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ham radio magazine

incorporating HAM RADIO HORIZONS

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More Details? CHECK—OFF Page 120

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magazine

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HAM RADIO HORIZONS

DECEMBER 1981

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Observation & Opinion

This month I'd like to introduce a close friend and fellow Californian, *Bill Gay, WA6PNY. Bill and his wife* visited us on the last leg of an extensive trip across Canada that lasted 2½ months. They met many Amateurs and had a wonderful time operating their station, which was installed in a 31-foot trailer. Here are some of their experiences and a look at what other American hams might expect from our colleagues up north, in Bill's own words. **Editor.**

The hospitality extended to my wife and me by Canadian Radio Amateurs during our trailer trip across that country is something I'll never forget. Trailering with a mobile ham station is a great way to make friends, and I want to thank all the hams I met from British Columbia to Quebec for their warmth and generosity.

I had no idea what was involved in obtaining permission to operate in Canada. I wrote to the Canadian Department of Communications for information and even included a copy of my license. I was told just to bring my gear and operate as if I were in the U.S. No fuss, no bother. With the reciprocal licensing agreement, I was allowed to work essentially all the ham bands with the same privileges I have at home as an Advanced-class licensee.

We had no problems whatever crossing into Canada.

"Where are you from?"

"San Diego."

"Where are you going?"

"Across Canada!"

"How long are you going to be in the country?"

"Two or three months."

"Okay, go ahead."

Unbelievable! I was prepared to pay duty on food, my equipment, and so forth, but there was no inspection and no hassle.

One of the highlights of the trip occurred after we'd stopped at a KOA campground just outside Calgary. I called Fred Dettmers, VE2BQY, (whom I'd met previously) on the radio and asked if there was an autopatch on the local repeater. I was told, "Oh yes. Standard access: star up; pound down." I was amazed! No secret codes, no PL tones — just star up and pound down. Another example of Canadian hospitality.

While visiting with Fred and his wife, I had an opportunity to obtain an insight into the differences between Amateur Radio in Canada and the United States. Consider, for example, that the Amateur population in Canada is only about 21,000, compared with 53,000 in California alone. It's easy to understand the concern of the Canadian ham who must contend with the terrific wall of signals coming up from south of the border, especially when Canadians are trying to work into Europe.

The licensing structure in Canada is interesting. Three classes of license are offered: Amateur, Advanced, and Digital. For the Amateur license, the applicant must pass a ten-WPM code test, a written exam, and an oral exam. This license class grants all-band privileges, code only, plus VHF phone. After six months and proof of at least twelve contacts, a 10-meter-phone endorsement and full power privileges are granted. The Digital license allows digital operation at VHF/UHF.

The Amateur-class licensee is eligible to apply for the Advanced license after one year. This exam consists of a fifteen-WPM code test and another written test. The Advanced license permits full band and mode privileges. After five years, the Advanced-class Amateur may obtain a two-letter call sign if available. Licenses are issued for five years, with an annual fee payable to the DOC.

Our trip lasted 2½ months. I had a chance to operate in all the VE districts except VE1 and to meet a fine group of people. One real challenge was a request I received to explain the new Amercian call sign system. It seems that no one in Canada really understands what's going on, who's who, or what's what with our new calls. I'm not sure I understand either.

Bill Gay, WA6PNY

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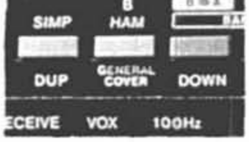

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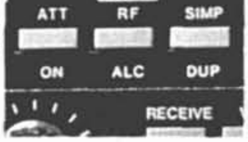

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comments

coaxed into noticing

Dear HR:

Your July article "Buying Parts By Mail" left out a very reliable source of coaxial cable and other parts. Please notice that Nemal Electronics (5685 S.W. 80th St., Miami, Florida 33143) has a wide selection of coaxial cable and cable accessories for sale at very attractive prices. In addition to that, their service is excellent. I can usually expect to get my order from them in little more than a week's time. Next time you need something in the cable line, I suggest you give them a call.

Dave Karpiej, K1THP
Plainville, Connecticut

a new breed

Dear HR:

What is wrong with this new breed of Amateur operator? Is it that we're friendly, considerate, and delighted with the idea of being a ham operator? When I was young we looked upon ham operators as elitists — eccentric individualists, mostly rich and *kooky*. Well, times have changed, what with the age of electronics and with the advent of inexpensive Citizen-Band Radio, and many of us who suffered through the changes on 11 meters have migrated to ham radio.

There are those of us who will become the ideal ham operator, knowledgeable in all phases of electronics, capable of tearing a radio apart and arranging it in perhaps better-than-new condition. And there will be those of us who will wish we could but cannot, who will resort to the Bash book and memorization in order to escape the trials of 11 meters. It behooves the well-versed Amateur operator to use his expertise to help others and to turn his attention to more constructive matters — perhaps new rules and regulations to replace antiquated ones.

So I say Viva La Nuevo Amateur operator and remember you are now a part of the elite. Handle it with dignity and care and to you who did it the hard way — understanding is the name of the game.

Judith M. Stevens, KA4IZU
Clearwater, Florida

RFI cures

Dear HR:

In regards to John Frank's article about RFI (September, 1981), I think the rule of thumb he speaks of in reference to **fig. 2** is misleading. The rule is implemented when no ac signal is desired across the resistor being bypassed, as in an emitter or cathode lead. This is not the case for a preamp input. The rule should be tied to the interfering signal. The bypass cap must have a high impedance with respect to the circuit impedance at the highest audio frequency presented to the amplifier.

Al Izatt, WB7SYB
Aberdeen, Washington

Part of the problem in selecting bypass capacitors for RFI cures is that there are two frequencies involved (audio and radio), and we want to bypass only one of them.

The rule of thumb I mentioned in my article provides a starting point for determining how much capacitance should be added to bypass rf without affecting audio. The optimum value of the bypass capacitor will depend on the impedances involved, the severity of the interference, and the frequency of the offending signal.

My own experience shows that bigger is not necessarily better when you are adding bypass capacitors to cure RFI. I prefer using the smallest amount of capacitance that will solve the RFI problem.

John W. Frank, WB9TQG
Madison, Wisconsin

low SWR

Dear HR:

I enjoyed the article by Stan Gibilisco, W1GV/4, entitled "How Important Is Low SWR?" in the August, 1981, issue. It is an excellent article and I believe it will help many people, especially me. I believe, however, that there is one small mistake in **fig. 2**. All the cable losses are off by a factor of two. This I believe is because the cable loss is actually one-half the measured value because the measured value is a two-way cable loss. I refer you to the article by K9MM.*

John Biro, K1KSY
Chelmsford, Massachusetts

In response to the letter from John Biro, K1KSY, I have performed my own calculation, as follows:

Let m = *line loss when matched;*
E = *"forward" voltage as measured at transmitter;*
e = *"reflected" voltage as measured at transmitter*
r = *SWR;*
ρ = *reflection coefficient* = $(r-1)/(r+1)$

Then, with the far end of the line short-circuited,

$$-2m = 20\log_{10}(e/E) = 20\log_{10}(\rho) = 20\log_{10}[(r-1)/(r+1)]$$

$$\text{Thus } m = -10\log_{10}[(r-1)/(r+1)]$$

*This formula produces results that agree with John's and show that **fig. 2** in my article is in fact off by a factor of 2.*

Stan Gibilisco, W1GV/4
Miami, Florida

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*John E. Becker, K9MM, "Calculating Feedline Loss with a Single Measurement at the Transmitter," *ham radio*, June, 1978.

More Details? CHECK—OFF Page 120

presstop

PROJECTED FCC STAFF CUTS could drastically alter the agency over the next two years. According to Communications Daily of October 8, over 500 Commission jobs are due to be cut during fiscal 1982 and 1983. The Reagan-administration-mandated cuts will be particularly severe in the Private Radio Bureau, which had 258 positions (250 of them filled) when fiscal 1981 ended. It's to be reduced to only 193 people in the next 12 months, and to 176 the following year. Of the Bureau's present 250 people, 145 work in licensing at Gettysburg and are thus considered essential. As a result, all of the PRB's cutback will be in Washington, where it employs 105. The planned reduction will leave only 31 people doing the Bureau's Washington work two years from now! This will undoubtedly mean a great deal of workload doubling up, with the attention paid to each of the services the Bureau administers reduced accordingly.

The Field Office Bureau will fare just as poorly under the recently announced plans, with its staff to be reduced from the present 455 to 311. A number of Field Offices will have to be closed, and the services provided by others drastically reduced. Enforcement efforts will also have to be sharply curtailed as well. Of course, other FCC bureaus will also be feeling the pinch, and there's even a rumor the FCC's Laurel (Maryland) Lab will close.

Some Key Provisions of Senator Goldwater's bill, S.929, take on a new meaning as the impact of the FCC cutback sinks in. Amateurs administering exams, and taking an active part in enforcement, could help the Commission greatly should it no longer be able to properly support these activities itself.

Chairman Fowler Has Announced his intention to seek a relaxation of the projected cuts from the Office of Management and Budget. Because of the importance of the FCC to a healthy Amateur Service, Amateurs could do themselves a service by asking their Congressmen to provide more FCC funding.

SENATOR GOLDWATER'S PRO-AMATEUR RADIO BILL was passed by the Senate September 25 by unanimous consent. This important piece of legislation, S.929, would affect not only the Amateur Service but would also affect CB and radio control licensees as well as the electronics manufacturing industry.

Establishment Of RFI Susceptibility standards for the TV and home entertainment electronics industry could well be the most significant result of this comprehensive bill, if it becomes law. It would vest in the FCC the authority to set such standards, as a means of reducing escalating RFI problems. It would also increase the term of an Amateur license from five to ten years, while a last-minute amendment by Senator Goldwater would also permit the FCC to discontinue the licensing of CB and radio control operators entirely, a deregulatory measure that has received some support from both FCC staff and Commissioners recently. In addition, it would specifically exempt Amateur transmissions from the secrecy provisions (Section 605) of the Communications Act. Though it was long assumed that Amateurs were not included in Section 605 coverage, recent legal decisions have generally applied its limitations to Amateur operations.

The Commission Could Enlist Volunteer assistants from both the Amateur Radio and CB communities, under still another provision of Senator Goldwater's bill. These volunteers would be permitted to work directly with FCC engineers in monitoring both Amateur and CB frequencies for unlicensed or otherwise improper operations. Amateur Radio licensees would also be permitted to serve as volunteer examiners for "entry level" Amateur license applicants, a long-standing practice in Amateur Radio that has recently been termed "illegal" under present laws by the FCC legal staff.

One Key Provision Of S.929, as introduced by Senator Goldwater, was not included in the bill the Senate passed. This was the provision that would have given the Commission the power to restrict the purchase of transmitting equipment to those having the appropriate license to use it. Though generally supported by the Amateur community, this provision contradicts the deregulatory philosophy of the present administration.

The Next Step For S.929 is in the House of Representatives, where it could be tied to appropriate legislation already pending there. More likely, it will be considered by itself, possibly replacing existing legislation such as Rep. Dannemeyer's HR 2203. It will go to the House Committee on Communications, chaired by Rep. Timoty Wirth, and it's possible that some action could be taken on it by early next year.

Support Of S.929 By Amateurs, expressed to their Representatives, should help to keep the bill moving toward passage.

AVAILABILITY OF THE NEW 10-MHZ BAND looks farther and farther away. First, the WARC treaty hasn't yet been ratified by the Senate, and, though that could happen soon, until it does there will be little further FCC action on new allocations. When those new allocations do become official, by revision of Part 2 of the FCC Rules, U.S Amateurs will still face a rule-making proceeding to determine how the new band will be used: class of licensee, power, and type of emissions. At best, the whole procedure could take many months, and with the severe staff cuts the Commission is facing it could stretch out indefinitely.

10-MHz Operation on January 1, 1982, is expected by Amateurs of a number of countries whose administrations have already implemented the WARC changes.

Introducing incredible tuning accuracy at an incredibly affordable price: The Command Series RF-3100 31-band AM/FM/SW receiver.* No other shortwave receiver brings in PLL quartz synthesized tuning and all-band digital readout for as low a price.† The tuner tracks and "locks" onto your signal, and the 5-digit display shows exactly what frequency you're on.

There are other ways the RF-3100 commands the airways: It can travel the full length of the shortwave band (that's 1.6 to 30 MHz). It eliminates interference when stations overlap by narrowing the broadcast band. It improves reception in strong signal areas with RF Gain Control. And the RF-3100 catches Morse communications accurately with BFO Pitch Control.


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*Shortwave reception will vary with antenna, weather conditions, operator's geographic location and other factors. An outside antenna may be required for maximum shortwave reception.

†Based on a comparison of suggested retail prices.

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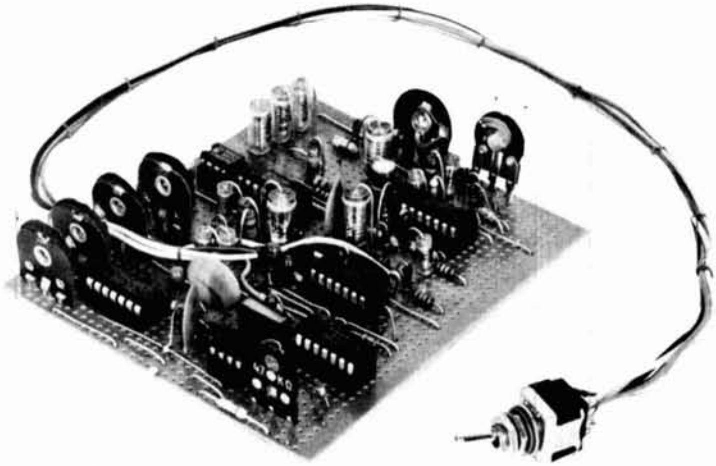

an a-m/fm converter for facsimile transmission

A circuit that features input and output lowpass filters and a VCO

In recent years, facsimile transmission by Amateur Radio has been attracting increasing interest.[1] Thus, since September, 1980, the official bulletin of the DARC is regularly transmitted in facsimile by DJ8BT at Frankfurt. Most Amateur stations operating in this mode are using second-hand commercial or military equipment, although a number of home-built facsimile recorders are in use as well.

In the facsimile transmitter, the picture or document to be transmitted is scanned photoelectrically, the resulting video signal being used to amplitude modulate a carrier of constant frequency, conventionally in the range from 1300 to 1900 Hz. The modulated carrier is sent via a line or radio channel to the facsimile recorder, which converts the amplitude variations into a copy of the original picture or document.

The amplitude-modulated facsimile signal is most suitable for transmission over line circuits, where the transmission-loss variations with time can be kept within ±1 dB. When sent by radio, however, especially over long-range circuits, it is particularly vulnerable to amplitude changes caused by fading. One solution to this problem is the transmission of the a-m facsimile signal by a frequency-modulated voice channel of sufficient quality, thus employing double-modulation technique (emission F4 with amplitude-modulated subcarrier). Due to the large bandwidth required, this procedure is confined to UHF.

high-frequency radio transmission

For high-frequency radio circuits, therefore, other techniques have to be used. One implies that the a-m signal from the facsimile scanner is demodulated to produce the video signal, which is then used for modulating the carrier frequency of the high-frequency transmitter (emission F4 without subcarrier). For most purposes, the frequency is chosen to be $f_0 - 400$ Hz for white and $f_0 + 400$ Hz for black, f_0 being the nominal transmitting frequency.[2] However, for meteorological charts the black and white limits are reversed, and on low-frequency circuits the limits $f_0 \pm 150$ Hz are used.[3]

Alternatively, the a-m facsimile signal is converted into an audible frequency-modulated signal, which is then used to modulate a high-frequency radiotelephone transmitter (emission A4 with frequency-modulated subcarrier). Especially, if a properly adjusted SSB transmitter is used, the emission (A4J with fm subcarrier) will be equivalent to F4 without subcarrier. This is the method preferred by the International Radio Consultative Committee (CCIR). As a standard, the subcarrier frequency is set to 1500 Hz for white and 2300 Hz for black,[2] with the limits reversed for weather charts.[3]

Because most commercial and military facsimile apparatus on the surplus market lacks the fm-subcarrier facility, the need arises for modulation conversion when such apparatus is to be used on high-frequency channels. Whereas an a-m/fm converter is always required at the transmitting end, the F4 signal can often be received rather satisfactorily without any additional equipment, simply by detuning the high-frequency receiver. However, fm/a-m converters are available, like the one recently described by PE1CMX.[4]

The facsimile apparatus I use is an FX-1-B, one of the classical facsimile transceivers designed and manufactured in the early 1940s by the Times Facsimile Corporation for the U.S. Army Signal

By **Karl-Gustav Strid, SM6FJB**, Sofiagatan 83, S-416 72 Gothenburg, Sweden

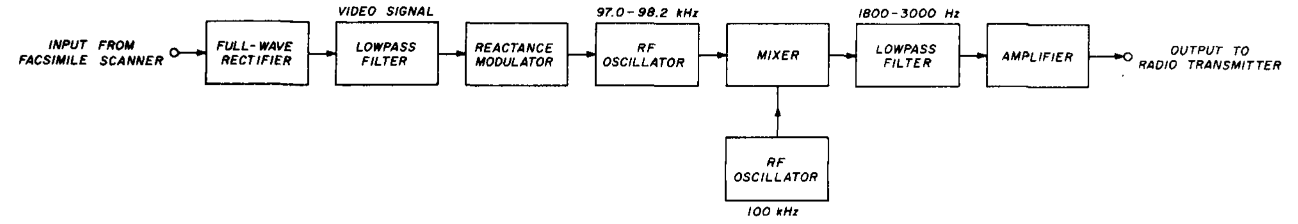

fig. 1. Block diagram of transmitting portion of facsimile converter CV-2/TX.

Corps. Part of facsimile equipment RC-120-B, it scans an 18 × 22 cm original at 90 strokes per minute with index of cooperation $M = 264$. The transmitted signal consists of an amplitude-modulated 1800 Hz carrier, the contrast (that is, the level difference between white and black) amounting to 8-15 dB, depending on the recording technique employed at the receiving end. For such a set to be useful on long-range radio circuits, modulation converters for both the transmitting and the receiving end were designed and built. As a basic requirement, fm transmission was to conform with the 1500/2300 Hz standard. Furthermore, the contrast of the a-m signal was to be adjustable to any value up to 30 dB, positive or negative.

design of a transmitting converter

As an example of an existing facsimile a-m/fm converter, **fig. 1** shows the block diagram of the transmitting circuits of facsimile converter CV-2/TX used by U.S. Army Signal Corps.[5] The a-m facsimile signal is full-wave rectified and the carrier frequency suppressed by a lowpass filter. The video voltage thus produced is passed to a reactance-modulator stage controlling the frequency of an oscillator working slightly below 100 kHz. Beating this variable-frequency output with that from a fixed oscillator at 100 kHz yields the desired audible fm signal, which after lowpass filtering and amplification, is fed to the microphone input of the radio transmitter. (A similar heterodyne technique has been used by HA5WH for generating teleprinter AFSK signals.[6])

The present design is based on a different approach, as shown in **fig. 2**. The video signal obtained by full-wave rectification and lowpass filtering of the a-m facsimile signal is used, after contrast adjustment, to control the frequency of a square-wave oscillator, whose output is lowpass filtered to produce a sinusoidal fm signal.

The a-m facsimile signal may be presented to the converter with either positive or negative contrast. In the former case the white level is nominally 1 mW across 600 ohms (775 mV), the black level lying 8 to 30 dB lower; in the latter case these levels are reversed. The fm signal ouput to the radio transmitter conforms with the recommendations of the CCIR and the International Telegraph and Telephone Consultative Committee (CCITT),[2] white corresponding to 1500 Hz and black to 2300 Hz.

circuit description

The complete circuit of the facsimile transmitting converter appears in **fig. 3**, and its various parts are analyzed below.

Rectifier and video filter. A small input transformer, T1, isolates the converter from the facsimile apparatus; it can be omitted if the units have a common ground potential. A precision half-wave rectifier is built around amplifier U1A. The negative half-periods of the a-m signal are presented with reversed sign across R4 at the summing point of the amplifier U1B, where the original signal is added through R5 and R6; balanced full-wave rectification occurs by adjustment of R6.

The video voltage is separated from the carrier by an active filter of third-order Darlington response, consisting of a simple lag circuit, U1B, and a Sallen-and-Key lowpass circuit, U1D, with an added highpass path, U1C, to insert a notch at twice the carrier

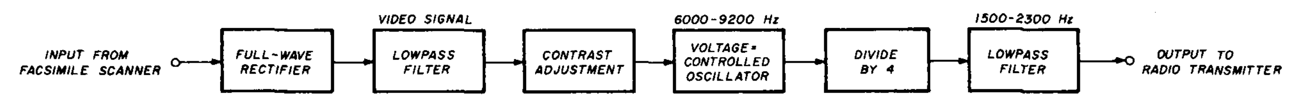

fig. 2. Block diagram of alternative facsimile transmitting converter.

frequency (3600 Hz). The filter was built with readily available plastic-film capacitors of 2.5 percent tolerance and metal-film resistors of the E48 series having 1 percent tolerance. **Fig. 4** shows the response of the video filter.

The video signal is delivered negative with respect to ground; it can be measured at test point TP1. The input potentiometer, R1, is set to yield approximately −2.5 volts at TP1 for maximum input signal. Due to amplifier offset, an output is likely to be present at

capacitors (polystyrene-film capacitors unless otherwise stated)

C1,C2,C9	
C10,C11	100 pF ± 2.5%
C3	1100 pF ± 2.5%
C4,C13	0.01 μF ± 2.5%
C5	4700 pF
C6,C8	1 μF 12 volt tantalum electrolytic
C7	0.01 μF
C12	6200 pF ± 2.5%
C14	100 pF ± 2.5%
C15	0.015 μF ± 2.5%
C16	100 pF
C17,C19,C20	22 μF 12 volt electrolytic
C18,C21	0.1 μF ceramic

switches

S1	single-pole switch (if required; see text)
S2	2-pole, 2-way switch

transformers

T1	input transformer (see text)
T2	output transformer (see text)

resistors (0.25 watt carbon-film resistors unless otherwise stated)

R1	10k potentiometer
R2,R3	56k
R4	24k
R5	43k
R6,R13,R18,R19	10k trimmer potentiometer
R7	162k ± 1% metal film
R8	169k ± 1% metal film
R9	23.7k ± 1% metal film
R10,R11	38.3k ± 1% metal film
R12,R27	10k
R14	15k
R15	10k trimmer potentiometer (number as required; see text)
R16,R17,R21,R22	10k ± 1% metal film
R20	2200
R23,R24,R31	27k
R25	100
R26	5100
R28	6800
R29	12k
R30	4700 trimmer potentiometer
R32	300k (see text)
R33	86.6k ± 1% metal film
R34	56.2k ± 1% metal film
R35	11.5k ± 1% metal film
R36	21.5k ± 1% metal film
R37	22.6k ± 1% metal film
R38	12.1k ± 1% metal film
R39	15.4k ± 1% metal film
R40,R41	36.5k ± 1% metal film
R42	1200 (see text)
R43	1000
R44	1200
R45	7500

integrated circuits

U1,U2,U5	MC 3403 P (CA 3403E, μA 3403 PC)
U3	RC4151 NB
U4	HCF 4013 BE (CD 4013 BE, HEF 4013 BP, MC 14013 BCP, 4013 BPC)
U6	TDB 0723 A (CA 723 E, MC 1723 CP, μA 723 CN, μA 723 PC)
U7	ICL 7660 CPA

semiconductor devices

CR1-4	BA 221 (1N914, 1N4148)
Q1	BC 548 C

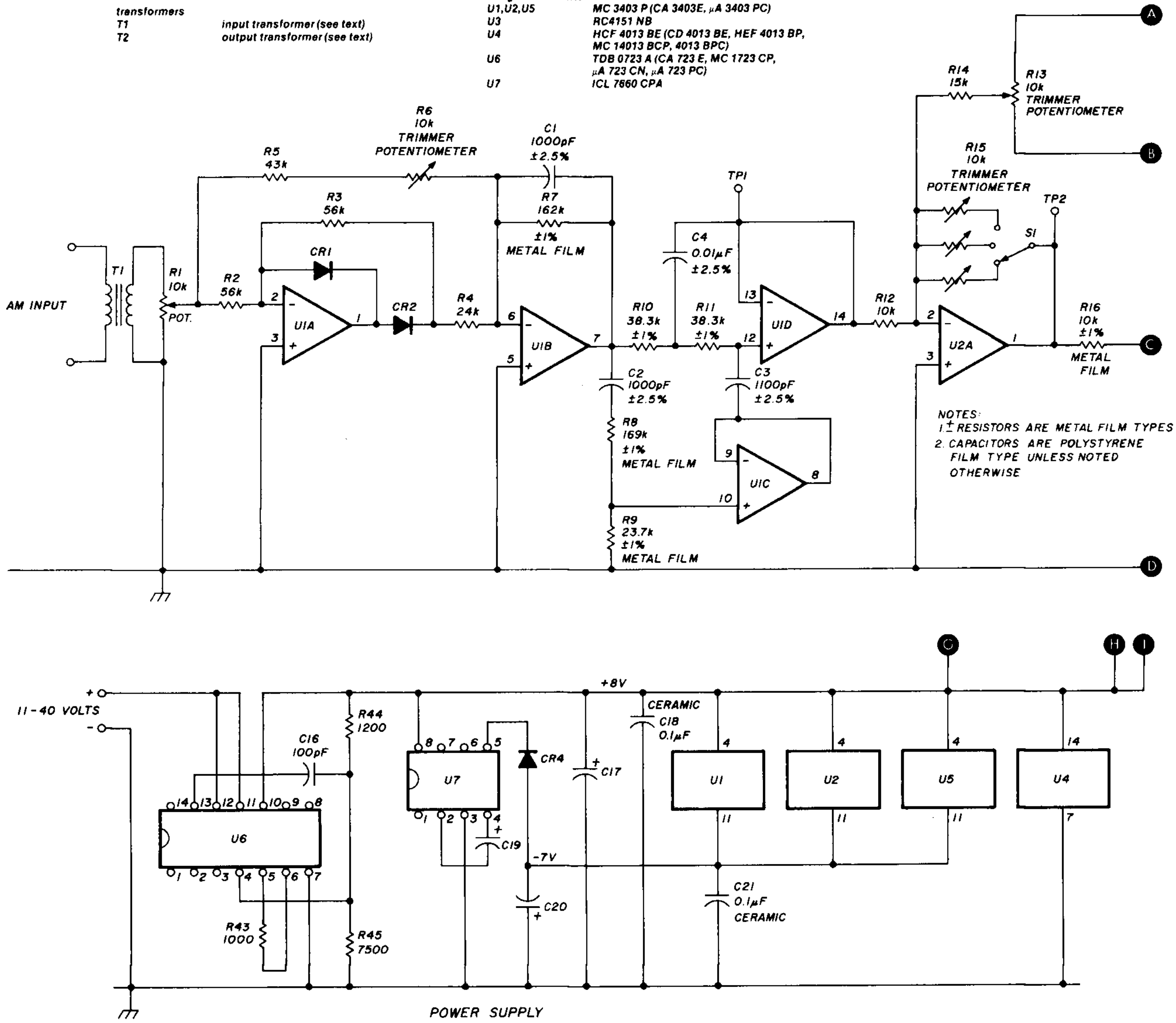

fig. 3. Circuit diagram of facsimile transmitting converter.

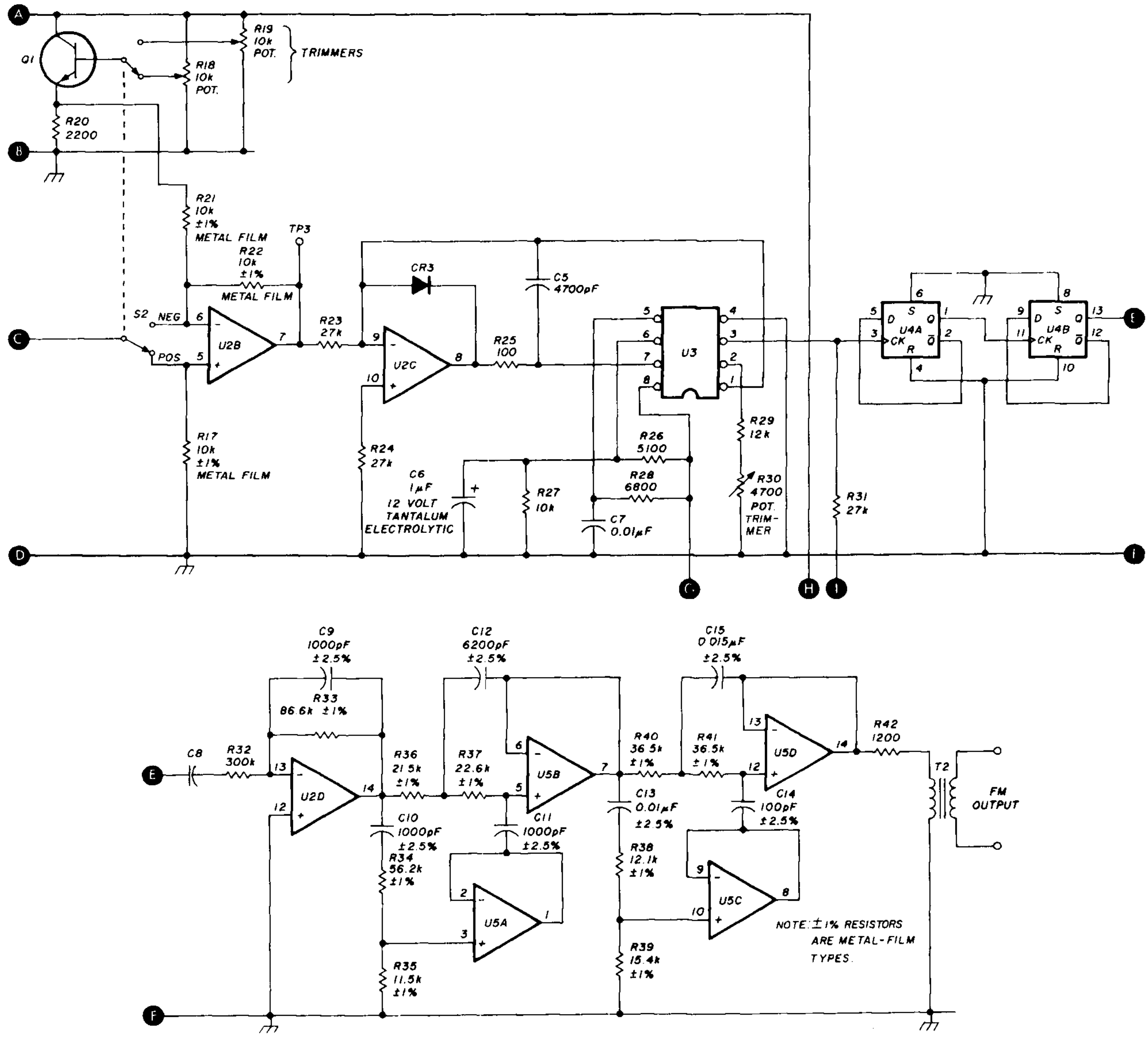

fig. 3. Circuit diagram of facsimile transmitting converter (continued).

TP1 for zero-input signal; this error will be eliminated in contrast adjustment.

Contrast adjustment. Video contrast, which may be positive or negative and of arbitrary magnitude (to about 30 dB), is adjusted in a two-stage dc processor (U2A, U2B), shown in simplified form in **fig. 5**.

In the first stage, a constant voltage, u_0, is added to the video signal, u_I, so that zero output is produced at test point TP2 when the a-m facsimile signal is set to its nominal maximum amplitude. The stage gain (A, determined by the resistance ratio of R15 to R12) is adjusted to obtain −800 mV at TP2 when the input a-m signal is reduced by the nominal contrast. If the converter is to be used with several different facsimile scanners, any relevant number of contrast-setting resistors (R15) may be used; the actual contrast is selectable by switch S1.

The second stage is used as a summing or subtracting amplifier. Resistors R16, R17, R21, and R22 have a 1 percent tolerance. For an a-m facsimile input of positive contrast, a further constant voltage ($u_L = 1500\ mV$) is subtracted from the signal to yield at test point TP3:

$$u_2 = -u_L - A(u_I + u_0) \tag{1}$$

where A is the stage gain of the first stage (U2A). Observing the negative sign of u_I, we find $u_2 = -1500\ mV$ for a maximum (white) and $u_2 = -2300\ mV$ for a minimum (black) input signal. For an input of negative contrast, the sign of the video signal is reversed, and a constant voltage $(u_H = 2300\ mV)$ subtracted so that, at TP3,

$$u_2 = -u_H + A(u_I + u_O) \qquad (2)$$

Thus, $u_2 = -2300\ mV$ for maximum (black) and $u_2 = -1500\ mV$ for minimum (white) signal.

Transistor Q1 provides a low-impedance source for the voltage fed to R21; otherwise the source impedance would affect the stage gain of U2B in transmission with positive contrast.

Those who wish to transmit facsimile by direct frequency modulation of the transmitter's carrier oscillator may use the adjusted video signal at TP3 as the input.

Voltage-controlled oscillator. The heart of the oscillator is U3, a monolithic IC comprising a comparator, single-shot multivibrator, and a gated precision current source with an internal voltage reference. The device is manufactured by Raytheon. Besides the original version RC (RM, RV) 4151, an improved version, the RC 4152, has been announced; the latter was not, however, available to me.

The negative video voltage at TP3 is summed with positive-charge pulses from pin 1 of U3 into an integrator, U2C. The integrator output is fed into the comparator at pin 7 of U3, thus controlling the multivibrator. The pulse-repetition frequency will settle so that the average value of the current at pin 1 will equal the current due to video input. The magnitude of the charge pulses is determined by R29 and R30, which set the oscillator's voltage-to-frequency conversion factor.

Having a duty cycle that varies with frequency, the pulse train produced by U3 is passed to the two-stage flip-flop, U4, which provides a symmetrical square-wave train at one-fourth the original pulse-repetition rate. The overall conversion factor is chosen to be 1 Hz/mV, that is, the limits 1500 and 2300 mV of the adjusted video voltage will correspond to 1500 and 2300 Hz respectively in the square-wave output.

No measure for offset compensation of U2C was found necessary.

