to 3750 kHz in each of the rf and mixer stages. Recheck circuit wiring and make sure that agc voltage is available at the mosfet gates.

Apply a 5-mV signal to the output of the 455-kHz mechanical filter or at TP3. If the i-f amplifier is operating correctly, an oscilloscope will display an audio signal at the audio input capacitor or across the 10-ohm load resistor. If you have finished the agc and S-meter sections, then visible S-meter movement

*Printed-circuit boards are available from Spectrum Research Laboratory, Inc., P. O. Box 5824, Tucson, Arizona 85703. The double-sided plated, completely drilled board is $27.50, including handling and postage.

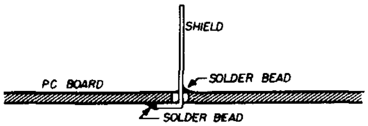


fig. 14. Installation of shields on the printed-circuit board.

should occur and agc control should be apparent by putting the agc switch in the *on* position and varying the 5-mV 455-kHz input signal from 1 to 15 mV while monitoring the mosfet gate voltages.

Install the dual-gate mosfet in the rf and mixer stages. Connect the hf oscillator to the mixer. Apply a 30-μV 3750-kHz signal to the input connector of the i-f and attach the oscilloscope to the output of the i-f amplifier IC. Tune the hf oscillator to a point where an i-f output is apparent. Adjust both slugs of the i-f transformer for maximum output signal. Adjust coils L12, L11 and L10, in that order, for maximum output signal. Now go back and readjust all trimmer components for 3750 kHz, and zero adjust the band-spread and capacitor trimmer. At this point, the receiver may be used for 80-meter reception.

To verify receiver operation, apply a 1-μV signal to the input with an oscilloscope monitor at the audio output. Tuning across the 1-μV signal and peaking the trimming controls should produce an obvious audio signal. With a 30-μV signal applied, 100% modulated with 1000 or 400 Hz, the upper and lower sideband trimming capacitors in the bfo circuit can be adjusted to provide audio reception at the appropriate level. Individually tune the bfo capacitors for maximum audio

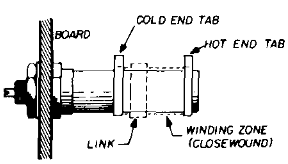


fig. 15. Inductor assembly. Complete coil winding data is given in table 1.

output. The output levels can be matched by adjusting R32 and R33.

cw filter

Properly wired and with good op-amps, the CW filter circuit should function immediately. Review the wiring of relay K2; turning the CW control clockwise should activate the relay, switching the audio through the operational amplifier circuits rather than directly to the audio amplifier. The potentiometer provides tunable audio; for CW operation a particular beat-note may be accentuated over another adjacent signal, much like a Q-multiplier. CW operators will find that by carefully using either the upper or lower bfo positions and the CW audio filter, passband characteristics will be equivalent to a 500-Hz filter. If you don't

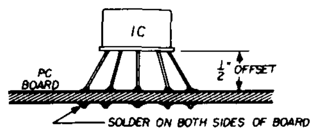


fig. 16. ICs are slightly offset as shown here to provide stress relief.

want to use 1% precision resistors, matched carbon composition types with values close to those indicated in **fig. 4** are quite suitable for this circuit.

oscillators

Any npn transistor with current gain greater than 50 should work without difficulty in the bfo and 100-kHz oscillators. In the 100-kHz oscillator, substitution of a inductance value other than 10 mH will cause odd collector loading and erroneous oscillator frequencies. Adjustments in the collector-to-base resistor R_A will correct for variations in device gain and crystal impedance (see **fig. 18**).

converter section

To align the converter, the following procedure is suggested. First, verify the operation of transistor Q3, the crystal oscillator, moving the switch from the 40-

through 10-meter positions. Oscillator operation should be apparent by monitoring the common terminal of S1-C for the signal; the voltage level may vary between crystals. Some difficulty may be experienced in obtaining stable oscillation on the correct frequency in each of the oscillator positions. Variations in impedance between crystals will cause the base bias voltage to shift and cause erroneous output. Some adjustment of R13 and R14 is required, depending upon the device you use. In the circuit in **fig. 2**, the gain of the transistor was approximately 85. VE3GFN suggests a slightly different circuit;[5] however, I was not able to duplicate his circuit and obtain a stable output signal in all four crystal positions.

Minimum output voltage in the 10-meter position is approximately 1 volt.

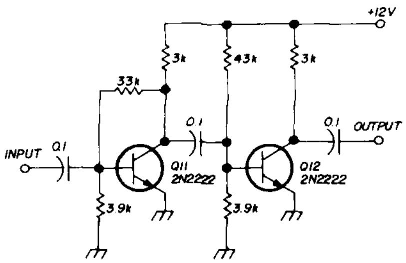


fig. 17. Alternate agc circuit.

Inductors L8 and L9 should be peaked for maximum signal output level at the appropriate crystal frequency. Grid dip L1 and L2 for 14.2 MHz, and L3 at 3.8 MHz. Put the band selection switch in the 20-meter position and apply a 100-μV 14.250-MHz signal to the antenna input. With a scope monitoring either the i-f amplifier output or the audio output, tune the hf oscillator for apparent signal reception. Adjust L3 for maximum signal output. Apply a 10-μV signal to the antenna input and adjust L1, L2 and L3 for maximum output level.

Put the band selection switch in the 40-meter position and apply a 100-μV 7.250-MHz signal to the antenna input. Adjust only C10 and C13 for maximum output signal.

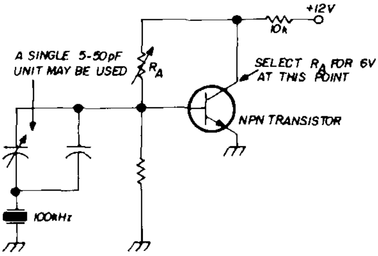


fig. 18. When initially adjusting the bfo or 100-kHz oscillators using other than the recommended transistors, it may be necessary to select the base-to-collector resistor R_A to compensate for variations in transistor gain and crystal impedance. Adjust R_A for 6 volts at the collector of the transistor.

The 10- and 15-meter bands are aligned in the same way, peaking the appropriate inductors for maximum signal. Final trimming of all inductors should be made again after installing shielding or covers around the converter section.

Some sensitivity and gain losses can be expected on 10 meters if you substitute different devices. Substitution of HEP 2004 transistors and adjustments in the value of R1 may be necessary. The more stable MFE-3006, MFE-3007 or MFE-3008 might prove useful.

And last, but not least, adjust transformer T2 for minimum 455-kHz speaker hiss.

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ham radio

integrated-circuit sequential switching for Touch-Tone repeater control

Modular construction combined with three-digit sequential decoding gives this all-IC unit flexibility with immunity from accidental keying

R. B. Shreve, W8GRG, 2842 Winthrop Road, Cleveland, Ohio 44120

Touch-Tone signals, which combine one frequency below 1 kHz with one above to represent each of ten digits, can be decoded with filters and relays or with integrated circuits. The Bell System 247B KTU uses LC filters, transistors and relays; a solid state IC decoder is described in the July, 1971 *QST.*[1] Either will provide a discrete digital impulse for each Touch-Tone signal received.

Using one of these impulses to control a switched circuit is easy – so ten tones should make it possible to perform ten functions. And they would, if no one else ever transmitted the same tones on the frequency you selected for a control frequency. To make a system that will act only on signals addressed to it and disregard all others, circuits are needed that will recognize multiple digits in a prescribed sequence. This article describes such a system.

design requirements

What should a Touch-Tone control unit for a repeater provide? At the Lake Erie Amateur Radio Club repeater, WB8CQR, the objectives were:

1. Accept Touch-Tone signals as reproduced at the output of a standard fm receiver.

2. Retransmit signals not addressed to the repeater control, but otherwise disregard them, so that others can use Touch-Tone on the same frequency

without interfering with the repeater controls.

3. Recognize signals directed at the control unit, interpret them and act on them without retransmitting them.

4. Disregard erroneous, irrelevant or incomplete codes, resetting to its stand-by state automatically.

The control unit is designed for a repeater with the transmitter and the primary receiver about a half mile apart, connected by a single telephone pair. There are two receivers on the primary input frequency, one at the main receiver site and one remote, both tone guarded. A second receiver at the main site, on a secondary frequency and unguarded, is used principally by base stations.

Wire control of the transmitter from a number of remote points is provided in accordance with the station license. The Touch-Tone control unit, located at the main receiver site, supplements the wire control but does not replace it. The Touch-Tone unit performs the following functions:

1. Disables the keying circuit to the transmitter, without affecting the receivers.

2. Switches the output to an alternate frequency.

3. Switches a guarded receiver from tone guarded to open.

4. Disables each receiver separately. The disabling circuits are interlocked so that it is impossible to disable all inputs at the same time.

Since each of the listed functions must be reversible, a total of twelve codes is required. Although two-digit codes would suffice, and allow plenty of room for expansion, it was felt that three-digit codes would give enough greater security against false or accidental keying to justify the additional equipment.

To get greatest flexibility during development and maximum adaptability to future change, all integrated circuits are grouped in modules, on etched circuit boards. The boards are approximately four inches square and plug into sockets

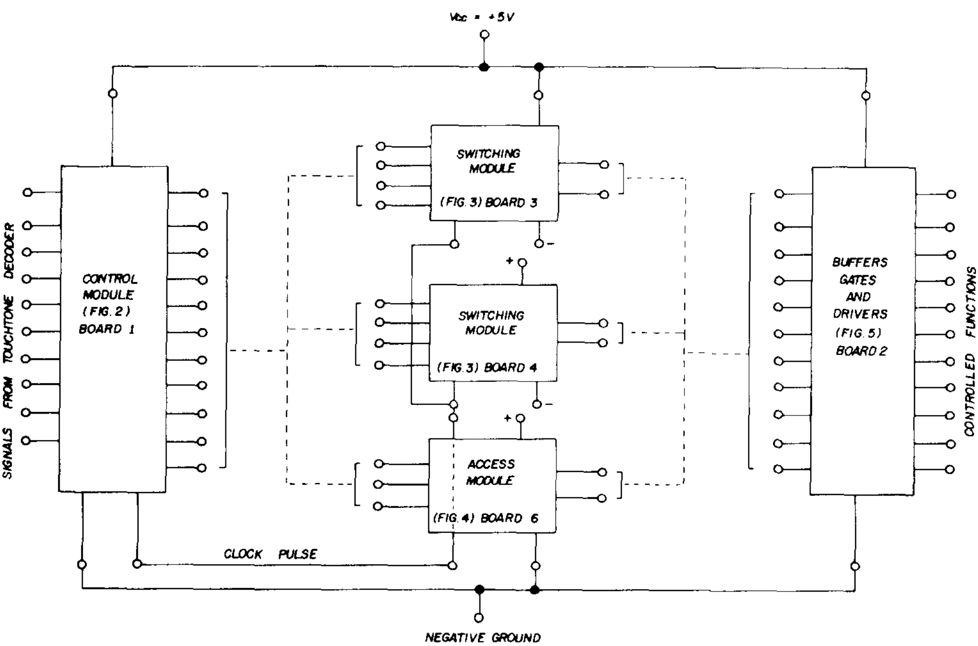
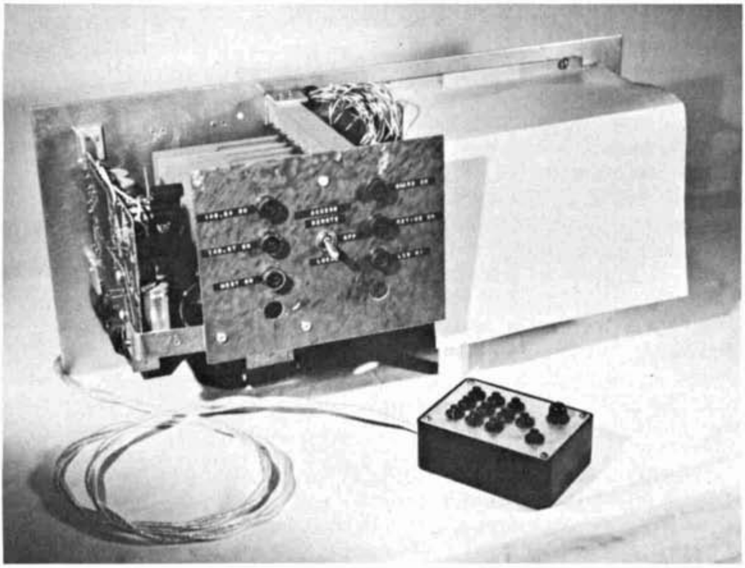


fig. 1. Overall block diagram showing relationship between all modules.



The unit occupies one half of a 19-inch rack. On the left is the power supply; the tops of the logic boards are visible to its right behind the panel on which indicator lights show the status of the six functions controlled. Space is provided for two additional lights if another switching module board is added later. The box in the foreground is the local control unit, with ten digital keys in the Touch-Tone pattern, a button to key the transmitter and a light showing when the gate is open to permit access to the unit.

that provide 22 possible connections to each side of the board. There are four types of modules, as shown in **fig. 1**. They are:

Control module (board 1, **fig. 2**). Processes incoming Touch-Tone signals and generates a clock pulse to drive the J-K flip-flops on the other circuit boards.

Buffers, gates and drivers (board 2, **fig. 5**). Provides additional logic elements to expand and combine outputs of other circuits.

Switching modules (boards 3, 4 and 5, **fig. 3**). Identical switching modules, two on each board; each module performs one on-and-off function.

Access module (board 6, **fig. 4**). A special switching module and timer that controls access to the switching modules.

Audio input to the decoder is taken from a circuit that also carries the transmitter audio input, so that tones heard by the decoder are also retransmitted if the transmitter is keyed. The decoder is one that grounds one of ten output terminals for the duration of each tone combination representing a digit. If the Blakeslee solid-state decoder is used, output inverters should be used, or the NOR gates in the output circuits should be replaced with POSITIVE OR gates, so that each Touch-Tone digit is represented by a "low" decoder output.[1]

control module

The control module circuitry is shown in **fig. 2**. Decoder outputs are connected to terminals 2, 4, 6, 9, 11, 13, 15, 17, 18 and 20. For each input an inverted output is provided at the adjoining terminal. These outputs are the digital impulses used to drive the sequential switching circuits. Eight of the digits are also connected to the inputs of an SN7409 quadruple AND gate used to expand the input capability of one half of an SN7413. The other two digits are connected directly to the SN7413 inputs — which digits to which inputs is immaterial; the arrangement shown was the simplest circuit-board layout.

The Texas Instruments SN7413 is a dual quad-input NAND gate with Schmitt-trigger action, characterized by hysteresis of about 0.8 volts between the levels of the turn-on and turn-off input signals. This makes it possible to operate one half of the gate as a multivibrator by

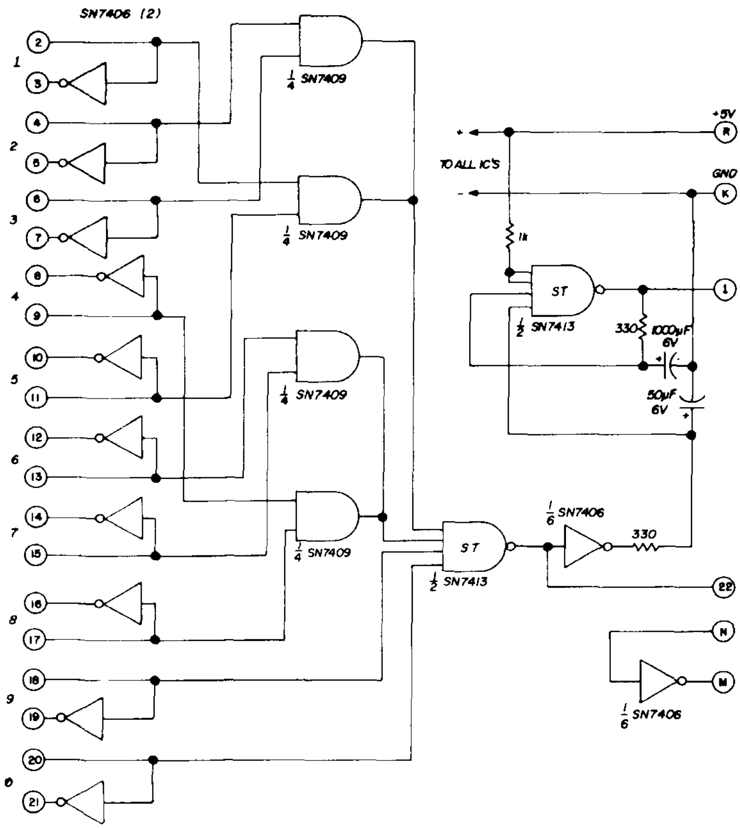


fig. 2. Diagram of the control module (referred to as circuit board number 1). Numbers in circles identify terminals on one side of board, letters those on other side.

feeding its output back to one of its inputs. The 330-ohm resistor and 1000-µF capacitor give a cycle time of about 0.63 seconds – 32 cycles in approximately 20 seconds. This is the clock pulse for the switching and timing circuits.

Its rate can be changed if desired by using a different value of capacitance. The 330-ohm resistor should not be changed as it will affect the operation of other parts of the circuit. Two unused inputs of the multivibrator are stabilized at high level by connection to V+ through a 1000-ohm resistor, as recommended by the manufacturer.

The fourth multivibrator input is connected to an inverter driven by the output of the other half of the SN7413, used here as a simple NAND gate. As long as this input to the multivibrator is in a high state, the multivibrator will oscillate under control of its own feedback circuit. When any Touch-Tone digit is received, however, it will cause a low input and high output at the NAND gate. The resulting low input to the multivibrator overrides the feedback circuitry, stopping the clock with its output in a high state until the tone signal ends. The 50-µF capacitor and its companion 330-ohm resistor introduce just enough delay into

Note: The control module and the buffer/driver printed circuit boards are two-sided which might make them impractical for home etching. The author can offer commercial-quality glass-epoxy boards for $10 for a set of three – the control module, the buffer/driver and one switching board of two modules. Additional switching module boards are $3 each. Boards are undrilled, but the price includes postage. Add $1 per board for drilling. The author can also supply the Texas Instruments ICs for those unable to get them locally. Write to R. B. Shreve, W8GRG, 2842 Winthrop Road, Shaker Heights, Ohio 44120.

