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APRIL 1972

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editor

Douglas S. Stivison, WA1KWJ
assistant editor

Nicholas D. Skeer, K1PSR
vhf editor
J. Jay O'Brien, W6GDO
fm editor

Alfred Wilson, W6NIF
James A. Harvey, WA6IAK
associate editors

Curt J. Witt
art director

Wayne T. Pierce, K3SUK
cover

T. H. Tenney, Jr. W1NLB
publisher

Hilda M. Wetherbee
advertising manager

offices

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

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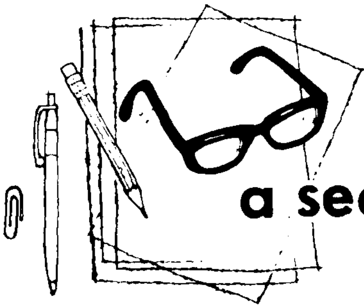

a second look

by jim fisk

Early this month a team of scientists from the Signetics Research and Development Department in Sunnyvale, California announced completion of a revolutionary new instrument that promises to transform every field of human endeavor, from radio communications to theology. Led by bio-electronics expert Dr. Ulfias Stopgapski, famous for his theory of positive retrogression, the team unveiled the instrument, called the *omphalometer*, on the first of April.

"The instrument is the ultimate outgrowth," Dr. Stopgapski said, "of my theory of retrogression. I first conceived the idea while assisting my good friend, Professor Ottmar Heissluft, catalog some Tibetan relics in Stanford University's Museum of Anthropology. We were cataloging what were reputed to be dried parts of the antomy of the Yeti, the so-called Abominable Snowman of the Himalaya. These were actually dried navels. I noticed that no two were alike, and this led me to launch a small investigation of my own, involving several volunteers from the Life Sciences Department. Sure enough, all the navels were different."

By using the omphalometer (the name comes from *omphalo,* meaning navel, with the suffix *meter*, or "means for measuring") an operator can perform *omphaloskepsis*. This later technique is, in Dr. Stopgapski's words, "Mediation while gazing at the navel, as practiced by some mystics. This is the first electronic instrument in the world by which the American public can become mystics and omphaloskeptics at home. Monastaries and prolonged meditation are now obsolete."

After sample markets in the United States are tested, the instruments will be exported to the Far East where the demand is expected to be enormous. It may also play a vital role in the Vietnamization Program, although details are reported to be classified.

With the latest scientific evidence showing that palmistry has some validity, the medical world is hailing the omphalometer as a significant new means of prognosis, for it establishes the pattern of the navel's convolutions and thus indicates the future course of a disease. In fact, a patient's *omphalospectograms* can be compared by computer with thousands of others to predict future events and future illnesses. To convert a standard omphalometer to medical use the operator merely attaches an *OmPhallus Probe* to the patient's navel.

Nor is medicine the only application for the versatile omphalometer. One security officer, speaking for the members of his profession, stated that the instrument will soon be installed at all plants that have won contracts from the Government. "It's a natural," he said, "No two belly-buttons are alike, and you know what that can mean to the surveillance and detection people. Why, heck, we'd do away with ID badges. All the employee would have to do would be to show his navel to an *OmphaloScanner,* and the door would open electronically, click-shoosh, at least if he didn't have anything to hide."

Jim Fisk, W1DTY
editor

My thanks to Roy Twitty, public relations manager of Signetics Corporation, for providing this bit of nonsense, which combines equal parts of St. Patrick's Day blarney and April First foolery.

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two meter fm transmitter

Reliability, economy and proven design characterize this five-watt fm transmitter

Ron Vaceluke, W9SEK, 17 West 540 Hillcrest, Wood Dale, Illinois 60191

In the September, 1970 issue of *ham radio*, Joe Price, WA9CGZ, and I described a 2-meter fm receiver and promised a companion transmitter. This is it! Our goals were similar to those laid down for our receiver: it had to give good performance without costing a fortune to build. Power output had to be adequate not only for repeater use but for point-to-point work as well. This meant that a power output of about 4 to 6 watts was desirable, without the use of vswr protection circuitry.

swr considerations

The lack of vswr protection may raise a few eyebrows, but let's consider this for a while. In the "good old days" when tubes were still being used, vswr protection was never thought of in a ham rig. No one in his right mind would operate his rig without an antenna connected

RMV Electronics, Box 283, Wood Dale, Illinois 60191 can supply a complete parts kit and assembly manual for this transmitter for $59.95 plus $1.40 postage. RMV also can supply just the printed-circuit board, coil forms and assembly manual for $14.50. postage paid. The ferrite beads mentioned in the text are also available, nine for $1.00, postage paid, from the same source. Illinois residents should add the 5% sales tax.

because the tube in the final amplifier would blush red before turning white hot and melting. Then the operator would blush and . . .

Of course, a tube was more forgiving; it could take more abuse before failing than could most transistors. A high vswr is not only rough on the transmitter but is also an indication that something is not performing properly, which usually amounts to poor efficiency. This results in having to run more power output to make up for losses in a poor antenna system. The cheapest way to improve not only *transmitter output efficiency*, but receiver sensitivity as well, is to use a good antenna with a low vswr. This, of course, holds true for any rig, on any band.

Occasionally things go wrong and damaging conditions can crop up (or *off* when the car wash chops the antenna from the car) which place the final amplifier in jeopardy. Most commercial rigs have vswr protection circuits built in *because of economic necessity*. After all, it's far better to install an inexpensive rf power transistor and its attendant protection devices than to invest in a good unprotected rf power transistor. The only problem with this is that protection circuits often fail at times when they are needed the most.

The transistor used in our design is made by Fairchild Microwave and Optoelectronics, part number MSA8508. This device was chosen after testing less expensive devices which would blow when the load was removed or the antenna jack was shorted. The MSA8508 withstood this test as well as vswr from unity to infinity.

crystal oscillator

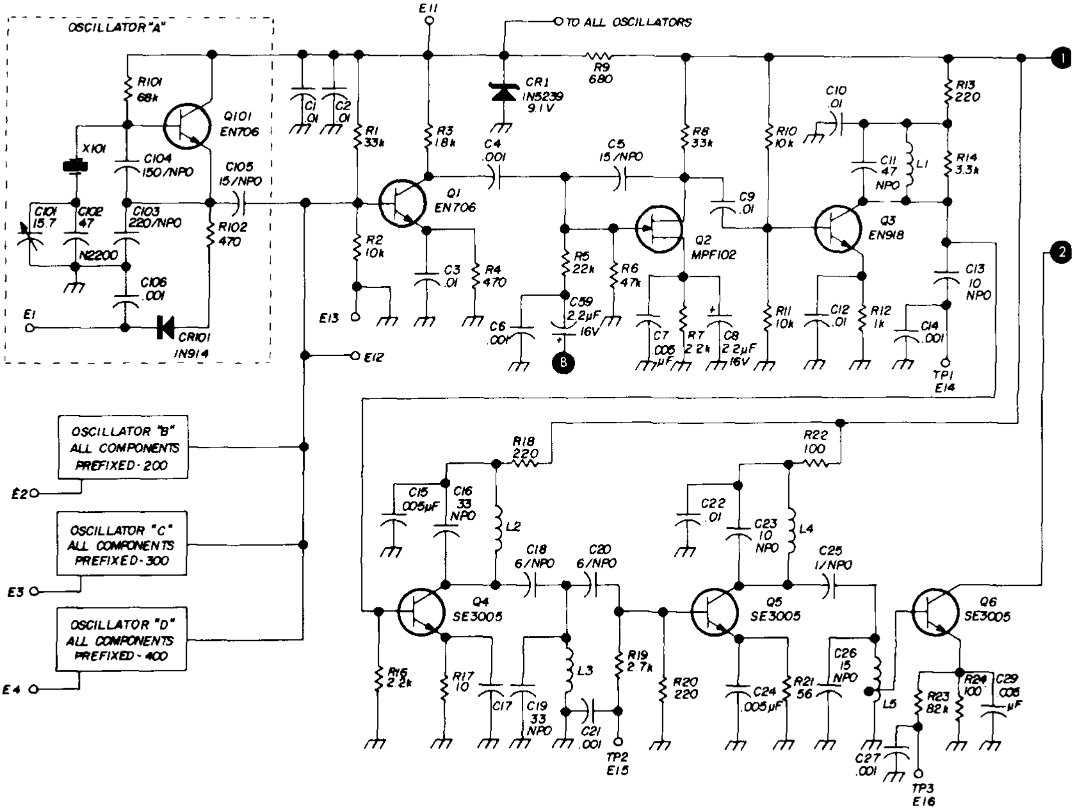
The crystal oscillator was next in line for a shakedown. I felt that an oscillator that could be switched remotely would be more desirable than one which had to have its crystal switch placed right at the transmitter board. Early attempts at switching the crystals with diodes did not work out very well because of the diodes' change of junction capacitance and resistance with change in temperature. Commercial two-way radio equipment has always used a separate oscillator for each frequency, and it's easy to see why. This, then, was our choice also; four channels would be a good start and could be added to, if desired. If maximum stability is desired, use a good quality crystal manufactured by a reputable firm. Buying poor grade crystals is false economy. We recommend the 0.0005% temperature and frequency tolerance; crystals will vary widely from unit to unit *even though they are made by the same* manufacturer.

circuit description

Each oscillator has its emitter lead brought out to a terminal which is grounded for operation and left open if not used. A diode is included in each emitter lead to provide isolation and prevent false operation if other voltages are present on the frequency-selector switch contacts. The output of each oscillator is connected to the input of a buffer amplifier, Q1, which is slightly forward biased.

Following the buffer is an MPF102 fet phase modulator, Q2. This has both the rf and audio applied to its gate input and produces a phase-modulated signal at the output. A slight amount of a-m is also produced but is removed by the following stages. Transistors Q3 thru Q6 are all frequency doublers which multiply the 9-MHz signal sixteen times to the resultant 144-MHz signal which is applied to Q7 for further amplification. The outputs of Q4, Q5 and Q6 are all double-tuned to reduce the passage of undesired frequencies which are usually present.

Transistor Q7 is a straight-through amplifier and uses a Motorola 2N4427. I emphasize the manufacturer of this device because I found that transistors carrying the same number by a different manufacturer could not produce the output required while the Motorola units did. This conclusion was not reached on



C32, C48, C54, C101, C201, C301, C401	1.9-15.7 pF variable	C43	7-100 pF variable
C37	8-60 pF variable	C44	37-250 pF variable
		L1	21 2/3 turns no. slug tuned. This and all other coils have an inner diameter of 0.215 inches.

fig. 1. Schematic of the two-meter fm transmitter.

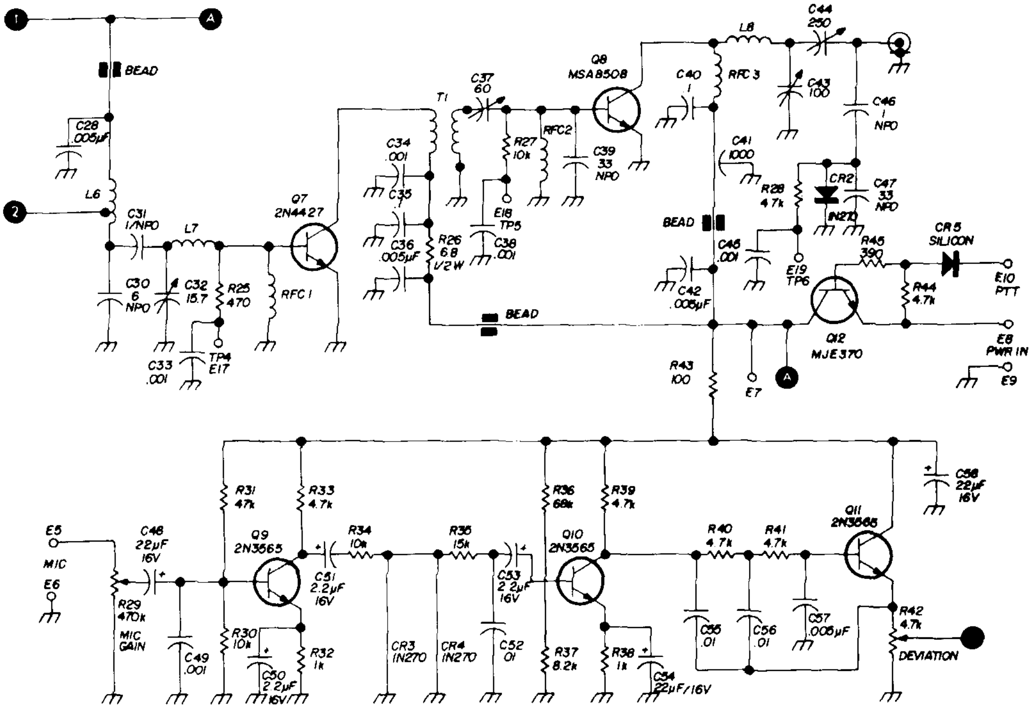
the basis of one rig but of many that have been built. A HEP S3001 is also a good choice for Q7.

The rfcs in the base leads of Q7 and Q8 consist of a 10-ohm resistor and two ferrite beads. The rfc in the base lead of a power-amplifier stage can be the cause of many headaches to someone trying to get one of these devices to work. A choke with a high Q can cause the stage to be highly unstable, while a very low-Q choke will begin to shunt some of the drive and therefore, be wasteful. I found the present value by cut-and-try. The final amplifier, Q8, produces approximately 5- to 6-watts output which can be connected to an antenna or a power amplifier.

Use a 50-µA meter or vom for metering. Test point TP6 uses a capacitive divider and diode rectifier to indicate relative rf output. All other test points except TP3 measure the developed base bias of the stage being checked; TP3 measures the emitter voltage of Q6.

audio stages

Transistors Q9 thru Q11 amplify the low output from the microphone to the level necessary for the modulator stage. The input is designed for a dynamic microphone. Two controls are provided in the audio stages. R42 is the deviation control which, when set at maximum, will give about 10-kHz deviation. The microphone gain control, R29, is used to



L2,L3	7 1/3 turns no. 24, slug tuned	L8	2 turns no. 18, air wound
L4	7 1/3 turns no. 22, slug tuned	RFC1,RFC2	2 ferrite beads and a 10 ohm, 1/2 watt resistor
L5	7 1/3 turns no. 22, slug tuned, tapped at 1 2/3 turns	RFC3	5 3/4 turns no. 20, air wound
L6	4 2/3 turns no. 20, air wound	T1	5 1/2 turns no. 20, primary, 1 1/2 turns no. 20, secondary interwound with primary
L7	7 turns no. 20, air wound		

compensate for the output level of the different type microphones that may be used with the rig. Do not use R29 for deviation adjustment because you want as much audio as can be tolerated by Q9. This is because the semilog clipping action of diodes CR3 and CR4 depend upon a strong audio signal being delivered to them. If the output of the microphone, compressor or RTTY afsk generator is very high, Q9 will be driven to the point of distortion; R29 should be set just below this point.

Transistor Q12 switches power on during transmit and off during receive. Normally the transistor is not conducting – it's like a switch that is open. However, when the cathode of diode CR5 is grounded, Q12 will conduct, and the switch is closed. Power is distributed to all circuits through a liberal amount of decoupling circuits. These decoupling circuits are highly recommended to minimize stray coupling through the power distribution circuitry. Part of the decoupling scheme used on Q6, Q7 and Q8 is ferrite beads; they perform this function well at these frequencies.