Output filter. The square-wave train from U4 can be resolved into odd harmonics of its fundamental frequency, which implies that it can be changed into a sinusoidal signal by a filter that suppresses all components of frequency above three times the lowest

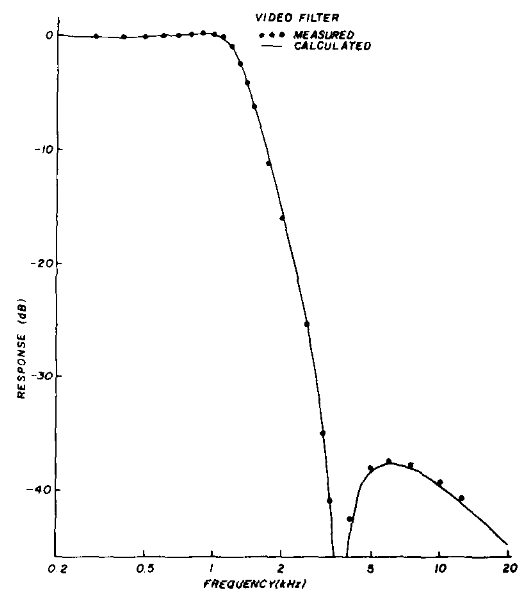

fig. 4. Calculated (solid line) and measured (dots) characteristic of video filter. The carrier-suppression notch was measured at −60 dB at 3518 Hz.

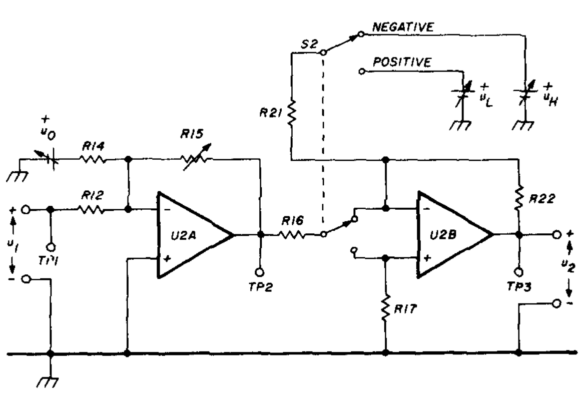

fig. 5. Processing of video signal. Switch S2 selects between positive and negitive contrast of the input a-m signal.

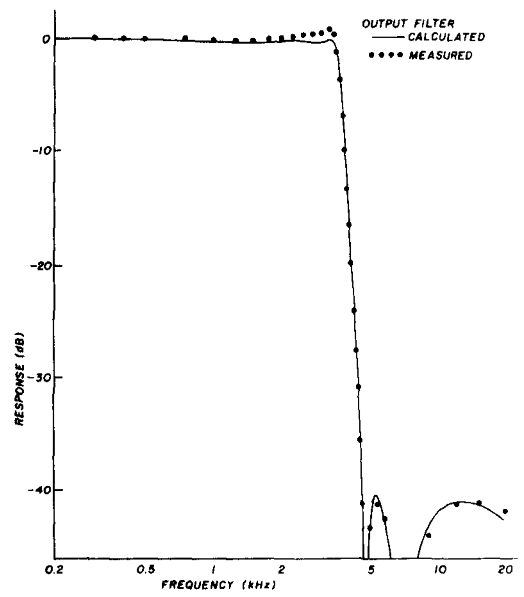

fig. 6. Calculated (solid line) and measured (dots) characteristic of output filter. The notches were measured at 4765 Hz and 6960 Hz.

carrier frequency used; that is, above 4500 Hz. On the other hand, this filter must pass the entire spectrum of interest — for a maximum carrier frequency of 2300 Hz and a maximum video frequency of 750 Hz, the filter cutoff frequency should not occur below

$$2300\,Hz + 1.6 \times 750\,Hz = 3500\,Hz$$

To achieve such steep cutoff, the filter was given a fifth-order Darlington response. A simple lag circuit, U2D, is followed by two cascaded Sallen-and-Key stages, U5B and U5D, with additional highpass paths, U5A and U5C respectively. Thus, notches are produced at 7010 Hz and 4760 Hz respectively, yielding attenuation in excess of 40 dB above 4400 Hz and still keeping the passband attenuation below 1 dB up to 3400 Hz (**fig. 6**). The filter was implemented with 2.5 percent plastic-film capacitors and 1 percent metal-film resistors.

The final stage, U5D, is coupled to the transmitter through a small transformer, T2, if required; otherwise capacitive coupling may be used. Resistor R42 was included to provide a matched 600-ohm output at T2; it may be omitted. The level of the output fm signal may be adjusted by changing the resistance of R32.

Power supply. The converter operates from a negative-ground dc source of 12 volts nominal. For the contrast adjustment and voltage-controlled oscillator to work unaffected by any supply-voltage variations, a regulated supply is provided at 8.25 volts; the voltage regulator, U6, is internally compensated for temperature drift. In addition, the operational amplifiers require a negative supply of −7.25 volts, which is furnished by a monolithic voltage inverter, U7. This device is a type ICL 7660 by Datel Intersil.

Proper operation occurs over the input-voltage range of 10.5 — 40 volts; current consumption is 25 mA throughout this range.

construction notes

The prototype converter was built on a 3.7 by 4.3-inch (95 by 110 mm) piece of perf board, but the design can be readily transferred to an etched circuit board. In a definitive design, the simple carbon trimmer potentiometers used with the prototype will be replaced by multi-turn Cermet trimmers.

alignment procedure

The instruments required for alignment of the facsimile converter comprise a dc voltmeter, a cathode-ray oscilloscope and, preferably, a frequency counter. Moreover, a sine-wave signal source is necessary; this may be the facsimile scanner.

Alignment is carried out as follows:

1. With a low-frequency (50-Hz) sinusoidal signal applied to the converter input, R6 is adjusted to produce a symmetrical full-wave-rectified output signal at test point TP1, as shown on the oscilloscope screen.

2. A signal at the nominal carrier frequency (1800 Hz) and the nominal maximum level (775 mV) is fed into the converter. R1 is set to yield approximately −2.5 volts at TP1. Then R13 is adjusted for zero voltage at TP2.

3. The input signal level is reduced by the nominal contrast (typically 8-30 dB), and R15 is adjusted to obtain −800 mV at TP2. If the converter is to be used with several contrast settings, this procedure is repeated for each position of S1.

4. The input signal is removed and TP2 is shorted to ground. With S2 set at position POSITIVE, R18 is set for −1500 mV at TP3, and with S2 at NEGATIVE, R19 is set for −2300 mV at TP3.

5. With −2300 mV at TP3 (S2 at NEGATIVE), R30 is adjusted for a frequency of 2300 Hz measured at the converter output. With −1500 mV at TP3 (S2 switched to POSITIVE), the frequency should then read 1500 Hz. The short at TP2 is removed.

The converter is now ready for use.

performance

Factors of importance to the converter's functioning are the responses of the filters and the linearity of

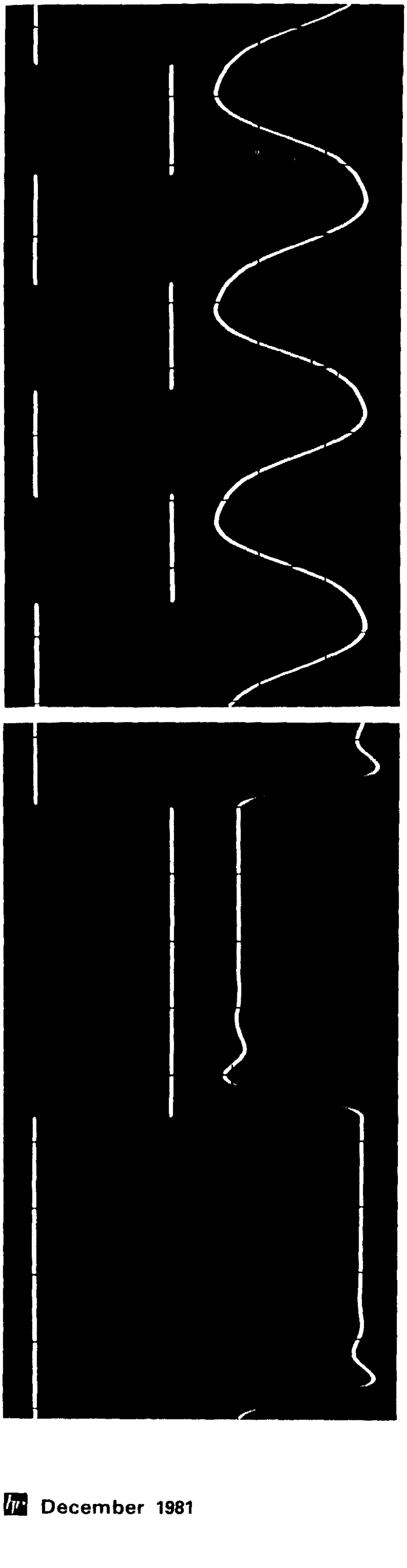

fig. 7. Square-wave response of video filter at 100 Hz (left) and 622 Hz (right).

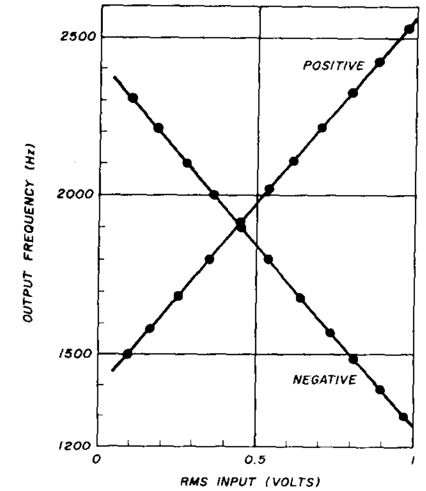

fig. 8. Plots of the output frequency versus RMS input voltage at 1800 Hz for both positions of S2 with converter adjusted for 18-dB input contrast.

the voltage-controlled oscillator.

The measured characteristic of the video filter was found to closely reproduce the calculated behavior (**fig. 4**). Its step response (**fig. 7**, left) shows 340 μs rise time, about 12 percent overshoot and a slight oscillation of 400 μs half-period. The smallest picture element to be resolved in a facsimile transmission with $M=264$ and 90 scanning strokes per minute, having a duration of some 804 μs (corresponding to a 622 Hz square-wave train), is well rendered by the filter (**fig. 7**, right).

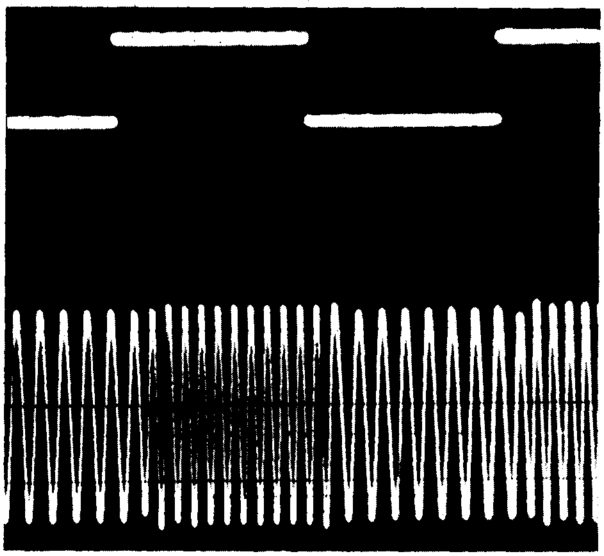

fig. 9. Output signal of 1500 Hz and 2300 Hz (bottom) produced by 100-Hz square-wave train (top) applied to input of video filter.

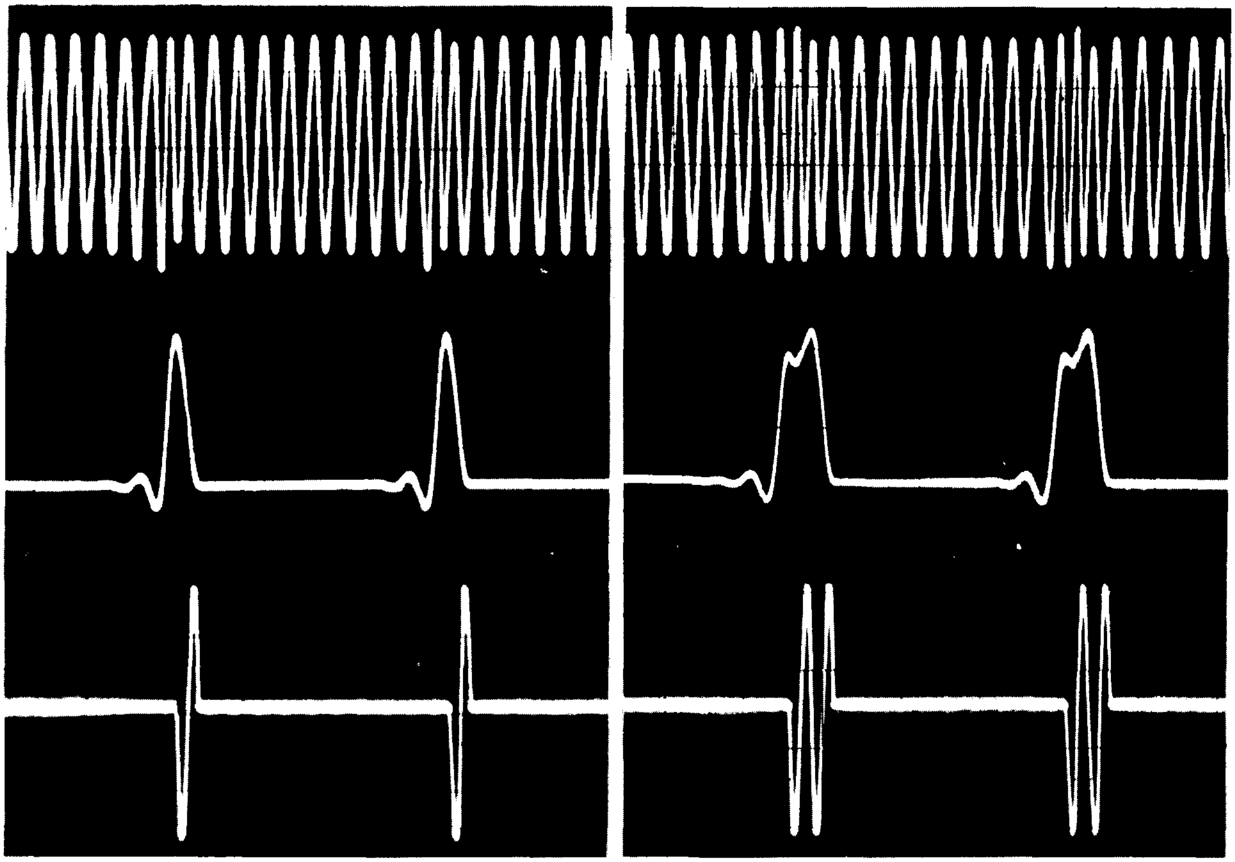

fig. 10. Overall response (bottom) to burst-modulated 1800-Hz sine wave (top) applied to converter input, producing at TP3 a video signal (center) alternating between − 1500 mV and − 2300 mV. Burst duration 1100 μs (left) and 555 μs (right).

No deviation from linearity could be observed between input voltage and output frequency (**fig. 8**). With TP3 shorted to ground, the frequency of oscillation was measured to 5.7 Hz at pin 3 of U3, confirming that any offset adjustment of the oscillator could be omitted.

The output filter showed a slightly elevated response in the passband near cutoff (**fig. 6**) as compared to its calculated performance. This was due to tolerances of the filter components, especially the capacitors, and resulted in a 3 percent (0.3 dB) increase in output amplitude from 1500 Hz to 2300 Hz. However, in view of the baseband response of the transmitter to be used, no correcting measures were taken.

The overall response of the converter (**figs. 9** and **10**) is sufficient to reproduce the 800-μs bursts representing the smallest picture elements. For abrupt changes in input level, a slight overshoot occurs in the output envelope; the observed 7 percent (0.6 dB) fluctuation is smaller than will be seen with certain teleprinter audio-frequency-shift keyers.[7]

The rms output signal at pin 14 of U5D amounts to 1.0 volt. The signal magnitude may be altered by a change of R32, the output amplitude varying inversely with resistance.

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ham radio

part two:
audio and AGC
board, synthesizer,
and power supply

up-conversion receiver
for the
high-frequency bands

This receiver is designed as a group of modules and boards. Front panel reflects clean layout and operator convenience.

author's note
The object of this two-part construction project is strictly educational. I wanted to see if it was possible to produce a fairly good unit with readily available parts and, if so, to go on to design and construct a transceiver. Because of this, the module construction was done in breadboard fashion. There are no board layouts available, but some of the photos show typical construction techniques used throughout.

Last month, in part one of this two-part article, I described the basic design of my up-conversion receiver, then went on to discuss the mixer stages, i-f filter, and BFO. This month, in part two, I will complete my discussion of the up-conversion high-frequency receiver, beginning with the audio and AGC board.

audio and AGC board

The product-detector output is terminated in 51 ohms on the audio board and drives both the audio output circuitry and the AGC circuitry as shown in **fig. 10**. A two-pole Butterworth lowpass active filter provides 20 dB gain and reduces the wideband noise from the i-f output. A summing amplifier provides an auxiliary audio input for CW sidetone or a DX spotting net receiver. Power gain is provided by an LM380. A few additional dB of negative feedback is used to reduce the LM380 hiss and distortion to a negligible level. The over-all audio gain is 48 dB maximum. The bandwidth is 150-2400 Hz. Total harmonic distortion is better than -60 dB at 0.8 watt output.

The AGC is an audio-driven hang-type system. Much time was spent deciding what arrangement to

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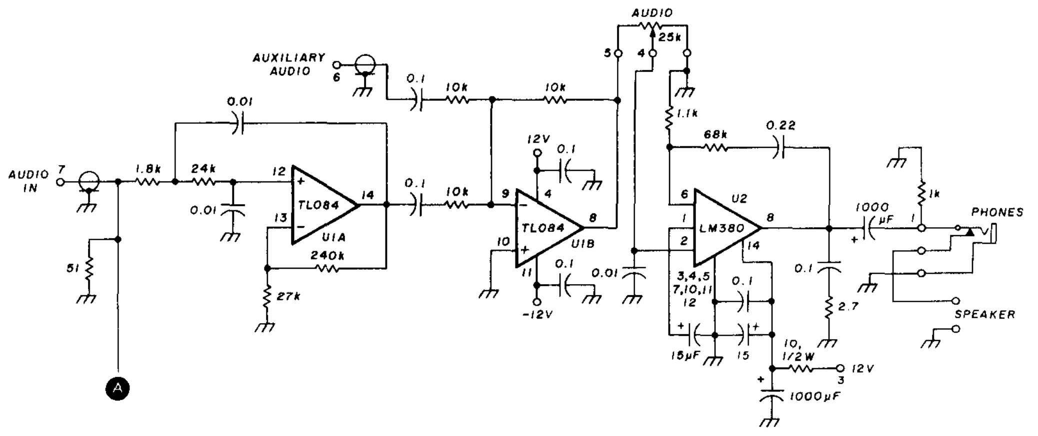


fig. 10-1. Audio and AGC schematic (B3 board).

use, because much of the "operating character" of the receiver stems from its AGC system. One need only to listen to some of the modern transceivers to note that an otherwise adequate receiver can be almost ruined by poor AGC system design.

The hang-AGC system allows the decay time constant to be set very long to eliminate overshoot on strong CW signals. Many tests were run, and I found that an attack time faster than 10 milliseconds would result in the receiver responding too readily to single noise spikes, such as those produced by oil burners and wall switches. Of course, if the attack time constant is too long, each transition from weaker to stronger is accompanied by a large overshoot. The required attack time is easily obtained at audio frequencies rather than at i-f, and the resulting circuitry is easy to implement and is noncritical. For a step input of no signal to one millivolt, this receiver overshoots less than 2 dB. There is no overshoot on dots and dashes of a CW signal after the initial acquisition. It sounds quite smooth on SSB and CW.

The gain of op amp U3A determines the normal operating level in the product detector. This is because the minimum signal that will create AGC voltage has a peak voltage just adequate to overcome the drop in the IN914 rectifier. For the AGC threshold, the level at the product detector input is -17 dBm. The attack time is controlled by the 1k resistor. The gain of U3B is set so that the 2N5640 FET is biased off for the signals that would normally activate the AGC. When the signal drops in level or disappears, the 2N5640 turns on and rapidly discharges the AGC capacitor through a 100k resistor. The hold time is determined by the 15 μF capacitor in the 2N5640 gate circuit. The AGC switch allows for selection of 0.3 second or 0.7 second. U3C provides the offset voltage required by the MC1590 i-f amplifiers. The gain of the U3C circuit is held low to provide a slope of about 7 dB to the over-all AGC characteristic. Control voltage for the front-end attenuator is supplied by U3D. The threshold adjustment is normally set for 100 microvolts.

synthesizer

The synthesizer locks a 45- to 75-MHz VCO to a 5.05-5.55-MHz VFO in 0.5-MHz bands, as selected by an offset crystal oscillator. The offset signal could also be synthesized, but in the interest of simplicity and minimizing spurious outputs, a crystal oscillator was chosen.

45-75 MHz VCO. This VCO uses a grounded-gate U310 FET in the Colpitts configuration. See **fig. 11.** One of four ranges may be selected by applying 8 volts to a range-select input. PIN diodes are used to minimize stray capacitance. Tuning is accomplished by an MV104 varactor. The varactor is returned to -8 volts, and the normal range of the tuning voltage is ± 5 volts. The coils are adjusted so that the maximum of each range is the fourth root of the over-all ratio times the minimum frequency; that is,

$$\text{range 1 max} = \sqrt[4]{\frac{75}{45}} \times 45 = 51.13\,\text{MHz} \quad \textbf{(1)}$$

$$\text{range 2 max} = \sqrt[4]{\frac{75}{45}} \times 51.13 = 58.09\,\text{MHz} \quad \textbf{(2)}$$

$$\text{range 3 max} = \sqrt[4]{\frac{75}{45}} \times 58.09 = 66.01\,\text{MHz} \quad \textbf{(3)}$$

$$\text{range 4 max} = \sqrt[4]{\frac{75}{45}} \times 66.01 = 75.00\,\text{MHz} \quad \textbf{(4)}$$

The purpose of range selection is to improve oscillator stability and to minimize the VCO gain constant for reducing phase noise. The VCO range is selected by a diode matrix on the crystal-oscillator board.

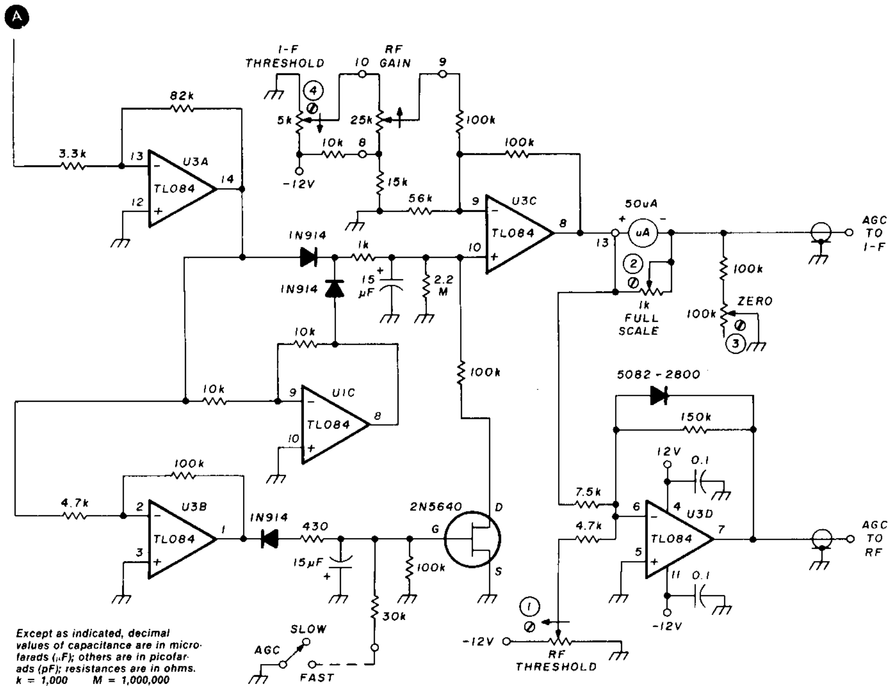


fig. 10-2. Audio and AGC schematic (B3 board), continued from previous page.

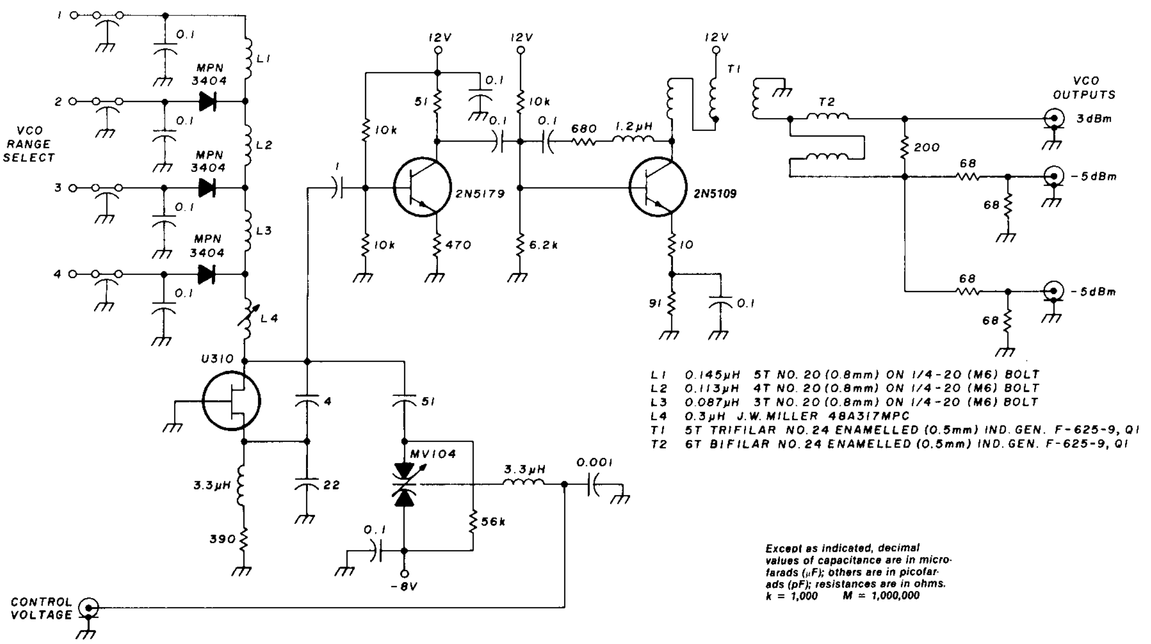


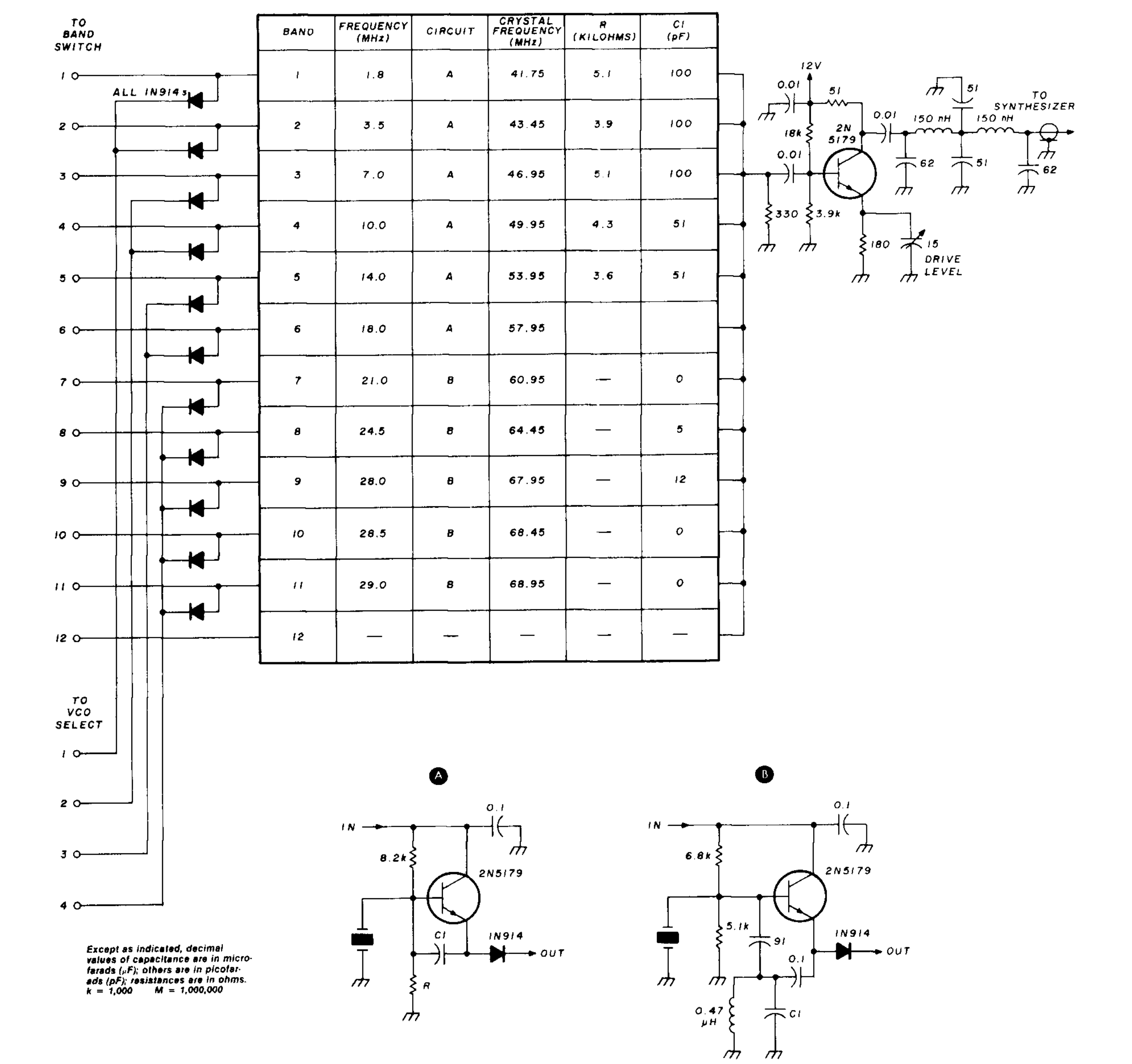
fig. 11. 45 to 75-MHz VCO schematic (part of M7 module). Unit uses a grounded-gate U310 FET in a Colpitts circuit. One of four ranges may be selected by applying 8 volts to a range-select input. Tuning is by an MV104 varactor.

A 2N5179 isolation amplifier couples a small amount of VCO output power to a 2N5109 power amplifier. This amplifier drives a two-way power divider. One output goes to the first mixer module at a 3-dBm level. The other output is split to provide synthesizer feedback to drive the display module.

Crystal oscillator. Twelve crystal oscillators are used to select 12 bands. The limitation is in the switch itself, although twelve bands are more than adequate for my use. The receiver frequency coverage is shown in **fig. 12**. With this arrangement, all currently available bands are covered except for the top 200 kHz of the 10-meter band. Also, the three new bands are covered, and one spare (12) remains unused. The oscillator in use is selected by an 8-volt level from the bandswitch.

Two types of oscillator circuit are used: the A type is for third-overtone and the B type is for fifth-overtone crystals (**fig. 12**). These circuits are very simple, and the price paid for this simplicity is that a certain amount of adjusting must be made with component values for reliable operation.

Each oscillator is adjusted to start and operate on the correct overtone, to remain there for B+ varia-



BAND	FREQUENCY (MHz)	CIRCUIT	CRYSTAL FREQUENCY (MHz)	R (KILOHMS)	CI (pF)
1	1.8	A	41.75	5.1	100
2	3.5	A	43.45	3.9	100
3	7.0	A	46.95	5.1	100
4	10.0	A	49.95	4.3	51
5	14.0	A	53.95	3.6	51
6	18.0	A	57.95		
7	21.0	B	60.95	—	0
8	24.5	B	64.45	—	5
9	28.0	B	67.95	—	12
10	28.5	B	68.45	—	0
11	29.0	B	68.95	—	0
12	—	—	—	—	—

fig. 12. Crystal-oscillator schematic (B5 board). Twelve oscillators are used to select 12 bands. Two types of oscillator circuit are used. Circuit in A is for third-overtone and that in B is for fifth-overtone crystals. Receiver frequency coverage is shown in the table.

