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50-MHz SSB EXCITER
We’re convinced...we’ve built the world’s finest amplifier in its class!

HENRY RADIO’S

THE NEWEST MEMBER OF THE FAMOUS HENRY RADIO FAMILY OF FINE AMPLIFIERS

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- Less expensive. If your budget is limited, but you still want a GOOD quality linear to kick your signal way up, with sharp clear signals, the 1KD-5 will give you just about everything you want...and without sacrificing quality.

GENERAL INFORMATION

The 1KD-5 is a 1200 watt PEP input (700 watt PEP nominal output) RF linear amplifier, covering the 80, 40, 20 and 15 meter amateur bands (10 meters on units shipped outside the U.S.)

Tube Complement: 6m182Z glass envelope triode operating in a grounded grid circuit

ALC Circuit: ALC circuit to prevent overdrive from high power exciters. Also boosts average talk power.

Type of Emission: SSB CW RTTY or AM

Antenna Relay: DC relay system for hum free operation. Requires shorting contact to ground during transmit to key amplifier into transmit.

Power Output Indicator: Self-contained relative RF power meter

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Input Circuits: Cathode P1 input matching circuits for maximum drive and linearity.

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All of the above except the 2002, 3K A & 4K ULTR...are available at Tempo dealers throughout the U.S.

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DELAYED SWEEP
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Run up to 3 KW or 1.5 KW PEP and match everything from 1.8 thru 30 MHz: coax, balanced line, random wire. Built-in balun.

NEW MFJ KW VERSA TUNERS HAVE THESE FEATURES IN COMMON

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EXCLUSIVE RF AMMETER

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This is MFJ's best 3 KW Versa Tuner IV. The MFJ-984 Deluxe 3 KW Versa Tuner IV gives you a combination of quality, performance, and features that others can't touch at this price.

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Versatile antenna switch lets you select 2 coax lines thru tuner and 1 thru or direct, or random wire, balanced line or dummy load.

A 200 watt 50 ohm dummy load lets you tune your exciter off air for peak performance. Efficient, encapsulated 4:1 ferrite balun.

2. MFJ-981 3 KW VERSA TUNER IV
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The MFJ-981 3 KW Versa Tuner IV is one of MFJ's most popular Versa Tuners. An accurate meter gives you SWR, forward and reflected power in 2 ranges: 2000 and 200 watts. Encapsulated 4:1 ferrite balun.

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$199.95
Antenna switch lets you select 1 coax thru tuner or direct, or random wire and balanced line.

The MFJ-982 3 KW Versa Tuner IV gives you a versatile 7 position antenna switch that lets you select 1 coax thru tuner and 2 coax thru tuner or direct, or random wire and balanced line. Encapsulated 4:1 balun. If you already have a SWR/wattmeter, the MFJ-982 is for you.

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$169.95
Heavy duty encapsulated 4:1 ferrite balun for balanced lines.

The MFJ-980 is MFJ's lowest priced 3 KW Versa Tuner IV but has the same matching capabilities as the other 3 KW Versa Tuner IV's. Features an efficient, encapsulated 4:1 ferrite balun for balanced lines.

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T. H. Tenney, Jr., W1NLB
publisher

James R. Fish, WHHR
editor-in-chief

editorial staff

Marcia French, W1CHQ
administrative editor

Patricia A. Harris, N1HPM
Alfred Wilson, W1HR
associates

Thom F. McRae, Jr., W1WQG
Joseph J. Schroeder, W1UUV
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publishing staff

J. Craig Clark, Jr., MAAT
assistant publisher

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advertising manager

James H. Gray, W1KXU
assistant advertising manager

Harold R. Kent, W1WQG
Dorothy A. Sargent, KA186B
advertising sales

Sue Sherrock
circulation manager

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October 1979
I've been interested in the history of radio nearly as long as I've been a Radio Amateur, and am continually on the lookout for old wireless equipment to add to my collection. Local ham flea markets and auctions are often the source of unexpected treasures, and I attend as many as I can; not too long ago I missed an opportunity of a lifetime when I passed up an auction of surplus electronic equipment at an old, respected New England college. Much of the “surplus” gear dated back to the 1920s and was built into custom-made wooden cases which were then in fashion; most of the buyers, unfortunately, were antique dealers who were interested only in the finely crafted cabinets — the priceless radio equipment inside was destined for the trash heap.

In many respects it was a replay of an event in Oklahoma several years ago: The auction of the electronics equipment and junk collection of a prominent local amateur. From all reports, it was quite a collection, filling four large warehouses. Except for the huge volume (and original cost) the collection resembled the typical “hell box” of every amateur who lived through the halcyon days when building your own transmitter was conventional practice and everyone eagerly added to his junk collection at every possible opportunity.

However, there was one big difference in the Oklahoma collection: Where most Radio Amateurs painfully part with dollars, this amateur painlessly parted with thousands of dollars. Think back a few years — what was the most delectable piece of radio gear you remember? It was probably in the Oklahoma collection. And not just one, but several. Parts, radio sets, test equipment, you name it, it was all there in unimaginable profusion. One whole warehouse floor was reportedly crammed full of big transmitters, spark coils, and rotary gaps for 1920-style transmitters, spiderweb coils and thousands of variable capacitors of every possible make and description. A complete inventory would go on for pages.

Now here's the tragedy: These priceless articles, which belong in a museum, were grouped in huge lots with utter junk and sold to junk dealers! The probability that these dealers could differentiate between valuable antiques and valueless junk is frighteningly small. Antique radio equipment that can never be replaced, items not preserved in any museum, were probably bulldozed under at a county landfill dump.

This scene, on a much more modest scale, is probably repeated many times a year all over the country. Without getting morbid, each one of us should realize that we are not immortal. Each of us has a collection of electronic gear that will, if someone doesn’t know any better, be bulldozed under with the trash at the city dump when we join the list of Silent Keys. Each item, when you acquired it, represented a jewel to be treasured and was carefully put away. If you were ever so careless as to toss out one of these treasures, you almost certainly would have an immediate pressing need for an identical article. I know, because it happens to me every time I clean house!

The point is this: Talk to your heirs. Clue them in as to what items, if any, belong in a museum. Better yet, make arrangements with the executor of your estate to donate certain prized items to a local school or college; antiques should be given to a museum of your choice. The same sort of foresight applies to your newer equipment as well. Give your executor the names of several trusted amateur friends who will help dispose of modern radio gear and test equipment. They will know the fair market value — your executor may not. There have been more than a few cases where an amateur’s survivors have been ripped off to the tune of thousands of dollars; don’t let it happen to your family.

Jim Fisk, W1HR
editor-in-chief
ICOM

and 6 meters: Nobody Does It Better.

ICOM's new IC-551 is the all mode 6 meter unit in a compact, easy to use instrument, which uses a built-in microprocessor for frequency control and scanning. The no backlash, no delay dual VFO light chopper system, similar to the IC-701 and the IC-211, is included as a standard feature at no extra cost, and provides split frequency operation as well as completely variable offsets.

For quick access to DX excitement, three memories are provided for programmed beacon watching. The IC-551 can scan three memories and be programmed to stop on the first one heard. When not scanning, the three memories and two VFO's provide five different frequencies for the operator to select.

The new IC-551 uses ICOM's famous 100 Hz step digital tuning system, with a fluorescent readout similar to ICOM's RM2 microprocessor. ICOM's dual VFO, single knob tuning spins through the 6 meter band at 10 KHz or 1 KHz steps at the touch of the high speed tuning button and/or mode switch. Your 6 meter operations have never been easier.

- Two Digital VFO's Standard
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- Variable Output from 1 to 10 watts
- Dial Lock Switch for Mobile Use
- Pulse Noise Blanker Standard
- Variable Scan Speed
- Optional FM Unit
- Optional RF Speech Processor and Variable Bandpass Module (similar to the IC-701 ... makes 10 watts sound like 25)
- Optional VOX Unit with Microdelay™

The new IC-551, 50 MHz Band Transceiver. At your dealer now.

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Please send me: [ ] IC-551 specifications sheet; [ ] full-color ICOM Product Line Catalog; [ ] List of Authorized ICOM Dealers.

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CITY

You may send a machine copy of this form.
RTTY demodulator

Dear HR:

I would like to make some comments on the article by KB9AT in the October, 1978, issue: "Digiratt PLL2."

In his third sentence the author states, "The one common drawback to PLL terminal units is that they decode only half the available information present in the RTTY signal."

In other words, we could eliminate one of the two tones and still end up with the same results. We could go to a similar signal like CW but Baudot encoded. This would save some bandwidth and let our transmitter finals live longer because of the shorter duty cycle. As far as I know, most if not all TUs use some kind of discriminator, PLL or otherwise, which produces at its output a positive voltage corresponding to one tone and a negative voltage corresponding to the other tone, both with respect to a reference voltage, which might or might not be at ground potential.

These two voltages are then processed through filters and/or a comparator before going to the keyer stage. What if one of these tones is missing? One of these two output voltages is also missing. And the place where the missing tone should be is now filled with noise. When we send that noise through a comparator to the keyer stage, the keyer stage will start switching back and forth on noise pulses. So we see that it's absolutely necessary to have two tones.

My second argument is with the author's poor choice of PLL for his TU. If at any time he had read the data sheets and looked at the graphs that go with this PLL tone decoder, he definitely would have made another choice. First, the data sheet gives a simple equation to calculate the bandwidth, which is

\[ \text{BW} = \frac{V_i}{F \cdot C_2} \]  

and the minimum detectable signal is 20 mW. Inserting this value into eq. 1 shows that with the author's choice of a filter capacitor, which also determines the bandwidth, we have a bandwidth of 15 Hz. Going to a more normal input voltage of 2 volts we find a bandwidth of 48 Hz. Now, going with these numbers one step further, on the data sheets we find the graph Greatest number of cycles before output. We find that as much as 300 Hz occur before the 567 will lock up on that short 2125-Hz tone.

We know that each bit in our Baudot-encoded machines at 60 wpm is only 0.022 second long. This means that we have, from those 2125 Hz, only available per bit 0.022 \times 2125 = 46.75 Hz, far less than we need in the worst-case lockup time. So we lose that bit altogether. When we have an R or a Y, where we have six transitions, we switch back and forth between the two PLLs; and every time each PLL must search and try to lock up.

Agreed, the data sheet also says that "assuming random initial input phase, only during random initial input phase, only during random initial input phase, only during random initial input phase, only during random initial input phase, only during random initial input phase, only during random initial input phase, only during random initial input phase, only during random initial input phase, only during random initial input phase, only during random initial input phase."

This means that we can transmit all bits in a letter such as R or Y. Furthermore, we should take into account that most machines will print garble when we have a signal distortion (shortening of the pulse) of 30 per cent on a well-adjusted machine!

Now even with the loop filter C completely removed, the worst-case lock up time can still be 27 Hz, which is far more than 30 per cent, and is about 58 per cent.

So with all of this in mind we can see that the 567 is a very poor choice for 60 wpm or more on RTTY, and we can see why this chip was never intended to be used for that purpose. There are many other choices that would have been far better, which I've tried in all the years I've been on RTTY. Other chips that are intended for RTTY have a lockup transient only at the very beginning of each transmission, or when the signal appears at the input of the TU. By careful choice of loop filter C, these loops will almost instantaneously follow each tone deviation that might appear within its capture range.

Joe C. Zegers, WB6PMV Sunnyvale, California

Dear HR:

Reader Zegers has raised some interesting questions in his letter. I wish to reply to his statements with this letter.

I stand by my statement that phase locked loops decode only one frequency, which in RTTY is one half of the information. Actually, a more correct statement would be that they decode only a small range of frequencies within their detection bandwidth.

It is true that PLL circuits (such as the popular 565 for instance) are often connected to an op-amp, and a positive and negative voltage swing obtained for use in keying circuits. However, both the 565 and the 567
TS-180S DUAL SSB FILTER

What advantages are provided by the dual SSB filter system in the TS-180S? The dual SSB filter system in the TS-180S provides the following advantages:

- Improves receiver signal-to-noise ratio (S/N).
- Improves receiver selectivity.
- Allows greater RF speech-processor compression level.

Which filters are supplied as standard features? The TS-180S operates with these filters:

| YK-86SSB IF SSB Filter #1 | Standard, Built in |
| YK-86SSB IF SSB Filter #2 | Optional |
| YK-88CW 500-Hz CW Filter | Optional |

How much is selectivity improved by adding the second SSB filter? Even with just the one standard SSB filter, the TS-180S is very selective. Passband widths with the single and dual filters, as well as with the CW filter, are shown below:

<table>
<thead>
<tr>
<th>RESPONSE</th>
<th>SINGLE SSB FILTER</th>
<th>DUAL SSB FILTER</th>
<th>CW FILTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>-6 dB</td>
<td>2.4 kHz</td>
<td>2.2 kHz</td>
<td>0.5 kHz</td>
</tr>
<tr>
<td>-60 dB</td>
<td>4.2 kHz</td>
<td>3.0 kHz</td>
<td>1.5 kHz</td>
</tr>
</tbody>
</table>

The newly developed MCF type filter, including both the YK-86SSB and YK-88CW, has sharp response characteristics. The newer filters are notable in their lack of response "humps" away from the main portion of the passband curve.

How much does the second SSB filter improve S/N? Adding a second crystal SSB filter between the IF amplifier and the detector reduces wideband noise from the IF amplifier by 3 dB, thus giving a certain improvement in overall receiver S/N.

How does the dual SSB filter system also improve RF speech-processor compression level? The following maximum compression levels are available with the TS-180S RF speech processor.

<table>
<thead>
<tr>
<th>MAXIMUM COMPRESSION LEVEL</th>
<th>SINGLE SSB FILTER</th>
<th>DUAL SSB FILTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 dB</td>
<td></td>
<td>30 dB</td>
</tr>
</tbody>
</table>

PC-1 PHONE PATCH

Is a matching phone patch available for Kenwood equipment? After many requests, Trio-Kenwood is introducing the PC-1 phone patch, which may be connected between a transceiver and the telephone-line. (We recommend obtaining a voice connecting arrangement from the telephone company for legal attachment to the telephone line.)

Does the PC-1 use a hybrid circuit for VOX operation? The PC-1 is able to interconnect the transmitter, receiver, and telephone line voice coupler while accommodating a great difference in voice levels to and from the telephone line, and cancelling the audio level from the receiver at the input to the transmitter's VOX circuit.

Is the PC-1 easy to adjust? Three easy adjustments are made after a phone call is established:

- NULL control, with a clear, continuous signal tuned in on the transceiver, for minimum deflection of the PC-1 meter.
- RX GAIN control, to about 0 dBV on the PC-1 meter, for hearing the signal clearly through the telephone receiver.
- TX GAIN control, for proper VOX operation while the party on the telephone speaks.

The dual filter system functions in the IF stage, which is common to both the transmitter and receiver. The RF compressor speech processor in the TS-180S is always on, with selectable time constants of SLOW (natural sounding audio) and FAST (more audio punch for the pile-ups). Up to 15 dB of compression in the FAST mode may be achieved without sideband expansion (splitter), using a single filter. With the dual filters, the sideband is filtered again and a high-quality SSB signal of high talk power is obtained, with a maximum compression level of 30 dB without splitter.

Can both the optional second SSB filter and optional CW filter be used for receiving at the same time? Yes.

Where is the dual SSB filter system located in the TS-180S? The dual SSB filter system is in the TS-180S IF unit, and the second filter may be installed easily by the user. The general circuit configuration is shown below.
DISASTERS OR EMERGENCIES should not require that all other activity on the Amateur bands cease, the commissioners decided at their last meeting before their annual August recess. The issue was raised in a Petition for Rule Making, RM-2015, which had been filed after a weather emergency that occurred during the 1972 Field Day and resulted in considerable interference between emergency nets and Field Day operators.

In the Petition Had Proposed that all but emergency operations be automatically prohibited on all Amateur bands for the duration of an emergency, but the commissioners agreed, in their dismissal of the petition, that Part 97.107 of the Rules already provides the means for doing just that when — and if — it is needed.

Radio Control Enthusiasts would have lost one of their limited channels if another interesting Petition for Rule Making had not also been dismissed by the commissioners. In that petition, RM-2215, the Saf-T-Onics Company had proposed equipping all autos with a transmitter and receiver on a common RC channel so that blowing a car's horn would activate a warning signal in all other nearby vehicles.

A WELL-PLANNED ATTACK on malicious interference, led by ARRL Southwestern Director W6E3J, has been started on the West Coast. Enlisted in the battle are area congressmen, including Representative James Corman of Van Nuys, a nine-term veteran of the House of Representatives and long-time friend of Los Angeles attorney N6AHU, and Senator Alan Cranston. Both have met with concerned local Amateurs for briefings on the jamming problem as well as run-downs on Amateur Radio's value on the local, national, and international level.

Rep. Corman, a senior member of the powerful House Ways and Means Committee, seems genuinely disturbed over what he has learned of the malicious interference problem, and is quite determined to do something about it.

U.S. AMATEUR POPULATION DROPPED during July for the first time in five years, with the operator total down 100 from the all-time high of 365,985 a month earlier. Most significant is that the falloff comes entirely from a drop of 700 in the Novice Class, which would have been expected to have more than held its own due to the recent extension of Novice licenses to five year, renewable terms.

Other than Novice Operators, who dropped from 66,992 to 66,285 during July, all other classes showed an increase last month. Extras went from 23,493 to 23,627; Advanced from 84,436 to 84,531; General from 121,743 to 122,066; and Technicians from 69,321 to 69,045. However, Novice losses more than offset those gains.

NEW EAST GERMAN PREFIXES in the Y2-Y9 block have just been announced, with special call signs for individuals, clubs, and special-purpose stations. Under the new system DM2AAO would become Y21AO, while DM2CAO would be Y23AO. Club stations will begin with Y3 (Y31AA, Y37AB, for example). Short calls are for repeaters (Y21A-Y29Z), contest teams (Y31A-Y39Z), beacon (Y41A-Y49Z) and bulletin stations (Y61A-Y69Z).

THE PROTO-FLIGHT SOLAR PANEL for Phase III Mission A, provided by Solarex Corporation, has been received and has been given thermal vacuum cycling tests. The tests will be followed by vibration tests, after which, if all goes well, more of these panels will be built.

WS2MPU Reports That The Solar Cells for Phase III now total 4,077, and 39 battery cells have been sponsored for this OSCAR program.

COMPLAINTS ABOUT THAT "WOODPECKER" signal that tears up the HF bands still should be phoned in to the FCC's Watch Officer, (202) 632-6975, 24 hours a day. The purported Russian Over-The-Horizon radar is heard from about 5 to almost 30 MHz.

THE FOUNDATION FOR AMATEUR RADIO has announced the six winners of its 1979 scholarships. The winners are WB9LAD, W08KD, WB8TDA, WD5GZL, WB5LME, and N9AKC. These scholarships are open to all Radio Amateurs holding at least a General Class license. This year's applications were received from 28 states. Information on next year's scholarships will appear in next May's issues of the major Amateur Radio publications.

633 KILOMETERS ON 3 CENTIMETERS is the new DX record set on July 27 by I4CHY/7 and I2PZD/2. I2PZD/2 operated from a mountain top northeast of Milan, while I4CHY/7 was in Testa del Gareano on the Adriatic coast. Both used Gumplexers and 1-meter dish antennas. I4CHY/7 made 20 contacts on 10 GHz during his two-week operation, including one at 571 km with I3ZJL's homebrew 3-mW rig, and another with YU3JN/2 near Trieste (about 400 km).

A WARC COMMEMORATIVE POSTAGE STAMP has been issued by the Federal Republic of Germany. The 50-pfennig stamp shows the front panel of a Collins KWM-2 transceiver tuned to the 21-MHz CW band. Now that this WARC commemorative has been printed, plans for a separate Amateur Radio commemorative have been dropped.
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- **FREE**: 1. Model 247 Antenna Tuner ($69), or:
  2. Model KR-20A Keyer ($69.50), or:
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- **FREE**: 1. Model 670 Keyer ($29), or:
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TE-12 Twelve-Tone Sub-Audible or Burst-Tone Encoder • Frequency range is 67.0 - 263.0 Hz sub-audible or 1650 - 4200 Hz burst-tone • Measures 4.25” x 2.5” x 1.5” • $79.95 with 12 K-1 elements.

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COMMUNICATIONS SPECIALISTS
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Construction details of a high-performance, 50-MHz exciter which features CW/SSB operation, digital readout, and modular-type construction for circuit improvement and modification.

This article describes an SSB/CW exciter with digital frequency readout. It covers ±100 kHz segments centered on 50, 51, 52, and 53 MHz. The power output has been limited to 50 milliwatts because the primary use of the exciter is to drive solid-state transmitting converters. The wide frequency range allows coverage of all present weak-signal band segments and satellite passbands.

A modular approach was used in building the rig. I was convinced of the flexibility of this technique by Joe, W1JR. The rig could very easily have been built with fewer modules and still retained its testability. However, I wanted to be able to change very small pieces of the rig without pulling the whole thing off the air. I also felt that taking modularity to this somewhat sublime limit would make the exciter more reproducible. There is a disadvantage to the approach though; you do not end up with a small box. But if you are a casual builder or apt to change designs in midstream, then this is the only way to go.

The exciter can be broken down into analog and digital sections. Fig. 1 shows the block diagram of the analog section, which is made up of ten modules. Each module contains a “complete” function. If you start with the audio preamp, the exciter can be built up from it; that is, all existing modules are used in testing the next. I kept the port impedances of the rf modules at 50 ohms to aid in testing. It also allows easy changes to any given module with minimum impact on the whole project.

Most of the analog portion of the rig was stolen in bits and pieces from the many designs that have appeared in various Amateur Radio journals. Whenever possible, I picked the “cheapest” way to go, consistent with getting the rig to fly with minimum

By Rick Commo, K1LOG, 3 Pryor Road, Natick, Massachusetts 01760
problems. I also imposed the constraint that there would be no hot switching of any rf, in order to facilitate a neat and functional panel layout.

The digital section, shown in fig. 2, consists of six modules, or in this case, boards. It was also built from the bottom up starting with the time base. References are included at the end of this article.

The specifications for the exciter, which are tabulated below, are on a par with the majority of commercial low-band rigs advertised in the Amateur journals:

- **maximum power output**: 50 mW CW
- **carrier suppression**: >45 dB, with respect to single tone
- **IM products**: –32 dB, with respect to two tones
- **harmonics responses**: –50 dB, with respect to full carrier
- **nonharmonic responses**: –45 dB, with respect to full carrier

**audio module**

The audio module (see fig. 3) is not complicated. Two op-amps provide a voltage gain of about 50 and lowpass filtering. An LM308 was used for the first stage because it has somewhat lower noise than most garden-variety op-amps. Just about any op-amp could be used for the second stage, with appropriate changes in (or deletion of) the compensation capacitor.

In this design the first stage has a gain of five and the second a gain of ten. This was more than enough for the microphone that I use. Any gain adjustments the reader feels are necessary in his own case should be done in the first stage. This will preserve the roll-off of the lowpass filter.

Be forewarned: Getting skimpy with audio bypass capacitors is not a good idea, especially in the bias network for the unused inputs. Any hum that appears on these inputs gets amplified right along with the main audio. It doesn’t take too much noise to make a poor sounding signal.

**BFO module**

The BFO module, as shown in fig. 4, contains two oscillators and a buffer. The oscillators are pretty standard, the only thing done special being to match the fets for the approximately equal zero bias drain current \(I_{DSS}\). This was done by shorting the gate to the source and measuring the current with 12 volts applied between the source and drain. The buffer amplifier is described in the ARRL Solid-State Design manual.\(^1\)

The amplifier was driven directly from the oscillators. This was done to insure a clean waveform. With an input impedance of essentially zero ohms, the amplifier keeps the crystals adequately decoupled from each other.

Two outputs are taken from the amplifier. The high-level output goes to one input of the frequency counter. The low-level output, which is variable (200 mV max) goes to the modulator. The oscillators are adjusted on frequency by \(C_1\) and \(C_2\). If the counter is built first, it can be used to do the netting. I used the McCoy crystals that came with the filter, although a 9.000-MHz KVG crystal was tried and no problems were encountered.
balanced modulator

The modulator (fig. 5) uses an MC1496. This circuit has been around a while, but it's easy to get going and has excellent carrier balance. It is fed with about 60 mV of 9-MHz rf and about 600 mV of audio. A balanced circuit was used in the output. This gives a 3-dB increase "for free." A single-ended design will work as well, and has been used in many other designs. The output of the module is about -10 dBm.

Some thought should be given to the layout of the modulator in order to prevent BFO leak-through and, hence, degraded carrier balance. The initial attempt at building the modulator had all the components stuck in the box. This resulted in some carrier coupling to the audio inputs. Some 200-pF bypass caps cured the problem, but I decided to rebuild the module anyway. The second module was built with many of the modulator pins going to Teflon feed-throughs. In this way, most of the dc and all of the audio was wired on the outside of the box. This resulted in a much cleaner layout and the module worked the first time power was applied.

Care should also be taken to avoid overdriving the modulator with the BFO. Initial efforts with this module were very frustrating because of this problem. The best way to set the modulator up is to null the carrier, then inject an audio tone and reduce the BFO drive level until the output of the transmitter starts to fall off. Leave the BFO set at that level.

The filter-amp module provides gain and matching for the 9-MHz crystal filter (see fig. 6). I used a McCoy Golden Guardian, because I got some at a flea market cheap. Other filters may be used, however, if appropriate changes are made in the matching resistors (560 ohms for the McCoy). The gain of the module is controlled via the unbypassed emitter and source resistors. The second gate of Q2 can be used as an ALC input if desired.

Attention should be paid to the supply-line filtering to reduce leakage around the filter. While this is not as important in an exciter as it would be in a receiver, it still pays to be careful.

The variable capacitors on the input and output of the filter are there to resonate out the residual inductance of the filter's transformers, thus reducing pass-band ripple. This is most easily done by padding the LSB crystal to exactly 9.0000 MHz, and then tweaking the two capacitors for maximum output. This will get pretty close to optimum passband ripple.