Power for the oscillators is derived from zener diode CR1 and limiting resistor R9, providing regulated 9.1 volts. Voltage to the transmitter should be kept between 12 and 15 volts. Five-watts output will be easily obtained at 13.6 volts; this is the average voltage found on an automobile battery that is being charged with a running automobile engine.

The transmitter is built on a 3 x 7-inch double-sided G-10 printed-circuit board. The top surface is used as the ground with all remaining conductor paths on the bottom. Most of the resistors are mounted vertically to save space. If PC-board construction is not desired it can be built on perforated board, but be certain to allow a wide ground path for best results.

Heat sink Q7 with a finned dissipator and bolt Q8 to a piece of 2¾ x 2½ x 1/8-inch aluminum. Heat conduction of these devices to their respective heat sinks is enhanced by the use of Wakefield no. 122 thermal compound which is recommended over the usual silicone grease commonly used a few years ago.

tuneup

Initial tuneup is done in three steps. Power is left off Q7 and Q8 while all remaining stages are tuned. Install a crystal in oscillator A and ground lead E1. Apply +13 volts to lead E8 and -13 volts to any convenient ground point. Measure the voltage at the collector of switching transistor Q12 (point E7) and observe no—or very little (0.1 to 0.2 volts)—voltage. Momentarily ground lead E10 and the voltage out of Q12 should be around 12.5 volts. If the voltage is much lower than this, remove the ground from lead E10 and remove all power from the rig before trying to find out what's wrong. Assuming, however, that the proper voltage is available from Q12, tuneup can begin.

Note that all test points except TP3 produce negative current. Connect a 50-μA meter to TP1 and tune L1 for maximum. Tune L2 and L3 for a maximum reading at TP2 and L4 and L5 for a maximum reading at TP3. Connect the meter to TP4 and tune L6 and C30 for a maximum reading (considerably lower than the readings obtained at the previous test points).

Proceed by connecting power to Q7 and metering the base circuit of Q8 at TP5. Tune C37 for a maximum reading; this should be about 25 μA or more. If everything has functioned well up to this point, the final amplifier, Q8, can now get the smoke test. Connect the output to a load which will present a low vswr at 144 MHz. If a wattmeter is available, connect it to the output circuit. If a wattmeter is not used, connect a meter to TP6. Apply power to all stages and tune C43 and C44 for maximum; power output will be between 6 and 7 watts. Now reduce the output power to 5 watts by using C43 and C44.

You reduce power because it is better to run the output stage a little cooler than to push for maximum with its higher collector current. The value of collector current will vary under changes of vswr, and some values of vswr can drive the collector current close to the transistor's absolute maximum rating. By backing off on the power output/collector current slightly, the current will never reach this high limit even with a high vswr. It may be wise to meter TP6 continuously when using the rig to ensure proper operation because a high vswr will give a higher reading at this point than is normally obtained under low vswr conditions. Although the final transistor can operate under these adverse conditions, efficiency is poor, and it should be adjusted for maximum performance.

Speaking of performance, always use an antenna which has been cut to frequency by means of an swr bridge and not just by the antenna manufacturer's cutting chart. In the case of mobile installations especially, the location of the antenna can cause the required antenna length to vary quite a bit compared to what the cutting chart shows. If at all possible, use a gain antenna rather than a ground plane or a short whip. An antenna with 3-dB gain is the same as doubling your power into a unity-gain device.

reference

1. Ronald Vaceluke, W9SEK, and Joseph Price, WA9CGZ, "An FM Receiver for Two Meters," *ham radio*, September, 1970, page 22.

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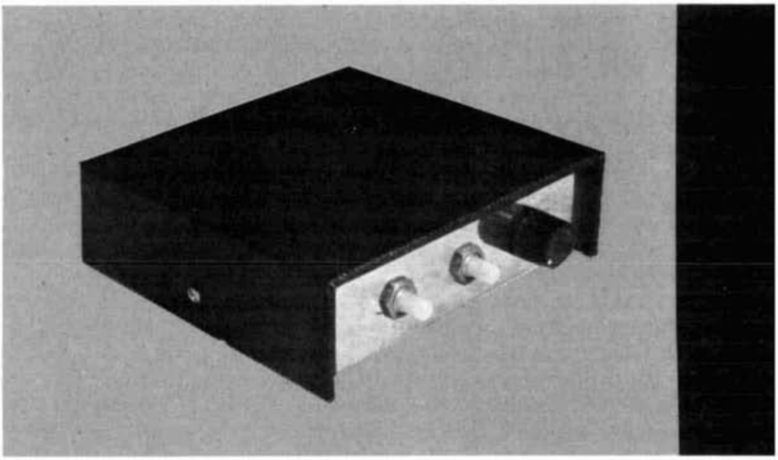


low-distortion two-tone oscillator for ssb testing

A handy piece of test equipment featuring excellent spectral purity

Hank Olson, W6GXN, Box 339, Menlo Park, California 94025

A good sine-wave oscillator is an asset to any ham shack or electronic service bench. For adjustment of single-sideband equipment, one oscillator is a necessity, and two such are very helpful at times. Since most ham shacks are lucky to have even one audio test oscillator, two-tone testing is a rare luxury.

Here is a dual Wien Bridge oscillator that produces 800 Hz and 2000 Hz (both frequencies within the normal voice-frequency range) of good purity for ssb testing. I took advantage of some of the new inexpensive operational amplifier ICs which provide large blocks of gain and ease of application. IC op amps are also used as active low-pass filters to provide optional harmonic reduction of each of the two tones generated. An etched circuit-board layout is provided and laid out so that you can build a simple two-tone generator and combiner with two ICs.*

You can also add one or two stages of

*A printed-circuit board and a complete parts kit for this unit are available from Southwest Technical Products, 219 West Rhapsody, San Antonio, Texas 78216.

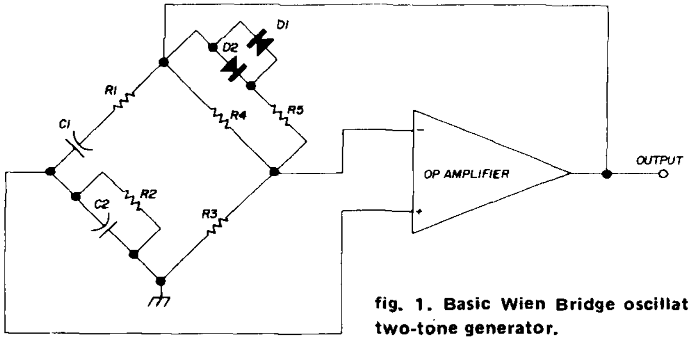


fig. 1. Basic Wien Bridge oscillator used in the two-tone generator.

low-pass active filtering after each oscillator, for successively purer output. The full-blown circuit with two stages of low-pass active filtering following each oscillator provides a two-tone output

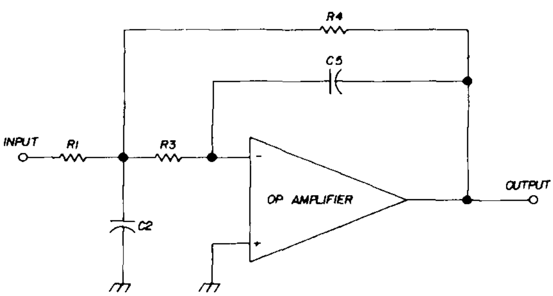


fig. 2. Basic active R-C low-pass filter used in the two-tone generator.

with all other components (harmonics of 800 Hz and 2000 Hz) down more than 70 dB.

The basic Wien Bridge oscillator circuit used in the two-tone oscillator is shown in **fig. 1.**[1] Note that this variation is different from the classic Wien Bridge oscillator using a lamp as the nonlinear resistance element in the R3 position. In the original lamp version the lamp decreases the gain of the loop by *increasing* resistance with increasing oscillation amplitude. The diodes used as a nonlinear resistance in **fig. 1**, however, *decrease* effective resistance with increasing amplitude; so they are placed in the *upper* leg of the negative-feedback half of the bridge. Like most Wien Bridge oscillators, the frequency of oscillation is $1/2\pi R1C1R2C2$. Unlike most Wien Bridge oscillators, however, there is no feedback time constant (usually provided by a lamp or thermistor *thermal* time constant). The back-to-back diodes operate essentially instantaneously to control amplitude, but since they conduct nearly symmetrically and have a large resistance in series with them, nonlinearity is not too severe. The result of the nonlinearity introduced by the back-to-back diodes is that odd harmonics are larger than ordinarily present in a Wien Bridge oscillator. However, the nonlinearity is not all bad as it helps to increase the stability of the oscillator.[2]

If you are content with a two-tone spectrum that has all harmonics down 40 dB or more, the circuit may consist of only U1 and U4. That is, the circuit is simply the two Wien Bridge oscillators and an operational adder. However, if you want better spectral purity of each of the two tones, follow each oscillator with one or two sections of active low-pass filtering to attenuate harmonics. The

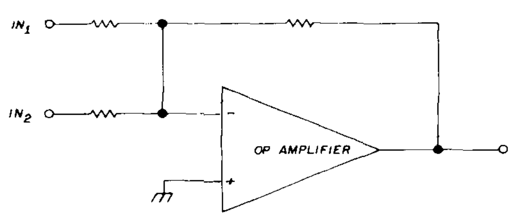


fig. 3. Basic operational adder used in the two-tone oscillator.

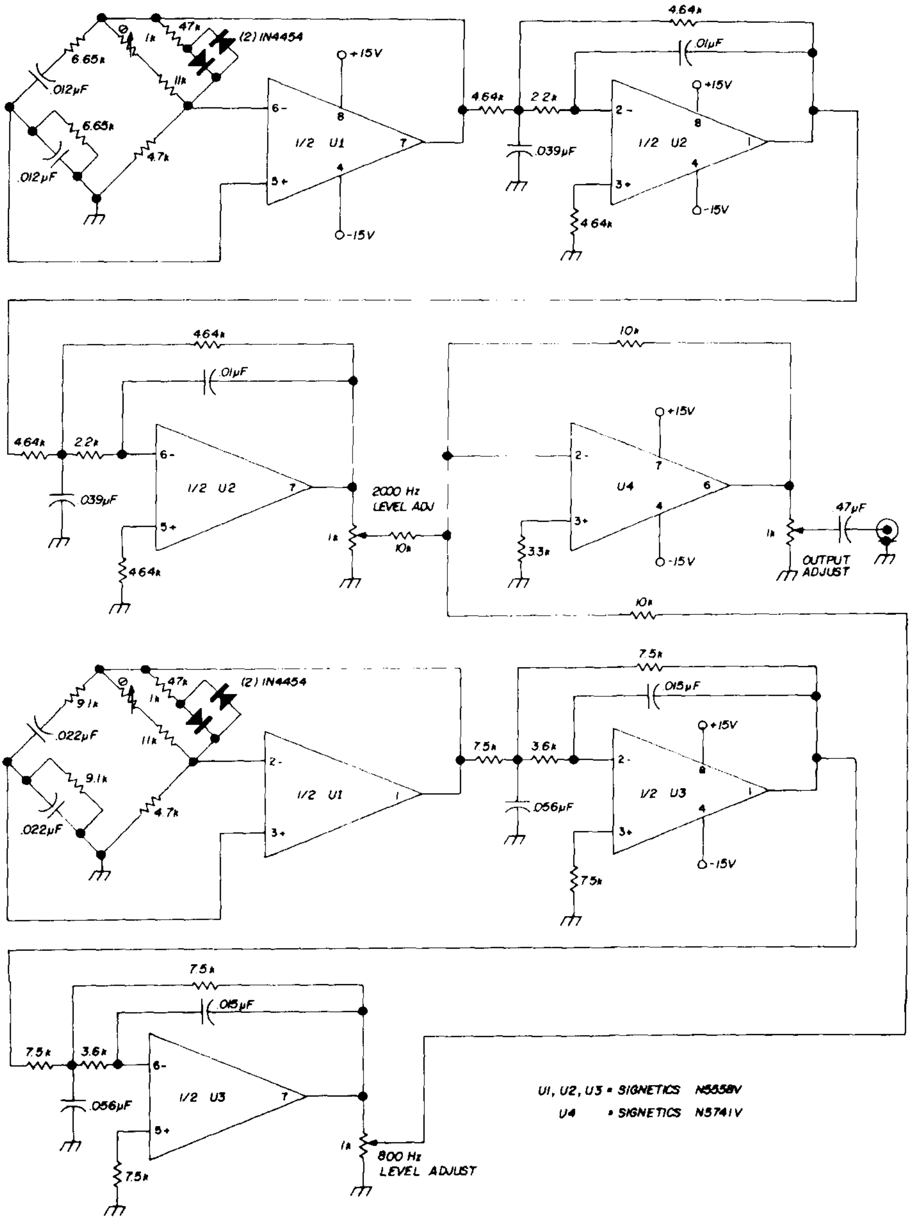


fig. 4. Complete circuit of two Wien Bridge oscillators, two sections of active low-pass filtering for each oscillator and the operational adder.

harmonics of the 800 Hz oscillator are more troublesome, of course, since the second, third, and fourth all fall in what is generally considered to be the audio-frequency range: 300 to 3300 Hz. Depending on your application, the low-pass filter following the 2000-Hz oscillator may or may not be necessary. In any case, because of the way that the circuit board is laid out, the low-pass filters may be left out entirely, one section may follow each oscillator, or two sections

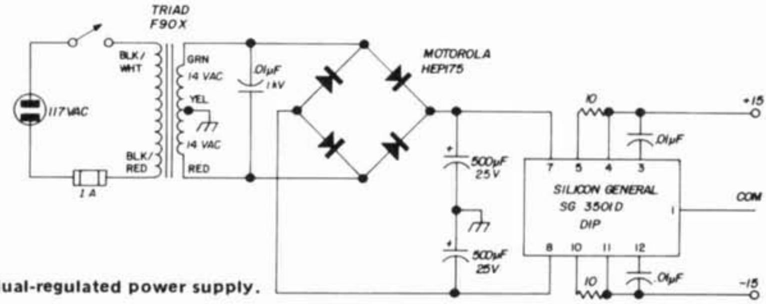
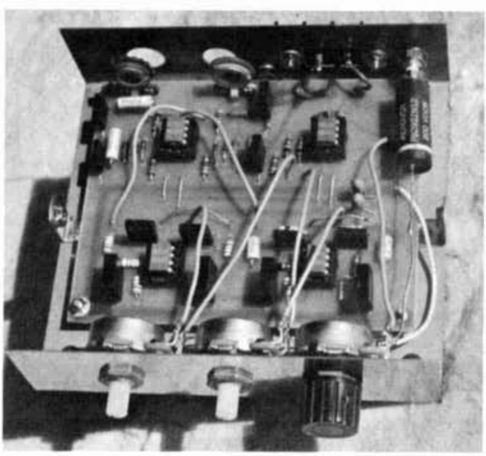


fig. 5. IC dual-regulated power supply.

may follow either or both oscillators.