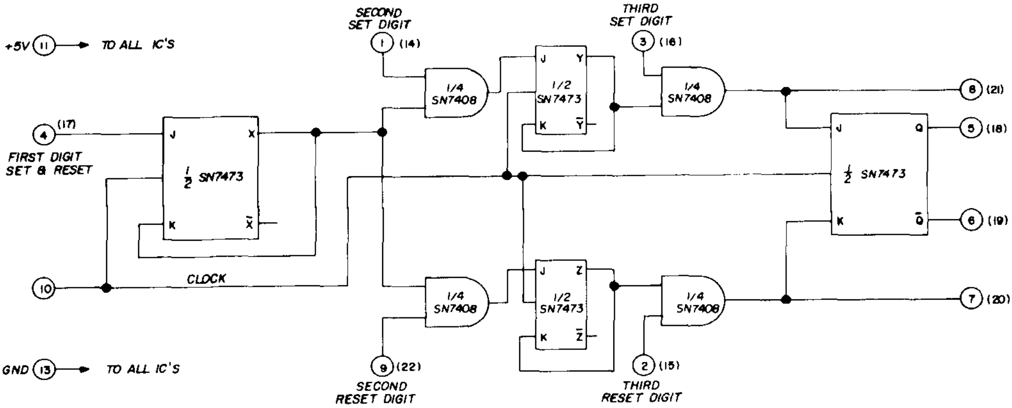


fig. 3. Basic three-digit sequential switching module. Each switching circuit board contains two identical modules and a common clock and power terminals. The terminals for one module are identified by the circled numbers, the terminals of the remaining module by the numbers in parentheses. These boards are referred to as circuit boards 3, 4 and 5. They are all identical.

the circuit so that the clock lags the Touch-Tone impulse by an interval which permits a switching module to recognize and act on the impulse during the clock cycle it generates.

Eleven of the twelve inverters in the two SN7406 ICs on the control module board are used in the control circuitry. Input and output of the twelfth are brought out to circuit-board terminals for use in an output circuit.

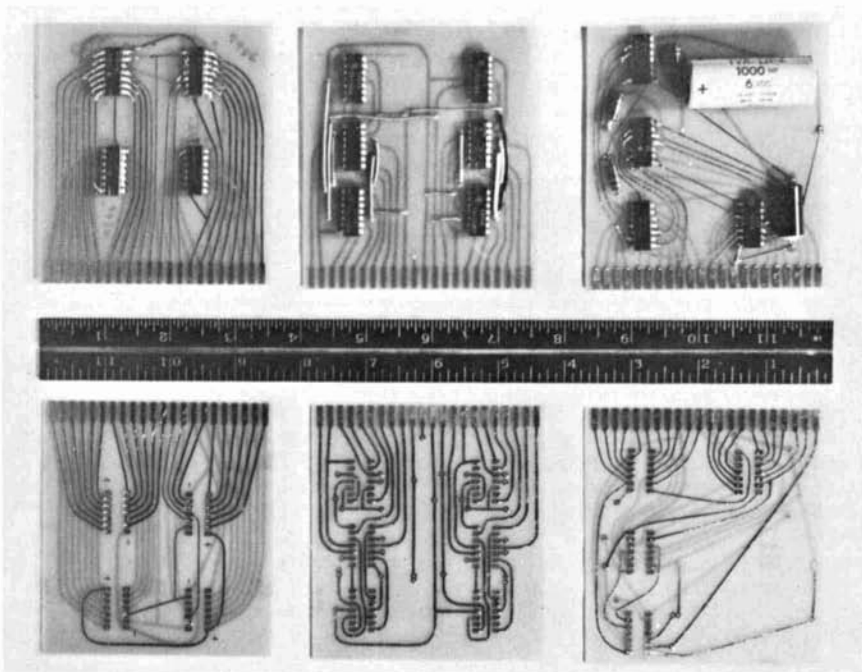
switching module

A typical three-digit sequential switching module is shown in **fig. 3**. It is made up of two SN7473 dual J-K flip-flops and a SN7408 quad two-input AND gate. If the clock input, terminal 10, is connected to terminal 1 of the control module, the switching module will react to the sequence of three digits connected to its *set* or *reset* terminals. There are two identical modules on each switching circuit board, with common clock, V+, and *ground* terminals. The remaining terminals for one module are identified by numbers in circles, and for the other by numbers in parentheses.

The *set* and *reset* codes for each module have the same first digit. For example, if 743 is selected as the *on* code for a function, the *off* code will also start with a 7. The module is programmed by connecting its *set* and *reset* inputs to appropriate inverter outputs on the control module. Assuming that 743 is the selected code, a Touch-Tone 7 will switch the first digit J input to the high state. This high is read into the flip-flop as the tone switches the clock to high, and the flip-flop will be *set* when the tone ends and the clock goes low.

The *set* flip-flop has a high X output for one clock cycle. If a 4 (the second digit in the sequence) is received during this clock cycle, it will act with the high X to generate a high J input at the second stage flip-flop. This flip-flop will in turn stay set for one cycle, during which presence of the correct third digit will set the final stage. The resulting high Q or low $\overline{Q}$ is used to control the desired function.

The third stage of the switching module does not reset automatically, since its K input is controlled by one of the *reset* sequence AND gates. It will switch back to its original state only when the proper *reset* sequence of digits is received. If a code sequence is interrupted or incomplete, the first two flip-flops of a switching module return to their standby state after being set for one clock cycle. False responses are minimized and no code addressed to one module will cause another to hang up even though they have one or two digits in common. The circuit will also distin-



Front and back views of the three circuit boards. On the left, the buffer/driver board; in the center a typical board with two switching modules; on the right the control module.

guish between sequences such as 743 and 734.

If on first thought a 0.63-second clock cycle seems too short an interval in which to send successive Touch-Tone digits, it should be remembered that the clock stops as long as a tone is held. Clock "low" time is also lengthened when a tone is received, as the 1000-μF timing capacitor is fully charged instead of being limited by the Schmitt-trigger hysteresis voltage.

The switching action has been described in simple form, with the switching-module clock input directly connected to the control board. In actual service, multiple switching modules require additional logic elements between the clock and the flip-flops. The SN7413 has a fanout capability of ten, and each switching module board has eight clock inputs, so SN7417 drivers are used to expand the clock output. One SN7417 will drive twelve flip-flops, so two are needed for each three switching-module circuit boards.

Additional control of the clock impulse is used to accomplish the objective, mentioned earlier, of having the repeater retransmit Touch-Tone signals intended for call-up or control of other stations without acting on them, and suppress transmission of signals used in its own control. A two-digit access code serves to identify the signals addressed to the repeater.

access module

The access module, board 6, is shown in **fig. 4**, which also shows related logic circuits on the other boards. The access module has two parts – a two-digit sequential switch similar to the three-digit switching modules, and a six-stage binary counter. The AND gate connection for access digit one is unnecessary, but the board was made by modifying a switching module board, and it was easier to connect the input to the gate than directly to the flip-flop.

In the access module, the control-module clock output drives the switching

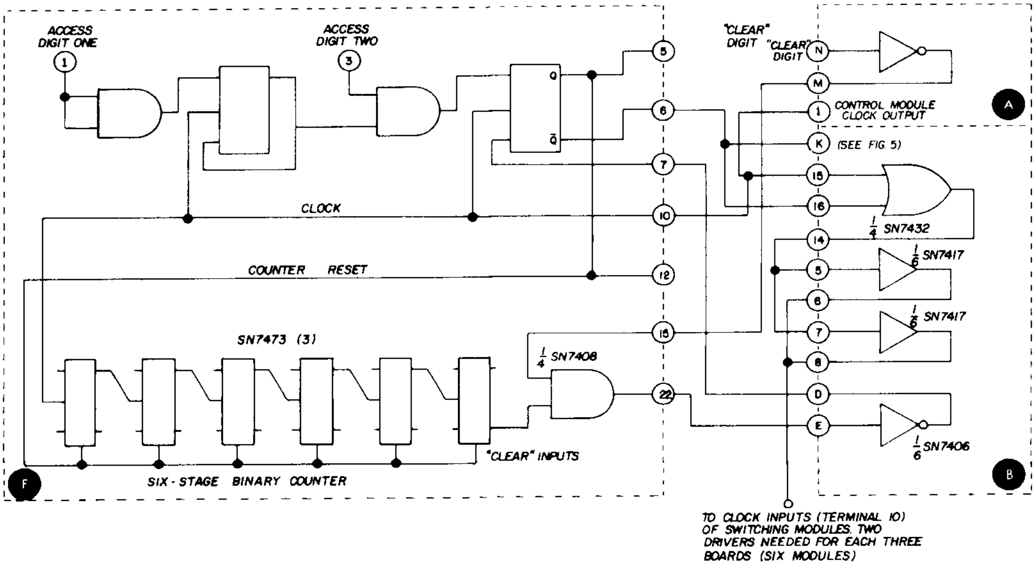


fig. 4. Diagram of the access module (circuit board 6) and related logic circuits on the other boards. The access module is labeled F, the control module is A and the output and driver logic on board 2 is B.

unit programmed to recognize the access code, and the first stage of the binary counter. It is also connected to one input of a SN7432 POSITIVE OR gate. The other input of this gate is driven by the $\overline{Q}$ output of the switching unit. As long as this output is high, the gate output is high regardless of the state of the control-module clock.

The gate actuates two SN7417 drivers, which in turn provide the clock impulses for all the switching modules on the other boards. Until the access switching module is set by receipt of the appropriate two-digit code, no clock pulses reach the switching modules on the other boards, so no Touch-Tone signals affect them. In addition, although the control clock is connected directly to the first stage of the binary counter, the counter clear inputs are connected to the Q output of the access switch, so it can not count as long as this switch output is low.

When the access switching module is set by the correct two-digit code, its Q output goes high and $\overline{Q}$ goes low. The SN7432 gate output now cycles with the control clock, activating the switching modules on boards 3, 4 and 5. The high Q output also releases the clear inputs of the binary counter, which starts counting the clock cycles.

As long as the access switch is set, the other switching modules will respond to the codes for which they are programmed. When the desired actions are completed, transmission of a single *clear* digit, generating a low at terminal 15 on board 6 resets the access switch, deactivating the other switching modules. If the unit is wired in this way, to clear with a single digit, that digit can not be used as part of an instruction code. If the *clear* input is not wired, or if the operator fails to transmit the *clear* signal, the binary counter will reset the access switch automatically after 32 clock cycles.

output logic

Design of the output logic circuits will depend on the functions to be performed and the nature of the equipment being controlled. Board 2 can be assembled with a variety of buffers, gates and drivers. Mine has a SN7406 inverter-driver, SN7417 non-inverting driver, SN7403 quad NAND gate and SN7432 quad POSITIVE OR gate. Use of some of this logic in the control unit has already been described. A good example of what

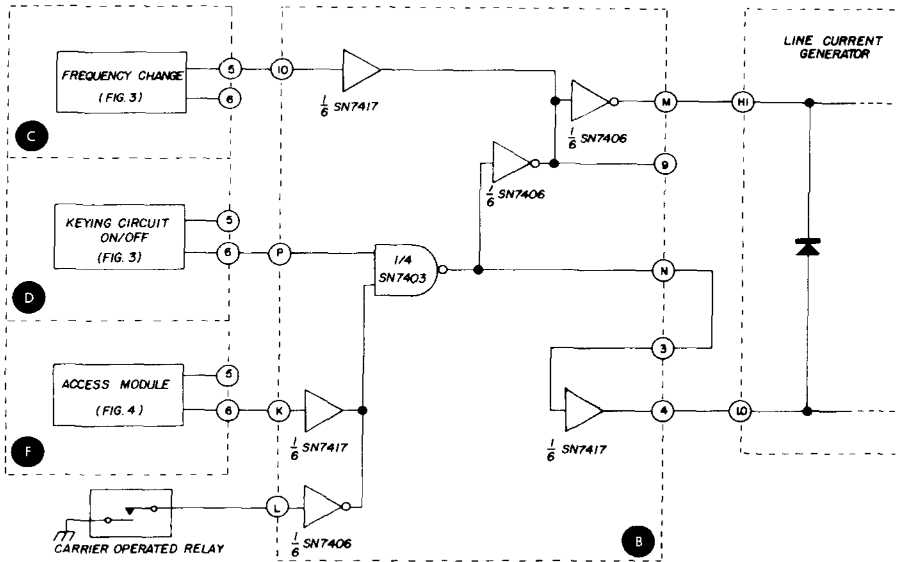


fig. 5. The keying control logic on circuit board 2 is labeled B. C and D are switching modules and F is the access module.

can be done by combining several outputs with appropriate logic is the keying control logic circuit shown in **fig. 5**.

As mentioned earlier, the receiver and transmitter are about a half mile apart, connected by a single telephone pair which carries both audio and dc keying current. The latter is supplied by a line current generator which will put either a low or high dc current on the line, depending on how it is keyed. The difference in current level may be used to select one of two transmitter frequencies. High line current flows when the generator *hi* input is grounded; low current flows if *lo* is grounded and *hi* is ungrounded. No current flows when both inputs are ungrounded.

For the *hi* input to be grounded, the input to the SN7406 inverter to which it is connected must be high. A low output from the *frequency change* switching module will prevent the *hi* input being keyed, while a high level output from it will permit the other part of the logic circuit to control.

Output of the SN7403 NAND gate is low when both its inputs are high. When low, it keys the *lo* generator input, and also keys the *hi* input if not inhibited by the *frequency change* switch. Low output of the *keying circuit on/off* switch prevents the transmitter being keyed. Likewise, a low $\overline{Q}$ output from the *access* switch, present when the switch is set to give signals access to the switching modules, prevents their retransmission.

If none of the logic is set to disable the keyer circuit, the carrier operated relay (COR) controls keying of the transmitter.

conclusion

Other control functions – silencing a single input, or switching the tone guard on or off, use very simple logic and will not be described in detail. It is hoped that what has been described will give you a picture of the unit's versatility.

Power requirements of the complete unit of six circuit boards, excluding the Touch-Tone decoder, total about 600 mA at 5V. Each additional pair of switching modules adds approximately 100 mA to the load.

reference

1. Douglas A. Blakeslee, W1KLK, "A Second Look at Linear Integrated Circuits," *QST*, July, 1971, page 29.

ham radio

RTTY ribbon re-inkers

A quick conversion of a $2 surplus unit gives almost endless perfect page copy

Irvin M. Hoff, W6FFC, 12130 Foothill Lane, Los Altos Hills, California 94022

Any typing machine takes some kind of ribbon at periodic intervals in order to present a good appearance. Teleprinters for RTTY are no exception. Depending upon the amount they are used, a typical ribbon might last from a few weeks in a busy station to a few months in one less active. Cotton ribbons are normally used, as they are relatively inexpensive and can be tossed out when the page copy becomes too light to read easily. While nylon ribbons are much stronger, fray less readily and present a somewhat better appearance, they are also higher priced.

A few years ago I was given a ribbon re-inker. I managed to whack this unit up and mount it on my 28ASR, although it required drilling a hole in the case-hardened steel used on the model

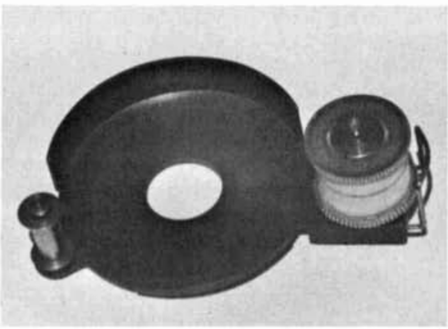


fig. 1. View of the basic reinker as used on the model 15 or 19. For the 28, this is inverted, the reservoir plugged into the other side and the unit modified as in fig. 2.

28 – no easy feat. A nylon ribbon came with the unit, and even though the teleprinter at W6FFC is running 7 to 10 hours per day, the same ribbon is still in use after some three years! Whenever it gets a bit light, I merely put a little additional ink in the reservoir, and the copy looks excellent again for a week or so more.

Normally, I do not write articles about hard-to-find surplus items. However, recently I was able to get a fairly large supply of these items and thus felt such an article might be of general interest. The kits were originally made for model 15 machines in the military services. The basic re-inker unit is shown in **fig. 1** and has a detachable reservoir around which the ribbon is placed prior to its being wound on the spool. The top of this reservoir unscrews and ink is poured in, it then seeps out two small holes onto felt pads that surround the reservoir, and the ink then is distributed on the ribbon as it contacts the pads. One reservoir-full will take approximately one full ribbon traverse to distribute; once on the ribbon it then evens itself from layer to layer in a few hours or several traverses. The usual tendency is to overink, but after several years, I can usually get the results I want.

As it comes in **fig. 1**, the unit adapts immediately to the model 15 or 19 merely by removing one nut and exchanging this unit for the one already on these teleprinters. The re-inker also can be modified quickly so it will go on a model 28 teleprinter.

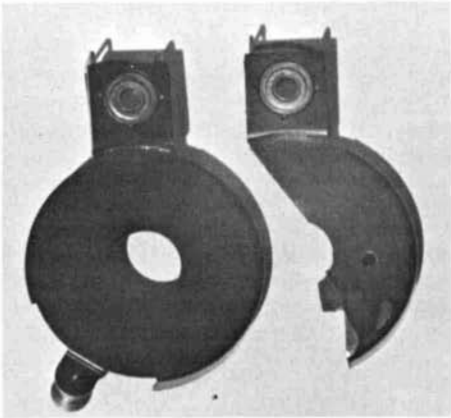


fig. 2 The reinker base: before and after.

Fig. 3 is a full-size template for cutting and drilling the re-inker. Cut out or copy the template, turn the re-inker so the flanged lip and post are down and place the template on the re-inker base with the legs of the template around the resevoir plate.

Mark lines B and C on the re-inker base and, using tin snips, a hack saw or a sabre saw, cut out at A (non-critical), B and C. The cut at C is critical and should be done carefully. Discard the shaded portions entirely.

Mark the hole, but do not drill it yet. Take the bolt out of the ribbon holder, and while holding the re-inker in position, swing it slightly until you can see your mark in the hole–check to make sure

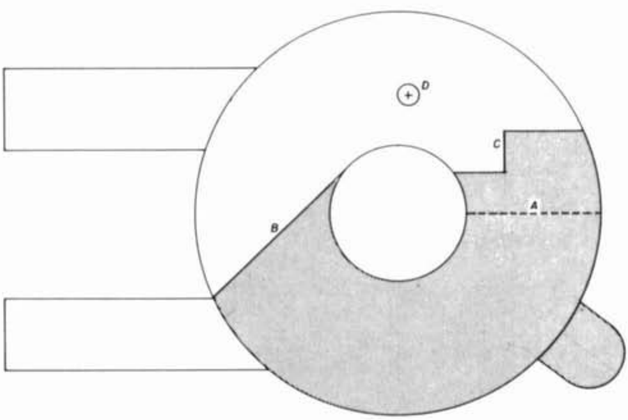


fig. 3. Template for modifying the basic unit to fit the model 28 or 35.

your hole is centered or remark it correctly. Drill the hole with a 7/64-inch drill, replace one short ¼-inch 4-40 bolt on the model 28 with a 3/8-inch 4-40 and fasten the re-inker in place with a nut. Beside changing the 4-40 bolt, there is no modification to the model 28 itself.