VFO module

The 5-MHz VFO (fig. 7) is built around an ARC-5 (transmitter) capacitor. This tends to make the VFO quite a bit bigger than it might have been, but it does have the advantage (in VFO design) of mass and built-in gear reduction. The "back wall" of the capacitor was drilled and tapped so that the VFO circuitry could be mounted directly on the capacitor.

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The oscillator uses a JFET and is buffered with a dual-gate MOSFET. I found that the loading of a MOSFET was significantly less than that of a JFET. The output of the buffer goes to an amplifier to raise the output up to a usable level. No compensation has been done on the VFO as yet. However, since the ARC-5 capacitor is made of Invar, the VFO is fairly stable as is. At room temperature, the drift over a two-hour period, starting cold, was on the order of 300 Hz. The frequency variation over wide temperature ranges has not yet been investigated.

Harmonics were a problem with this VFO. Without the half-wave filter, the second and third harmonics were only 15 and 20 dB down, respectively. The third harmonic created a bad spur, since 15 MHz is not that far down on the skirts of the first mixer's filter. Adding the half-wave filter brought the second harmonic down to 30 dB and the third down to 48 dB, at which point the spur problem went away.

**Mixer Modules**

The 14- and 50-MHz mixers shown in Fig. 8 are identical, with the exception of the filters. All ports of the double-balanced mixers are padded to insure that they see 50 ohms. If not, the mixer will most likely not perform properly. The output of the filter is also padded for essentially the same reason, to guarantee that the filters are properly terminated at all frequencies. The post-filter amplifier is a broadband design built around the 2N5179. It has more than enough gain to bring the signal back up to a usable level. The IF signal into the modules is held to 0-dBm max, with an LO level of about +13 dBm. This is done to insure that IMD products are at least 30 dB below full output, which runs between 0 and +3 dBm.

The mixer modules turned out to be the weak link in the chain as far as IMD products were concerned. Since access to a spectrum analyzer was limited, further work on the mixers had to be curtailed. I suspect that substituting a 2N3866 for the 2N5179 and increasing the collector current to 30-50 mA would improve the IMD specs considerably.

**LO Module**

The LO module (see Fig. 9) consists of four oscillators...
I started out by trying to diode switch the crystals but was never really happy with the results. I ended up building four separate oscillators and switching the power to the desired oscillator. The secondaries of the tuned circuits are diode switched so that they would not interact with one another and also to reduce the loading of the active oscillator. While this technique takes more components than other methods of dc switching, it is versatile in that the frequency range of the module is limited only by the bandwidth of the buffer amplifier since no compromises are required on the part of the oscillators. This is significant if you want to steal the circuit for an all-band exciter or receiver where the LO frequencies could vary considerably.

A "broadband" class-A amplifier is used to buffer the oscillators and raise the signal level. The 4:1 balun normally expected in the output has been replaced with a 2-pole filter in order to reduce oscillator harmonics. The harmonics were all better than -55 dB with respect to the LO signal.

A single stage of amplification was used in the 50-MHz PA module (see fig. 10). This was all that I needed to get the signal up to the 50-mW level. It uses a broadband, class-A amplifier into a 2-pole filter. The output is sampled and rectified for use in a peak detector.

I used an MSC CATV transistor because I had some on hand and I preferred to use a stud mount package. A 2N3866 would probably work just as well at a lower cost if you use adequate heat sinking.*

The transistor is biased for approximately 100 mA of collector current. The output filter is similar to the

*MSC transistors are available in stud mount (H002) or TO5 package (H003) for $5 plus $1.50 handling for one H002 or two H003s. Send a certified check or money order and your callsign to Ham Trans, Box 383, South Bound Brook, New Jersey 08880. No phone orders.

fig. 6. Schematic of the SSB filter and amplifier module. F1 is a KVG 9FA, 9FB, or equivalent, 9-MHz crystal filter. The terminating resistors and trimmers (R1, R2, C1, and C2) must match the filter used. L1 is thirty-eight turns of no. 28 AWG (0.3 mm) wound on a T75-2 core. The tap is located eight turns from the cold end.

fig. 7. Schematic of the VFO used in the 50-MHz exciter. The VFO is much bigger than would be expected, since it is based on an ARC-5 tuning capacitor. L1 is thirty-two turns of no. 26 AWG (0.4 mm) wound on a T50-6 core. L2 is forty turns of no. 26 AWG (0.4 mm) also wound on a T50-6 core with the tap at fourteen turns from the cold end. The inductors in the half-wave filter, L2 and L3, are both seventeen turns of no. 24 AWG (0.5 mm) wire wound on T50-6 cores.
one used in the second mixer except that the coupling capacitor was increased to reduce losses. It is tuned for maximum signal at 51 MHz.

**peak detector**

A peak detector is used in place of the usual output detector. This allows the meter to "catch" the voice peaks on sideband so that the operator can tell if he is exceeding the drive-level limit. The output voltage as seen in the schematic, fig. 11, from the detector is fed into U1, a unity-gain follower. As the voltage rises, the output of U1 follows and charges up the capacitor through the diode. As the input drops below the voltage across the capacitor, the diode becomes back biased, preserving the voltage on the capacitor. Since the op amps have mosfet inputs, their input resistance is on the order of 10^12 ohms and the discharge time constant is determined by the resistor across the capacitor and the capacitor's internal leakage. If a Mylar capacitor is used, the time constant can be extended into the minutes range. I used a time constant of 30 seconds because my meter is a heavily damped instrumentation meter and it takes a while to get to full scale. I would recommend a time constant of about 10 seconds (which requires a resistance of 10 megohms). Do not substitute a different op amp for the CA3130s. They were picked because their inputs will operate right to ground and their outputs will go to within millivolts of the supply rails.

In use, the operator tunes up the transmitting chain with the exciter in the CW mode and the peak detector switch set to the "average" position. The meter is set to a convenient reference point with the sensitivity pot and then switched to the "peak" position. The meter will then catch the peaks of the sideband, giving the operator a fairly accurate indication as to whether or not he is exceeding the limit.

**PTT control**

The exciter is turned on by either the PTT switch on the mike or by a PTT input jack on the back of the chassis (for a foot switch). If either jack shorts to ground, the transmit relay is energized and the supply voltage is applied to the modulator, mixer, and PA modules (see fig. 12). I used a relay instead of a solid-state switch for compatibility with other devices in my transmit chain. However, there is certainly no

---

fig. 9. Diagram of the local oscillator module which provides four crystal-controlled frequencies. Each oscillator is tuned by the small trimmer in the collector circuit: L1 is twenty-five turns of no. 24 AWG (0.5 mm) on a T37-10 core. The secondary is two turns wound over the cold end. L2 and L3 are both wound with twenty-five turns of no. 24 AWG (0.5 mm) wound on a T37-10 core. The tap on L2 is eight turns from the cold end, with the tap on L3 at five turns from the cold end. The resistors in the T-type attenuator are selected to provide a 20-mW output.

fig. 8. Schematic of the mixer and bandpass-filter module. The mixer is an SRA-1. T1 is ten turns of no. 26 AWG (0.4 mm) wire wound on a Ferroxcube 266T125-4C4 core.
reason why a power transistor couldn’t be used in place of the relay.

counter overview

The digital counter counts each of the oscillators in sequence and then displays their sum. Since the heterodyne scheme for the exciter is all additive, the sum of the oscillators is also the final signal frequency. The counter was broken down into a five functional module as an aid in troubleshooting. All of the modules except the displays and their decoders are mounted under the chassis and all power and signal leads associated with the digital circuitry are well filtered.

A single LM309K is used to regulate the counter. It runs hot and should be well heat sunk. Most of the chips, with the exception of the oscillator and the front-end ICs, could probably be replaced directly with their low-power Schottky (74LS) equivalents without any problems and with a very significant savings in power dissipation. It is one of the things I plan to do in the future.

time base

A 1-MHz TTL oscillator is used to drive four decade dividers (see fig. 13). The output of either U5 or U6 is selected by the state of TP2. If this point is grounded, the counter will display to the nearest 1 kHz and the update rate will be twenty-five times a second. If this point is high, then the readout will be to the nearest 100 Hz and the update rate will be 2.5 times a second.

The exact frequency of the time-base crystal is set by a trimmer, C1. I had the advantage of owning a precision counter which I used to count the time base frequency at TP1. An alternative approach would be to loosely couple TP1 to your receiver and then beat one of the harmonics to WWV. The crystal I use is one that came from a digital communications board, but it works well. If I were starting from scratch, I would add a divide-by-four stage and use a good quality 4-MHz crystal. For an exciter though, the counter is accurate enough.

control logic

The control logic takes the reference signal from the time-base generator and creates all the control signals for the entire counter. The circuit is more complex than most for two reasons. The first is that the counter must gate in three separate signals and add them together. The second is that I have had some bad experiences using differentiators as sequential pulse generators, as is sometimes done for the load and reset pulses. This type of circuit can often lead to noise problems and I preferred to avoid them. With the illustrated control circuit (see fig. 14) there is a finite “quiet” time between all of the gating pulses, the load, and the reset pulses (see fig. 15).

The time-base input is inverted by U5 and also divided by two in U2A. Clock 2 is fed to U1, a modulo-six divider. When the fifth state is decoded by U6, pin 9 of U2B goes high, resetting the divider. The next clock 2 pulse causes pin 9 to return low. The result is that pin 8 of U2 creates a gating pulse equal to clock 1 divided by ten with a “quiet” time equal to one clock 2 period.

U3 is wired as a modulo-4 divider. Each of the
states of U3 is used for one of the counter functions shown below:

<table>
<thead>
<tr>
<th>state</th>
<th>U3:3</th>
<th>U3:5</th>
<th>action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>high</td>
<td>low</td>
<td>G1 high during GE</td>
</tr>
<tr>
<td>2</td>
<td>low</td>
<td>high</td>
<td>G2 high during GE</td>
</tr>
<tr>
<td>3</td>
<td>high</td>
<td>high</td>
<td>G3 high during GE</td>
</tr>
<tr>
<td>0</td>
<td>low</td>
<td>low</td>
<td>load high during (GE-not and CK1-not and CK2-not) reset high during (GE-not and CK1-not and CK2)</td>
</tr>
</tbody>
</table>

U3 is updated to its next state by the clock pulse from U6B. By using a state counter and the four clocking phases, race conditions were avoided and the counter worked the first time it was turned on (wiring errors excepted!).

prescaler

The counter front-end board contains the count enable gates and a prescaler (fig. 16). While it is a simple board, caution should be taken in its layout and construction. Don’t forget, it will have a 39-MHz signal applied to one of the inputs. Each of the oscillators is applied to a section of U1 for squaring up and buffering. The logic signals are then gated and ORed before being prescaled. In order to use the 50-MHz clocking rate of the first stage, U3 is wired divide-by-two, then five. Although pin 12 U3 is no longer symmetrical, it still has a period equal to ten times the input period. That’s all that really matters since the 7490s used in the main counter are edge-triggered.

The signals from the oscillators are buffered by sections of U1. These buffers are biased so that their outputs just start to go low. This minimizes the amount of rf voltage needed to toggle them. The analog inputs are decoupled from the digital circuitry by the baluns in order to limit the chance of ground loops reflecting digital noise onto the transmitted signal.

There is some digital noise, however. I believe it is the result of not using high-impedance buffers to drive the timing gates. The noise is way down though; it couldn’t be seen on the spectrum analyzer used to measure the transmitter’s performance.

main counter

The main counter board, as seen in fig. 17, uses a
display module

This module consists of two boards, one for the displays and one for the decoders and the current limiting resistors (see fig. 18). Common-anode displays were used; any of the MAN-1 compatible types should work.

The ripple-blanking feature was used to disable the leading zero when the counter is gated for a 1-kHz

![Diagram of the display module](image)

fig. 16. Diagram of the preamp/scaler circuit. Individual sections of the 74S00 and 74S10 provide the buffering and gating of each signal. The 74196 acts as a prescaler, dividing each frequency by ten prior to the main counter. L1, L2, and L3 are wound of Fair-Rite type six balun core. The primary and secondary are both three turns of no. 30 AWG (0.25 mm) wire.

fig. 17. Schematic of the main counter and data latches. Each latch IC provides six latches, reducing the number of ICs by two.

LSD. I set up the display with two decimals to simulate the commas between the MHz, kHz, and Hz digits. This was done for convenience only, since I always have the display reading out to 100 Hz.

module construction techniques

All the analog modules, except the VFO, are 10 x 6.4 x 2 cm (4 x 2.5 x 0.75 inch); the VFO is 11.5 x 8.9 x 7.6 cm (4.5 x 3.5 x 3 inches). See fig. 19. They are all constructed from double-clad circuit board which is soldered into a box. A 4-40 (M3) brass screw (with

![Diagram of module construction techniques](image)
fig. 18. The display module contains the LEDs, limiting resistors, and data decoders. The MAN-1 type LEDs are mounted on a separate board behind the exciter’s front panel. The limiting resistors are mounted on component carriers.

the head removed) is soldered into each corner of the box as a means of attaching the cover. For mounting, 8-32 (M4) brass nuts are soldered on the inside (bottom) of the box and the box is then screwed onto the main chassis with 8-32 (M4) screws. I made all the boxes by hand using a hacksaw, a nibbling tool, and a file. It takes about an hour to make up a box. I finally had a friend punch out a bunch of covers and sides for me, which saved a lot of time and made the whole project much more enjoyable.

I use a “standard” bread-boarding chassis which has a row of holes that allows the modules to be
fig. 19. Construction details of the analog modules. Each box is constructed from pieces of circuit board soldered into the desired shape and size.

mounted on 3.8-cm (1.5-inch) centers. The front of the chassis has a piece of angle with 4-40 (M3) clearance holes every 1.3 cm (0.5 inch). Whenever a pot or switch is needed, a small piece of printed circuit board is cut out and attached to the angle to form a "panel." This may seem like a lot of extra work, but it does have the advantage of keeping all the boxes "glued" together. When everything works, the modules are transferred to the final chassis and the breadboarding chassis is ready for the next project.

The modules are interconnected with hook-up wire or RG-174 coax, depending on the type of signal. A couple of ferrite beads were slid over each of the analog power leads. I used phono connectors on all but the output of the final amplifier module in the interest of cheapness and availability. I used a BNC as the final output connector for compatibility with my switching relays. I believe the phono connectors are fine for low-level work up to about 144 MHz. Beyond that, I prefer to use BNC connectors.

The exciter is built on a 33 x 17.8 x 5 cm (13 x 7 x 2 inch) chassis which is mounted to a 48.3-cm (19-inch) rack panel on 10-cm (4-inch) standoffs. This was done to allow plenty of room for controls. Most of the mechanical work was done with commonly available hand tools. The exception was the red display filter which was machined so that it would look nice when mounted on the chassis.

digital construction techniques

The digital modules were built on perforated G-10 fiberglass boards (fig. 20). Power and ground rails are wired with no. 20 AWG (0.8-mm) wire on the bottom of each board. Individual IC sockets are wired into the rails with no. 24 AWG (0.5-mm) solid hookup wire. All signal wiring was wire wrapped.

The power rail is bypassed to the ground rail at each row of sockets with a 0.01-pF ceramic capacitor. The power and ground rails of all the boards are brought back to a common power and ground point. Interboard wiring is done with hookup wire. The outputs from the counter latches were connected to the decoders via 0.001-pF feedthrough capacitors. Ferrite beads were also used on the latch side of the caps.

The story not usually told in most construction articles is the grief encountered in building the equipment. I have had my share with this exciter. There was a growing pile of copper clad boxes as I tried out different and not so successful ideas. The modular approach saved me a lot of time by allowing the development and comparison of different circuits which performed the same function.

acknowledgments

I would like to acknowledge the helpful comments of Joe Reisert, W1JR, and Hank Cross, W100P. Many of their suggestions were incorporated into the final design of the exciter. Thanks also to Javed Bukhari, AP2JB/W1, for manuscript critiques.

references


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compact loop antenna
for 80 and 40 meter DX

Quad loops make good low-band DX antennas for those with restricted space — a look at several loop configurations and their advantages

No question about it: the challenge of the five-band DXCC award has created great interest in low-band antennas and has inspired experiments with a wide variety of vertical and horizontal antennas including dipoles, monopoles, delta loops, quad loops, and slopers. Antennas with good performance on 80 meters are typically too large for a city lot. For example, vertical monopoles require extensive ground systems, and horizontal dipoles should be at optimum height. For low-angle radiation, optimum height is on the order of a half wavelength. On 80 meters this is clearly out of the question for most Amateurs.

My home is on a suburban lot where high towers and an effective ground system are impossible. These constraints led to the development of a compact, horizontally polarized loop antenna which has demonstrated competitive performance on both 80 and 40 meters.

loop antenna close to ground

Fortunately, the quad loop offers promise of reasonably good DX performance at low height. Experience has shown that the performance of a Yagi and a quad are roughly the same with respect to height.* There is some evidence, however, that at very low heights the quad may outperform the Yagi. The reason may be that loops contain the electromagnetic field better than dipoles. For whatever reason, the closed loop configuration is relatively immune to nearby objects. The loop configuration also may be relatively immune from some of the effects of nearby ground. For these reasons, the quad loop appears to be a good choice for low band antennas if used with supporting structures within the means of most Amateurs.

L.V. Mayhead, G3AQC, described the performance of loop antennas at low heights in an excellent article, "Loop Aerials Close to Ground," in the RSGB journal, *Radio Communications.* In his article, Mayhead described experiments with a variety of full-wavelength loop antennas close to ground. He modeled the antennas at 470 MHz for radiation-pattern measurements, then constructed two of the best

By George M. W. Badger, W6TC, 341 La Mesa Drive, Portola Valley, California 94025

*Wayne Overbeck, N6NB, in his article "Quads vs Yagis Revisited," (reference 1), states on page 17: "The result was conclusive: the relative performance of the quad and Yagi was exactly the same at both 7.6 meters (25 feet) and 21.3 meters (70 feet)! This was true on zero-angle line-of-sight signals, high-angle 'short skip,' and on long-haul DX signals." There was no height at which the quad's relationship to the Yagi changed." (Italics mine). Editor.
configurations for 75 meters and compared them with a dipole at comparable height. Serious low-band DXers should read this article. It offers further evidence that loops make good low-band DX antennas when height is restricted.

**evolution of a two-band loop**

An 80-meter quad loop is shown in fig. 1. The total distance around the loop is a full wavelength. The feedpoint is at the bottom. When used on 80 meters, the current maxima are at the center of the top and bottom spans of the loop (solid circles). Maximum radiation occurs from these two in-phase current maxima. The radiation is horizontally polarized.

When the loop in fig. 1 is operated on 40 meters, four current maxima appear (open circles). The antenna is resonant on the second harmonic; however, the 40-meter current maxima tend to cancel. The radiation pattern deteriorates into many vertical-

![fig. 1. Full-sized 80-meter quad loop showing current maxima for 80 meters (solid circles) and current maxima for 40 meters (open circles). Arrows show relative phase.](image)

...and horizontally polarized lobes. For this reason, two-wavelength closed loops perform poorly, so quad loops are rarely used on the second harmonic.

**radiation resistance**

The area of the loop shown in fig. 2 is half the area of a full wavelength 80-meter quad loop. It is twice the area of a 40-meter quad loop. For this reason, on 40 meters, the radiation resistance is high, the efficiency is high, and the bandwidth is broad. The measured impedance at the open-wire line terminals is about 120 ohms. On 80 meters the loop is only half the area of a full-wavelength 80-meter quad loop. Therefore, the radiation resistance is lower and the bandwidth is narrower. On 80 meters the impedance at the open-wire line terminals is about 50 ohms, thus presenting a good match for standard 50-ohm coaxial cable.

Neither the shape nor size of the loop, nor the length of the open wire line, is of particular impor-

![fig. 3. The full-sized loop further distorted into the familiar delta-loop configuration. The 80-meter current maximum is at the top. The 40-meter current maxima add in phase.](image)
ends of the top section slant down to the patio overhang and follow the overhang to the feed point. The lengths of wire are in different planes. Last summer, with the beautiful tall pine trees at Lake Tahoe as supports, I built the symmetrical delta loop shown in fig. 4. Figs. 5 and 6 show the SWR plots.

**bandwidth**

In general loop antennas have more bandwidth than thin dipoles or monopoles. The antenna described here is no exception. The loop is oversize on 40 meters (1 ½ wavelengths), so its bandwidth is extremely broad. The SWR doesn’t exceed 1.3 over most of the band and doesn’t exceed 1.5, even at 7.3 MHz (see fig. 6). On 80 meters the loop is only ¾ wavelength. Even with this reduced size, the bandwidth is still satisfactory. The 2.0 SWR bandwidth is 250 kHz, substantially more than the 150 kHz typical of an 80-meter dipole or inverted V. Installing the antenna in a rectangular configuration rather than the delta loop configuration further improves bandwidth.

**dual-band feed**

A 75-ohm, quarter-wave transformer matches the 50-ohm coaxial transmission line to the 120-ohm input impedance of the loop on 40 meters. On 80 meters, the transformer is only one-eighth wavelength long and doesn’t materially affect the 80-meter match. Thus the antenna operates on both bands with a common transmission line.

The two-band feed system (fig. 4) consists of any length of 50-ohm line, a quarter wavelength (on 40 meters) of 75-ohm line, and the open-wire line. A simple balun is included in the 75-ohm matching section.

**building the 80/40-meter loop**

To build the 80/40 meter loop, start with a total length of 87 meters (285 feet) of copper wire. The flat top should be roughly 26 meters (85 feet) long. Make the open-wire transmission line between 6 meters (20 feet) and 11 meters (35 feet) long. The wires should be separated by about 10 cm (4 inches). Spreaders can be made by cutting 1.6 mm (1/16 inch) fiberglass spreaders...
into 1.3 x 11.5 cm (½ x 4½ inch) lengths drilled at each end. Wire these strips onto the open-wire line at roughly one-meter (3-foot) intervals. Make the 50-ohm coaxial transmission line from any length of RG-8/U or RG-58/U line, depending on the power level. On 80 and 40 meters RG-58/U is adequate up to several hundred watts input. For a full kilowatt use RG-8/U.

Make the matching transformer with RG-11/U or RG-59/U coax cut to 6.95 meters (22 feet 9 inches), the correct length for solid polyethylene insulation. If you use foam polyethylene insulated coax, the correct length is 8.41 meters (27 feet 7 inches).

A simple and adequate balun can be added at the loop end of the 75-ohm matching transformer by wrapping ten turns of the coax into a coil. The coil diameter should be ten to fifteen times the outside diameter of the cable used. Place the coil balun as shown in fig. 4 and use tape to hold it in shape. Connect one end of the quarter-wave transformer to the open-wire transmission line with alligator clips.

Using the alligator clips, adjust the open-wire transmission line length until the SWR curve is well centered for 75-meter SSB. See curve A, fig. 5. Now plot an SWR curve over the 40-meter band. You'll find it broad and well centered (see fig. 6). When you're satisfied with the 75- and 40-meter SWR, remove the excess wire and solder the 75-ohm coax to the open wire line.

From curve A of fig. 5, notice that the SWR climbs excessively in the CW portion of the 80-meter band. Use the extra length of line and the switch shown in fig. 7 for 80-meter CW operation and adjust the extra length of line for optimum SWR over the CW part of the 80-meter band. (See fig. 5, curve A.) Add the switch and line close to the coax at X in fig. 4. Use a relay or, because point X is near ground level, a switch mounted in a convenient location.

**W3GNQ loop**

W3GNQ decided to erect his antenna in the general shape of fig. 2; his antenna is shown in fig. 8. The rectangular shape and short open-wire line result in the SWR curves of figs. 9 and 10. The bandwidth of Dick's antenna is broad enough so he can operate on 80, 75, and 40 meters with no switching.

**Bandwidth and terminal impedance**

To gain an understanding of how the input impedance and bandwidth vary with loop size and shape, I made scale models of various loop antennas. All loops were 406 cm (160 inches) in total length including open-wire line. All were resonant between 75 and 90 MHz. I measured terminal impedance and relative bandwidth on a variety of configurations with a Hewlett-Packard RF Vector Impedance Bridge. The curves of figs. 11 through 14 show the data. Fig. 11 shows how the terminal impedance and relative bandwidth change with the ratio of square loop size to open-wire line length. When the ratio of the total length of the loop to the length of one side is four, the open-wire line length is zero, and the loop is one wavelength in circumference. The input impedance

![SWR Curve](image)
is 145 ohms. As the loop decreases in size, the open-wire line becomes longer and the terminal impedance drops. It reaches 50 ohms at $L_t/L_s$ (total length to side length ratio) between five and six.

I measured the relative bandwidth of the models by recording the impedance-bridge frequency above and below resonance at the +10 and −10 degree points as read on the phase-angle meter. Of course, bandwidth improves as the loop increases in size.

Data taken on a delta loop model is shown in fig. 12. Here the open-wire line length was held constant while changing the ratio of top span length to total length. When the terminal impedance is 50 ohms, the bandwidth is the same as that of the square loop when proportioned for the same input impedance (fig. 11). The square configuration, however, is capable of greater bandwidth. Furthermore, you can infer from the two sets of curves that a rectangular antenna (fig. 8) will have better bandwidth than either a square or triangular loop. The bandwidth shaped quad is the preferred choice because of higher impedance and greater bandwidth.

Antennas near ground at 3.5 MHz will have a terminal impedance different from that of the scale models because of the effects of nearby ground. I've tried none of the antennas of figs. 11 through 14 at full scale, so the convenient relationship between 75-
and 40-meter resonant length may not hold for these configurations. Therefore, antenna designs based on these curves may require further experimentation.

**advantages of the W6TC compact loop antenna**

1. The antenna is an excellent radiator on both bands, as theory predicts and as proven in practice.
2. The antenna provides a good match for 50-ohm line on both 80 and 40 meters.
3. The antenna is small compared with other 80-meter antennas. The largest dimension is substantially less than 30 meters (100 feet).
4. The antenna is broadband.
5. The antenna can be supported on relatively low supports and still give reasonably good performance.
6. The shape isn’t critical. The antenna can be put in the delta, square, rectangular, or any similar open configuration. It can be installed on a single metal tower in the shape of a diamond or inverted delta.
7. The antenna is horizontally polarized, so a ground system is not required.
8. Only one dimension, the overall length, is critical. This adjustment is made from the ground; it’s not necessary to take down the antenna for adjustments.
9. An antenna tuner is not required.