The low-pass filters, like the Wien Bridge oscillators, utilize IC op amps and R-C elements to accomplish frequency-selective functions. These R-C active low-pass filters are quite stable, easily calculated, and have the advantage of providing gain if desired.[3] The basic active low-pass filter is shown in **fig. 2.** There are three Rs and two Cs that completely determine the gain and cutoff frequency of this filter. The ratio of R1 and R4 determines the *gain* of the filter (1 in our particular example), but you must not get the impression that varying R1 and/or R4 will affect *only* gain. R1 and R4 also affect the filter frequency cutoff. The cutoff frequency of the filter that follows the 800 Hz oscillator is set at 1000 Hz, and the one that follows the 2000 Hz oscillator is designed for 2500 Hz. Each *section* of active low-pass filter affords a roll-off of 12 dB per octave.



Inside view of the test oscillator shows parts placement.

The operational adder (**fig. 3**) provides a way of combining (or adding) the two tones with virtually no interaction between oscillators. Such an adder is quite often called a mixer in the audio world; but I prefer to call it an adder, because it actually algebraicly *adds* the two inputs. Since the summing point (the inverting input to the op amp) appears to be a virtual ground, each oscillator (or oscillator followed by a filter) sees 10k to ground. This fact, that there is a virtual ground at the very point where the signals are connected together, assures that the two oscillators cannot affect each other. Since the operational adder is a very linear device, it does not cause mixing (why I choose not to call it an audio mixer), and no detectable cross-products are produced. If this adder were nonlinear, of course, we should expect to see all sorts of spurious frequencies such as 2000 − 800 = 1200 Hz, 2000 − (2 x 800) = 400 Hz, and so on. The exact spectrum of spurii would depend on the nature of the nonlinearity.

Fig. 4 shows the complete circuit with two Wien Bridge oscillators, two sections of active low-pass filtering for each oscillator, and the operational adder. At this writing, only Signetics is making available the half dual-inline package N5558V, used as the dual op amp. However, both National Semiconductor and Motorola are soon to offer their own equivalents; the Motorola equivalent is to be called an MC1458CP1. The half dual inline packaged "741" (Signetics N5741V in **fig. 4**) is also made by Texas Instruments, Motorola National Semiconductor, Fairchild and others. Each of these second-source companies has their own particular (similar) number for the IC. For example, the Motorola number is MC1741CP1.

Note that there are five controls in the circuit. There is a negative feedback control on each oscillator circuit, used to set the amplitude of oscillation. These controls should be adjusted to give about 12 V p-p output from each oscillator (a setting giving too low an output will increase the percentages of harmonics). Since the negative feedback controls are only set once, they are board-mounted screwdriver-adjust trimmer pots. The other three controls – used to set the amplitude of each tone and combined output level – are mounted off the board.

Since the two-tone test generator requires ±15 V at 20 mA, it may be powered by a group of series-wired batteries. Four Burgess F4BP and two Burgess F2BP types are more than adequate. It is a good idea to use a dpst switch with this battery pack so the +15 V and −15 V are applied at one time. An IC dual-regulated supply may also be used. Such a supply is shown in **fig. 6**. The Silicon General SG3501 is used here for both + and − regulation. This IC is only offered by Silicon General at this writing, but is soon to be second-sourced by Motorola.

Measurements of harmonic content (and to check for possible cross-products) were made using a General Radio 1900A wave analyzer, which has a dynamic range of 80 dB.

references

1. R. Botos, "Breadboard Techniques for Low Frequency Integrated Circuit Feedback Amplifiers," Motorola Application Note AN271, October, 1966.
2. B. Oliver, "The Effect of μ-Circuit Non-Linearity on the Amplitude Stability of RC Oscillators," *Hewlett Packard Journal,* April-June, 1960.
3. "Handbook of Operational Amplifier Active R-C Networks," Burr-Brown, Tucson, Arizona.

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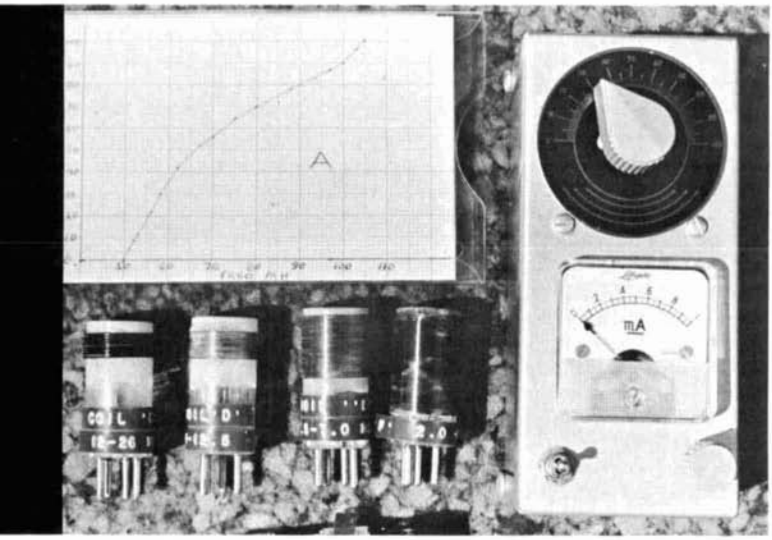


frequency measuring oscillator

Looking for a small, self powered gdo? This design offers a forward-reading meter and full coverage between 2-100 MHz

R. C. Alexander, W6IEL/7, Route 3, Box 502, Sequim, Washington

One of the most useful testing devices is the grid-dip oscillator. This instrument has evolved through many stages of development from tube-types to modern solid-state models known as gate-dip oscillators or tunnel dippers. One of the advantages of the later designs is user convenience – no need for primary power, which can be a problem when climbing a tower to make antenna adjustments.

frequency-measuring oscillator

Here's a still later development in solid-state gdos, but with a new (and more nearly correct) title and a different mode of indication. Instead of a dip in meter indication, the fmo meter swings forward with alacrity, which makes for easier observance of resonance.

The circuit is shown in **fig. 1**. Transistor Q1 is in a Colpitts oscillator circuit. The oscillator is followed by Q2, Q3; a high-gain dc amplifier of the Darlington configuration. Connections and polarities are such that meter movement is in the forward direction when the circuit to be tested is near or at resonance.

construction

The fmo can be housed in a 2¼ x 2¼ x 5-inch utility box. If you desire this shirt-pocket size, the switch and pot should be of the miniature variety such as used in small transistor broadcast sets. For those wishing to duplicate the instrument shown, a parts list (**table 1**) and coil data (**fig. 2**) are provided. A full-scale layout drawing (**fig. 3**) is also shown.

A 2 x 3¼-inch circuit board holds the parts. Three of the circuit wires (shown dotted in **fig. 3**) are installed on the *underside* of the board to reduce capacitance effects. All other wiring is installed on top of the circuit board. Install the transistors upside down, with leads facing up, and bend the leads toward their respective soldering pins, which may be small brass push-through connectors or standoffs. Holes 1 and 2 in **fig. 3** are for mounting screws (see photo).

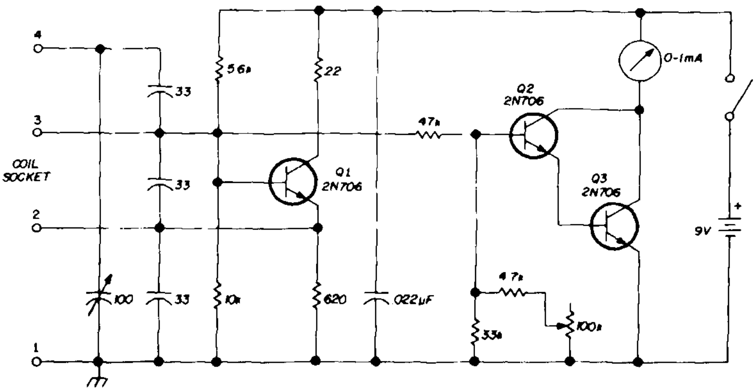


fig. 1. Schematic of the frequency-measuring oscillator. Circuit features forward-reading meter and full coverage from 2 to 100 MHz.

tuned circuit

The superior performance of the fmo at all frequencies is due primarily to the coil-capacitor arrangement, in which feedback and bandspread are obtained automatically. Except for coils A and B, each coil has a series-parallel capacitor arrange-

table 1. Parts list for the frequency-measuring oscillator.

qty	description
1	aluminum mini-box, 2¼ x 2¼ x 5"
1	2" 0-100 dial-plate
1	pointer knob, 1"; modify if needed
1	small knob for pot control
1	perfboard piece, 1/16 x 3¼ x 1-7/8"
2	3/8 x 1¼" mounting pillars, poly or steatite
1	miniature 0-1 dc milliameter, 1½" mounting-hole size
1	*miniature* pot, ½" diameter, 0-100k
1	miniature spst toggle switch
1	battery mounting strap
1	miniature 5-pin socket, Amphenol 78S-5S, with retainer ring. Modify per instructions
3	33-pF miniature glass or ceramic capacitors
1	.022-µF (or .02) mylar or paper miniature capacitors
1	0-100 pF variable capacitor, Hammarlund MAPC-100-B or equivalent, with ¼" shaft
7	¼ watt resistors, one each 22, 620, 4700, 5600, 10k, 33k, 47k
3	transistors, 2N706, npn silicon
7	miniature capacitors for coils, mylar or ceramic, three 100 pF, two 240 pF, two 470 pF
4	coil forms, Amphenol 24-5H, 5-pin. Miscellaneous wire, solder, and flea clips for terminals

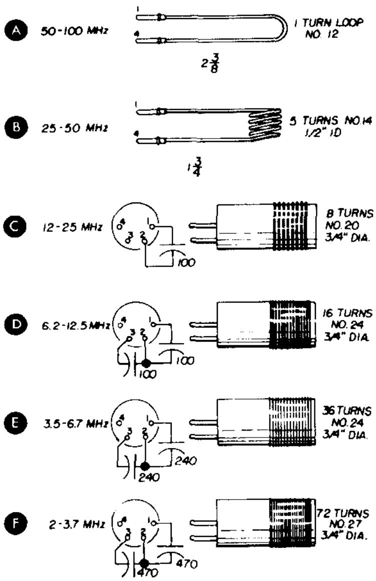


fig. 2. Coil-construction data. Pin 5 is removed from the four low-frequency coils and used for plug-in support of coils A and B.

ment, which provides the bandspread feature described.

Wind a few extra turns on coils E and F so wire can be removed if necessary to bring the circuit within the desired frequency range. This modification may be necessary as the small fixed capacitors will be within 10-20% of their marked values, and adjustment of the tuned circuit is made by removing coil turns. A light coat of Q dope should be applied to the coils. Final calibration (described below) is done after the coil dope is completely dry.

coils and sockets

The coil forms and sockets are modified by removing pin 5 of each form and the center shield of the socket. (These pin numbers are not used; the number sequence is shown in **fig. 2.**) The removed pins are used to support coils A and B in the socket.

When constructing the low-frequency coils, install the padding capacitors well down inside the coils, keeping the leads short. The lead from pin 4 goes to the top end of the coil; this is to minimize desoldering problems when removing turns from the top of the coil for calibration.

Keep all leads as short as possible

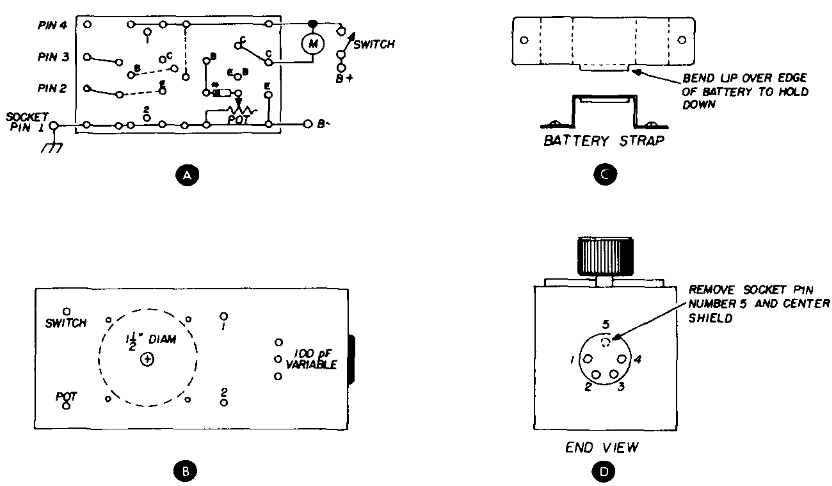


fig. 3. Full-scale layout drawings. (A) and (B) are templates for the circuit board and enclosure top. Holes E, B, C are for transistor leads. Component marked with asterisk is the 4.7k resistor in fig. 1, which was added after unit was built. Holes 1 and 2 are for mounting polystyrene pillars. Lower edge of knob (D) must be sawed off so set screw will reach capacitor shaft. Note that the numbers molded on the socket are not used. Three small holes in (B) are used to hold the dial in place.

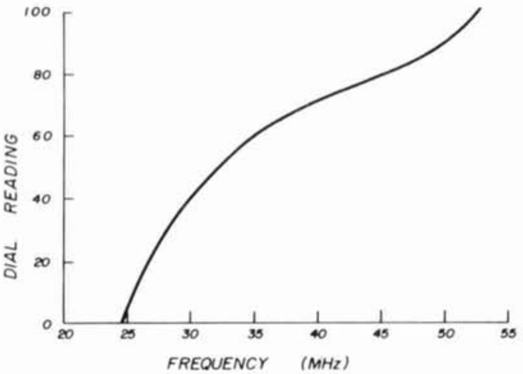
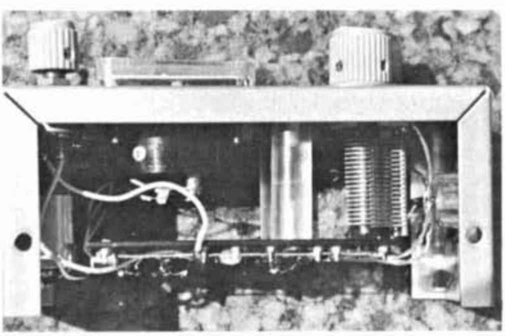


fig. 4. Typical calibration curve. Data is for coil B, 25-50 MHz.

between coil socket, variable capacitor, and the circuit board. Place a solder lug under *each* mounting screw for the variable capacitor, and run a wire from these lugs to pin 1 of the coil socket. Wire a short lead directly from pin 1 of the socket to the end of the ground wire (B–) along the edge of the circuit board nearest the coil socket.

Care should be used when soldering leads and capacitors into the coil forms as the material softens when excessive heat is applied. A heat sink, such as a pair of long-nose pliers with a rubber band



Side view of completed instrument. Objects to left of tuning capacitor are polystyrene support pillars.

around the handle, should be used when soldering heat-sensitive components. This also applies to transistors.

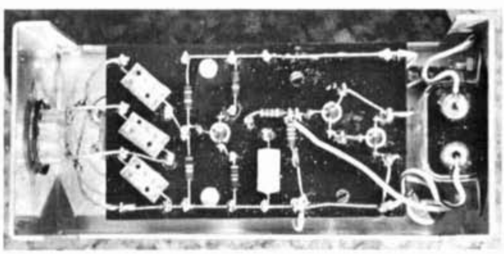
An inexpensive milliammeter with low damping action is suitable. A 0-1 mA meter is adequate; a more sensitive meter costs more and provides no added advantage.

calibration

The instrument should be calibrated against a receiver of known accuracy. Plot the calibration curves with at least 20 data points for each coil range. **Fig. 4** is a calibration chart for the 25- to 50-MHz range. Accuracy will be only as good as the data source and the care used in calibration.

operation

The fmo is used in the same way as the earlier gdos; that is, when the circuit or



Wiring on component side of circuit board.

coil being measured and the fmo are tuned to or near the same frequency, the meter will swing forward. It will not dip as in a gdo. The pot is first adjusted to take the meter slightly off zero, the sensor coil is brought close to the coil or circuit under measurement, and the fmo knob is turned until a sharp forward meter indication is obtained. The fmo is then backed off. The smallest amount of coupling that will give a meter indication should be used.