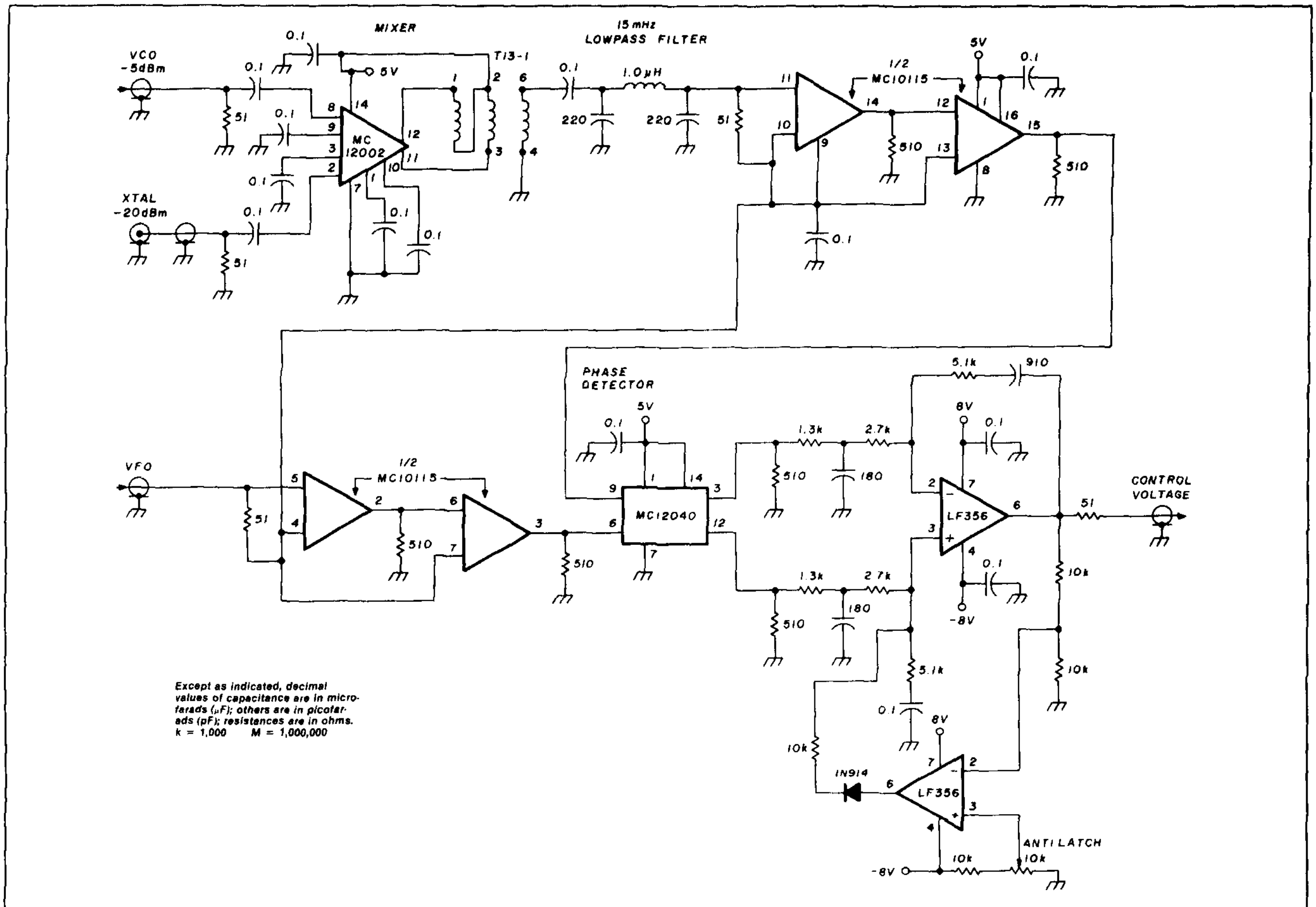


fig. 13. Phase-detector schematic (part of M7 module). VCO and crystal-oscillator outputs are mixed in an MC12002 IC. The two square waves representing the difference sideband signal are processed by an MC12040 phase and frequency detector. The LF356 IC operates as a differential loop filter.

tions of ±2 volts, and to provide approximately the same drive level out of the module. It's not important that each oscillator be exactly on frequency, since the digital readout provides the receiver frequency accuracy. These frequencies vary about ±1 kHz in my receiver.

A 2N5179 isolation amplifier drives a lowpass filter through a 50-ohm line to the synthesizer module. A 15-pF trimmer capacitor tips the frequency response to help keep a constant drive level across the 40- to 70-MHz band.

Phase detector. The VCO and crystal outputs are mixed in an MC12002 double-balanced modulator IC. See **fig. 13.** A lowpass filter selects the difference sideband signal, and one-half of a MECL comparator (MC10115) changes it to a square wave. Another half of the MECL comparator squares up the VFO output, and the two square waves are then processed by an MC12040 phase and frequency detector. This unit is functionally identical to the MC4044 but it is an MECL implementation and is usable to 80 MHz. Also, at any frequency, it provides less random jitter due to differential propagation delays between input and output. The MC12040 output drives a differential loop filter using an LF356. Some attenuation of the sampling frequency spikes is provided by the 180 pF capacitors in the loop filter.

The normal VCO operation voltage range is ±5 volts. Under some conditions the VCO output can go below the crystal frequency. When this occurs, the feedback sense shifts to positive, and the loop will latch up with the VCO drive voltage at the negative rail. A second LF356 senses this condition, and jams the loop to a normal lock.

5-MHz VFO. This VFO uses a 2N5397 FET in the Vackar configuration, as shown in **fig. 14.** A surplus BC221 tuning capacitor is the main tuning element. I used it because of the high-quality worm drive that comes with it. The over-all tuning rate is about 14 kHz per knob revolution.

The output is taken through the capacitive tap across the tuned circuit. This method gives a good sine wave because of the high circuit Q. Two isolation stages buffer the output.

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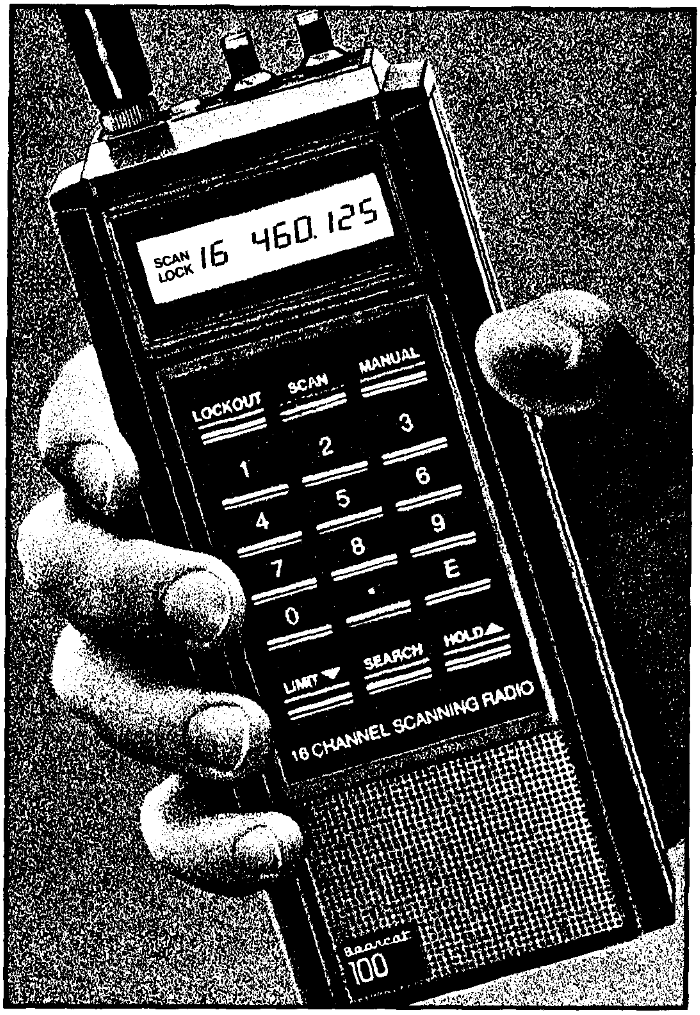

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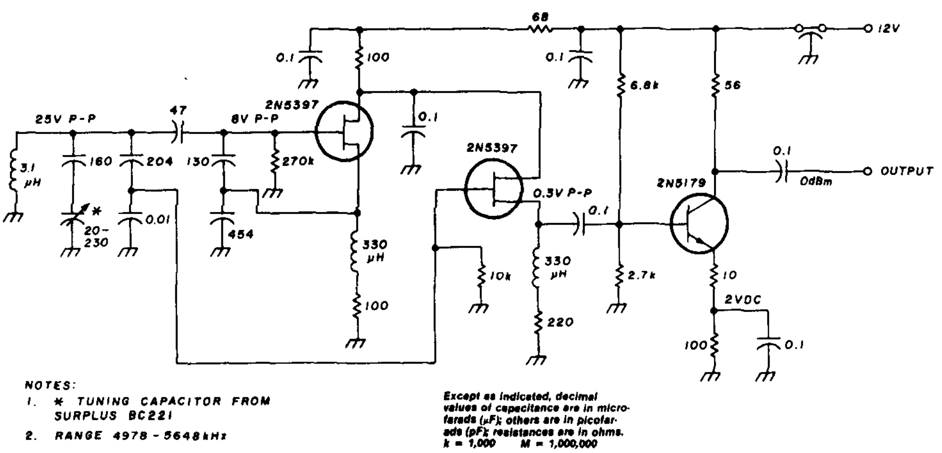

fig. 14. 5-MHZ VFO (part of M7 module). A 2N5397 Vackar oscillator is used in this circuit. High circuit Q provides a good sine wave. Two isolation stages buffer the output.

The VFO has been very satisfactory in operation; however, I could have used heavier material than a minibox, because a shift of 100 Hz is noticeable if the receiver is turned upside down while listening to a CW signal. Flexing of the tuned circuit components causes this problem.

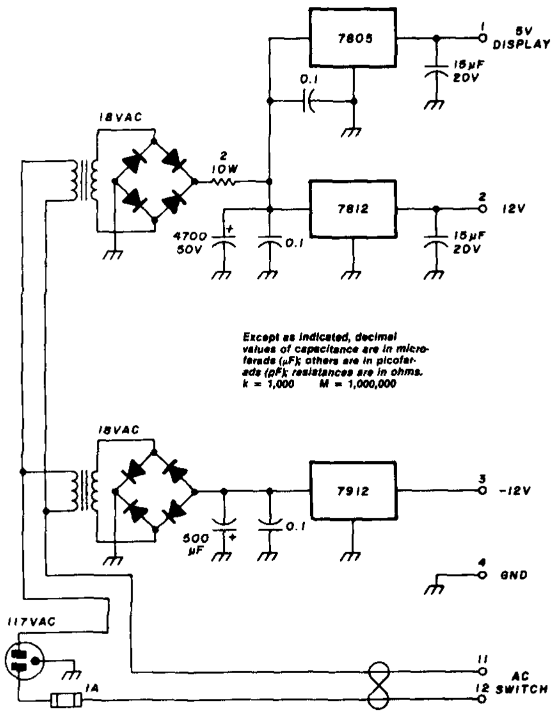

fig. 15. Receiver power-supply schematic (M8 module). Full-wave bridge circuits provide regulated positive and negative voltages for the receiver.

The short-term stability characteristics of this oscillator determine the over-all receiver performance. Therefore, high-Q components should be used in the oscillator tank circuit.

power supply

The power supply module schematic is shown in **fig. 15**, and the wiring diagram of the receiver in **fig. 16**.

display module

A six-digit counter displays receiver frequency. The counter is preset to minus 450,000 counts to subtract the first i-f from the displayed value. The counter then counts the synthesizer frequency but displays the signal frequency. A 10-MHz clock generates the count gate. This oscillator can be set to zero beat with WWV to calibrate the display. The schematic is shown in **fig. 17**.

construction

The receiver is designed as a group of modules and boards with 50-ohm interfaces. This design allows for flexibility during the construction phase; several of the modules were modified or reconstructed in some way. This receiver is strictly a breadboard unit, although it's easy to work on and is fairly sturdy from an electrical and mechanical viewpoint. Many of the modules are fastened to the sides of the frame and are easily removable. The sides may be unscrewed to gain access to the inner portions of the receiver; yet, the unit is operational in this condition. Some of the boards are fastened under the main deck and covered by shield cans. Module and board layouts are shown in the photos.

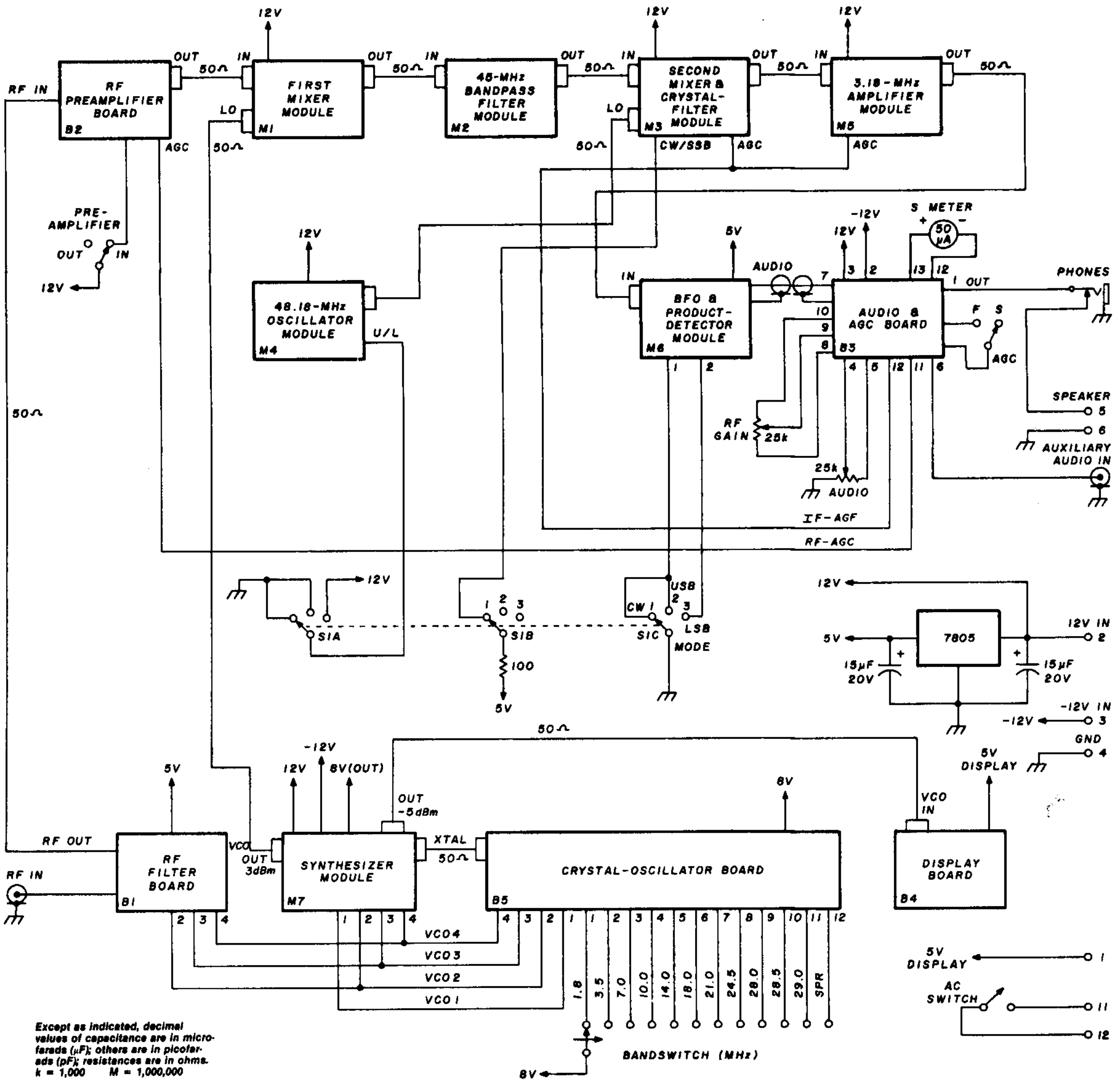

fig. 16. Interconnection diagram. The receiver is designed as a group of modules and boards with 50-ohm interfaces.

Several board construction techniques are used. The rf circuitry is built onto blank printed-circuit material. Miniature terminal strips are soldered to the boards, and the components are mounted on the strips. This method requires no hole drilling except for the four mounting holes. The audio-AGC board is built on a VERO™ card, and the display module uses wire wrap. All boards have ground planes and use extensive bypassing.

All parts are readily available through mail-order houses. Suitable and equivalent SSB and CW filters are available from Fox-Tango Corp. The PTI and Minicircuits™ components may be purchased direct. Although an account was not kept, the cost was of the order of several hundred dollars for the receiver.

in conclusion

Was it worth the effort? Yes! I learned a great deal. I now have the feeling that a *good* transceiver can be built for about half the price of available units.

As for improvements, a few came to mind: There should be more filtering at the 5-MHz sampling frequency. The switching sidebands are only down 80 to 85 dB. This is not sufficient with an open front-end design. The VCO and VFO should have better har-

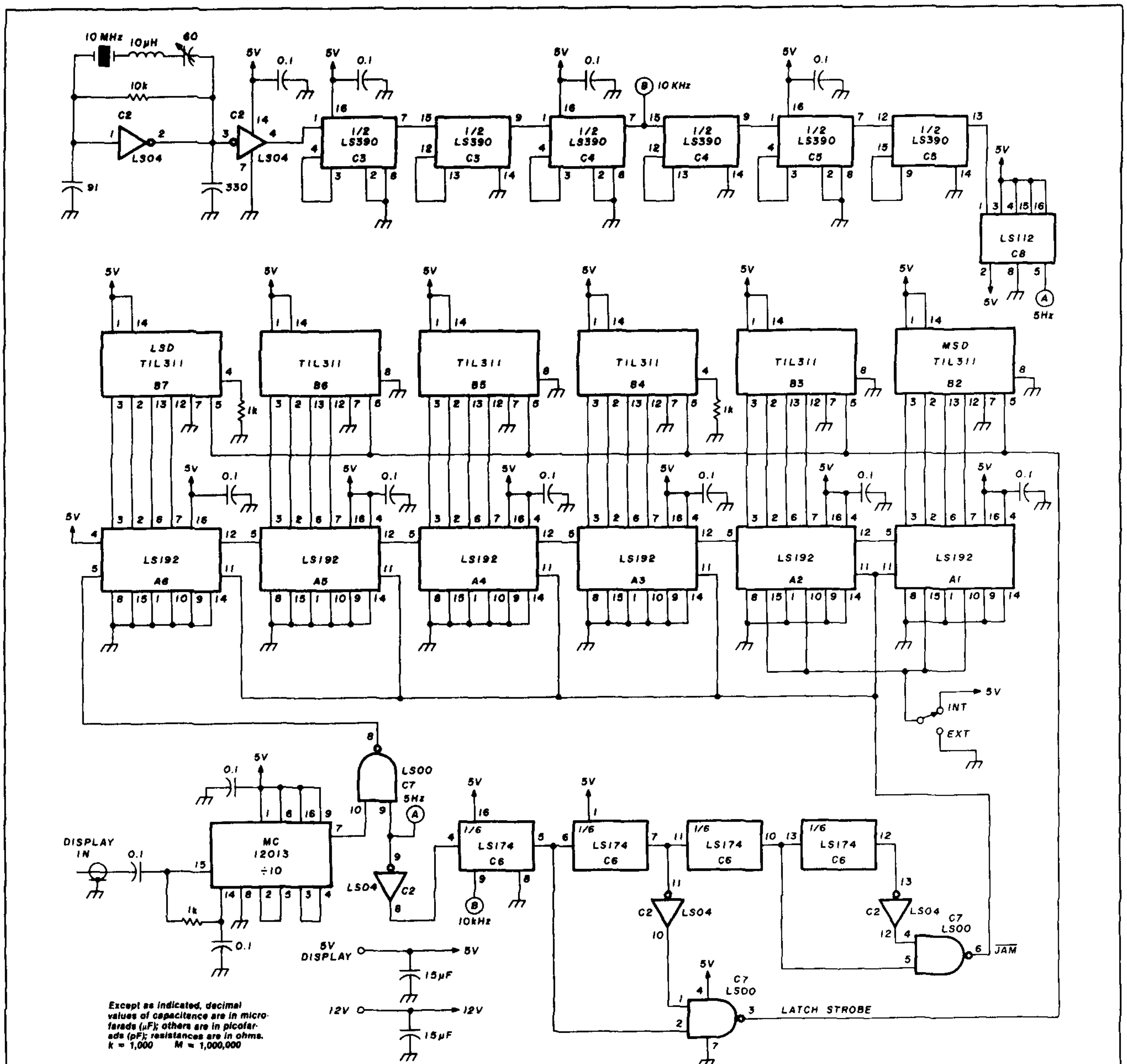

fig. 17. Display-board schematic (B4 board). A six-digit counter displays receiver frequency.

monic filtering, which will eliminate the VFO fourth harmonic response from appearing at 21.2667 MHz as well as other spurious signals.

The VFO and synthesizer should be mounted in separate shielded boxes. Tank-circuit voltage in the VFO is quite high, and this field contributes to the filtering problem. Space should be allowed for more 3.18-MHz crystal filters for operating flexibility.

acknowledgments

Credit is due to WB2DGJ, KB2NJ, and WA2QAF for helping with the construction, and to WA2IFG (my XYL) and Grace (my secretary) for helping with the typing. Pictures were furnished by W2PJK.

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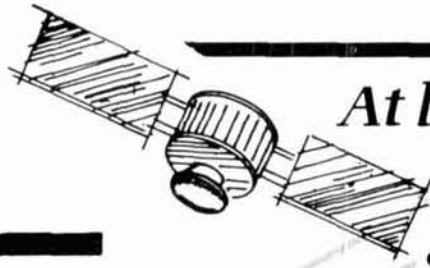
ham radio



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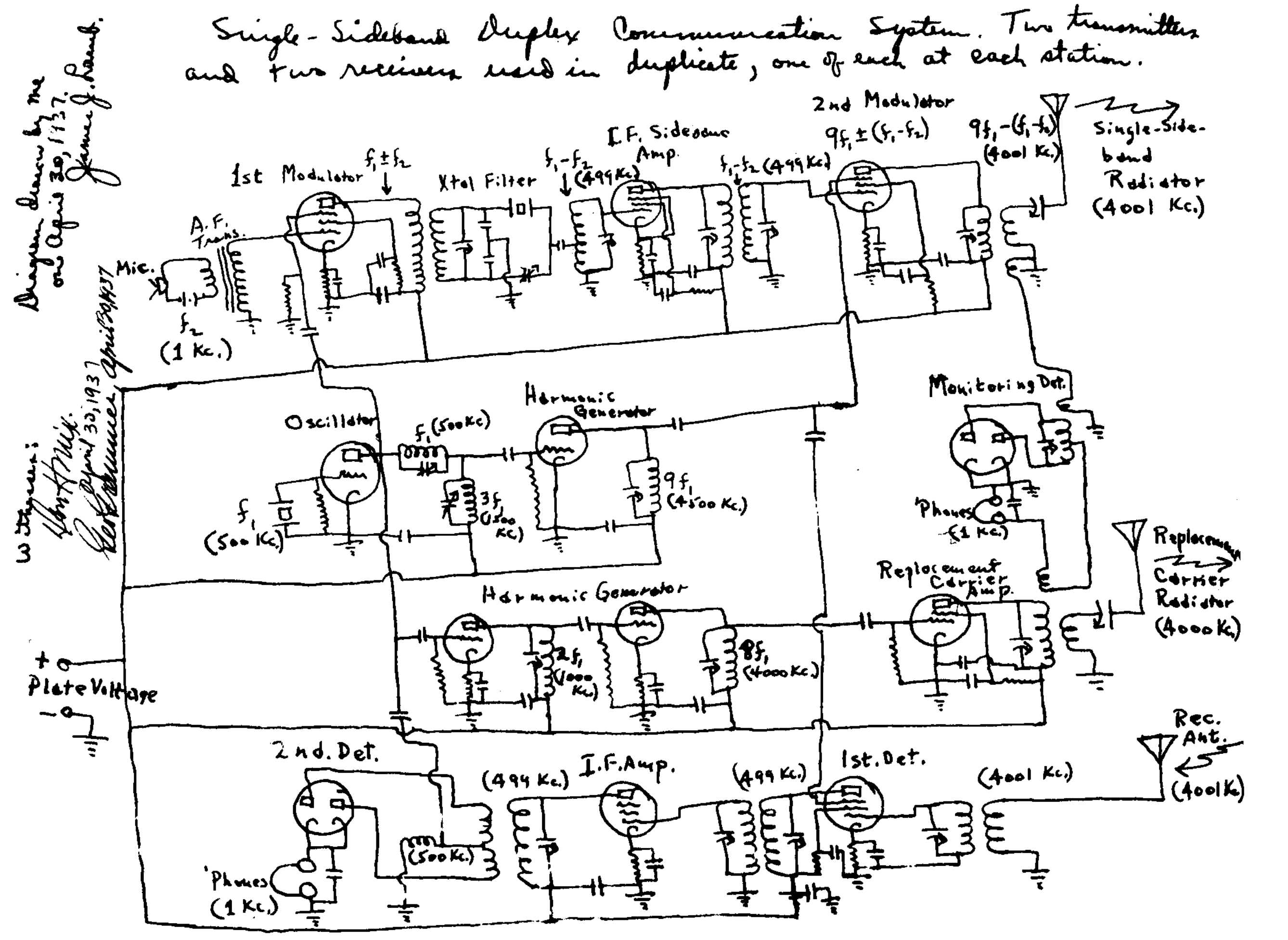


fig. 1. Schematic of the proposed single-sideband transceiver, April 30, 1937. World's first SSB transceiver was designed by Jim Lamb, W1AL, then Technical Director of *QST* magazine. While the concept was feasible, it was never discussed in *QST* because it was "too complicated for the average Amateur." The idea lay dormant for twenty years until Collins Radio Co. developed the famous KWM-1 transceiver. Jim's transceiver was designed to work in the 80-meter band on USB. Judging those days from these days, it looks as if the idea would have worked. The weak link was the sideband filter shown, which could not reject the complete unwanted sideband. Note that a "replacement carrier" was radiated by a separate antenna. Witnesses signed the sketch on the left margin: George Grammer and Don Mix, both well-known communications engineers.

The single-sideband transceiver is the standard "black box" of the modern station. Was there a time when Amateurs were without this popular means of communicating?

Old-timers can recall the days of the mid-fifties when SSB was new and exciting. In 1957, the Collins Radio Company introduced the KWM-1 SSB *transceiver;* Herb Johnson, W6QKI, was hard at work designing the prototype of the famous *Swan series of transceivers.*

But the concept of the SSB transceiver was actually developed in the spring of 1937! For twenty years the idea had lain dormant. War, and the lack of suitable sideband filters and stable oscillators, put SSB on the back burner for all except a few experimenters who toyed with this exotic form of communications.

Nevertheless, the basic idea for the SSB *transceiver came about in April,* 1937, when James J. Lamb, W1AL, then the Technical Editor of *QST,* completed the design of a "single-sideband duplex communication system" and had his sketch witnessed for posterity (**fig. 1**).

Jim's novel transceiver worked in the 80-meter Amateur band on a fixed frequency (4.000 MHz). A block diagram is shown in **fig. 2**. This clever design anticipated frequency synthesis decades before its time. The transmitter portion of the transceiver is at the top of the sketch. Starting, for example, with an audio tone of 1 kHz, the signal is amplified and mixed with a 500-kHz carrier from a crystal oscillator. The sum and difference frequencies (499 kHz and 501 kHz) are passed through a crystal filter, which passes the lower (difference) sideband of 499 kHz and rejects the 501-kHz signal. The wanted signal is amplified in a 500-kHz passband amplifier and fed to a mixer for conversion.

The mixer injection signal is at 4.5 MHz and is derived from the ninth harmonic of the 500-kHz oscillator by virtue of a times-nine multiplier, or harmonic generator. The resulting signal is upper sideband, with the 1-kHz tone at 4.001 kHz.

Jim Lamb added a "replacement carrier" generator to supply a carrier at 4.000 kHz. Note that the carrier was radiated by a separate antenna. The purpose of the carrier, it is thought, was to ensure a reference frequency for the unstable receivers of those days. No information is provided in the drawing as to the relative

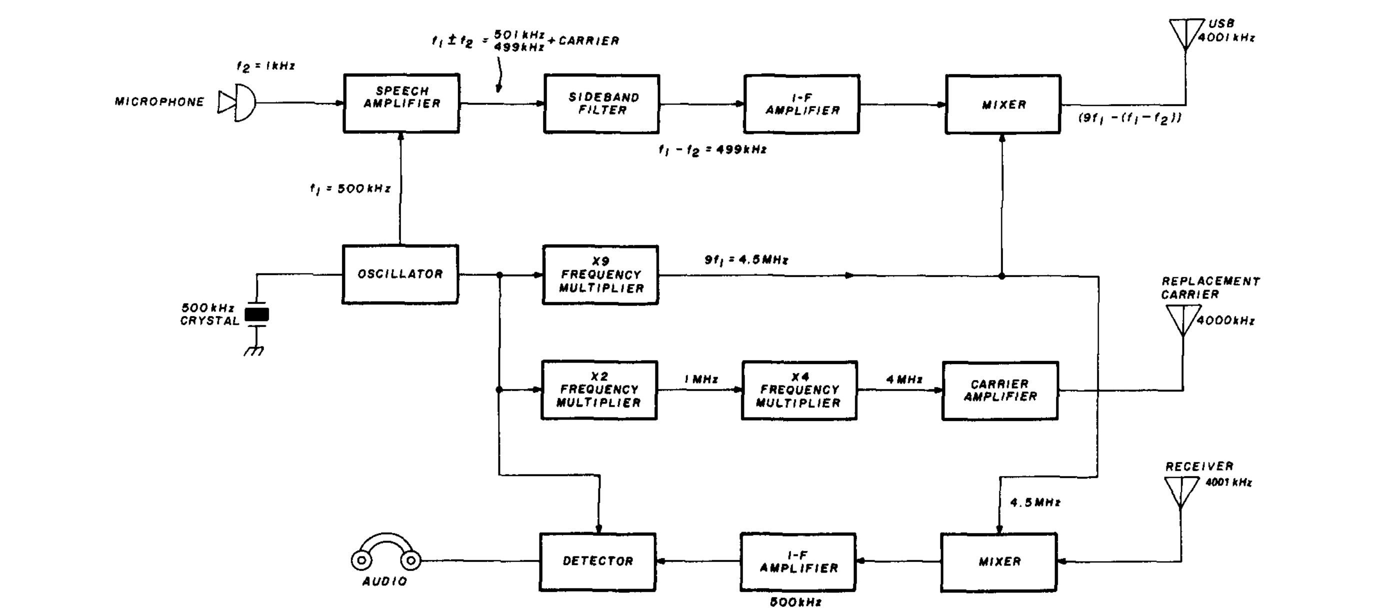


fig. 2. Block diagram of the 1937-model SSB transceiver designed by W1AL. Transmitter portion is at the top, with the receiver portion at the bottom. All injection frequencies were generated by a 500-kHz oscillator. This single-frequency design transmitted USB at 4 MHz. Because of the difficulties involved, SSB lay dormant for nearly 20 years, although the principles were well known and commercial SSB circuits had been in service since the early twenties.

signal amplitudes of the carrier and *the sideband signal*.

The lower portion of the sketch represents the receiver portion of the transceiver. Referring to the block diagram, the incoming signal at 4.001 kHz is mixed with the 4.5-MHz injection signal and the resulting signal, at 499 kHz, is amplified and passed to a diode detector receiving mixing voltage from the 500-kHz crystal oscillator. The audio signal developed is passed to a headset and the eager operator.

W1AL clearly understood the principle of frequency synthesis, as all his mixing voltages were derived from a single crystal-controlled oscillator. To make sure everything functioned as it should, a diode monitor was added that sampled the carrier and the sideband signal.

So there it was! A breath-taking new concept that eventually would change Amateur Radio and commercial high-frequency communications techniques. But did this startling technique ever appear in *QST*? A look through the 1938 index and a search of the individual issues of the magazine reveal nothing. *What had happened to the great idea?*

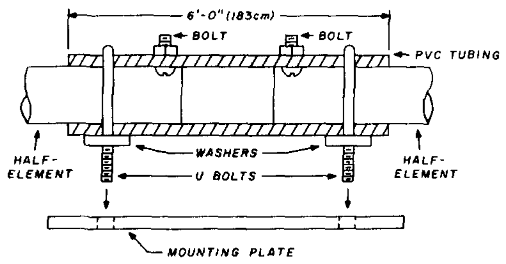
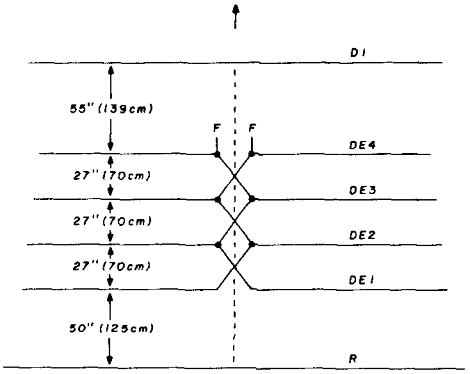


fig. 4. Log-periodic elements are insulated from the boom by a length of PVC plastic tubing. Two top bolts pass through element and tubing to make connections to transposed transmission line made of 1/4-inch-diameter tubing. U bolts passed over PVC tubing to clamp element firmly to mounting plate, which is attached to boom by two additional U bolts.

In a personal discussion with Jim Lamb (now living in California), I learned that the idea had been rejected by the General Manager of the League, at that time Kenneth Warner, because there was no interest in single sideband among Amateurs: the concept was too complex for Amateurs to understand, and the transceiver would be too expensive to build and too complicated to align. Thus the transceiver slumbered for two decades until postwar interest in this novel means of communicating *brought SSB into the Amateur bands to stay*.

QST comfortably avoided SSB until the fall of 1947, when Mike Villard, W6QYT, and Art Nichols, WØTQK, appeared on SSB working Amateurs on 80 and 20 meters. (Before this date, one or two experimental Amateur SSB stations had been on the air, but their transmissions seemed not to be of general interest.) Now, the time was ripe. The January, 1948, issue of *QST* editorialized on the virtues of "single-sideband, suppressed carrier" transmission, and actual operational SSB equipment was featured. *But by now Jim Lamb had left the League; it would be up to others to carry forward his far-sighted communications concepts.*



ELEMENT	LENGTHS	
	ENGLISH	METRIC (cm)
D1	14' - 11"	(453)
DE4	14' - 5"	(440)
DE3	15' - 2"	(462)
DE2	15' - 9"	(482)
DE1	16' - 6"	(503)
R	18' - 1"	(553)

fig. 3. Top view of LPY beam for 10 meters. Design covers the complete range of 28.0 to 29.7 MHz with low value of SWR. Ideal for solid-state transmitters. Beam is fed at F-F with 4-to-1 balun and 50-ohm coaxial line. Overall boom length is 15 feet 8 inches (4.7 meters). Design adapted from JH1ZGA, as shown in *CQ-ham radio* magazine (Japan).

a six-element wide-band beam for 10

As every 10-meter enthusiast knows, it is a difficult task to cover the whole 10-meter band with most of the common Yagi or quad antenna designs. If the beam is tuned at, say, 28.6 MHz for operation at the lower end of the band, gain and front-to-back ratio start going to pot near 29 MHz — and at the top end of the band, 29.7 MHz, the beam is relatively worthless. The same is true for beams peaked at the high end of the band: operation is severely hampered at the low-frequency end.