10. The center of the long span of the delta-loop version doesn’t support a heavy feedline.

**conclusion**

There’s no substitute for full-size antennas supported on tall towers. With low band antennas, “the higher, the better” has always been true. However, if you have room for only one small, low antenna for 80 and 40 meters, this antenna may be your best choice. I hope the examples of full-size antennas and the scale-model data presented here will provide design guidance for your version of the antenna.

Experience with this antenna on the air has been gratifying. While evaluation of low-band antennas is always highly subjective, the W6TC loop appears to be quieter on receive and seems to punch through the pileups better than other low-band antennas tried at W6TC. Working DXCC on 80 meters is difficult from the West Coast. However, after building this antenna, the new countries seemed to come a little easier. Dick, W3GNQ, finds the antenna especially competitive on 75 meters. While direct A-B comparisons were never possible because of space limitations, this antenna, in my opinion, has that extra edge that only on-the-air experience can discern.

**references**


*ham radio*
An addition to the
talking digital
frequency readout
described in an earlier
issue of *ham radio*

It was no time at all after completing the talking frequency readout unit that I recognized the desirability of using its voice for Greenwich Mean Time (or UTC). The investment in the speech synthesis module had already been made and the original readout box was not crowded, so I investigated digital clocks.

**clocks**

The first clock chip I acquired didn’t have BCD output and was meant to drive 7-segment LEDs. Although I located an interesting chip that could have converted the clock data to BCD, I thought its price in unit quantities was too high — above my budget for the whole project. Later I discovered the MM5312 clock chip that sells for $3-$4, which has both BCD and 7-segment data outputs. The MM5312 doesn’t read seconds or have all the bells and whistles, but it is a true 24-hour clock on a 24-pin chip. A Radio Shack 5082 miniature 5-digit readout allowed me to get familiar with its operation. (Ignoring the third common cathode makes the middle digit blank.) The visual readout is optional and may be omitted, if desired.

**circuit description**

The talking clock schematic is shown in fig. 1. I planned to use whatever I could for the original circuit to provide the data sequencing immediately after completion of the previous word, regardless of the word time duration. It would have been possible to obtain both frequency and time in response to each inquiry, because the 74193 can control a sequence of sixteen data positions. However, because of the sentence-shortening features of the frequency readout, it seemed unnecessarily complicated to produce a skip past the omitted positions at the end of the sentence. Instead, I chose to provide the clock data in the 0 through 3 (first four) data locations. Stopping after the first four is easiest: merely invert the C address line with a spare gate on the original board and substitute its output for the six- or eight-word stopper.

Two other poles of the frequency/time switch are used to make sure the sentence starts at the 0 address. The switching is ahead of the provisions for deleting the first word on the single-digit MHz bands and ahead of the MHz-delete switch, which delays the start past the first decimal point. Thus in the time mode, all four 74193 preset lines are grounded.

The circuit that causes the voice to say point in the third and seventh locations (2 and 6) is disabled by switching the fifth data-line input of the voice to ground when in the time function; otherwise, the third digit of the time readout would be really strange and come out of the unused vocabulary of the S2A.

**switching logic**

We must still switch the data itself between the two sources, readout and clock. A 74157 multiplexer must have been designed precisely for this job (fig. 1); it acts as a 4-pole, 2-position switch for digital data in TTL form. When its pin 1 is connected high (to +5 volts), the time data at pins 11, 13, 3, and 6 appears at pins 9, 12, 4, and 7 respectively. When it is low (at ground), the data at pins 10, 14, 2, and 5 from the readout is passed through to the same four output pins. Its power pin, no. 16, must have +5 volts present in either mode. Power may be removed from the 7404, 7400, and 7432 while in the readout mode. Power to the 74193 and other chips on the interface board is required in both modes, since the 74193 and gates are required to step from one digit to the next at its command.

**data sequencing**

The path is now cleared for clock data to reach the speech module, and four defined sequential slots are reserved for it. As is usually the case, the most inter-

By Raymond W. Brandt, N9KV, 824 N. Marion Avenue, Janesville, Wisconsin 53545
Testing problems come up last. I'd visualized four sets of BCD data available at the same time, which I would have to multiplex, as with the frequency data. But when I examined the 5312 only one set of BCD terminals existed, indicating that the data must somehow be internally multiplexed. Great! That should hold the chip count down. But the problem then was how to control the internal multiplexer. In the normal application, with visual readout, there's no need for this as long as the rate is high enough so that all four LEDs glow simultaneously. But I can't use parallel data for words that have to be said in sequence — and the sequence must be controlled.

The four clock terminals, 18 through 21, go low in sequence so that the appropriate digit LED will glow when the data for that digit is present on the common data lines to all four digits. These four terminals can at least be used to tell which digit's data is appearing on the output BCD data lines at any point in time.

**clock mux rate**

The clock multiplexing rate is determined by an external RC network connected to pin 22. Looking at this signal on a scope, we see a beautiful repetitive sawtooth waveform. If you use a large capacitor, you'll notice that the four digits light up in sequence, from right to left in backward order. A bit scary. If we ground pin 22, killing the sweep, the readout stops in one of the four positions, more or less at random, but
nevertheless depending on when we do it. A method for controlling the internal multiplexer was evolving. (Maybe I can work out an educated screwdriver to short it out at just the right times.)

A scheme materialized that allowed the multiplexer to scan whenever the clock output data didn’t coincide with that requested by the 74193 address position. We want the tens of hours first and the minutes last. When the scanner comes to the correct digit, the multiplexer parks there until it has been pronounced. At the end of the word, the busy line from the voice says, “OK, I’m through,” and the 74193 is advanced to the next address. This action releases the scanner lock and it roams (in the wrong direction), looking for the next appropriate digit. It skips over the next two digits presented to it and locks on the third, which is to the right of the last one presented.

Table 1 does a better job of explaining the operation of the circuit. When one of the 7432 positive OR gate outputs goes low, a diode connects it to the scanning waveform and locks it into position. (A positive OR gate has an output low only when both its inputs are low.)

The address is available from the 74193 in BCD form; we need only the A and B lines to describe the first four addresses. A pair of inverters (7404) and four NAND gates (7400) convert this data to decimal form. Since a NAND gate produces a low output only when both inputs are high, we can play the game four ways and come up with combinations minus A minus B for 0, plus A minus B for 1, minus A plus B for 2, and plus A plus B for 3.

If we apply each output to a separate NOR gate input, then choose the correct line from the four clock terminals, 18 through 21, the 7432 section that will stop the scanner on tens of hours must have the tens of hours terminal (clock pin 18) as one input and the first address, 0, as the other.

It seemed strange to go to all the trouble of sorting things out through two sets of gates only to wind up connecting all four signals to the same place with diodes. But that was pretty much what I started out looking for — the smart screwdriver. Looking at each 7432 output separately, you should see a square wave that is down one-quarter of the time if you slow it down with a 0.1-µF capacitor across the 0.001-µF.

The visual display stops when the scanner stops, so it’s easy to establish what’s going on. I used silicon diodes to combine the four signals.

summing up

The gating circuits involving the 7475 latches (reference 1) in the frequency interface board were not modified. I found no error by letting the counter waveform control the start latch, and the reset and address stepping functions were just what I wanted. I added a minimum-design power supply to power the clock chip, which of course is on continuously to maintain time.

Three pushbutton switches permit setting the clock. Upon power interruption, the clock starts running from 0000. When the fast button is pressed, time speeds by at an hour-per-second rate; the slow position advances time at a minute-per-second rate. The hold button permits stopping the clock without resetting.

When listening to WWV, let the clock run to a minute ahead of real time and depress the hold button until the time catches up. On the next minute from WWV, note how many seconds fast you are and hold for a similar period, and you’ll find you’re right on to the second. The voice repeat switch comes in handy when setting the clock.

Printed circuit boards for the talking readout have been completed and check out. They are available from O.C. Stafford, 427 South Benbow Road, Greensboro, North Carolina 27401. At the time of submission, design of a circuit board for the talking clock addition, incorporating the four chips and diodes shown in the article, has been initiated by O.C. Stafford.

Since the unit now performs two functions rather vital to the visually handicapped Amateur, it’s been dubbed the “Second Operator.” Let your fingers do the talking.

references

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the handi-counter

A high-frequency counter featuring the Intersil 7216-D built into a hand-calculator case

This is a fun construction article. It involves mating Intersil's new ICM-7216-D 10-MHz counter chip into a small hand calculator case. Frequency limit is ±550 MHz depending on device options.

I purchased one of the first 7216-D chips. In checking out its many features, I needed an LED display. I had recently purchased two hand calculators in a Poly-Paks penny sale. As I robbed the 9-digit display, the possibility of using the case for a small portable counter evolved into the handi-counter.

design criteria

A small pocket-type counter is designed with sensitivity, frequency range, and accuracy to use for emergency frequency calibration of TR-22 handi-talkies. To meet these requirements, a bare minimum of parts evolved into the circuit of fig. 1 with the following specifications:

- Frequency limits: ±250 MHz
- Sensitivity: reads TR-22 at 0.9 meter (3 feet)
- Accuracy: ±100 Hz or ±10 Hz
- Voltage and current: 5 volts at 137 mA
- Readout: seven digits at 1.0-second gating; eight digits at 10.0-second gating

The handi-counter frequency response may be extended to around 600 MHz as shown in fig. 2,* in which a 74196 chip (U2) is substituted for the 74LS90 (U2 in fig. 1). The specifications for the circuit in fig. 2 are as follows.

- Frequency limits: ±550 MHz
- Sensitivity: 100 mV at 450 MHz
  50 mV at 146 MHz
- Accuracy: same as the circuit of fig. 1
- Voltage and current: 5 volts at 185 mA
- Readout: same as the circuit of fig. 1

fig. 1. 250-MHz counter using the Intersil ICM-7216-D counter chip.

By R. M. Naglee, K5WKQ, 2402 Maxwell, Midland, Texas 79701

*A PC-board layout for the 600-MHz version is available from the author. Please send a self-addressed, stamped envelope.
The circuits in figs. 1 and 2 are the same old standbys that have been used for years, so no credits are given. The 11C90 divides the incoming signal by ten into the 74196 or 74LS90, once more dividing by ten into the 7216-D.

construction

I used the Heathkit laboratory breadboard in the investigation of the many features available in the 7216-D. I used only a few features of the 7216-D (more later about these). Both circuits were thoroughly checked in breadboard fashion. I decided on the circuit of fig. 1 for my counter; you may wish to do otherwise. I used the small LED readout display from the calculator, fig. 3.

The connections for this display were verified in the following manner. I soldered 12.5-mm (0.5-inch) lengths of No. 22 AWG (0.6 mm) wire into each of the pins and plugged the display into the breadboard. I connected a 220-ohm resistor to the 5-volt supply. Then in a trial-and-error method, using a ground wire and the current-limited 5-volt wire, I located each digit and segment. For optimum brilliance and minimum current, 220-ohm current-limiting resistors were used. The frequency-determining capacitors were used for the 10-MHz crystal I had on hand; yours may be different — start out with 39 pF in each.

PC board. I used the old PC board with cutout for display from the calculator to get dimensions. I designed the new circuit board in pencil on grid paper in reverse. Then, using a piece of clear Mylar as a base, I used rub-on sheets for all ICs and pads, following the pencilled design. I used a Keuffel and Esser (K&E) size 00 LeRoy pen and India ink to connect the pads. This was my first experience using the positive method in PC work, and I was pleasantly surprised at the results.

The next step was to flip the clear Mylar base, placing the image next to the emulsion side of a presensitized fiberglass board. I used a piece of clear
ICM 7216-D counter IC

Fig. 1 shows all four available gates. Only two are used in my counter. Pads for additional gates were provided for future use. The pinout of the 7216-D is correct; pins 4 and 5 are digits 3 and 2 as shown. Calibration was for cold starts; that is, no warmup time because for my use the counter is used only for short intervals.

These circuits use only a portion of the capabilities of the 7216-D. During breadboard design all of the features were investigated. The device has such a potential that I've ordered another chip for a counter to be used in my station. It will count between $0.1$ Hz and 600 MHz with a TXCO crystal. The ICM 7216-D features:

1. Frequency measurement from dc to 10 MHz (mine went to 12.5 MHz)
2. Output drivers will drive large common-cathode LED displays plus overflow LED
3. Selectable decimal points
4. Leading zero blanking
5. Eight-digit multiplexing outputs
6. Single 5-volt supply
7. Either 1- or 10-MHz crystals
8. Selectable 0.01, 0.1, 1.0, or 10.0 second gating times
9. Display hold
10. Display blanking

Power supply. Four ni-cad AA cells with 450 milliampere-hour ratings were connected to the existing charger plug in the calculator case. I used a small plastic battery holder.

Antenna. The antenna is a telescoping type, which is available from Radio Shack stores. It's bolted to a Bakelite bracket, which is cemented to the case.

circuit boards are available from Whitehouse & Co., Newbury Drive, Amherst, New Hampshire 03031.
The data sheet accompanying my chip was for the 7216-C, which uses a common anode display. The pinout was incorrect. Fig. 1 pinout is correct.

concluding remarks

I take no credit for any of the designs, only for putting it all together into a small calculator case. I'll be glad to answer all correspondence that includes a self-addressed, stamped envelope. For those interested in cost:

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<th>part</th>
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<td>10 MHz crystal</td>
<td>Circuit Specialists</td>
<td>2.25</td>
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<tr>
<td>Two calculators</td>
<td>Poly-Paks</td>
<td>2.98 each</td>
</tr>
<tr>
<td>Four AA nicads</td>
<td></td>
<td>5.95</td>
</tr>
<tr>
<td>One battery holder</td>
<td></td>
<td>0.95</td>
</tr>
<tr>
<td>One F. G. circuit board</td>
<td></td>
<td>1.95</td>
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<tr>
<td>Miscellaneous resistors and capacitors</td>
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<td>1.45</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$51.83</td>
</tr>
</tbody>
</table>

Watch out for Murphy's Law. The special switch in the calculator board was removed safely but went to pieces. Therefore, two spdt miniature toggle switches, on-off, and 1.0 or 10.0 second gating were needed.

ham radio

Like a legendary character of yesteryear, the new TRI-EX "L’IL GIANT" is destined to become a modern-day Superstar among crank-up towers that is. It’s strong, durable, yet lightweight. Four 12 foot (3.6m) sections, each with a solid 9½ foot (7.6m) telescoping overlap for added strength. Cranks up securely and effortlessly to heights of up to 40 feet (12m).

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building low-voltage dc power supplies

Not many years ago Amateurs and other electronics hobbyists who needed low-voltage dc power supplies used batteries or a simple, unregulated, ac-powered circuit. The most common commercial dc power supplies of that day were unregulated, poorly filtered, and often referred to as "battery eliminators." Such power supplies were used to service car radios and other mobile equipment but were not too good for much else.

Modern solid-state electronic circuits require regulated low-voltage dc power supplies. Many circuits will work best only when the dc power supply voltage is regulated. Oscillators, for example, won’t oscillate at the correct frequency unless the power-supply voltage is correct. Even where the absolute operating voltage isn’t critical it must remain at the value that existed when the oscillator frequency was adjusted, or the frequency will be different. If the oscillator power-supply voltage changes while the oscillator is running, the frequency will change. Imagine mobile two-way radio if your receiver local oscillator changes frequency enough to move off-channel every time you accelerated away from a traffic light! Sound unreasonable? I’ve seen many fm broadcast auto radios that shifted 4-6 MHz under acceleration when the internal voltage regulator (8 volts dc) was open.

In digital electronic circuits, especially the very popular TTL, the dc voltage must be regulated. The TTL family of devices will not operate properly or may burn out if the incorrect voltage is applied. TTL devices typically want to see 5 ± 0.25 volts, and in no instance must the voltage rise above 5.6 volts! In reality a narrower range of 5 volts ± 50 mV may be required. It seems that some TTL devices, especially complex or multifunction ICs, become flaky at less than 4.9 or 4.95 volts despite the fact that the manufacturer specified a wider range.

The need for regulated, low-voltage, dc-power supplies, then, is well established. What remains is to determine how to go about making such a supply with a minimum of effort and cost and with little or no sacrifice in utility. Before considering voltage-regulator circuits, let’s first review the principles of dc power supplies.

transformers

A transformer (fig. 1A) scales the 110-volt ac power main’s voltage to that required at the power supply output. In the case of our low-voltage dc supply, the transformer must be a step-down type; i.e., the secondary voltage, $E_s$, is lower than the primary voltage, $E_p$. Transformers operate only from alternating current (ac) sources and obey the following relationships:

$$\frac{E_p}{E_s} = \frac{I_s}{I_p}$$  (1)

Note from eq. 1 that the current ratio is the inverse of...
fig. 2. Rectifiers are a necessary ingredient in a dc power supply. (A) and (B) show rectifier current flow in terms of the ac input cycle. The output waveform (C) is unidirectional but pulsating (not pure dc). Because of the missing half cycles, the average voltage at a half-wave rectifier output is only 0.45 times the applied rms voltage, $E_{rms}$.

the voltage ratio. A transformer that steps voltage down will show an apparently equal step-up of current. This concept can, unfortunately, become confusing at times, because the actual secondary current, $I_s$, is determined by the secondary voltage, $E_s$, and the load resistance, $R_L$, connected across the secondary. The current step-up idea probably arises from the way eq. 1 is often presented:

$$E_p I_p = E_s I_s$$  \hspace{1cm} (2)

Eq. 2 tells us that $I_p$ will vary as changing load conditions cause $I_s$ to vary; as $I_s$ goes up $I_p$ will also go up to keep the equation constant.

Note that eqs. 1 and 2 contain no loss terms. Real 60-Hz power and filament transformers are efficient devices; efficiency ratings of from 95 to over 99 per cent are common. This fact justifies our use of simplified equations; the error terms are very small.

Transformers are rated by the primary and secondary voltages, the secondary current, and the primary VA rating; i.e., volts time amperes. In most cases the primary voltage will be either 110 volts, 220 volts, or will be selectable between 110 and 220 volts. The secondary voltage is determined by the turns ratio between primary and secondary windings. Both voltages are specified as root-mean-square (rms) values, but both the peak and peak-to-peak voltages become important in dc power supply design. The relationships between $E_p$, $E_{pp}$, and $E_{rms}$ are shown in fig. 1B.

Most transformers are built with the primary winding nearest the core. As a result, the primary is more easily overheated. The primary VA rating, then, limits the power available from the transformer. The primary VA rating cannot safely be exceeded. Some get away with it but this can’t be guaranteed. Only transformers built to military specifications are over-specified sufficiently to make the temptation to overrate reasonable.

rectifiers

Rectifiers (fig. 2) pass current in only one direction. This feature allows them to convert bidirectional ac into unidirectional pulsating dc. Fig. 2A shows a simple half-wave rectifier circuit. On the positive alternation of the ac cycle, the diode rectifier anode is positive with respect to the cathode, so current will flow. On negative alternations the rectifier is reverse-biased and no current will flow (fig. 2B). The output waveform (fig. 2C) although unidirectional is not pure dc; it is pulsating dc. Because of the missing half cycles, the average voltage at a half-wave rectifier output is only 0.45 times the applied rms voltage. To deliver any given level of voltage and current with this circuit requires a transformer with a primary VA rating 40 per cent higher.

Fig. 3. Full-wave rectifier using two diodes and a center-tapped transformer (A) and the double-humped waveform (B), which is characteristic of the full-wave rectifier.
fig. 4. Full-wave bridge rectifier (A). Output waveform is shown in (B) as in the full-wave rectifier, but average output voltage is 0.9 times 
the applied rms potential. The average output voltage produced by the full-wave rectifier is 0.9 times the applied rms potential.

A full-wave bridge rectifier is shown in fig. 4A. This circuit does not need the transformer centertap — but at the cost of two additional rectifier diodes. On one-half of the ac cycle, point A will be positive with respect to point B. In this case, diodes CR1 and CR2 are forward biased and CR3, CR4 are reverse biased. Current flows from point B, through CR2, \( R_L \) and CR1 to point A on the transformer. On the second half of the ac cycle the situation reverses; point A is negative with respect to point B. Diodes CR3 and CR4 are forward biased while CR1, CR2 are reverse biased. Current will flow from point A, through CR3, \( R_L \) and CR4 to point B.

Again we see the current flowing through load resistor \( R_L \) in the same direction on both halves of the ac cycle. The output waveform, fig. 4B, is the same as in the previous full-wave case. The average output voltage is 0.9 times the applied rms voltage.

The transformer used with the bridge circuit need not be center tapped. The zero potential reference point is designated as the junction of the anodes of CR2 and CR3. This point is labeled \( - \), while the junction of CR1 and CR4 is labeled \( + \). Some prepackaged bridge rectifiers (fig. 4C) have the dc terminals labeled with the + and − symbols while the other two terminals are labeled AC or have the sine wave symbol as shown.

The bridge rectifier will produce an output voltage two times that of the regular full-wave circuit (from the same transformer) because it uses the entire secondary winding on both halves of the ac cycle. But this is not for free, because the primary VA rating must not be exceeded. The secondary current of most center-tapped transformers is rated for the regular full-wave circuit. If a bridge circuit is used, then

fig. 5. Simple filter circuit (A) and the filter capacitor action on the pulsating dc input (B).
the available current is only one-half the rated current or we'll find that the primary VA rating may be exceeded. The full secondary rated current can be obtained only if the transformer is designed for use in full-wave bridge rectifier circuits.

Most electronic circuits can’t use pulsating dc but instead require pure dc (or nearly so). The pulsations are called ripple. Half-wave rectifiers produce a 120 per cent ripple component and a ripple frequency of 60 Hz (the ac line frequency). Full-wave rectifiers, on the other hand, produce a ripple component of only 48 per cent and a ripple frequency of twice the ac line frequency, or \((2)(60) = 120\) Hz, in the U.S.A.

**filters**

A filter circuit smooths the pulsations to produce nearly pure dc. In the simplest case, fig. 5A, the filter capacitor \(C_1\) is across the output in parallel with the load. The action of the filter capacitor is shown in fig. 5B. The heavy lines indicate the pulsating dc waveform without the filter, while the light lines show the output with the filter. Capacitor \(C_1\) will charge to approximately \(E_p\). But after the peak has passed, the charge will return to the circuit. The effect of returning the charge from \(C_1\) to the circuit is to fill in the area between pulses (shaded area, fig. 5B). The filter reduces the ripple component to a low percentage.

The value of \(C_1\) is critical to the performance of this circuit. In general the minimum required capacitance for \(C_1\) is higher in half-wave circuits than in full-wave circuits because of the higher ripple factor. For low-voltage full-wave supplies, the value of \(C_1\) should be at least 500 \(\mu F\) in small-current supplies (i.e., under 500 mA), and 1000 \(\mu F\) in supplies up to 1 ampere. A general rule of thumb in the over-1-ampere range is to make \(C_1\) not less than 1000 \(\mu F/\text{ampere}\), with some authorities calling for not less than 2000 \(\mu F/\text{ampere}\). By the second rule, then, a 4-ampere power supply should have not less than 4 times 2000, or 8000, \(\mu F\) of filter capacitance.

The circuit in fig. 5A is the simplest dc power supply, but even with a high-value filter capacitor it will show some ripple in the output waveform. A voltage regulator will reduce this ripple to almost zero even though the regulator’s main function is to maintain the dc output voltage constant. One power-supply manufacturer emphasized the regulator ripple-reduction feature by claiming that the circuit “amplified” the 10,000-\(\mu F\) filter capacitance to make it “equivalent” to a 1-\(\text{farad}\) capacitor! What was meant by this over statement is that it would take a 1-\(\text{farad}\) capacitor to achieve the same ripple reduction obtained from a 10,000-\(\mu F\) capacitor and a voltage regulator.

**voltage regulation**

All dc power supplies have a certain amount of internal, or source, resistance, \(R_s\). When a load current, \(I\), is drawn from the power supply, a voltage drop, \(E = IR_s\), will occur across the source resistance.

The value of the internal resistance can be determined by Ohm’s law. The voltage used in this calculation is the power supply open-terminal voltage. This voltage is measured by disconnecting load resistor, \(R_L\), then measuring the power-supply output
fig. 9. Zener regulator using a series-pass transistor (A). A feedback circuit using an error amplifier IC is shown in (B).

when no current flows (see fig. 6). The current used in the calculation is that which will flow when the output terminals are short circuited. Don't try to make this measurement, however! Few real-world power supplies can withstand an output short circuit without damage. An alternative method for determining the internal resistance is this:

$$R_s = \frac{E - E_0}{I}$$

Where:
- $R_s$ is the internal resistance of the supply (ohms)
- $E$ is the unloaded (i.e., $I = 0$) output voltage
- $E_0$ is the loaded output voltage (i.e., $I = 0$)
- $I$ is the output current

Voltage regulation is a measure of how stable the output voltage remains between no load and loaded conditions. Fig. 7 shows the mechanism that causes the output-voltage change. Internal resistance $R_s$, is effectively in series with load resistance $R_L$. The output voltage, then, can only be a fraction of the open-terminal voltage because $R_s$ and $R_L$ form a voltage divider. The output voltage at full load will be:

$$E_0 = \frac{ER_L}{R_s + R_L}$$

Voltage regulation is usually specified in terms of a percentage, which is calculated from:

$$\text{per cent regulation} = \left( \frac{E - E_0}{E} \right) \times 100$$

regulator circuits

In this article we'll consider three basic forms of regulator circuit: zener diode, zener-referenced series-pass, and feedback.