The frequency-measuring oscillator is a versatile instrument. In addition to checking resonance of coils, antennas and other tuned circuits, it may be used as a CW signal source for circuit alignment. It's also useful for measuring inductance and capacitance within the range of component values used at rf.

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emitter-tuned preamplifier
for 21 MHz

A simple and stable two-transistor project to improve receiver performance on the 21-MHz band

Courtney Hall, WA5SNZ, 7716 La Verdura Drive, Dallas, Texas 75240

Some of the commercial receiving gear I have owned has shown a pronounced need for more gain at 21 MHz. Measurements at my station show that the antenna noise at 21 MHz is 25 to 30 decibels less than at 7 MHz. The term antenna noise is used here to include all noise received by the antenna, whether it is atmospheric noise, galactic noise, man-made noise or whatever. Antenna noise is the increase in noise heard when the antenna is connected to the receiver. It is not intended that very strong local sources of man-made noise be included in this definition, but only those which appear randomly.

If the antenna noise cannot be heard, then many low-level signals cannot be heard either. Receiver gain should be sufficient to hear antenna noise, and a preamp connected between the antenna and the receiver is one way to bring the gain up.

In my case, a circuit was required which would be stable, have 25- to 30-decibels gain, bandwidth of about 300 kHz (I operate CW only), reasonable noise figure and adequate cross modulation and intermodulation performance.

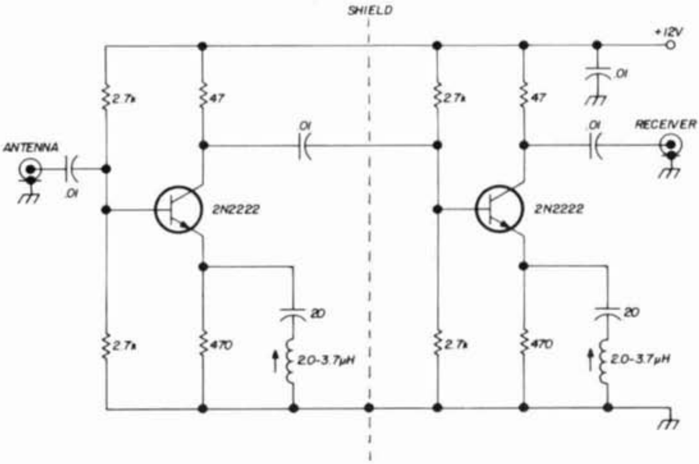


fig. 1. Schematic of the 21 MHz emitter-tuned preamplifier.

The first circuit I experimented with was a simple fet common-source amplifier, unneutralized, with parallel tuned circuits in the gate and drain leads. Stability was a severe problem, and the circuit was more likely to oscillate than amplify.

I decided on an emitter-tuned amplifier similar to one described by Chow and Paynter[1] would be worth a try. My version of the circuit is rather different from theirs because of the difference of intended application.

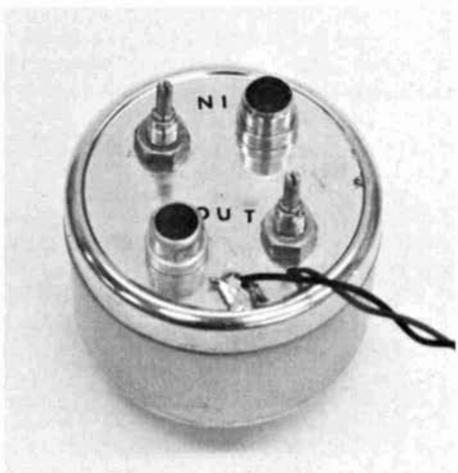
theory

The voltage gain of a common-emitter transistor amplifier stage is roughly equal to the load seen by the collector divided by the impedance in the emitter circuit. The intrinsic emitter resistance of the transistor must be included as part of the emitter circuit impedance when estimating gain. Its value is:

$$r_e = \frac{26}{I_E \text{ (ma)}}$$

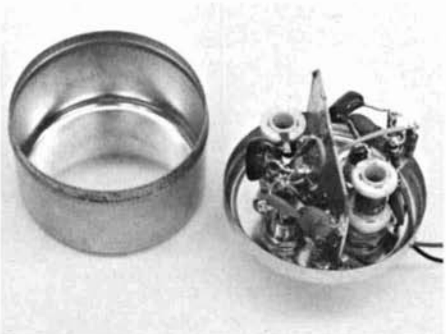
To keep r_e small so that gain will be high, each transistor is operated at about 10 mA emitter current; this results in r_e being about 2.6 ohms.

Fig. 1 is a schematic of the 21-MHz emitter-tuned preamp. Tuned amplification is achieved because the series-tuned emitter circuits present low emitter circuit impedances at resonance and high emitter circuit impedances outside the passband. The coils I used had an unloaded Q of about 120 at 21 MHz, and the 20-pF capacitors were duramica. Impedance of the series-tuned circuits at resonance should be about 3 ohms. Total emitter impedance, including intrinsic emitter resistance, should be about 5.6



Complete preamp is built in a can; hookup wire brings in power; phono jacks connect to receiver and antenna.

ohms. The collector resistor of each transistor is 47 ohms; if a 50-ohm load is paralleled with this resistor, the collector will see an equivalent load of about 25 ohms. Thus the voltage gain should be $25/5.6 \cong 4.5$ or about 13 dB. Two stages would then have a gain of 26 dB. Measured gain of the two-stage amplifier was 27 dB, indicating the above estimate was reasonably close.



All wiring is done on the can's lid without the use of tie points.

The 3-dB bandwidth is determined by the Q of the series-tuned circuits. Intrinsic emitter resistance must be included as part of the series-tuned circuit, but the 470-ohm resistor has negligible effect at resonance. With r_e included in the series-tuned circuit, Q is 66, giving a bandwidth of about 300 kHz. This was verified by measurement. Two stages decrease the bandwidth to about 200 kHz.

Input impedance to the base of each transistor was not measured, but since estimated gain and measured gain agree so closely, this impedance is assumed to be in the range of 50 to 100 ohms.

Outside the passband, the series-tuned circuits become large impedances, and the emitter resistance approaches a limit of 470 ohms, resulting in a gain-per-stage of 0.05 to −26 dB. This means −52 dB outside the passband for two stages. The floor of the response curve should be 79 dB below the peak amplification, but it is probably not this good due to stray leakage paths.

At first glance, this amplifier circuit may appear to have poor noise figure as well as poor cross-modulation and intermodulation performance. Measurements of this type were not made, however, no operational shortcomings were detected. The noise output of the receiver dropped 20 dB or more when the antenna was replaced with a 50-ohm resistor, indicating internal amplifier noise was well below the noise received by the antenna.

construction

The amplifier was built in a small steel can 2 inches in diameter by 1-3/8-inches high. All parts are mounted on the lid of the can as shown in the photograph. A brass shield, soldered to the lid, separates the two amplifier stages; holes are drilled through the shield to pass the interstage coupling lead and the 12 volt lead. Components are soldered together without tiepoints, and are supported by their leads. This results in compact construction and short leads. Hookup wire feeds in the power supply voltage, and phono connectors are used for input and output. The coil slugs should be adjusted for maximum receiver output at the center of the frequency range to be used.

conclusion

This amplifier is simple, easy to build and relatively fool-proof. Current drain is rather high, but stability is excellent. The emitter-tuned amplifier offers a quick and easy way to obtain rf or i-f gain. It may be used at other frequencies by using appropriate series-tuned circuits, but gain and bandwidth will be a function of Q. Less gain is to be expected at higher frequencies due to decreasing transistor h_{fe}.

reference

1. "A Handbook of Selected Semiconductor Circuits," NObsr 73231, prepared by Transistor Applications, Inc. for the Bureau of Ships, Department of the Navy, circuit 4-7, pages 4-33 and 4-34. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

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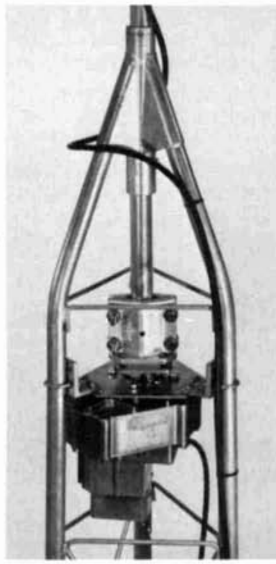

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tuning toroidal inductors

Professional tips on using simple test equipment and ingenuity to measure and tune toroidal inductors

G. K. Shubert, WAØJYK, 1308 Leeview Drive, Olathe, Kansas 66061

Toroidal inductors have been praised as the ultimate inductor for miniaturized equipment. Their usefulness extends from audio to vhf with power levels from sub-microwatt to several hundred watts. The magnetic field of the toroid is closed, and, for this reason, it is somewhat self-shielding and will operate well under crowded conditions.[1] This closed magnetic field also means that a grid-dip oscillator is going to be worthless because there is not enough flux leakage from the toroid to permit coupling. Put the grid-dipper on the shelf. It is time to develop some practical methods and procedures to tune those toroids.

equipment

You will need a signal source with a low distortion sine wave because it will give a better indication at resonance. A distorted waveform can be restored to a clean sine wave with a parallel tuned circuit to ground. Hewlett-Packard makes some beautiful signal generators but don't overlook the following possibilities:

1. Heathkit, Eico, and other budget-priced equipment.
2. Military and commercial surplus.
3. Homebrew oscillators.
4. The station transmitter (in spot mode or swamped).
5. A vfo.
6. Receiver audio (beat bfo against crystal calibrator).
7. Electronic organ.

A meter will be required mostly for use as a null detector. The possibilities for meters are a bit more limited but consider:

1. Any vtvm.
2. A diode and a sensitive dc meter.
3. A vom.
4. A receiver with an S meter.
5. An oscilloscope.

The problem of measuring frequency is a little more difficult. The dial calibration of some generators is adequate for some applications. More high-quality digital frequency meters are being found in ham shacks now for several reasons. Heathkit has a very reasonably priced counter kit, but possibly even more important to the ham is the switch that industry is making toward the new integrated-circuit counters. This has made available numerous low-frequency tube-type counters that still perform quite well. Counters are not the only answer. Anything from a crystal calibrator to an electronic organ or a pitch pipe can be used to find the frequency.

equipment connections

Any of the five equipment setups may be used to tune any coil and capacitor. However, there are some preferences. It is generally best to tune the circuit as a parallel circuit if it is to be used in the equipment in parallel resonance, and best to tune in series if it is to be used in series resonance. An exception to this rule is at

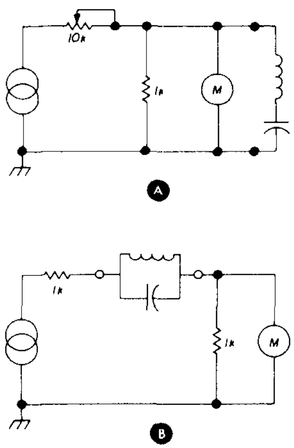

fig. 1. Test setups for determining resonant frequency of an L/C circuit using toroids. Both circuits will show a voltage minimum at resonance. A is series resonant and B is parallel resonant.

frequencies above about 2 MHz where it is desirable to tune *all* circuits in parallel to minimize the effects of lead lengths, even if the actual final circuit is series resonant.

Use a low signal level; ten millivolts is a good level, but unfortunately, most inexpensive vtvms will not indicate a level this low. If a good high-impedance vtvm is available but lacks the ten millivolt sensitivity, then **fig. 2** is the hookup to use with a volt or two at the peak reading.

It should be noted that the hookup of **fig. 2** indicates a peak or maximum voltage at resonance while **fig. 1A** and **fig. 1B** both indicate nulls or voltage minimums.

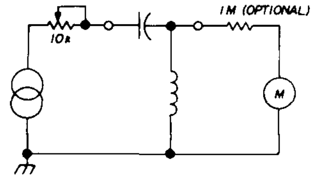

fig. 2. Setup for use with a high impedance vtvm lacking 10-mV sensitivity. The voltage will peak at resonance (usually 1 to 2 volts).

Fig. 3 requires an oscilloscope, but may be used with generators that have high harmonic distortion or noise in the output. This is a phase-shift method of tuning, and, if a good scope is available, this method is very accurate. Off-resonance frequencies cause an ellipse to be displayed which closes to a straight line at resonance. Distorted signals may be used, but the straight line at resonance will not be perfect.

Small coils and low-frequency coils require low test levels, but as physical size and frequency increase, the core is less likely to saturate, and higher test levels may be used. The cause and effect of saturation is too complex to detail here.[2] A good test to determine if the level is too high is to decrease the level to half or lower and check the resonance again. There should be no change in the resonant frequency. This test may be used to allow higher test levels on larger cores or at higher frequencies.

tuning to frequency

It is easy to get the inductance of a toroid in the ballpark by winding the turns determined by:

$$\text{turns} = 1000\sqrt{L_{mh}/A_l}$$

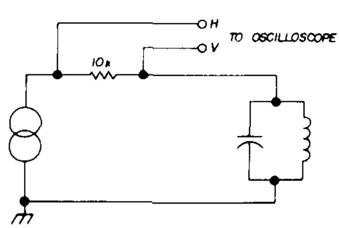

fig. 3. Accurate test setup uses an oscilloscope and the phase-shift principle. This setup can be used with signal generators with distortion and noise in their output.

L_{mh} = wanted inductance in millihenries.
A_l = millihenries per thousand turns on the core. (If A_l is given in microhenries per hundred simply move the decimal one place to the left.) A_l is sometimes stamped on the core but, most often, must be obtained from the manufacturer's data sheets.

Any one or a combination of the following methods may be used to fine tune the toroidal inductor:

1. Adding or subtracting turns. It is helpful to figure the hertz per turn or turns per hertz and compute the total turns to be adjusted. Raiding the wife's sewing basket for a crochet hook will accelerate turns removal. Obviously, if the coil has very few turns this method is not accurate enough.

2. All the remaining methods are variations of the variable capacitor method. The variable capacitor may be all or only a small portion of the total tuning capacity. Of course, true variable capacitors of the rotor/stator or piston type with dielectrics of air, ceramic, glass or quartz as well as the multi-plate compression mica types work very nicely; they are fine if you don't mind spending a mint just to tune a circuit.

3. The most economical variable capacitor on record is two pieces of magnet wire tightly twisted together and then trimmed to the desired capacitance – commonly known by old-timers as a gimmick. Number 22 or 23 heavy insulated magnet wire is a good choice and yields from 1 to 5 pF per inch depending on how tightly it is twisted. Trim off a fraction of an inch at a time to raise the resonant frequency of the circuit; if too much is trimmed off simply twist the remaining wire a little tighter.

4. Disc-ceramic capacitors may be ground off with a small sanding disc or grinding wheel. Disc capacitors can be reduced in value by 50 percent with no deterioration in performance. Just be certain that the grinding action takes place longitudinally to the plates. In other words, don't smear any metal across the dielectric between the plates. Disc ceramic capacitors offer several advantages in this application. The entire circuit capacitance can be in the single disc capacitor. The disc can be a negative temperature coefficient type which will compensate for temperature drift in the inductor. Large capacitances are physically very small in the low voltage, high temperature coefficient capacitors. Once the circuit is tuned the exposed capacitor edge should be coated with melted wax or polystyrene (Q-dope).