An exact-size template is furnished with each re-inker sent out by the author if a self-addressed stamped envelope is furnished for the purpose.

Possibly I got ahead of the story, so I will try to give a better explanation. On the model 28, the left-hand ribbon holder has a spindle on front for the ribbon to pass over, just to the right of this is a vertical gate through which the ribbon passes – when the ribbon comes to the end, a rivet in the ribbon catches in this gate, carrying it to the right, activating the reversing mechanism. If you remove the ribbon spool, you will note this reversing lever is pivoted at the rear and held in position with the ¼-inch 4-40 bolt previously mentioned. A collar prevents the lever from binding as the bolt is tightened. This is the bolt that is exchanged for a longer one, and it is to this bolt that the re-inker attaches. **Fig. 4** shows how this appears when finished – it is not necessary to even remove the ribbon holder from the teleprinter. **Fig. 5** shows how this appears from the bottom – and also shows how the ribbon goes through the gate, past the spindle and around the reservoir prior to being

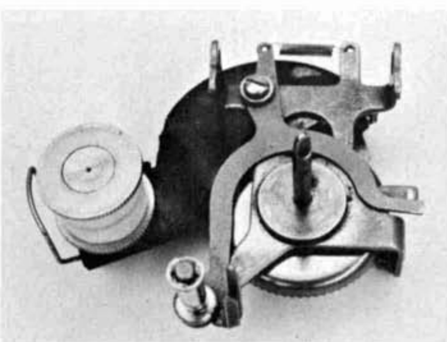


fig. 4. The ribbon holder has been removed to show how the modified reinker is attached for the 28 or 35.

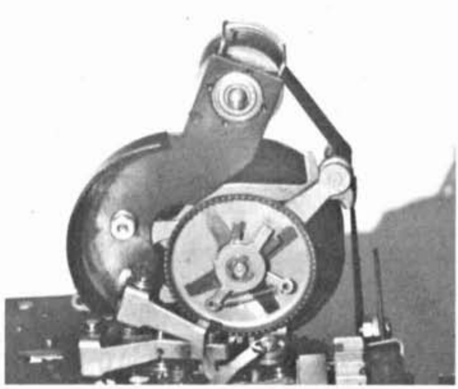


fig. 5. The underside of the ribbon holder with the reinker held in place.

wound on the spool. **Fig. 6** illustrates the end result.

After getting the unit mounted, make sure the reservoir is at the same height as the ribbon spool itself – or of the spindle, and that it is vertical with respect to the spindle. Otherwise the ribbon might want to "overlay" onto itself a little as it goes past, indicating the reservoir is not centered properly. You can bend this up or down somewhat with a pair of needle-nosed pliers if needed, or with your fingers.

ribbon holder removal

Although not necessary, some of you may prefer to remove the ribbon holder entirely – it only takes a moment and does make the installation of the re-inker simpler, as well as offering a good means of determining if the reservoir is centered the best. There are two C-clamps and one spring to unhook, and the unit pulls right off the post around which it oscillates up and down. **Fig. 7** shows the first retaining ring to be removed on the bottomside of the unit, the lever is then pulled free. Normally this lever causes the ribbon spool to oscillate up and down, allowing you to read the page copy when the typing unit is not striking a letter.

Fig. 8 shows the retaining ring at the top of the ribbon holder and **fig. 9** shows the one spring on the right side of the

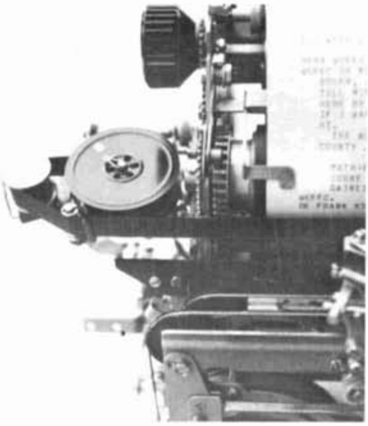


fig. 6. The complete reinker in use on a model 28 teleprinter.

ribbon unit as observed from the front. When reassembling the ribbon holder, refer to **fig. 7** again and make certain the two levers shown on the left of the photo are interhooked as shown, which is simple enough to do while you are sliding the unit back into place.

other re-inkers

Other re-inker ideas have been tried and one is offered commercially. This latter system involves removing the ribbon from the machine, taking off the top plate of a special ribbon spool that comes with the kit, dropping ink at strategic places around the wound-up ribbon, and leaving it overnight for the ink to distribute itself uniformly. Then the special top is replaced and the ribbon and spool are placed back on the machine. This sytem never appealed to me.

Another system that was developed by Rex Peters, W4ZAG, merely was to take an empty ribbon spool and drill large holes in it at various places so that dropping some ink into the holes would allow the ribbon to disperse this ink over a period of time. Rex used this system for several years, but now uses the reservoir method described in this article. Other systems have been tried, but they seem to have little merit compared to the reservoir method.

ink

Various firms sell ink that is satisfactory. I use metal tubes of ink obtained from the National Cash Register Company – they resemble medium-sized toothpaste tubes. Ink used for ribbons is considerably thicker than ink used for fountain pens, so it is not as runny, although it is still in liquid form, and not really a paste. NCR ink comes in several colors; I use their black K-575. One tube is enough for at least a year's supply unless your station is quite active. Ink is available through any NCR distributor; look in the Yellow Pages in your phone book. The price has been 75c a tube.

When printed copy gets a little light, just remove the top of the reservoir and insert some ink – do not fill it too full or it will ooze out the hole in the top of the reservoir when it is replaced. You can put ink in regardless of the direction the ribbon is going, or whether it is at one end or in the middle. However, it will work the very best if you wait until the ribbon is all wound up on the right-hand spool and just starting to come back to the left. This puts ink on as it winds up, rather than as it unwinds. You can force the ribbon to go either direction you wish if you manually hold that reversing gate to one side for a few characters.

The usual tendency is to wait too long

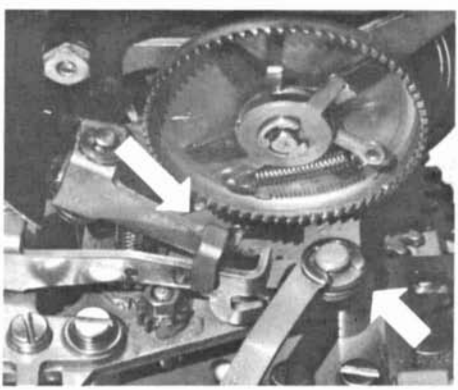


fig. 7. The bottom side showing the retaining ring (right) that is removed to take off the ribbon holder and (left) the manner in which the ratchet levers are unhooked.

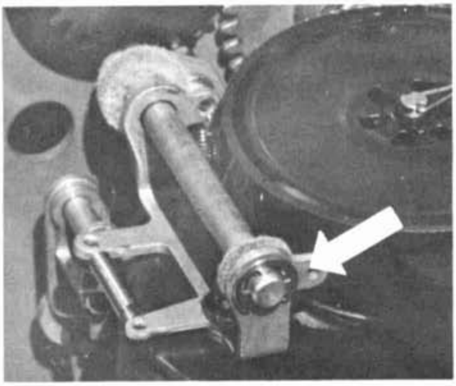


fig. 8. The retaining ring at the rear of the left spool is also removed to take off the ribbon holder.

and then over-ink. Do not put more than one reservoir full at a time on the ribbon. It may appear for awhile that nothing is happening and that it really needed lots of ink – you will want to put more on, but don't. Give it at least 24 hours or a few traverses of the ribbon (best of all, both!), and it will act like a new ribbon again. If you load several reservoirs full concurrently, you will soon find it is too black and certain characters will fill up and smudge, making terrible looking page copy for a few hours. This has been one reason a few people have not cared for re-inkers, but if you use some of these hints, you will not have the usual problems.

the re-inker kit

These kits contain the base plate, two reservoirs (one for a spare), a nylon ribbon, a large number of spare felts (after three years, I'm still using the original ribbon and original set of felts), a tool (plastic) for slipping the new felts onto the reservoir cylinder, a nice plastic box (excellent for storing radio parts), a small wire tool for cleaning out the seep holes in the cylinder (I've never needed to do this) and finally a plastic bottle of ink. This ink is pretty old, and too thick – I recommend you throw it out first thing. It will clog the seep holes and generally be unsatisfactory unless thinned – too much bother to mess with.

With this system, you can keep copy looking as though you had a new ribbon on, all the time, and still not get your fingers dirty. Even if you had unlimited access to free ribbons for merely carting them home, you would soon prefer using the same nylon ribbon with a re-inker.

The re-inker has been so nice I tried for some time (mentally) to see if I could figure out some method by which I could re-ink the nylon IBM cartridges on my Selectric typewriter (about $2.50 each). I gave up, although Dave, W7RSJ, says he has figured out a way to do it! Many typewriter ribbons could be re-inked on your teleprinter and then replaced on the typewriter, too!

availability

The author has a number of these available for $2, postage paid anywhere in the U. S. A. Please do not order from outside the U. S. A., as we have no facilities for going through customs, nor

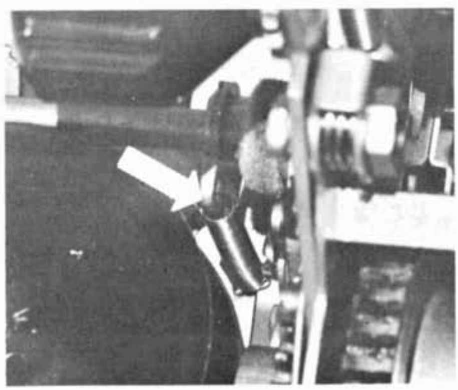


fig. 9. The third and final thing to remove the ribbon holder is to unhook this spring at the right of the ribbon holder.

an export license. Include an sase for an extra template for model 28s or to return your money in case we run out of the limited supply available. Send to:

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More Details? CHECK–OFF Page 94

accurate noise-figure measurements for vhf

For the serious vhf experimenter a simple circuit and procedure for measuring vhf noise figures with accuracy

Louis N. Anciaux, WB6NMT, Box 1000, Dixon, California 95620

Building a low-noise preamplifier utilizing the solid-state devices available today, you can obtain very impressive receiver sensitivities at vhf.[1] For weak-signal work, such as meteor scatter, long-haul tropo and moonbounce, lowest noise performance obtainable is paramount. To ensure this, an accurate measure of the receiver's nf (noise figure) must be obtained. Adjusting for lowest noise performance using a noise source or a weak-signal source is unsatisfactory at best, and actual performance is unknown. The nf is still unknown.

Ready access to an automatic laboratory nf meter is generally not possible for many, so a suitable means of obtaining nf measurements must be found. Several nf meters utilizing the characteristics of a temperature-limited diode have been published previously.[2, 3] The Sylvania type 5722 is a diode specially constructed for use as a temperature-limited noise source. This tube, selling for approximately $8.40, exhibits predictable noise output response, which is readily determined by measuring the current passing through the diode.

noise factor

Using this diode, the *noise factor* of the receiver may be obtained when the noise output of the diode exactly matches the noise output of the receiver. When this condition is satisfied, the *noise factor* is simply

$$20\,IR \qquad (1)$$

where I is the current thru the diode, R is the load resistance and the number 20 is a constant.[4] For the usual 50-ohm system, this reduces to 1000I; or the *noise factor* is equal to the magnitude of the current in mA passing through the diode. To obtain *noise figure* (nf), merely take ten times the logarithm of the *noise factor.*

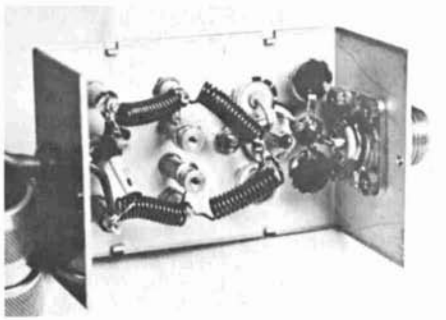
design notes

To make accurate nf measurements, you must know the load resistance and current through the meter with a fair degree of certainty. Previous models have failed to consider the load resistance as an rf network, using only a 50-ohm resistor and excessive lead lengths. Above 100 MHz especially, the small reactances associated with lead lengths of the order of 0.5 inch are sufficient to cause an error approaching 1 dB when measuring receivers with under 3-dB nf. Current through the diode must be known with precision, 5% error being an excessive amount.

The nf meter described here gives excellent performance and repeatable results through the 432-MHz band. Comparison with industrial meters of high accuracy have shown excellent agreement. Error is under 0.1 dB for the bands 220 MHz and below, and at 432 MHz, the meter consistently reads within 0.5 dB of the industrial meter. At 432 MHz, W6FZJ consistently measured preamps at 0.3-dB higher with the meter described here than with a commercial meter.

precautions

Be careful with the rf head construction and with the meter circuitry. A large scale meter is a must, as the current must be measurable to less than 0.1 mA. Since most nf measurements of greatest interest are under 5 dB, a 4-inch or larger scale meter with full-scale deflection of 5 mA is an excellent choice. You can use a shunt to obtain readings up to 25 mA, as desired. If you use a meter with less than a 5-mA movement and a shunt resistor, it must be calibrated against a known standard. Particularly under 3 mA, readings *must be accurate* to less than 0.1 mA. Note that the current path is directly



Interior view of the rf head. Readily visible are the various components and their placement within the minibox. The three 150-ohm resistors must be placed to ensure shortest possible leads. Low-loss ceramic socket for the 5722 keeps losses low at higher vhf ranges.

through the meter and should the rf head develop a short, it means an instant demise for the meter. You may add some sort of meter protection if you want.

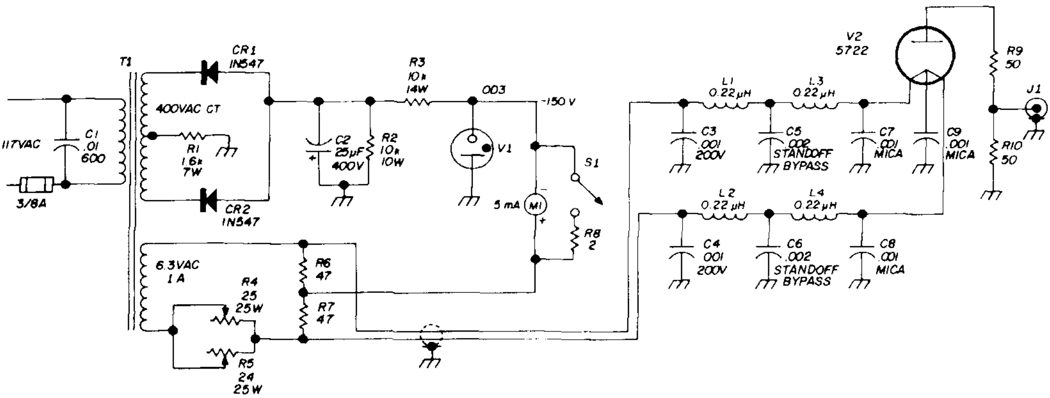
construction

To begin building the rf head, place the tube socket near one end of the minibox, so that R9, the 50-ohm quarter-watt resistor, will just fit between the anode pin and the center pin of the connector which is mounted on the end of the minibox. Either three 150- or four 200-ohm quarter-watt resistors may be used for the load, R10. Carefully select these resistors to obtain a near match between them, as well as a final paralleled value as close to 50 ohms as possible. By placing them symmetrically around the UG-58A/U connector, their leads, soldered directly to the connector body and to the center pin, are no longer than 1/32 inch. This will ensure a load resistance which exhibits a very few ohms reactance at 432 MHz.

The single 50-ohm quarter-watt resistor from the anode pin to the connector center pin acts as a swamp to minimize swr effects from the receiver input circuitry which can cause erratic readings. The uhf button-mica bypass capacitors at each of the three cathode leads should be located to keep lead lengths as short as possible, and of equal length. The rfcs farthest from the 5722 socket may be made larger, up to 10 μH, to allow use well below 100 MHz. The model shown here is used mainly for 220-MHz preamps; thus both rfcs were chosen as 0.3 μH.

power supply

The best way to control filament voltage is with a small Variac in the primary of a separate 6.3 V transformer. A second method, as shown, uses two power rheostats in parallel. One allows the filament voltage to be increased to the point of diode conduction (approximately 1 mA) and the other acts as a fine-tuning control to set the current to the appropriate level. The dc supply is non-critical, as long as the voltage does not vary radically and is free from excessive ripple. A 100- to 200-volt supply is satisfactory, and will be beyond the diode's space-charge potential sufficiently to ensure repeatable results.[5] The VR tube is not necessary, as only the current through the diode affects the noise produced, and small voltage variations will not hurt.



J1	UG-58A/U chassis jack	R10	three 150-ohm ¼W or four 200-ohm ¼W resistors selected to yield 50 ohms when paralleled
L1,L2 L3,L4	approx. 0.3 μH, 16 turns no. 20 wire, ¼-20 bolt used as mandrel. L1 and L2 may be up to 10 μH.		

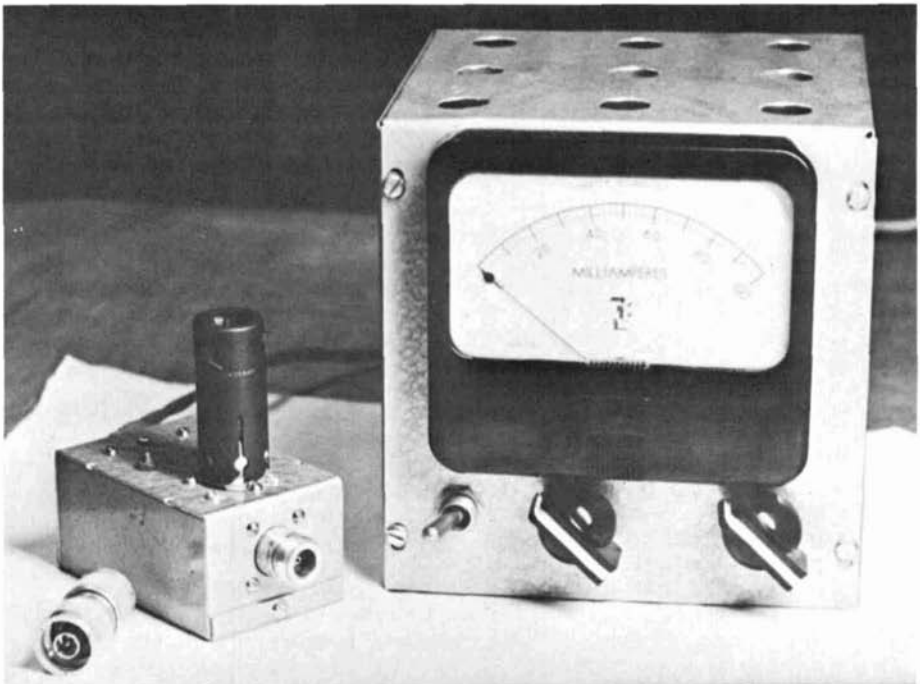
fig. 1. Complete schematic of the noise figure meter including the power supply and the rf head. They are shown here connected with shielded cable. Consult the text for modification to the inductors for different frequency ranges.

operation

To use the meter for determining nf, you must be able to accurately measure a 3 dB change in noise output of the receiver. When the noise output of the 5722 diode equals that being produced by the receiver, the nf of the receiver may be determined from the diode's characteristics. A vtvm, or a vom on low-ac range, may be used to measure the receiver's audio output. In this case, the receiver must use a product detector and the agc must be disabled. In receivers using square-law detectors (diode types), you must use the 3-dB pad insertion method. Some receivers have very responsive S-meters which may be used as indicators when using the 3-dB pad.