JH1ZGA, a Japanese Amateur

writing in *CQ-ham radio* magazine (Japan), has solved this problem with an adaptation of the log-periodic principle to the Yagi antenna. He describes a homemade LPY (log-periodic-Yagi) beam consisting of four LPY elements plus a reflector and a director (**fig. 3**). The beam is easy to build, requires no adjustment, provides nearly uniform gain across the band, and exhibits an SWR figure ranging from about 1.5-to-1 at 28.0 and 29.7 MHz to 1.1-to-1 at the design frequency of 28.6 MHz. Now, that's hard to beat!

The beam is built on a 2-inch (5-cm) diameter boom, 15 feet 8 inches (4.8 meters) long. The elements are tapered, made of telescoping sections of aluminum tubing, the largest sections being 1 inch (2.5 cm) in diameter and the smallest being about 7/8 inch (2 cm) in diameter. Element lengths and spacings are given in the drawing.

The transposed transmission line running between the elements is made of 1/4-inch-diameter tubing, with the ends flattened to fit over the inner mounting bolts of the elements.

The reflector and director elements are clamped directly to the metal boom, whereas the four driven elements of the log-periodic cell must be insulated from the boom. There are a number of ways of doing this. The original JH1ZGA design calls for the elements to be slipped within a short length of plastic (PVC) conduit pipe, as shown in **fig. 4**. The conduit is then affixed to the boom by means of a U-bolt and mounting plate.

Impedance at the feedpoint (F-F) is about 200 ohms, so a 50-ohm transmission line and a 4-to-1 balun transformer are used to provide a good match.

Since the log periodic cell of four elements provides gain, as do the parasitic elements, the overall gain figure of the beam is approximately equivalent to that of a six-element Yagi. Best of all, the gain and front-to-back ratio are realized across the whole 10-meter band.

a word to the wise

The winter season is coming, with rain, snow, wind, and ice. Before the onslaught of bad weather it is a good idea to examine your antenna installation to make sure it will stay up when bad weather hits. The *before* and *after* photos of **figs. 5** and **6** show what happened to one East Coast Amateur whose enthusiasm for a big signal was greater than his ability to install a proper support structure. The 90-foot telescoping tower had three stacked monoband beams mounted on a heavy steel mast protruding from the top of the tower. A huge rotator was mounted at the top of the tower, too. The tower was firmly anchored at the base and house roof, and was self-supporting. But the designers of the tower clearly indicated in the data sheet what the maximum wind loading for the tower was; it was ignored. The result was that the tower twisted in heavy gusts of wind and the whole schmeer came crashing down one stormy night. Luckily, the mess landed in the yard and no one was injured.

The unlucky Amateur is now back on the air with his big beams, but the whole antenna installation has been redesigned by a certified mechanical engineer to make sure that it will withstand winter weather.

You may not have a problem as serious as this, but the moral is clear — make sure your antenna installation is robust enough to withstand the coming winter storms!

more on interference

My remarks last month on RFI (radio frequency interference) merely touched the tip of the iceberg. RFI is rapidly getting out of hand. RFI is a double problem that comprises both interference *to* communicators (Amateurs, CBers, and commercial communication circuits) and interference to others *by* communicators.

RFI travels from place to place by radiation, induction, or conduction. Radiation is electromagnetic propa-

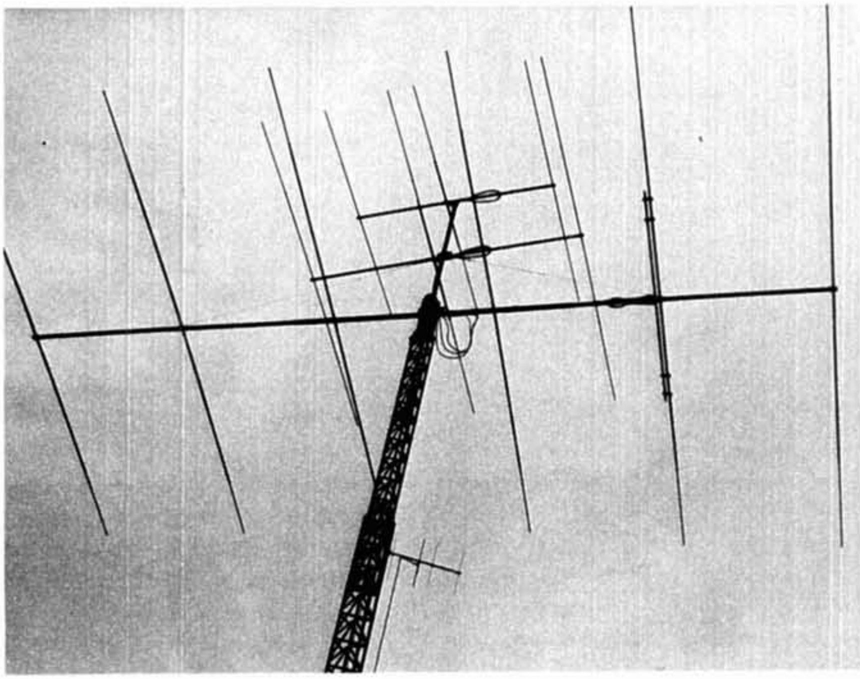


fig. 5. July, 1980. The high-power antenna farm of a prominent East Coast DX-er before the winter storms hit. The self-supporting crankup tower held stacked 20-, 15-, and 10-meter arrays, a heavy-duty rotator, and a side mounted 2-meter beam. All worked well until.....

gation through space. Conduction is transmission through an electrical circuit. Induction is transmission by means of a magnetic field. Transmission of RFI by an electrostatic field is also possible.

In practical terms, this means that radio noise can be radiated from the source to a nearby receiver, or can be coupled to the receiver through a common power source, or radiated from the power line to the receiver, or induced by proximity of source and receiver power lines.

RFI can be cured or attenuated in the majority of cases by a systematic investigation of the noise source and the transmission path. An important tool in the investigation of power-line RFI is a portable, multiband, battery-operated receiver with a built-in loop-stick antenna. The directional properties on the broadcast band of such a receiver will indicate a direction in which the interference source probably lies. Driving about an area "infested" with power-line noise usually provides a general indication of the noise source.

An important point to remember is that the area blanketed by interference is inversely proportional to the frequency of reception. That is, the closer the investigator gets to the noise source, the higher in frequency it can be heard. Thus, while listening a great distance from the noise source, it may be heard in the broadcast band but cannot be heard at, say 5 MHz. Drawing closer to the source, it can then be heard at 5 MHz but not at 30 MHz. Drawing still closer, the noise may be loud at 30 MHz, but barely audible at 100 MHz. At this point, the search can be shifted into the fm broadcast band (88-108 MHz) or into the Amateur 2-meter band.

Interference caused by radio transmitters of all types can be tracked in much the same manner with a directional antenna, although tracking is done on the frequency of transmission (or on a harmonic frequency). Perseverance, experience, and several receivers in an automobile can work wonders in the interesting and practical art of RFI tracking.

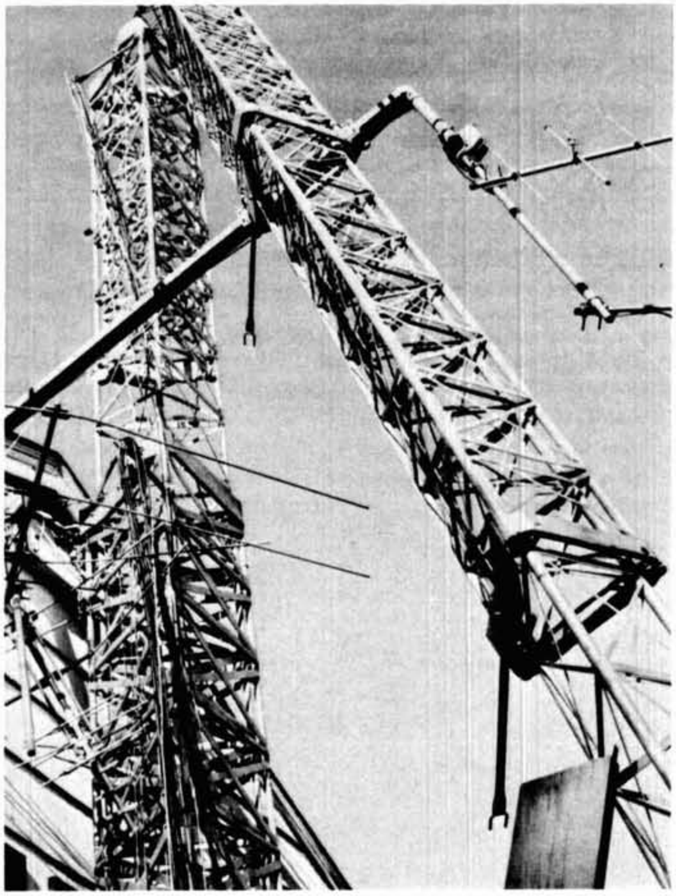


fig. 6. The winter storms hit, and the tower fractured at mid-joint. Luckily, no one was injured when all of this metel tumbled down from the sky. Is your antenna designed to stay up?

the spark discharge

The spark discharge is a common source of radio noise and TV interference, and it can be generated by a number of sources. The discharge sounds like a buzzing, rasping, popping noise, and appears as a band of horizontal dot-dash lines moving slowly up the screen of a television receiver. The width and intensity of the lines are dependent upon the strength and severity of the interference.

One prolific source of radio noise caused by spark discharge is the neon sign. High voltage is required to operate a neon sign, and radio noise can be caused when the neon pressure in the sign drops, causing flickering. The on-off ionization of the gas causes the radiation of a rough, spark-like radio noise that can travel for a great distance.

WA6FQG, Bill Nelson, an experienced RFI investigator, discovered bad interference on his own ham set one day. With the aid of his rotary beam he found the general direction of the noise and tracked it to a neon sign more than three miles distant. It was an animated sign over a nightclub. First, the letters *TOP* would flash, followed by the letters *LESS*, and then the complete word *TOPLESS* would flash.

Bill told the owner of the sign that it was causing severe interference to radios in the vicinity, but the owner couldn't care less. He told Bill that he was probably the ham they were always hearing on the stereo whenever the topless dancers were at their best.

The sign is still flashing, but, luckily, Bill was planning to move away soon. Information Bill provided about RFI filters and sign maintenance fell on deaf ears. The dancers are still twirling their tassels and the neon sign flickers to this day. You win some, you lose some.

Bill Nelson is one of the nation's top-notch RFI investigators, who's done this type of work for over two decades for a large California public utility. He's summed up his vast knowledge of RFI in a new handbook, *Radio Frequency Interference* (Radio Publications, Wilton, Connecticut 06897). It's available from Ham Radio's Bookstore, Greenville, New Hampshire 03048, for $8.95 plus $1.00 for shipping and handling. I've had a pre-publication look at Bill's book and it is good.

an interesting observation on TVI

Interference caused by harmonics of the television receiver's sweep oscillator can be a nuisance on the Amateur high-frequency bands. They were not much of a problem to me on 20 meters, but recently when I tried 80 meters, the devilish buzzing signals nearly obliterated the band. While gazing at the TV receiver and wondering what to do, I noticed that the receiver has a three-wire, 120-volt power cable and that it was plugged into a two-pronged wall outlet. An adapter plug was used that matched the three-prong TV plug to the wall plate. The ground wire of the three-wire cable was attached to a pig-tail on the adapter. I noticed the pig-tail had not been grounded to the conduit bolt on the wall plate, but left hanging in midair.

Grabbing a screwdriver, I immediately attached the pig-tail to the wall plate bolt (**fig. 7**). Checking my receiver on 80 meters, I noted happily that the S-meter reading on the TV oscillator harmonics had dropped nearly a quarter-scale! In 20 seconds of work I had reduced the racket from unbearable to merely annoying! Moral: Check your TV receiver. If the ground prong of the power plug is not grounded to the equipment ground wire of your wiring system, it would be a good idea to make this connection.

A few days later I tossed out the two-prong wall plate and substituted a new three-prong plate which automatically grounded the equipment ground wire of the TV power cord. Since modern appliances are all equipped with a three-wire power cable, examine your wall receptacles. If they have two conductors plus an equipment grounding wire, replace the old two-connector receptacles with modern three-connector designs. Wiring instructions are included with the new receptacles.

ham radio

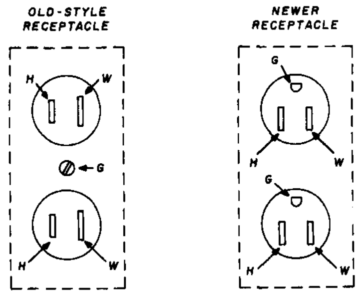


fig. 7. Many homes built during the fifties and sixties are wired with wall plugs shown at left. The neutral wire (white, W) with a nickel screw is unfused and at, or near, ground potential. The other wire (black, red or blue with a brass screw) is hot, H. In most instances a third ground wire is run between all metal receptable boxes (G) and is grounded at the meter box. At the right is the newer receptacle in use since mid-sixties. Equipment ground (G) is separately grounded at the meter box and is coded green. House wiring varies from town-to-town, so check yours and don't assume this wiring information is universal! If in doubt make the equipment ground connection through an 0.01 μF, 1.4 kV ceramic disc capacitor.

More Details? CHECK—OFF Page 120

communications receivers
for the year 2000

Feedback amplifiers, i-f filters, i-f detectors, frequency synthesizers: part 2

Part 1 of this article, which appeared in the November, 1981, issue discussed new approaches to receiver design, microprocessor applications in receivers, input filters, and input mixers. In this, the second and final part, I address feedback amplifiers, i-f filters, i-f detectors, and frequency synthesizers.

feedback amplifiers

The grounded field-effect transistor circuit using the CP643 has an intercept point of 35-40 dBm relative to the output, which means that the gain (about 10 dB) must be deducted from the input. The noise figure depends on the source resistor. If the driving source is in the vicinity of 50 ohms, the noise figure will be about 3 dB. To get a lower noise figure a higher drive impedance is required.

Texas Instruments in Germany made a high-power field-effect transistor called the P8000, then replaced it with the P8002. This transistor has about 2-dB noise figure when driven at 50 ohms. In addition, it uses a special metal housing and can dissipate more heat. This transistor appears to have been discontinued, but some are available from me (send an SASE).

A further reduction in noise with the same intercept point can be obtained by using feedback. The BFT66, made by Siemans (about $3 each) exhibits a noise figure of about 1 dB and an intercept point of almost 40 dBm when used in the feedback circuit shown in **fig. 6**.

Noiseless feedback circuit. The circuit can be analyzed under the simplifying assumption that the common-base transistor has an input impedance of 5 ohms, an infinite output impedance, and unity current gain, while the transformer is considered to be ideal. With these assumptions, it can easily be shown that a two-way impedance match to Z_0 will be obtained if the transformer ratio is chosen such that $n = m^2 - m - 1$. With this choice the power gain will equal m^2, the load impedance presented to the collector will be $Z_0\ (n + m)$, and the source impedance presented to the emitter will be $2 \times Z_0$.

Usable turns ratios are obtained for $m = 2, 3$, and 4, yielding gains of 6, 9.5, and 12 dB and load impedances of 3, 8, and $15 \times Z_0$ respectively.

It is seen that, similar to a conventional common-base amplifier, the gain of the stage is determined by the ratio of load impedance, Z_l, to the input impedance, Z_{in}. In this case, the gain is given by $Z_l/Z_{in} + 1$; whereas it is just Z_l/Z_{in} in the conventional configuration. The significant difference is that the transformer-coupled device provides a two-way impedance match, which is obtained by coupling the load impedance to the input and the source impedance to the output through the action of the transformer.

The dynamic range considerations for this device are similar to those of the directional-coupler circuit but with some important differences. First, the operation of the circuit depends on the completely mismatched conditions presented by the transistor to the circuit; that is, the emitter presents a short circuit and the collector an open circuit. Hence there is no requirement to introduce resistive elements for impedance matching as there was in the directional-coupler circuit. Therefore, a noise figure advantage is obtained with this circuit. Secondly, the source impedance of $2 \times Z_0$ presented to the emitter tends to give optimum noise figures. Finally, despite the small currents involved, relatively large output powers can be provided because of the high load impedance, which goes along with the higher gain versions.

The main disadvantage of the circuit is that the

By **Dr. Ulrich L. Rohde, DJ2LR,** 52 Hillcrest Drive, Upper Saddle River, New Jersey 07458

high load impedance tends to limit the bandwidth. Nevertheless, sufficient bandwidth can be achieved to provide broadband i-f gain with noise figures competitive with those which could previously be obtained only in very narrowband units.

As it is desirable to keep the dc operating level over a wide temperature range, an additional bias circuit was developed that maintains almost temperature-independent biasing.

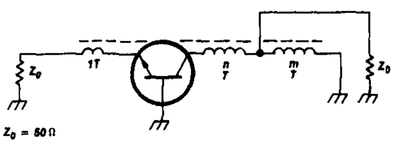


fig. 6. The noiseless feedback circuit using a BFT66 with a noise figure of about 1 dB. An intercept point of almost 40 dBm is possible.

Two-stage low-noise amplifier. Fig. 7 shows a two-stage amplifier that will operate up to 1,000 MHz using this low-noise technique. The output lowpass filter prevents harmonics from occurring at the output. If this circuit is used as the second i-f following the crystal filter of a receiver and drives the second mixer to obtain a lower i-f of, say, 9 MHz, we don't want any harmonics at the output that may cause intermodulation distortion products.

Two BFT66 stages are shown cascaded; the first with temperature-compensating bias. Depending on the turns ratio of transformers T1 and T2, different gains can be obtained. It's desirable to place the tap at the output transformer output so that the transformed input impedance is equal to 50 ohms.

Several other combinations of this amplifier are possible, and its significant advantage over previously published circuits is that it uses transformer, or "noiseless," feedback rather than resistive feedback, therefore the noise figure is substantially lower.

high-dynamic-range amplifiers

Conventional amplifiers built from single-stage circuits suffer from in-band intermodulation distortion, and the previously described noiseless feedback circuit can only be set at gain values depending upon even turn ratios, as discussed.

Let's look at **fig. 8**, in which we see the second mixer of a receiver where the first i-f is converted to a lower i-f such as 9 MHz. The output of the second mixer operates into a diplexer and, therefore, splits up the energy. The drive into the amplifier is therefore reduced by 3 dB, as only one sideband is available.

We find the familiar BFT66 circuit and a PNP/NPN output stage. Since this stage really is an emitter follower, its inherent feedback keeps the distortion low and the low drive impedance allows matching into various impedances.

This circuit is driven from the high-input-impedance point (collector) of the BFT66. To prevent any changes in output impedance, the output transformer of the BFT66 is terminated with 56 ohms. As a result, the PNP/NPN circuit has power gain, very little

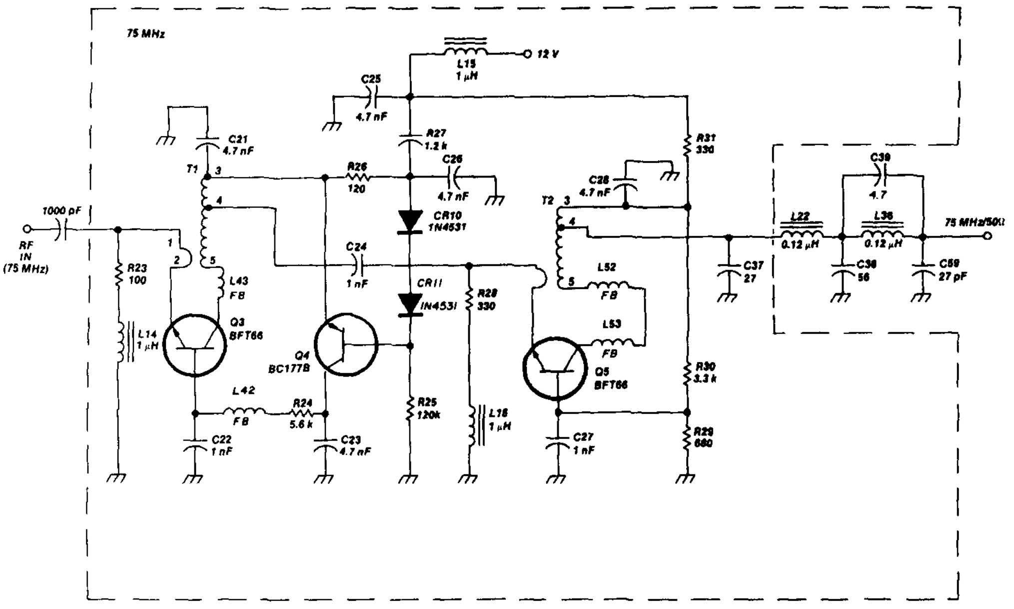


fig. 7. Two-stage amplifier with two BFT66 transistors that can be used as a mixer termination.

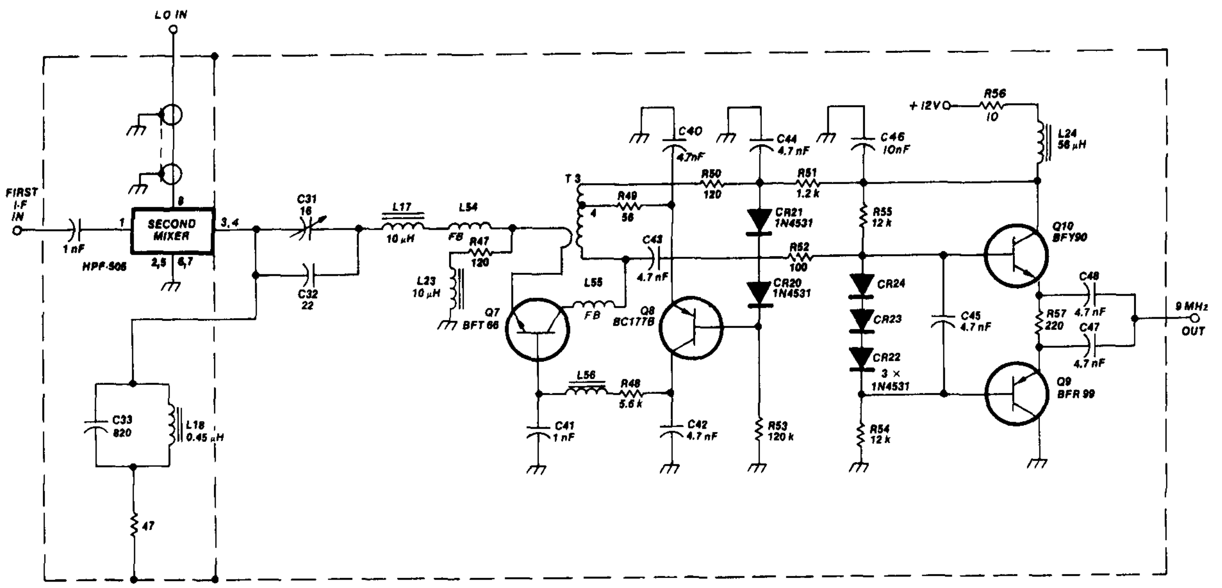


fig. 8. Second mixer of a receiver chain, including the diplexer, low-noise amplifiers, and power-output stage.

feedback, and extremely low distortion. The noise figure is now determined by the BFT66 stage, and the second stage contributes very little. The other advantage of this circuit is that there are no tuned circuits; therefore, it can be used from a few hundred kHz to almost 100 MHz. This makes this circuit design very useful.

i-f filters

I mentioned earlier that there is a distinct difference between static and dynamic selectively. Static selectivity of a filter is defined as the selectivity one measures if a point-to-point measurement is taken and the curve is then plotted. If this is done more rapidly and we start to sweep the filter, then depending upon the sweep time the picture is going to change.

First, the filter shows a delay, which means it takes a certain number of milliseconds or microseconds before the signal arrives at the output. From the use of noise blankers, we note that a crystal in the receiving passband acts as a pulse stretcher, which means that the pulse of extreme amplitude and longer duration is changed into one of considerably lower amplitude and substantially lower duration. This effect is equal to the ringing noticed in reception of Morse code.

From the literature we know that several crystal filter types are available. Originally, one started out with mechanical filters, and the earlier mechanical filters also exhibited excessive ringing. The dynamic response of a filter is determined by its design. A filter with a rectangular-shaped response has the highest selectivity and the highest ringing.

Let's consider a 200-Hz CW filter with a shape factor of 3 and a substantial phase jump on the corners, which therefore results in excessive nonlinear distortion and ringing. In my recent paper,[3] I presented several crystal filter computer programs and showed how to design crystal filters that avoid this ringing.

First of all, from filter theory, it is known that a single-tuned circuit has the least amount of ringing but insufficient selectivity. To duplicate a 6-8 pole crystal filter, 6-8 discrete tuned circuits isolated by an amplifier are required. This is called synchronous tuning, and modern spectrum analyzers are still using this approach. If the bandwidth must be changed,

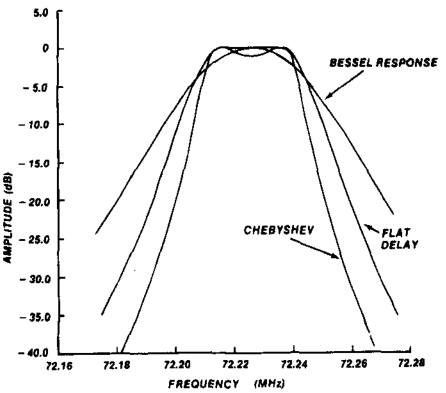


fig. 9. Amplitude response of a Bessel filter, a filter with flat group delay, and a Chebychev filter.

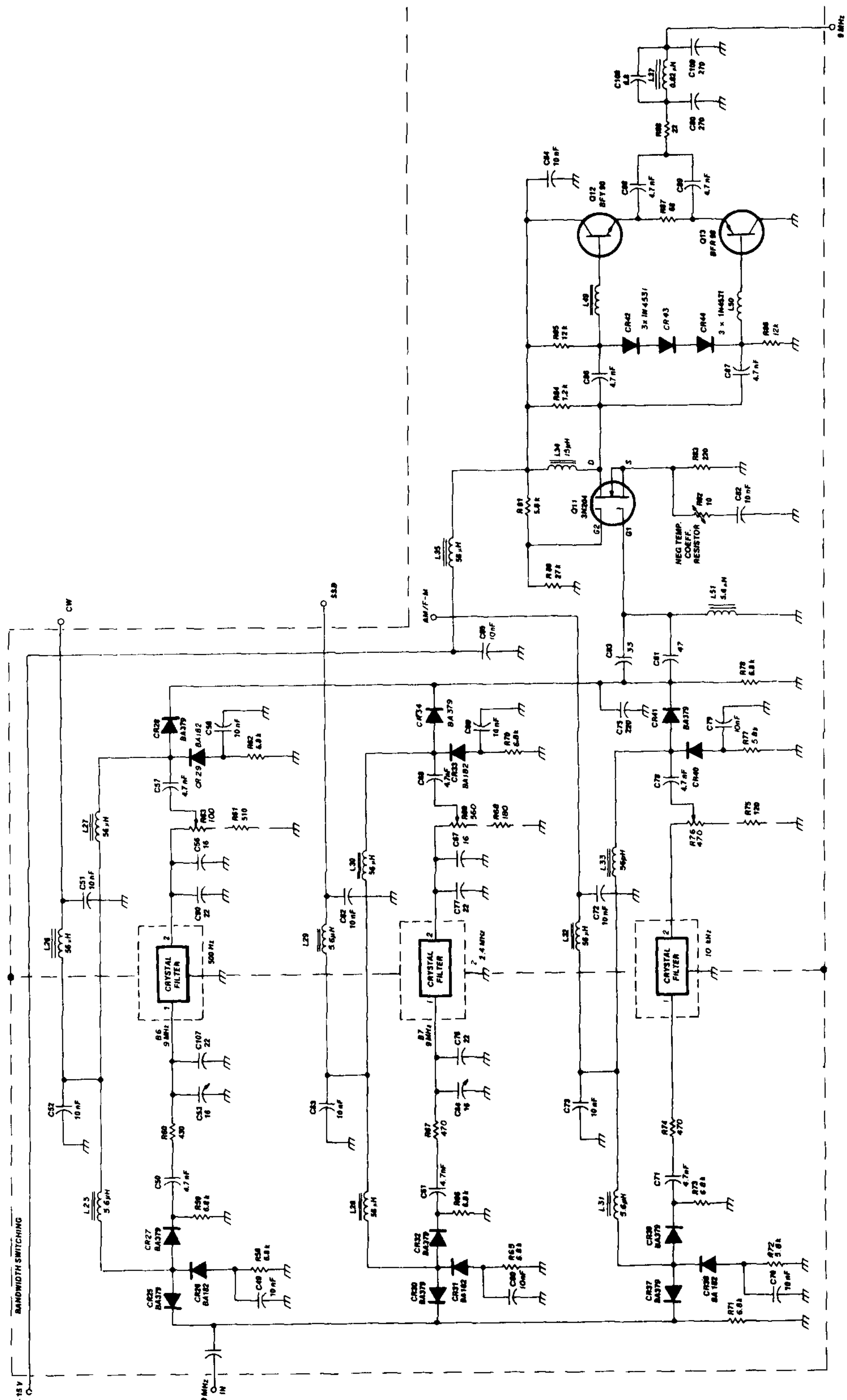


fig. 10. I-f section containing three i-f filters, switching arrangement, gain adjustment, and temperature-compensated high-level output stage.

each filter circuit must be tuned with a tracking circuit, which makes these analyzers expensive but gives perfect response. Mathematically, the equivalent of such a filter is "Gaussian shaped." It has the poorest selectivity but the best pulse response.

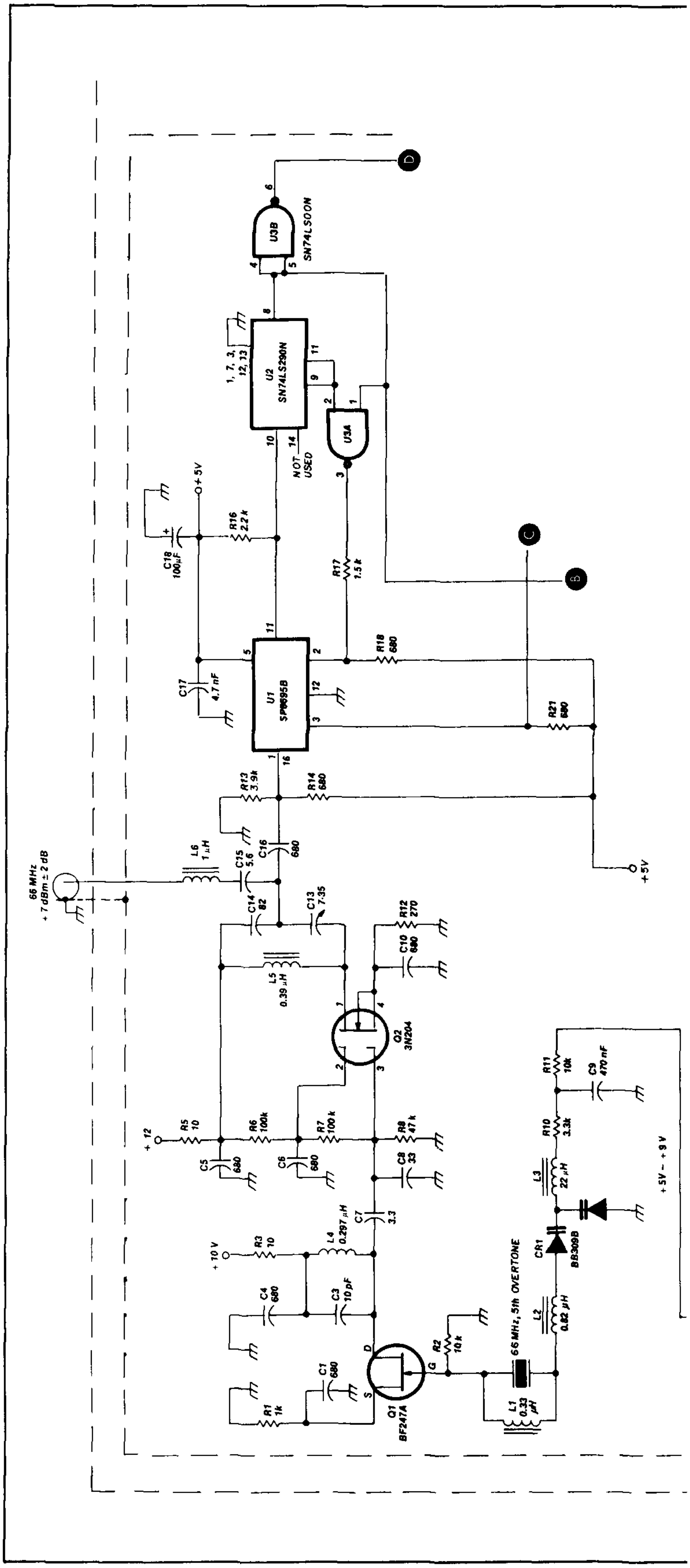
It should be noted that, for Amateur purposes, both CW and SSB are basically pulse-type modulation. In both cases, there is no carrier and no constant level. However, in the case of single sideband signals, several frequencies of different amplitude are available simultaneously. The human voice has harmonics, and if the circuit introduces distortion, we have a wider or splattered signal. Therefore, the single-sideband filter energy both inside the bandwidth and outside the bandwidth bounces against the skirts.

Let's take a look at **fig. 9**, which shows the three most important types of filter curves: Bessel response, flat delay, and Chebyshev. The Bessel response is an approximation of the Gaussian filter with improved skirt selectivity. The flat delay filter exhibits a constant group delay, or a group delay with an extremely small ripple. As a result, the pulse response and skirt selectivity are excellent. The disadvantage of this filter is its somewhat higher insertion loss. Finally, as a comparison, we see the Chevyshev filter with the familiar flat top in the passband, while the flat-delay filter shows a slight dip.

These filters are based on certain mathematical equations, as is the elliptical filter, which is not elliptical in the sense that it looks elliptical, but rather certain equations, called elliptical integrals, are used to calculate its characteristics. Modern computers and desktop calculators use these filters. I am currently evaluating some new types of filters that are computer optimized and easy to build.

The ultimate rejection of these filters is an important parameter, and also the termination on both sides affect performance. It is therefore very important how these filters are inserted into the circuit. **Fig. 10** shows a recommended method using switching diodes and having a provision to adjust for the different gains at the different bandwidths. The German company, KVG, makes excellent filters. Their CW filter, XF9NB (available from Spectrum International), has a superior ringing performance.