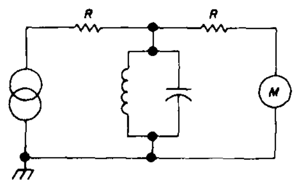

fig. 4. Circuit for determining Q. Make the two resistors as large as possible.

5. Spreading or compressing the turns of the coil will vary the turn-to-turn capacitance and change the resonant frequency slightly. This method is actually cheating and is mentioned only as a quick-cure method involving some risk. A toroidal inductor has a closed field only if it is perfectly symmetrical and any intentional distortion of the winding will cause flux leakage to the chassis, other inductors and other circuits. The best practice is to preserve symmetry. The start and finish of the winding upset the symmetry enough but are necessary evils.

Q measurement

Some of the equipment used to tune the toroidal inductors can provide information about the quality factor or Q of the coils.[3] Use the setup in **fig. 4** with nearly maximum output from the signal generator and the largest possible values for the resistors. It is very important to not load the Q with a low-impedance generator or meter. If loading from the meter or generator cannot be avoided, it is still practical to make Q comparison tests to evaluate inductors. Adjust the frequency for a peak reading on the meter. Here again a low voltage level is preferred. Tune up in frequency until the voltage is 0.707 of the original reading. Record this frequency as F_h. Now tune the generator down in frequency until the level is again 0.707 of the peak voltage and record this frequency as F_l. These are the 3-dB down points, or half-power points. The formula that closely approximates Q from the 3-dB points except for Qs less than 10 is:

$$Q = \frac{\frac{1}{2}(F_h + F_l)}{(F_h + F_l)}$$

The tips in the preceding paragraphs are by no means limited to the tuning of toroids, but, since toroidal cores are not adjustable, some of these methods must be used. All of the methods are used daily in commercial practice, and are all practical. There have been so-called adjustable toroids available, but the adjustment was at only one point on the core which upset the symmetry and caused flux leakage and stray-coupling problems. It is also possible to grind notches in the core material of a coil with few turns and, if done at many different points around the core, a high degree of symmetry can be maintained. Core grinding is tedious and seldom used commercially.

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ham radio

nostalgia with a vengeance

A blonde, a kilowatt and a memory —

Irv Gottlieb, W6HDM, 931 Olive, Menlo Park, California 94025

It was during spring-cleaning of the attic under dire forebodings from my wife that it happened. For it was thusly, while investigating a pile of boxes situated in a long undisturbed corner, that I discovered the bottles. Antiquated bottles they were; mellow in their peaceful hibernation with thick coatings of dust.

Envisioning a sweet rendezvous with cherished brew of Ohmar's squeezings, I deftly brushed away the dust. Alas, the bottles were devoid of the coveted spirits! In fact, the bottles, though of ancient vintage, were quite empty except for the insolently protruding gizzards of primitive electron tubes. Closer inspection revealed enumerations such as 211E, 210 and 250.

Tempus fugit and shades of hades, how time flies! (In the manner of greased lightning, OM.) Shutting my eyes to black out the eerie illumination, sweet reminiscence conveyed me, dream-like, to days of yore. Ah, sweet days of yore. . .

In the wee small hours of a misty morning, I deposited the belle of the senior class on her doorstep and bestowed the usual prolonged kiss in the usual tender fashion. Then, not being overly-desirous of a QSO with her OM, I leaped into the waiting Essex.

With effervescent gusto I coaxed the last rpm from the protesting connecting rods. Soon, I was home with my first and true love, the 80-meter Hartley with one 211E, three 210s and two 250s coordinating more-or-less in parallel.

I reached up and yanked the handle of the main switch. Fondly, I beheld the glowing filaments. (Brother, you too would glow with double voltage on your filaments.) Trembling with anticipation of a hot DX contact, I appraised the performance of the rig in the usual professional manner.

I pressed the key for a few brief moments. A 500-cycle roar of defiance shattered the ether. The motor-generator tugged in agony at the half-inch bolts which secured it to the four-by-four support, then resigned to its torment by dropping speed. The lights in my room dimmed by an amount deemed proper.

I picked up a pair of binoculars and observed the light bulb in my neighbor's garage, some fifty yards due South. The intensity of its glow indicated healthy antenna radiation. I released the key just as the filament of one of the 250's became visible through the plate. Feeling well rewarded for my efforts, I turned my attention to the receiver.

The receiver, though completed only ten days previously and not completely de-bugged, had already revealed itself as a signal snatcher *sui generis*. It was, in fact, the reception of a VK from Australia that motivated the DX quest about to take place.

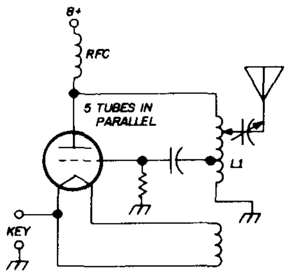


fig. 1. Salient features of the transmitter. Abundant harmonic generation assured a response on some band. L1 is copper-tubing tank from a Hoyt automatic water heater. Plate voltage was 1200V on spaces, 1000V on dots and 850V on dashes.

The design, my own, consisted of a regenerative rf stage, regen detector in a reflex arrangement which re-squirted the signal back into the rf stage, which now functioned as an audio amplifier. This was followed by two stages of conventional audio amplification, or *almost* so.

The slight departure from the "run of the mill" involved the use of Model T spark coils as inter-stage transformers. The tubes, chosen after much deliberation were 201As.

I placed the 8000-ohm Baldwin phones over my noggin and turned on the receiver. It was, verily, full with the joy of life. As I advanced the various controls, a terrific fringe howl sallied forth from the cans and reverberated within my tortured head like a freight train stalled in a tunnel! Quickly, I jerked the phones off and backed down the regen controls, lest the OM burst into the shack with an R9 lecture about the need of sleep for growing boys, etc. Swearing with R9 fervor, albeit in hushed breath, I resolved to be more careful with those very, very critical knobs.

Using the utmost caution to maintain regeneration just on the threshold of oscillation, I searched the endless kilocycles for a voice lost in the wilderness. It wasn't long in forthcoming. Somewhere in the depths of Boltzman's constant, all but buried in the crackle of shot noise, shot capacitors, themal agitation and ionized soldering paste, I heard it . . . yes I heard it, a weak CQ!

Carefully, ever so carefully, I advanced the you-know-which controls. Now, a tiny bit more, a shadow here, an Angstrom there. The results were no less than magical. The signal, except when fading obliterated it entirely, now was R3 in any ham's lingo. Only thing was, the fading was somehow mysteriously synchronized with the announcement of the station's identity.

Carefully, ever so carefully, I trimmed the other controls with my left hand, while my right maintained vigilance with the detector regen control. Waiting in suspended animation for the final station identification, I arose from my chair. I leaned over the receiver to provide the nth degree of trimming by means of body capacity. A bead of perspiration dripped from my brow and landed dangerously close to the grid terminal of the detector tube. I blew the saline droplet away from the socket.

Then it happened . . . I caught the call just before he signed off. It was none other than the VK recently logged! Shades of hades, could I work him?

I laid the earphones on the operating table and promptly went to work with the home-spun bug. This was constructed from materials distinctly out of the ordinary, among which were the innards of a Pocket Ben, ignition breaker points and a segment of corset stave donated by the belle of the senior class. Between the bug and raucous note, I was certain my signals had that spark of personality needed to attract the attention of DX ops.

For the first minute or so, my sending fist trembled and threatened to freeze. However, the bug gave unselfishly of its

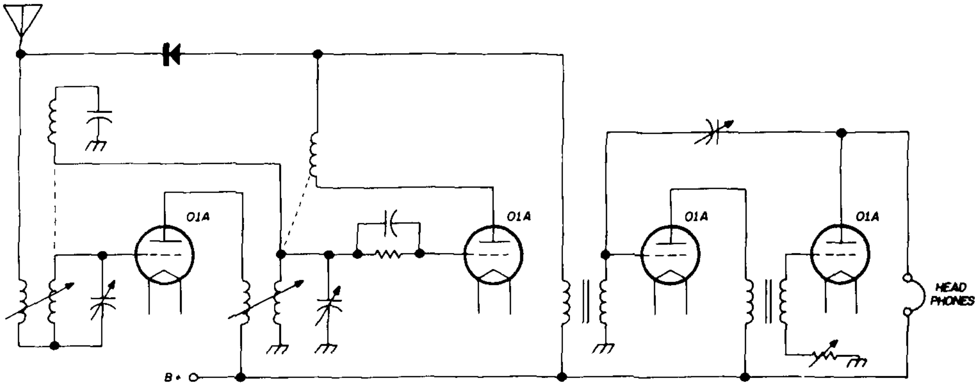


fig. 2. Schematic depicting general idea of the receiver. This set is regenerative to the nth degree; it should not be confused with workable schemes.

dots and I soon regained poise. I settled down to a fifteen minute grind of three VK calls interspaced by two of my own.

The dit-dahs were now oozing with the solid self confidence that I pounded into them. My enthusiasm mounted until I could scarcely contain myself. Finally, I repeated my call eleven times and culminated with a stately 'RK'!

I climbed into the phones and listened. Amidst the playful electrons, I heard *nothing*, absolutely *nothing*. Ever so carefully, I applied torque, one part physical, nine parts pyschic, to the detector regeneration knob. The impending fringe howl was lurking in the infinitesimal depths of perception, intent upon springing out at me, tiger-like. Precariously but nonetheless skillfully, I held it at bay.

Within the innermost realm of consciousness, I became aware of minute fluctuations in the background noise having the characteristics of dots and dashes. I copied it mentally: "sure gld to wrk the West coast OM. Ur sig FB here in Melbourne. Pse give my report . . . " The signal faided out but I could sense he was signing over.

I prepared to acknowledge his message. So intoxicated was I with the prospect of bettering my previous DX record by some seven thousand miles that I had to deliberately pause a few seconds before tickling the bug.

Then, *boom,* like a bolt of lightning did the terrible catastrophe strike! The phones, still on my head, became the forerunners of the present day dynamic speaker. Unmerciful decibels assailed by burning ears. Between the jack-hammer thumps, the fringe howl lashed out with tongues of sonic flame.

I tore the phones from my head and threw them on the table. The thumps were saying, "VK3– de W6– tnx for fb rept. Ur coming in QSA 5, R6." "R6! Shades of hades," I muttered to myself, "All he has is a superhet with no regeneration and he has the gall to call a signal R6 which I can just barely pick up."

W6– resided in the high-falutin section of town because his OM was well heeled, the owner of a chain of shoe stores. W6 attended private school, owned a brand new Model A Ford and had a 5-kW rig full of store-bought components. What with all this, he now runs away with my DX station!

So what? Did I begrudge his monied pop? Was I envious of his classy rig? Did I resent his swiping my VK? Shades of hades, *no*. After all, it was I who was the steady of the belle of the senior class! But OM, that is another story altogether . . . anyhow she's mighty anxious that I get this attic cleaned up, pronto!

ham radio

improved selectivity for direct-conversion receivers

The subject of these mods is the Ten-Tec RX10 — however, they may be applied to any direct-conversion receiver with good results

Vladimir N. Gercke, K6BIJ

About fifty years have elapsed since radio amateurs replaced their one- and two-tube regenerative receivers with the superheterodyne circuit. Progress has been spectacular . . . Or has it?

It is now possible to build a receiver for the high-frequency bands that performs as well as or better than the superhet without the problems caused by i-f amplifiers, such as images and spurious oscillations. The improved circuit is based on the old synchrodyne detection method and is known as direct conversion. It has been described in earlier issues of *ham radio.*[1, 2] A direct-conversion receiver available commercially is the RX10.* Reviews of the RX10 have appeared in *ham radio* and elsewhere.[3, 4]

To improve the selectivity of my RX10 I developed the front-end modifications described here, which are adaptable to other direct-conversion circuits as well.

Selectivity is provided by a sharp audio filter preceding the audio amplifier and the high Q of the input tank circuit. The high Q is developed by regeneration; when regeneration is removed selectivity will be about equal to that of a galena crystal set.

*Manufactured by Ten-Tec, Inc., Sevierville, Tenn. 37862.

Fig. 1 shows five diode-detector circuits and their respective selectivity curves:

A. Crystal or tube detector with no tuned circuit.

E. Same as D, but with extremely low L/C ratio.

As shown in **fig. 1,** the culprit is dimension A, which is the portion of the response curve that levels off and continues indefinitely above and below f_0, the frequency of interest.

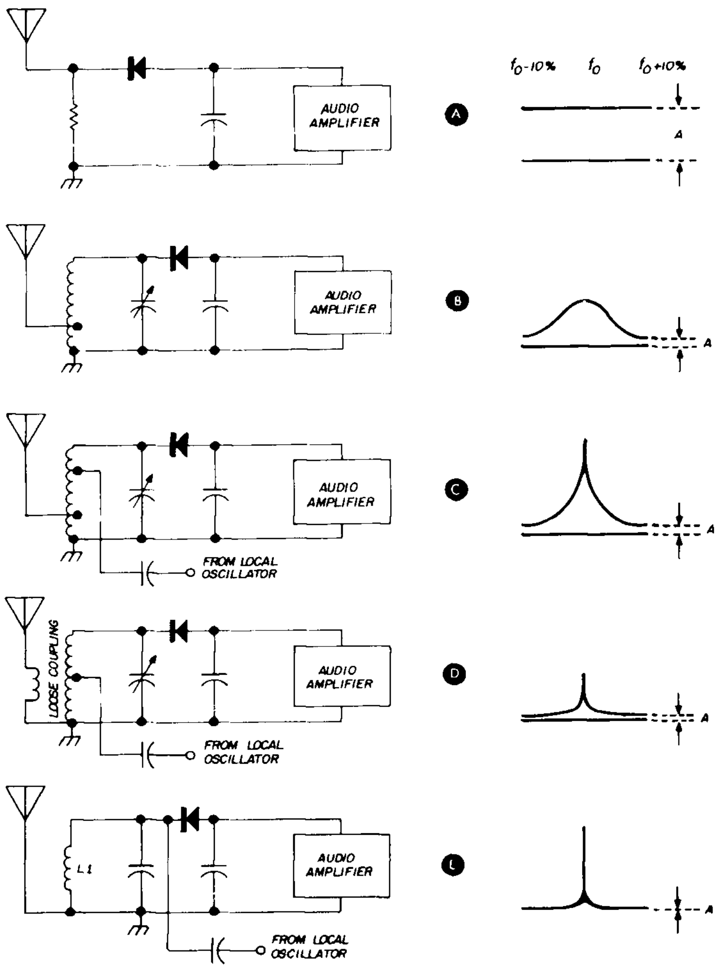


fig. 1. Five diode-detector circuits and their respective selectivity curves. Circuits C, D and E are direct-conversion types. Bias and audio filters have been omitted for clarity.

B. Same as A with added tank circuit.

C. Same as B with injected local-oscillator voltage.

D. Same as C with very loose coupling to the antenna.

Loose coupling, as in **fig. 1D,** will decrease dimension A almost to zero; but most of the signal is lost. An audio system with extremely high gain will be needed to restore the signal.