The 3-dB pad insertion method is the most accurate, and therefore, the preferred method of obtaining nf measurements. Connect a speaker to the receiver output and set the volume to some reference level. Attach the nf meter rf head directly to the converter or preamp input. Insert a 3-dB pad into the i-f line between the converter and receiver, noting a decrease in output from the receiver. As you turn on the 5722's filaments slowly, and as the diode current increases, the noise output of the receiver will also increase. When the output of the receiver is the same as the reference level prior to insertion of the pad, read the diode current and turn the filaments off.

Removing the pad should return the indicator to its original reference level. If it does, then repeat the procedure to obtain another diode-current reading. If the diode current is the same, then change the reference level to another value, and repeat the same procedure to obtain diode current. If all diode-current readings are the same and are repeatable, then it is generally safe to assume the readings are valid. However, if the readings vary from trial to trial, then precautions are necessary.



The noise figure meter and rf head. The 4½-inch scale meter allows direct reading to 0.1 mA with interpolation to 0.025 mA readily possible. The interconnecting cable allows the rf head to be used separated from the nf meter, facilitating measurements. The UG-57B/U adaptor connects two UG-58A/U chassis jacks together directly, keeping losses to a minimum.

problems

If you obtained erratic diode-current readings, there are several possible causes. First, if the audio output is being read on a vtvm and a 3-dB change is sought, inserting a 3-dB pad in the i-f line should also indicate a 3-dB change on the vtvm. If it does not, then either the agc is not disabled or you are overloading the mixers or detectors. Second, if the swr between the converter and receiver is not 1:1, then using two additional pads should cure this problem. Inserting the

3-dB pad between these two pads will allow you to make repeatable measurements. The two additional pads act as swamps to stabilize the circuitry. Third, if the converter or preamp-input circuit is grossly mis-adjusted, (not 50 ohms) erratic readings will also occur. Fourth, if the converter or preamp is not properly neutralized, very erratic readings result.

If a preamp, previously measured into another converter at a low noise figure, shows considerably higher nf, it may be due to very high nf in the second stage (converter input). This is seen from the relationship:

$$F_T = F1 + \frac{F2}{G1} \qquad (2)$$

where F1 and F2 are *noise factors* of the first and second stages, F_T is system *noise factor,* and G1 is the *gain factor* of the first stage.[4] In this case, the second stage nf must be reduced to an acceptable level, either by redesigning or by adding another rf stage.

For example, consider a 2-dB nf preamp with 10-dB gain and a converter with a 15-dB nf. Converting dB to *factors,* 2 dB = 3.01, 15 dB = 17.61, 10 dB = 10; and plugging into the equation yields a *noise factor* of 4.77 and a system nf of 3.0 dB. This shows the importance of having the second stage nf reasonably low in order to enjoy fully a good preamp's performance. In the case of a 5-dB second stage, system nf would be 2.34 dB. Increasing the gain of the preamp to 15 dB would further reduce the system nf to 2.2 dB.

procedure

As an example in making a nf measurement, connect the rf head of the nf meter to your preamp input. The converter output is fed into a 6-dB pad, through a piece of coax to another 6-dB pad and into the i-f receiver. The S meter on the receiver reads S-3. Inserting the 3-dB pad in the i-f line after the first 6-dB pad, shows a drop to nearly S-2. The diode filament current is slowly increased until the noise produced by the diode just equals the S-3 reference level. The diode current is read as 2.3 mA. The diode filaments are turned off and the 3-dB pad removed from the i-f line. The S-meter should again read S-3.

Repeat the above procedure and obtain another diode current. Assuming it is again 2.3 mA, remove one of the 6-dB pads and insert a 10-dB pad in its place, obtaining a new reference level. The diode current obtained now should be the same if all is well, otherwise, problems exist. Make at least two tests to obtain diode current.

To convert this reading of 2.3 mA to nf, simply take ten times the logarithm of 2.3. That is, log 2.3 = 0.362, thus nf = 3.62 dB. The accuracy of the current meter becomes apparent at this point. If the accuracy is only ± 0.1 mA, then the current may be 2.2 mA or 2.4 mA. The nf corresponding to these currents are 3.4 dB and 3.8 dB. The nf of the receiving system is 3.6 ± 0.2 dB. When making readings around 1.5 mA, ± 0.1 mA error corresponds to nf of 1.46 dB at the low- and 2.04 dB at the high-error point. This 0.5 dB or so difference in nf at this level represents more like 1 or 2 dB in receiving sensitivity, and for moonbounce work, those dB really count.

I would like to express my appreciation to W6FZJ for originally bringing to me the idea of the distributed impedance load in the rf head, and to W7CNK for many enlightening discussions during which we both came to understand many of the reasons for doing things the way we have and for his helpful criticism in reading the drafts of this article.

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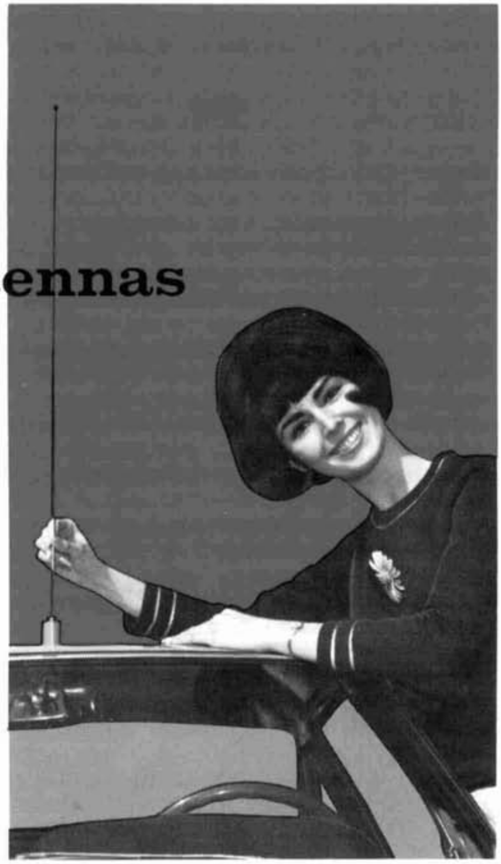

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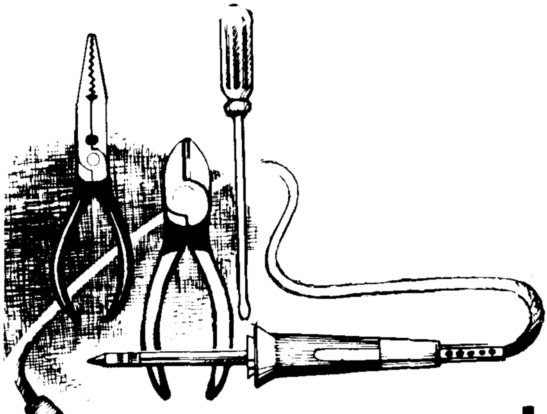


circuits and techniques

ed noll, W3FQJ

digital multivibrators

Old-fashioned circuits *acquire new names.* One of the most common electronic circuits is the bistable multivibrator which, for more than three decades, has been standard in television and radar circuits. It is often called a toggle or flip-flop multivibrator. In the clipped computer language it is called an FF. There are a variety of multivibrator types to be found packaged in digital integrated circuits. Although some refinements have been made by the computer industry, the multivibrator circuitry is rather fundamental as compared to some of the earlier versions used in radar and television equipment. You old timers will remember the phanastron!

Two vacuum tubes or two transistors fed back upon themselves can be made to flip-flop. A very basic multivibrator can be formed by feeding back two NAND or NOR gates upon themselves as shown in **fig. 1.** In computer vernacular the inputs are called *set* and *reset* or simply S and R, while the outputs are designated Q and Q. These correspond to the trigger inputs and the MV outputs of the past. The block symbology and the truth tables are also shown in **fig. 1**.

The Q and $\overline{Q}$ can be given logic 0 and logic 1 designations. The *set* or logic 1 state of such a flip-flop corresponds to a Q output of 1 and a $\overline{Q}$ output of 0. The converse of the above (Q of 0 and $\overline{Q}$ of 1) is spoken of as the *reset*, cleared or zero-state position. Customarily you say that the circuit has been *set to 1* or *reset to 0* representing the two states of the flip-flop. These designations are shown on the truth table.

When there are simultaneous logic 1 inputs the next state becomes indeterminate and in truth chart language it is said to be not allowed, forbidden or indeterminate. In general, simultaneous logic 0 inputs represent a no-change condition and values are related to the previously set or reset position.

An additional input can be added to a multivibrator which permits toggling or flip-flop operation. This input applies so-called *clock* information to both inputs simultaneously, **fig. 2A**. As per the fundamental triggered-multivibrator, the output frequencies are one-half the clock

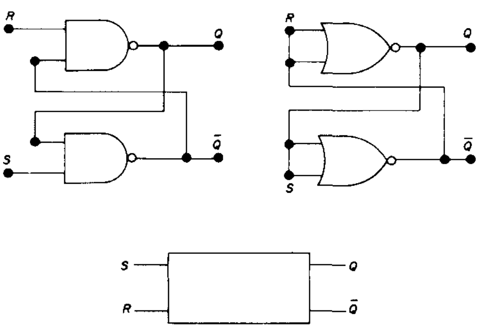


fig. 1. The basic flip-flop multivibrator and its truth chart.

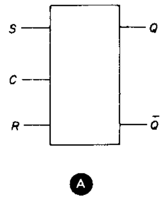
S	R	Q	$\overline{Q}$
1	0	1	0
0	1	0	1
1	1	——————— forbidden	
0	0	——————— no change	

input frequency. This is the basic binary multivibrator, or 2-to-1 divider, or 2-to-1 counter. The logic of the output is controlled by the set and reset inputs of the clocked R-S multivibrator.

A popular multivibrator circuit in-

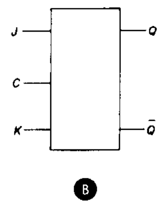
change over the output logic.

A popular digital multivibrator is the universal flip-flop such as the 7472N shown in **fig. 3**. This combination permits you to set up a variety of multivibrator functions because it has both input pairs,



S	R	Q	$\overline{Q}$	
1	1	— — — — — —		forbidden
0	1	0	1	
1	0	1	0	
0	0	— — — — — —		no change

fig. 2. Clocked R-S and J-K flip-flops.



J	K	C	Q	$\overline{Q}$	
0	1	1	1	0	
1	0	1	0	1	
1	1	1	— — — —		complement
0	0	0	— — — —		no change

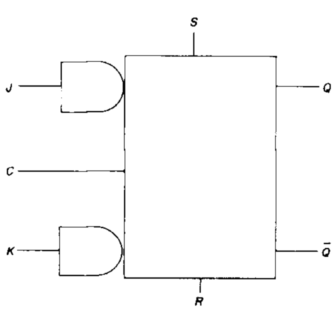
all other combinations —
no change

cluded in digital ICs is the J-K flip-flop, **fig. 2B**. This arrangement permits ease in setting the flip-flop to a desired condition. In addition to the usual set and reset positions as shown in the truth chart, it is possible to supply logic 1 level to the J and K inputs simultaneously. If the clock pulse is also of logic 1 level there will be a switchover of the output logic voltages. However, if both the J and K inputs are logic 0 the clock pulse is not able to

R-S and J-K. The use of the J, K and C inputs permit J-K FF operation. Since the R and S inputs are overriding, the multivibrator can also be operated in the R-S manner. For simple operation as a 2-to-1 divider, you need only apply signal to the clock C input.

experiments

You can learn much by experimenting with several of the low-cost digital ICs.



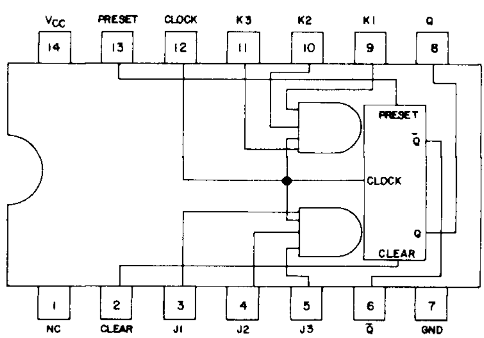


fig. 3. Universal flip-flop (A) and the actual pin connections of the 7472N (B).

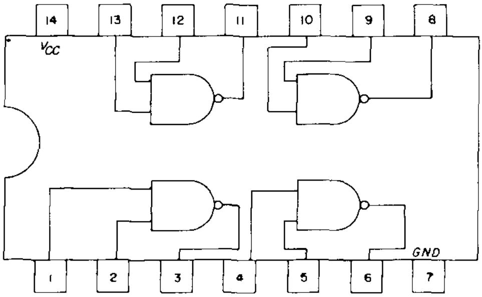


fig. 4. Connection diagram for the 7400 quadruple 2-input NAND gate.

Later these can be combined into a calibrator, counter or some other unit that can be useful in your station.

A small perforated board, 4½ x 5½ inches, supported on four stick-on protector pads can serve as a versatile test board. Several 14-pin in-line sockets can be attached to the board. All socket terminals, or as many as are needed, can be wired to soldering lugs that are screwed to the board. This arrangement gives you versatility and better experimental wear-and-tear with frequent rewiring when various types of digital ICs are to be used.

experiment 1
NAND gate

A readily available and low-cost digital IC NAND gate is the SN7400N (7400 series) which consists of four individual NAND gates with dual inputs, **fig. 4**. Supply voltage is connected to pin 14 for this TTL device, while common (ground), is connected to pin 7.

Connect the circuit of **fig. 5**. Use just one of the gates in the device. The circuit connections are simple; the dual inputs

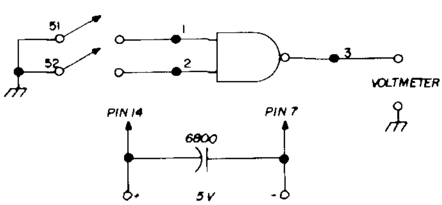


fig. 5. One-quarter of an SN7400N NAND gate connected to show dc operation.

are pins 1 and 2 and the output, pin 3. Connect a voltmeter across the output. Two spst switches permit you to establish the logic 0 and logic 1 inputs. This device has two states as in any binary logic system. The logic 1 state or *high* is represented by a voltage greater than plus 2 volts (positive logic) while the logic 0 state or *low* is represented by a voltage of 0.8 volts positive or less.

When the gates are open, the emitter voltage in the basic TTL circuit of **fig. 6** is more than 2 volts positive, and the emitter junction is being reverse biased. Open both switches and measure the dc voltage at pins 1 and 2 to confirm this statement.

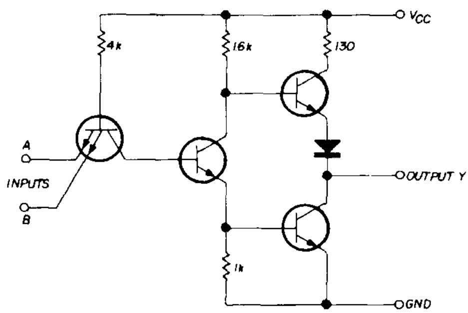


fig. 6. Basic circuit for a single gate in a 7400 digital IC.

The collector junction is forward biased and the collector current present in the base-emitter circuits of the output transistor results in a saturation current and 0 output voltage as indicated by the voltmeter. In this connection then, logic 1 voltage is present at pins 1 and 2 while logic 0 voltage appears at the output.

Now close switch S1. What happens to the voltmeter reading? Measure the voltages at pins 1 and 2. Note in particular that the voltage at pin 1 represents logic 0. Logic 1 voltage remains at pin 2 and the output voltage is also logic 1. When switch S1 is closed the input emitter junction is forward biased and the collector current now changes direction and cuts off the output transistor. Its collector voltage rises to near the supply voltage and produces logic 1 output.

Repeat this step with switch S2 closed and S1 open. Repeat again with both switches S1 and S2 closed. Set down the *truth table and compare it with the truth* table of a NAND circuit as given previously in the April column.

experiment 2
flip-flop

Rewire the experiment board to the circuit of **fig. 7**. Two of the NAND gates of the device are now wired together. The output at pin 3 is connected to pin 4 while output 6 is fed back to pin 2. This

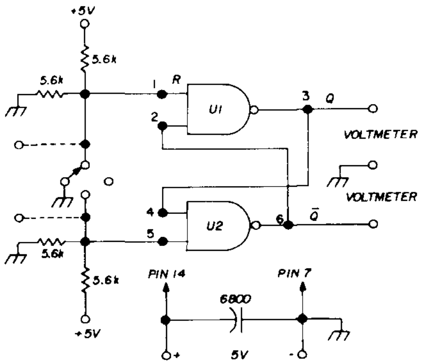


fig. 7. NAND gates in flip-flop. U1 and U2 are each ¼ of an SN7400N. Dashed lines show connections for an audio input.

feedback path is normal for a flip-flop multivibrator.

Connect the voltmeter between output 3 and common. Connect ground to input 1 with the switch. Is output 3 logic 1 or logic 0? Connect the voltmeter to output 6. Is it logic 1 or logic 0?

Restore the voltmeter to output 3. Set the switch to its unused center position. What happens to output 3 and output 6?

Connect the voltmeter to output 3. Use the switch to ground input 5. What happened as the switch closed? Check the outputs at 3 and 6. Note how the output is toggled as the switch is changed from input 1 to input 5 and vice versa. Complete the truth chart of **fig. 8**.

1 R	5 S	3 Q	6 $\bar{Q}$

fig. 8. NAND gate flip-flop truth chart to be filled in from actual experimental readings taken with the circuit of fig. 7.

experiment 3
ac flip-flop

Change the input of the flip-flop, **fig. 7**, in accordance with the dashed lines. Set the switch to its unused center position. Apply a 1000-Hz sine wave to the input. Connect the oscilloscope between output 3 and common.