For single sideband we find only one filter. If we change both the BFO as well as the second LO frequency in the receiver by 3 kHz, we can eliminate the second filter and still maintain a correct dial reading. In the section on frequency synthesizers, I show a simple circuit that can be used for the second LO and the BFO to shift the crystal frequency against an internal standard — a less expensive solution than using two filters.



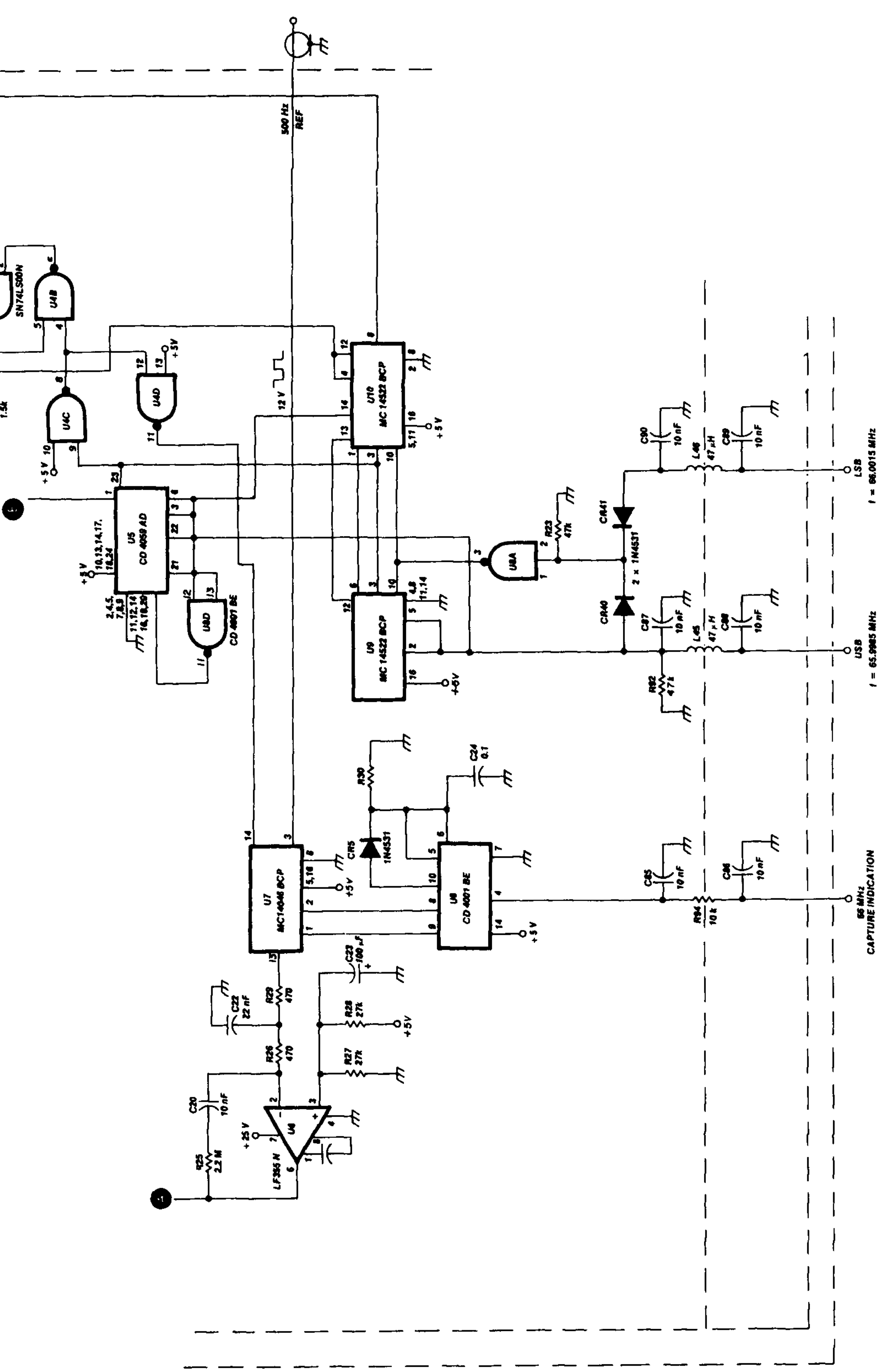


fig. 11. Schematic diagram of a single-loop synthesizer synchronizing a 66-MHz crystal, used as a second LO, against 500 Hz from the standard.

i-f detectors

Multimode receivers require a-m, fm, and SSB detectors. Since we want the audio at the same level, gain adjustments must be provided. Probably the best and least expensive solution for this problem is to use the SL624 Plessey IC. This chip contains the detection circuits for all three modes of operation.

Another attractive solution is to use the SL624 for fm only and the SL623 only for SSB and a-m, which allows somewhat greater flexibility in the design parameters. A third solution is to use the SL640/41 as the product detector if only SSB is required. This product detector requires the least amount of components but is not used very frequently. While it is more forgiving as far as high i-f levels are concerned, it is also less well known. A summary of i-f circuits is found in reference 4.

frequency synthesizers

Earlier I mentioned that we need a synthesizer for the BFO and for the LO. Having the BFO and LO synthesized allows i-f shifts and/or allows the use of the 2.4-kHz filter for both upper and lower sideband. **Fig. 11** is the schematic diagram of a synthesizer with a voltage-controlled crystal oscillator that is used as the second LO, and the 66-MHz crystal can be pulled ± 1.5 kHz. The same technique can be used to build a BFO synthesizer by expanding the number of dividers and using a "soft" 9-MHz crystal. It is possible to pull a 10-MHz crystal about 1 or 2 kHz, and if the reference fequency is set at 100 Hz, this should be sufficient resolution to build an i-f shift system. New approaches are being developed to design simpler synthesizers. The most important is the fractional-N synthesizer, which is discussed below.

Conventional single-loop synthesizers use frequency dividers in which the division ratio, N, is an integer between 1 and several hundred thousand, and the step size is equal to the reference frequency. Because of loop-filter requirements, the decrease of reference frequency automatically means an increase of settling time.

It would be unrealistic to assume that a synthesizer with a reference lower than 100 Hz can be built, because the large division ratio in the loop would reduce loop gain so much that tracking would be very poor and the settling time would be several seconds.

If it were possible to build a frequency synthesizer with a 100-Hz reference and fine resolution, this would be ideal because the VCO noise from 2 or 3 kHz off the carrier could determine the noise sideband; while the phase noise of frequencies from basically no offset from the carrier to 3 kHz off the carrier would be determined by the loop gain, division ratio, and reference. Because of the higher reference frequency, the division ratio would be kept smaller. Traditionally, this conflicting requirement has resulted in multiloop synthesizers.

An alternative would be for N to take on fractional values. The output frequency could then be changed in fractional increments of the reference frequency. Although a digital divider cannot provide a fractional division ratio, ways can be found to accomplish the same task. The most frequently used method is to divide the output frequency by $N + 1$ every M cycles and to divide by N the rest of the time. The effective division ratio is then $N + 1/M$, and the average output frequency is given by:

$$f_o = \left(N + \frac{1}{M}\right) f_r \tag{1}$$

This expression shows that f_o can be varied in fractional increments of the reference frequency by varying M. The technique is equivalent to constructing a fractional divider, but the fractional part of the division is actually implemented using a phase accumulator. The phase accumulator approach is illustrated by the following example.

Consider the problem of generating 455 kHz using a fractional-N loop with a 100-kHz reference frequency. The integral part of the division is $N = 4$, and the fractional part is $1/M = 0.55$ or $M = 1.8$ (M is not an integer). The VCO output is to be divided by five ($N + 1$) every 1.8 cycles, or 55 times every 100 cycles. This can be easily implemented by adding the number 0.55 to the contents of an accumulator every cycle. Each time the accumulator overflows (contents exceed 1), the divider divides by five rather than four. Only the fractional value of the addition is retained in the phase accumulator.

Arbitrarily fine frequency resolution can be obtained by increasing the size of the phase accumulator. For example, with a 100-kHz reference frequency, a resolution of $10^5/10^5 = 1\ Hz$ can be obtained using a 5-BCD accumulator.

This technique is being used in the Racal RA6790 and in some Hewlett-Packard signal generators. A more detailed description of this can be found in reference 5. Research engineers at Phillips have recently used a similar technique and have built a two-chip frequency synthesizer, HEF 4750 and HEF 4751, which is being distributed by Signetics. With these two chips and very little external circuitry, it is possible to build a synthesizer system to more than 1000 MHz with 100-Hz step size. As the single-loop synthesizer is the cleanest of all the synthesizers, and as the noise sideband depends highly on the VCO, this new technique will mean a reduction in price and an increase in performance of simple synthesizers.

Signetics has several good application reports

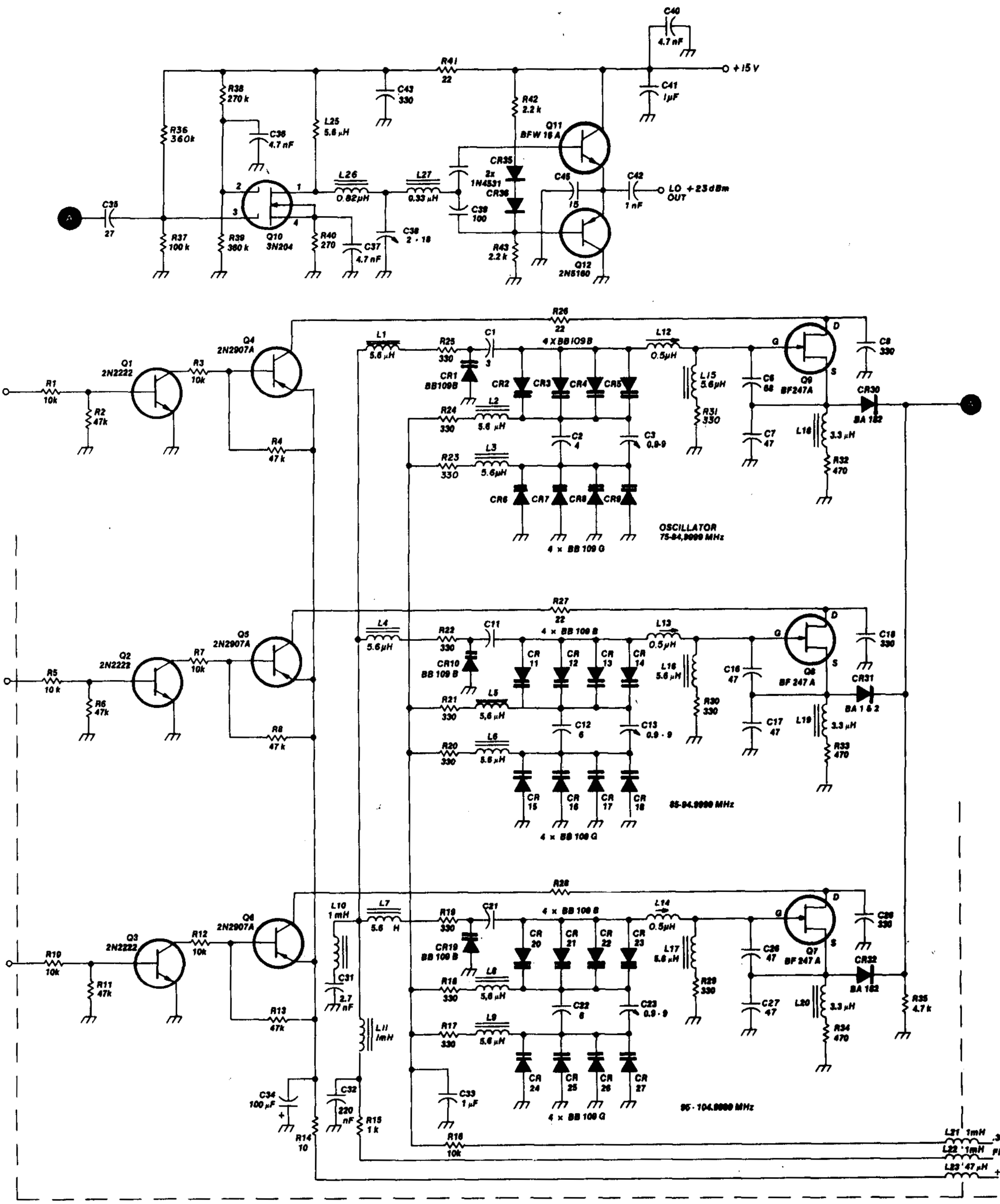


fig. 12. Schematic diagram of three low-noise VCOs with coarse and fine tuning input, select circuits, and 23-dBm post amplifier, recommended for shortwave receivers.

available for this synthesizer device. Its prime advantage is that a single-loop synthesizer can be built that uses a reference such as 1 kHz, and a resolution or step size of 100 Hz can be obtained, which is ten times the resolution. This is done in a technique similar to that of the fractional N, and the lockup time is determined by the 1-kHz reference loop filter rather than the 100-Hz filter system.

As the VCOs are so important, **fig. 12** shows a combination of three VCOs, each covering 10 MHz. They can be used for a 10-kHz to 30-MHz receiver with a 75-MHz i-f. The coarse tuning can be accomplished using a digital/analog converter, and the fine tuning can be done by the synthesizer. It is recommended that a two-bit D/A converter be used, which means that the frequency is coarse and preset with 100 kHz.

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ham radio

More Details? CHECK—OFF Page 120

the rf-power distributor

Another method for routing rf signals in your station

The problem of rf-power distribution in an Amateur Radio station has been solved using many methods. While visiting other Amateur stations I've observed techniques ranging from manually operated patch cords to the complex, remotely operated, coaxial-relay box.

The rf-power distributor described here will appeal to any Amateur who has several coaxial cables entering his station and the choice of operating more than one transmitter. The unit offers fingertip selection for instant optimizing of any antenna and transceiver combination. It is virtually maintenance free.

typical problem

I have two types of transceivers and three different antennas, each having a feed line. Many Amateurs have worked themselves into a similar situation by adding one antenna at a time followed by a long lapse before the next installation. This action results in a big outlay for coaxial cable, which has been carefully routed down towers, around eaves, and through wall-connecting boxes.

I do recognize that this problem is easily resolved by installing an antenna relay control box, thus eliminating all but one feedline. But with all my feedlines semi-permanently in place (and their expense being history), I chose to place the rf-power distributor in the station on the operating table. Indoor placement of this control also eliminates the possibility of relay malfunctions because of moisture and other problems.

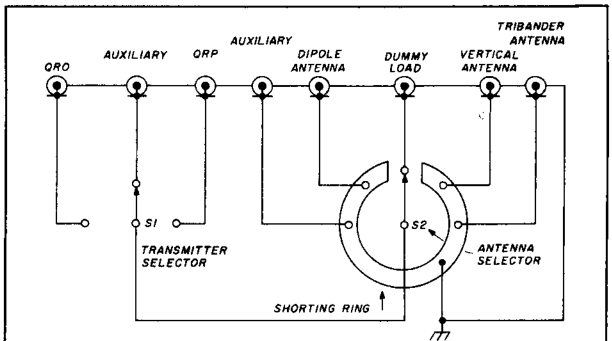

fig. 1. Rf-power distributor circuit diagram.

obtaining parts

With a well-supplied junk box or a few visits to local hamfests, this project can be produced with a minimum of cost in just a few evenings. The main parts are a handful of SO-239 connectors and two good-quality ceramic rotary switches. The antenna rotary selector switch preferably should be the type that shorts out all but one position. This is a good feature that can be used to ground all but one antenna.

For the cabinet I used a 5×7×2-inch (12×18×5 cm) inverted aluminum chassis. The removable top was cut and formed from a piece of vinyl-covered aluminum. I wired the unit with No. 14 AWG (1.6 mm) bus wire using direct routes. The schematic is shown in **fig. 1**.

construction notes

Two auxiliary positions were included: one for each of the selector switches. I had a limited amount of rear panel space for the connectors, so I wired my auxiliary connector to the antenna selector. If you have more than two rigs and no auxiliary antenna, a simple rewiring job can accommodate your situation. The front panel (photo) is labeled to satisfy either

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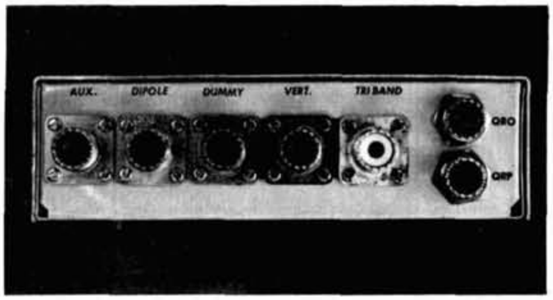

Front view and rear view of the home made rf-power distributor.

condition. Of course, if you use a larger chassis, the problem will disappear with added connectors.*

The chassis was finished with several coats of DS-GM-283 Green Dupli-Color™ automotive paint. Remember to mask the connector openings to prevent the paint from forming an insulator. The project was completed by installing four rubber feet and a pair of Heathkit knobs. I also included a selector position for my dummy load. For troubleshooting and off-the-air tune-ups this position has been used many times.

Most of my coax cables are the larger type RG-8/U. As a result, they influence the natural resting position of the unit. I solved this problem by sandwiching the unit between my rotator control box and speaker cabinet.

The ceramic rotary switches have a dc-current capability of 3 A. This is adequate for any input-power level up to the legal limit. I use these switches to carry power levels varying from 3 to 1000 W input with no contact degradation or change in the standing-wave ratio. By quickly selecting the proper antenna, I can optimize my station for the band conditions at the moment.

Commercial coaxial-switch boxes have been available for many years. Two of them, at considerable cost, would provide this function. On the other hand, the rf-power distributor described here will do the same job and demonstrates that practical equipment can be inexpensive.

*In this case, you might want to break the line between S1 and S2 in **fig. 1** and add two connectors to accommodate accessories such as an SWR bridge or antenna matcher. **Editor**

ham radio

the half-square antenna

Practical information on feeding and operating this popular radiator

The half-bobtail or half-square antenna has begun to receive a substantial amount of attention in recent Amateur publications. This versatile antenna has yet to make the impression it deserves in actual field use, however. This is due, in my opinion, to a lack of practical information regarding methods of feeding it.

The purpose of this article is twofold. First, it is to discuss examples of feed systems for the half-square antenna that are currently in use at several stations in widely varying environments. Second, it explores the virtues of this antenna as a multiband performer.

The theory of operation of this antenna has been discussed by Ben Vester, K3BC.[1] Interested readers may refer to the bibliography for additional background.

feed system

The basic layout of the antenna is shown in **fig. 1**. Of primary interest to most Amateurs (beyond performance) is how to connect the coax and get the antenna fired up.

Several feed methods have been examined in terms of available parts, weathering, and ease of adjustment. By far the simplest is the parallel-tuned tank circuit (**fig. 2**).

Network *L1C1* should resonate at the desired operating frequency. The values of *L1* and *C1* are calculated by:

$$LC = \frac{25{,}350}{f^2} \tag{1}$$

where L = inductance (mH)
C = capacitance (pF)
f = frequency (MHz)

A large value of L for a given frequency is desirable, because it decreases the Q of the LC network, thus increasing the bandwidth of the feedpoint. A value of 13 μH was chosen for L; therefore, for C at 7.15 MHz:

$$C = \frac{25{,}350/7.15^2}{13} = 38.1\ pF \tag{2}$$

In practice, a few additional turns for *L1* are needed. So two or three turns are added (3 μH) to the calculated value for *L1*. In my case, L is made of 15 turns of B&W No. 3033 3-inch (7.6-cm) diameter coil stock, but any 15-μH coil of No. 14 (1.6 mm) or larger wire will handle a kilowatt output.

Coils are easy to procure or wind, but capacitors are expensive, difficult to find, or both. Also, should a variable capacitor be desired for *C1*, weatherproofing becomes a problem. Because of these constraints, I chose a homemade capacitor that could be made from inexpensive RG-8/U coax and easily weather-proofed with silicone sealant.

The capacitor value is calculated using **eq. 2**, and the appropriate length of RG-8/U cable is determined by the distributed capacitance listed in the literature for the properties of common transmission lines. For RG-8/U the value is approximately 30 pF/foot (98.4

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pF/meter). Therefore, if 38 pF is required, the desired length is found by dividing the capacitance per unit length for RG-8/U into the desired number of picofarads. That is, *30 pF/12 inches = 2.5 pF/inch (0.98 pF/cm)*, so that *38 pF/2.5 pF/inch = 15.2 inches or 38.6 cm*. A 15.2-inch (38.6 cm) length of RG-8/U will provide a 5-kV capacitor at inconsequential cost. Weather-proofing is important.

It is important to note, however, that until the sealant has cured, it is not an insulator and will short out the capacitor at the treated ends. The capacitor need not slow the project down; rather, it can be assembled and weather-proofed first and set aside to cure while the rest of the project is carried out.

Refer to **fig. 3** for capacitor details. The capacitor *is formed by the center conductor on one end and* the shield on the opposite end. Treat both ends (except for the wire at the connection point) liberally with silicone sealant. This produces a reliable capacitor that will stand high power levels.

The feed system is completed by the input tap setting. A good initial setting is to tap up from the ground side two to three turns for 50 ohms. By using an SWR bridge at the antenna, the tap may be set exactly for a 1:1 SWR at any part of the band you desire. The following is an adjustment procedure that has proven effective (refer to **fig. 4**):

1. Set input (low-side) tap at 2½ turns up from ground.

2. Set high-side tap at one turn greater than predicted in calculations.

3. Measure SWR across band and note the low point; this is primarily influenced by the high-side tap. If the low point is not in the area of the band you desire, move the tap higher for a decrease in frequency or move the tap lower for an increase in frequency.

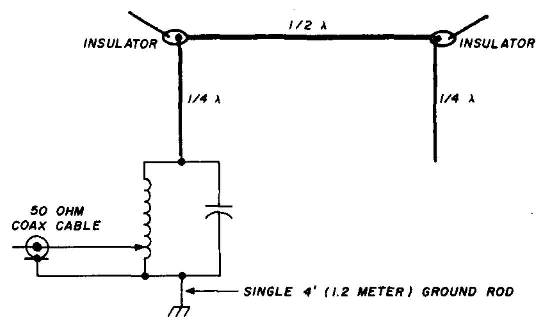

fig. 1. General arrangement of the half-square antenna, which originally appeared in *QST* and later in reference 1. It was described in these publications by Ben Vester, K3BC.

4. Once the low point of SWR has been set at the *desired portion of the band* (no matter what its value), proceed to adjust the low-side tap ¼ to ½ turn at a time to get a match of 1.2:1 or better at the desired operating frequency.

I've used this approach in three different environments. It has resulted in a match of 1.1:1 in no more than twenty minutes.

multiband operation

As may be seen from the wavelength relationships of **fig. 1**, this antenna, when constructed for 40 meters, is resonant on several other bands. By merely changing the feed system slightly, the antenna will perform very well on harmonically related bands. For example, the 40-meter array may be operated on 20 meters as a pair of half-wave verticals spaced one wavelength apart. While the phasing is not ideal, the performance of this antenna is very impressive, given the investment of time and money it requires. **Table 1** shows the manner in which the antenna can be operated on harmonically related bands and what feed point changes are needed.

performance

At the time of this writing, this antenna has been evaluated in two ways. First, it has been compared

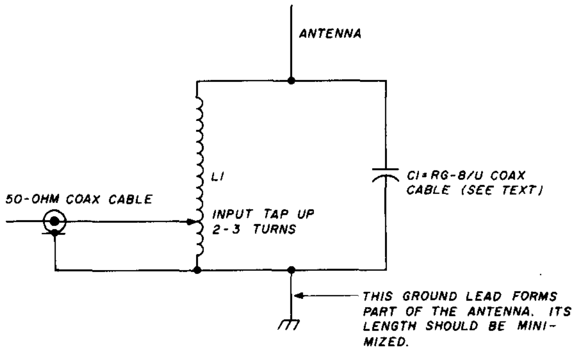

fig. 2. Antenna tuning network consists of a parallel-tuned circuit, which features simplicity and ease of adjustment.

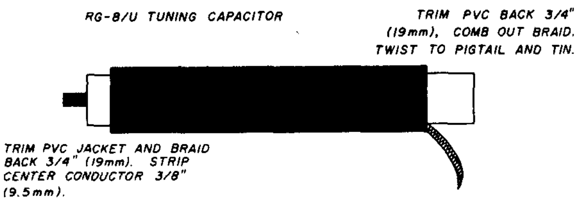

fig. 3. Construction details for the network capacitor.

(by instant switching) with on-site antennas. In comparison with a full-wave loop vertically polarized and mounted 8 feet (2.4 meters) off the ground, the half-square array consistently outperformed the loop by two to three S-units. There were virtually no instances where the loop was superior to the half-square, regardless of time of day, bearing, or distance. The period of these observations was approximately one month of daily use.

This same comparison, that is, loop to half-square, was made in terms of communication effectiveness during the recent ARRL phone SS contest. For a similar 15-minute period (in the same half hour) the half-square array produced over double the number of contacts that were achieved with the loop.

table 1. Characteristics of the half-square antenna as an harmonic radiator. Band design: 40 meters.

Amateur band	antenna operates as	feed
160 meters	¼λ Marconi	bypass tuning network and feed against ground
80 meters	½λ end fed	add ≈ 100 pF across existing coil cap. Input tap need not be readjusted.
40 meters	half-square array	as designed
20 meters	pair ½λ verticals spaced 1λ	tap coil for fewer turns (total). Retap input. Change tuning cap.
10 meters	pair 1λ verticals spaced 2λ	tap coil for fewer turns (total). Retap input. Change tuning cap.

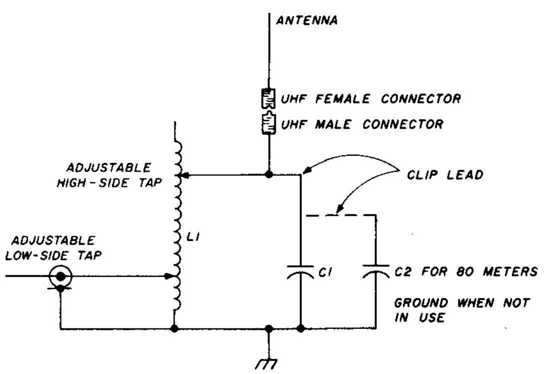

fig. 4. Tuning network is completely adjustable. The inductance is made of 15 turns of B&W No. 3033 coil stock (15 μH); capacitor is made of RG-8/U coax cable as described in the text. In this arrangement C1 is 38.1 pF. System resonates at 7.15 MHz.

In a second comparison, the half-square array was compared with a roof-mounted trap vertical with eight radials. Again, in virtually every case, the half-square array was superior. The half-square's superiority was 3 to 5 S-units.

In my own application, the half-square was compared with a center fed 130-foot (40-meter) dipole, at 35 feet (10.7 meters), using balanced wire feed and a tuner. During the day, the systems were nearly equal, with a slight edge given to the dipole. As soon as the sun set, however, the half-square array emerged as a truly superior, if not an amazing performer. My half-square pattern is broadside east-west. I frequently operate between 1130 and 1300Z from fall through spring. Each morning, I work approximately five to ten JAs with a mean signal report of 589 using a kW. In addition, I have worked VKs, ZLs, H44, and YB9 as well as other scattered Pacific and Asian countries. In the recent CQ WW phone contest, I was able to compete in the pileups with the "big guns" for the very first time. It was rare for me to make more than four attempts to raise anyone. Countries in Africa and Europe were worked during the test as well as in Asia and the Pacific.

closing remarks

It seems we may have hit upon a complete antenna for a variety of Amateurs. It has proven to give high performance for DX as well as being more than adequate for normal use. It is efficient and easily fed. The half-square array is economical both in terms of initial investment and multiband applicability. The next time you get the bug to experiment with an antenna, try the half-square array. It may end your experimental urges (because of its high performance), or it may further stimulate you to try the extended approaches of parallel arrays recommended by the original author, Ben Vester. See you on 40, 160, 80, 20 and 10.

acknowledgment

I wish to thank KØCQ for advice as well as AIØZ and WDØERH for their hours of comparisons and willingness to try something new with something old.

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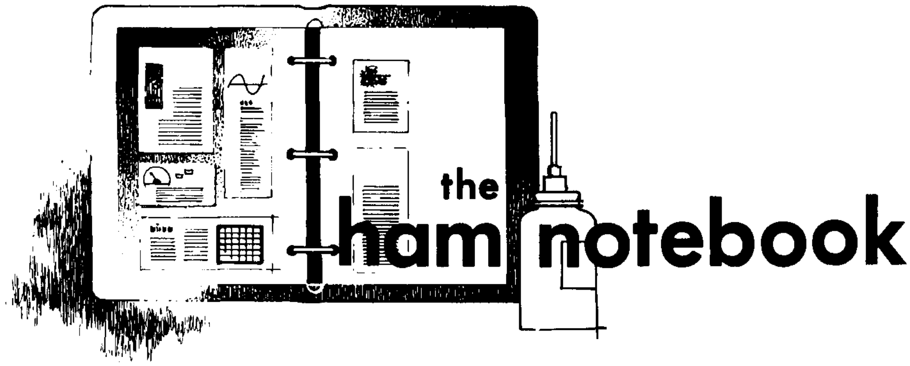

extending the range of the K9LHA 2-meter synthesizer

Although my CMOS 2-meter synthesizer, described earlier in *ham radio*,[1] tuned only 146 to 148 MHz, capability was designed into the circuit and circuit boards for wider coverage. This was mentioned in my article, and it prompted a number of letters asking how to add 144-146 MHz coverage. Until recently I'd not tried using that capability for a wider tuning range and could only indicate how the design was planned. Now, having actually modified a synthesizer, I'd like to share the results.

extending frequency coverage

Extending the range of my synthesizer involves the addition of one or two switches and some minor circuit changes as follows:

1. Remove the jumpers under U1 connected to pins 8 and 9.

2. Connect the range switching circuit of **fig. 1** to the input pads next to pins 8 and 9 of U1.

3. Change crystal Y2 to 47.3333 MHz.

4. Change crystal Y1 to *Y1 freq. = (47.3333 − i-f/3) MHz. If i-f = 10.7 MHz, Y1 freq. = 43.7666 MHz.*

5. Increase C12 to 39 pF and retune the VCO for a tuning voltage of 1.0 volt at 144.000 MHz in both receive and transmit modes by adjusting T1 and C14.

6. Readjust T2 and T3 to the new crystal frequencies so that you don't overdrive the squaring amplifier (Q8/Q9). It may be necessary to increase R39 and R43 to 470 ohms or so, depending on the activity of your crystals.

7. Increase R25 to 1.5k.

So that you can understand the reasons behind these changes, or improve upon the changes if you wish, let me briefly explain their intent. First, I suggest you spend a few minutes reviewing fig. 2 and the numbers directly beneath it in the synthesizer article.[1]

potential problems

A mixer in the synthesizer loop means that there are two VCO frequencies that will produce the same output frequency from the variable divider. Unfortunately, one of the two frequencies causes the phase detector to push the VCO away from, rather than toward, lock. In fact, lock will not occur unless it's forced in some way; preventing this condition is crucial in the design. One method is to restrict the VCO tuning range so that the wrong frequency cannot be reached; another is to select a high mixer i-f, so that the desired and image frequencies are separated as much as possible. The receive/transmit pulling circuit also helps since it

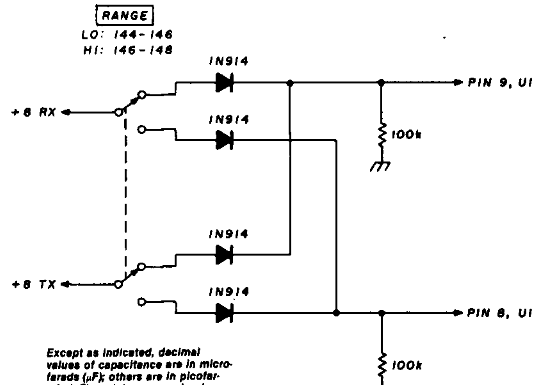

fig. 1. New range switch.

permits use of two, more precisely controlled tuning ranges for the VCO.

Because the desired and image VCO frequencies are separated by twice the variable divider input frequency (the "i-f"), the minimum divide ratio plays a very important role in avoiding the unlock problem. Unfortunately, while a large minimum divide ratio is desired, dividers are limited in speed capability, and a compromise is necessary. I found a value of $N = 400$ worked fine in my original design as well as in the full-coverage version.

The formula in fig. 2 (reference 1) shows that both receive and transmit crystals (Y1 and Y2) must be changed to cover the new frequency range, and the new frequencies are shown here. When the new crystals are installed the oscillators can be retuned.

The nature of these oscillators is such that they must be tuned to the high side of the crystal frequency to ensure reliable starting. The slugs of T2 and T3 also serve to adjust the output level from the squaring amplifier (Q8/Q9).

tuning transformers T2 and T3

In making this adjustment, I found that the squaring amplifier behaved very badly if overdriven at the upper range of frequencies. It is therefore important that T2 and T3 be set so that the squaring amplifier *just reaches* clipping level. I also noted that T2 and T3 had to be detuned considerably from resonance. This resulted in an error in oscillator frequency. To allow tuning closer to resonance it was necessary to increase the value of the two emitter resistors, R39 and R43, to reduce oscillator output. Again, your need to do this will depend upon the activity of your crystals.

Although retuning alone allowed the VCO to cover the full 144-148 MHz range, the tuning voltage came uncomfortably close to the supply voltage at the top end. Since I wanted to keep the tuning voltage within 1.0-5.0 volts to allow for temperature drift, I made a slight increase in the padder capacitor value, C12.

After tuning the synthesizer to the top of its new range, I found loop stability had been degraded and settling time was much too long. Therefore I increased the loop-filter damping resistor, R25, to 1.5k. A check with an f-m broadcast receiver showed that this change did not make any audible increase in sideband noise on the synthesizer output.

variable divider

The variable divider needs additional control inputs applied to pins 8 and 9 to tune the synthesizer over twice the range, as before. While it's possible to use another thumbwheel switch section for the MHz digit, the code required is not BCD; and a code-changing scheme would have to be used. The approach in **fig. 1** is simply to use an additional toggle switch to choose between low (144-146 MHz) and high (146-148 MHz) ranges. Although this makes it a bit more difficult to read the operating frequency directly, the cost and complexity are much reduced. If you feel there's no need for receive and transmit frequencies on opposite sides of 146 MHz, only one range switch is required. The input to the switch comes from +8 (*not* +8RX or TX), and the four diodes are not needed.