RX10 modifications

The circuit of **fig. 1E** seemed to be the solution to the selectivity problem. The tank coil was made with two turns of heavy wire, and the tap for the antenna was ½ inch from the ground end. All signals below f_0 are returned to ground, and all signals above f_0 are blocked by the enormous value of C1 (13,500 pF for 80 meters). C1 consists of several silver micas in parallel to reduce lead inductance, which can otherwise defeat the purpose of the circuit.

All my experiments were made with the Ten-Tec RX10 receiver. The front end was modified according to **fig. 2,** a partial schematic of the unit. The value of L1 is a compromise; it's too large for 20 meters and too small for 80 meters. One turn for L1 and 2,400 pF for C1 would be better for the 20-meter band.

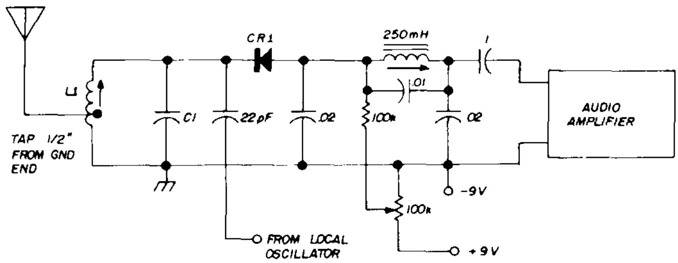
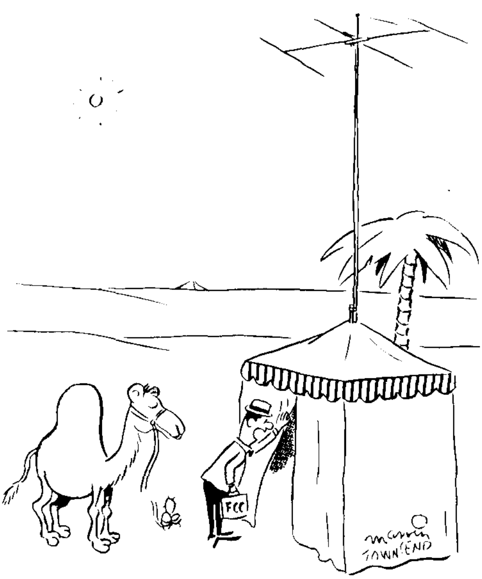


fig. 2. Modified front end of the RX-10. L1 is 2 turns no. 12 solid copper wire, 5/8-inch diameter; C1 is 1400 pF, 4400 pF and 13500 pF for 14, 7 and 3.8 MHz, respectively. CR1 is any hf or vhf diode or a transistor E-B or C-B junction chosen for minimum noise (varies to 10 dB among units with the same 1N or 2N prefix.)

conclusion

The selectivity of a tuned circuit is a function of its Q, the ratio of reactance to resistance at the resonant frequency. The excellent selectivity of the modified RX10 front end is due to the high Q obtained by decreasing the L/C ratio and by decreasing circuit resistance with large-diameter wire in the tank coil.

Perhaps we've been on the wrong track by climbing the vertical wall of the superhet for 50 years. Maybe we should go back and see if there's a path, or freeway, around that wall.



"Sir, are you aware that you are interfering with television reception in this area?"

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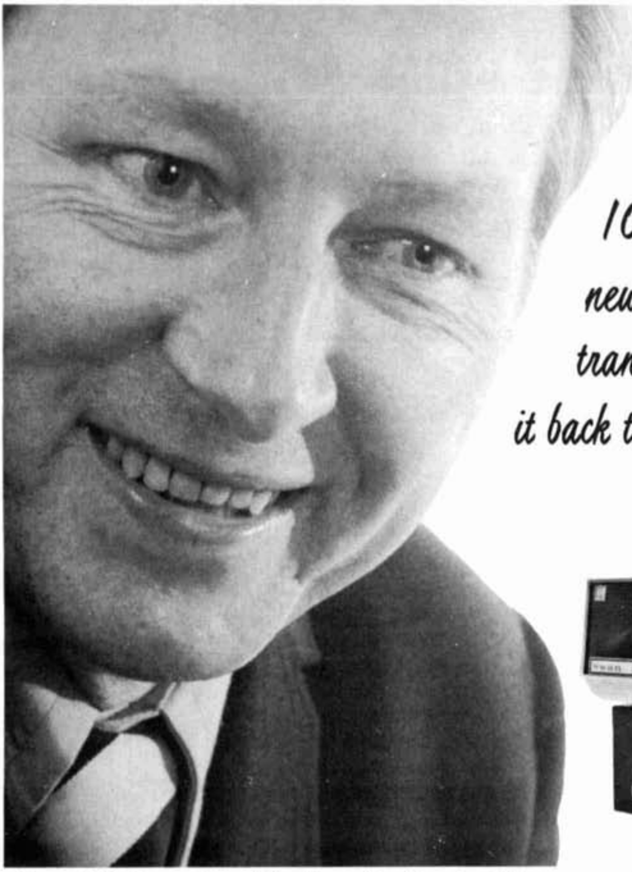

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George, W6OGM

(G. W. McGinley, executive vice president and general manager, Swan Electronics)

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More Details? CHECK—OFF Page 110

digital station accessory

Concluding construction details, including the input amplifier, and counting circuits for direct frequency read-out of your receiver or transmitter

E. H. Conklin, K6KA, Box 1, La Canada, California 91011

My first counter, fortunately, used the relatively slow Fairchild DTL 9093 dual flip-flops. Two of these and a gate can divide by ten, with no input circuitry, from low audio rates up to 2.2 MHz. For many digital dial read-out purposes, however, these will not do for the first decade or so. Higher-speed TTL units are comparable in price, but take more care in driving the first FF to make them toggle (and produce a divided output).

Later, the decade dividers became available at reasonable prices. The ones tried here – the Sylvania SM90 which has no counter outputs and the 7490 made by Texas Instruments, National Semiconductor, Philco, Motorola and others – all toggled directly at low audio rates as well as at rf. In normal use these are up-counters; although with decimal read-outs like the Nixie, down-counting can be arranged by inverting the wiring.

Data sheets indicate a maximum frequency of 10 MHz, minimum, and 18 MHz, typical, for the 7490. My tests showed that some ICs toggled to a maximum of 30 to 41 MHz without an input amplifier, and much higher with certain amplifier circuits. Care must be taken to bypass the plus V_{cc} to prevent spikes from causing a miscount which can occur when noise or hum is present. Some types of input circuitry require relatively high input at low audio frequencies. Careful design of input circuitry for proper wave shape and signal level may be required to toggle the ICs from low audio frequencies up to extreme frequencies.

For most purposes a selected SN7490N decade can start the count string, following a satisfactory count gate. Tests on the low-cost SN7400N quadruple two-input gates indicated that a few operated above 110 MHz. One high-speed SN74H00N went to 45 MHz.

The JK flip-flops, such as the Sylvania SF7473N, were somewhat variable when tested on audio and rf. Several went to 33 or 34 MHz, but others did not. Therefore, if one of these units is used in the first counting position, selection is desirable.

Fully programmable up/down counters can be preset readily to start at any number so that division can be by any number. Most interest has been in decade operation, such as is provided by the SN74192N synchronous, programmable up/down decade counter. Input clock frequency typically can be 32 MHz. Power dissipation is greater than the 7490 decade counter.

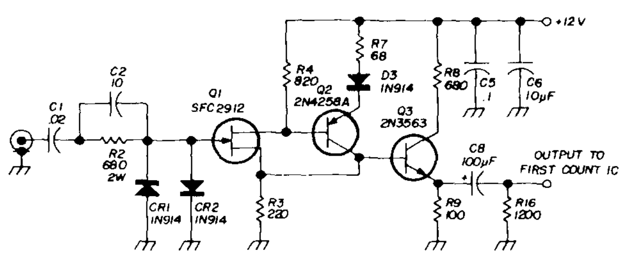
The 74192, when used as the initial count FF, requires a count gate. Note that down-counters may be needed in only some decades. That is, if a receiver dial reads only to 0.1 kHz, and a one-second counting gate is used, the units and tens decade counters can be 7490 up-counters because they do not affect the read-out. Furthermore, the MHz counter also can use 7490 up-counters if they do not affect the read-out.

fier can be very strict if the digital station accessory is to be used for many purposes. It should be possible to obtain suitable drive for the first count IC, U16, with any input from about a tenth of a volt, to 25 volts or more. The impedance should be high so it does not significantly disturb the circuit to which it is attached. It should require no tuning or adjustment; it should respond to frequencies from below five hertz up to 50 MHz or so. Also, it should drive the first count IC reliably.

Although the 7490 decades will respond over such a frequency range, it is not always convenient to connect the IC directly to the circuit. This has resulted in a great deal of experimentation, and some of the more difficult problems were solved while resting in the middle of the night!

The basic circuit started with the seven-transistor amplifier used in the new 80-MHz Heath SM-105A counter. This

fig. 1. Input amplifier. See text regarding bypass of R9 and variations in resistor values. Q1 is Heath (TI) 417-251 at $2.25; Q2 is Heath 417-260, 80c; Q3 is Heath 417-125, 65c. Noise generation somewhere ahead of Q1's input gate was minimized by connecting 30 pF from final output to ground.



Dc wired information from a bandswitch can be provided to the megahertz read-outs without any counter, latch or decoder/driver for MHz information. Of course, this works best on amateur band equipment, but MHz read-out probably would be eliminated on all-wave receivers where 30 switch positions may not be tolerated anyhow. To clarify this, note that the down-count is a frequency division just like an up-count. The only difference is the direction of the BCD count going to the read-out display.

input amplifier

The requirements for the input ampli-

circuit was found to be sensitive as to selection of voltage, components and part values. The substitution of the 2N5485/MPS107 jfet, an inexpensive plastic device, proved to be subject to problems. Some of these problems did not affect another amplifier of similar design which used the metal-cased SFC2912 (Heath 417-251, $2.25), the case of which can be grounded. Somewhat improved performance may be obtained by further variation of resistor values from those shown in **fig. 1**, but the values shown do work.

Using a large output-coupling capacitor, and a variable sink resistor across the

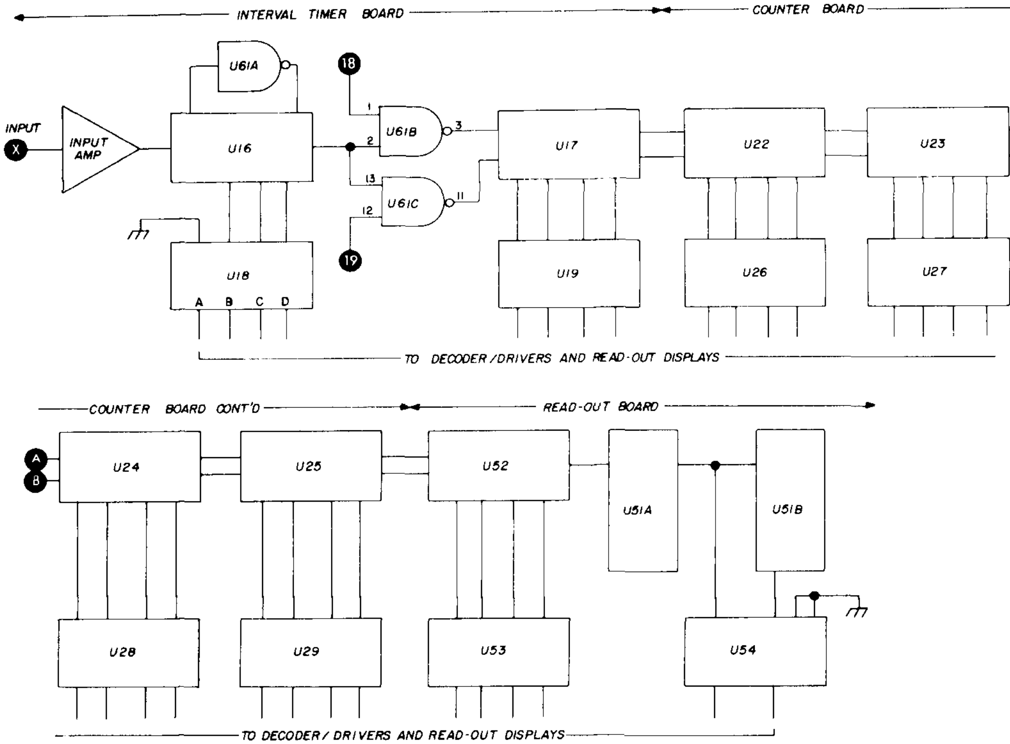


fig. 2. Flow chart for counter ICs. Circle are plugs.

following IC, this amplifier successfully drove a selected 7490 FF to 65 MHz. When the capacitor and a fixed sink resistor were installed permanently with shortened leads, there was some sacrifice in performance, but results were still adequate. The first IC, the A section of a TC7490E,* followed by a 74H00 gate, toggled accurately to 52 MHz when R9 in the amplifier was by-passed with several microfarads. A Philco 7490 counted to 34 MHz.

A 15-μF capacitor temporarily installed across R9 increased amplifier output and produced a square wave. However, when the leads were shortened and the fixed resistor substituted, the capacitor was omitted to prevent possible injection of noise which might result in miscounting; later, I found that toggling of the first IC on audio frequencies was being affected by spikes on the 5-volt power supply line. No further attempt was made to readjust the value of R16, the IC input sink resistor, for maximum frequency; counting from below 4 hertz up to nearly 50 MHz seemed adequate.

The input amplifier occupies about one square inch of the upper rear corner of the IT-board, and does not interfere with the mounting of the DIP ICs on that portion of the board which carries the V_{cc} and ground busses. Also, it leaves space for the end-mounting of steering diodes for multiple programs for the up/down counters. The top edge buss had been opened for use as a plus 12-volt V_{cc} buss for the input amplifier (connected to Plug-Y). The remainder of the edge buss remains at ground potential, plug-Z.

count chain

Vector sockets were provided for the count gate, U61A, and the first two count ICs, U16 and U17, shown in the

*Available from Solid State Sales, Box 74, Somerville, Massachusetts 02143.

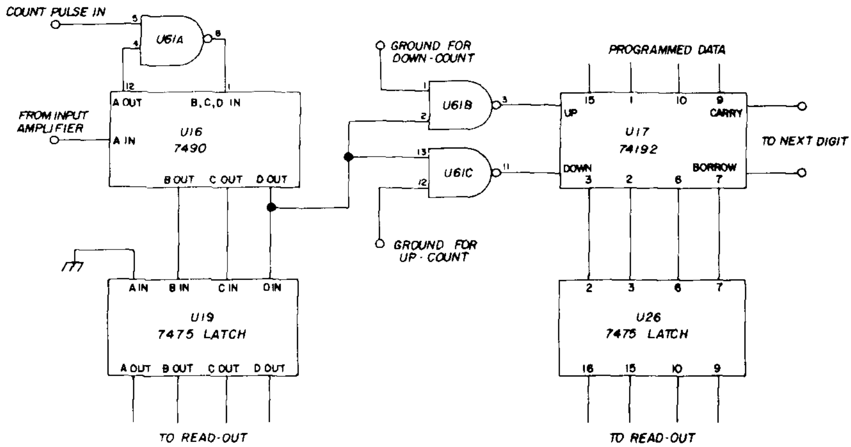


fig. 3. Flow chart for input gates and first two counter decades.

block diagram, **fig. 2**. These facilitate testing individual ICs and selecting the most satisfactory one for these critical positions.