Zeners have a property that allows them to be used as voltage regulators. Fig. 8A shows the curve for a typical zener. In the $+E$ region the diode is forward biased and behaves exactly like any other silicon diode. But in the $-E$ region, in which the diode is normally reverse biased, the zener behavior is somewhat different from that of the ordinary diode. From zero volts to a point called $V_z$ the zener acts like an ordinary diode; current passed is zero. But at $V_z$ the zener "breaks over" and conducts a reverse current. $V_z$ tends to remain constant and is the voltage to which the zener will regulate the applied voltage.

Fig. 8B shows a typical zener voltage regulator circuit. CR1 is connected in parallel with the load. R1 is a series-current limiter that protects the zener from excess current flow. Without R1 the CR1 would burn out.

The simple zener voltage regulator is used for light-duty work only. A general rule of thumb is that the load current should be held to 10 or 20 per cent of the zener current, hence the limitation to low-current applications.

A better solution is to use the zener as a reference source in a series-pass circuit as in fig. 9A. In this circuit Q1 is the control device and CR1 is a reference. The output voltage is given as approximately:

$$E_0 \approx V_z - V_{be}$$

The maximum output current is approximately the normal load current, $I_b$, allowed by the zener multi-
plied by the beta of Q1; assuming that neither Q1 maximum collector current nor its maximum power dissipation ratings are exceeded.

Another series-pass type regulator is the feedback circuit shown in fig. 9B. In this simplified schematic the bias on the series-pass element, Q1, is determined by the output of an error amplifier. This amplifier is a differential circuit, meaning that its output is proportional to the difference between two input voltages (i.e., $E_{ref} - E_o$). If $E_o$ changes from the value set by $E_{ref}$ (when the load current changes), then the amplifier output changes in a direction that corrects the change.

Most readers aren’t interested in designing complex dc power supplies but want to know how to make supplies that will meet their needs. The supplies in this section will meet the needs of most Amateur Radio applications for either workbench or project use.

The easiest way to obtain supplies up to 5 amperes capacity at a fixed voltage is to use a three-terminal IC regulator. Such regulators can be obtained in most standard voltages up to 24 Vdc.

Several families of three-terminal regulators are available at current levels of 100 mA, 750-1000 mA, 3 amperes, and 5 amperes. Fig. 10A shows several case styles used for these devices. The letters denoting the case style are used as a suffix in the regulator type number. An LM309, for example, is a 5-volt regulator, so an LM309H is a 100-mA device in a TO-5 transistor package, while the LM309K is a 1-ampere device in a TO-3 transistor package. The T-style package is generally limited to 750 mA in free air although frequently advertised at 1 ampere.

Often the ratings of these devices are exceeded even though this isn’t always good practice. The claim is made that the ratings can be exceeded if proper heat-sinking is applied. I’ve seen the H-style package devices operated at 150-200 mA, T style at 1 ampere, and the K style at 1.5-2 amperes.

The most common three-terminal devices are the LM340-series and the 78xx-series. For LM340 devices the case style would be denoted by the suffix letter (H, K, or T), while the output voltage is denoted by a hyphen and the voltage; i.e., a 12-volt output 750-ma (T package) device would be given the designation LM340T-12. The 78xx-series devices replace the “xx” in the generic type number with the voltage rating. The 7805, then, is a 5-volt device while the 7812 is a 12-volt device.

The basic circuit for these regulators is shown in fig. 10B. T1, diodes CR1 and CR2, and capacitor C1 are the same as in any unregulated supply (a bridge rectifier may be substituted for CR1/CR2). Capacitor C1 is the filter capacitor and should have a value not less than 2000 μF/ampere ($I_{max}$). Capacitors C2 and C3 improve regulator noise immunity and should be mounted as close as possible to the regulator body. Capacitor C4 is optional but improves the circuit transient response. C4 should have a value of not less than 100 μF/ampere.

Until recently there were few three-terminal voltage regulators on the market for current levels over 1 ampere. The LM323, for instance, would pass 3 amperes at a fixed 5 volts. Fairchild Semiconductor now offers several devices in the 5-ampere range. Lambda Electronics* offers three lines of three-termi-
nal devices in TO-3 packages. The LAS-15xx series produce 1.5 amperes, the LAS-14xx series produce 3 amperes, and the LAS-19xx series produce output currents up to 5 amperes. As in the 78xx series, the "xx" is replaced by the output voltage. An LAS-1905, then, is a 5-volt, 5-ampere device, while the LAS-1512 is a 12-volt, 1.5-ampere device.

An exception to the Lambda numbering scheme is the LAS-19CB, which delivers 13.8 volts dc at the output up to 5 amperes. This device is designed to power Amateur Radio and CB mobile transceivers on the bench or in a base-station. (Most "12-volt" mobile electrical systems are actually 13.8-volt electrical systems.)

All three-terminal regulators have a certain minimum and maximum input-output differential voltage \((E_{in} - E_{o})\) rating. A typical number is 2.5 volts for the minimum and a maximum in the 30-40 volt range. The minimum \(I/O\) differential is the smallest difference that will allow the regulator to operate properly, while the maximum voltage rating is the level that will probably cause device burnout if exceeded.

The \(I/O\) differential, however, can be a trouble area for the unwary. A 5-volt, 5-ampere device may be rated for a maximum input voltage of 35 volts dc and a maximum power dissipation of 50 watts. The power actually dissipated is:

\[
P_d = I(E_{in} - E_{o})
\]

\[
P_d = 5(E_{in} - 5)
\]  

(7)

So if the maximum input voltage is 35 volts,

\[
P_d = 5(35 - 5) = 5(30) = 150\text{ watts}
\]  

(8)

Clearly, we can't expect to draw the full current at the maximum input voltage without exceeding the device power dissipation rating. By rearranging eq. 7 to solve for \(E_{in}\) when \(P_d\) is 50 watts, the maximum input voltage at full-rated output current is 15 volts. Although the 5-volt device is used as an example, the same reasoning applies to other regulators as well.

Lambda Electronics also offers a line of adjustable four-terminal regulators in packages that are similar to TO-3. A simplified internal circuit is shown in fig. 11A. Note that it's a feedback device with thermal, safe operating area and current overload protection. Overload protection is very important in situations where the device being powered shorts out or where the alligator clips on your bench supply come together! The series-pass element in these four-terminal regulators is a Darlington pair to take advantage of the extremely high gain. The case (similar to TO-3) and pinouts are shown in fig. 11B. Although standard TO-3 heatsinks will work for this device, it's necessary to drill the extra holes.

The Lambda four-terminal adjustable voltage regulators can be set to any output voltage within their specified range using potentiometer \(R_p\) (fig. 11C is a typical circuit). The range for most models is 4-30 Vdc. The LAS-15U, LAS-14U, and LAS-19U produce output currents of 1.5, 3, and 5 amperes respectively. With the exception of the control pin and the potentiometer, the four-terminal regulator uses the same general circuit as the three-terminal devices.

High-current power supplies (over 5 amperes) are sometimes tricky to design properly. You can't just slap a zener into the base circuit of a series-pass transistor and make it work reliably. Additionally, ready-built, high-current power supplies are often quite costly. A reasonably simple solution to these problems is a Lambda high-current, hybrid-module device:

<table>
<thead>
<tr>
<th>Lambda series</th>
<th>ratings</th>
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<tbody>
<tr>
<td>LAS2000</td>
<td>5 amperes/85 watts</td>
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<tr>
<td>LAS3000</td>
<td>10 amperes/140 watts</td>
</tr>
<tr>
<td>LAS4000</td>
<td>10 amperes/170 watts</td>
</tr>
<tr>
<td>LAS5000</td>
<td>20 amperes/270 watts</td>
</tr>
<tr>
<td>LAS7000</td>
<td>30 amperes/400 watts</td>
</tr>
</tbody>
</table>

The LAS5205 is a 20-ampere, 5-volt regulator, while the LAS7215 produces 15 volts at 22 amperes. Fig. 12 shows an example of a hybrid voltage regulator. The voltage trim pot should have a minimum value of \((0.25E_{o} \times 1000 \text{ ohms/volt})\) except for 5-volt models, in which case a value of 3000 ohms is used. In practice these are minimum values and the actual value must be found by experimentation. In the case of my own LAS5205, used in a Digital Group Z-80 computer, the required value was 12 kilohms.

Note that both pins 2 and 20 are plus-input-voltage terminals. This can lead you astray in some cases...
because pin 1 will operate with only 2.5 volt // O differential voltage, while pin 20 must have not less than 7.5 volt // O differential. Pin 1 is the normal high-current terminal leading to the series-pass transistor while pin 20 powers the internal control circuit.

In my computer power supply, \( E_{in} \) for the high-current side was 8 volts (obtained from a 6.3-Vac filament transformer), while the control circuit input voltage on pin 20 was derived from the +15 volt supply used with a +12 volt regulator in the computer.

**overvoltage protection**

One aspect of regulated power-supply construction often overlooked by the Amateur is overvoltage protection. Very few electronic circuits can tolerate excessive input voltage for more than a few seconds. TTL IC devices, for example, can burn out if more than 5.6 volts is applied to \( V_{cc} \) for an extended period of time. Amateur and CB transceivers that normally operate on 13.8-volt systems will flunk a smoke test when +17 volts is applied, which is the normal voltage obtained from a rectified and heavily filtered 12.6-volt transformer!

The solution is to provide some form of overvoltage protection (OVP); that is, a means of turning off the power supply if the output voltage exceeds a preset limit. Fig. 13 shows a common approach to OVP design. CR1 is a zener with a breakdown voltage greater than \( E_{th} \) but less than \( E_{z} \). When \( E_{th} \) rises to a value higher than the breakover voltage, CR1 conducts and turns on the gate of silicon-controlled rectifier CR2. When CR2 turns on, a short-circuit occurs across the regulator output that blows fuse F1. This a brute-force approach called an "SCR crowbar."

Lambda Electronics offers monolithic SCR crowbar devices in TO-66 and TO-3 packages as well as certain heavy-current devices in custom packages. Information on these devices may be obtained by writing to Lambda Electronics at the address given previously.

**Fig. 13.** Overvoltage protection scheme using a zener (CR1) and a silicon-controlled rectifier (CR2). The circuit is known as the "SCR crowbar" approach.

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<table>
<thead>
<tr>
<th>9.0 MHz FILTERS</th>
</tr>
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<tbody>
<tr>
<td>XF9-A 2.5 kHz SSB TX</td>
</tr>
<tr>
<td>XF9-B 2.4 kHz SSB RX/TX</td>
</tr>
<tr>
<td>XF9-D 3.7 kHz AM</td>
</tr>
<tr>
<td>XF9-E 1.2 kHz FM</td>
</tr>
<tr>
<td>XF9-M 0.5 kHz CW (4 pole)</td>
</tr>
<tr>
<td>XF9-2B 0.5 kHz CW (8 pole)</td>
</tr>
</tbody>
</table>

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More Details? CHECK — OFF Page 110
active antenna coupler
for VLF

A discussion of active low-frequency and very low frequency antenna preamps, with some details for extending the frequency range to 10 MHz and above.

The goal of this project has been to have a single, electrically short antenna operate over a wide frequency range with a minimum of interference or operational problems. The biggest problems are those of local noise pickup from 60-Hz harmonics and overload from strong, out-of-band signals (above 300 kHz). In general, any jfet, mosfet, or even CMOS inverters may be used to provide high power gain, but some circuits work better than others.

The primary purpose of a vlf receiving antenna coupler is to convert the low-level signal at the high-impedance pickup point on a short antenna to a low-impedance level for driving the feed cable back to the receiver. The use of bipolar transistors has invariably resulted in problems due to intermodulation distortion or cross modulation from nearby broadcast-band transmitters. A jfet is far less susceptible to this problem over a wide dynamic range. One of the most common jfets available is the MPF102, which I used in the preamplifier circuit shown in fig. 1.

circuit description

The input lightning arrester is of obvious value when a good low-impedance ground system is provided at the antenna mounting. The series input resistors, with the capacitance of the neon bulb and trigger diode, serve as double RC filters to help reduce broadcast-band and high-frequency signals. They also provide static discharge protection. The choice of trigger diode for the low-voltage limiter is critical. Some diacs and thyristors are quite nonlinear and have appreciable resistance/capacitance variations. Some General Electric and Japanese diodes, apparently constructed as back-to-back 14-volt zeners, appear to work best and will prevent burnout of the preamplifier in all but the worst-case, direct-hit situation. You should never use parallel, opposed polarity silicon or germanium diodes in place of a trigger diode, because these produce an almost ideal crystal detector for broadcast-band signals with direct audio signals flowing down the cable.

The output transformer in fig. 1 is operated in a step-down mode from the jfet drain terminal to provide a higher current driver for the cable at a 150- to 350-ohm impedance level. Fifty-ohm cable is not a perfect match, but at these low frequencies the cable looks like a capacitor and there is no VSWR problem because of the very short electrical length of the cable. The transformer is a standard 600-ohm, center-tapped, line-to-line type. Some UTC suboncer models work just as well and will pass frequencies to 300 kHz or more when terminated with a 330-ohm resistor at the receiver end. Power for the preamplifier flows up the cable from the 330-ohm isolating resistor at the receiver end. The cable capacitance helps limit the high-frequency response. In fact, additional capacitance directly in parallel with the coaxial cable may be used to restrict the preamplifier response for use below 100 kHz.

The coupling capacitor to the receiver should be fairly large if you are interested in signals down to the 10-kHz range or below. The preamplifier will drive 50-ohm cables up to 30.5 meters (100 feet) long and still provide adequate response up to 200 kHz. Seventy-five ohm cable can be used to reduce the cable capacitance for longer runs.

The input impedance and sensitivity of the preamplifier are limited by the input RC protective networks and the relatively high-current operating level. It is a good idea to check the current with a meter temporarily connected in series with the 330-ohm power supply isolating load resistor. Current should be about 4.5 mA at + 5 Vdc. If you observe a drastically different current, try changing the 330-ohm load resistor, but be sure to check the preamp operation. In testing dozens of MPF102s, a bad one with too

By Ralph W. Burhans, Ohio University, Department of Electrical Engineering, Athens, Ohio 45701
low an Idss specification could be found. You should be able to generate a 50-mV rms output signal, with no distortion at the receiver end, when a 50-mV rms, 100-kHz input signal is connected to the antenna terminal through a 100-pF capacitor. A 100-pF antenna input capacitor will roughly simulate a 2-meter (6-foot) whip antenna for testing purposes with a low-impedance signal source.

Limiting will start at about 100-mV rms, which is more than enough range for most receivers. When the input signal is strong enough to start limiting, the output is reasonably symmetric because of the grounded source and high current operation of the MPF102. The noise figure of about 3 dB is adequate for most uses, since the antenna noise is quite high. Typically, in the 100-kHz region, the atmospheric noise level will be over 10 μV/kHz/meter. With a 3-dB noise figure, the preamp generated noise is about 0.1 μV/kHz.

**receiver coupling**

The simplest way of coupling the preamp to a receiver is shown in fig. 1. Other methods using another transformer to drive two receivers or a tuned input circuit are illustrated in fig. 2. The wideband, two-receiver circuit is of value in operating a low-frequency, 10.2-kHz Omega receiver in parallel with a wide tuning range receiver with the same antenna. The tuned-circuit coupling method has been used for a number of experimental receivers with Polya- kov's detector\(^1\) and a direct-conversion method with a balanced mixer.\(^2\) These input circuits might also be used with some of the surplus RAK-RBA receivers, the Palomar Engineers vlf converter, the new Elmek LXX 60-kHz receiver, and with various modern the ac ground noise pickup problems. The arrangement shown is mounted on a cast iron sewer vent pipe which serves as a good low-impedance ground. A small plastic crutch-tip cap at the end of the antenna whip helps reduce corona discharge problems in turbulent weather. I usually seal all joints, including the preamp box, with silicone rubber sealing compound to prevent moisture from entering. However, in the past, water has sometimes entered the box or antenna connectors. A small bleed hole is drilled in the very lowest or bottom part of the box assembly to drain away any moisture that runs into the assembly.

My only bad experience with lightning was when one of the systems failed due to a strike on a tree nearby. The antenna system apparently suffered a side streamer discharge, but the preamplifier itself was not damaged. The coax cable shield was burned to a crisp inside the jacket with not much obvious damage to the plastic outer jacket. There was a burn point where the cable bent over the roof at a well-grounded rain gutter. The receivers connected in the lab were not damaged.

**other antennas**

The preamplifier of fig. 1 can be used with hori-
zontal antennas up to 30 meters (100 feet) long, if desired. However, I do not recommend antenna lengths of 150 meters (500 feet), which some DX hunters have used. In many cases, there is not much advantage in long wires over a good vertical radiator. The problem with the long wire is a good ground, underneath the length of the antenna, which will not have fluctuating 60-Hz ground currents. A big problem with long-wire vhf antennas for Amateur users is that the wire picks up 60-Hz harmonics along the entire length of the antenna, which tends to cancel the effectiveness of the length. For a simple installation, a single vertical antenna mounted reasonably in the clear will provide a better signal-to-noise ratio than a long wire strung out over the landscape.

An E-field whip antenna with a wideband preamplifier has one big advantage in that all tuning is done at the receiver end of the circuit. A tuned circuit antenna has to be adjusted for each new frequency range and this becomes a major problem when the antenna is mounted remote from the receiver shack. Loop antennas have a similar restricted bandwidth, compared with this wideband system. H-field loop antennas do have another advantage in that they may be rotated to reduce noise pickup. With an E-field antenna whip, there is no easy way of reducing noise pickup from nearby power lines and varying ground currents except by changing the antenna location, moving it higher, or providing better ground systems directly under the antenna.

**audio interference**

Audio rectification problems sometimes develop as a result of strong broadcast signals. This does not appear to affect the receiver’s signal-to-noise ratio as long as the audio signals do not pass directly into the detector. Some experimental direct conversion receivers have exhibited direct audio feedthrough. This can sometimes be cured with a highpass filter at the receiver input instead of the 0.1-µF coupling capacitor. Tuned transformer or link-coupled input circuits can also be used to reduce direct audio interference feedthrough.

Audio rectification is caused by some nonlinear element or corroded joint and a parallel ground loop where some of the dc current for operating the preamp is being modulated. In one case, on a flat roof building, connecting the antenna mounting to a supposedly conducting member of the roof structure resulted in high broadcast noise pickup at the receiver. The problem was solved by isolating the preamp ground return from the antenna-mount lightning arrester ground such that there is no direct dc connection at the roof. The preamp box “floats” at the end of the coax cable and there is no chance of the roof truss ground providing parallel ground currents along the cable to generate additive or cross modulation effects. This can be done in fig. 3 by substituting a tight jam-fit plastic pipe coupling for the

![fig. 3. Vlf/low-frequency antenna and preamplifier mounting details.](image-url)
Amphenol DM (double male) fitting with only the center conductors of the uhf fittings connected with a short length of threaded rod. Thus, the antenna mount is insulated from the preamp and cable with the common ground point at the receiver end of the circuit.

**widerband modifications**

Attempts to operate these jfet preamps over a wider bandwidth results in many problems. One circuit which has been used up to 10 MHz is illustrated in fig. 4. The input protection is reduced to provide less attenuation. The trigger diode will typically contribute 12 to 25 pF of added capacity. At vlf, this is not of much consequence, but at 10 MHz this results in about a 5 dB signal loss. Fig. 4 uses feedback to provide high current gain and unity voltage gain. The gain is adjusted for the $I_{DSS}$ of a particular 2N5457 by changing the value of the 680 ohm to 1-kilohm resistor. I usually try to adjust for unity voltage gain at 100 kHz. This provides the best linearity and a dynamic range of up to 200,000 μV rms. The output impedance of this amplifier is 80 ohms. There will be a VSWR ripple at the higher frequency range when driving a 50-ohm cable as illustrated in fig. 4B.

VSWR effects at the high end are noted in both cases. The transformer preamp has a still higher output impedance, but this is of little consequence since I was not interested in performance above 200 kHz. Vlf receivers usually look like a 300- to 600-ohm load to the preamp cable with the preamp of fig. 1.

With conventional high-frequency receivers, the input may look like a 50-ohm load, which also produces a VSWR effect. The circuit of fig. 4 has been used for WWV reception at 10 MHz with performance often better than that obtained using an untuned short length of antenna wire. Thus, while there is an apparent 16 dB voltage loss at 10 MHz, the preamp still has some power gain at this frequency when used with a short antenna. Most high-frequency receivers have excess rf gain and a low enough signal-to-noise performance to be used with this preamplifier up to about 10 MHz. The circuit of fig. 4 is better matched to 75-ohm or 95-ohm cable providing slightly fewer VSWR effects and somewhat better frequency response.

A number of other variations have been tried, including use of two or more transistors in the preamplifier box configured as a source follower driving an emitter follower. None of these have provided
much better performance than the circuit illustrated in fig. 4A. One interesting possibility for those who like to wind their own toroidal transformers would be a bifilar-wound toroid connected as a 4:1 unbalanced step-down transformer from the jfet drain terminal. An inductance of about 1 to 4 mH should provide a wideband device over the range from 60 kHz and up. Surplus pulse transformers have been used in this manner with some success, but it’s difficult to obtain a really wideband circuit without reducing all protection at the input to the jfet. There is an inherent problem in that at vlf frequencies you require a very high input impedance for a short whip antenna, but at higher frequencies like 10 MHz, the antenna is a much lower impedance and should be terminated with a lower-impedance circuit.

Still another thought for the experimenter is to consider the methods used in the input circuits of wideband oscilloscopes covering up to 30 MHz. The difficulty here is dynamic range and the circuit complexity, usually requiring a separate dual power supply to lead to the preamplifier and perhaps even balanced shielded cable at the output.

High impedance circuits require low capacitance at the input to provide a really high frequency response. One of the most common problems is that of the capacitance to ground of the antenna mount and lightning arrester. This has a big effect on the sensitivity of a short antenna at frequencies like 10 MHz when coupled to a high-Z circuit.

**high-gain preamplifier**

For very short antenna systems, such as used in mobile or airborne systems, a high-gain preamp is desirable to make up for the low-level signal received on antennas less than 1 meter (3 feet) in effective height. Some vlf receivers are designed such that a low level of 1 μV or so is required for minimum detectable signal. With an electrically short antenna, there may not be enough signal developed to activate the receiver threshold properly, hence, some more gain is often desirable. A preamplifier with 20 dB gain over a frequency range of 100 Hz to 1 MHz is shown in fig. 5. This circuit uses the same 2N5457 jfet as in fig. 4, but is operated as a voltage amplifier instead of a source follower. The emitter follower provides a low output impedance. This preamp will also work up to about 20 MHz, but the gain drops off to 0 dB or unity at this frequency. The circuit is more susceptible to overloads than the previous preamps so some input RC filtering is used to restrict the range.

Other variations are of course possible, including the use of the output transformer coupling method of fig. 1 and other biasing schemes for operating the jfet at higher gain. In portable/mobile use, there is not so much concern for a low output impedance cable driver since the receiver can be located close to the preamp with a short length of cable. Circuits like fig. 5 have been used in general aviation aircraft with good results in the 100-kHz Loran-C range. Marine users are cautioned against using these high-gain preamplifiers because of ground-loop interference problems caused by rusty hulls and poor grounding practice in many boats. A conventional preamplifier more like fig. 1, mounted up on a mast well away from the superstructure, will usually provide satisfactory performance, particularly when the coax cable is not grounded to the antenna mount, as discussed previously.

**results**

This antenna and preamplifier system has been used to receive the 10.2-kHz Omega signals on all eight stations including LaReunion Island, halfway around the world. In Ohio, I regularly receive twelve different Loran-C transmissions from the East Coast, Northeast, and Gulf Coast 100-kHz chains. At night, I observe Loran-C skywave signals from the West Coast chain over 4000 km (2500 miles) away. WWVB puts in a strong 150-μV signal in Ohio, but is often in-
interfered with by MSF in England on the same 60-kHz frequency. Other signals noted are the time frequency standard stations in Switzerland on 75 kHz, Japan on 40 kHz, as well as numerous communications and military FSK-type signals in the 14 to 150 kHz range. The system works well in the 1750-meter Amateur band (160 kHz to 190 kHz), but I have not yet made any serious attempt at DX hunting. The most interesting DX received is on 15.625 kHz, part of the USSR Alpha vlf navigation system.

Harmonics of 60 Hz and TVI from harmonics of the 15.75-kHz horizontal oscillator in nearby N sets are the most common interference observed in urban locations. In my receiving shack, the 60-Hz troubles usually do not start until the mercury vapor arc lights in front of my home start operating, and other 60-Hz uses increase during the prime evening hours.

In some installations, BCI from nearby transmitters can be a problem. These can usually be cured with an additional low-pass filter or trap inserted in the receiver input circuit, with better grounds on the antenna pole mounting, and with proper care in design of the receiver input circuits to minimize cross-modulation problems. Common-mode 60-Hz pickup is sometimes a problem caused by combinations of poor ground connections at the antenna coupler box and the receiver location. If this cannot be cured by relocating the antenna, then another method is to use a balanced, twisted-pair, shielded transmission line. The unused half of the preamp output transformer and a similar balanced input transformer at the receiver with a 330-ohm current limiting resistor connected to the center tap can be used to reduce common mode pickup problems. In general, balanced transmission lines have not been used because it is difficult to obtain suitable lines and weatherproof fittings that will pass frequencies to 300 kHz without excessive expense. It is easier to cure these problems by antenna location or ground changes.

acknowledgments

The effort on vlf/low-frequency antenna couplers has been part of a study of low-cost methods for producing receiving systems for the general aviation community, sponsored by the NASA Langley Research Center. This paper is a direct result of that work. The help of student assistant Edwin Jones is appreciated in testing some of the most recent preamplifier systems.

references


More Details? CHECK-OFF Page 110 october 1979
connectors for CATV coax cable

How to beat the high cost of connectors for popular “1-inch” CATV coaxial cable

Large quantities of “1-inch” CATV coax cable have recently become available from various sources. The electrical characteristics of this cable make it attractive for Amateur vhf-uhf applications, particularly for long transmission lines. The cable is offered at modest cost, from tag ends to full-reel lengths of up to 732 meters (2400 feet).