Here's hoping this information will help builders who wanted full band coverage. It's been fun hearing from builders of my synthesizer, and I'm interested in both their successes as well as problems. As before, I'll be glad to answer questions if accompanied by a self-addressed, stamped envelope.

I have plenty of the VCO coil forms ($1, postpaid, including wire), and I understand that RadioKit still has the circuit boards and parts available.*

*RadioKit, Box 411, Greenville, New Hampshire 03048.

reference

1. Tom Cornell, K9LHA, "CMOS 2-Meter Synthesizer," *ham radio*, December, 1979, pages 14-22.

Tom Cornell, K9LHA

medium-scan television

Recent developments in an interesting Amateur Radio communications mode

In 1958 when Copthorne MacDonald began experimenting with the fundamentals of slow-scan television, it was assumed that the only kind of image that could be sent over the high-frequency Amateur bands was unimportant, low-resolution still pictures. Time has passed, and it has turned out that even though the pictures are of relatively low resolution, now in color, they serve a very important place in Amateur communications.

With the low cost of digital memory today, it is certain that higher resolution digital scan converters will be designed and built that will improve the present quality of pictures by at least one hundred percent. Most of us today know that the original analog system did have more resolution than present day digital scan converters.

The real compromise in SSTV is the lack of motion. There is a great amount of information in each frame of television so that when many frames are transmitted giving motion, the required bandwidth is prohibitive. About the only hope that the Amateur has to transmit motion and still keep the bandwidth within legal allocations is to examine the image for electronic sampling "tricks" that can be used to increase the apparent motion.

background

In 1978 a group of Amateurs consisting of WØLMD, W9NTP, WB9LVI, W3EFG, and W6MXV applied for a Special Temporary Authorization (STA) from the FCC to test a narrow band MSTV system on 10 meters. Mathematical analysis easily shows that even a few fields per second of motion will require more than the normal amount of voice bandwidth, which is assumed to be about 3 kHz. It is very easy to calculate the required bandwidth. It will first be assumed that the horizontal and vertical resolution of MSTV will have 128 pixels per horizontal line and 128 lines per frame. Since it takes two pixels (one black and one white to approximate a sine wave) for each Hz, the total amount of bandwidth is:

$$BW = \frac{128}{2} \times 128 \times \textit{number of frames per second}$$

The early experiments concerning motion showed that the minimum number of frames per second to give acceptable motion is 7.5. This results in a bandwidth of 65.5 kHz. The only place that bandwidths of this size can be found in the high-frequency part of the spectrum is on 10 meters. The FCC STA request was actually for as large a spectrum bandwidth that could be obtained. When the STA was granted, it showed that only 36 kHz were available in the vicinity of 29.0 MHz. All tests have since been performed on 29.150 MHz.

bandwidth restrictions

Several problems immediately surfaced when MSTV was considered to be restricted into this bandwidth. First of all, rf-transmission is almost always twice the base video bandwidth that is calculated by the above formula. Even if the video signal were transmitted as single sideband, it would not fit the 36-kHz spectrum allocation.

Several approaches are possible. Every parameter of the picture must now be considered to be vulnerable to restriction. If the motion were cut into one-half or one-quarter, the signal would fit into the 36-kHz band. Tests have shown that the picture becomes very jumpy and cannot really be considered true motion if the field time or frame rate is dropped much below 7.5 frames per second.

There are many other parameters that can be changed to keep the video low in bandwidth and still give apparent motion on the screen. Tests have been made in which the picture was divided into quarters. Only one fourth of the picture was transmitted at any

By Dr. Don C. Miller, W9NTP, RR1, Box 95, Waldron, Indiana 46182

one time. Other tests divided the picture into strips and transmitted one strip at a time. Still other formats sent every other line and combined the two transmissions similar to commercial interlaced television. All these schemes achieved the required 36-kHz bandwidth but left serious objectional artifacts on the screen that bothered the viewer.

The most ambitious test was to build a system employing a microprocessor that compared one stored image to a new image stored at a later time. The advantage of this system is that once the original image has been transmitted, only the changes need be transmitted in the future. Provision was made for periodic updates if the original picture had suffered interference. This system certainly works, but it is questionable that it could be made to work in a noisy, 10-meter-band environment. There is also the problem of transmitting the addresses of the changed pixels, which are liable to consume as much time and bandwidth as the redundant parts of the picture. I concluded that a better system for the Amateur is one that has a periodic update in all parts of the screen that is scanned into the memory rather than one that is addressed.

The Special Temporary Authorization (STA) permission from the FCC, which has been in effect from 1978, has been renewed by the FCC for an additional two year period. The original five Amateurs (plus one additional) have been given permission to transmit MSTV on 29.150 MHz with a maximum bandwidth of 36 kHz. These six Amateurs are WØLMD, W9NTP, WB9LVI, W3EFG, W6MXV, and NØAB. During these two years additional Amateurs can be added to the list. Each case will be considered by the FCC when permission is requested. I will be glad to work with anyone in preparing a request if they enlist my help.

Mathematical analysis shows that the maximum field rate that can be used for MSTV under these bandwidth restrictions is two fields per second for a 128-pixel by 128-line television picture. This results in a base video bandwidth of 16 kHz. One exception to this is the use of wideband single sideband. This will be considered in due time when a source of proper filters is located.

Since the last update, various motion formats have been tried, and some of the best ones were chosen for further tests. These tests have shown that if the full raster is transmitted, it is necessary to have an effective rate of at least 7.5 fields per second to give the illusion of reasonable motion. The 7.5 fields per second can be achieved easily by field grabbing at one eighth of 60 fields per second. The base bandwidth of such an image is 64 kHz, which is far beyond the capabilities of the allocated 36-kHz rf bandwidth.

early work

Some years ago one of the MSTV investigators, W3EFG, developed a bandwidth-reduction system called Sampledot for his employer (General Electric Company). The scheme was demonstrated in various mechanizations for several years. Sampledot works on the principle of transmitting only a fraction of the total number of pixels during any fast scan (60 Hz) field time. The chosen pixels for transmission are sampled from numerous small areas that are repeated many times throughout the total field time.The samples are taken in a pseudo-random fashion to reduce any repeated lines or edges that could result from regular sampling times.

The result is that, since each pixel is not transmitted every time the original field is scanned, the chosen pixel can be stretched in time, or "boxcar'-ed," to reduce the base video bandwidth. All the pixels in the entire field will be sampled after many pseudo-random passes through many different 60-Hz field times. The effect is to give continuous motion on a one partial field basis at less than 60 fields per second.

recent work

Recently, in the laboratory where various forms of adaptive picture bandwidth reduction were being tested, we set up the old Sampledot scan converter, which had also been converted to a field-grab system for comparision. Other digital scan converters were also available, to make it possible to demonstrate both Sampledot and field-grab systems simultaneously. A digital scan converter makes it possible to use field rates of other than 60 Hz for further bandwidth reduction. These two scan converters were coupled together to permit the demonstration of a Sampledot image derived from a 7.5-Hz field-grab image.

The image that viewers liked, in terms of minimum bandwidth, was a 4/1 Sampledot image at a field rate of 7.5 Hz. This gives a potential bandwidth reduction of 8×4, or 32. When divided into the 60-Hz field rate of the source television image, it results in an effective field rate of two fields per second, or a base video bandwidth of only 16 Hz (our objective for a transmission capability of 36-kHz rf bandwidth).

This experiment was based on a 128 × 128 pixel image. We feel that eventually the image should be 256 pixels by 128 lines. This means that the base bandwidth will be 32 kHz. If it evolves as wideband single sideband, the system of field-grab Sampledot will work out very well. Remember that no one has built this system yet, but the construction should be quite simple if you own a two-memory Robot 400. See the January 1981 issue of *QST* for how this can be accomplished.

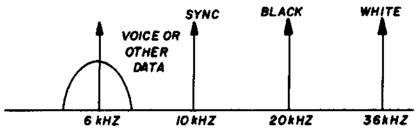

fig. 1. Proposed spectrum arrangement for the MSTV fm system.

SSB or fm?

The next standard to be set is the choice of transmission mode. Theory dictates that the maxmium base bandwidth signal that can be transmitted through a 36-kHz rf bandwidth is 18 kHz. Single-sideband techniques would raise this to 36 kHz. But it would also add many unknowns to the detection and generation process; so fm has tentatively been chosen for MSTV.

After much testing of SSTV standards back in the 60s, the originators decided upon a base bandwidth of 900 Hz, a synchronization frequency of 1200 Hz, and a white frequency of 2300 Hz. Using some of the same logic that was called forth to determine the SSTV standards, I would like to suggest as a starting point that a particular spectrum be used for further tests (see **fig.1**). If it is found later that other frequencies are more useful, it will be an easy matter to readjust the oscillators and discriminators for different standards.

reception and transmission

My suggestion for reception is the modification of an existing transceiver. Many tranceivers can be modified in this way; one example is the FT-101. This transceiver has an i-f output for spectrum analyzers or panadapters that is brought out ahead of the SSB filter. This low-level i-f signal can be amplified by means of solid-state amplifiers. The bandwidth can be limited with filters (active, passive, or special filters that you might find at hamfests). It does not mean that filtering must be done at the frequency brought out of the special i-f output. A simple mixer and oscillator circuit can translate the signal to the frequency of your favorite "bargain" filter (see **fig.2**). (According to information received from the "FOX-TANGO club," filters will be available from Yaesu.)

The detection can be done in a manner similar to that of the Robot 400. The tuned-filter discriminator works very well. The output frequency of some transceivers is in the 3-MHz band. Good high-frequency operational amplifiers could be substituted for the types in the Robot 400. Of course the active filter elements must be redesigned for the new wideband MSTV.

Fig. 2 also contains a block diagram of the suggested circuits for MSTV transmission. If you're interested in building circuits and testing them, get in touch with one of the six STA hams previously listed. We have no boards, just lots of messy connections on the bench, hundreds of ideas, and an enthusiastic, creative spirit reminiscent of the way ham radio "used to be." Test signals are put on the air every Saturday, for the first ten minutes of each hour, beginning when the 10-meter band opens (29.150 MHz). Call in after the ten-minute tests for the latest updates, or give us a call on the SSTV net each Saturday at 1800 GMT on 14.230 MHz.

ham radio

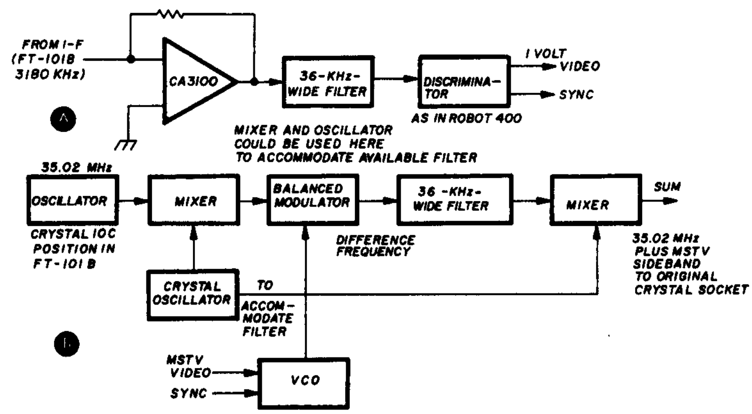

fig. 2. Block diagram for the proposed modifications to an FT-101 or similar transceiver. Conversions for receiver and transmitter sections are shown in A and B respectively.

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short circuits

dip meters

In the article entitled "A New Look at Dip Meters," on page 28 of the August, 1981, issue, varactor diode CR2 in **fig. 7** should be rotated 180 degrees; *otherwise the bias voltage* will be returned to ground, and no tuning will occur.

The conversion factor for feet to meters in **table 1**, page 35 of the same issue should be 0.305, not 3.05 as shown.

transmission-line design

Unfortunately, several typographical errors crept into the mathematical equations in the article by H.M. Meyer, Jr., W6GGV, that appeared in the March, 1981, issue ("Transmission-Line Circuit Design, Part Four"). For an errata sheet, send a stamped, self-addressed envelope to *ham radio*, Greenville, New Hampshire 03048.

digital frequency display

The following corrections should be noted for the article "Digital Frequency Display For Single-Conversion Transceivers," which appeared on page 28 of the March issue. In **fig. 2**, U9 *pin 14 should be connected to* +5 volts, not to pin 13; pins 13, 12, and 8 should be tied together; pins 9 and 10 should be tied together. For U10-16, pin 14 on each should be connected to +5 volts, and in U10, 11, and 13 pin 7 of each should be *connected only to ground. In* **fig. 1**, note that, for U17-22, the grounded pin is pin 12.

operation upgrade

Part one of "Operation Upgrade" in the September, 1981, issue, contained an error. $Energy = EIt$, rather than EI/t. If $P = EI$ and $I = Q/t$, then $P = E\left(\frac{Q}{t}\right)$. To remove time and leave pure energy the formula would have to be $P = E\left(\frac{Q}{t}\right)$ *times* t.

digital techniques

In part 1 of the article on digital techniques by W1BG (page 44 of the September, 1981, issue), the A input of the first counter in **fig. 4** should be *at ground, not 5 volts.*

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- YK-88SN (1.8 kHz) narrow SSB filter.

MC-50

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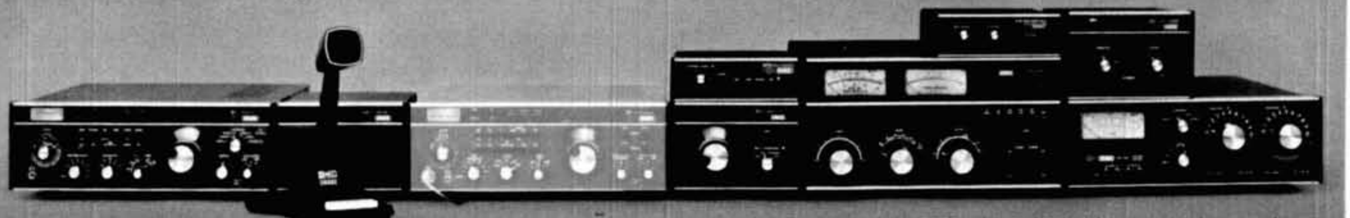

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* NOTE: Transmitter coverage for MARS, Government, and future WARC bands is available only in ranges authorized by the FCC, Military, or other government agency for a specific service. Proof of license for that service must be submitted to the R. L. Drake Company, including the 500 kHz range to be covered. Upon approval, and at the discretion of the R. L. Drake Company, a special range IC will be supplied for use with the Aux7 Range Program Board. Prices quoted from the factory. See Operator's Manual for details. (Not available for services requiring type acceptance.)

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More Details? CHECK—OFF Page 120

HAM CALENDAR December

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		AMSAT East Coast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) **AMSAT** Mid-Continent Net 3850 kHz 8PM CST (0200Z Wednesday Morning) **AMSAT** West Coast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) **1**	**GEORGE WASHINGTON UNIVERSITY SCHOOL OF ENGINEERING & APPLIED SCIENCE** – Dr. Ulrich Rhode & Dr. Jack Smith will give a short course in frequency synthesizers. If interested, contact the Office of Continuing Engineering Education at the university. The course number is 866DC and the fee is $575. – 2-4. **2**	**3**	**PIKE COUNTY ARC & OLD POST ARS SPECIAL EVENTS STATION** – Call sign W9CZH. Time 0000 Z on Dec. 4 through 2300 Z Dec. 6. – 4-6.** **160 METER CONTEST** – 4-6. **4**	**17TH ANNUAL TELEPHONE PIONEERS QSO PARTY** – 1900 UTC, Dec. 5 through 0500 UTC Dec. 7. CW call CQTP. Phone call CQ Telephone Pioneers – 5-7.** **5**
WEST COAST QUALIFYING RUN – 6. **HAZEL PARK ARC SWAP & SHOP** – Hazel Park High School, Hughes St., 9½ Mile Road, one mile east of I-75, Hazel Park, MI. SASE to Jack Field, WA8UPU – 6. **6**	**WEST COAST BULLETIN** – 9PM PDT (8PM PST) 0400 UTC, 3540 KCS, A-1 22 WPM. **7**	**AMSAT** East Coast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) **AMSAT** Mid-Continent Net 3850 kHz 8PM CST (0200Z Wednesday Morning) **AMSAT** West Coast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) **8**	**W1AW QUALIFYING RUN** 10. **9**	**10**	**11**	**10-METER CONTEST** – 12-13. **12**
	14	**AMSAT** East Coast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) **AMSAT** Mid-Continent Net 3850 kHz 8PM CST (0200Z Wednesday Morning) **AMSAT** West Coast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) **15**	**16**	***TRIPLE STATES RADIO AMATEUR CLUB*** – will operate from Bethlehem, WV from 1400 to 2300 UTC daily. – 17-21.** **17**	**18**	**19**
	WEST COAST BULLETIN – 9PM PDT (8PM PST) 0400 UTC, 3540 KCS, A-1 22 WPM. **21**	**AMSAT** East Coast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) **AMSAT** Mid-Continent Net 3850 kHz 8PM CST (0200Z Wednesday Morning) **AMSAT** West Coast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) **22**	**23**	**24**	 **25**	**26**
27	**28**	**AMSAT** East Coast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) **AMSAT** Mid-Continent Net 3850 kHz 8PM CST (0200Z Wednesday Morning) **AMSAT** West Coast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) **W1AW QUALIFYING RUN** 29. **29**	**30**	**STRAIGHT KEY NIGHT** – 31.		

W1AW Schedule

October 25, 1981-April 24, 1982 **MTWThFSSn = Days of Week** **Dy = Daily**

W1AW code practice and bulletin transmissions are sent on the following schedule:

UTC	Slow Code Practice	MWF: 0300, 1400; TThS: 0000, 2100; Sn: 0300, 2100
	Fast Code Practice	MWF: 0000, 2100; TTh: 0300, 1400; S: 0300; Sn: 0000
	CW Bulletins	Dy: 0100, 0400, 2200; MTWThF: 1500
	RTTY Bulletins	Dy: 0200, 0500, 2300; MTWThF: 1600
	Voice Bulletins	Dy: 0230, 0530
EST	Slow Code Practice	MWF: 9 A.M., 7 P.M.; TThSSn: 4 P.M., 10 P.M.
	Fast Code Practice	MWF: 4 P.M., 10 P.M.; TTh: 9 A.M.; TThSSn: 7 P.M.
	CW Bulletins	Dy: 5 P.M., 8 P.M., 11 P.M.; MTWThF: 10 A.M.
	RTTY Bulletins	Dy: 6 P.M., 9 P.M., 12 P.M.; MTWThF: 11 A.M.
	Voice Bulletins	Dy: 9:30 P.M., 12:30 A.M.
CST	Slow Code Practice	MWF: 8 A.M., 6 P.M., TThSSn: 3 P.M., 9 P.M.
	Fast Code Practice	MWF: 3 P.M., 9 P.M.; TTh: 8 A.M.; TThSSn: 6 P.M.
	CW Bulletins	Dy: 4 P.M., 7 P.M., 10 P.M.; MTWThF: 9 A.M.
	RTTY Bulletins	Dy: 5 P.M., 8 P.M., 11 P.M.; MTWThF: 10 A.M.
	Voice Bulletins	Dy: 8:30 P.M., 11:30 P.M.
PST	Slow Code Practice	MWF: 6 A.M., 4 P.M.; TThSSn: 1 P.M., 7 P.M.
	Fast Code Practice	MWF: 1 P.M., 7 P.M.; TTh: 6 A.M.; TThSSn: 4 P.M.
	CW Bulletins	Dy: 2 P.M., 5 P.M., 8 P.M.; MTWThF: 7 A.M.
	RTTY Bulletins	Dy: 3 P.M., 6 P.M., 9 P.M.; MTWThF: 8 A.M.
	Voice Bulletins	Dy: 6:30 P.M., 9:30 P.M.

Code practice and CW bulletin frequencies: 1.835, 3.58, 7.08, 14.08, 21.08, 28.08, 50.08, 147.555 MHz.

RTTY bulletin frequencies: 3.625, 7.095, 14.095, 21.095, 28.095, 147.555 MHz.

Voice bulletin frequencies: 1.835, 3.99, 7.29, 14.29, 21.39, 28.59, 50.19, 147.555 MHz.

On Monday, Wednesday and Friday, 1400 through 2200 UTC, transmissions are beamed to Europe on 14, 21 and 28 MHz.

Slow code practice is at 5, 7-1/2, 10, 13 and 15 wpm.
Fast code practice is at 35, 30, 25, 20, 15, 13 and 10 wpm.

Code practice texts are from *QST*, and the source of each practice is given at the beginning of each practice and at the beginning of alternate speeds. For example, "Text is from February 1980 *QST*, pages 9 and 82" indicates that the main text is from the article on page 9 and the mixed number/letter groups at the end of each speed are from page 82.

On Fridays, UTC, a DX bulletin replaces the regular bulletin transmissions.

CW bulletins are sent at 18 wpm; Teletype bulletins are sent at 60 wpm with 170-Hz shift, then repeated on 110-baud ASCII.

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DXer's diary

By Bob Locher W9KNI

The months of fall, October and November, are possibly the most exciting months of the year on the DXer's calendar. The summer doldrums are over, and the noontime null caused by solar absorption is greatly diminished as the sun moves further south. Thunderstorms and their attendant QRN are far less noticeable, and 40 and 80 meters are really snapping back to life.

Spring is in full sway in the Southern Hemisphere. As the sun crosses the equator, paths worldwide improve, giving DXers everywhere shots at far-flung places. Ten meters is hotter than a pistol, bringing new thrills to its devotees, while 15 to 20 are really strutting their stuff.

On the other side of the ledger are the spate of solar disturbances. The period after a peak in the sunspot cycle is the worst for frequent solar upheavals, which can devastate conditions for days on end, especially on the higher frequencies. Still, the storms peak out in the summer months and their intensity fades as we head into the months of late fall.

I settle into the operating chair and adjust the headphones till they're comfortable. I glance over at my chalkboard, knowing what I'll find — very little. A couple of forlorn notes on VK9NV, now over three months old. He seems to have disappeared from the bands. Maybe the incessant pileups of Japanese, American, and European DXers finally got to him. I guess I couldn't blame him if they did. But it sure doesn't help me if he's given up operating.

There's a note on the DXpedition to S9R, Sao Thome, West Africa. But yesterday's "DXer's Tout Sheet" said that the operation was going to be delayed at least six weeks, and very possibly would have to be cancelled. It figures; I need that one.

I move the bandswitch to 20 meters. Let's put the antenna on NNE, bisecting the paths to Europe and the transpolar route. It's 0000 Zulu. Europe will probably still be coming in if conditions are any good, and the path across the pole should be opening right now as morning sunlight chases the MUF up from its dog-watch lows.

I set the receiver right at the bottom edge of 20, at 14000 kHz, and start tuning up the band. It's Friday night, so there's hope of increased activity all over the world.

Hah. There's G3FXB, in QSO with somebody, just starting a transmission. I listen, but it becomes obvious that Al is well into a ragchew with someone. I listen to that fine fist, 30 or 35 words per minute and music to the ear. Al's one of the top dogs in the DXCC program Honor Roll, a fixture on the lists for many years. Al is active, and that's part of the secret of staying on top. He's always operating contests, usually in rivalry with his close friend G3MXJ. In between contests, Al is often heard ragchewing.

A chat with Al would be nice if nothing is happening on the band. I set my extra VFO on his frequency as a marker, so that I can easily find him again, and continue tuning higher up the band.

There's a good strong signal calling CQ. Almost instantly I recognize it from the fist: it's VU2BK. A retired Indian Army officer, he's very active on the bands and generally the strongest signal from India. I pause and take a close look at his signal. I don't need a contact but a look at his signal can tell you a lot about the band. The very fact that I'm copying him at all says something, and his S8 signal sure adds to the assessment that the band is in fairly good shape at the very least. Hmm. No trace of auroral buzz, and, really, very few of the usual characteristics of a long-haul signal. The really long-haul signals, while pleasant to listen to, often have telltale marks impressed on them that disclose their long-haul origins. These include subtle but continual tiny shifts in frequency (Doppler shifts) caused by the slightly different paths delivering the signal, softened keying characteristics caused by the time delay differentials of the different paths — and often at least a trace of auroral buzz.

No, this signal is very clean and pretty strong, which indicates good conditions and that his primary path is overwhelming the marks and signatures secondary paths would add.

One of the games that any DXer, but especially a CW operator, constantly has to practice is identifying whether a signal is DX or not without hearing the call, so that, while tuning a band, time won't be wasted waiting for domestic stations in QSO to sign. The ability to quickly read that aspect of a signal is invaluable in contest and pileups as well.

A trained operator, even listening to a stateside station in QSO, can usually figure out whether the station you hear is into a good one; there are few operators who don't show excitement when working a new one. It's a subtle thing on CW, but it's still noticeable. The tip-off is timing. A fellow who's in contact with what is for him a new country usually has a very choppy timing and spacing on his fist, reflecting his excitement, and the world's best keyer won't cover it up.

Of course, the new one for him might be the fellow that you've been ragchewing with every Wednesday night for the last two years, or it could be a guest operator at some big gun's station experiencing the thrill of his very first DJ QSO, but whenever you hear the signs that someone is excited about his QSO, you have to wait and see who he's got.

I keep moving the receiver slowly up the band. Hmmm. There's a loud and raucous signal. Obviously an intruder, not an Amateur station at all. Some exotic form of modulation, something that no ham ticket anywhere in the world would authorize for 20 meters. And not only is the signal 20 dB over S9, but it has nasty little sidebands as well, making the signal over a kHz wide. Probably a Moscow to Havana circuit. Oh well, it's a good place to tune up my rig, where no legitimate ham will be bothered. I move the rig up, key down and check output and SWR. All's well. I tune on up the band, getting clear of the sidebands of that illegal intruder.

The receiver dial tells me that I'm just above 14,050. I start to spin the dial back down, but stop. I've been covering the slot of 14,000 to 14,050 regularly for a long time, and recently, with very little to show for it. That area is where the action usually is, but what the heck, let's tune higher.

As with almost every band, the higher on 20 meters you go the slower the fists, in general. It seems as if the newcomers are afraid of getting blown away by hot-shots down at the bottom end of the band, and so they stay higher up. It's a good practice, just like the swimming pool; practice your strokes in the shallow end before you high dive into the deep end.

And DX stations do the same thing. So, perhaps a good one can be dredged up by working the high end. My tuning up this high in the band is slower, but still very interesting.

Almost immmediately I come across a goody; a slow, hesitant fist, not too strong, "CQ CQ DE SV9MT SV9MT KN." Crete, a nice catch, though not one I need. I chuckle at the KN at the end of his CQ; obviously a newcomer, but he'll learn. The first couple pages of my first log book show me giving reports of 995.

As I pick up the 2-meter microphone I hear him start a CQ again. I call it in.

"Hey, I've found Crete on 20 meter CW, that's SV9MT, Sugar Victor Nine Mexico Tango, fourteen oh sixty eight, fourteen oh sixty eight, from W9KNI."

"Hey, W9KNI, here's WD9IIC. Bob, I need that one, but I've got my station all torn apart. I can be back on in five or ten minutes. Are you working him?"

"WD9IIC from W9KNI. OK, Dick. Nah, he's calling CQ, and not getting any takers. I don't need him, but I tell you what. If nobody comes back to him after the call he's making now, I'll try to work him and hold him for you. He's going real slow, so if I get a QSO, you'll have ten minutes for sure. OK?"

"Fine, Bob. That would be real nice. 'Preciate it, I'll get my stuff together here quick. W9KNI from WD9IIC."

"Rah-jer."

I listen to the SV9 — there, he signs. I listen closely. Yes, someone is coming back to him — about the same strength — sounds like another European. Yes, it's a DF9, a German, going nice and slow, almost dead zero on the SV9. He signs.

The SV9 starts up, coming back to the German. I pick up the 2-meter microphone again.

"OK, Dick, you got a reprieve. A DF9 got him. You want I should watch the frequency till you're ready? WD9IIC from W9KNI, go ahead."

"OK, Bob, thanks. W9KNI from WD9IIC. I've got the receiver working again now and I'll have the transmitter hooked back up in a couple minutes. Let me find that fellow now, so that you won't have to sit around and wait. What was that frequency again?"

"Ah, he's on fourteen oh sixty eight. He's going real slow, and he's pretty much in the clear."

"OK, the one saying QTH HR CRETE? Yup, that's got to be him. OK, Bob, I'm all set. Thanks again. W9KNI from WD9IIC."

"Yeah, good hunting, Dick. W9KNI clear."

I start tuning higher again. Hmm. OK, there's fellow really clipping along; got to be at least sixty words per. A keyboard artist, for sure. Yeah, he signs it over; it's W9TO with a W6. And right next to him, just above him, a slow, steady CQ, a DX station almost for sure from the sound of it. I keep listening. Yes, it's LX1TK, Luxembourg. Not really rare, but not common either.

I decide to see if Dick caught the SV9 yet. I touch the VFO spotting button and move the receiver to the frequency. Right on time, too. There's the SV9 signing clear with the DF9.

WD9IIC starts calling, dead zero on the frequency that the DF9 was on. But so is someone else. I pick up the 2-meter mike, "WD9IIC from W9KNI. Hey, you got competition, Dick. Make it a l-o-n-g call. I'll tell you when to stop."

I listen. Dick keeps signing his call. The other station ends his call. "OK, Dick, two more times, two more times."

Just as Dick ends, the other station realizes that the SV9 hasn't come back and starts calling again. But it's too late. He's been had. The SV9 starts coming back to WD9IIC.

"Way to go, Dick!"

"Thanks, Bob." Dick's response is brief; he's busy copying.

It's a good feeling to help a friend get a new one; almost as exciting as working a new one for yourself. The sense of pride feels good. And, at times, a little coaching on 2 meters can make all the difference.

Yes, Dick is in solid with the SV9. I call it in again on 2 meters, then resume tuning higher up the band.

There's 9TO again, still burning up the frequency. And there are six or eight stations calling the LX. Funny how they'll pick up on something like the LX and miss the rare SV9 a few kHz away. But it happens all the time.

Another CQ. OK, it's an EI. Someone calling a KP4; yes, an SP9. Hmm. Someone promising a direct QSL, wait and see what that one's about for sure. There.

"GJ4CTS DE WD4KHJ." I call the GJ4 in on 2 meters — not terribly rare but someone might want it. Nobody asks for a repeat, so I tune on.

A loud teletype signal tells me that perhaps I'm a little high. I look at the dial. Yup, I'm at 14087. OK. I decide to move back to 14050 and start up again. This end of the band seems interesting tonight.

"Hey, Bob, thanks a lot. That was a new one for me. Hope that I can re-pay the favor. W9KNI from WD9IIC."

"Ah, great, Dick. WD9IIC, here's W9KNI. Fine. Hey — you can pay me back. I need Kamaran. I'll be on for another twenty minutes or so; find me one before I QRT, OK?"

"Hah. OK, I'll start now. Thanks again."

"Yeah, you do that! See you later."

I glance at the antenna rotor control; still set between the paths to Europe and the transpolar route to deep Asia. I haven't heard anything on the transpolar path except the VU2 earlier. I decide to swing the antenna a bit further south, to 45 degrees, dead on Europe. I'll still hear the transpolar signals, though perhaps an S-unit weaker, but, on the other hand, I'll have a better chance of hearing Africans.

I keep tuning higher, listening carefully as I go. There's an ISØ on Sardinia, working a PY in Brazil. There's a bit of a pileup; I listen. OK, it's various European stations chasing an HP1, a Panamanian.

There's a Frenchman calling CQ. There's a UP2 calling a WD4. There's another CQ, a slow one, using a hand key for sure. There, he's signing. His fist is a bit difficult. G8AL? No, that can't be. Sounds like it though. He's calling CQ again. Can't be a G8. Could it? There, he's signing again. Let's try it again. Hey! Hey! It's a TN8, not a G8. TN8AL, the Congo, and one I need. I didn't know that anyone was on from there, but here one is.

Pull the VFO up zero on him. Turn on the linear. Zapp! It's up and running. He continues his CQ call, obviously a new operator. I move the VFO just above him and key down for a moment. Yes, everything is OK as I trim the drive level of the exciter. OK, re-zero him. Move the antenna. I glance at my great circle map on the wall. OK, 80 degrees should be close enough. There, he's signing again. Yes! It's definitely TN8AL. OK, he's done.

I pause a moment, Yes, there's someone else calling him, but he's 300 or 400 hertz off. I start my call — oops. Thirty or thirty-five words per minute is a little fast for a new fellow sending perhaps twelve! I move the keyer speed. That's better.

I give a two-by-three call; "TN8AL TN8AL DE W9KNI W9KNI W9KNI AR K." I stand by.

The frequency is silent. Then the other station that was calling the TN8 starts to call again. I pause a moment longer. But, just as I'm about to start a second call, I hear:

"W9KN W9KN?" DE TN8AL TN8AL K K K." A new operator, for sure. I call again.

"R TN8AL TN8AL DE W9KNI W9KNI W9KNI KNI KNI W9KNI AR KN."

I wait. A long pause. There, he starts again.

"W9KNI W9KNI . . ." Great! He's got my call OK now . . . "TN8AL R HELLO OM ET MERCI EEEEE TNX QSO RST 489 489 QTH BOX 1293 BOX 1293 BRAZZAVILLE BRAZZAVILLE NOM CAMTI CAMTI OK? W9KNI DE TN8AL KN KN."

Wow!

"R TN8AL DE W9KNI . . ." Hmm. This fellow obviously speaks more French than English. Not surprising.

"MERCI CAMTI POUR LE QSO ET VOTRE RST 579 579 PRES DU CHICAGO QTH PRES DU CHICAGO ET NOM EST BOB BOB QSL SVP MA QSL BOX 1293 OK SURE RIG 600 WATTS ET YAGI WX 6C 6C TRES FROID HI HI OK CAMTI? TN8AL DE W9KNI AR KN."

"R W9KNI DE TN8AL R FB CHER AMI BOB ET MERCI POUR LE QSO RIG 100 WATTS ET DIPOLE QSL SURE 73 A BIENTOT SK W9KNI DE TN8AL SK."

"R 73 CHER AMI CAMTI ET BONNE CHANCE A BIENTOT DE W9KNI SK EE."

The slow QSO has given me time to get all the log data written while he was transmitting. I listen — no one is calling him except the fellow that I beat out when he was calling CQ. But I can change that. I pick up the 2-meter microphone . . .