Ordinarily, the input signal passes first through a count gate which controls the time during which the count is made, and the output drives the first FF. However, this resulted in some limitations (later found to be associated with noise spikes on the power supply) which were readily overcome by an unusual course. The A section of a selected 7490 decade up-counting divider, U16, was driven directly by the amplifier; this was followed by the count gate U61A which drove the BCD section of the 7490 (see **fig. 3**). This odd arrangement allows the A section to continue to count; the effect on the read-out is eliminated by tying the U18 latch input to V_{cc} or ground, whichever tends to correct the normal one-count error due to the relative phase of the time-base gating and input wave. At most, it will produce an error on one hertz in the count.

If part of the same gate is used for coincidence-gating, such as was done in U61D, there will be some interaction in the outputs of all gates in the same IC, even when V_{cc} is adequately by-passed to ground. Although this possibility should be kept in mind it did not cause any trouble in my unit.

Following the A section of U16, up and down gates U61B and C were installed for later use with the 74192 up/down counters. If 7490s are used these gates should be omitted.

The 7490 up-counting decade FFs may be used for U17, U22, U23, U24 and U25. These will be satisfactory for normal counting functions and for counting the synthesized operating frequency.[1,2,3]

The outputs of the counting decades are connected to the numbered D inputs of their respective 7475 memory latches, U20, U21, U26 through U29, U53 and U54. For use with MSD047 or SN7447N decoder/drivers and Minitron read-outs, the latch Q outputs are wired to the decoder/drivers on the read-out board.

Note that the V_{cc} switching scheme permits wiring the count latches on the IC-board to the AND gates which control clock information (but capacitors must be installed across V_{cc} switching contacts to keep the clock from advancing). Note that the final two decades are on the read-out board. The last of these is a dual JK FF which is adequate for a count of four; it repeats if the frequency is 40 MHz or above.

The general wiring of the 7490 ICs is much the same as described last month, except that it is necessary to reset all of the count decades after the end of the count and after the transfer pulse, to display the count, and be ready for the next period. This means that there never is a grounded R_0 reset input in the count chain. However, one R9 input on each IC should be grounded.

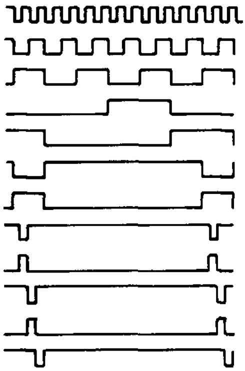


fig. 4. Pulses from resolution input, through divider U20 and U21, and selection of coincidence gating to generate the necessary pulses.

gating

The gating system follows the general plan described by Kenneth Macleish, W7TX.[2] However, there are many ways to accomplish this.

By charting the divide-by-two and divide-by-three square waves at the end of the time-base chain, **fig. 4**, it is easy to select gating inputs that will provide a one-second count period (or decimal fraction). After this, there must be a short off-period containing a transfer (memory latch) pulse and a reset pulse. For 74192 up/down counters, there also must be a load pulse which transfers the programmed frequency correction into a presetting of the 74192 counters from information at their data inputs. These pulses can be produced simply by coincidence gating. Connecting the gates to the correct square-wave output produces the desired pulses at the right times.

Although this method is widely used there may be a small error in having reset pulses begin or end with the finish or start of the count period. This is because the propagation time through an IC may not be the same as the time required for resetting it. Therefore, the positioning of these pulses in the noncounting period has been selected differently.

Also, the divide-by-twelve SN7493N, used by W7TX as a final time-base divider, was replaced by two 7473 dual JK flip-flops. One of these could have been the 16-pin SN7476N, which is available at surplus prices. This has a common clock for the two FFs so, generally, it may be used where that is satisfactory, including the divide-by-three circuits in the time and clock sections. The 7476 is provided with separate clear and preset pins which are useful for counting days and months which start with "1".

Fig. 4 shows the pulses in the final time-base divider, using the two 7473s. The entire gating schematic is in **fig. 5**. Note that the Q and not-Q outputs are useful to avoid the requirement of a reversing NAND gate.

The load function in the 74192 up/down counters must be eliminated, or the load data be zero, in every case for unprogrammed counting of some unknown frequency. This can be done in several ways, including running the load signal out to a switch and back again. **Fig. 7** includes gate U60D, otherwise unused, which can be used with another NAND gate (or both can be replaced with one AND gate) to give one-wire control over a program loaded into the up/down counters.

Some resets, such as that for the 7473s, go to ground to reset. Others, like the 7490 and 74102, must go to a logic high. Because there is a fan-out limit of eight to ten in DTL and TTL gates, the reset signal for the 7473s is wired out to other boards on plug-D. NAND gates U62C, U70C and U80A invert the reset signal on those boards as necessary for 7490 and 74192 ICs.

Each memory latch presents a load of four FFs to the transfer pulse. Thus, only two 7475s are being driven by one gate section. An inverted transfer pulse is wired out to other boards, then inverted by NAND gates U62D, U70D and U80B.

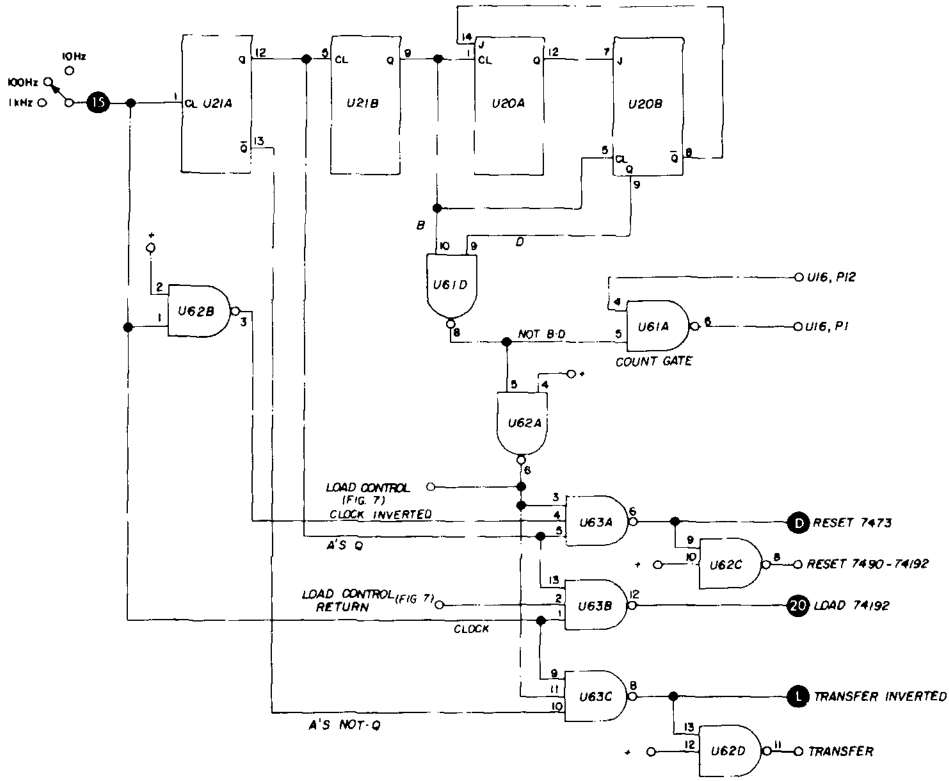


fig. 5. Detailed flow chart from resolution to generation of pulses, with pin designations. See fig. 7 for single-line load control using two NAND gates or one AND gate.

Three "resolutions" are provided at plugs 12, 13 and 14. The one-second gating counts units of hertz; the one-tenth-second gating counts tens of hertz; and the one-hundredth-second period produces hundreds of hertz. For some fast-tuning applications the shorter count periods are useful. Also, during CW and RTTY keying, the short periods will occasionally produce a stable read-out, while others will be short-counted due to keying during the gate-open time. This occurs in the "signal mode" of the synthesis method, but not in the vfo count method that will be described later.

When up/down counting is used with the loading of a correction, it would be complicated to change the programmed loading for more than one counting period. Therefore, only one resolution is suggested: Whenever the switches inject a programmed correction which is satisfactory to the operator.

The different pulses can be seen on a scope but it is somewhat of a problem to identify where each one occurs in the non-counting period. In case of trouble, try disconnecting one source of these pulses and study what happens. When the coincidence gating plan is worked out and followed, however, everything turns out right. Nevertheless, keep in mind that a reset pulse before a transfer pulse will give a read-out of exactly nothing. A reset pulse after a load pulse in the 74192 will clear the load. This could be useful in preventing the loading function, if properly planned.

testing

It is possible to feed the input amplifier with 60 Hz from the ac line, an audio oscillator, a grid-dip oscillator or a tap from the timing chain to test the count chain. A scope together with ac and dc inputs to meters can also be used. The dc assumes a medium value except that it is lower in the D output of decades due to the duty cycle in the divide-by-five section. The scope distinguishes between true stable counting and added noise counts. A low-C probe for the scope and an rf probe for the meter are necessary at high frequencies. However, the scope can often be put at the end of a decade or two to show what is going on at high rf inputs. Above 20 MHz of so, there does not seem to be much of a square wave anywhere.

digital dials

W7TX has covered the method of *synthesizing the original transmitting or receiving* frequency by heterodyne mixers. In this method, the three frequencies in the Collins S-Line are mixed in a manner that results in up-counting the synthesized operating frequency itself.

In general, this method is accurate, although you can expect one small difference: When in the transceive mode, the transmitter is on a slightly different frequency if the bfo is not on the same frequency in the two units — due either to the receiver's variable bfo or to the fact that the two bfo crystals may not be on exactly the same frequency. This would show up if the counter were switched from the receiver to the transmitter.

In some types of reception, the count accuracy depends upon zero beat. This is satisfactory with ssb, but involves some possible error on CW unless some means of limiting the error is employed. In correspondence W7TX pointed out that sufficient bfo signal leaks into the i-f so a scope on the i-f output would indicate when there is zero beat between the signal and the bfo. Also, the "signal mode" by which the i-f signal itself is counted, rather than the bfo, is often preferred by the user.

When the signal is keyed, the counting in the signal mode may be a longer period than the dashes, thus giving many short counts unless the key is held down. This happens particularly in the high resolution (long counting period). On the other hand, while the read-out will often stand still in the lowest resolution (short counting periods) the decimal point then is moved over so that the frequency is not measured as accurately.

If an oscillator, such as the exciter's CW calibrator, is placed in zero beat with the signal, or to one side of frequency-shift keying, accurate information on frequency and shift can be obtained.

Somewhat more design work may be required for using the synthesis method in some receivers[3] such as those where the heterodyning process changes on different bands. In some others, such as the Racal,[4] it may prove to be almost impossible to filter the resultant desired frequency from all its components.

It has been mentioned in the Motorola application note that the MC1496 and μA796 double-balanced mixers can operate as frequency doublers by introducing the same signal at both input ports. Such a device might provide a convenient way to multiply oscillator frequencies to separate several receiver or exciter oscillators.

The CA3001 amplifiers are covered by an RCA data sheet, File No. 122, and an application note, ICAN-5038. Although many of the circuits shown require a negative as well as a positive power supply, the small negative current can frequently be obtained from the same power supply.

The cost of the CA3001 is higher than that of the MC1550. The CA3001 differs from several competing types due to the incorporation of emitter-followers. These permit cascading stages with similar connections. Useful gain can be obtained beyond 30 MHz although the design goal was 20 MHz in a broadband amplifier.

Tests of the low-cost MC1550 provided negative gain when I attempted to cascade two of them. Motorola Application Note AN-299 discusses this, and proposes that the second of a two-stage video amplifier be operated as a com-

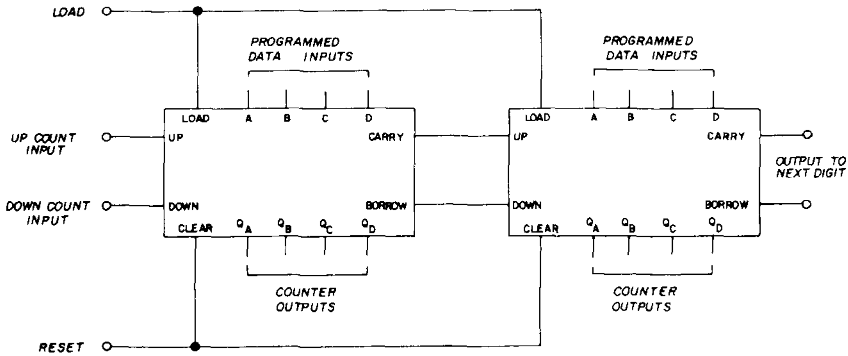


fig. 6. Method for using serial up/down counters, type 74192.

mon-collector, common-base amplifier. This permits direct capacitive coupling between stages.

Both of these devices can provide symmetrical limiting, thus tending to square up the waveform when the low input requirements are exceeded slightly.

Another matter should be kept in mind when recreating the original operating frequency. The recreated original frequency should not create interference to the receiver. Also, the transmitter output should not cause troubles in the counter.

In arranging the switching in the station digital accessory, provision was made for use of the synthesis method, and also for putting a vfo signal through a tuned circuit and separate amplifier before connecting it to the counter input amplifier. In practice, however, the Racal and Collins receivers produced adequate voltage directly at the counter amplifier without the use of a tuned circuit or special amplifier. However, such an amplifier should increase the isolation between the receiver and the counter, which would be desirable.

up/down counting

One goal for the digital station accessory was to provide for a direct vfo count with programmed frequency corrections. In that way, the dial of essentially any receiver or exciter can be replaced with a digital electronic counter. One means to do this is with the 74192 up/down counter.* Like the 7490 decade, it takes a plus voltage to reset. It has two inputs and outputs, one input to be driven while the other is held at a logic high. It has four binary-coded decimal inputs for presetting when a *load terminal* receives a logic low pulse. These BCD inputs, when not connected, will assume a logic high, so they must be grounded if a load pulse is not to transfer the BCD inputs to the internal decade counter. It is shown in **fig. 6**. As stated, the up/down counter actually is a frequency divider like the 7490 and programs always go high, but only the BCD read-out is down-counting.

The digital accessory, as now built, continues to use the A section of a 7490 before the count gate, to obtain suitable performance, followed by the BCD section (see **fig. 3**). This means that the units read-out will actually be up-counted, never down-counted. However, if the units figure is required, all is not lost. It is necessary only to subtract it from zero for the actual frequency. For example, say that a frequency shows as 14,200.794. Subtract the ending 4 from 790, and the actual frequency is 14,200.786. This is subject to the plus or minus one-count error of the count gating and the A section of the first decade.

Also, only five up/down counters are

*Although not advertised at a comparable price, the one-line-input and up/down control is available in the SN74190N. The programmable SN74196N decade is also useful, but it is an up-counter only.