The “1-inch” CATV cable, however, is not without its drawbacks, and this article suggests ways to circumvent these with ordinary construction practices using shop tools and readily available materials.

hardline “1-inch” CATV cable

The CATV cable is shown in fig. 1. Table 1 gives physical and electrical properties. Perhaps the cable’s major disadvantages are 1) its handling properties below room temperature, at which it has the ductility of gas pipe; 2) its relatively large bend radius; and, most of all, 3) the high cost of end connectors.

Fig. 2 shows, from left to right, an expensive commercially available end connector; an Amateur design in the raw; and the Amateur design in a moisture-proof final configuration. Relative costs for the two Amateur designs are quite low.

For the obvious reason of cost, and because of the relative bulk of the commercial connector, I evolved the Amateur design, which can be made with fairly common materials, and, to a large degree, common hand tools.

These were the other major considerations achieved in the Amateur design:

1. No electrolytic action between dissimilar metals
2. Resistance to moisture penetration
3. Minimum discontinuity bumps in line impedance introduced by the connector

materials and tools

Tables 2 and 3 show the materials and tools you’ll need for making the connectors. Fig. 3 illustrates the raw parts needed for the suggested Amateur design, denoted A, B, and C, D, and G. Fig. 3 also suggests not only the assembly steps, but interrelated with the following text, features and mechanics of fabrication, treatment, and parts use to the point of final assembly, as shown in the connector at the right-hand side of fig. 2.

The tools should be available to the average builder or his friends, or they can be rented from local outlets.

fabrication

Steps for making your coax connector are given below. Refer to fig. 3 as you proceed.

By John H. Ferguson, WI1IM, 94 Concord Road, Wayland, Massachusetts 01778
1. Using a tubing cutter, make a cut through the vinyl cable jacket and seamless-tubing shield about 15-25 cm (6-10 inches) from the cable end. Then, using a fine-blade hacksaw, cut through the dielectric and inner conductor. Make the cut flush with the outer surface of the cable. Remove aluminum filings from the dielectric surface. Figure 3 shows what it should look like.

2. Find the precise center of the copper-pipe-cap outer face. Center punch the cap center, and drill a hole using a sharp no. 42 (2.4-mm) bit. Remove burrs from the pipe cap inside.

3. Force the pipe cap firmly over the square end face of the cable.

4. Clamp the cable vertically in a vise. Using the pipe-cap center hole as a guide, carefully drill a no. 42 (2.4-mm) tap hole straight down to a depth of 1/2 inch (25.5 mm) into the copper clad center conductor of the cable. For quantity jobs, get a machinist friend to make a drill guide as shown in figure 4. Then tap the center conductor 4-40 (M3) screw and remove chips from the tap and hole after each turn of the tap.

5. Remove the hex nut and lockwasher from the bulkhead connector (Amphenol 83-879) and discard the lock washer. Mount the connector upright in a vise. Carefully drill down from the top, through the solder tip, with a no. 33 (2.9-mm) drill. Set the connector with its new short tip aside.

6. Reduce the head diameter of a 4-40 x 1/2-inch (M3 x 12.5-mm) screw to about the same outside diameter (see A, figure 3) as the male tip of a PL-259 connector. This can be done by inserting the screw into a drill and rotating the screw head against a flat fine-

---

**Table 1. CATV "one-inch" coax cable characteristics.**

<table>
<thead>
<tr>
<th>part</th>
<th>material</th>
<th>nominal OD mm (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-conductor</td>
<td>solid bare copper-clad aluminum</td>
<td>5.8 (0.227)</td>
</tr>
<tr>
<td>B-insulation</td>
<td>extruded foam polystyrene</td>
<td>22.6 (0.9)</td>
</tr>
<tr>
<td>C-shield</td>
<td>seamless aluminum tubing</td>
<td>25.4 (1.0)</td>
</tr>
<tr>
<td>D-jacket</td>
<td>extruded polyethylene (black)</td>
<td>28.4 (1.1)</td>
</tr>
</tbody>
</table>

**Physical properties**
- Maximum pulling force: 261 kg (575 lbs.)
- Minimum bending radius: 10 times cable diameter
- Nominal weight: 641 g/km/(430 lbs./1000 ft.)

**Electrical characteristics**
- Frequency (MHz) to maximum attenuation (dB/100 meters)
  - 5 MHz: 0.26
  - 30 MHz: 0.66
  - 50 MHz: 0.85
  - 216 MHz: 1.9
  - 240 MHz: 2.0
  - 260 MHz: 2.1
  - 270 MHz: 2.2
  - 300 MHz: 2.3

- Frequency (MHz) to maximum attenuation (dB/100 feet)
  - 5 MHz: 0.08
  - 30 MHz: 0.20
  - 50 MHz: 0.26
  - 216 MHz: 0.99
  - 240 MHz: 0.63
  - 260 MHz: 0.65
  - 270 MHz: 0.68
  - 300 MHz: 0.7

1. Attenuation varies ±2 per cent nominal per 10°C variance in ambient temperature.
2. Attenuation varies ±1 per cent nominal per 10°F variance in ambient temperature.

---

The foam dielectric is not particularly hygroscopic, but some moisture will inevitably accumulate near the exposed end. Remove the section of contaminated cable before installing the connector.

---

†Use of the drill guide requires temporary cut and removal of about 6.5 mm (1/4 inch) of the black polyethylene jacket to allow the guide to slip down over the aluminum shield (C or figure 1).

---

**Table 2. Materials for making the coax-cable connector.**

<table>
<thead>
<tr>
<th>quantity</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4-40 x 1/2-inch (M3 x 12.5 mm) BH or RH nickel-plated screw</td>
</tr>
<tr>
<td>1</td>
<td>83-378 bulkhead vhf female receptacle (Amphenol)</td>
</tr>
<tr>
<td>1</td>
<td>copper end cap for 1-inch (25.5-mm) rigid copper water tubing</td>
</tr>
<tr>
<td>4</td>
<td>6-32 x 1/4-inch (M3/5 x 6.5-mm) hex-head sheet-metal screws</td>
</tr>
<tr>
<td>1</td>
<td>bottle of Liquid Tape (General Cement)</td>
</tr>
<tr>
<td>1</td>
<td>end of CATV cable to attach to connector</td>
</tr>
</tbody>
</table>

---

**Figure 2.** Standard commercial CATV-cable connector, left, and the Amateur design.
### Table 3. Tool requirements.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1-inch (25.5-mm) tubing cutter for copper or aluminum</td>
</tr>
<tr>
<td>1</td>
<td>fine-tooth hacksaw blade and frame</td>
</tr>
<tr>
<td>3</td>
<td>3-inch (77-mm) vise</td>
</tr>
<tr>
<td>1</td>
<td>1/8-inch (3-mm) wide flat-blade screwdriver</td>
</tr>
<tr>
<td>1</td>
<td>fine-tooth flat file and emery cloth</td>
</tr>
<tr>
<td>1</td>
<td>150-watt soldering iron or Benzomatic torch</td>
</tr>
<tr>
<td>1</td>
<td>center punch</td>
</tr>
<tr>
<td>1</td>
<td>electric drill motor with 1/4 or 3/8 inch (6.5-mm or 9.5-mm) chuck</td>
</tr>
<tr>
<td>1</td>
<td>4-40 (M3) tap and wrench</td>
</tr>
<tr>
<td>1</td>
<td>5/8-inch (16-mm) OD socket punch</td>
</tr>
<tr>
<td>1</td>
<td>1/4-20 (M7) bolt, lockwasher, and nut</td>
</tr>
<tr>
<td>1</td>
<td>no. 12 SS compression hose clamp</td>
</tr>
<tr>
<td>1</td>
<td>high-speed drill bits, nos. 42, 33, 29, and 1/4 inch (2.4, 2.9, 3.5, 6.5 mm)</td>
</tr>
<tr>
<td>1</td>
<td>open-end wrench or socket for 1/2-inch (12.5-mm) bolt</td>
</tr>
<tr>
<td>1</td>
<td>piece of steel wool</td>
</tr>
<tr>
<td>1</td>
<td>corrosion-proof rosin-core solder, about 20 inches (50 cm) long</td>
</tr>
</tbody>
</table>

mesh file. The final outside diameter should be 0.15 inch (3.8 mm).

7. Using another 4-40 (M3) screw to temporarily block the tapped hole of the center conductor, liberally coat and seal the face of the dielectric, shield, and black vinyl jacket of the cable with General Cement liquid tape or equivalent material.

8. Drill out the hole in the face of the pipe cap to 1/4-inch (6.5-mm). Using an upside down 1/4-inch (6.5-mm) bolt and nut to secure the cap in a vise, make four fine hacksaw cuts 90 degrees apart about 3/4 inch (19 mm) down from the lip of the cap. (See F, fig. 3). Between the slots drill four 0.09-inch (2.4-mm) holes about 1/4 inch (6.5 mm) back from the same lip about 90 degrees apart.

9. Remove the cap from the vise and the superfluous 1/4-inch (6.5-mm) hardware. Insert a 5/8-inch (16-mm) diameter chassis punch. Tighten the bolt on the punch. You should have a clean 5/8-inch (16-mm) hole in the copper cap face.

10. Burnish the cap surface with steel wool. Insert the body of the bulkhead receptacle from the inside of the cap. Tighten the flat nut. (See F, fig. 3).

11. With the torch and minimum flux, solder the flat nut onto the cap surface. Use care to fill the void on the flat, keyed side of the receptacle body.

12. Insert the 4-40 (M3) screw, threads down, into the female flange fingers of the receptacle. Push the cap connector assembly down onto the face of the coax, then tighten the screw into the tapped center conductor. Slip the hose clamp over the cap to the cap lip.

13. Very carefully drill through the guide holes in a) the copper cap; b) through the black jacket; and c) just deep enough to puncture the outer seamless aluminum jacket of the coax cable. Use the no. 42 (2.4-mm) drill.

14. Carefully enlarge the four copper cap holes with a no. 29 (3.5-mm) drill just enough to allow the 6.32 x 1/4-inch (M3/5 x 6.5-mm) screw shanks (see G, fig. 3) to pass through the cap material.

15. Install the sheet-metal screws (four each) through the copper cap, vinyl, and into the cable outer aluminum jacket. Make sure the screws are hand-tool tight, no more.

---

**fig. 3.** Raw materials needed for the Amateur design of a coax connector for the hardline CATV cable. Assembly steps are shown for the final connector (extreme right, fig. 2).
16. Remove the hose clamp. Check for short circuits or high leakage between inner and outer conductor. If all is well:
17. Coat the cap body, hex-head screws, and junction of the vinyl jacket with G.E. "Liquid Tape," "Tool Dip," heat-sensitive tape, or 1-1/2 inch (38 mm) heat-shrink tubing treated with the torch. Make sure the connector threads are nice and clean.

This completes the assembly procedure for the Amateur-design CATV-cable connector.

**final notes**

Metal-to-metal contacts will be reasonably non-electrolytic; that is, silver-plated connector (inner), to stainless-steel 4-40 (M3) screws, to aluminum inner conductor. Also this applies to the stainless-steel sheet-metal screws, from copper cap to aluminum jacket.

The nominal impedance of the completed connector is about 65 ohms. It will show a small impedance bump at about 146 MHz. For matching considerations using 50- or 75-ohm sources, see references 1-5.

**acknowledgments**

I wish to express my thanks to the following Amateurs for help on this project: W1SCS, W1WME, K2TJZ, K1MOQ, W1TXK, WA1YRQ, and W1BF.

**references**


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For those who wish to mount the encoder in a hand-held unit, the PC board measures only 9 1/8" x 1 3/4". This partial kit with PC board, crystal, and components.

**PRICED AT:** $14.95

**ACCUEKEYER (KIT)**

- ACCUKEYER is a revised version of the very popular WB4VVF ACCUKEYER originally described by James Garret, in QST, March, 1978. AMATEURS HANDBOOK.

**PRICED AT:** $16.95

**ACCUEKEYER — MEMORY OPTION KIT**

- ACCUKEYER MEMORY OPTION KIT provides a simple low cost method of adding memory capability to the WB4VVF ACCUKEYER. WHILE DESIGNED FOR DIRECT ATTACHMENT TO THE ABOVE ACCUKEYER, IT CAN ALSO BE ATTACHED TO ANY STANDARD ACCUKEYER BOARD WITH LITTLE DIFFICULTY.

**PRICED AT:** $16.95

**NEW! CLOCK KIT — HAL 79 FOUR-DIGIT SPECIAL — $7.95**

- OPERATES ON 12-VOLT AC (NOT SUPPLIED). PROVISIONS FOR DC AND ALARM OPERATION.

**6-DIGIT CLOCK — 12/24 HOUR**

- COMPLETE KIT: CONSISTING OF 2 PC G-10 PRE-DRILLED PCB BOARDS, 1 CLOCK CHIP, 6 FND 359 READOUTS, 13 TRANSISTORS, 3 CAPS, 9 RESISTORS, 5 DIODES, 3 PUSH-BUTTON SWITCHES, POWER TRANSFORMER AND INSTRUCTIONS. NOT BE FOULED BY PARTIAL KITS WHERE YOU HAVE TO BUY EVERYTHING EXTRA.

**PRICED AT:** $12.95

**CLOCK CASE**

- Available and will fit any one of the above clocks. Regular Price — $6.50. But only $4.50 when bought with clock.

**SIX-DIGIT ALARM CLOCK KIT**

- FOR HOME, CAMPER, RV, OR FIELD-DAY USE. OPERATES ON 12-volt DC OR 120-volt AC, and has its own 60-Hz time base on the board. Complete with all electronic components and two-piece, pre-drilled PCB boards. Size 4" x 3". Complete with speaker and switches. If operated on DC, there is nothing more to buy. IF OPERATED ON DC, THERE IS NOTHING MORE TO BUY.

**PRICED AT:** $16.95

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**MORE DETAILS? CHECK — OFF PAGE 110**

**Ham Radio**

October 1979
The TS-520SE is an economical new version of the TS-520S...the world's most popular 160-10 meter Amateur transceiver. Now anyone can easily afford a high quality HF transceiver, providing 200 watts PEP input on SSB and 160 watts DC on CW!

The TS-520SE is a high-quality 160-10 meter SSB/CW transceiver intended for ham-shack use. The following changes were made to produce the new "SE" model:

- Replaced the heater switch with a CW WIDE/NARROW bandwidth switch, for use with the optional CW-520 500-Hz CW filter. A big improvement for the CW operator!
- Removed DC converter terminals. Now it operates strictly on 120 VAC and is not intended for mobile use.
- Removed transverter terminals. Now it is strictly a 160-10 meter SSB/CW transceiver.

All other proven features and high quality of the TS-520S have been retained in the TS-520SE, including:

- Effective noise blanker.
- Three-position (OFF, FAST, SLOW) amplified-type AGC circuit.
- RIT control.
- Eight-pole crystal filter.
- Built-in 25 kHz calibrator.
- Front-panel carrier level control.
- Semi-break-in CW with sidetone.
- VOX/PTT/MANUAL operation.
- TUNE position for low-power tune up.
- Built-in speaker.
- Built-in cooling fan.
- 20-dB RF attenuator.
- Provisions for four fixed channels.
- Speech processor consisting of a very effective audio compression amplifier.

The TS-520SE functions with many popular accessories, including:

- DG-5 digital frequency display/counter.
- VFO-520S remote VFO.
- SP-520 external speaker.
- CW-520 500-Hz CW filter.
- AT-200 antenna tuner/SWR and RF power meter/antenna switch.
- TL-922A linear amplifier.
- MC-50 dynamic microphone.
- SM-220 Station Monitor with BS-5 pan display module.

SPECIFICATIONS FOR THE TS-520SE

<table>
<thead>
<tr>
<th>GENERAL</th>
<th>Frequency Range:</th>
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</thead>
<tbody>
<tr>
<td>Mode:</td>
<td>SSB (USB, LSB), CW</td>
</tr>
<tr>
<td>Antenna Impedance:</td>
<td>50-70 ohms</td>
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<tr>
<td>Frequency Stability:</td>
<td>Within ±1 Hz during one hour after one minute of warm-up, and within 100 Hz during any 30-minute period thereafter</td>
</tr>
<tr>
<td>Power Requirements:</td>
<td>250 W PEP (SSB), 160 W DC (CW)</td>
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<tr>
<td>Dimensions:</td>
<td>11-1/8 inches wide, 9 inches high, 13-3/16 inches deep</td>
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<tr>
<td>Weight:</td>
<td>5.2 pounds</td>
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</table>

<table>
<thead>
<tr>
<th>TRANSMITTER</th>
<th>Input Power:</th>
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<tbody>
<tr>
<td>Carriers Suppression:</td>
<td>Better than 60 dB</td>
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<tr>
<td>Unwanted Sideband Suppression:</td>
<td>Better than 40 dB</td>
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<tr>
<td>Spurious Radiation:</td>
<td>Better than 40 dB</td>
</tr>
<tr>
<td>Microphone Impedance:</td>
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<tr>
<td>AF Response:</td>
<td>400-2,000 Hz</td>
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</table>

<table>
<thead>
<tr>
<th>RECEIVER</th>
<th>Sensitivity:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selectivity:</td>
<td>3:1 at 1 kHz</td>
</tr>
<tr>
<td>Image Ratio:</td>
<td>Better than 50 dB</td>
</tr>
<tr>
<td>Audio Output:</td>
<td>1.8 W (8-ohm load with less than 1% distortion)</td>
</tr>
<tr>
<td>AF Output Impedance:</td>
<td>4-16 ohms</td>
</tr>
</tbody>
</table>

Ask your Authorized Kenwood Dealer about the amazing TS-520SE...and its surprisingly affordable price!
Kenwood TR-2400... It's a synthesized 2 meter hand-held transceiver... the answer to any Amateur's operating requirements! Its many advanced features include:

**CONVENIENT TOP CONTROLS**
- LCD digital readout
- Readable in direct sunlight (better than LEDs)
- Readable in the dark (with lamp switch)
- Virtually no current drain (much less than LEDs)
- and display stays on
- Shows receive and transmit frequencies and memory channel
- 10 Memories (always retained with battery backup)
- Automatic memory scanning for "Busy" or "Open" channels
- Mode switch for the following operations:
  - Simplex
  - Standard repeater by offsetting the transmit frequency
  - Repeater with nonstandard splits by offsetting the
    transmit frequency to any frequency stored in memory 10
  - REVERSE momentary switch for the following applications:
    - Checking signals on the output of a repeater
    - Determining if a repeater is "upside down"
  - Built-in Touch-Tone generator using 16-button keyboard
  - Keyboard selection of 5-kHz channels from 144,000 to
    147.995 MHz
  - UP/DOWN manual scanning and operation from 143.900 to
    148.495 MHz in single or fast continuous 5-kHz steps. Even
    operates on MARS repeaters within this range by using memory
    10 for transmit offset frequency.
- LCD "arrow" indicators
- "ON AIR"
- Memory recall
- Battery status
- Lamp switch on
- Two lock switches to prevent accidental frequency change and
  accidental transmission
- Subtone switch (subtone module not Kenwood-supplied)
- BNC antenna connector
- 1.5 watts RF output

The TR-2400 comes with the following standard accessories:
- Flexible rubberized antenna with BNC connector
- Nicad battery pack
- Battery charger

Optional accessories include:
- Leather case
- Base Stand (for quick charge and easy base-station
  operation)
- DC (automobile) quick charger

*Simplified Schematic*
end-of-transmission “K” generator

An easy-to-build circuit for sending the Morse character “K” at the end of a transmission

Ever since the Apollo moon shots, Amateurs have been aware of the advantage of a tone at the end of a transmission to indicate that the “over” has finished. Under poor conditions this tone indicates unequivocally to the other station that it’s his turn to transmit. There’s a growing fashion now in Britain to use not just a single tone but a “dah-di-dah” sequence, making the Morse character “K”, meaning “over” in telegraphy. The circuit described here will perform this function using only two standard ICs and a handful of other components.

The “K” generator

The heart of the unit is U2, an IC type CD4017 (fig. 1). This device is a decade counter with decoded outputs, which means it has ten outputs: zero, one . . . nine. Initially the zero output is high and all the others are low. When a clock pulse is applied to the clock input, the zero output goes low and the one output goes high. After the next clock pulse, only the two output will be high. This sequence continues until the nine output is high; after that, the zero output goes high again and the sequence repeats.

Also provided on U2 are a reset and a clock inhibit input. When a high is applied to the former, the counter goes straight to the state of having the zero output high. Applying a high to the clock inhibit input freezes the counter in its current state, and further clock pulses have no effect until the clock inhibit input goes low again.

By Paul M. Jessop, G8KGV, 1157 Warwick Road, Solihull, West Midlands B91 3HQ, England
In this application a free-running clock is connected permanently to the clock input and the clock inhibit is connected to the zero output. Consider the effect of this if the counter is in the zero state: the zero output is high; therefore the clock-inhibit input is high. Thus clock pulses have no effect on the counter and it remains in the zero state, seemingly permanently. However if the clock inhibit is forced through the resistor until the trigger input reaches its upper triggering voltage. The output then goes low, and the capacitor discharges through the resistor until the lower triggering voltage is reached. Then the output goes high, and the capacitor starts to charge again. The output is thus a square wave.

In the circuit of fig. 1, two of the Schmitt inverters are used as oscillators. U1E is a free-running oscillator, which clocks the counter. U1F is a gated oscillator working in the audio range, which generates the tone. Diode gating is arranged so that the tone is inhibited if any of the diode inputs are high. These diodes are connected to the zero, four, and six outputs of U2 so that the tone is on when the counter is in its resting state and also during the gaps between the dots and dashes.

The input to the unit is in two paths. The first triggers the counter at the end of the transmission. The input signal is inverted and fed to a differentiator C2, R3 (fig. 1). The pulse generated on the leading edge of the input signal is suppressed by CR4, but that generated on the trailing edge is fed to U1D where it’s squared. For the pulse duration, the counter clock inhibit input is pulled low through CR5.

briefly low, the counter will cycle through its outputs, one to nine. When it overflows to zero, the clock inhibit is again high and no further counting occurs.

We thus have a method of making the counter cycle once through its complete set of outputs. Not counting the zero waiting state, nine counter states remain, and it so happens that the sequence for “K” in Morse is nine dot units long (on-on-off-on-off-on-on-on). Arranging the outputs correctly we can make the unit send “K” when wanted.

The other chip used in this project is U1, a 74C14 (40106), which contains six inverting Schmitt triggers. By judicious use of diodes, these triggers are sufficient to complete the required logic functions. The first building block to be constructed from a Schmitt inverter is a relaxation oscillator (fig. 2). Operation is as follows: the capacitor charges briefly low, the counter will cycle through its outputs, one to nine. When it overflows to zero, the clock inhibit is again high and no further counting occurs.

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Because R4 is relatively high in value, this action will occur regardless of the state of the zer output. Once the clock inhibit input has been pulled low, the counter starts and the zero output goes low, which forces the clock inhibit input low regardless of the U1D output state.

The input voltage is also fed to integrating network R1, C1. On the leading edge, C1 charges up quickly through CR1; but on the trailing edge, a delay occurs while C1 discharges through R1. The voltage on C1 is squared and inverted by U1A and fed to the diode AND gate CR2, CR3. Its other input is the counter zero output. If either of these is low, the output is low and U1B output is thus high, feeding the transmit/receive switching.

Thus, as the press-to-talk switch is released, U1A output will be low because of the delaying action of C1. A moment later, the counter zero output will go low, which keeps the transmitter switched on, even though C1 has discharged. Only when the counter has cycled completely will the zero output go high again. Now both inputs to the diode AND gate will be high and the transmitter is switched off.

Interface circuits

This completes the description of the logic part of the circuit, but the unit will, at this stage, only work with CMOS input and output levels. Clearly some kind of interfacing is needed in any real situation. For the input side, the circuit of fig. 3 will suppress any contact bounce generated by the press-to-talk switch and provide the appropriate input levels to the unit. Because of the time constant of R7, C6 the spikes generated by the contact bounce aren't fed to the input. The value of R7 is smaller than either that of R1 or the on resistance of CR1, so the charging and discharging of C1 is not affected. Clearly, a normally closed switch could be used by interchanging the positions of the switch and R7.

For the output interfacing, the situation is rather more complicated by the variety of circuits with which the unit could be required to operate. I used the arrangement shown in fig. 4. The transistor was an old germanium power device, but any variety of NPN transistor with adequate voltage and current ratings will probably work. In my home-brew transmitter, one of the PTT lines was connected to the supply rail so that the transistor operated in common-collector mode. The same circuit will operate just as well in common-emitter mode where one of the PTT lines is at zero potential.

Where the transmitter switching arrangement is unusual, or the unit is to be used with a variety of transmitters with differing switching methods, it's best to isolate the unit by a relay. Fig. 5 shows a circuit for driving a reed relay; again the transistor type isn't critical. It is, however, important to make sure that the relay is adequately rated for the current drawn through the PTT line since, if overloaded, the contacts tend to weld together and leave the transmitter permanently on — to the potential embarrassment of the operator!

Construction

With circuits of this type layout isn't critical. Construction can be in just about any form desired. The circuit can then be either hidden in a spare corner of the rig or built into a separate box. Where the relay driver is not used, the current drain is very low, so a separate battery supply is quite feasible if a suitable voltage isn't available in the transmitter. If you go this route, a common connection must be made to the transmitter chassis, probably through the PTT line, to allow the switching transistor bias current to flow.

Finally, for local contacts, the "K" can be suppressed as shown in fig. 6 if you wish. Operation is then as normal.

Good luck with your new and improved DX potential from G8KGV, Solihull, England. Dah-di-dah.
Wilson...
has your needs well in hand.

Today's Amateur demands rugged, rapid and accurate communications between Hams in the know. That's why they choose the Wilson Mark Series of hand-held radios. With exceptional qualities like these ... why not choose the most popular radio available for yourself?

FEATURES
Advantages such as solid state circuitry, rugged Lexan case, removable rear panel (enabling easy access to battery compartment) and compact mini-size enhance the Mark Series portable radio's versatility. In addition, Wilson carries a full line of accessories to satisfy almost any of your requirements.