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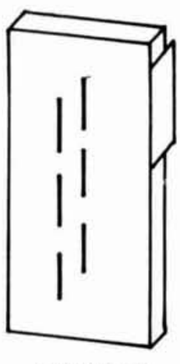

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THE AMP-LETTER is starting soon. Why buy an overpriced amp when you can build you own? The AMP-LETTER is devoted to the design, construction, and operation of Amateur Amplifiers. Let the AMP-LETTER and its readers help you find parts and information. For details write: Andy Thornburg, KB9WL, RR2, Box 39A, Thompsonville, IL 62890.

MOBILE OPERATORS: Anteck's Mobile Antennas cover 3.2 to 30 MHz inclusive, with no coil changing. 50 Ohms input. Two models, the MT-1 MANUAL, MT-1RT REMOTE-TUNED from the operators position. Uses two Hyd. Pumps and Motors. MT-1 $129.95, MT-1RT $240.00 plus UPS postage. Check your local dealer or write for Dealer List and Brochure. ANTECK, INC., Route One, Box 415, Hansen, ID 83334. 208-423-4100.

ATLAS DD6-C Digital Dial $120.00 plus $4.00 UPS. NEW, while they last. Mical Devices, P.O. Box 343, Vista, CA 92083.

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

HEATH SB-102 with CW filter, HP-23B power supply and SB-600 speaker. All in excellent, clean condition. Original owner. Best offer near $400.00. Glen Jenkins, WB4KTF, 11726 Bobwhite Dr., Houston, Texas 77035. (713) 728-9641.

BUSINESS WANTED: Entrepreneur/hams interested in buying an active electronics manufacturing business, preferably ham-related. Reply to J. Smallwood, Box 242, Blacksburg, VA 24060. 703-951-9030.

RECIPROCATING DETECTOR Handbook, $10.50 ppd. Peters Publications, 19 Loretta Rd., Waltham, Mass. 02154.

CUSTOM EMBROIDERED EMBLEMS — Your design, low minimum. Informational booklet. Emblems, Dept 65, Littleton, New Hampshire 03561.

FOR SALE: QST, HAM RADIO, CQ, 73. 20¢ each. SASE for list. W8YCG, 7281 Hi-View Drive, North Royalton, Ohio 44133.

MANUALS for most ham gear made 1937/1970. Send $1.00 for 18 page "Manual List", postpaid. HI-MANUALS, Box H802, Council Bluffs, Iowa 51502.

FOR SALE: World War II Japanese Navy, Air Force radio receiver, headphones, sending key, hand microphone. Good to like-new condition $395.00. Send SASE plus $1.00 for color photo, detailed description of each item and acquisition background. Robert O. Routh, W9DJW, 1955 E. 75 N., Lebanon, Ind. 46052.

SATELLITE TELEVISION: Information on building or buying your earth station. Six pages of what's needed, where to get it, costs, etc. $4.00 to Satellite Television, RD #3, Oxford, NY 13830. Build your own parabolic antenna. Book also available. Send SASE for details.

BUSINESS OPPORTUNITY — Manufacturer's Representative — Los Angeles based seeks business partner with electronic engineering background, fluency in foreign language an asset. Cover both S. Calif. and International market. Please mail resume to Ham Radio Magazine, Box O, Greenville, NH 03048.

WANTED: Help in completing the largest collection of Hallicrafter equipment in the world. Urgently needed are receivers with aluminum colored panels, back lighted plastic dials with "airplane" hands, early transmitters, unusual accessories, etc. Chuck Dachis, WD5EOG, "The Hallicrafter Collector," 4500 Russell Drive, Austin, Texas 78745.

SPECTRUM MONITOR, Cushman CE-15, mint condition, $4100. John Townsend, 2504 Buckingham Rd., Wilson, NC 27893. (919) 237-2177.

ELECTRONIC BARGAINS, CLOSEOUTS, SURPLUS! Parts, equipment, stereo, industrial, educational. Amazing values! Fascinating items unavailable in stores or catalogs anywhere. Unusual FREE catalog. ETCO-012, Box 762, Plattsburgh, NY 12901. SURPLUS WANTED.

FOR SALE: Kenwood TS-820S, new finals, excellent condition, headset with attached boom mic, phone patch. All $895. Heath IG-18 sine & square $120. I ship. Certified check or money order. Bruce Bierman, WA8SJC, 7534 Mayfield, Chesterland, OH 44026 (216) 729-4643.

HAM RADIO REPAIR, experienced, reasonable, commercial licensed. Robert Hall Electronics, P.O. Box 8363, San Francisco, CA 94128. W6BSH, (408) 292-6000.

LOCKSMITHING: Free book. Locksmithing Institute, Dept. 319-121, Little Falls, NJ 07424.

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XTAL FILTERS: New SSB filters by Filtech, 9 MHz, 2.1 kHz, BW, similar to KVG XF9-B, $25 postpaid. K8DRN/4, J. Wiggenhorn, 1678 NW 84th Dr., Coral Springs, FL 33065. (305) 752-7444.

WANTED: Government Surplus radar equipment, microwave equipment and "old" General Radio test equipment. P. J. Plishner, 2 Lake Avenue Extension, Danbury, CT 06810 WA1LDU.

QSL ECONOMY: 1000 for $12. SASE for samples. W4TG, Box F, Gray, GA 31032.

TUBES, TUBES wanted for cash or trade: 340TL, 4CX1000, SCX1500. Any high power or special purpose tubes of Eimac/Varian. DCO, 10 Schuyler Avenue, No. Arlington, NJ 07032. (800) 526-1270.

ATTN: ANTIQUE RADIO COLLECTORS. Two SCR-536 Army Signal Corp radio sets mfrd. May '45. Complete with original packing, spare tubes and manuals. Mint cond. Operating on 3.8 MHz using BC611 rec. & transmitter. Best offer over museum's collectors price. Will ship prepaid. Contact W3BAG, P.O. Box 183, Brad. Hts., MD 21714.

FT-101E, fan, three filters SSB, 600, 250 installed. Includes spare tubes (originals ok), free UPS shipping. $675 firm. John Skubick, 791 - 106 Ave., Naples, FL 33940.

LIONEL LOCOMOTIVE COLLECTORS. Gage 027 one each: Engine 1110 and Engine 258 plus cars and controls. Mint condition. Best offer. W3BAG, John Murray, P.O. Box 183, Brad. Hts., MD 21714.

MIRROR-IN-THE-LID, and other pre-1946 television set wanted. Paying 500+ for any complete RCA "TRK" series, or General Electric "HM" series set. Also looking for 12AP4, MW-31-3 picture tubes, parts, literature on pre-war television. Arnold Chase, WA1RYZ, 9 Rushleigh Road, West Hartford, Conn. 06117 (203) 521-5280.

UPX6 & UPX4 cavities wanted. Milt Cooper, W6QT, 2805 Russell St., Berkeley, CA 94705.

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

YAESU FL101 $300.00; Yaesu FT101EE $450.00; Panasonic RF4800 digital general coverage receiver $250.00; all mint. Jim Cammack, KD4TR, 755 Sherwood Drive, Lexington, KY 40502. (606) 278-8626, (606) 253-5824.

WANTED: Micor and Master II base stations, 406-420 MHz. Any solid state 2 and 6 GHz microwave equipment, AK7B, 4 Ajax Place, Berkeley, CA 94708.

D & V RADIO PARTS — Variable capacitors, chokes, toroids, etc. Reduced prices many items, stamp please. 12805 W. Sarle, Freeland, MI 48623.

MAKE HAM RADIO FUN! Supplement your learning programs with a motivational hypnosis cassette. Tape #3, Learning the Code; Tape #4, Breaking the Speed Barrier; Tape #7, Electronic Theory. Free catalog. For tapes, $10.95 each to Gem Publishing, 3306 North 6th St., Coeur d-Alene, ID 83814.

CONFIDENTIAL INSIDER HAM RADIO NEWSLETTER — The best in the business! $14.00 for 24 issues published twice a month. Sample: SASE with two stamps. W5YI Report, P.O. Box 10101H, Dallas, TX 75207.

VERY In-ter-est-ing! Next 5 issues $2. Ham Trader "Yellow Sheets", POB356, Wheaton, IL 60187.

EXCELLENT OPPORTUNITY IN SUNNY SOUTHWEST. Join our staff of 20+ technicians. Motorola MSS servicing 2-way radio, mobile telephones, micro-wave and CCTV equipment. Openings at all levels for technicians. Contact: Jim Strickland, K5EXB, Circle Communications Co., 2740 South Freeway, Ft. Worth, Texas 76104. Phone: (817) 923-7334.

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AFC SEMI-KITS! Stop VFO drift. See June 1979 HR. $55.00 plus $3.00 UPS. Mical Devices, P.O. Box 343, Vista, CA 92083.

NEED HELP for your Novice or General ticket? Recorded audio-visual theory instruction. No electronic background required. Free information. Amateur License, P.O. Box 6015, Norfolk, VA 23508.

SELL: HW-1681 with power supply (all new), \$185.00; Millen Grid Dip, \$35.00; Recency HR-312 (2 meters), \$175.00; many other items. SASE Joseph Schwartz, 43-34 Union Street, Flushing, NY 11355. (212) 461-5933.

HAMS FOR CHRIST — Reach other Hams with a Gospel Tract sure to please. Clyde Stanfield, WA6HEG, 1570 N. Albright, Upland, CA 91786.

MOTOROLA Micor 2 meter repeater \$800.00. Sinclair 2 meter duplexer \$650.00. Motorola HT220 UHF 4 frequency \$300.00. Icom IC551D 6 meter transceiver \$650.00. KLM 6 meter beam \$50.00. Icom IC 701 HF Transceiver \$900.00. Icom IC211 2 meter transceiver \$500.00. Icom RM2 remote control \$90.00. Amplex 2 meter kilowatt amplifier less p/s \$250.00. Eric Meth, VE2AS, 171 Heward Ave., Toronto, Ontario, Canada M4M 2T6. (416) 469-1084.

BUY-SELL-TRADE *Send \$1.00 for catalog. Give name address and call letters.* Complete stock of major brands new and reconditioned amateur radio equipment. Call for best deals. We buy Collins, Drake, Swan, etc. Associated Radio, 8012 Conser, Overland Park, KS 66204. (913) 381-5900.

AKAI VC100 TV camera (s/n U51115-90033) and VM100 monitor (s/n U51115-9078). Need schematics, service manual or connection instructions. Will pay postage both ways or xeroxing costs. Peter Simpson, KA1AXY, 18 University Drive, Natick, MA 01760.

WANTED: Heath IT-5283, IG-5282, IM-5284, IT-5230, CRT, checker, CMA-1550 engine analyzer, IP-2718, IP-2717, IT-5235, IC-5228, IT-3120. E. Tanrath, 3035 LaSalle Avenue, Rockford, IL 61111. (815) 877-0883.

SATELLITE TELEVISION...HOWARD/COLEMAN boards to build your own receiver. For more information write: *Robert Coleman, Rt. 3, Box 58-AHR, Travelers Rest, SC 29690.*

Coming Events

PLAYBOY CLUB: Plan ahead now to attend the ARRL Hudson Division Convention, October 30-31, 1982, at the Playboy Club, Great Gorge, McAfee, NJ. For info send SASE to HARC, Box 528, Englewood, NJ 07631.

ILLINOIS: Wheaton Community Radio Amateurs Hamfest will be held February 7, 1982, at Arlington Park Race Track EXPO Center, Arlington Heights, Illinois. Free Flea Market tables and expanded floor space. Large commercial area including the new "computer" section. For commercial info call WB9TTE at 312-766-1684; for general info call WB9PWM at 312-629-1427. Clear paved parking. Awards. Tickets \$3.00 at entrance, \$2.50 in advance. Send SASE to WCRA, P.O. Box QSL, Wheaton, IL 60187. *Talk-in on 146.01/61 and 146.94. Doors open 8 AM. Be There!* — KA9KDC.

SOUTH BEND, INDIANA Hamfest Swap & Shop, January 3, 1982, first Sunday after New Year's Day at Century Center downtown on U.S. 33 ONEWAY North between St. Joseph Bank Building and river. Industrial history Museum in same building. Half acre carpeted in one room. Tables \$3 each. Four lane highways to door from all directions. Talk-in Freq: 52-52, 99-39, 93-33, 78-18, 69-09 and 144.83-145.43.

VIRGINIA: The Richmond Amateur Telecommunications Society's annual "Frostfest," Sunday, January 10, Virginia State Fairgrounds, Richmond. Gates open 8 AM. Activities include CW and Homebrew contests. Admission: \$3.00. Flea market tables extra. Major prizes awarded promptly at 3 PM. For information: Joe Stern, (804) 737-0333.

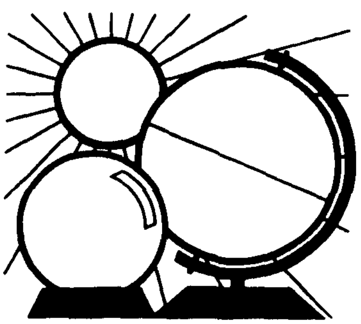
OPERATING EVENTS

DECEMBER 17 TO DECEMBER 21: The Triple States Radio Amateur Club will operate from Bethlehem, West Virginia from 1400 to 2300 UTC daily. Frequencies for WD8DDL/8 will be: 7.275, 14.325, 21.425 and 28.550 MHz on SSB. *7.110, 14.075, 21.110 and 28.110 MHz on CW.* For a special holiday season card SASE to TSRAC, 26 Maple Lane, Bethlehem, Wheeling, WV 26003.

JANUARY 1, 1982. Worked All Hawaii Awards available to all licensed Amateurs. Sponsored by the Big Island Amateur Radio Club. Contacts after 0000Z. Any mode, any band. Three classes. Class A: Work 100 Hawaiian stations. Class B: Work 50 Hawaiian stations. Class C: work 25 Hawaiian stations. Award fee \$3.50 U.S. Address award applications to: Big Island Amateur Radio Club, P.O. Box 1688, Kamuela, Hawaii 96743.

JANUARY 17: The Phil-Mont Mobile Radio Club Station W3TKQ will be celebrating its 30th anniversary and commemorating the Club's association with the Franklin Institute and the birthday of Ben Franklin, Philadelphia's First Citizen. Station will operate 80 through 10 meters from 8 AM to 8 PM. A special QSL card/certificate for a SASE. Frequencies: lower edges of the General and Advanced bands.

More Details? CHECK—OFF Page 120



DX FORECASTER

Garth Stonehocker, KØRYW

last-minute forecast

The 27-day solar maximum is expected to peak around the middle of the month, which leaves the beginning and end of the month with lower flux and flare activity. Geomagnetic disturbances can be expected about December 1, 11, 20, and 28. The two mid-month disturbances are solar flare effects, and the others are from coronal hole thinness, increasing the solar wind. From these solar/terrestrial relationships, the best DX is probably going to be at night on the lower-frequency bands during the first week and a half. Then the higher bands will be favored for long-haul DX for the next week and a half. DX conditions may be poorer during the last week and be best on the lower bands again.

December is probably the best month for winter DX. Although the hours of daylight are quite short now in the Northern Hemisphere, the ionosphere-propagated frequencies rise rapidly, with the rising sun, to the higher frequency bands of good DX. The sunspot number and solar flux remain high enough to ensure good MUFs during this winter DX season. The earth is closest to the sun, which results in a 5 percent rise in solar flux and ionospheric density during winter. December is also one of the quietest months of the year in terms of geomagnetic disturbances. Radio noise propagated from the thunderstorm centers over the few land masses of the Southern Hemisphere are far from us, so the 80- and 160-meter bands are good for daytime use and become good possibilities for DX during the long winter nights. All these conditions make for good DX. The longest night — winter solstice — is on the 21st this year.

The Geminid meteor shower, which reaches its peak on December 13-14, provides the richest and most reliable display of the year, with rates of 60-70 per hour (measured mainly by radio because of the poor weather in December). Also, a smaller portion of the shower (15-20 per hour) is observed on December 22. Lunar perigee and full moon occur on December 11.

band-by-band summary

Six meters will open occasionally during time of 27-day solar flux maxima. The openings will follow the sun — east before noon, south at noontime, and west and transequatorial during the evening.

Ten and fifteen meters will be like the openings on six, except more frequent and longer in duration. Worldwide DX will abound from after sunrise until well after sunset during periods of high solar flux (listen to WWV at 18 minutes after the hour for the daily flux value).

Twenty meters, the universal DX band, will be open most days during December this year, to most parts of the world during the day and into the night. Best conditions can be expected just after sunrise and just before sunset. Long skip will be available as the band opens upon sunrise, and will last until well after sunset.

Forty meters is a transition band between the daytime bands at high frequencies and the nighttime bands at this and lower frequencies. Our new 1979 WARC 30-meter band will provide the in-between band that may allow round-the-clock communications on 350- to 2500-mile (560-4000 km) paths. As is, 40 meters is very active to most areas of the world during hours of darkness to just before sunrise. In late afternoon, the band will open to the east, covering Europe, then swing around to the south at about midnight, and west to the Pacific by dawn. Short skip will be available on most days.

Eighty and one-sixty meters are expected to be excellent on this best month of the year for the top bands. Low noise during the long nights will give hours of pleasure if you are looking for the rare ones on these bands. DX from the coastal areas over water to South Africa, South America, and Australia-Asia will be easiest; but rare ones from anywhere will be worth the effort. You ragchewers on these bands try some DXing.

ham radio

DECEMBER

EASTERN USA

GMT	EST	N ASIA FAR EAST	NE EUROPE	E S. AFRICA	SE CARIBBEAN S. AMERICA	S ANTARCTICA	SW NEW ZEALAND	W OCEANIA AUSTRALIA	NW JAPAN
0000	7:00	15	20	10	15	15	10	10	15
0100	8:00	15	20	15*	15	15	10	10	15
0200	9:00	15	20	15	15	15	15	15	15
0300	10:00	15	20	20	20	15	15	15	20
0400	11:00	20	20	15	20	15	20	20	20
0500	12:00	20	40	15	20	20	20	—	20
0600	1:00	20	40	15	20	20	40*	—	20
0700	2:00	—	20	—	20	20	20	20	20
0800	3:00	—	20	—	40	20	20	20	20
0900	4:00	—	20	—	40	20	20	20	20
1000	5:00	—	20	20	40	20	20	—	—
1100	6:00	—	15	15	20	—	40	40	—
1200	7:00	20	10	10	15	20	80*	40	—
1300	8:00	20	10	10	10	—	80*	20	—
1400	9:00	20	10	10	10	—	—	20	20
1500	10:00	15	10	10	10	—	—	15	20
1600	11:00	15	10	10	10	—	15	15	—
1700	12:00	15	15	10	10	—	15	—	—
1800	1:00	—	15	10	10	—	10	10	—
1900	2:00	—	15	10	10	—	10	10	—
2000	3:00	—	20	10	10	—	10	10	40
2100	4:00	—	20	10	10	—	10	10	20
2200	5:00	15	20	10	10	15	10	10	15
2300	6:00	15	20	10	10	15	10	10	15

MID USA

GMT	CST	MST	N ASIA FAR EAST	NE EUROPE	E S. AFRICA	SE S. AMERICA	S ANTARCTICA	SW NEW ZEALAND	W OCEANIA AUSTRALIA	NW JAPAN
0000	6:00	5:00	10	20	10	10	15	10	10	10
0100	7:00	6:00	10	20	10	15	15	10	10	10
0200	8:00	7:00	10	20	15*	15	15	10	15	10
0300	9:00	8:00	15	20	20*	15	15	15	15	10
0400	10:00	9:00	20	20	20*	15	15	15	15	20*
0500	11:00	10:00	—	40*	20	20	15	20*	20	20
0600	12:00	11:00	—	40	—	20	15	20	—	20
0700	1:00	12:00	—	40	—	40	20*	20	—	20
0800	2:00	1:00	—	40	—	40	20*	20	—	20
0900	3:00	2:00	—	—	—	40	20	20	—	20
1000	4:00	3:00	—	—	—	40	20	20	—	20
1100	5:00	4:00	—	—	—	40	20	20	—	—
1200	6:00	5:00	—	20	15	40*	—	20	—	—
1300	7:00	6:00	—	20*	15	20	—	40	20	—
1400	8:00	7:00	—	10	10	10	—	20	20	—
1500	9:00	8:00	20	10	10	10	—	20	20	40
1600	10:00	9:00	20	15	10	10	—	15	20	—
1700	11:00	10:00	20	15	10	10	—	15	15	—
1800	12:00	11:00	20	15	10	10	—	15	15	—
1900	1:00	12:00	20	15	10	10	—	10	20*	—
2000	2:00	1:00	20	20	10	10	—	10	10	20*
2100	3:00	2:00	20	20	10	10	—	10	10	15
2200	4:00	3:00	—	20	10	10	—	10	10	10
2300	5:00	4:00	—	20	10	10	—	10	10	10

WESTERN USA

GMT	PST	N ASIA FAR EAST	NE EUROPE	E S. AFRICA	SE S. AMERICA	S ANTARCTICA	SW NEW ZEALAND	W OCEANIA AUSTRALIA	NW JAPAN
0000	4:00	10	20	10	15	15	10	15	10
0100	5:00	10	20	10	15	15	10	10	10
0200	6:00	10	20	15*	15	15	10	10	10
0300	7:00	15	20	15	15	15	10	10	15
0400	8:00	15	20	20*	20	15	10	15	15
0500	9:00	15	40	20	20	15	15	15	20
0600	10:00	20	40	20	20	20	15	15	20
0700	11:00	—	40	20	20	20	15	—	20
0800	12:00	—	20	20	20	20	20	—	20
0900	1:00	—	20	—	20	20	20	—	40
1000	2:00	—	20	—	20	20	40*	—	40
1100	3:00	—	—	—	40	40	40	40*	40
1200	4:00	—	—	—	—	20	40	40*	40
1300	5:00	—	—	20	20	20	40	40	40
1400	6:00	—	20	15	15	20	40	40	40
1500	7:00	—	20	15	10	20	40	20	40
1600	8:00	20	20	10	10	—	20*	20	40
1700	9:00	20	15	10	10	—	15	15	40
1800	10:00	20	10	10	10	—	15	15*	40
1900	11:00	20	15	10	10	—	10	10	20
2000	12:00	15	15	10	10	—	10	10	20*
2100	1:00	15	20	10	10	—	10	10	15
2200	2:00	15	20	10	10	—	10	10	10
2300	3:00	10	20	10	10	—	10	10	10

*Look at next **higher** band for possible openings.

SEMICONDUCTORS SURPLUS

2822 North 32nd Street, #1 • Phoenix, Arizona 85008 • Phone 602-956-9423

TEST EQUIPMENT

HP 3450A
Multi-function meter 300.00

HP 694C Sweep Oscillator
8.0 to 12.4 GHz 800.00

HP 8690B Sweep Oscillator
with 8693B plug in
4.0 to 8.0 GHz 4000.00

HP 180A Oscilloscope
with HP 1815A TDR/Sampler &
HP 158DA Narrow-band TDR
2500.00

HP 5245C Frequency Counter
with 5253A plug-in 100-500 MHz
1000.00

HP 1784A Recorder Plug-in for
HP 175A Oscilloscope 150.00

HP 1783A Time Mark Generator
for HP 175A Oscilloscope 100.00

HP 606A Signal Generator
50 kc to 65 MHz 800.00

HP 606B 1000.00

Quantity: 2
HP 175A Oscilloscope
with 1781B Delay Generator &
1754A Four Channel
Amplifier 400.00

HP 5381A 200.00
80 MHz Frequency Counter

HP 425A
DC Micro Volt/Ammeter 100.00

Quantity: 3
HP 1754A Four Channel
Amplifier for HP 175A
Oscilloscope 75.00 ea.

HP 608D
VHF Signal Generator
10 MHz to 420 MHz 400.00

HP 6214A Power Supply
0-10 VDC, 0-1 Amp 100.00

SPECIAL PURCHASE

Hewlett Packard Cathode Ray Tube
Display - Model 1332A.
X-Y scope with 2-axis. Without
case. Fully transistorized. Used.

Reconditioned. Manual supplied.
$395.00
As is. Not reconditioned.
$195.00

TRANSISTORS/IC'S

Motorola MHW 252 VHF power amplifier.
Frequency range: 144-148 MHz.
Output power: 25W.
Minimum gain: 19.2 dB.
$39.99 each

Motorola MC 1316P.
House no. same as HEP C6073 &
EC9814.
2-W audio amplifier.
$1.29 ea., 10 for $9.50

MEMORY EPROMS C.P.U.'s ETC.

68B21	9.99
2716	4.99
2708/4708	2.00
6820	4.00
6845	20.00
8202	25.00
8212	1.50
8214	3.00
8257	6.00
8279	9.00
1793	29.99
2114-2 & 3	2.00
4044	2.00
4027	1.00
3232	3.00
2732-6	14.99
Z80 CPU	5.00
Z80 CTC	5.00
Z80A - PIO	6.99
Z80A - SIO O	19.99
Z80A - SIO I	19.99
Z80A-SIO II	19.99
8251, 2651	4.50
3341	3.00
8741	25.00
8748	39.00
MC1408L 6	3.25
MC1408L 8	4.25
8T28	1.99
TMS1000NL	4.00
1702	4.00
1488	.99
1489	.99
8085	9.99
2102	.69
MC6800P	9.99
8080	3.00
8080A	4.50

Floppy Disk Power Supply:
Handles two units with the
greatest of ease 89.99

EMI FILTERS

#NF 10870-8	10 Amps	6.99
#F 1845	5 Amps	3.99
# 3B1	3 Amps	2.99
# 2B2	2 Amps	2.69
# 3B4	3 Amps	2.99

Fairchild 007-03 IC.
ECG no. 707 Chroma demodulator.
$1.29 ea., 10 for $8.50

Motorola rf transistors.
Selection Guide & Cross-Reference
Catalog.
43 pgs. $1.99 each

RCA Triacs.
Type T2310A.
TO-5 Case with heat sinks.
1.6 Amp, 100 VDC, lgt 3mA.
Sensitive gate.
$1.00 each

Cooling fans
2" round x 3" long, 12 VDC.
$5.95 each

RCA power transistors.
NPN RCS 258.
Vceo 60 NFE 5mA.
IC 20 Amps Vce 4V.
250 Watts, Ft 2 MHz.
$3.00 each

RCA Triacs.
Type T4121B/40799.
200 VDC 10 Amps.
Stud type.
$3.69 each

RCA Triacs.
Type 40805/T6421D.
30 Amps, 400 VDC.
$5.00 each

Motorola rf amplifier.
544-4001-002, similar to type MHW 401-2.
1.5 Watts output.
440-512 MHz.
15 dB gain min.
$29.99 each

3-M Company Bumpons. (stick on feet)
2 types:
Type 1
SF-5012, black
0.5" dia. x 0.14" high
(12.7 x 3.55 mm)
70-0700-1813-3 sheet of 4 $3.00

Type 2
SJ-5519, brown
0.78" x 0.35" rect. x 0.2" high
(19.8 x 8.89 x 5.08 mm)
70-0700-2982-5 sheet of 64
self adhesive $4.29

Quantity: 2
HP 197A Scope Camera, 200.00 ea.

HP 197B Scope Camera 200.00

HP 431B RF Power Meter 150.00

HP 431C RF Power Meter 200.00

TEKTRONIX OSCILLOSCOPES

454 $1900.00
547/1A1/1A2/1A4 $1500.00

2 New Tektronix 602 CRT -
Display

BOONTON EQUIPMENT

Quantity: 2
Model 74C-58
Capacitance Bridge
Test Freq. 100 kc $300.00 ea.

Quantity: 1
Model 71A
Capacitance - Inductance meter
F=1 Mc/s $300.00

Quantity: 1
Model 750
1 MHz Direct Capacitance
Bridge $1000.00

Quantity: 1
Model 700A
Digital C/L Meter $1000.00

Solder Wick

Size #2 Cat. #40-2-5 1.00
Size #4 Cat. #40-4-5 1.00

CORES AND BEADS

#43	Shield Bead	4/1.00
#61	Toroid	3/1.00
#43	Balun	10/1.00
#61	Balun	8/1.00
#61	Balun	6/1.00
#61	Balun	4/1.00
#61	Beads	10/1.00
Ferrite Rod 1/4 x 7 1/2		2.99
Ferrite Beads 1/8" long		12/1.00
Ferrite Beads 3/8" long		6/1.00
Ferrite Beads 1/16" long		12/1.00

SWITCHES

Sub miniature push button switch
2/.88
DPDT miniature toggle switch
(used)
.59
SPDT miniature toggle switch
(used)
.39

CABLE TIES

#/T-18R 100 per bag
mil. spec. #MS-3368S, 4"
Made by Tyton Corp.
$2.50 per bag
10 bags - $20.00

HIGH VOLTAGE CAPS

420 MFD @ 400 VDC 3.99 each
600 MFD @ 400 VDC 3.99 each

DOOR KNOB CAPS

470 pF @ 15 KV	$3.99 each
Dual 500 pF @ 15 KV	5.99 each
680 pF @ 6 KV	3.99 each
800 pF @ 15 KV	3.99 each
2700 pF @ 40 KV	5.99 each

CORES

4/1.00

T20-12	T30-6	T37-6
T25-6	T30-12	T37-10
T30-2	T37-2	T44-6

T50-6.... 2 for 1.00

MAGNET WIRE

$22.50 per spool

#24	A.W.G.	9 lb.
#26	A.W.G.	9 lb.
#25	A.W.G.	9 lb.
#30	A.W.G.	8 3/4 lb.
#31	A.W.G.	6 lb.

CONTINUOUS TONE BUZZER

#MB12 "Soma"
Freqz 450 Hz, size 5/8 x 5/8
12VDC $2.00 each

mH	2.99
mH	2.99
mH	2.99
mH	2.99
mH	2.99
l mH	2.99
mH	2.99
mH	2.99
5 mH	2.99
3 mH	2.99
mH	2.99
mH	2.99
mH	2.99
mH	2.99
mH	2.99
5 mH	2.99
mH	2.99
5 mH	2.99
3 mH	2.99
mH	2.99
4 mH	2.99
7 mH	2.99
9 mH	2.99
mH	2.99
mH	2.99
5 mH	2.99
mH	2.99
2 mH	2.99
mH	2.99

47 mH	2.99
50 mH	2.99
59 mH	2.99
60 mH	2.99
71.5 mH	2.99
78.7 mH	2.99
86 mH	2.99
100 mH	2.99
120 mH	2.99
150 mH	2.99
175 mH	2.99
200 mH	2.99
205 mH	2.99
237 mH	2.99
240 mH	2.99
300 mH	2.99
360 mH	2.99
390 mH	2.99
430 mH	2.99
500 mH	1.50
600 mH	2.99
1000 mH	2.99
1.5 Hy	2.99
2.0 Hy	2.99
2.5 Hy	2.99
3.0 Hy	2.99
5.0 Hy	2.99
10 Hy	2.99

B type crystals

$2.50 each

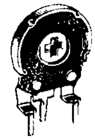
51-T	
T15	T28
T16	T29
T17	T30
T18	T31
T19	T32
T20	T33
T21	T34
T22	T35
T23	T36
T24	T37
T25	T38
T26	T39
T27	T40

51-R	
R15	R28
R16	R29
R17	R30
R18	R31
R19	R32
R20	R33
R21	R34
R22	R35
R23	R36
R24	R37
R25	R38
R26	R39
R27	R40

oldering Kit

Weller Soldering Iron Kit
23K.............. 9.99 each
ncludes:
- 25 Watt soldering iron, develops 750° of tip temperature
- tips (screwdriver, chisel, cone)
- soldering aid tool
- coil 60/40 rosin core solder

TRIMPOTS



Thumb wheel type.
.39 each or 10/2.50
not sold mixed

100	20000
150	25000
200	50000
250	200K
500	250K
1000	500K
1500	750K
2000	2 megs
2500	2.2 megs
5000	3 megs
10000	5 megs

ATLAS FILTERS

ATLAS CRYSTAL FILTERS FOR ATLAS HAM GEAR

Your Choice

$15.95 ea.

5.645 - 2.7/8
5.595 - 2.7 USB
5.595 - 2.7/8/L
5.595 - 2.7 LSB
5.595 - .500 4
9.0 - USB/CW

Used NiCads

Used C Nickel Cadmium Batteries
1.8 amp hour
Pack of ten $8.99 per pack

TRANSFORMERS

#70169-2............. 4.99 each
26 VCT @ 1 Amp and
2.5 V @ 1 Amp

New GE model 6C-9 9 V Nicad
Battery.................. 4.29

New MCM Moving Coil Tach
Generator
Model M100.......... 8.99 each

New Mallory Mini Sonalert
Model #SC-18. Works at 12 VDC
3500 Hz.............. 4.69 each

New T.V. Colorburst Crystals
3.579545.............. .99 each

WIDEBAND RF TRANSFORMERS

Tyep T16-1........ ......6.50 each

	Insertion Loss
.3 to 120 MHz	3dB
.7 to 80 MHz	2dB
5 to 20 MHz	1dB

RELAYS

Meko #109P80060........... .99
5 VDC SPDT

Meko...................... .99
5 VDC SPST

AMF/P&B................2.99
R10-E1-Y2-J1.0K - 8.5 MA
6 VDC DPDT

Omron MHE202PG.......... 2.99
VA - DC12 DPDT

AMF/P&B 4.99
KUMP11D18
12 VDC DPDT

Sigma 65F1A............... 1.69
12 VDC SPDT

NAP Controls.............. 2.99
13 A 12D12 DPDT

Magnecraft 1.99
W104MX-2
250 ohms 12 VDC SPDT

AMF P&B.................2.69
R50-E2-Y1
12 VDC 210 ohms DPDT

AZ530-13-2................2.69
12 VDC 45 ohms SPDT

Sigma #70RE62............. 4.95
12 VDC 3P6T

P&B KH4695-1.............2.99
120 VAC 2P4T

P&B GA-2290............. 3.09
110 VDC 2P4T

P&B PR5DY............... 3.99
25 A 12 VDC SPDT

P&B PR7AY............... 5.99
25 A 115 VAC DPST

AMF P&B................. 4.99
PRD11AY0
24 VAC 25 A DPDT

MS188-901/188-212081-102
70 ohms SPST............. 1.69

CONNECTORS

PL-258	
UHF female to UHF female	1.69
M-359	
UHF 90°	2.50
UG363 UHF double female	
Panel mount	2.99
UHF M	
PL-259 to RCA	.90
F71-1115	
4 pin plug	.75
F71-1116	
4 pin jack	.75
F71-1120	
6 pin plug	.85
F71-1121	
6 pin jack	.85
Din plug & jack	
5 pin male & female	.49
BNC UG260	
BNC male for RG 59U	1.25
BNC UG88U	
BNC male for RG 58U	
UG 273	
BNC female to PL-259	2.50
UG 274	
BNC T	
2 female to 1 BNC male	3.75
UG 21	
Type N male	3.60
UG 23	
Type N female	3.75
PL-259	.69
SO-239	.69
F 61 female chassis mount	
connector with hex nut	10 1.99
UG 306	
BNC male to female 90°	2.59
UG255	
BNC male to female 90°	2.79
UG 491	
BNC male to 80-239 female	3.00
UG 1094 BNC female	
chassis mount	.80
UG 914	
BNC female to BNC female	
RS-232 Hoods	1.00
RS-232 Male PCB type	2.00
RS-232 Female PCB type	2.00
Centronics male	6.99
F-59 connector for UG 59U	
cable 100/13.95 or 10/	2.00

CERAMIC COIL FORMS
$1.00 each

#1	3/16" x 4/8"
#2	3/16" x 1/4"
#3	1/4" x 3/4"
#4	3/8" x 7/8"
#5	3/8" x 5/8"
#6	1/2" x 2 3/4"

All of the above have powdered iron cores.