Slowly increase the amplitude of the audio signal. When the audio level is adequate the sine wave will toggle the flip-flop. Note the quality of the output square wave. It has steep leading and trailing edges. Flip-flops are often used to sharpen the edges of slower rising and distorted waveforms.

Increase the level of the audio input wave. Observe how constant in voltage the output remains once the input wave is sufficient in magnitude to cause toggling. Try audio input frequencies of 100, 10,000 and 100,000 Hz. The quality of the output waveform remains good and the amplitude constant.

Reset to 1000 Hz. Display four square

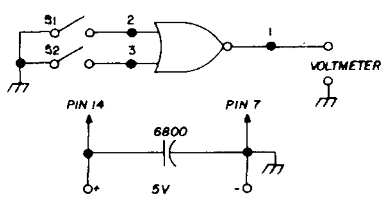


fig. 9. A 7402 NOR gate set up for dc operation.

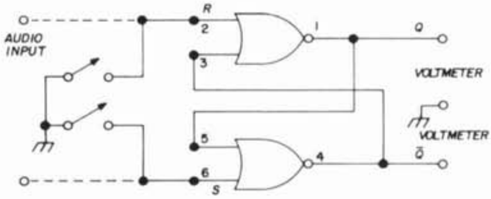
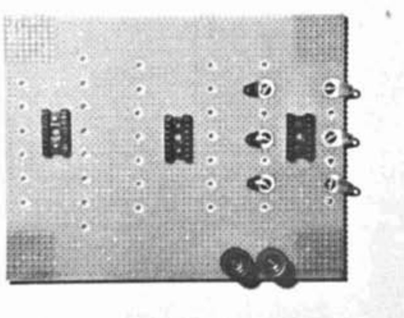


fig. 10. NOR gates arranged into a flip-flop.

waves on the oscilloscope screen. Transfer the oscilloscope to input 1 and note that output frequency and input frequency are the same.

experiment 4
NOR gate

Remove the 7400 positive NAND gate and prepare to use a 7402 NOR gate IC. Connect the circuit of **fig. 9**. Positive voltage is applied to pin 14 and ground to pin 7 as for the 7400. In this case, however, pins 2 and 3 are the inputs while pin 1 is the output. Switching arrangement is the same as that of the NAND circuit shown in **fig. 5**. Open is again logic 1; the switch closed to common corresponds to logic 0. Connect the voltmeter to the output and set down the voltage readings with both switches open, both switches closed, S1 open and S2 closed and, finally, S2 open and S1 closed. Prepare your own truth chart and compare with the NOR logic truth table of April's column.



W3FQJ's breadboard for IC experiments uses IC sockets and solderless binding posts for quick circuit changes while still protecting the delicate IC wire leads.

Open both switches and apply a 1000-Hz tone to the input. Connect the oscilloscope across the output. Remember, to activate the NOR gate both inputs must be driven to the logic 0 state. Therefore, when driven from a single audio source, the two inputs must be paralleled.

Slowly increase the audio level. After passing a certain point you will obtain NOR gate output. Again, a good square wave is obtained. Check the output on 100, 10,000 and 100,000 Hz.

2 R	6 S	1 Q	2 $\bar{Q}$

fig. 11. NOR gate flip-flop truth chart to be filled in from actual experimental readings taken with the circuit of fig. 10.

experiment 5
NOR gate flip-flop

Connect the flip-flop circuit of **fig. 10**. To observe the operation of the NOR gate flip-flop you will need two spst switches. Use the voltmeter to measure the voltage at outputs 1 and 4. Record these outputs for switches S1 and S2 closed, S1 and S2 open, S1 open and S2 closed, and, finally, S2 open and S1 closed. Note that for both S1 and S2 closed, logic 0, the output is indeterminate and is a function of whether S1 or S2 was closed previously. Complete the truth chart of **fig. 11**.

experiment 6
master crystal oscillator

A simple dual-input NOR gate, **fig. 12**, can be connected externally into a feed-

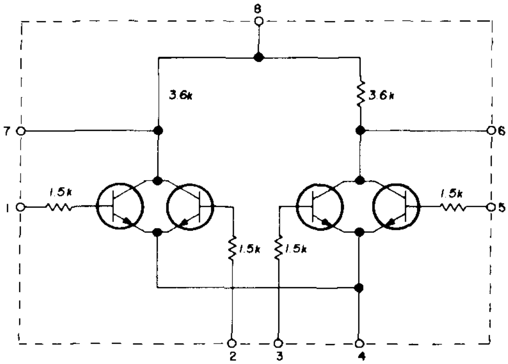


fig. 12. HEP580 MRTL dual-input NOR gate.

back circuit to perform as either a free-running multivibrator or a crystal-controlled square-wave generator. In the latter case, a crystal is inserted in the feedback path between output 6 and paralleled inputs 1 and 2. The second feedback path is provided by a capacitor inserted between output 7 and inputs 3 and 5.

The HEP 580 IC has an 8-pin base. Mount an 8-pin round socket on the breadboard. Assemble the circuit shown in **fig. 13**. Only four external parts are required: two resistors, a capacitor and the crystal socket. This is one of the simplest 100-kHz crystal calibrators you can make.

The square wave output can be observed at pins 7 and 6. The harmonic content of the IC output is high and clear calibration points can be found on frequencies as high as 52 MHz.

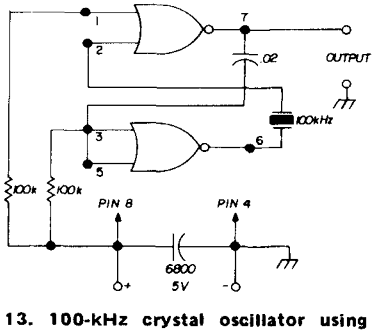


fig. 13. 100-kHz crystal oscillator using the HEP580.

experiment 7

2-to-1 flip-flop counter

The addition of a low-cost J-K flip-flop multivibrator to the output of the 100-kHz generator provides you with a 50-kHz output as well. A TTL SN7472 will do, **fig. 14**. It can be inserted into the same in-line socket used previously in experimenting with the NAND and NOR gates. Supply voltage and common are again attached to pins 14 and 7 respectively. The output of the 100-kHz generator, pin 7, is applied to the clock input, pin 12. It is possible to obtain 50-kHz output at either the Q or $\overline{Q}$, pins 8 and 6 respectively, of the counter.

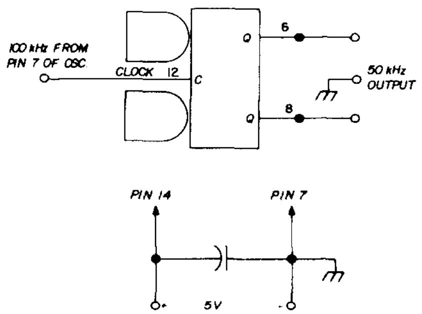


fig. 14. An SN7472 J-K flip-flop used as a 2-to-1 divider.

Observe the input signal at pin 12 with the oscilloscope. Display four cycles of the square wave. Now transfer the oscilloscope to the Q output, pin 8, and note that the frequency has been halved. A 2-to-1 count has been made.

Calibration points can be heard readily up into the six-meter band. In using a calibrator, the oscillator alone (divider switched off) can be used to locate 100-kHz points. Output of the divider can then be used to locate the 50-kHz intermediate points.

Next month additional counter stages will be added to the calibrator.

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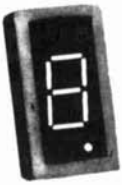

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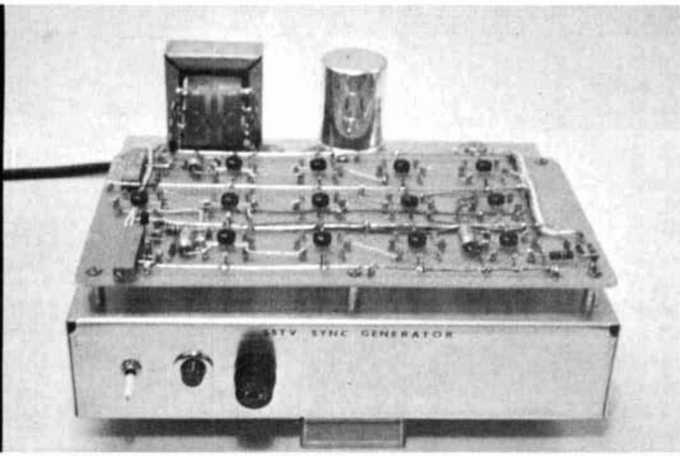
851/951	DTL monostable multivibrator	$1.00

MOTOROLA DIGITAL

MC724	Quad 2-input RTL Gate	$1.00
MC788P	Dual Buffer RTL	$1.00
MC789P	Hex Inverter RTL	$1.00
MC790P	Dual J-K Flip-flop	$2.00
MC799P	Dual Buffer RTL	$1.00
MC780/880	RTL decade counter	$3.00
MC1013P	85 MHz Flip-flop MECL	$3.25

More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94



sync generator

for sstv

RTL flip-flops and gates in a circuit designed to provide stable horizontal and vertical sync pulses for slow-scan television

David R. Patterson, WA2EWO, 524 Gropp Avenue, Trenton, New Jersey

The availability of low-cost resistor-transistor logic (RTL) ICs suggests the possibility of constructing a stable sync generator for slow-scan television application.

Present sstv standards use a 15-Hz line-scanning rate and an 8-second frame rate. This combination gives the 120-line raster suggested under present standards. Normally these scanning rates are referenced to the 60-Hz power line frequency to provide stability and reduce 60-Hz hum in the sstv picture.

counting circuit

The counting-type sync generator shown here was built using two popular IC twins – the RTL 914 dual 2-input positive-logic NOR gate and the RTL 923 J-K flip-flop.* The J-K flip-flop is a very convenient device for use in counting circuits. One input pulse changes the output state, while a second pulse is

*Don't overlook the HEP line of ICs for this and similar projects. The HEP series are selected "universal" substitutes chosen from Motorola's extensive family of devices for "Hobbyists, Experimenters, and Professionals" – hence "HEP". For example the 914 gate (Motorola MC714G) is available as HEP584. It will perform as indicated in this application. **editor.**

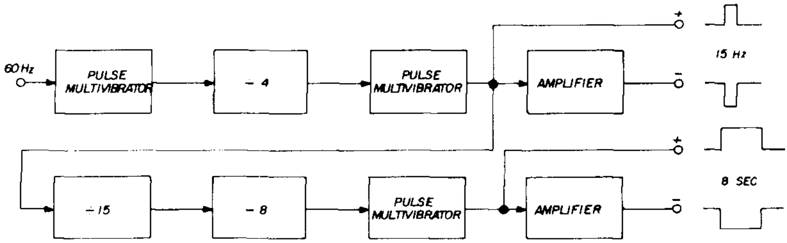


fig. 1. Block diagram showing counting sequences to obtain sstv horizontal and vertical scanning pulses.

necessary to restore the output to its original state. Thus two input pulses are required to complete one output cycle of the flip-flop. The counting process may be expanded by adding more flip-flops in series.

The output frequency of the flip-flop chain is related to its input in terms of powers of 2. This action is expressed as 2^n where n is the number of flip-flops connected in series. Flip-flops interconnected in this way form what is known as a binary ripple counter. If it's desired to count by a sequence other than 2^n, the normal counting sequence of the binary counter must be altered to achieve the desired count. Such change may be obtained by several methods. In the sync generator described here, gates are used to sense a particular count. The gates are then reset to restart the first counter so that the sequence begins again.

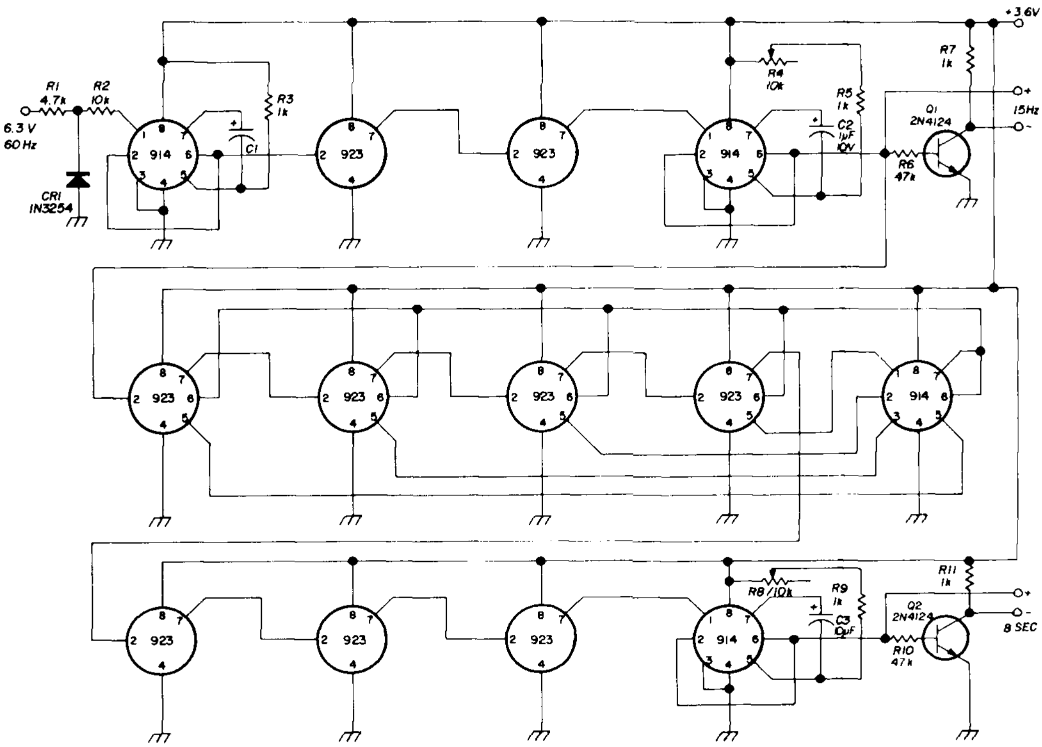


fig. 2. Sync-generator schematic. Binary ripple counters and 2-input NOR gates provide desired output.

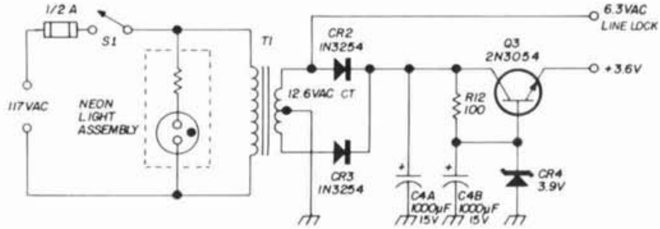


fig. 3. Suggested power supply. Regulation is provided by the zener in the base of Q3.

counting sequence

The block diagram of **fig. 1** shows three basic counting sequences in the sync generator. The reference frequency, 60 Hz, is divided or counted by 4. As explained previously, this process will require two flip-flops; i. e., $2^2 = 4$. This circuit provides one output pulse for four input pulses, or an output frequency of 15 Hz. The next counter is a basic "divide by 16" counter that has been modified by gates to count by 15. Two gates (one IC package) are parallel-connected to sense the output of each J-K flip-flop and reset on the 15th input pulse. Thus the output is 1 Hz. The final counting sequence is provided by a "divide by 8" counter. Since $2^3 = 8$, three flip-flops and no gates are required. For every 8 pulses one output pulse results, or one output pulse every 8 seconds. This provides the sstv frame rate described above.

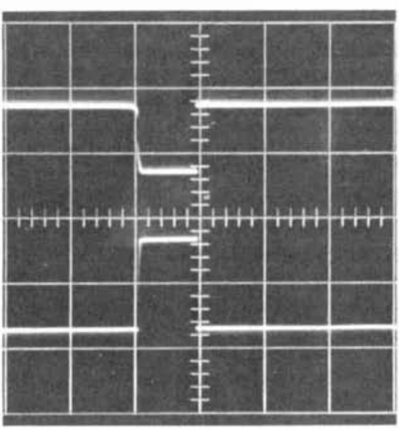


fig. 4. Oscillograph of the 15 Hz scanning pulse.

To provide the desired output-pulse width, two gates (one IC package) may be connected as a monostable multivibrator. The multivibrator output pulse can be adjusted to the desired pulse width by changing the RC time constant and bias voltage, or both, applied to the gate. Two units supply the proper output-pulse width of 5 ms for the 15-Hz scanning rate and 30 ms for the 8-second vertical or frame rate. A third multivibrator supplies a fast-fall-time pulse, derived from the power-line frequency, to trigger the first counter. The complete sync generator is shown in **fig. 2**.

power supply

Both output-pulse polarities are indicated on the schematic. Individual preferences will determine the actual polarity used. A simple emitter follower, zener-referenced power supply is shown in **fig. 3**.

adjustments

Only two adjustments are required. The output-pulse width is adjusted by R4 to provide the 5-ms output pulse at a 15 Hz rate, and R8 is adjusted to provide a 30-ms pulse every 8 seconds. **Fig. 4** shows the plus and minus output of the 15-Hz, 5-ms line-scanning pulse. Positive output is 1 volt, and negative output is 3.6 volts.

The circuit described has proved to be an economical way to obtain stable synchronizing pulses for sstv use. The breadboard-type construction allows easy access to any point in the counting circuits if pulses other than those for sstv are desired.

ham radio

getting started in microwaves

Buy new, build your own, or scrounge surplus; here is how to start experimenting with microwaves

William T. Roubal, 2725 Montlake Boulevard East, Seattle, Washington 98102

Many potential microwave enthusiasts have probably been frightened away simply because of the high price of new equipment. Such fears need not prevail, however, since many quality waveguide components, tubes and auxiliary pieces are available from dealers in surplus, often for as little as 1% of the new-market cost. Additionally, if you are mechanically inclined and can do metal work, you can fabricate some really beautiful pieces of your own equipment. Homemade components may not be devices calibrated to the nth degree, but they will be quite functional and will illustrate basic principles.