SPECIFICATIONS
The Mark radios offer: • 144-148 MHz range • 6 Channel operation • Individual trimmers on TX and RX xtals • Rugged Lexan outer case • Current drain: RX; 15 mA, TX; Mark II: 500 mA, Mark IV: 900 mA • A power saving Hi/Lo Switch • 12 KHz ceramic filter and 10.7 monolithic filter included • 10.7 MHz and 455 KHz IF • Spurious and harmonics, more than 50 dB below quieting • Uses special rechargeable Ni-Cad battery pack • LED battery condition indicator • Rubber duck and one pair X tals 52/52 included • Weight: 19 oz, including batteries • Size: 6" x 1.770" x 2.440".

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capacitance measurements with a frequency counter

A digital capacitance meter has been on my shopping list for some time, but it’s been difficult to justify the expense of the single-function instruments available. An article in QST followed by investigation of the literature on the NE555 led to the design of a frequency counter attachment that allows capacitance to be read from the counter display. Using a 7-digit counter, capacitance values from 1 pF to 1 μF may be read with an accuracy of about 2 per cent ± 2 pF. A range switch isn’t required.

design

The NE555, when used as a one-shot, produces a pulse of width

\[ T = kRC \]  

(1)

where \( k \) is inherent in the 555, \( R \) is the charging resistor, and \( C \) is the capacitance being measured. By ANDing an oscillator output with this pulse, a burst of pulses is produced each time the 555 is triggered. The pulse frequency in the burst is that of the oscillator, while the number of pulses in the burst is determined by the length of the pulse produced by the 555. The value of \( R \) may be adjusted so that when a 1-pF capacitor is measured, the 555 output causes exactly one oscillator pulse to appear in the burst. Increasing the capacitor to 100 pF will make the 555 output 100 times longer and allow 100 oscillator pulses in the burst. Counting the pulses in one burst will then indicate the capacitance in pF.

To ensure that exactly one burst occurs per frequency-counter gate time, the 555 is triggered by the opening of the frequency counter gate as shown in the block diagram, fig. 1.

The effects of stray capacitance are compensated for by providing a third input to the AND gate which forms the burst, nulling the first part of the pulse from the 555. Typical waveforms are shown in fig. 2.

circuit description

The design is implemented as shown in fig. 3 using a 4009A and a NE555. The functions are shown in the same relative positions in the block diagram and schematic for clarity.

The crystal oscillator is standard and provides a stable square-wave output. The crystal frequency isn’t critical but should be greater than 1 MHz to allow measuring 1-μF capacitors using a 1-second

![fig. 1. Block diagram of the capacitance measurement attachment for a frequency counter.](image-url)
fig. 2. Typical waveforms. Letters at left key the waveforms to both the block diagram and the schematic.

gate time. CMOS speed is restricted when operating from 5 volts, so frequencies above 2 MHz may not work too well.

The trigger circuit consists of a one-shot started by the leading edge of the gate pulse. The output pulse width is adjustable to allow compensation for the effects of stray capacitance, as described earlier. The one-shot is followed by an inverter, which cleans up the pulse shape and provides the proper polarity to trigger the 555 and drive the AND gate. The capacitance-to-pulse width conversion is done by the trusty NE555 in a standard one-shot configuration.

The AND gate is home-grown CMOS/diode logic, which works well and avoids the need for a third IC. The voltage divider on the output reduces amplitude and, more important, the output impedance, thus avoiding stray pickup from the oscillator.

construction and calibration

Perf board construction is adequate if the ICs are bypassed with 0.01 µF capacitors directly at the Vcc pins and if the output voltage divider is located a short distance from the crystal.

A metal box should be used to house the unit, since it's sensitive to 60 Hz pickup. This phenomenon is evidenced by a slow variation of about one-half per cent in the reading as the counter gate beats with the line frequency. A variation of over 2 per cent occurs without an enclosure.

The 100-pF capacitor at the oscillator output affects starting and should be adjusted for reliable

fig. 3. Schematic diagram. Relative position of functional sections matches the block diagram.
operation. The 830k resistor in series with the calibration pot is actually two resistors in series to get a nonstandard value. Using a higher-frequency crystal may require this value to be reduced for calibration.

The frequency-counter gate signal must be made accessible to allow triggering the unit. I installed two pin jacks in the back of my counter to provide both the gate and +5 volts. I used a 200-pF series capacitor to bring the gate line out, to prevent damage to the counter in the event that the line is inadvertently shorted.

Calibration is best done using a one per cent capacitor with a value of several thousand pF as a standard. Lacking this, several silver-mica capacitors in parallel will probably be adequate, since the deviations from the marked values should average out.

Begin calibration by adjusting the ZERO SET control to the maximum resistance setting. Then, without a capacitor in the measurement socket, adjust ZERO SET until a reading is obtained on the counter. Back off slowly until a zero reading is obtained again. Connect your standard capacitor and adjust the CAL control to obtain the correct reading. Then repeat the procedure to correct for adjustment interaction.

If your counter has 0.1-second and 1-second gate times, be sure to use the 1-second gate when measuring capacitors above 0.01 μF.

variations on the theme

It's possible to add a second range by paralleling the charging resistance (830k + CAL) with values that are a factor of 1000 smaller to allow reading capacitors between 0.001 μF and 1000 μF. Note, however, that capacitor leakage causes artificially high readings, so electrolytics with an internal resistance of 1 megohm or less can't be read accurately.

Much of the circuit is also applicable to using the 555 as a direct-reading ohmmeter covering 1 ohm to 1 megohm in a single range.

concluding remarks

A frequency counter attachment has been described that measures capacitance. My hope is that frequency counters will soon be replaced by multifunction instruments incorporating voltage, current, resistance, capacitance, and frequency-measurement capability, much as the voltmeter was replaced by the VOM. Until that time, the versatility of your frequency counter may be increased with devices such as that described here.

reference

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DIGITAL MULTIMETER

$99.95 WIRED

Low cost, high performance, that’s the DM-700. Unlike some of the hobby grade DMMs available, the DM-700 offers professional quality performance and appearance at a hobbyist price. It features 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch high LED display, with automatic decimal placement, automatic polarity, and overrange indication. You can depend upon the DM-700, state-of-the-art components such as a precision laser trimmed resistor array, semiconductor band gap reference, and reliable LSI circuitry ensure lab quality performance for years to come. Basic DC volts and ohms accuracy is 0.1%, and you can measure voltage all the way from 100 mV to 1000 volts, current from 0.1 mA to 2.0 amps and resistance from 0.1 ohms to 20 megohms. Overload protection is inherent in the design of the DM-700, 1250 volts, AC or DC on all ranges, making it virtually goof proof. Power is supplied by four C size cells, making the DM-700 portable and, as options, a nicad battery pack and AC adapter are available. The DM-700 features a handsome, jet black, rugged ABS case with convenient retractable tft ball. All factory wired units are covered by a one year limited warranty and kits have a 90 day parts warranty. Order a DM-700, examine it for 10 days, and if you’re not satisfied in every way, return it in original form for a prompt refund.

Specifications

DC and AC volts: 100 mV to 1000 Volts, 5 ranges
DC and AC current: 0.1 mA to 2.0 Amps, 5 ranges
Resistance: 0.11 to 20 megohms, 6 ranges
Input protection: 1250 volts AC/DC all ranges fuse protected
Input impedance: 10 megohms, DC/AC volts
Display: 3½ digits, 0.5 inch LED
Accuracy: 0.1% basic DC volts
Power: 4 C cells, optional nicad pack, or AC adapter
Size: 6”W x 3½”H x 6”D
Weight: 2 lbs with batteries

Prices

DM-700 wired + tested $99.95
DM-700 kit form: 79.95
AC adapter/charger: 4.95
Nicad pack with AC adapter/charger: 19.95
Probe kit: 3.95

The CT-70 breaks the price barrier on lab quality frequency counters. No longer do you have to settle for a kit, half-kit or poor performance, the CT-70 is completely wired and tested, features professional quality construction and specifications, plus is covered by a one year warranty. Power for the CT-70 is provided by four AA size batteries or 12 volts, AC or DC, available as options are a nicad battery pack, and AC adapter. Three selectable frequency ranges, each with its own pre-amp, enable you to make accurate measurements from less than 10 Hz to greater than 600 MHz. All switches are conveniently located on the front panel for ease of operation, and a single input jack eliminates the need to change cables as different ranges are selected. Accurate readings are insured by the use of a large 0.4 inch seven digit LED display, a 1.0 ppm TCXO time base and a handy LED gate light indicator.

The CT-70 is the answer to all your measurement needs, in the field, in the lab, or in the ham shack. Order yours today, examine it for 10 days, if you’re not completely satisfied, return the unit for a prompt and courteous refund.

Specifications

Frequency range: 10 Hz to over 600 MHz
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More Details? CHECK — OFF Page 110
cross-guide coupler
for 10-GHz

Design and construction
details of the
cross-guide coupler,
an easy to build
directional coupler
for 10 GHz

When it becomes necessary to sample a portion of the transmitted power from a signal source or transmitter, a directional coupler is normally used. A great variety of commercial couplers are available, but they are beyond the means of most Amateurs. Once in a while, surplus dealers have sales of X-band equipment, but these pieces can still be quite expensive. Sometimes at a ham auction or flea market pieces can be purchased quite reasonably. However, directional couplers are hard to come by, so building one is an alternate approach.

The simplest type of directional coupler is the cross-guide design shown in fig. 1. Many commercial cross-guide designs have cruciform hole coupling which make the coupling ratio and directivity frequency independent.1 Broadwall directional couplers also have broadband performance, but it is at the expense of long length and precision machining. The round hole cross-guide coupler has the advantage of short length and good performance over a limited bandwidth. It is the easiest form to design and build.

design

The practical range of coupling in a round hole cross-guide coupler varies between 20 and 45 dB down from the incident power. Fig. 2 shows the hole arrangement relative to the coupler ports; also shown is a graph of how the coupling varies as ratio of hole diameter to guide width.2,3

The following is an example of a design procedure to build a cross-guide coupler using the graph in fig.

2. First, the center of the 10.0 to 10.5 GHz Amateur band is 10.25 GHz. Since the bandwidth of the round hole cross-guide coupler is approximately 10 per cent, the coupling coefficient should not change more than a few per cent in the 10.0 to 10.5 GHz band. The second step is to decide on the desired coupling ratio. Sources such as reflex klystrons and Gunn diodes, which have an output power in the 10 to 20 mW range, require a sampling coupler to have a coupling ratio of 25 dB or greater. This will keep the power level into the detector in the square-law region. Referring to the graph in fig. 2, the D/a ratio for 26 dB is 0.335, where a is the broad dimension of the waveguide. For WR-90 waveguide (i.e., X-band guide), the broad dimension, a, is 22.86 mm (0.900 inch). The large hole diameter is:

$$D = 0.335 \times (22.86) \text{ mm} = 7.66 \text{ mm (0.3015 inch)}$$

The smaller hole is 2D/3, so:

$$2D/3 = \frac{2(7.66)}{3} \text{ mm} = \frac{2(0.3015)}{3} \text{ inches} = 5.11 \text{ mm (0.201 inch)}$$

Finished directional coupler.

By Richard A. Bitzer, WB2ZKW, 3 Ray Street, Milltown, New Jersey 08850
Now that the hole diameters are known, their distance from the center line of each guide must be \( \lambda_g/8 \). To calculate \( \lambda_g \), the quantities \( \lambda_0 \) and \( \lambda_C \) must be known.

\[
\lambda_0 = \frac{c}{f} = \frac{3 \times 10^8 \text{m/sec}}{10.25 \times 10^9 \text{Hz}} \left( \frac{1.18 \times 10^{10} \text{in./sec}}{10.25 \times 10^9 \text{Hz}} \right)
\]
\[
= 0.02927 \text{ meter (1.152 inches)}
\]
\[
= 29.27 \text{ mm}
\]

where \( \lambda_0 \) = free space wavelength

\( C \) = velocity of light in free space

\( f \) = frequency of operation

For TE\(_{10}\) propagation mode down WR-90 waveguide, the cut-off wavelength is:

\[
\lambda_C = 2a
\]
\[
= 2 \times (22.86) \text{ mm (2(0.9) inches)}
\]
\[
= 45.72 \text{ mm (1.8 inches)}
\]

The guide wavelength, \( \lambda_g \), for TE\(_{10}\) mode is:

\[
\lambda_g = \frac{\lambda_0}{\sqrt{1 - \left( \frac{\lambda_0}{\lambda_C} \right)^2}}
\]
\[
= \frac{29.27 \text{ mm}}{\sqrt{1 - \left( \frac{29.27}{45.72} \right)^2}} = \frac{1.152}{1.800} \text{ inches}
\]
\[
= \frac{29.27}{0.768} \text{ mm (1.152/0.768 inches)}
\]
\[
= 38.10 \text{ mm (1.5 inches)}
\]

The hole centers are \( \lambda_g/8 \) from the center lines of both guides, therefore \( \lambda_g/8 \) is 4.76 mm (0.0187 inch).

The above example can be repeated for any desired coupling ratio between 20 dB and 45 dB, useful over the bandwidth of the 10-GHz Amateur band.

**construction**

The directional coupler uses two 76.2 mm (3-inch) pieces of WR-90 waveguide and four UG-39/U cover flanges. Fig. 3 shows an exploded view of the coupler. From a length of waveguide, cut two pieces 76.2 mm (3-inches) long and file the ends square and smooth. On piece number 1, scribe and drill the hole locations according to the design data. File off all burrs, since it is important not to have any obstruction inside the waveguide. With piece number 2, a slot is to be cut so that this piece fits centrally over the holes in piece number 1. One way to do this is to cut a piece of wood to fit the inside dimensions of the guide and insert it into the guide. Scribe the slot dimensions on the guide and cut on the inside of the scribe marks with a fine hack saw. Do not cut too deep, for the depth of the cut is the wall thickness dimension. The sawdust from the wood should tell you when to stop. The two pieces are placed over one another as shown in fig. 3 and soldered together. Use a torch rather than a heavy duty soldering gun or iron. Be careful not to let any solder run into either guide. If it does, it can be carefully filed out.

The next step is to solder the flanges onto the waveguide sections. Use a piece of flat aluminum sheet to work on. Place the flange face down. Wrap the guide assembly with a damp cloth to keep the two pieces from coming unsoldered while soldering on the flange. Place the waveguide into the flange, supporting the waveguide while soldering. Repeat this step for the remaining flanges. An alternative procedure in soldering the pieces together is to use a higher temperature solder for the cross pieces and a lower temperature solder for the flanges. To complete the job, use emery cloth to smooth finish the flange faces. For appearance, the coupler can be

**fig. 1. Diagram of the cross-guide coupler configuration. Note that the one end of the coupled arm can be terminated.**

**fig. 2. Graph of the relationship between the coupling factor and the physical dimensions of the waveguide and coupling holes.**
painted and labeled, giving a commercial looking appearance.

results

The cross-guide coupler was designed to have the coupled power down 26 dB from the incident power. The measured value of the coupled arm is −26.2 dB. The directivity was measured to be 22.6 dB, about average for cross-guide couplers. Referring to fig. 1, directivity is the ratio of the power down the coupled arm to that coupled into the load arm from the source. The main arm VSWR is 1.03 to 1, and the insertion loss is 0.05 dB. The coupler was used to sample power from a 10-GHz signal source test bench set up. For this application, the decoupled, or load end, arm has to be terminated with a load, which can be easily made by using a 76.2-mm (3-inch) long guide, flange on one end and a copper sheet across the opposite end. Inside, glue a wedge of 3.16-mm (1/8-inch) thick Masonite coated with Aquadag across the center of the narrow dimension of the guide. The VSWR of such a load measured 1.03:1.

references

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gate arrays
for pattern generation

Gate array structuring has been the subject of many papers, and a number of methods have been devised to simplify design. All the methods have one thing in common: pattern recognition by examination. This is true whether you have a static or dynamic pattern.

All large gate structures take a bit of time to design regardless of the examination method. Simple methods can be used in most Amateur designs. The example for this part of the series is a digital CQ generator for perfect CW keying of those two letters.

organization

The basic time period in CW is dot length. Dashes are three dot lengths. Since the letters CQ are familiar, spacing can be shortened to three dot lengths with five dot lengths between groups. (It’s assumed that a letter group will be repeated a selected number of times.)

Dot length will be the clock for a binary counter that times the pattern. Each CQ letter group requires eighteen clocks for key down, fourteen for key up. The total is thirty two, and a five-stage binary counter will take care of timing.

Timing generator lines are labeled A through E (fig. 1), A being the least-significant bit and the fastest. The first step is to tabulate the timing generator states and fit them with the desired pattern. Table 1 shows this.

Both letters are nearly the same length. The E timing line can be used as a letter selector. This simplifies state examination to only four timing lines. Note that the first two states in table 1 are not used.

The timing generator has not been specified, but some assumptions are made. All zeroes will be in a reset condition and must be key up. A binary 00001 may or may not have the same length from all zero to between other states; this is determined from the case where the timing generator clock is not synchronous with manual pattern start.

pattern breakdown

Table 1 indicates that six states of the first four lines are common to both letters. This simplifies gating, because timing line E doesn’t have to be considered for those six states. Only two states are exclusive for letter C; four are exclusive for letter Q.

Common letter states of lines A through D are all even decimally. A will be low for all six. Concentration now narrows to B, C, and D lines for the common states, which allows a detailed breakdown as shown in table 2.

Common states can be reduced to three: ĈB, ĈC, and ĈD. The X is a don’t-care bit state; that bit can be either 1 or 0. Some further examination of don’t-cares will show three other combinations: ĈD, ĈB, and ĈD. Either of the three state combinations can be used. It’s also possible to set up inhibits from ĈB and ĈD. The choice depends on the exclusive letter states. Only letter Q seems to have don’t-cares, with combinations of ĈD or ĈB.

By Leonard H. Anderson, 10048 Lanark Street, Sun Valley, California 91352
also come from the timing generator if inverted states are present.

**a gate array pattern decoder**

Fig. 1 shows one configuration. Common letter states are generated by using the inhibit states from table 2 and creating them in G10 and G11. NAND-gate outputs will be low when all inputs are high (the Nand Rule). G10 and G11 will thus inhibit G12 on states DCB and DBC; G12 is enabled on the other six states.

Choice of inhibit gating allows using DCB for letter Q. An inverter restores the high state for AND operations. State CBA is common to both letters, as is BA. Use of common partial states allows a reduction in total package count, although it may appear to use more gates. Packages have quadruple 2-input gates and dual 4-input gates; it may be that use of more 2-input gates will result in fewer packages.

G14 and G15 AND the two states for letter C. G19 ANDs the DBA don't-care state from table 2, while G20 and G21 AND the remaining two states. G16 and G22 are ORs. G17 and G23 AND each state combination with E and E respectively. G24 ORs everything, and key down occurs when the output is high.

Total package count for the circuit of fig. 1 is six: one hex inverter, two dual 2-input NANDs, and three triple 3-input NANDs (two gates connected as inverters). This isn't very economical or simple in layout — two other digital devices can help simplify things.

**decoders and multiplexers**

A decoder (sometimes called demultiplexer) will provide a single low output on one of two, four, eight, or sixteen output pins depending on one, two, three, or four data select lines. It can be thought of as a rotary switch with a grounded arm and all stator contacts as the outputs. Binary-data-select input will determine switch position.

A multiplexer will select one of two, four, eight, or sixteen inputs based on binary-data-select lines and transfer this information to a single output. The multiplexer can also be thought of as a switch: all inputs go to stator contacts, and the arm is the output. Position is determined by data-select control inputs.

**a simple pattern decoder**

Fig. 2 applies a 74L154 TTL decoder package with other low-power TTL NAND gates to the pattern-decoding task. The 74L154 has sixteen outputs active low and fits the sixteen states of table 1. Its outputs can be ORed as required.

G30 ORs the two exclusive states for letter C, while G31 ANDs them with E. G35 is connected as an inverter to generate E high. G32 ORs the four exclusive letter Q states, ANDing them with E in G33. G34 ORs the six common letter states plus the two ANDed exclusive letter states.

U1 has two chip select pins marked G1 and G2.
These pins are used in arrays of decoders for enabling only one out of many. This circuit has only one chip, so it's enabled all the time by tying both pins low.

**simplest decoder**

This circuit uses a 74150 TTL multiplexer, or mux, and a single inverter as shown in fig. 3. The switch analogy describes operation. Timing lines A through D switch the inputs from E0 through E15 to output W. Inputs are high for key down; low for key up.

Common states of key down are wired to \( V_{CC} \), while unused states (7, 13, 14, 15) are wired to ground; if unconnected in TTL, those inputs will go high. Exclusive letter states are obtained from E directly or from the inverter for \( E \).

The S pin is a strobe, similar to a chip select. It is also used for mux array selection. Note that output W is active low from the inversion bubble (fig. 3).

**timing and polyphase clocks**

Dot rate is quite slow in the CQ generator, so small difference in delay through an array won't be noticed. If the pattern were faster, say for a TV sync generator, the propagation delay differences would be very apparent.

The gate array has propagation delays of three to six gates depending on the path. The decoder delay is slightly shorter but variable. The mux circuit of fig. 3 can be considered even; it's dependent on the internal structure of U2, which is usually symmetrical.

A way to even up differences in delay (some may be from the timing generator) is to use a delayed phase clock line and a D flip-flop for each output. This is shown in fig. 4 and could be used anywhere in a large array.

Very large arrays can use several clock phases or a polyphase clock generator. Five or more phases are not unusual. In the polyphase clock, the different phases have even increments of time delay in the clock period. Each D flip-flop is a latch for a particular line and is clocked by a phase with a differential equal to the maximum of all gate arrays plus setup time of the D flip-flop itself. Delays may differ in the array, but the latch output is synchronized by the delayed clock.

**reference**

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Drake TR-22C sensitivity improvement

A simple modification to the TR-22C has resulted in a significant improvement to the receiver sensitivity. The modification consists of the removal of the built-in telescopic antenna. The antenna is secured to a small plastic block by a single machine screw. To remove the antenna, simply unscrew the antenna from the plastic block and remove it from the transceiver chassis, along with the protective vinyl sleeving covering the antenna. Leaving the plastic block and coaxial cable intact will permit easy reinstallation of the antenna and sleeving should “over-the-shoulder” operation be desired at a later time.

Following removal of the antenna, perform the rf-alignment procedure as follows:

1. Connect a signal generator set at 146.52 MHz to the rear panel antenna connector. Set the level for approximately half-scale deflection on the signal strength meter. I used a friend’s signal on 146.52 MHz in lieu of the signal generator.

2. Adjust Ls1, Ls2, Ls4, Ls9, Ls10, and TcT3 for a maximum signal strength meter reading. TcT3 is located on the transmitter circuit board. The individual trimmers should be peaked several times to ensure optimum performance.

The results of this simple modification have been quite gratifying. Several stations heard prior to the removal of the telescoping antenna were usually in the noise level, if heard at all. After removal of the antenna, these same stations were either full quieting or well above the noise level. It appears that the 0.059-wavelength open-circuited line (i.e., the collapsed telescopic antenna) introduces enough capacitance to the receiver front end to detune it, thereby lowering the sensitivity.

Since I do not have the appropriate test instruments but wanted to verify the much improved receiver performance, I repeated the following tests several times: I contacted several stations using local repeaters or direct simplex operation with both my 5/8-wavelength mobile whip and my J-Pole base station antenna. Signal strength readings were taken before and after the removal of the telescopic antenna (including rf alignment of the receiver). In all tests, the TR-22C showed significant improvement in sensitivity when operated without the built-in antenna.

Further improvements can be made in the receiver’s performance by replacing the jfet Qs7, with a 2N3823, replacing the cable between terminal “RA” on the transmitter circuit board and terminal “RA” on the receiver board, and making sure to solder the braid and center conductor close to the circuit boards rather than on top of the “pins” serving as circuit-board terminals. Replace the existing coax cables with RG/174/U or equivalent.

G. A. Herlich, K7OR

S-line backup power supply

Recently I acquired a Collins 516F-2 power supply with an open circuit high-voltage winding in the transformer. After the initial enthusiasm of rewinding the transformer* had subsided, I sought other means of providing a backup supply for my 32S-1/S3.

Replacement or rewound transformers are available from independent sources as well as Collins, but even then the cost is approximately $100. A good, used, 516F-2 transformer costs around $150; therefore I decided to homebrew a spare supply using readily available parts.

The price of the transformer used in the backup supply (fig. 1) is less than $25 — considerably less than the replacements already mentioned. If a transformer with a higher secondary voltage rating is used (no more than 750 Vac is recommended), a third filter capacitor and bleeder resistor should be added to provide a sufficient safety margin for the plate-supply string. The low-voltage filter as well might be changed from the capacitive input shown to a choke input by eliminating C3 to keep the low voltage supply within the 300-volt range required. A separate 6.3-volt filament transformer connected in reverse supplies the bias voltage. Under full-load conditions, the supply delivers 660 Vdc at 230 mA, 300 Vdc

at 175 mA, 6.3 Vac at 8A, and −80 Vdc for bias.

The supply is contained on a 180 × 230 × 51 mm (7 × 9 × 2 inch) aluminum chassis, which is compatible with the 516F-2 cabinet. If you wish to install the supply in the cabinet, the front and rear chassis lips should be reinforced with flat aluminum stock. A paper or cardboard template may be used to transfer the mounting hole locations to the reinforcements.

Socket SO-1 was included on the chassis' rear lip to provide a switched ac source to power a cooling fan used on the 32S(-). Instead of using the standard ac receptacle (Radio Shack 270-642), a 2-pin male cable/female chassis connector (Radio Shack 274-201 and 274-203 respectively) may be used. The female chassis connector requires a 16-mm (5/8-inch) hole. The female cable power socket (SO-2) is an 11-pin Amphenol 78S-11 with a protective cap and cable-strain relief clamp.

The power drawn by the 32S(-) is well within the transformer's capabilities. After hours of operation on CW, the transformer was only comfortably warm to the touch.