SEMICONDUCTORS SURPLUS

2822 North 32nd Street, #1 • Phoenix, Arizona 85008 • Phone 602-956-9423

SEMICONDUCTORS SURPLUS

2822 North 32nd Street, #1 • Phoenix, Arizona 85008 • Phone 602-956-9423

ORDERING INSTRUCTIONS

Check, money order, or credit cards welcome. (Master Charge and VISA only.) No personal checks or certified personal checks for foreign countries accepted. Money order or cashiers check in U.S. funds only. Letters of credit are not acceptable.

Minimum shipping by UPS is $2.35 with insurance. Please allow extra shipping charges for heavy or long items.

All parts returned due to customer error or decision will be subject to a 15% restock charge. If we are out of an item ordered, we will try to replace it with an equal or better part unless you specify not to, or we will back order the item, or refund your money.

PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE. Prices supersede all previously published. Some items offered are limited to small quantities and are subject to prior sale.

We now have a toll free number, but we ask that it be used for *charge orders only*. If you have any questions please use our other number. We are open from 8:00 a.m. - 5:00 p.m. Monday thru Saturday.

Our toll free number for *charge orders only* is 800-528-3611.

MINIMUM ORDER $10.00

NEW CHERRY BCD SWITCH
New end plates
Type T-20 .... 1.29 each

Johnson AIR Variables

$1.00 each

T-3-5	1 to 5 pF
T-6-5	1.7 to 11 pF
T-9-5	2 to 15 pF
189-6-1	.1 to 10 pF
189-502-Y	1.3 to 6.7pF
189-503-105	1.4 to 9.2pF
189-504-5	1.5 to 11.6pF
189-505-5	1.7 to 14.1pF
189-505-107	1.7 to 14.1pF
189-506-103	1.8 to 16.7pF
189-507-105	2 to 19.3pF
189-508-5	2.1 to 22.9pF
189-509-5	2.4 to 24.5pF
545-043	1.8 to 11.4pF

CRYSTAL FILTERS

EFCL455K13E	3.99
EFCL455K40B2	2.99
FX-07800L, 7.8 MHz	12.99
FHA103-4, 10.7 MHz	12.99

MURATA CERAMIC FILTERS

SFD 455D	455 KHz	2.00
SFB 455D	455 KHz	1.60
CFM455E	455 KHz	5.50
CFU455H	455 KHz	3.00
SFE 10.7MA	10.7 MHz	2.99

TEXAS INSTRUMENT TIL-305P
5 x 7 array alphanumeric display
$3.85 each

ARCO CAPS

304	100-550pF	1.50	469	170-780pF	1.40
400	.9-7pF	1.00	4615	390-1400pF	2.02
402	1.5-20pF	1.00	404	8-60pF	1.00
420	1-12pF	1.00	405	10-80pF	1.00
423	7-100pF	1.00	422	4-40pF	1.00
426	37-250pF	1.01	424	16-150pF	1.00
464	25-280pF	1.00	427	55-300pF	1.00
465	50-380pF	1.39	462	5-80pF	1.50
467	110-580pF	1.03			

TUBES

6KD6	5.00	6939	7.99
6LQ6/6JE6	6.00	6146	5.00
6MJ6/6LQ6/6JE6C	6.00	6146A	5.69
6LF6/6MH6	5.00	6146B/8298	7.95
12BY7A	4.00	6146W	12.00
2E26	4.69	6550A	8.00
4X150A	29.99	8908	9.00
4CX250B	45.00	8950	9.00
4CX250R	69.00	4-400A	145.00
4CX300A	109.99	4-400C	145.00
4CX350A/8321	100.00	572B/T160L	44.00
4CX350F/J/8904	100.00	7289	9.95
4CX1500B/8660	300.00	3-1000Z	229.00
811A	20.00	3-500Z	141.00
6360	4.69		

RF Transistors

MRF203	P.O.R.	MRF453/GE185	17.25	BFR96	15.00
MRF216	31.00	MRF454	19.90	BFW92A	15.25
MRF221	10.90	MRF454A	21.83	BFW92	24.30
MRF226	12.65	MRF455	16.00	MMCM918	9.80
MRF227	3.45	MRF455A	16.00	MMCM2222	9.80
MRF238	12.65	MRF458	19.90	MMCM2369	8.80
MRF240	15.50	MRF472	1.00	MMCM2484	9.08
MRF245	34.00	MRF474	3.00	MMCM3960A	9.80
MRF247	34.00	MRF475	2.90	MWA120	8.80
MRF262	9.20	MRF476/C1306	2.90	MWA130	8.00
MRF314	20.70	MRF477	11.50	MWA210	3.00
MRF406	13.80	MRF485	3.00	MWA220	3.00
MRF412	25.30	MRF492	23.00	MWA230	3.00
MRF421	36.80	MRF502	1.04	MWA310	2.10
MRF422A	41.40	MRF604	2.07		
MRF422	41.40	MRF629	3.45		
MRF428	46.00	MRF648	33.35		
MRF428A	46.00	MRF901	2.15		
MRF426	15.50	MRF902	1.30		
MRF426A	15.50	MRF904	1.65		
MRF449	12.65	MRF911	2.20		
MRF449A	12.65	MRF5176	1.15		
MRF450	13.80	MRF8004	1.00		
MRF450A	13.80	BFR90	14.30		
MRF452	15.00	BFR91	15.65		

NEW MRF472
12.5 VDC, 27 MHz
4 Watts output
10 dB gain
1.69 ea.
10/9.50
100/69.00
1000/480.00

TO-3 TRANSISTOR SOCKETS
Phenolic type .... 6/$1.00

PL259 TERMINATION
52 Ohm 5 Watts $1.50 each

NEW SIMPSON 260-7 $99.99

TORIN TA700 FANS NEW $29.99 each
Model A30340
230 VAC @ .78 Amps
Will also work on 115 VAC

RG174/U - $15.00 per 100 ft.
Factory new

PLASTIC TO-3 SOCKETS
4/$1.00

CRYSTAL FILTERS
Tyco 001-19880 Same as 2194F
10.7 MHz narrow band
3 dB bandwidth 15 KHz min.
20 dB bandwidth 60 KHz min.
40 dB bandwidth 150 KHz min.
Ultimate 50 dB insertion loss 1 dB max.
Ripple 1 dB max. Ct. 0+/-5 pF 3600 Ohms
$3.99 each

78MO5
Same as 7805 but only 1/2 Amp
5 VDC .49 each or 10/$3.00

TRIMMER CAPS

Sprague. Stable Polypropylene.
.50 each or 10/4.00
not sold mixed
1.2 to 13pF
2 to 30pF
3.9 to 18pF
3.9 to 40pF
3.9 to 55pF

Carbide Circuit Board Drill Bits for PCB Boards
5 mix for $5.00

Johnson AIR Variables

1/4 x 2 1/2" shaft
$2.50 each

193-10-6	2.2 to 34 pF
193-	1.5 to 27.5pF
193-	.6 to 6.4pF

$1.00 each

160-107-16	.5 to 12 pF
193-10-9	2.2 to 34 pF
193-10-104	2.2 to 34 pF
193-4-5	3 to 30 pF

RF Power Device

MRF454 Same as MRF458
12.5 VDC, 3-30 MHz
80Watts output, 12dB gain
$17.95 ea.

E.F. JOHNSON TUBE SOCKETS

#124-0311-100 .... 6.99 each
For 8072 etc.

#124-0107-001 .... 13.99 each
For 4CX250B/R, 4X150A etc.

#124-0111-001 .... 4.99 each
Chimney for 4CX250B/R and 4X150

#124-0113-001 and 124-0113-021
$12.99 each
Capacitor for #124-0107-001

#123-209-33 Sockets....6.99 each
For 811A, 572B, 866, etc.

UNELCO CAPS

6.8pF	47pF
8.2pF	62pF
10pF	100pF
12pF	160pF
13pF	180pF
14pF	200pF
20pF	240pF
24pF	380pF
33pF	470pF
36pF	1000pF
43pF	350V

$1.00 each

86 Pin Motorola Bus Edge Connectors

Gold plated contacts
Dual 43/86 pin .156 spacing
Soldertail for PCB .... $3.00 each

110VAC MUFFIN FANS

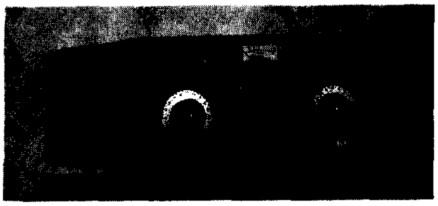
New $11.95
Used $5.95

J-Fet

J310 N-CHANNEL J-FET 450 MHz
Good for VHF/UHF Amplifier, Oscillator and Mixers 3/$1.00

More Details? CHECK—OFF Page 120

NEW products



the MAXI TUNER

Clean and rugged design is featured in this antenna tuner offered by RF Power Components. No tapped inductor in this tuner. You can obtain continuous coverage from 1.7 to 30 MHz using the full legal power limit.

The MAXI TUNER design is based on the principle of conjugate matching. The circuit consists of a matching network arranged in the T configuration, with two variable capacitors forming the horizontal part of the T. A continuously variable inductor, connected to the midpoint of the two capacitors, forms the vertical part of the T. This arrangement avoids the step-function tuning in matching networks that use tapped inductors.

Rotary inductors and counter dials are very expensive, but they are the whole secret to efficient tuner operation. With this arrangement you can get the inductance exactly right, not just within "a turn or two," which is typical of tuners using tapped coils.

The MAXI TUNER uses two massive 500-pF capacitors with 6:1 ratio ball drives for velvet-smooth tuning control. The inductor, a 28-μH unit, is extremely rugged and is wound on a ceramic form. Electrical contact with the inductor is provided by a roller wheel, which allows continuous tuning.

Two models are available: one with a built-in SWR metering circuit and one without. An optional 4:1 balun is also available for use with balanced transmission lines.

The MAXI TUNER presents a 50-75 ohm resistive load to your transmitter. It matches antennas using unbalanced coaxial cables, random-length end-fed antennas, or antennas using open-wire transmission lines (with the optional balun). Power-handling capability is 3 kW PEP (2 kW PEP when the optional balun is used). A custom cabinet and handsome styling make this unit a welcome addition to any Amateur station. Dimensions: 14.5 inches wide, 6.5 inches high, and 13.5 inches deep (36.8 by 16.5 by 34.3 cm). Weight: 15 pounds (6.8 kg). For more information, write RF Power Components, 1249 Garfield, Niagara, Wisconsin 54151 (715) 251-4118.

Macrotronics TERMINALL

Macrotronics, Inc., has announced the introduction of TERMINALL, an integrated hardware and software system which converts the TRS-80 microcomputer (Model I or III) into a state-of-the-art communications terminal.

TERMINALL includes all the necessary computer interfacing, audio demodulating, AFSK tone generating, and transmitter keying hardware integrated in one cabinet. This reduces equipment interconnection to a minimum and allows the operator to be on the air receiving and transmitting Morse or RTTY in minutes. Plug it into the receiver headphone jack and copy Morse code, Baudot, or ASCII. Plug it into the CW key jack and send Morse code. Attach a microphone connector and send Baudot or ASCII using audio tones (AFSK).

The software may be loaded into the computer from cassette or disk. Enter your callsign and the time to initiate the program. You begin receiving immediately. No settings or adjustments are necessary to receive Morse code — it's fully automatic. Press BREAK-@ to transmit, or return back to receive. Text may be typed while receiving or transmitting.

TERMINALL comes complete with

More Details? CHECK—OFF Page 120

software on cassette and disk, assembled and tested hardware, and an extensive instruction manual. List price is $999. For complete ordering information or name of dealer closest to you, contact Macrotronics, Inc., 1125 N. Golden State Blvd., Turlock, California 95380.

CW audio processor and keyer

Trac Electronics, Inc., announces the introduction of two unique products for the CW enthusiast. The TRAC*ONE CW processor, Model TE 424, is an advanced CW audio processor which receives the audio from any rig, passes it through a phased-locked-loop tone decoder, removing all QRN and QRM, and reproduces a fully adjustable CW audio signal. Front-panel controls allow full adjustment of frequency tone, delay, and gain. The frequency control is adjustable from 300 Hz to 2500 Hz, a match for any rig. While the CW signal is being decoded a front panel LED flashes in sync with the signal, establishing that the unit is locked onto the audio from the rig. The TRAC*ONE contains a built-in speaker and a headphone jack on the rear panel, and is operated on a 9-Vdc battery or with an ac-adapter. In the BYPASS position, the Model TE-424 TRAC*ONE may be left in line and the rig audio is passed through to the speaker.

The TRAC*ONE CMOS keyer, Model TE-464, combines the full featured TRAC*ONE with a deluxe state-of-the-art CMOS electronic keyer. The keyer contains self-completing dots and dashes, dot and dash memory, iambic keying with any squeeze paddle, 5-50 WPM, speed, volume, tune and weight controls, sidetone and speaker, rear panel switch for use with a bug or straight key, quarter-inch jacks for keying and output. The Model TE-464 keys both grid block and solid state rigs and operates on one 9-Vdc battery or a 9-Vdc/ac adapter.

For further information, contact Trac Electronics, Inc., 1106 Rand Bldg., Buffalo, New York 14203.

More Details? CHECK—OFF Page 120

National Semiconductor Clock Modules

12VDC AUTOMOTIVE/ INSTRUMENT CLOCK

APPLICATIONS:
- In-dash autoclocks
- After-market auto/ RV clocks
- Aircraft-marine clks.
- 12VDC oper. instru.
- Portable/battery powered instrumnts.

Features: Bright 0.3" green display. Internal crystal time-base. ± 0.5 sec./day accur. Auto. display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete—just add switches and lens.

MA1003 Module (3.05"L×1.75"H×.98"D) . **$16.95**

CLOCK MODULES

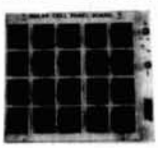
MA1023	.7" Red Digital LED Clock Module	8.95
MA1026	.7" Dig. LED Alarm Clock/Thermometer	18.95
MA5036	.3" Red Digital LED Clock/Timer	6.95
MA1002	.5" Red Digital LED Clock & Xformer	9.95
MA1010	.8" Red Digital LED Clock	7.95
MA1032	CBA .5" Digital LCD Clock	17.95
MA1043	.7" Green Digital LED Clock	8.95

TRANSFORMERS

102-P20	Xformer for MA1023, 1043 & 5036 Mods.	3.49
102-P22	Xformer for MA1026 Clock Modules	3.49
102-P24	Xformer for MA1010 Clock Modules	3.49

NEW!

Sun Power Your Electronics! SOLAR CELL PANEL KIT

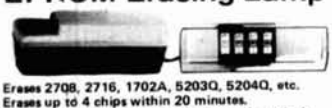


Features:
- **Output: 10VDC, to 100mA in Series 5VDC, to 200mA in Parallel**
- **Panel may be easily connected for Series or Parallel out**
- **Over 11 square inches of active cell surface**
- **Voltage line tap @ 0.5V increments**
- **Provision for charging batteries**
- **Overall panel size: 4¾"L x 4½"H x ½"D**

The JE305 Solar Cell Panel Kit contains 20 each solar cells. On the panel board are power line taps which allow the user to select voltages (one voltage at a time) from 0.5VDC to 10VDC. The applications of each panel can be further expanded by coupling additional panels in series for more voltage or in parallel for more current. The premium grade solar cells provide the current necessary for the operation of most portable transistor radios, small battery powered cassette tape players and unlimited experimental solar projects.

JE305 . . . . $39.95

EPROM Erasing Lamp

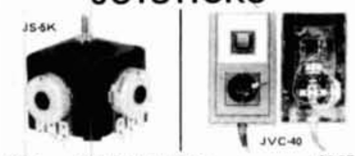


- **Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.**
- **Erases up to 4 chips within 20 minutes.**
- **Maintains constant exposure distance of one inch.**
- **Special conductive foam liner eliminates static build-up.**
- **Built-in safety lock to prevent UV exposure.**
- **Compact — only 7-5/8" x 2-7/8" x 2"**
- **Complete with holding tray for 4 chips.**

UVS-11EL Replacement Bulb $16.95

UVS-11E $79.95

JOYSTICKS



JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in case	$4.95

ALLIGATOR CLIP TEST LEADS

Heavy-duty leads, color coded. Insulated alligator clip on each end. 15" long. Two each black, red, blue, white and yellow.

#ALCP (10 per pack) . . . . $2.95/pkg.

NEW!

JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95

(Picture not shown but similar in construction to above)

JE200 Reg. Power Supply Kit (5VDC, 1 amp) . . $14.95
JE205 Adapter Brd. (to JE200) ±5, ±9 & ±12V . $12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp . $19.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A	CPU	4.95
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	6.95
DP8253	Prog. Interval Timer	8.95
DP8255	Prog. Peripheral I/O (PPI)	5.95
DP8257	Prog. DMA Control	9.95
DP8259	Prog. Interrupt Control	9.95
DP8275	Prog. CRT Controller	39.95
DP8279	Prog. Keyboard/Display Interface	9.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95
DP8310	Octal Latched Peripheral Driver	5.25
DP8311	Octal Latched Peripheral Driver	5.25

6800/6800 SUPPORT DEVICES

MC6800	MPU	7.95
MC6802CP	MPU with Clock and RAM	14.95
MC6810AP1	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	13.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	11.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	13.95
CDP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MCS6500	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	7.95
INS8039N-6	CPU—Sgl. Chip 8-Bit (128 bytes RAM)	9.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	9.95
TMS9900JL	MPU—16-Bit	39.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402N	256-Bit Dynamic	2.95
MM5013N	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	1.95
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V (1404A)	1024-Bit Dynamic	1.95
2518N	Hex 32-Bit Static	1.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 250-Bit Static	4.00
2529V	Dual 240-Bit Static	4.00
2532N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Band Filter	19.95
AF122-1CJ	Touch Tone High Band Filter	19.95
LM308CH	Super Gain Op Amp	1.15
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.5ppm/C°)	5.00
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0809CCN	8-Bit A/D Converter (8-Ch. Multi.)	5.25
ADC0817CCN	8-Bit A/D Converter (16-Ch. Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	30K BAUD UART	6.95

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
21L02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	3.25
2114L	1024x4 Static 450ns Low Power	3.49
2114-2	1024x4 Static 200ns	3.95
2114L-2	1024x4 Static 200ns Low Power	4.95
74S200	256x1 Static	6.95
4116N-4 (UPD416)	16K Dynamic 250ns (MM5290N-4)	2.95
4164N-3	64K Dynamic 200ns	19.95
MM2147J	4096x1 Fast 70ns	7.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.95
MM5262	2Kx1 Dynamic	.49
MM5280/2107	4096x1 Dynamic	4.95
MM5290N-2 (4116)	16K Dynamic 150ns (UPD416C-3)	3.95
MM5298J-3A	8K Dyn. 200ns (lower ½ of MM5290J)	1.95
HM6116-4	16K (2Kx8) Static 200ns	14.95
82S25	64 Bit RAM (16x4OC)	3.49
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	9.95
TMS4045	1024x4 Static	9.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	4.95
TMS2716	16K EPROM (-5V, +5V, +12V)	9.95
2716Intel(2516)TI	16K EPROM (Single +5V)	8.95
2732Intel TI	32K EPROM	17.95
2758	8K EPROM (450ns) (Single +5V)	7.49
2764Q	64K EPROM (Hitachi HN462764)	49.95
5203	2048 PROM	14.95
82S23(74S188)	32x8 PROM (Open Collector)	3.95
82S115	4096 Bipolar PROM	14.95
82S123(74S288)	32x8 Tri-State Bipolar PROM	3.95
82S185	8K PROM	16.95

— Over 30 More PROMS Listed in Our Catalog —

ROM'S

2513(2140)	Character Generator (Upper Case)	9.95
2513(3021)	Character Generator (Lower Case)	9.95

NMOS READ ONLY MEMORIES

MCM66710P	128x9x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

SPECIAL FUNCTION

DS0025CN	Dual MOS Clock Driver (5MZ)	3.50
DS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
MM58167N	Microprocessor Real Time Clock	8.95
MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Bus Int.	7.49
COP470N	32-Seg. VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM53190N	Push Button Pulse Dialer	7.95
MM57499N	96/144-Key Serial Keyboard Encoder	8.95

RADIO CONTROL CIRCUITS

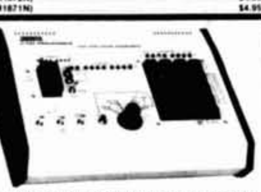
Ideal to use for: Toys, hobby crafts, robots, trains, burgler alarms, IR data link, remote slide projector control, consumer remote data links, energy-saving remotely switched lighting systems.

LM1871N R.C. Encoder/Transmitter Chip . . . $5.49
A complete 6 channel dig. encoder and R.F. transmitter, low power, at freq. of 27MHz or 49MHz, a field strength of 10,000uV meter at 3 meters. 9V operation on chip RF oscillator/transmitter, on chip 4.6V reg. Up to 80MHz carrier freq. operation.

LM1872N R.C. Receiver/Decoder Chip . . . $5.49
A complete R.F. receiver/decoder, used at either 27, 49 or 72MHz. It provides 4 independent channels when used w/LM1872 (2 analog, 2 dig.) operates from 4-1.5V cells. Crystal controlled.

SRX1504 49.435MHz Crystal (LM1872N) . . . $4.95
SRX1505 49.890MHz Crystal (LM1871N) . . . $4.95

JE608 PROGRAMMER
2704/2708 EPROM PROGRAMMER



GENERAL APPLICATIONS:
- **To program EPROMS 2704 and 2708.**
- **Developmental system for microcomputer circuits**
- **To read the contents of a pre-programmed EPROM**
- **To compare EPROM(s) for content differences**
- **To emulate a programmed EPROM**
- **To store program in RAMS for alterations**
- **Three seperate Display Registers: 8 LED's for Hex Key entries, 10 LED's (2^0-2^9) for Address Register and 8 LED's for Data Memory Register. The Data Memory Register displays the content of the RAMs from the EPROM Chip. Development of microprocessor systems by means of a ribbon cable from the programmer panel test socket to the EPROM socket on the microprocessor board. Rapid checking verification of programmed data changes. User may move data from a master to RAM's or write into RAM's with keyboard entries. Allows manual stepping manipulation (up and down) at any address location. Stand-alone EPROM Programmer consisting of: A 19-key Hexadecimal Keyboard assembly, Programmer Board assembly with 4 power supplies and a LED/Test Socket Panel Board assembly. The Test Socket is zero force insertion type. Power requirements: 115VAC, 60Hz, 6W. Compact desk-top enclosure: Color-coordinated designer's case with light tan panels and molded end pieces in mocha brown. Size: 3¼"H x 11"W x 8¾"D. Weight: 5 lbs.**

The JE608 EPROM Programmer is a completely self-contained unit which is independent of computer control and requires no additional systems for its operations. The EPROM can be programmed from the Hexadecimal Keyboard or from a pre-programmed EPROM. The JE608 Programmer can emulate a programmed EPROM by the use of its internal RAM circuits. This will allow the user to test or pretest a program for a system, prior to programming a chip. Any changes in the program can be entered directly into the memory circuits with the Hexadecimal Keyboard so that rewriting the entire program will not be necessary. The JE608 Programmer contains a Programmer/Board w/25 IC's & includes power supplies of: -5V, +5V, +12V and +26V. The Hexadecimal Keyboard and LED/Test Socket Panel board are separate assemblies within the system.

JE608K Kit $399.95
JE608A Assembled and Tested $499.95

JE608-16K ADAPTER BOARD
FOR 2716/2758 EPROMS

GENERAL DESCRIPTION:
The JE608-16K Adapter Board allows the JE608 Programmer to be modified for the additional programming of the 2716 and 2758 EPROMS. The adapter provides for adding an address switch for the 2^{11} bit and also for selecting the proper power and timing pulses to be applied to the EPROM. Programming and emulating the 2716 (16K) EPROM is done seperately to each half (1024x8) of the EPROM because of the existing 8K RAM capacity in the JE608 Programmer.

JE608-16K	Adapter Board Kit	**$29.95**
JE608-Upgrade	(Send assembled JE608 to factory for adapter installation of the JE608-16K Adapter Board Kit)	**$99.95**
JE608A-16K Mod.	Assembled JE608 w/Adapter (JE608-16K) Installed	**$599.95**

$10.00 Min. Order – U.S. Funds Only
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Postage—Add 5% plus $1.50 Insurance

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Send 86¢ Postage for your
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12/81

BOOKS

National Semiconductor — Intersil — Intel

30001	**National CMOS Data Book** (640 pages) 74C, CD4000, and A/D Converters	$5.95
30002	**National Interface Data Book** (704 pages) DP, DS8000, DS3600, DS75000, etc.	$5.95
30003	**National Linear Data Book** (1376 pages) LM, LF, ADC, DAC, LH Series	$8.95
30004	**National Series 80 — Board Level Computer** (224 pages)	$4.95
30005	**National TTL Logic Data Book** (624 pages) 7400, LS, L, H, S, and DM8000 Series	$8.95
30006	**Buy above (3) 30001,3,5 as a set**	$19.95/lot
30009	**Intersil Data Book** (1074 pages)	$6.95
010400	**Intel Component Data Catalog** Full data sheets for Intel's products incl. memory devices, microproc., peripherals & indust./mil. products (1328 pages)	$10.00
205610	**Intel Peripheral Design Handbook** Full data sheets, appl. notes for Intel peripheral device components (644 pages)	$7.50

AC and DC Wall Transformers

Ideal for use with clocks, games, power supplies or any other type of AC or DC application.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12 VAC 250mA	$3.95
AC 500	117V/60Hz	12 VAC 500mA	$4.95
AC1000	117V/60Hz	12 VAC 1 amp	$5.95
AC1700	117V/60Hz	9 VAC 1.7 amp	$3.95
DV 9200	117V/60Hz	9 VDC 200mA	$3.25
DC 900	120V/60Hz	9 VDC 500mA	$3.95

CONNECTORS

DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
D20418-2	Screw Lock Hdwr. (2) DB25S/P	2/$.99
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
- ★ **8 ea. MM5290 (UPD416/4116) 16K Dyn. Rams (*NS)**
- ★ **Documentation for Conversion**

TRS-16K2	*150NS	$29.95
TRS-16K3	*200NS	$24.95
TRS-16K4	*250NS	$19.95

JE610 ASCII Encoded Keyboard Kit

The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10 mA for operation. Features: 60 keys generate the 126 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector. Size: 3½"H x 14½"W x 8¾"D

JE610/DTE-AK (After assembled as pictured above) . . . **$124.95**

JE610 Kit 62-Key Keyboard, PC Board, & Components (no case) . **$ 79.95**
K62 62-Key Keyboard (Keyboard only) . . . **$ 34.95**
DTE-AK (case only — 3¾"Hx11"Wx8¾"D) **$ 49.95**

NEW! JE212 — Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT
Provides -12VDC from incoming 5VDC . . $9.95

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD

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More Details? CHECK—OFF Page 120

ham radio cumulative index

a note on this index

In an effort to give our readers as many articles as possible in this issue of *ham radio*, we have switched from a ten-year to a five-year cumulative index. By doing so we have made approximately ten additional pages available for feature articles. Those readers who wish to a see a cumulative index for years previous to 1977 should consult previous December issues of *ham radio*. Back issues are available from Ham Radio's Bookstore for $3.00 postpaid.

Please let us know what you think of this change, and whether you would prefer to see five- or ten-year cumulative indexes in future December issues of *ham radio*.

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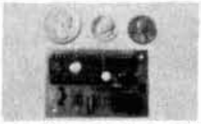

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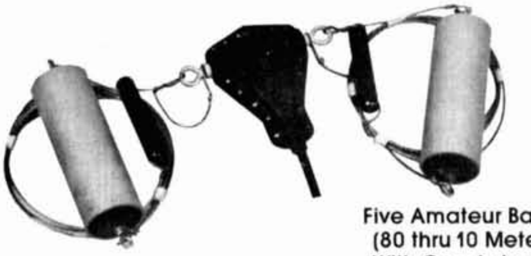

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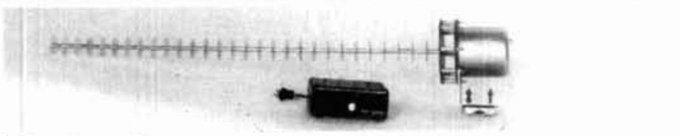

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440 SYNTHESIZED

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146 STILL THE LEADER

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The FT-101ZD Mk III is the latest chapter in the success story of the FT-101 line. Armed with new audio filtering for even better selectivity, the FT-101ZD now includes provision for an optional FM or AM unit. Compare features and you'll see why active operators everywhere are upgrading to Yaesu!

Variable IF Bandwidth
Using two 8-pole filters in the IF, Yaesu's pioneering variable bandwidth system provides continuous control over the width of the IF passband — from 2.4 kHz down to 300 Hz — without the shortcomings of single-filter IF shift schemes. No need to buy separate filters for 1.8 kHz, 1.5 kHz, etc.

Improved Receiver Selectivity
New on the FT-101ZD Mk III is a high-performance audio peak/notch filter. Use the peak filter for single-signal CW reception, or choose the notch filter for nulling out annoying carriers or interfering CW signals. In the CW mode, you can choose between the 2.4 kHz SSB filter and an optional CW filter (600 or 350 Hz) from the mode switch.

Diode Ring Front End
The FT-101ZD now sports a high-level diode ring mixer in the front end. This type of mixer, well known for its strong signal performance, is your assurance of maximum protection from intermod problems on today's crowded bands.

WARC Bands Factory Installed
The FT-101ZD Mk III comes equipped with factory installation of the new 10, 18, and 24 MHz bands recently assigned to the Amateur Service at WARC. In the meantime, use the 10 MHz band for monitoring of WWV!

RF Speech Processor
Not an additional-cost option, the FT-101ZD RF speech processor provides a significant increase in average SSB power output, for added punch in those heavy DX pile-ups. The optimum processor level is easily set via a front panel control.

Worldwide Power Capability
Every FT-101ZD comes equipped with a multi-tap power transformer, which can be easily modified from the stock 117 VAC to 100/110/200/220/234 VAC in minutes. A DC-DC converter is available as an option for mobile or battery operation.

Convenience Features
Designed fundamentally as a high-performance SSB and CW transceiver, the FT-101ZD includes built-in VOX, CW sidetone, semi-break-in T/R control on CW, slow-fast-off AGC selection, level controls for the noise blanker and speech processor, and offset tuning for both transmit and receive. The Mk III optional FM unit may be used for 10 meter FM operation, or choose the optional AM unit for WWV reception or VHF AM work through a transverter (AM and FM units may not both be installed in a single transceiver).

Full Line of Accessories
See your Yaesu dealer for a demonstration of the top performance accessories for the FT-101ZD, such as the FV-101Z External VFO, SP-901P Speaker/Patch, YR-901 CW/RTTY Reader, FC-902 Antenna Tuner, and the FTV-901R VHF/UHF Transverter. Watch for the upcoming FV-101DM Digital Memory VFO, with keyboard frequency entry and scanning in 10 Hz steps!

Nationwide Service Network
During the warranty period, the Authorized Yaesu Dealer from whom you purchased your equipment provides prompt attention to your warranty needs. For long-term servicing after the warranty period, Yaesu is proud to maintain two fully-equipped service centers, one in Cincinnati for our Eastern customers and one in the Los Angeles area for those on the West Coast.

Note: A limited quantity of the earlier FT-101ZD (with AM as standard feature) is still available. See your Yaesu dealer. FT-101ZD Mk III designates transceivers bearing serial #240001 and up, with APF/Notch filter built in and AM/FM units optional.

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EIMAC's 4CW300,000G Power Tetrode. A new generation of high-performance power tubes.

EIMAC's 4CW300,000G combines all the desired features transmitter designers look for: high peak plate current, low grid emission, low internal capacitances and low internal inductance. This is the first of a new generation of high performance power tubes for LF, HF, VHF and pulse service.

Laserfab pyrolytic graphite grids

The control grid and screen structures of the 4CW300,000G are precision-cut by a laser beam. Each element is monolithic and combines extremely low coefficient of expansion with low structural inductance. These features permit the 4CW300,000G to have a very high transconductance—10^6 micromhos—and allow efficient, high-frequency operation.

Rugged mesh filament

The EIMAC mesh filament provides exceptionally high peak plate current and permits low plate voltage operation. This leads to power supply economy, making the 4CW300,000G the economic choice for 300 KW AM broadcast service or long-pulse switch service, each of which demands a reserve of peak emission.

Improved anode structure

EIMAC's multi-phase cooling technique provides high plate dissipation to extract heat evenly and quickly from the anode, contributing to long tube life and operating economy.

EIMAC expertise

EIMAC's expertise in electron ballistics pyrolytic grid production, thermodynamics and circuit techniques combine to bring tomorrow's tubes for today's transmitter designs. More information is available from Varian EIMAC. Or the nearest Varian Electron Device Group sales office.

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