This article, therefore, is to show that you don't need unlimited resources to do some very interesting things with microwaves. Accordingly, nothing in the way of theory will be presented here. There are numerous applications for microwaves, both in communication and scientific research. The beginner as well as the advanced reader will find the public and college libraries the best source of information on both theory and applications.

getting started

Pick up an inexpensive, low-power

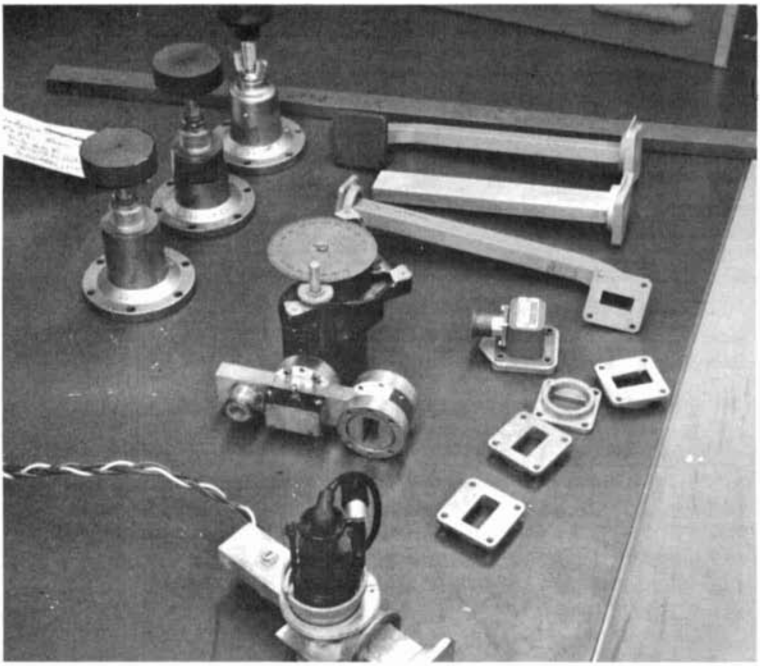


fig. 1. X-band waveguide components. From bottom to top are surplus 723 A/B klystron and holder, surplus resonant cavity, straight and bent sections of waveguides, UG-39/U waveguide flanges for do-it-yourself construction projects and waveguide-to-coax adaptor (next to flanges). The peculiar looking objects at the upper left are waveguide supports and were made by turning down the bakelite knobs salvaged from broken pressure regulators. The total value of the components if purchased outright would exceed $1,000. From surplus, all were obtained for less than $50.

klystron tube, hook it up to an appropriate power supply, and you're generating microwaves – no need to worry about interelectrode capacitance limiting

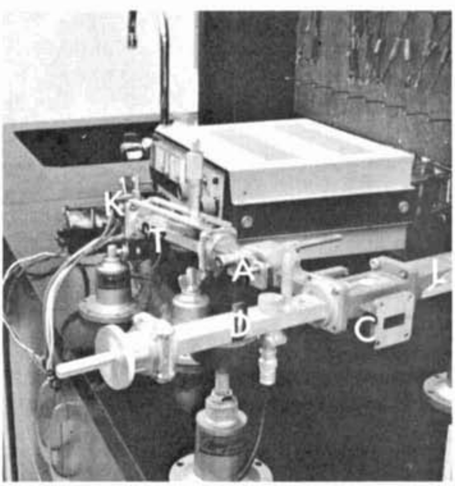


fig. 2. Experimental X-band microwave string.

your frequency, adjusting external tank circuits or watching lead dress, for all of these, and more, go out the window when you use a klystron. Add a few more inexpensive surplus items (or use homemade devices) and you're off and running. You can gradually expand your projects as your knowledge and technique develop.

Waveguides and related "plumbing" found most commonly are for X-band (9 GHz) applications (**fig. 1**). Fortunately some of the least expensive klystrons are also X-band generators. Accordingly, I shall limit my discussion to X-band components and methodology.

Fig. 2 shows a microwave string consisting of a Varian 998044 klystron (K), cooled by a small squirrel-cage fan (always force cool even the smallest klystron), homemade slide screw tuner (SST), surplus attenuator (A), surplus directional coupler (C), surplus absorptive

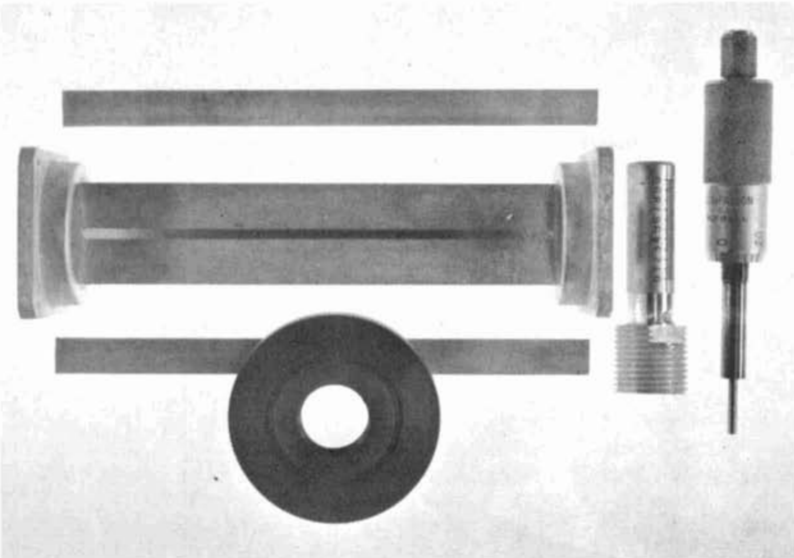


fig. 4. The homemade slide screw tuner. The tuning mechanism is a Sears micrometer body. In this version the threaded cylinder which holds the micrometer is ¾-inch OD instead of the specified 1 inch. The 1-inch piece is better electrically as it presents a larger surface area upon which to slide. It is included in fig. 5.

load (L) and a homemade tunable crystal detector (D). What you connect beyond the directional coupler will depend on what you want to study or illustrate. The assembly of **fig. 2** is used for studying

fig. 3. Microwave transmitter and receiver. The Berkeley Physics Lab by Heath-kit — transmitter and receiver (right foreground) and experimental patch board (sitting on power supply) — can be purchased prefabricated and complete, or ordered a part at a time, obtaining only what you need.

dielectric properties of materials which are inserted into a short section of empty waveguide and attached to the open port of the coupler. A simpler setup might consist of a klystron and horn radiator (transmitting antenna), and, at some distance away, a receiver (another horn coupled directly to a crystal detector). Such an arrangement can be used for demonstrating microwave propagation polarization and reflection. **Fig. 3** shows one such setup using Heath equipment. Here a square wave is being used to modulate the klystron (achieved simply by coupling a square wave source to the repeller voltage source using a 0.01 μF coupling capacitor.)

equipment assembly

Since the exposed metal envelope of the reflex klystron tube forms the anode, the tube is normally operated with the anode grounded and with the cathode and repeller operated below ground potential. For either the Varian klystron shown in **fig. 2** ($300, new) or the more common 723A/B (or 2K25) shown in **fig. 1** (about $30, new), you will need a

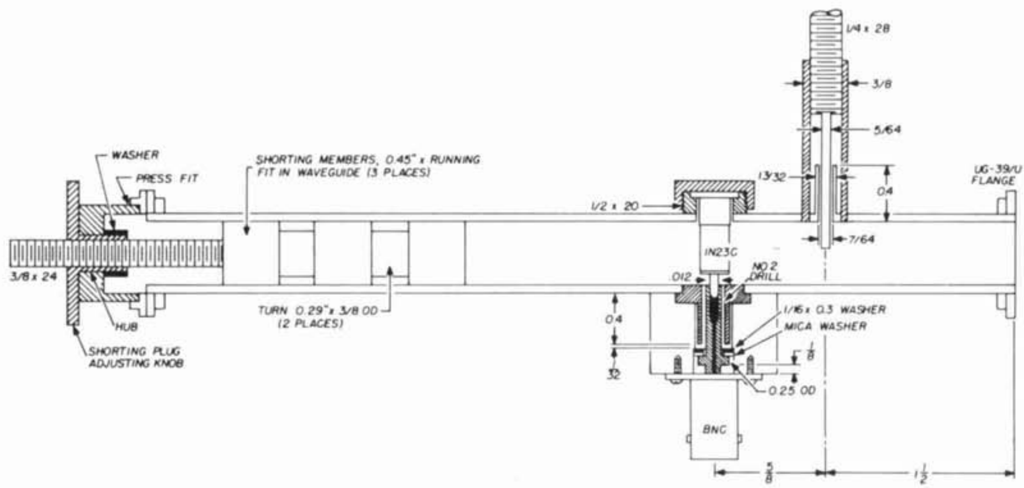


fig. 6. The homemade tunable crystal detector. All parts are brass plated with LT-26 electroless tin and soldered together.

well-regulated variable 0-300 volts dc cathode-to-anode supply, plus a variable −300 volts dc supply for the repeller; filaments, as usual, are 6.3 volts. The Heath Model IP-17 power supply provides all three voltages.

Though not an absolute necessity, the slide screw tuner will allow you to match up the microwave string for maximum overall efficiency. Used tuners, when available, may run $20 or more ($250, new), however, the metal working reader can build his own for about $11 (**figs. 4** and **5**). Variable attenuators may cost anywhere from $100 to $500, new. Nevertheless, the author has recently seen very good quality surplus units for $15. Similarly, brand new directional couplers will probably be priced under $20. **Fig. 6** shows a cross-section of my homemade crystal detector, and **fig. 7** is a photo of the parts assembly.

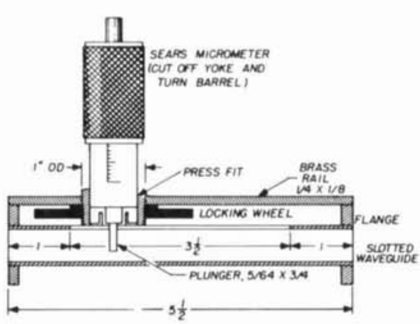


fig. 5. Construction details for the slide screw tuner. All fabricated parts are brass plated with electroless tin, using a simple, one-step process, before soldering together. Note the slot is shown in fig. 4 extending almost to the ends of the guide have been modified in this drawing. This is the recommended construction.

surplus

If you're lucky, your surplus items will be either gold or silver plated. If gold plated, they may show little or no tarnish. Usually a cleanup with nonflammable dry cleaning solvent followed with a soapy water scrubbing of exterior surfaces will make metal parts shine like new. Silver plated components, on the other hand, may be so badly tarnished as to look almost black. Carefully disassemble as much of the unit as you can (use caution since some items such as

*Both electroless tin and electroless gold are available from Shipley Company, Inc., 2300 Washington Street, Newton, Massachusetts 02162. More information on electroless plating is available in the article by Larry Hutchinson, "Practical Photofabrication of Printed-Circuit Boards," *ham radio,* September 1971, page 17.

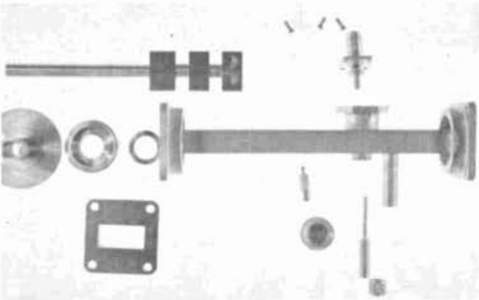


fig. 7. Construction details of the tunable crystal detector. The movable short and the tuning screw are adjusted for maximum crystal output. The drawing of fig. 6 differs in a few dimensions from the unit shown here. The text includes a few construction suggestions and hints on plating the parts. The real perfectionist can plate all the parts with gold.

slotted lines and certain couplers are very carefully mated together during assembly and are best left intact) and remove the tarnish using any of the ordinary liquid dip tableware tarnish removers.

Many used components will be made entirely of copper, bronze or brass without plating; more often than not, tarnish, corrosion and old paint are to be expected. Heavy tarnish, pitting and old paint can be removed from exterior surfaces with fine grit, wet-dry sandpaper and water. Generally, the internal surfaces will show less imperfections than the outside. Unless absolutely necessary, do not apply sandpaper or files to internal surfaces because close tolerances should not be altered. After the piece has been cleaned up, etch the piece briefly in mild acetic acid (or very dilute nitric acid). Rinse and dry the part, and plate the entire part with electroless tin.* The tin plate will improve electrical conductivity and will add new life to the metal. Tin-plated metal to be soldered can be heated in a direct flame; the plating will prevent oxidation and discoloration. For the ultimate in conductivity and corrosion resistance, brass parts can be gold plated with Shipley's electroless gold.

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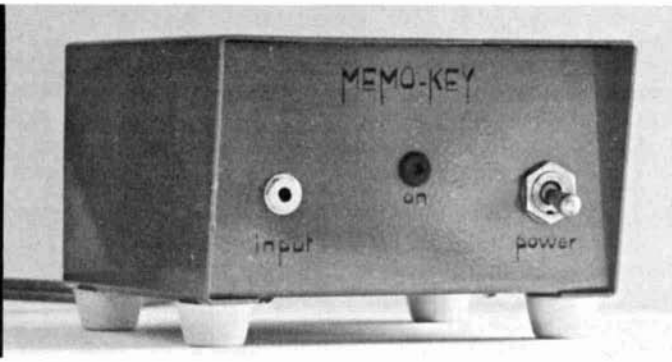


memo-key

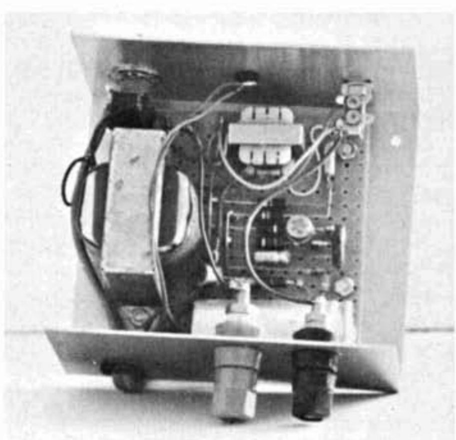
An inexpensive tape recorder and this electronic switch will increase your enjoyment of CW and RTTY

James R. Huffman, WA7SCB, Box 307, Mountain View, Wyoming 82939

This article may revolutionize your thinking about using code wheels for CW operation and paper tapes for RTTY. The memo-key can enhance your operating pleasure in many ways. Applications of the design are numerous and are limited only by your imagination.

how it works

The memo-key is shown in **fig. 1**. The circuit detects the presence of tones of various lengths that have been prerecorded on tape. These tones, which may be the recorded output of a code oscillator, side-tone from a receiver or keyer, or even a whistle, are converted to



Suggested parts layout.

on-off switching impulses in the output stage. The device will switch a maximum of 100 mA at 40 volts, which is sufficient to actuate a CW keying relay or drive a grid-block-keyed transmitter directly. Other applications are described later.

The memo-key may be operated from batteries or a power supply, as shown in **fig. 1**. Current drain is low, because the high-current output switch is not connected across the power supply. When driving a relay, a diode should be placed across the relay coil to suppress high-voltage spikes. The value of capacitor C4 may have to be changed slightly when switching currents other than 100 mA. The discharge time constant of the circuit is set for switching 100 mA; any load less than 100 mA slows the switching action considerably. In fact, when switching a low-current RTTY load, you may wish to eliminate C4 entirely, although sensitivity will decrease.

Two modifications may be necessary if you wish to use the memo-key with a tape deck. A level control should be connected across the deck output, then to the memo-key input. Also, no transformer will be needed at the input (T1 in **fig. 1**).

construction

Building the memo-key is no problem. A suggested layout is shown in the photo; however, layout isn't critical, nor is packaging. You may wish to use the utility box shown; rack-mount the unit, or even install it in the same enclosure with an RTTY converter. If you'd like to build a code oscillator, try one of the small 2-transistor units available from Burstein-Applebee or Allied Radio Shack. These units are small, operate from 6 Vdc, and are inexpensive.

As for the tape recorder, a good rule-of-thumb is: your existing tape recorder will probably be satisfactory for the applications shown. If you must purchase a tape recorder for this project, bear in mind the convenience of filing cassettes. Some of the catalog outlets

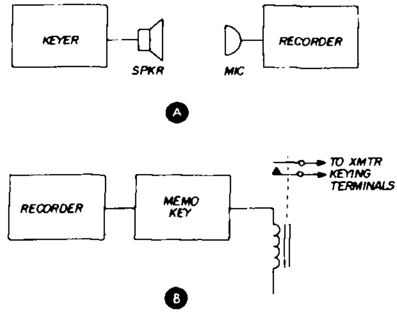


fig. 1. Memo-key schematic. Circuit is a simple electronic switch that will handle loads to 40 volts at 100 mA. Observe polarities when using suggested power supply or batteries.

send flyers showing cassette recorders for less than $20.00. Any of these recorders is satisfactory for use with the memo-key applications shown in this article.

some applications

Applying the memo-key to your particular needs is easy. For example, memo-key may be used as a code-wheel replac-

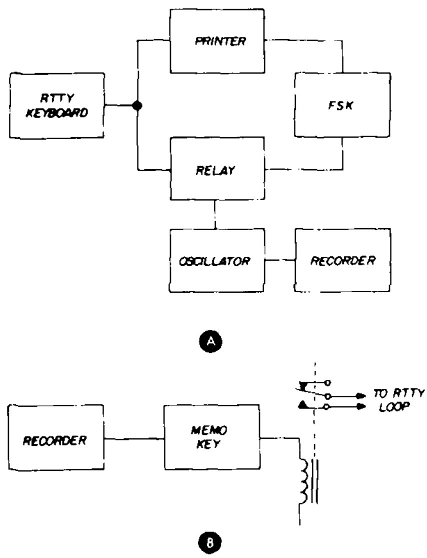


fig. 2. Using the memo-key for CW. Circuit keys the transmitter according to prerecorded input on magnetic tape. Reprogramming is easy, unlike paper tapes or "code wheels."

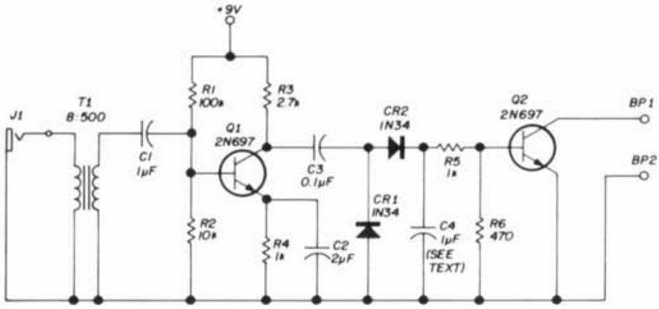
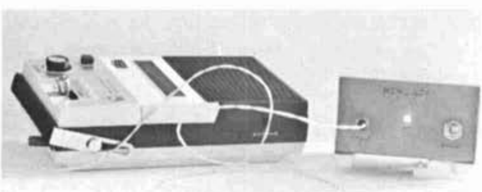


fig. 3. Memo-key for RTTY. Recorded input is stored on tape (mark = tone; space = no tone). Recorder output drives memo-key, which actuates a relay to drive the RTTY keyboard. To keep loop closed, the bias oscillator can feed a mark signal except in "play" mode.

ement to call CQ in contests. It may be used to close and open your end of a contact. In RTTY, you may use the memo-key to send "fox" tests, standard CQ's, elaborate ID's, or anything that can



Complete memo-key with cassette recorder. System is compact and offers easy storage of data for the active operator.

be put on paper tape. Other applications are also possible. Voiced "dits" and "dahs" can be converted to code-oscillator output for code-practice sessions.