Paul K. Pagel, N1FB

audio modification for Horizon/2

I have an early-model Standard Horizon/2 two-meter rig. I've noticed a lot of audio distortion when stations with very bassy audio come on. Also, PL tones come right through when a larger external speaker is used. The low-frequency rolloff in the receiver audio section is not adequate to keep the audio amplifier IC from being driven into clipping. By replacing the 1-μF coupling capacitor (C134) with a 0.02-μF capacitor unit, the problem was eliminated.

Roy H. Davis, WB9RKN

cliplead carousel

After many frustrating encounters with tangled test leads and several complaints from the YL about "that ball of spaghetti and alligators" hanging from the end of an otherwise neat workbench, I decided there had to be a better way. Encouraged by a sensible system I had admired at the junior college I attend in Rhode Island, I began my improvisation. The method used in school was a long board with slots cut into its edge to accept the ends of the test leads. This was functional, but it took a lot of wall space I didn't have, what with QSL cards, world map, bookshelves, and all. So I "borrowed" a wheel from my son's bicycle parts pile and cut slots into one side of the rim all the way around the wheel. Thinking ahead, I cut some of the slots wider than the rest to accommodate coaxial-type patch cords. The wheel's axle was then secured to the end of a wall bracket with the wheel horizontal at about eye level with the slotted side up. I used a piece of 5-cm (2-inch) aluminum for the bracket, but a standard shelf brace would do as well. Clipleads and patch cords can now be passed up through the inside of the rim and dropped into the slots. This holds them firmly and neatly, easy to see and to get at.

Robert E. Best, WB1AQM
have DTL/TTL compatible outputs and the 567 will sink a 100-mA TTL load at its pin 8 port. This is a low to high logic change, not a positive and negative voltage change in the case of the 567.

Further, Mr. Zegers’ statement that “the place where the missing tone should be is now filled with noise” is not supportable by fact. When a PLL, such as the 567, no longer detects a signal within its passband, it simply changes logic states. If this were not so, the Touch-Tone® decoder circuit using the 567 would not work.

Perhaps Mr. Zegers should examine my keying circuit in more detail. There is no 1V keying used, and while not Mil spec or RS232, it works quite well.

It is not, therefore, “absolutely necessary” to have two tones decoded from a RTTY signal, but it is desirable and that’s why I designed the PLL.

With regard to the reader’s statement indicating I did not read the data sheet, I suggest he reread his. The National Semiconductor Corporation and the Signetics Corporation both list the bandwidth equation as:

$$BW = \frac{1070 \sqrt{V_I}}{f_0^{0.62}}$$

Also, they list the minimum detectable signal as 20 mV, not 20 mW as Mr. Zegers does.

Also they specify the measurement at 20 mV/RMS and further state in the National Semiconductor Linear Data Book that the equation is an approximation only usable to ≤200 mV, so therefore, the 2-volt example given is not valid.

In actuality, the detection bandwidth is 15.1416 percent, not 15 Hz, at 20 mV/RMS input, which indicates that the reader erroneously assumed the resultant of the above equation to be Hz since he indicated that the bandwidth was 15 Hz. The resultant of the bandwidth equation is the percentage of $f_0$ that the PLL will detect and lock onto. At 20 mV/RMS, the detection bandwidth is ±160.8795 Hz, not 15 Hz, and the greatest number of cycles before output at 15.1416 percent bandwidth is 28 Hz not 300 Hz.

Obviously, since bandwidth will widen out between 20 mV/RMS and the saturation point of 200 mV/RMS, an overlap will result between mark (2125 Hz) and space (2295 Hz), and that is why in the PLL article it was necessary to slew the two PLL’s capture frequencies so as to make a “hole” between the two signals. The 2-stage active filter also helped narrow the response envelope to a more acceptable curve.

Finally, I disagree that the 567 was never intended for FSK demodulation. I’m not alone. National Semiconductor agrees with me on page 9-40 of their Linear Data Book, where they list among other uses for the 567 “wideband FSK demodulation.”

John Loughmiller, KB9AT Greenville, Indiana

Yagis vs quads

Dear HR:

I imagine you have received a great deal of correspondence concerning N6NB’s article in the May issue on the quad vs Yagi controversy. At the risk of adding to the bulk of mail you have already received, I would like to make some comments and offer a suggestion.

N6NB developed an excellent article based upon his experiments using the two portable towers and a triband two-element Yagi as a reference. However, the methods used to provide an accurate standard of comparison were not developed in such a manner that would lead me to conclude that a Yagi is better or worse than a quad. Since N6NB did not isolate and control his variables (such as boom spacing on the two-element quad) he really can’t make an objec-tive analysis on the relative performance of each antenna. The question of antenna feedlines for example, was not discussed, yet this variable can be of critical importance in evaluating any antenna array’s performance.

While Mr. Overbeck has shed some light on the quad-Yagi controversy, additional research is required before one can draw the conclusions developed by N6NB.

I would like to suggest that N6NB and his associates continue these experiments using tighter controls on the experimental process with the objective of publishing a follow-on article; then we might be able to objectively decide whether a quad is better or worse than a Yagi, and more importantly, under what conditions.

Dr. Kenneth Jenkins, WB6MMV Portland State University Portland, Oregon

Dear HR:

As Dr. Jenkins points out, there is no question that ignoring feedline loss variables could invalidate comparative antenna gain measurements such as those reported in my article. However, that variable was considered in all of my tests.

Since I had described my experimental procedures in an earlier article (which I footnoted), I did not repeat the full description in this particular article. I assumed that anyone wishing to critically analyze my procedures would read my previous article on the subject.

Dr. Jenkins is correct in stating that I tested only one two-element quad design. It would be interesting to test other two-element quad designs, but I did test all of the most popular designs using three or more elements; reporting how those antennas fared in comparison to Yagis of similar size was the main point of the article. Dr. Jenkins has suggested no experimental errors that would invalidate those results.

Wayne Overbeck, PhD, N6NB Malibu, California
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microcomputer-based morse code transceiver from Xitex

Xitex Corporation in Dallas, Texas, has just introduced a Morse code transceiver designed around a preprogrammed single chip microcomputer for the generation and reception of Morse code signals using a standard ASCII or Baudot terminal (such as Xitex Model SCT-100). Applications include military, Amateur, plus certain commercial systems.

The microcomputer’s on-chip 2048-byte memory contains both the send and copy algorithms, plus a software UART with multiple ASCII and Baudot baud rates. All timing signals are generated internally from a single external 4-MHz crystal. This not only reduces system costs, but also virtually eliminates RFI generation or susceptibility.

The copy portion of the device provides automatic synchronization from 1 to 150 wpm while it is continuously computing and displaying the corresponding wpm value.

The send mode features include precise control of the output Morse wpm rate in unit increments from 1 to 150 wpm, plus a 32-byte FIFO buffer which can be edited prior to transmission.

Another feature permits both send and copy operation in a unique “RTTY Emulate” mode. This permits the transmission of a 60-character ASCII subset using standard Morse codes plus “new” codes designed for special symbols and control characters (such as line feed, space, carriage return, etc.).

The MRS-100 Morse Transceiver will be available in October from authorized distributors or directly from Xitex. It will be offered in three basic configurations: a partial kit including the microcomputer and blank printed-circuit boards for $95; a full kit including an enclosure, power supply and all other components necessary to configure a complete system (less terminal) for $225; plus an assembled and tested unit for $295.

For more information, write Xitex Corporation, 13628 Neutron, Post Office Box 402110, Dallas, Texas 75240.

replacement antennas for handhelds

Centurion International has just introduced a comprehensive line of flexible replacement antennas for handheld radios. Until now, Centurion has been supplying these products exclusively to original-equipment manufacturers and have expanded the line to fit all units.

Four styles are available, one each for low-band and high-band, and a 15-cm (6-inch) whip, or a 5-cm (2-inch) “shorty” for uhf. All styles are available on any of thirteen different connector terminations to fit virtually any model.

The antennas are factory-tuned for high performance and minimum VSWR. Impedance is 50 ohms, and they have a 35-watt power rating. All units are encapsulated and are moisture-resistant.

For more information, contact Centurion International, P.O. Box 82846, Lincoln, Nebraska 68501.

TR-110 Isopack

The new TR-110 Isopack isolation transformer, which eliminates a shock hazard in the testing of transformerless equipment, is now available from B&K Precision Dynascan Corporation. Ruggedly designed for use in industrial, school, or shop-testing applications, the TR-110 Isopack features both direct voltage and dual isolated outputs to ensure operator safety during testing. In addition, the unit also reduces the possibility of damage to ac-powered test instruments due to improper ground connections.

The TR-110 Isopack has an adjustable, isolated, ac output from 90 to 140 volts in nine steps, an important feature for uncovering voltage-sensi-
tive and intermittent faults in TV and audio sets, or for quality control tests to observe the degree of regulation provided by a power supply. In addition, the adjustable output feature allows the user to select a specific line voltage, as often required for standard procedure testing, even when normal line voltage is low.

The isolated output function has a power rating of 350 VA continuous and 500 VA intermittent, and is convenient for connecting both test equipment and the unit to be serviced. An on-off switch and a pilot lamp are provided for the isolated output. The direct outlets are rated at 500 VA continuous.

The TR-110 is available immediately from local distributors at the suggested resale price of $75. For further information on TR-110 and other precision test instruments, contact B&K Precision, 6460 West Cortland Street, Chicago, Illinois 60635.

triband beam

Hustler announces the new Model 3-TBA triband beam antenna. This Amateur beam antenna covers the 10, 15, and 20-meter bands. Longest overall element length is 23 feet 10 inches, and the antenna is designed and tuned for a 24-dB front-to-back ratio. A unique design permits the elements to be much shorter than other beams on the market today.

Boom length is 14 feet and the antenna provides better than 8 dB gain. The 3-TBA handles power inputs of 1 kilowatt and is easily matched to 50-ohm cable.

The antenna is constructed of 100 per cent heavy-anodized aluminum with stainless steel hardware, yet weighs only 36 pounds. The all new Hi-Q trap design uses 12-gauge aluminum wire, requires no capacitors, and, once tuned at the factory, is permanently weather sealed for years of reliable operation. This antenna is sure to be a favorite with those operators entering DX contests.

The 3-TBA has a suggested list of $259.95 and is available now. For further information on this or other Hustler antenna products, write Sales Department, New-Tronics Corporation, 15800 Commerce Park Drive, Brookpark, Ohio 44142.

10-meter mobile antenna

With the 10-meter band now wide open, Hustler recently announced the introduction of a new, center-loaded, mobile 10-meter antenna. The new Hustler Model HOT-10 has a tapered, 17-7 PH, 53-inch stainless-steel mast, center-loaded to 10 meters.

The trunk lip mount includes a 180-degree swivel adjustment for vertical positioning. Supplied with 17 feet of top-quality RG-58 coaxial cable and factory-installed connectors, the antenna is ready to use. No tools are required for quick installation.

The HOT-10 has a suggested list price of $39.95 and is available now. For further information on this and other Hustler antenna products, write Sales Department, New-Tronics Corporation, 15800 Commerce Park Drive, Brookpark, Ohio 44142.

new 10-MHz oscilloscope

Two 10-MHz oscilloscopes recently introduced by Leader Instruments Corporation feature up to 1-mW sensitivity, a capability until now unavailable in low-cost instruments.

William Brydia, vice president of the firm, notes that "this combination of high performance and low cost was made possible by a much simplified design using integrated circuits for many functions. The result is an instrument that is efficient to manufacture, reliable, and very serviceable."

The LBO-513 Single Trace and LBO-514 Dual Trace oscilloscopes are both equipped with 8 x 10 cm displays, Z-axis modulation, X5 magnifier, and complete trigger controls. The LBO-514 Dual Trace unit also provides front panel x-y operation, CH-1/CH-2 trigger selection, and alternate or chopped display modes.

The LBO-513 Single Trace 10-MHz oscilloscope will be priced at $499, and the LBO-514 Dual Trace 10-MHz oscilloscope will sell for $649. Delivery is from stock.

All Leader Instruments carry a two-year warranty backed by conveniently located factory service centers on the East and West Coasts.

For further information, contact Leader Instruments Corporation, 151 Dupont Street, Plainview, New York 11802.

Basic Electricity and Electronics

This is a pair of books published by John Wiley and Sons of New York. They are written in a clear, easy-to-understand manner, and use a self-teaching format throughout each section, followed by a test at the end. You're involved in the text as you go through each subject, and the test provides a check on your performance. The illustrations in each book are well done, and enough of them are used to make each point clearly. There's plenty of room to make notes if you wish.

Basic Electricity is the book to start with, unless you already have a firm foundation in that subject. Even so, a review might just show up a few weak areas in what you thought you already knew. Electronics is the volume of greater immediate interest to the beginning Radio Amateur, but it depends upon the student having a working knowledge of electricity — in fact, the introductory pages in the book state that you should have Basic Electricity first.

Basic Electricity begins with an ex-
planning of what electricity is, starting with the relationship of atoms and electrons, charges that attract and repel, and continues through conductors and insulators. Other chapters delve into voltage, current, resistance, magnetism, inductance, capacitance, and more. Although the list seems long, each chapter is done so well that you seem to breeze right through them, and emerge at the end with a working knowledge of a particular segment of the electrical world.

Electronics follows the same format, starting with a review and test of what you know (or should have learned from Basic Electricity). This is followed by an introduction to some simple electronic components and an explanation of how they work. Diodes, transistors, ac circuits, transformers, oscillators, and amplifiers are among the subjects covered in the eleven chapters.

Anyone who conscientiously follows the lessons in these books will have the groundwork necessary to handle all but the most exotic of electrical or electronic problems he might encounter. Certainly, the theory part of any Amateur exam should hold no fears for one who has completed these two courses.

Both books are a part of what Wiley calls their Self-Teaching Guide, designed to be used by individuals. However, they would also be excellent for anyone who is conducting a class on electrical and electronic theory. At a price of $5.95 each, they'll earn their keep many times over.

Basic Electricity by Charles W. Ryan, and Electronics by Harry Kybett are available from Ham Radio's Bookstore, Greenville, New Hampshire 03048; $5.95 each, plus $1 for shipping and handling. Order JW-74787 (Basic Electricity), and JW-01748 (Electronics).

2-meter magnetic mount antenna

The new model Hustler BBLM-144A 2-meter magnetic mount antenna was recently announced by Newtronics. This base-loaded, 52-inch antenna offers a unique magnetic mount design with much stronger grip per square inch of magnetic surface than normally available in magnetic mounts.

Careful design of the shunt-fed matching system guarantees maximum signal radiation with a low SWR. The tapered stainless-steel radiator provides maximum protection against flutter and detuning at freeway speeds. Power capacity exceeds 200 watts.

The BBLM-144A includes 17 feet of top-quality RG-58 coaxial cable with factory-installed connectors. The unit has a suggested list of $39.95 and is available now. For further information on this and other Hustler antenna products, write Sales Department, New-Tronics Corporation, 15800 Commerce Park Drive, Brookpark, Ohio 44142.

4½-digit high-accuracy DVM

The Model MC-545 is a 4½-digit bench-type multimeter that features five function modes (dcV, acV, dcmA, acmA, and ohms) and provides automatic zero adjustment and polarity indication. The modes appear on the LED display. As an option, a BCD output (8, 4, 2, 1) can be provided for connecting the multimeter between a CPU and a digital recorder.

This highly accurate instrument has (1) a voltage measurement range of 2 to 1000 volts ac and dc; (2) a current measurement range (both ac and dc) from 2 to 1000 mA; and (3) a resistance measurement range to 200 megohms. Maximum indication is 19999 or – 19999.

For more information, write Soar Electronics, 200 13th Avenue, Ronkonkoma, New York 11779.

PE-100 sequential encoder

Communications Specialists announces the introduction of the PE-100 Two-Tone Sequential Encoder.

This desk-top encoder is capable of producing up to one-hundred individual paging codes, or it may be programmed for ninety paging codes and ten group-call codes. Measuring 22 x 18 x 10 cm (8.5 x 7.0 x 3.75 inches) this unit features a high-visibility LED readout display, a twelve-button miniature keyboard, and automatic transmitter keying with a LED indicator.

This encoder is completely solid state and uses digitally synthesized tone frequencies for high stability and accuracy. It is powered by low-voltage ac, which is obtained from an external step-down transformer furnished with the unit, or it may be powered by any unregulated 8 to 16 Vdc source capable of supplying 400 mA.

It is available in all EIA tone frequencies from 268.5 Hz to 3906.0 Hz, with a frequency accuracy of ±10.1 Hz throughout the full operating range. Frequency stability is 0.1 Hz from – 30 to + 85 degrees C.

This unit is compatible with most two-tone sequential systems, such as Quick Call II, Type 99, and 1 + 1. Output connections include isolated double-pole, double-throw relay contacts rated at 1 amperes.

A one-year warranty is given, provided the unit is returned to the factory for repair. Wired, programmed, tested, and complete with all tones, the PE-100 is available for immediate
delivery at $224.95. For additional information contact Communications Specialists, 426 West Taft Avenue, Orange, California 92667.

tunable subaudible tone encoder-decoder

Vega, of El Monte, California, has just introduced a new subminiature, tunable subaudible tone encoder-decoder for handheld radio as well as routine mobile-radio applications. The Model 185 is completely tunable to any EIA CTCSS frequency without adding or changing any components. Measuring just $224.95. For additional information contact Communications Specialists, 426 West Taft Avenue, Orange, California 92667.

tunable subaudible tone encoder-decoder

Vega, of El Monte, California, has just introduced a new subminiature, tunable subaudible tone encoder-decoder for handheld radio as well as routine mobile-radio applications. The Model 185 is completely tunable to any EIA CTCSS frequency without adding or changing any components. Measuring just 25 x 39 x 14 mm ($1 \times 1.5 \times 0.55$ inches), the unit includes a high-pass voice filter and adjustable output level. A unique self-squelching feature eliminates external squelch-circuit connections in most applications, making installation simple and quick. The Model 185 exceeds all EIA specifications, including frequency stability. The Model 185 is available for immediate delivery and comes with Vega’s three-year warranty. Suggested dealer net price is $69.95 in quantities of one to nine. For further information, contact VEGA, 9900 Baldwin Place, El Monte, California 91731.

nonmetal tower guys brochure from Phillystran

A new, free brochure explains ten major advantages of nonmetallic, nonconducting tower guys for radio and TV broadcasters, and for CATV and other signal-reception applications. In addition to dielectric integrity — which eliminates the problems of white-noise arcing and electromagnetic interference (EMI) — these new corrosion-resistant tower guys combine high strength, light weight, and inherent flexibility for installation ease. They also are essentially maintenance-free, even around salt-laden, corrosive atmospheres.

Phillystran tower guys eliminate pattern distortion and white-noise arcing at transmitting tower installations. For tower installations where extreme corrosion of steel guys is an especially severe problem, the new Phillystran guys will provide extremely long life, and, on an installed-cost comparison, will be competitive with conventional metal guys.

For more information, ask for your free brochure from Philadelphia Resins Corporation, 20 Commerce Dr., Montgomeryville, Pennsylvania 18936.

Shure 526T series II microphone

Shure Brothers has announced the new Shure Model 526T Series II Super Punch microphone with new design features that improve its overall versatility for base-station transmissions and make it compatible with virtually all transmitters and transceivers.

The new 526T Series II can be connected to a wide assortment of transceivers with input impedances of 500 ohms or higher. A new six-wire coiled cord and triple-pole, double-throw switch are arranged for universal compatibility with most transceivers. The new microphone can be used to replace original equipment microphones, either ceramic or dynamic, low or high impedance.

Important performance features of the new microphone include a dynamic element and a transistorized preamplifier that operates for hundreds of hours on a standard 9-volt
Hustler Five-Band Trap Vertical Antenna

Hustler recently introduced their new model 5-BTV, a five-band trap, fixed-station antenna. The unit covers 10, 15, 20, 40, and 80 meters (tunable to 75 meters). The 5-BTV consists of the popular Hustler model 4-BTV, RM-80-S resonator and spider assembly.

The Hustler 5-BTV delivers top signal performance, consistent contacts, five-band operation, and complete coverage. Use one feedline — any convenient length; switching or matching devices are not required.

The antenna is 7.7 meters (15 feet 5 inches) long, constructed of the finest-quality, heat-treated seamless aluminum tubing, with all stainless-steel hardware. VSWR is better than 1.6:1 at all band edges. Power capability is full legal limit on SSB and CW.

The 5-BTV has a suggested list price of $134.95 and is available now. For further information on this and other Hustler antenna products, including CB, professional, and monitor, write: Sales Department, Newtronics Corporation, 15800 Commerce Park Drive, Brookpark, Ohio 44142.

CSC logic probe kit

Continental Specialties Corporation, a well-known manufacturer of professional digital troubleshooting instruments, has introduced their first kit-style test instrument, which emulates their line of logic probes.

The kit instructions are well-written, offering step-by-step assembly procedures. Solder, wire, and all miscellaneous hardware are included in the kit — along with the printed circuit board, case, and all components, leaving no extras to buy. Even beginning-level kitbuilders can assemble the LPK quickly.

Once assembled, the LPK offers respectable performance as a logic probe. It is circuit powered through attached clip leads. HI, PULSE and LO LEDs display logic states and transitions. The high gain logic state is defined as 70 per cent or more of the supply voltage, the low state as 30 per cent less, making the probe compatible with most digital logic technologies or families. With its high (300,000-ohm) input impedance, circuit loading is reduced.

With the LPK, even very narrow pulses can be detected. Internal circuitry stretches pulses as short as 300 nanoseconds into 1/10th-second flashes of the PULSE LED: pulse trains at repetition rates up to 1.5 MHz keep the PULSE LED flashing.

The LPK includes self-protecting circuitry which permits the power leads to be connected in reverse or to as much as 25 Vdc without permanent damage; the probe tip, similarly, can contact ± 50 volts continuously, or 110 Vac for up to 15 seconds without permanent damage to the probe.

As a troubleshooting tool, the LPK holds it own against any logic probe in all but very high speed applications. As an educational venture for the kitbuilder, it should be noted that the LPK, while a digital tool, is based on analog circuitry — offering a unique opportunity to see how the two disciplines merge.

For more information, or for the name of your nearest CSC stocking distributor, call Continental Specialties Corporation toll-free at 1-800-243-6077.
TO: All Amateurs
FROM: Wilson Systems, Inc.

Inflation . . . gas shortages . . . etc., all leading to higher prices each week, and cutting
into the amount that we have to spend on our hobby. And face it, our hobby is what keeps
us sane in this runaway inflation period, our escape from the hustle and hectic grind of
working to make a living. We know — we see the same price increases at the grocery store,
the same increases in the gas prices. Wilson Systems, Inc., is going to do something to help
ease the purchase of your new tower and antenna.

As you may know, in January of 1979, Regency Electronics, Inc., purchased Wilson
Electronics Corp. What you may not know is that in August, 1979, Jim Wilson purchased
back the antennas and towers. There is now a new name to look for — WILSON SYSTEMS,
INC. — With the new name and new company comes new ideas, methods, products and
prices. Yes, prices. But not what you might expect. Wilson Systems is LOWERING the prices
to where you will find it hard to believe. Check them out in the following pages of this issue.
You will be surprised and pleased at what you will find.

What are we doing that will enable us to lower the prices? Well, we are Hams, too. We
like to pay the lowest price possible and will spend much time assuring ourselves this is
accomplished. We feel the same higher demands on our money for the house, food, and bills.
And as this demand increases, the amount of money left for our hobby decreases. So when
money is spent, we want the best quality for the best price.

There are a number of ways to bring the cost of a product down. By using a cheaper
grade of material, buying raw materials in larger quantities to obtain a better discount, by
cutting the profit ratio, and by eliminating the middle man. Wilson Systems will not lower
the quality of the product. In fact, we have improved the strength and quality of almost
every antenna in the line. The newly designed monobanders will stay up under heavy icing
conditions when others are falling apart. Wilson Systems is currently purchasing at the
lowest price possible from the aluminum companies, so these methods of cost reduction are
eliminated. The third method mentioned is one that we have decided to consider as a part of
the overall cost reduction plan, yet leaving room for research and development expense, so
we may bring you the products you want and at a price you will like.

The last method mentioned is always a risky one. The dealers do not want their profits
cut back just as you do not want your pay check cut. If you cut the dealers' profits back,
some of them will just push the product that will tend to give them the most profit, rather
than the one that will be the best performing for you. A rather drastic form of this method
is the one that Wilson Systems will be choosing. You will not be able to find the Amateur
products of Wilson Systems in stock at the dealers, or will they probably recommend them.
(After all, as long as they're not handling them and making a profit, why should they pro-
more or even recommend them??) No, you will only be able to enjoy the most product for
the least money by dealing with Wilson Systems factory direct. We will be offering you the
amateur antennas and towers at prices that are below, in most cases, what the dealers pay for
the products of other companies. And to make it even easier, we have a toll-free number for
you to place your order. Now isn't this what you've been looking for? The best product for
the least money!

Just remember these four points:

The fourth point? Remember the name . . . WILSON SYSTEMS, INC.

Yours Truly,
Jim Wilson
Wilson Systems, Inc.
A trap loaded antenna that performs like a monobander! That's the characteristic of this six element three band beam. Through the use of wide spacing and interlacing of elements, the following is possible: three active elements on 20, three active elements on 15, and four active elements on 10 meters. No need to run separate coax feed lines for each band, as the bandswitching is automatically made via the High-Q Wilson traps. Designed to handle the maximum legal power, the traps are capped at each end to provide a weather-proof seal against rain and dust. The special High-Q traps are the strongest available in the industry today.

### Specifications

<table>
<thead>
<tr>
<th>Band MHz</th>
<th>14.21-28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum power input, Legal limit</td>
<td>Up to 9 dB</td>
</tr>
<tr>
<td>Gain (dbd)</td>
<td>Up to 9 dB</td>
</tr>
<tr>
<td>VSWR at resonance</td>
<td>1.3:1</td>
</tr>
<tr>
<td>Impedance</td>
<td>50 ohms</td>
</tr>
<tr>
<td>F/B ratio</td>
<td>20 dB or better</td>
</tr>
</tbody>
</table>

**Boom (O.D. x Length)** 2" x 24/2½"  
**Wind loading** @ 80 mph, 114 lbs.  
**Assembled weight (approx.)** 37 lbs.  
**Surface area** 5.7 sq. ft.  

**SYSTEM 33**  (Formerly System Three)

Capable of handling the Legal Limit, the “SYSTEM 33” is the finest compact tri-band beam available to the amateur. Designed and produced by one of the world's largest antenna manufacturers, the traditional quality of workmanship and materials excels with the “SYSTEM 33”.

New boom-to-element mount consists of two 1/8" thick formed aluminum plates that will provide more clamping and holding strength to prevent element misalignment.

Superior clamping power is obtained with the use of a rugged ¾" thick aluminum plate for boom to mast mounting.

The use of large diameter High-Q Traps in the “SYSTEM 33” makes it a high performing tri-band beam and at a very economical price.

A complete step-by-step illustrated instruction manual guides you to easy assembly and the lightweight antenna makes installation of the “SYSTEM 33” quick and simple.

### Specifications

<table>
<thead>
<tr>
<th>Band MHz</th>
<th>14.21-28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum power input, Legal limit</td>
<td>Up to 8 dB</td>
</tr>
<tr>
<td>Gain (dbd)</td>
<td>Up to 8 dB</td>
</tr>
<tr>
<td>VSWR at resonance</td>
<td>1.3:1</td>
</tr>
<tr>
<td>Impedance</td>
<td>50 ohms</td>
</tr>
<tr>
<td>F/B ratio</td>
<td>20 dB or better</td>
</tr>
</tbody>
</table>

**Boom (O.D. x Length)** 2" x 14/4"  
**Wind loading** @ 80 mph, 114 lbs.  
**Assembled weight (approx.)** 37 lbs.  
**Surface area** 5.7 sq. ft.  

**GR-1**

The GR-1 is the complete ground radial kit for the WV-1A. It consists of: 150' of 7/14 stranded copper wire and heavy duty egg insulators, instructions. The GR-1 will increase the efficiency of the GR-1 by providing the correct counterpoise.
New, Improved Wilson Towers

Hinged Base Plate - Concrete Pad, Heavy Duty Winch

Mounting the House Bracket

The Hinged Base Plate allows tower to be tilted over for access to antenna and rotor from the ground.

FEATURES:
- Maximum Height 45' (will handle 10 sq. ft. at 38') @ 50 mph
- 800 lb. winch
- Totally freestanding with proper base
- Total Weight, 189 lbs.

The TT-45A is a freestanding tower, ideal for installations where guys cannot be used. If the tower is not being supported against the house, the proper base fixture accessory must be selected.

GENERAL FEATURES
All towers use high strength heavy galvanized steel tubing that conforms to ASTM specifications for years of maintenance-free service. The large diameters provide unexcelled strength. All welding is performed with state-of-the-art equipment. Top sections are 2" O.D. for proper antenna/rotor mounting. A 10' push-up mast is included in the top section of each tower. Hinge-over base plates are standard with each tower. The high loads of today's antennas make Wilson crank-ups a logical choice.

TILT-OVER BASES FOR TOWERS

FIXED BASE
The FB Series was designed to provide an economical method of moving the tower away from the house. It will support the tower in a completely free-standing vertical position, while also having the capabilities of tilting the tower over to provide an easy access to the antenna. The rotor mounts at the top of the tower in the conventional manner, and will not rotate the complete tower.

FB-45A... $79.95
FB-61A... 109.95

ROTATING BASE
The RB Series was designed for the Amateur who wants the added convenience of being able to work on the rotor from the ground position. This series of bases will give that ease plus rotate the complete tower and antenna system by the use of a heavy duty thrust bearing at the base of the tower mounting position, while still being able to tilt the tower over when desiring to make changes on the antenna system.

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RB-61A... 179.95

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Prices and specifications subject to change without notice.
At last, the antennas that you have been waiting for are here! The top quality, optimum spaced, and newest designed monobanders. The Wilson Systems' new Monoband beams are the latest in modern design and incorporate the latest in design principles utilizing some of the strongest materials available. Through the select use of the current production of aluminum and the new boom to element plates, the Wilson Systems' antennas will stay up when others are falling down due to heavy ice loading or strong winds. Note the following features:

1. Taper Swaged Elements — The taper swaged elements provide strength where it counts and lowers the wind loading more efficiently than the conventional method of telescoping elements of different sizes.

2. Mounting Plates — Element to Boom — The new formed aluminum plates provide the strongest method of mounting the elements to the boom that is available in the entire market today. No longer will the elements tilt out of line if a bird should land on one end of the element.

3. Mounting Plates — Boom to Mast — Rugged 1/4" thick aluminum plates are used in combination with sturdy U-bolts and "saddles for superior clamping power.

4. Holes — There are no holes drilled in the elements of the Wilson HF Monobanders. The careful attention given to the design has made it possible to eliminate this requirement, as the use of holes adds an unnecessary weak point to the antenna boom.

With the Wilson Beta-match method, it is a "set it and forget it" process. You can now assemble the antenna on the ground, and using the guidelines from the detailed instruction manual, adjust the tuning of the Beta-match so that it will remain set when raised to the top of the tower. The Wilson Beta-match offers the ability to adjust the terminating impedance that is far superior to the other matching methods including the Gamma match and other Beta-matches. As this method of matching requires a balanced line, it will be necessary to use a 1:1 balun, or RF choke, for the most efficient use of the HF Monobanders.

The Wilson Monobanders are the perfect answer to the Ham who wants to stack antennas for maximum utilization of space and gain. They offer the most economical method to have more antenna for less money with better gain and maximum strength. Order yours today and see why the serious DXers are running up that impressive score in contests and number of countries worked.

### SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model</th>
<th>Band</th>
<th>Gain</th>
<th>F/B Ratio</th>
<th>Matching</th>
<th>Longest Element</th>
<th>Boom O.D.</th>
<th>Boom Length</th>
<th>Turning Radius</th>
<th>Surface Area (sq ft.)</th>
<th>Windload @ 80 mph (lbs.)</th>
<th>Maximum Mast</th>
<th>Assembled Weight (lbs.)</th>
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<tbody>
<tr>
<td>M520A</td>
<td>20</td>
<td>11.5</td>
<td>25 db</td>
<td>Beta</td>
<td>36’6”</td>
<td>2”</td>
<td>34’2½”</td>
<td>25’1”</td>
<td>8.9</td>
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<td>2”</td>
<td>68</td>
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<td>M420A</td>
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<td>36’6”</td>
<td>2”</td>
<td>26’0”</td>
<td>22’6”</td>
<td>7.6</td>
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<tr>
<td>M515A</td>
<td>15</td>
<td>12.0</td>
<td>25 db</td>
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<td>25’3”</td>
<td>2”</td>
<td>26’0”</td>
<td>17’0”</td>
<td>4.2</td>
<td>107</td>
<td>2”</td>
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<td>M415A</td>
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<td>Beta</td>
<td>24’2½”</td>
<td>2”</td>
<td>17’0”</td>
<td>14’1½”</td>
<td>2.1</td>
<td>54</td>
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<td>25</td>
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<tr>
<td>M510A</td>
<td>10</td>
<td>12.0</td>
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<td>Beta</td>
<td>18’6”</td>
<td>2”</td>
<td>26’0”</td>
<td>16’0”</td>
<td>2.8</td>
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<td>36</td>
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<td>M410A</td>
<td>10</td>
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<td>25 db</td>
<td>Beta</td>
<td>18’3”</td>
<td>2”</td>
<td>12’11½”</td>
<td>11’3½”</td>
<td>1.4</td>
<td>36</td>
<td>2”</td>
<td>20</td>
</tr>
</tbody>
</table>

Wilson's Beta match offers maximum power transfer.
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**More Details? CHECK — OFF Page 110**

**October 1979**
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<table>
<thead>
<tr>
<th>Model</th>
<th>Continuous Duty (amps)</th>
<th>ICS* (amps)</th>
<th>Size (in.)</th>
<th>Shipping Wt.</th>
<th>Price</th>
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<td>RS-35A</td>
<td>25</td>
<td>35</td>
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<td>RS-20A</td>
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<tr>
<td>RS-7A</td>
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<td>7</td>
<td>3% x 8% x 9</td>
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<tr>
<td>RS-4A</td>
<td>3</td>
<td>4</td>
<td>3% x 8% x 9</td>
<td>5</td>
<td>$39.95</td>
</tr>
</tbody>
</table>

*ICs — Intermittent Communication Service (50% Duty Cycle)

Inside View — RS-12A

SECURITY CN IDENTIFIERS

MODEL 97812

PREPROGRAMMED MEMORY ID’s

MODEL 97812 — Multi-mode MCW ID’er • adjustable audio level • programmable code speed, tone & repeat interval • manual, auto & semi-auto modes • PTT latch circuitry to keep transmitter keyed during ID. • for repeater, base or mobile operation • 1.7” x 3” PCB. $44.95 kit*, $56.95 assembled**

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TECHNICAL MANUALS for Military Equipment. Government classification and nomenclature identification charts included with catalog, $1.00, Colonel Russell, 9410 Walthamp, Louisville, Kentucky 40222.

PORTA PAK — Make your FM mobile a self-contained portable. Models in stock up to 1000 watts. 4.5 amp hr model $80.00. 9 amp hr $103.00. Charged includ- ed, shipping extra. P.O. Box 67, Somers, Wi 53171.

HAM MAGAZINES starting with 1940 for sale. QST, HR, 72, CQ, SASE for list. WB0X, Box 452, Birmingham, Michigan 48012.

KITS: ST5X Terminal Unit/Power Supply/AFSK. WRJ, R88T. Give your name & address (subject to our editing). Repeat insertions of hamfest ads pay the non-commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency commissions allowed. Material should be typewritten or clearly printed (not all commercial rate. No cash discounts or agency

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MORE DETAILS? CHECK — OFF Page 110
ERC PROMISES UPTO THE MINUTE STATE-OF-THE-ART DESIGN AND PERFORMANCE WE'VE DONE IT FOR 1979

FOUR SIMULTANEOUS FILTERS IN ONE FOR UNPARALLELED QRM FREE RECEPTION (SSB & CW) PLUS A SPECIAL PATENTED CW PROCESSOR*

* THE BRAND NEW SL-56 AUDIO ACTIVE FILTER SUPERcedes OUR SL-55 IN BOTH CONCEPT AND PERFORMANCE. CONSOL-
* IDATION OF MANY COMPONENTS HAS ALLOWED US TO MAKE THE OPERATIONAL IMPROVEMENTS (COMARED TO THE SL-56) IN A FILTER GUARANTEED TO DO ANYTHING AT A COST ONLY SLIGHTLY higher THAN THE SL-55. THE FEATURES OF THE SL-56 ARE SO ADVANCED FROM ITS PRECEDE-
* NER'S THAT CALLING IT THE SL-55A IS NOT JUSTIFIED, UNLIKE OTHER FILTERS WHICH COST MORE, THE FILTERS OFFER A CHOICE OF ONE OR TWO FILTER TYPES AT A TIME (NOTCH, SBS, ... LMPS, ETC.) SL-56 PROVIDES WHAT IS REALLY NEEDED --- THE SIMULTANEOUS ACTION OF VIPE, 200-1600 Hz LOWPASS FILTER AND 6 POLE 5000 Hz HIGHPASS FILTER WITH A 60 db NICHOL WHICH IS TUNABLE OVER THE ULTRA WIDE 200-1600 Hz RANGE. THIS 3 FILTER COMBINATION IS UNBELIEVABLE IN QRM FREE SSB RECEPtion, ADJACENT CHANNEL QRM IS ELIMINATED ON THE HIGH AND LOW SIDES AT THE SAME TIME AND DOES NOT INTRODUCE ANY HOLLOWNESS TO THE DESIRED SIGNAL. ON CW THE SL-55 IS A DREAM, THE LOMPASS, HIGHPASS AND NOTCH FILTERS ARE ENGAGED ALONG WITH THE TUNABLE BANDPASS FILTER (400-1600 Hz) PROVIDING THE NEEDED ACTION OF 4 SIMULTANEOUS FILTER TYPES. THE BANDPASS MAY BE MADE AS NARROW AS 14 Hz (360). ADDITIONALLY, A SPECIAL PATENTED CIRCUIT FOLLOWs THE FILTER SECTIONS WHICH ALLOWS ONLY THE SEEN SIGNAL TO "GATE ITSELF" THROUGH TO THE SPEAKER OR HEADPHONES (2-4000 Ohm). RECEIVER NOISE, RING AND OTHER SIGNALS ARE REJECTED. THIS IS NOT A GENERATOR, BUT A MODERN CONCEPT IN RECEPTION. THE SL-56 CONNECTS IN SERIES WITH THE RECEIVER SPEAKER OUTPUT AND DRIVES ANY SPEAKER OR HEADPHONES WITH ONE WATT OF AUDIO POWER. REQUIRES 115 VAC. EASILY CONVERTED TO 12 VOLT OPERATION. COLLINS GRAY CABINET AND WRINKLE GRAY PANEL.

WARRANTY ONE YEAR FULLY RFI PROOF FULLY WIRE D AND TESTED AVAILABLE NOW $75.00 POSTPAID IN THE USA AND CANADA. VIRGINIA RESIDENTS ADD 4% SALES TAX.

ATN SL-55 OWNERS: THE CIRCUIT BOARD OF THE SL-56 IS COMPLETELY COMPATIBLE WITH THE SL-55 CHASSIS. OUR RETROFIT KIT IS AVAILABLE AT $55.00 POSTPAID.

ERC INTRODUCES A BRAND NEW CONCEPT IN THE MEASUREMENT OF VSWR AND POWER ACCEPTED BY THE LOAD

Requires 115 vac at less than 1/16 Amp.

Collins Gray Cabinet.

Dimensions: 3.5 x 5.5 x 7.5 inches.

Weight: 2 pounds.

The model SL-56* (20-2000 watts) and the ORP model SL-56A* (0.2-20 watts) digitally indicate antenna VSWR under any transmission mode --- SSB, CW, RTTY, AM etc. There is no calibration required and no magnetic meter needles to interpret. Simply look at the readout and that is the VSWR. The only signal indicator that lets you know the state of your antennas and transmitted power at all times while transmitting. Either model is a sophisticated device containing four circuit boards and thirteen integrated circuits.

SL-56 VSWR INDICATOR

** Two digit display indicates VSWR or resistance ratio of the antenna to the load, and provides a reliable check of the antenna system and the match between the antenna and the transmitter. The display is easy to read and is not affected by the antenna feedline. This feature is important in determining the overall performance of the antenna system. The display also indicates if the antenna is properly connected to the transmitter, and if any adjustments are necessary.

WARRANTY ONE YEAR

SL-56 NET POWER INDICATOR

- The net power indicator displays the detected peak of the net power for any modulation type. This is the power that the transmitter puts out, and it displays a delay time of about one second.

- The display is full. This means that the antenna is operating at its maximum efficiency and is not losing any power due to mismatch.

- The display is low. This indicates that the antenna is not operating at its maximum efficiency and is losing power due to mismatch.

- The display is zero. This means that the antenna is not connected to the transmitter, or is connected incorrectly.

- The display is high. This indicates that the antenna is operating at its maximum efficiency and is not losing any power due to mismatch.

- The display is off. This means that the antenna is not connected to the transmitter, or is connected incorrectly.

- The display is not working. This indicates that the antenna is not connected to the transmitter, or is connected incorrectly.

- The display is not connected. This means that the antenna is not connected to the transmitter, or is connected incorrectly.

- The display is not working properly. This indicates that the antenna is not connected to the transmitter, or is connected incorrectly.

- The display is not responding. This means that the antenna is not connected to the transmitter, or is connected incorrectly.

- The display is not functioning. This indicates that the antenna is not connected to the transmitter, or is connected incorrectly.

- The display is not showing anything. This means that the antenna is not connected to the transmitter, or is connected incorrectly.

- The display is not showing any information. This means that the antenna is not connected to the transmitter, or is connected incorrectly.

- The display is not showing any data. This means that the antenna is not connected to the transmitter, or is connected incorrectly.

- The display is not showing any results. This means that the antenna is not connected to the transmitter, or is connected incorrectly.

- The display is not showing any measurements. This means that the antenna is not connected to the transmitter, or is connected incorrectly.

- The display is not showing any values. This means that the antenna is not connected to the transmitter, or is connected incorrectly.

- The display is not showing any readings. This means that the antenna is not connected to the transmitter, or is connected incorrectly.

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These CRYSTAL FILTERS are for you!

600 Hz 6-Pole First - IF Filter for Drake R-4C
Superior bandpass, low loss. Improve the early-stage selectivity. Eliminate those high-jittered beat notes from signals that leak around the switchable second-stage IF filter. Recognize the change of strong signals overlapping the second noise, easing intermodulation and desensitization. Both the existing filter and our CF-600/6 can be mounted in the receiver and relay switched to retain phone sensitivities. CF-600/6: $80.00. Relay switch kit: $33.00.

125 Hz 8-Pole Second - IF Filter for R-4C
Still sharpest available! 375 Hz at 0 dB. Cuts QRM. Ideal for DX and contest work. Unaffected under crowded bands conditions. More selective than audio filters. Puts selectivity in AGC loop. Unlike audio filters, receiver gain not reduced by QRM outside passband. CF-125/8: $130.00.

Superior 8-Pole CW Selectivity for TR-4s
350 Hz at 6 dB, 850 Hz at -90 dB. Cuts QRM. More selective than 6-pole CW filter in TR-4s. For all TR-4s: $26.00 and above. CF-350/8: $120.00. Switch and mounting kit: $18.00.

Signal/Line CX-7, CX-11 8-Pole CW Filter
All-purpose Off bandwidth, low-loss, 350 Hz. Ideal for RTTY. CG-350/8: $120.00.

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MICHIGAN: 25th Annual VHF Conference, Saturday, October 27, 1979 at the I & E Building, Western Michigan University. Topics include Non-Yagi VHF Antennas, A New Method of Tuning the Baseloaded VHF Whip, and Microprocessor Basics for Amateurs. Dinner (by reservation only) - Deadline date October 24th at University Student Center. Registration $2, dinner $7. Make checks payable to Electrical Engineering Department, WMU, Kalamazoo, MI 49003.


MASSACHUSETTS: The Framingham Area Radio Association's indoor electronic flea market, Sunday, November 11, Framingham police drill shed behind the police station. Sellers set up 9 to 10 AM. Doors open 10 AM to 2 PM. Advance table reservations $5.00. Tables at door $7.50 (if available). Talk-in 75-15 and 52 direct. Refreshments available. Information or reservations: Framingham Area Radio Assoc., P.O. Box 1000, Framingham, MA 01701.

FLORIDA: The Florida Gulf Coast Radio Council's ARRL State Convention, November 17 and 18, Sheraton Sand Key in Clearwater Beach. Exhibits, forums, technical sessions and more. Ladies' forum, Sunday Luncheon and Fashion Show. Banquet Saturday evening. For information: The Florida Gulf Coast ARC, P.O. Box 157, Clearwater, FL 33717.

PENNSYLVANIA: The Foothills ARC, Greensburg, will be celebrating its 20th anniversary by holding a Mini-Field Day, Saturday, October 20, 1400 UTC thru 1400 UTC on October 21. Phone and CW operation on 10 thru 80 meters, 5-10 kHz up from bottom of General Class portion of each band. Certificates will be awarded to anyone working WLOV. SASE required.

CALIFORNIA: ARRL Southwestern Division Convention, October 19, 20, 21, 1979 at the Sheraton-Anaheim Hotel located at Ball Road and Interstate 5 in Anaheim, California. Friday, 4 PM - 9 PM, Saturday, 8 AM - 3:30 PM, 4 PM to 5:30 (ARRL Forum). 5:30 - 7:30 PM cocktail party; and 7:30 PM Banquet. Sunday, 0001 AM P.S.T. the WOUFF HONG Pageant; 9 AM breakfasts; and exhibits until noon. For more information or pre-registration, contact: HAMCON, P.O. Box 1227, Placentia, CA 92670. (714) 950-7140.

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Coaxial RF Probe for Frequency Counters and Oscilloscopes That Lets You Monitor Your Transmitted Signal Directly From the Coax Line.

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FINALLY! A RF PROBE that lets you connect into your coax cable for frequency measurements and modulation waveform checks directly from the transmitter.

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A NECESSITY IN ANY WELL-ORGANIZED HAM SHACK, the CoaxProbe* eliminates "jerry-rigging" and hassles when tapping into the coax line is desired.

A SPECIAL METHOD OF SAMPLING keeps output relatively constant with a wide variation of power. Power output of 8 watts gives .01v out, while 800 watts will give 1.8v out. (rms 3-30 mhz.) 2000 watts PEP rating too!

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USE IT ON 2 METER RIGS TO ADJUST FREQUENCY. The CoaxProbe* has a range of 1.8 to 150 mhz.

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NOW YOU CAN MONITOR SIGNALS when connected to the dummy load, eliminating unnecessary on-the-air radiation.

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THE MOST ADVANCED HF SSB TRANSCEIVER AVAILABLE.
FULLY SOLID-STATE SWAN ASTRO 150
Discover the unrivaled 
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Continuously variable to suit your preference.

Passband Tuning with 16 Pole Filters
Two 8-pole crystal filters in cascade provides a 1.4:1 shape factor at -100dB! The ultimate in selectivity.

Tunable Notch Filter
Provides the ability to "notch out" QRM. When used in conjunction with the passband tuning, provides the ultimate in removing interference.

Dual PTO's
Two independent high stability PTO's provide true split band operation. The digital counter reads the PTO selected, or in split band reads the PTO used for receive, then switches to the transmit frequency selected when the mic is keyed.

All Band Coverage using PLL and Synthesizer for Band Selection
Full coverage of 160 meters through all of 10 meters in 9 ranges...diode matrix programmed for now — or for the future!

The ASTRO 102BX with its companion PSU-6 Power Supply, 1500Z Linear Amplifier and ST-2A Antenna Tuner provides a matched and highly efficient 1500 watt PEP or 1000 watt CW complete station to be complemented by a great Swan antenna.
<table>
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<tr>
<th>State</th>
<th>Location</th>
<th>Address</th>
<th>Phone</th>
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<tr>
<td>Arizona</td>
<td>Ham Shack</td>
<td>4506-A NORTH 16TH STREET PHOENIX, AZ 85016</td>
<td>602-279-HAMS</td>
<td>Serving all amateurs from beginner to expert. Classes, sales &amp; service.</td>
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<tr>
<td>Arizona</td>
<td>Kryder Electronics</td>
<td>5520 NORTH 7TH AVENUE NORTH 7TH AVE. SHOPPING CTR. PHOENIX, AZ 85013</td>
<td>602-246-3799</td>
<td>Your Complete Amateur Radio Store.</td>
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<td>Power Communications</td>
<td>6012 N. 27 AVE. PHOENIX, ARIZONA 85017</td>
<td>602-242-6030</td>
<td>Arizona’s #1 “Ham” Store.</td>
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<td>California</td>
<td>JUN’S ELECTRONICS</td>
<td>11656 W. PICO BLVD. LOS ANGELES, CA 90064</td>
<td>213-242-2258</td>
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<td>California</td>
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<td>408-998-5900</td>
<td>One mile off I-95, no sales tax.</td>
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<td>408-247-4220</td>
<td>Audiocassettes — since 1933.</td>
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<td>Thomas Communications</td>
<td>3956 N. MILWAUKEE AVE. CHICAGO, IL 60630</td>
<td>312-631-5901</td>
<td>Serving the world’s Radio Amateurs since 1933.</td>
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<td>Connecticut</td>
<td>Erickson Communications</td>
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<td>312-631-5181</td>
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<td>312-420-8629</td>
<td>“Amateur Excellence”</td>
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<td>Illinois</td>
<td>Erickson Communications</td>
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<td>312-631-5901</td>
<td>“The place for great dependable names in Ham Radio.”</td>
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<td>Iowa</td>
<td>Bob Smith Electronics</td>
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<td>219-484-4446</td>
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<td>913-381-5901</td>
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<td>New - Used HF, VHF, &amp; Microwave Gear. Manufacturing &amp; Sales.</td>
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<td>Maryland</td>
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<td>301-247-4436</td>
<td>Contact Ham Radio now for complete details.</td>
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<tr>
<td>Massachusetts</td>
<td>Spectronics, Inc.</td>
<td>1009 GARFIELD STREET OAK PARK, IL 60304</td>
<td>312-848-6777</td>
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<td>You Should Be Here Too!</td>
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Dealers: **YOU SHOULD BE HERE TOO!** Contact Ham Radio now for complete details.
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<td>PAL ELECTRONICS INC.</td>
<td>3452 FREMONT AVE. NO. MINNEAPOLIS, MN 55412</td>
<td>Minneapolis</td>
<td>612-521-4662</td>
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<td>Concord</td>
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<td>New and Used Ham Equipment WA2AET “T” Bruno</td>
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<td>Syracuse</td>
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<td>Farmingdale</td>
<td>516-293-7990</td>
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<td>AMATEUR RADIO SALES &amp; SERVICE INC.</td>
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<td>Columbus</td>
<td>614-236-1625</td>
<td>Antennas and Towers for All Services.</td>
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<td>KRYDER ELECTRONICS</td>
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<td>Oklahoma City</td>
<td>405-789-1951</td>
<td>Your Complete Amateur Radio Store</td>
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<td>HAMTRONICS, DIV. OF TREVOS ELECTRONICS</td>
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<td>Scranton</td>
<td>717-343-2124</td>
<td>Authorized Atlas Radio East Coast Service Center.</td>
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<td>COMMUNICATIONS CENTER, INC.</td>
<td>443 NORTH 48TH ST. LINCOLN, NE 68504</td>
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<td>402-328-4097</td>
<td>ICOM, Bird, Cushcraft, CDE, Ham-Keys, VHF Engineering, Antenna Specialists.</td>
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<td>814-455-7674</td>
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