Control of transmitters, receivers, or other equipment in the home or amateur station is also possible—all information is remembered and stored as in a complex digital computer. You could push a "play" button on the tape recorder, and instantly the room lights would come on, then the transmitter and receiver tube filaments – all by feeding a shift register with the memo-key output.

concluding remarks

The advantages of using a system like memo-key are numerous: for one, programming is easily changed. The old code wheel is fine for calling CQ, but it doesn't lend itself to reprogramming. With memo-key, you can record yourself calling a station; then at the beginning and end of each transmission merely energize the recorder, and memo-key takes care of the identification.

Another advantage of memo-key is that tape storage is easily accomplished—a boon to the active RTTY and contest operator. A small cassette properly labeled would reduce storage space considerably. Since those paper tapes represent a lot of work it's to your advantage to use magnetic-tape storage, because magnetic tape is nearly impossible to rip, tear, or otherwise mutilate if the tape is neatly tucked inside a cassette case.

Wherever you put it; however you package it; however you use it—the memo-key will serve you well.

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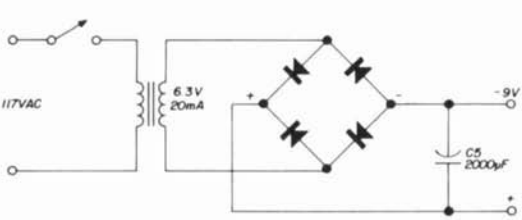
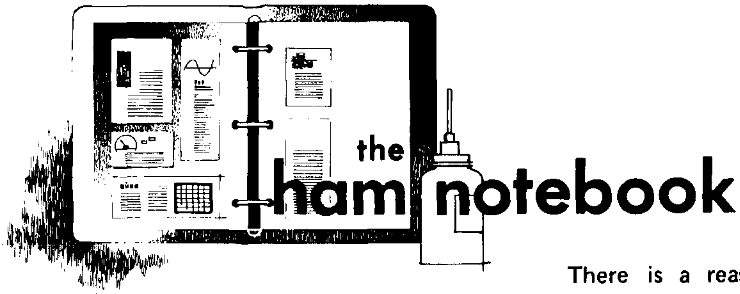


fig. 4. Suggested power supply circuit.



horizontal or vertical?

Antennas are considered to be reciprocal devices, transmitting and receiving equally well. Common amateur practice is to use the same antenna for both functions. Under some conditions, though, better results can be obtained with separate antennas.

On 1.8 and 3.5 MHz, and to a lesser extent on 7 MHz, high-gain directional antennas are impractical for most hams. The average amateur low-frequency antenna is fairly omnidirectional. Therefore, the antenna can generally provide no improvement in the signal-to-noise ratio, when the principal noise source is atmospheric.

Long-distance communication requires low-angle radiation. A study of theoretical antenna patterns shows that a horizontal dipole has the best low-angle radiation characteristics when it is one-half wavelength above ground. Since this is 140 feet at 3.5 MHz, most amateur 3.5-MHz horizontal antennas radiate at predominantly high angles – fine for short skip, but not very good for the really long-haul stuff.

The radiation from a vertical antenna is mostly low-angle at any height less than 5/8 wavelength. Many hams, hoping to improve their low-frequency DX performance, have installed vertical antennas and radial ground systems. They have generally been disappointed; they did not hear any more DX than they did on their old horizontal antennas, nor was the DX they did hear any louder. Sometimes the vertical seemed to be worse.

There is a reason for this. On the low-frequency bands the chief limiting factor is noise. At any time, atmospheric and man-made noise have a local field strength with which the signal must compete to produce a usable signal-to-noise ratio at the output of the receiver. If the signal field strength does not have a favorable relationship to the noise field strength, there is nothing to be done. The improvement has to be made at the transmitting end – either by the distant station raising power, or by increasing the efficiency of *his* antenna. It might almost be said that the configuration of the *receiving* antenna on the low-frequency bands is unimportant. As long as the receiving antenna is long enough to produce a fairly loud noise output from the receiver, it might as well be a short, random-length piece of wire!

The transmitting antenna may actually be worse for receiving. This is likely to be true if the antenna is vertical. Vertical antennas are much more sensitive to man-made noise, which is predominantly vertically polarized. Even after point sources of man-made noise are eliminated, almost every amateur lives in an environment with a background of man-made noise that is difficult to distinguish from true static. The situation is worst on the low-frequency bands.

I have been reading about the sensitivity of vertical antennas to man-made noise for years, but it was not until I had both vertical and horizontal 7-MHz antennas available at the flick of a switch that I realized how great the difference was. Switching from horizontal to vertical usually resulted in a noise increase of about 10 dB!

Transmitting, it was a different story.

For example, from my location ZS1A is pretty good DX on 7 MHz. I was able to work him with relative ease using my roof-mounted trap vertical. Using my horizontal dipole, I was usually able to hear him with a better signal-to-noise ratio. But I was *never* able to work him using the horizontal for transmitting.

Later experiments working the Orient and the Pacific confirmed this. The horizontal was better for receiving, but the vertical was from one to three S-points better on transmit. The difference, of course, was the greater man-made noise pickup of the vertical. I did not have a vertical antenna for 3.5 or 1.8 MHz, but I am sure the results would have been comparable.

From my own experience and a study of antenna and noise theory, I believe the following principles can be established:

1. For extreme long-distance transmission on low-frequency bands, verticals should be better than horizontals and probably are.

2. Comparisons of the effectiveness of low-frequency verticals with horizontals on the basis of receiving tests are not always valid. Field-strength measurements should be made.

3. For low-frequency DX reception, the antenna is of little importance, but a vertical may be worse than a horizontal because of man-made noise.

Undoubtedly the best scheme is to have both vertical and horizontal antennas available, with switching to make it possible for either to be used for receiving or transmitting independently of the other.

Of course, these findings only apply when it is not possible to erect an antenna having worthwhile gain and directivity — the usual situation on the low-frequency bands.

Harry R. Hyder, W7IV

Swan 350 CW monitor

This simple circuit provides a built-in CW monitor for the Swan 350. It can be built compactly, installed quickly and has plenty of output.

The parts were mounted on a small printed-circuit board with the resistors installed vertically. I used a solder lug as a mounting foot, secured by one of the crystal filter mounting nuts. This location permits relatively short leads to the required locations.

The resistor, R6, provides isolation of the circuit to prevent loading of the 6GK6 grid circuit and to attenuate the oscillator output to a comfortable level. A value between 1 and 2 megohms should

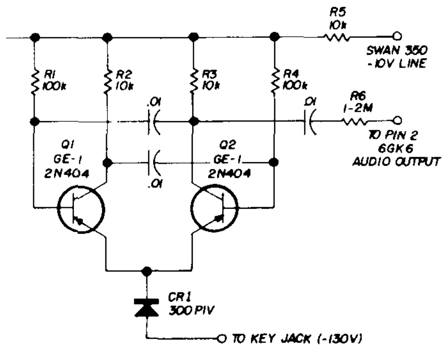


fig. 1. Simple CW monitor for the Swan 350.

do. With the components shown, the frequency is approximately 800 Hz. This frequency may be changed by altering any of the constants shown. The simplest way *would be substituting various transistors.* Just about all transistors will oscillate, and combining a germanium audio type and a pnp silicon rf type can provide some interesting notes!

With the transceiver in the receive mode and the audio and rf gain controls down, the oscillator can be used for practicing the code or adjusting a keyer. I use a pair of stereo headphones with the sections connected in parallel, and the note has more than enough volume. If you use a speaker, decreasing R6 to 1 megohm or 0.5 megohm should blast your eardrums. Changing the volume control during transmit will vary the output but will not change the pitch of the note.

Paul K. Pagel, K1KXA

new products

hf receivers

Radio Shack has introduced two new all solid-state 11-band receivers, the AX-190 for amateur band coverage and the SX-190 for general communications and shortwave listening.

Both receivers are dual conversion with a crystal-controlled first oscillator and tunable second oscillator. Sensitivity is given as 0.5 μV on ssb and CW, and 1.0 μV on a-m for 10 dB S+N/N.

A built-in Q-multiplier provides better than 60-dB image rejection and 50-dB spurious rejection. Built-in 25- and 100-kHz crystal calibrators assure visual dial accuracy of within 200 Hz. The dial reads direct to 1 kHz. Frequency stability is said to be better than 500 Hz per hour.

Other features include ceramic filters for sharp selectivity, dual time-constant agc, anl, crystal-controlled bfo, illuminated S-meter and a line/tape output and headphone jack. Each receiver has dual-regulated power supplies for operation on 120 Vac and 12 Vdc.

The AX-190 is crystal-controlled on 3.5-4, 7-7.5, 14-14.5, 15-15.5, 21-21.5, 27-27.5, 28-28.5, 28.5-29, 29-29.5 and 29.5-30 MHz, with a blank channel for special monitoring between 3.5 and 10 MHz. It has a vfo output and simplified interconnections for easy transmitter hook-up.

The SX-190 is supplied with crystals for reception on 3.5-4, 5.7-6.2, 7-7.5, 9.5-10, 11.5-12, 14-14.5, 15-15.5, 17.5-18 and 27-27.5 MHz, with blank channels for special monitoring on 3.5-10 MHz and 10-30 MHz.

The AX-190 and SX-190 receivers are priced at $249.95 each, with metal cabinet, 7 x 15 x 10-inches. A matching speaker is available for $19.95. The receivers are available at any of the local Allied Radio Shack stores. More information is available by using *check-off* on page 94.

regulated power supplies

The benefits of regulated power supplies are explained by Irving Gottlieb, W6HDM, in his new book "Regulated Power Supplies" published by Howard W. Sams. The first chapter lists the reasons why regulated power supplies are used. These include such benefits as increased efficiency, precision, greater dynamic range, feedback stabilization, higher signal-to-noise ratio and wider frequency response.

The second chapter discusses the static characteristics of regulated power sup-

More Details? CHECK—OFF Page 94

plies such as dc regulation, temperature effects, stability, long-time and short-time deviations and drift. Other chapters cover dissipation control and the uses of integrated circuits and monolithic modules. Representative examples of commercial power supplies are also explained. 160 pages; $5.95, softbound, from Comtec Books, Greenville, New Hampshire 03048.

fm transceiver with tone encoder

SAROC featured the introduction of Ross and White's new two-meter fm transceiver with built-in tone-burst encoder. The new RW-Bnd transceiver offers twelve-channel operation (four crystals supplied), three power levels of 0.1, 1 and 10 watts, all solid-state design, and the three-tone encoder. The tones are factory set for the three most common tone-burst frequencies, but they are easily changed in the field.

The unit sells for $359.95 with the built-in encoder. The same rig, but without the encoder, sells for $319.95. This model has provision for the installation of the encoder at any time in the future. Both units come with a microphone and mobile mounting bracket.

For complete specifications on this new rig, write to Ross and White Company, 50 West Dundee Rd., Wheeling, Illinois, 60090 and request the information sheet on the RW-Bnd. You can get the same information by using *check-off* on page 94.

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The Sound System

NEW! RB-550A Rotator and Control

All new control head and famous Hy-Gain model 400 Rotor Brake Rotator / Now in one complete package, one low price / Solid-state logic circuit furnishes electrical information for rotation and control of tower mounted rotator / 10 times the rotating and braking power of any other rotator.

Order No. 859 **Ham Net $199.95**

Phone Patch PR-550 Order No. 812	**Ham Net $ 49.00**
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AC Supply AC-400 Order No. 801	**Ham Net $ 99.95**
Mobile Supply G-1000DC Order No. 802	**Ham Net $129.95**
CW Filter F-3 Order No. 808	**Ham Net $ 37.50**
Calibrator CAL-250 Order No. 806	**Ham Net $ 25.00**
VOX Accessory VOX-35C Order No. 807	**Ham Net $ 29.95**
Mobile Dashboard Mounting Bracket—GTM Order No. 809	**Ham Net $ 8.95**
Floorboard Adaptor—ZZM (Not Shown) Order No. 810	**Ham Net $ 6.00**

Get the complete Sound System...550 from Hy-Gain

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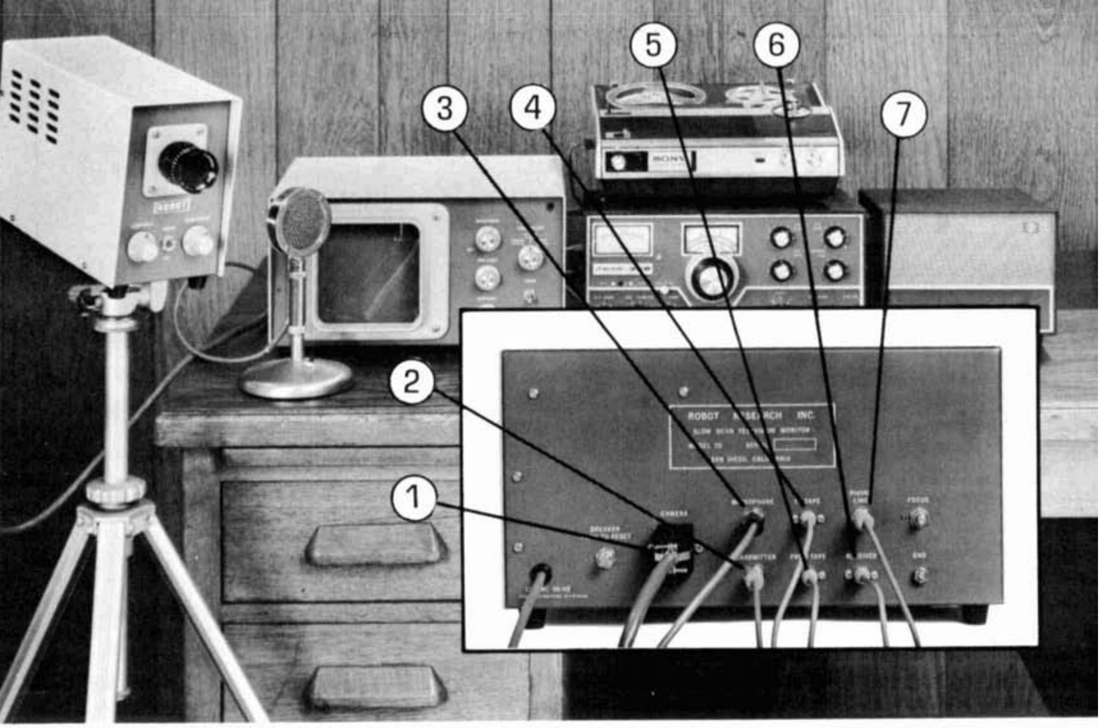

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IRON POWDER TOROIDAL CORES

CORE SIZE	-41 Mix Green 'HR' 20 kc - 100 kc μ=75	-3 Mix Gray 'HP' 50 kc – 1 mc μ=30	-2 Mix Red 'E' 500 kc – 30 mc μ=10	-6 Mix Yellow 'SF' 10 mc – 90 mc μ=8	-10 Mix Black 'W' 30 mc -150 mc μ=7	-12 Mix Grn-Wh 'IRN-8' 60 mc – 200 mc μ=5	Outer Diameter (inches)	Inner Diameter (inches)	Height (inches)
T-200	$2.50	$2.75	$3.00	$3.50			2.000	1.250	.550
T-130	1.50	1.75	2.00	2.50			1.300	.780	.437
T-106	.95	1.00	1.00	1.50			1.060	.560	.437
T- 94	.70	.75	.75	.95			.942	.560	.312
T- 80	.55	.60	.60	.80	.90		.795	.495	.250
T- 68	.45	.50	.50	.65	.75		.690	.370	.190
T- 50	.40	.45	.45	.50	.60	.65	.500	.303	.190
T- 37	.30	.40	.40	.45	.45	.55	.370	.205	.128
T- 25	.25	.30	.30	.35	.40	.45	.255	.120	.096
T- 12	.25	.25	.25	.25	.25	.35	.125	.062	.050

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FERRITE BEADS: .125" x .125", μ = 900. With Spec Sheet & Application Notes Pkg of 12, $2.00

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• The model fm-36 3-digit frequency meter has the same features that has made the 2 digit model so popular with Hams — low price, small size (smaller than a QSL card), 35 Mhz top frequency, simple connection to your transmitter, +0 −0.1 Khz readout — PLUS the added convenience of a third digit to provide a 6 digit capability. Kit or Assembled.

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- Complete single-band SSB transceiver 4 to 5 watts PEP output 15, 20, 40 or 75 meters.
- VFO tuning 3750 to 4000 on 75, full coverage on 40, 20 and 15 meter amateur bands.
- Suitable for dry battery operation.
- Light weight, small size, makes excellent portable — boat, aircraft, field or mobile.
- Contains 15 transistors, 1 mosfet, 2 Darlington amps, 1 I.C. and 17 diodes. Four-pole filter.
- Available accessories, AC power supply, MIC, headsets, lightweight dipole and 40 watt PEP linear amplifier.
- Xtal controlled emergency and net transceiver available. Write for full information on transceivers and accessories.

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hobbyist LEDs

Priced for the amateur experimenter, premium-quality light-emitting diodes are now available through the national network of Sprague distributors. Each distributor will have a working display of many LEDs and a specially-selected inventory of LEDs and related gallium arsenide semiconductors including visible light sources, infra-red sources, indicator lamps, alpha-numeric readouts, photosensors and opto-isolators made by Monsanto.

Although intended primarily for the experimenter, the new line of LEDs are exact replacements for thousands of devices in standard equipment and for many conventional miniature lamps.

Sprague suggests numerous experimenter projects using the new devices stressing the low-current demands and exceptional long-life of the LEDs. Panel indicators, light communications and digital readouts are a few of the more conventional suggestions.

More information is available from Sprague Products Company, North Adams, Massachusetts 01247, or by using *check-off* on page 94.

jewelry

Hobby Jewelry offers a variety of earrings, tie clips, lockets and cufflinks custom made with any call sign, initial or photograph. A variety of sizes and a choice of gold or silver finish is offered, with both finishes guaranteed for a year. More information and prices are available from Hobby Jewelry, 13407 Shoup Avenue, Hawthorne, California 90250 or by using *check-off* on page 94.

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Features:

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Specifications:

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CARRIER and unwanted sideband suppression: Minimum 60db.

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POWER LEVEL: 300 to 500 watts p.e.p. plus, continuous duty cycle.

POWER AMPLIFIER: 8072 final completely broadbanded driver and final. 150 watt continuous dissipation rating.

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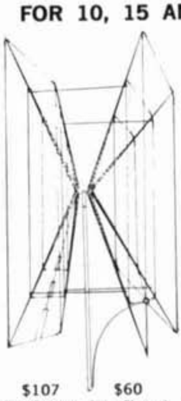
FOR 10, 15 AND 20 METERS



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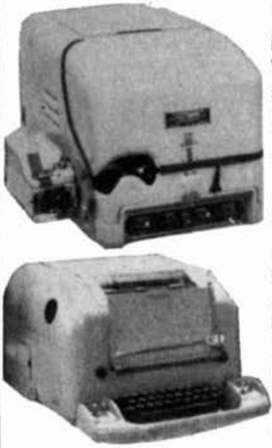

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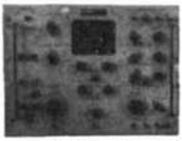

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17″ x 10″ x 11″
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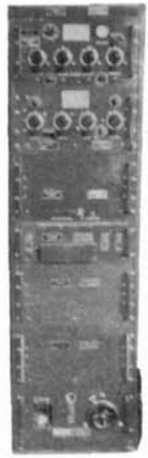
Used, good condition - **$65.00**



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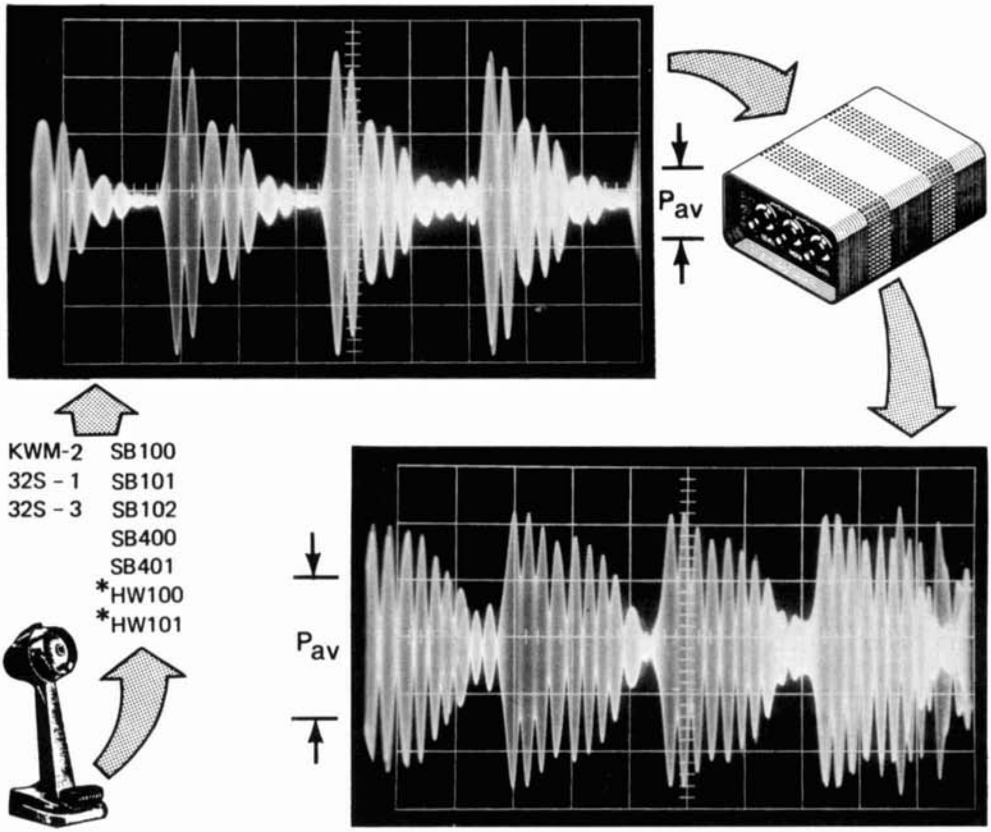

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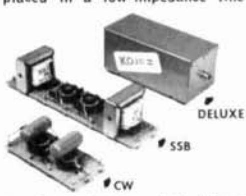
The SSB filter is of a low pass configuration, designed with a sharp cutoff to provide a rejection of better than 30 decibels at all ham band frequencies above approximately 3500 Hz. The filter is specificially designed to be placed in a low-impedance line for earphones or speaker.



The CW filter has a spot frequency of 780 Hz and a passband of 1100 Hz with a reference level, 40 decibels below the signal level at the design frequency. The peak of the passband is 100 Hz wide at the —3 decibel reference points. The CW filter is specifically designed for low-impedance input and high-impedance output. High-impedance crystal earphones are recommended. However, with low impedance earphones a small auxiliary amplifier or impedance matching transformer may be used.

KOJO filters are made up of top grade coils and components and are available in easy to assemble kit form with simplified instructions, or in a deluxe model. The deluxe model is completely built up and ready for use and is enclosed in a Gray cabinet* with convenient IN-OUT switch.

Try a KOJO and see what you can hear now and could not clearly hear before.

*Slight cabinet layout changes subject to take place without notice.

CW Filter Kit $ 8.95 **Deluxe CW Filter $16.95**
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All filters shipped postpaid. Arizona residents add 4% sales tax.

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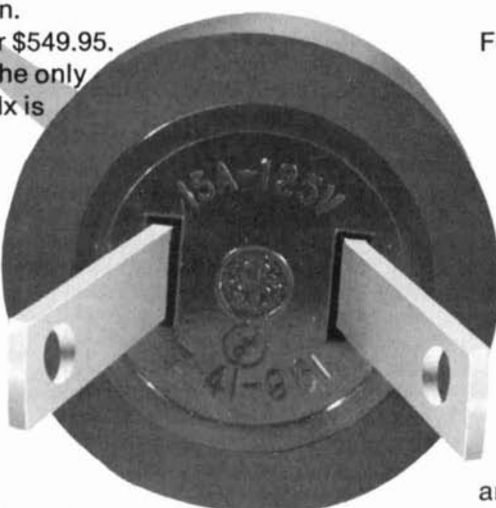
Plug yourself into a bargain



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For a little more than the $549.95 price tag, you can order the 570 with a CW filter.

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flea market

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SWAPFEST, June 25, Egyptian Radio Club, Granite City, Ill., 1 mile Southwest intersection 3 — Interstate 270. Food available. 146.76 talk-in. W9YIY, William F. Guennewig, 318 Hickory, Troy, IL 62294.

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FIGHT TVI with the RSO Low Pass Filter — p115 March 73 — write for brochure — Taylor Communications Manufacturing Company, Box 126, Agincourt, Ontario, Canada.

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FOR SALE: Delco car radios, 12 volts, transistor. Speaker, knobs included. New $14.50 postpaid. W5RSN, 1826 Cypress, Irving, Texas 75061.

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COPY MORSE CODE automatically, (Ham Radio November 1971) detailed construction plans $14.95. VMG Electronics, 2138 West Sunnyside, Phoenix, Arizona 85029.

ALUMINUM MAST SECTIONS: 9½' x 3" o.d., 20 lbs. ea. Extremely strong and rigid. Use as mast, boom, lamp/fence-post. $5.75 ea. Model 14 reperf, $15. Aircraft emergency horn (loud!), $32. 28LPR (typing reperf), unused, in orgnl sealed carton, $75. Unused, unboxed: 4CX250K, $19: 4CX300A, $19; RCA 4500 vidicon (SSTV), $480 catalog, $65; 3BGP1, $22. B&W 850A, $35. IBM Standard electric typewriter, $135. K3MNJ, 8361 Langdon St., Phila., Pa. 19152.

EARLY VACATION? Then tear up that ticket to Tahiti. There'll be more fun at the ARRL Hudson Division Convention, October 21-22, Hilton Motor Inn, Tarrytown, N. Y. Exhibits, Lectures, 2-Meter FM, RTTY, Contests, Gabfests, New York Sightseeing, Fun! No charge for a suntan. Info: Dave Popkin, WA2CCF, 303 Tenafly Road, Englewood, N. J. 07631.

2W. AUDIO AMPLIFIER I.C. short-proof ideal for monitors, intercomms, headphone applications, etc. Module $4.75, I.C. $2.85. Low noise dual preamp I.C. $3.95. 5V/1A regulator I.C. $2.95. Digital Clock/Counter power supply $12.95. Phone Patch module $21.95. Hundreds of I.C.'s and modules in Giant Catalog and Applications Guide. 25¢. Modevco Enterprises, Dept. 11S, P. O. Box 40073, Indianapolis, Indiana 46260.

YAESU FTdx 560 with speaker and CW filter $400. Electrovoice 619 microphone $20. Heathkit SB-610 monitor scope $45. Heathkit HD-10 keyer $30. Hustler 4BTV vertical $25. All perfect. Doug Henry, WA7OHD/6, 292 N. Main St., Orange, CA 92668.

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7403	.26	.25	.23	.22	.21	.20
7404	.28	.27	.25	.24	.22	.21
7405	.28	.27	.25	.24	.22	.21
7406	.52	.50	.47	.44	.42	.39
7407	.52	.50	.47	.44	.42	.39
7408	.32	.30	.29	.27	.26	.24
7409	.32	.30	.29	.27	.26	.24
7410	.26	.25	.23	.22	.21	.20
7411	.28	.27	.25	.24	.22	.21
7413	.58	.55	.52	.49	.46	.44
7416	.52	.50	.47	.44	.42	.39
7417	.52	.50	.47	.44	.42	.39
7420	.26	.25	.23	.22	.21	.20
7421	.26	.25	.23	.22	.21	.20
7426	.34	.32	.31	.29	.27	.26
7430	.26	.25	.23	.22	.21	.20
7437	.56	.53	.50	.48	.45	.42
7438	.56	.53	.50	.48	.45	.42
7440	.26	.25	.23	.22	.21	.20
7441	1.73	1.64	1.55	1.46	1.37	1.27
7442	1.27	1.21	1.14	1.07	1.01	.94
7443	1.27	1.21	1.14	1.07	1.01	.94
7444	1.27	1.21	1.14	1.07	1.01	.94
7445	1.71	1.62	1.53	1.44	1.35	1.26
7446	1.24	1.17	1.11	1.04	.98	.91
7447	1.16	1.10	1.04	.98	.92	.85
7448	1.44	1.37	1.29	1.22	1.14	1.06
7450	.26	.25	.23	.22	.21	.20
7451	.26	.25	.23	.22	.21	.20
7453	.26	.25	.23	.22	.21	.20
7454	.26	.25	.23	.22	.21	.20
7460	.26	.25	.23	.22	.21	.20
7470	.42	.40	.38	.36	.34	.32
7472	.88	.36	.34	.32	.30	.29
7473	.50	.48	.45	.43	.40	.38
7474	.50	.48	.45	.43	.40	.38
7475	.80	.76	.72	.68	.64	.60
7476	.56	.53	.50	.48	.45	.42
7480	.76	.72	.68	.65	.61	.57
7483	1.63	1.55	1.46	1.38	1.29	1.20
7486	.58	.55	.52	.49	.46	.44
7489	4.25	4.00	3.75	3.50	3.25	3.00
7490	.80	.76	.72	.68	.64	.60
7491	1.43	1.35	1.28	1.20	1.13	1.05
7492	.80	.76	.72	.68	.64	.60
7493	.80	.76	.72	.68	.64	.60
7494	1.18	1.12	1.05	.99	.93	.87
7495	1.18	1.12	1.05	.99	.93	.87
7496	1.18	1.12	1.05	.99	.93	.87
74100	1.52	1.44	1.36	1.28	1.20	1.12
74107	.52	.49	.47	.44	.42	.39
74121	.56	.53	.50	.48	.45	.42

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74123	1.21	1.06	1.00	.94	.89	.83
74141	1.63	1.55	1.46	1.38	1.29	1.20
74145	1.41	1.33	1.26	1.18	1.11	1.04
74150	1.63	1.55	1.46	1.38	1.29	1.20
74151	1.20	1.13	1.07	1.01	.95	.88
74153	1.63	1.55	1.46	1.38	1.29	1.20
74154	2.43	2.30	2.16	2.03	1.89	1.08
74155	1.46	1.39	1.31	1.23	1.16	1.08
74156	1.46	1.39	1.31	1.23	1.16	1.08
74157	1.56	1.48	1.39	1.31	1.23	1.15
74158	1.56	1.48	1.39	1.31	1.23	1.15
74160	1.89	1.79	1.68	1.58	1.47	1.37
74161	1.89	1.79	1.68	1.58	1.47	1.37
74162	1.89	1.79	1.68	1.58	1.47	1.37
74163	1.89	1.79	1.68	1.58	1.47	1.37
74180	1.20	1.13	1.07	1.01	.95	.88
74181	5.20	4.90	4.59	4.28	3.98	3.67
74182	1.20	1.13	1.07	1.01	.95	.88
74192	1.98	1.87	1.76	1.65	1.54	1.43
74193	1.98	1.87	1.76	1.65	1.54	1.43
74198	2.81	2.65	2.50	2.34	2.18	2.03
74199	2.81	2.65	2.50	2.34	2.18	2.03
NE501	2.99	2.82	2.66	2.49	2.32	2.16
NE531	3.81	3.58	3.36	3.14	2.91	2.69
NE533	3.81	3.58	3.36	3.14	2.91	2.69
NE536	7.31	6.88	6.45	6.02	5.59	5.16
NE540	2.16	2.04	1.92	1.80	1.68	1.56
NE550	1.24	1.17	1.11	1.04	.98	.91
NE560	3.57	3.36	3.15	2.94	2.73	2.52
NE561	3.57	3.36	3.15	2.94	2.73	2.52
NE562	3.57	3.36	3.15	2.94	2.73	2.52
NE565	3.57	3.36	3.15	2.94	2.73	2.52
NE566	3.57	3.36	3.15	2.94	2.73	2.52
NE567	3.57	3.36	3.15	2.94	2.73	2.52
N5111	.90	.86	.81	.77	.72	.68
N5556	1.87	1.77	1.66	1.56	1.46	1.35
N5558	.80	.76	.72	.68	.64	.60
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N5596	1.87	1.77	1.66	1.56	1.46	1.35
709	.42	.40	.38	.36	.34	.32
710	.42	.40	.38	.36	.34	.32
711	.44	.42	.40	.37	.35	.33
723	1.00	.95	.90	.85	.80	.75
741	.44	.42	.40	.37	.35	.33
748	.48	.46	.43	.41	.38	.36
1N270	.15	.14	.13	.12	.11	.10
1N751A	.30	.28	.26	.24	.22	.20
1N914	.10	.09	.08	.07	.06	.05
1N4002	.15	.14	.13	.12	.11	.10
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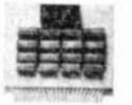

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WANTED: BC-946 or R-24/ARC-5 Receivers and parts. R. J. Ellis, 3613 Chalmers Ave., Huntsville, Alabama 35810.

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IT IS WITH PLEASURE I can announce that WA5MPQ (Hernando, Miss.) and myself (W5BW) have started up the "PURPLE MARTIN NET" and would be happy to have bird lovers to check in at 4 PM CST every Sunday afternoon on 7.251½ mhz. WA5MPQ is the Net Control and I will be the Alternate.

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HP175A - 50mHz scope w/dual trace, delayed sweep plug-ins	795
HP185B-DC-1gHz samp. scope w/186B	625
HP525A-10-100mHz plug-in for above	65
HP540-B-Trans. Osc. for counter-to 12gHz	385
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Kintel 301-DC standard-null voltmeter	220
Meas. 80 - Standard Sig. Gen. 2-400mHz	225
NE 14-20C-Freq.counter (sim. HP524C)	209
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1972 EXPERIMENTAL AIRCRAFT ASSOCIATION CONVENTION, Wittman Field, Oshkosh, Wis. July 30 thru August 6, 1972. All Flying Amateur Radio Operators are invited to attend. Will be monitoring 146.94 mh before, and all during the convention, as well as the Wis. SSB net. For a little something extra your QSL card dropped in a container at the Ham Headquarters may be a lucky one, and win you a piece of amateur gear as donated by Amateur Electronic Supply Co., 4828 W. Fond du Lac Ave., Milwaukee, Wis. If you are not a member of the EAA and would like to join, membership applications will be available at the Ham Headquarters, or you may request one by filing formal traffic addressed to W9KKK, Omro, Wis. via the Wis. SSB net or write to Elmer C. Erickson, W9KKK, 455 Birch St., Omro, Wis. 54963.

COLLINS Mechanical Filters. 455 kHz, 2.4 kHz bandwidth. $11.00 Postpaid. V. Mozarowski, VE3AIA, 1 Belgrove Drive, Islington, Ontario, Canada.

JULY 9, LAFAYETTE, INDIANA FAIRGROUNDS. Annual Indiana Radio Club Council Picnic and Hamfest. The fairgrounds is located at 1100 Teal Road, (Indiana Route #25), in the city of Lafayette, Ind. Easy access to Lafayette by Interstate 65. Hams flying in should use Halsmer Airport. There will be free shuttle service to and from Halsmer. This is a family affair. Fleamarket for the hams and fun and games for the rest of the family. Trailer parking. Advance tickets at $1.50 each by mail from W9YIP, 477 Robinson, West Lafayette, Ind. Orders should be mailed by July 4. Enclose payment and SASE or pick up advance tickets at hamfest. Tickets at the gate will be $2.00. Usual talk in frequencies.

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THE KANSAS NEBRASKA RADIO CLUB will hold their annual Hamfest on August 6 at the Moose Club at Concordia, Kansas. Registration will start at 0900 AM. All amateurs welcome.

ON THE 23rd AND 24TH SEPTEMBER, 1972 the North West Amateur Radio Conference is being held at this University. We would like to extend a warm welcome to any American Amateurs, who will be in Britain at that time, to attend the conference. University of Lancaster Amateur Radio Society, Bailrigg, Lancaster, England.

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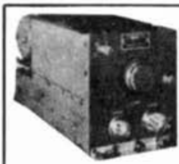

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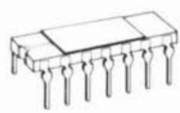

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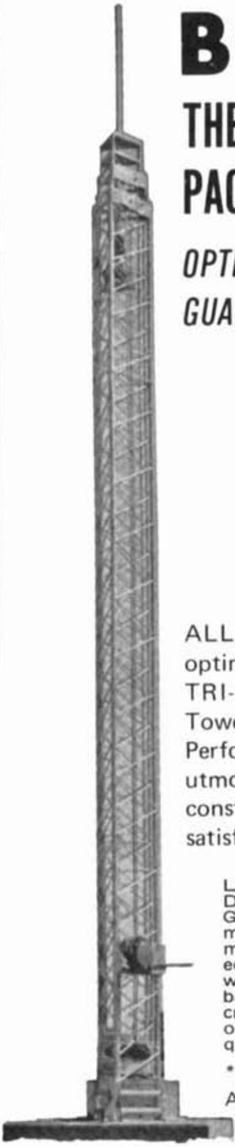

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