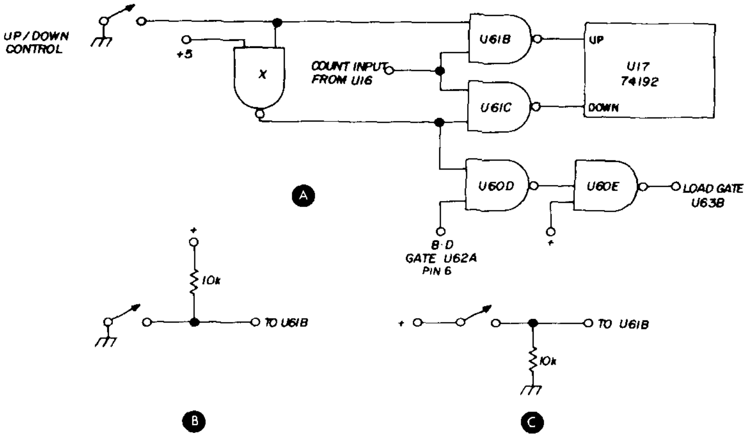


fig. 7. (A) Proposed method of single-line control of up and down count, with automatic elimination of load pulse for up-counting, if desired. Note that U60D can be fed from a switch as a single-line control. (B) Method of forcing gate inputs high if they do not assume a high level. (C) Method of using a switch on positive instead of negative power if desired for switching convenience.

used. One reason is that it is not usually feasible to count the megahertz in vfo counters, although arrangements could be made for a dc-switched display of megahertz. The carry from the sixth read-out to the seventh and eighth, therefore, will be up-counted. It is convenient to cut them off.

Ordinarily, the seventh decade could be driven by the D output from the last up/down counter. However, if it is driven from the carry output of the up/down counter, then the seventh and eighth read-outs will operate only on up-counting, but not on down-counting, which is desirable. This fits the specific application for the Racal receiver, and may fit others as well because the vfo itself does not indicate the band involved.

When tapping signals from the receiver oscillator or mixer, take care to avoid noise, birdies or transmitter pickup on the lead. RG-62A/U coax has been recommended for its lower capacitance than RG-58B and RG-174. For testing purposes, a Vector Voltage and Current Test Adapter can be inserted under the desired tube. It permits attaching a resistor in series with the coaxial cable. The resistor frequently can be as large as 5k to 7k. The coax feeds the counter's input amplifier through a selector switch. Should the signal not be sufficient, presumably a CA3001 or MC1550 IC video amplifier, possibly with a tuned circuit, could be inserted.

If the one-second display is not too far behind the tuning dial rotation rate, it is the most satisfactory resolution. Next would be the 10-Hz resolution, producing a one-tenth second count; this takes one less up/down counter, but removes all doubt as to the nearness of the indicated frequency to the 0.1-kHz read-out. In any event, you may make switching provisions to remove V_{cc} or ground from the decoder/drivers and read-outs beyond the effective count digits for the application involved, should they show up and be disturbing to the accurate reading of the dial.

Usually there are several ways to do the switching and control. The up/down counters must have plus V_{cc} on the unused up or down input. One way to do this is to have two gates, one for up-input and one for down-input, so arranged that a ground on the control-line second input of a gate will make that one's output go high (see **fig. 3**). This requires two control lines and, sometimes, more than minimum switch facilities.

A single control line, either for V_{cc} or ground, probably can be devised. One

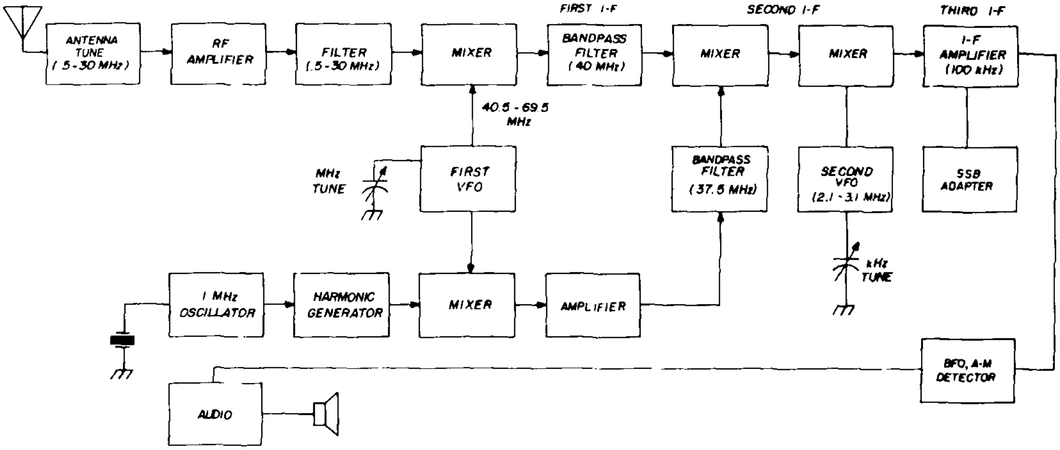


fig. 8. Block diagram of the Racal RA-17C.

way is to place a NAND inverting gate between the second inputs of the two up and down counting gates as shown in **fig. 7**. If a gate input does not assume an adequate positive potential when left open, a 10k resistor can be provided so that one control line can handle either ground or V_{CC} to switch between up and down counting. One of these may permit using the same switch contacts as already are serving another purpose, such as changing the programmed loading for several bands.

At my station only up-counting is required when not using a programmed error correction, and only down-counting when loading a program. These are suitable for Collins equipment (which can be through a mixing unit) and the Racal (on a direct vfo down-count). The elimination of the loading pulse can be accomplished automatically with a suitable AND gate in series with it, or two NAND gates which will reverse twice.

There are other ways of applying a gate to minimize the number of control lines and switch poles. One way is to use a 4-input load gate at U63B. Another is shown in **fig. 7**.

It is convenient to use the AND gate or some left-over NAND gates to cut off any one of the coincidence gate inputs to U63B that select the position of the load pulse. One consideration is to feed only a logic low to a following NAND gate to cut it off – a logic high will wash out the input pulses and feed the following gate with a logic high so it is not cut off.

programming

Let's say that we wish to down-count a vfo, and to have the counting start at a programmed frequency which will correct for all other oscillators and errors in the receiver. This is not difficult.

After a long warm-up, set the receiver dial exactly in zero beat at the zero end of the dial, with WWV or a harmonic of the digital station accessory's crystal calibrator after careful adjustment to WWV. Then, in the up-count position, determine the reading. This becomes the amount to preset into the up/down counters. Each digit should be converted to its binary equivalent, and the ABCD inputs of the 74192 ICs grounded except where they are to be at a logic high as required for the binary equivalent for that digit. Do this for each digit.

Example: The Racal receiver covers the entire 30-MHz range, with or without a tuned input circuit, and beats it with an unstabilized oscillator in the 40 to 70 MHz range. This vfo also feeds a mixer which mixes harmonics of a 1-MHz crystal, passes the mixed result through a 37.5-MHz band-pass amplifier and back to the signal stream. There, a mixer preceeded by a 40-MHz bandpass filter mixes the 37.5-MHz signal to produce a 2- to 3-MHz second i-f (see **fig. 8**).

Since the unstabilized oscillator is injected and removed (at another harmonic of the 1-MHz crystal) the second i-f signals have crystal accuracy. At this point, a 2.1- to 3.1-MHz vfo tunes the signal, and is counted, before it produces a 100-kHz IF. This, in the RA-17C at least, is mixed with an 82-kHz oscillator fitted with a fine-tuning dial, passes through L/C sideband filters in the 18-kHz range and is detected.

The thing to remember here is that the 2.1- to 3.1-MHz vfo covers a 1-MHz band and contains an error of at least the 100-kHz of the following i-f.

Set the dial at zero (vfo output, 3.1 MHz). Using one-second gating, count the vfo frequency. We can discard the megahertz figure because it will be beyond the first six digits and will not appear on the display, but we must program the 100,000-Hz i-f error and any other little errors lying around. This is done quite simply – by grounding every ABCD data input to the up/down counters except the A input to the sixth decade (fifth up/down counter in this case). This means that the six digits after a reset and load will read 100,000 *before* counting.

Now, for one second, this is down-counted (disregarding the 3 MHz which will not show), and the 3.1 MHz signal reduces the 6-digit reading to 000,000 Hz. This is what we want.

At the 2.1 MHz end of the dial the down-counting would fall 1 MHz short and leave it at 1,000,000 Hz. But, again, the 1 MHz is not indicated. All frequencies between the vfo ends are shown to the Hertz.

If the vfo to be counted has an increasing output frequency with its dial settings, then a slightly different procedure is used. Loading the program results in the same upward indication. But, we need a program below zero, for up-counting. Therefore, turn the vfo to the low-frequency end of the dial, set it carefully to zero beat with WWV or a calibrator harmonic, and count the frequency. This count must be subtracted from zero, and the result wired into the program.

Again, let's take an example based on a fictitious reversal of the Racal dial used in the down-count example above. Assume that zero frequency produces a 2.1-MHz vfo output, while the 1000-kHz higher end of the dial produces a 3.1-MHz output. Assume that the count at the low end is actually 2100 kHz. Here again, it would be desirable not to indicate megahertz through counting spill-over into the seventh and eighth decades. So, we have 100,000 to program. We subtract this from zero; the answer is 900,000 (to six figures). In the sixth count decade – in this case the fifth up/down counter – the A and D inputs should be left open or connected to a logic high, and all other inputs should be grounded.

Let's examine the results. The oscillator is at 2.1 MHz, so it starts up-counting at 900,000. The first 100,000 Hz brings it to an even 1 MHz, and the next 2 MHz brings it to a total of 3 MHz. But we decided not to indicate the MHz reading by a counting means, so the read-out is 000,000 Hz. Similarly, at the high-frequency end, the 900,000 programmed figure is raised by 3.1 MHz to a total of 4 MHz, and again it reads 000,000 Hz, inasmuch as we do not indicate the 4 MHz.

The Racal's fine-tuning control on the stable 82-kHz oscillator makes it possible to use the 100,000 program in every case, and then to adjust the zero setting on WWV with the fine tuning, which holds for every band.

To avoid errors due to the Racal's 1-MHz crystal being slightly off frequency, remove the 1-MHz crystal and feed the oscillator with 1-MHz obtained from the counter's 1-MHz test output, plug 5 of the input and time-base board as shown in **fig. 2**, last month.

Soldering does the job when only one band is to be programmed (30 bands in the Racal). In many receivers, however, five or more bands, involving different errors, may be present.

The bandswitch on the digital station accessory can be set to the same band as

table 1. Plug assignments common to two or more boards.

plug	to	purpose
D	RO-C-IT	reset 7473
E/J	reserved	program
K	BS3e	program
L	all	transfer invert
M	RO-C	count in/out
NPRS	IT-RO	tens BCD
TUVW	IT-RO	units BCD
Y	power	+12 V_{cc}
4/7	RO-C	100k BCD
8/11	RO-C	10k BCD
12/15	RO-C	1k BCD
16/19	RO-C	100-Hz BCD
20	IT-C	load 74192
21	IT-C	carry/up
22	IT-C	borrow/down

the receiver or transceiver. This switch can provide a pole for selection of up or down counting, provision of the load pulse and selection of the correct program for the band. Instead of soldering the programmed inputs in place, all programs should be counted for several bands, and written down. Then, convert these to binary-coded decimal for each digit. Add the values of the A, B, C and D outputs (1, 2, 4 and 8) to convert.

If all bands require a particular input pin to be at a logic high, that pin is left open. If all bands require a particular data input to be at a logic low, the pin must be grounded. But many inputs will have to be high on some bands, and low on others. For those bands on which a specific input must be grounded, this can be done through a steering diode (they can be mounted perpendicular to the *Plugbord* in nearby unused holes) for each affected band, with anode to the pin and cathode to the bandswitch contact. Then, when the bandswitch is turned to a particular band, it will ground all diodes connected to that contact.

For a particular five-band equipment, as many as four diodes (such as surplus silicon small-signal diodes) may be necessary to connect a particular input pin to the switch contacts for several bands. In the equipment described, with five up/down counters, each with four inputs, as many as fifteen diodes could connect to a single band-switch contact. On the average, however, somewhat less than half of this number may be necessary for the required programs. Five board plugs, E through J, have been reserved to ground the program input pins.

If the same bandswitch contacts are to be used for grounding some other circuit, such as up/down control, a steering diode may be required in this additional line to prevent the assumed logic high on the input pins from affecting others.

For ultimate cycle-accuracy, much of the above depends upon determination of zero beat. Sometimes, particularly with high-fidelity earphones or a loudspeaker, this can be done by ear. W3FQJ has described how to use a scope to show zero beat when connected to the i-f.[5] Another way is to use a separate audio oscillator, and adjust WWV and the vfo under test to the same audio beat, and then correct for the indicated offset oscillator frequency. A source of this audio signal is the 1-kHz output from the time-base chain of ICs, preferably through a stopping capacitor or high value resistance. When WWV or any other signal is in phase with this 1-kHz signal on the scope, the vfo is exactly 1 kHz off zero beat, and the read-out can be corrected mentally.

wiring

The time-base wiring was described last month. The remaining wiring for the input amplifier, resolution, gating, control and count decades can follow the accompanying figures and tables. These are based upon separate up/down controls, and taking the load-pulse control line out to a switch. Methods of reducing the plug and switch requirements for these have already been discussed. Addi-

table 2. Additional plug assignments for the input and time-base board.

plug	to	purpose
12	RS4b	1 kHz
13	RS4c	100 Hz
14	RS4d	10 Hz
15	RS4f	resolution
18	BS2c/j	up count
19	BS2b	down count
X	MS4a	rf in
M	BS3a	load control

table 3. Additional plug assignments for the read-out board.

plug	to	purpose
X	RS2b	decimal U32
21	RS2c	decimal U33
22	RS2d	decimal U34

tional plug assignments are given in **tables 1, 2 and 3.**

Connect all V_{cc} pins to the V_{cc} supply. Bring a NAND gate input, if unused, to V_{cc}. Bring all ground pins to the ground bus. In the final divider and the gating, follow **fig. 5.** Proceed with the detailed board connections listed in **table 4** for the input and time-base board. Note that +5-V buss for both plug-A and plug-B, on each side of the broken foil, must be connected to their proper plugs.

The count-board connections are given in **table 5.** Make similar connections from decade dividers to memory latches in each decade. The latch outputs can be connected more easily to the AND gates from the timer FFs than directly to the indicated plugs. However, there are three places where there is no time output from the time FFs to the plugs due to minutes and hours being less than 100. With counters being fed V_{cc} through plug-A only when counting, and the AND gates receiving +5V from plug-W only when time is displayed, the outputs can operate in parallel as indicated.

The read-out board connections appear in **table 6.** Connections for eliminating leading-edge zeros have been discussed; other connections involving the decoder/drivers and the read-out units are the same for each digit. Note, however, that the two unused inputs to the final memory latch should be grounded (or the same inputs to the decoder/drivers should be grounded) to prevent arbitrary activation of the final read-out above the digit 3. It will be recalled that plug-B is used for +5 volts to the middle four digits for use as a digital clock, and the two digits at each end receive their +5 volts from plug-A.

Switch wiring, using a new 4-pole, 11-position bandswitch for controlling band, up/down count, loading and load pulse is tabulated in **table 7.** No specific assignments are given as yet to the plugs for the mixer board, which has not yet been wired and tested with the shielded Weeductors and the MC1550 amplifier. Should anything of unusual interest develop in its construction, supplementary material will be published in *ham radio*.

To minimize the chance for switching that might step up the digital clock, a filter capacitor was added from the +5-volt switchable power supply to ground. Also, several 10-μF capacitors (or larger) were put across the resolution switch contacts to ground whenever they in-

table 4. Connections on the input and time-base board.

from	to	purpose
Plug-X	amp input	rf in
Plug-A	V_{cc} bus	+ count
U16p14	amp out	count in
U16p2	V_{cc}	unused
U16p3	U62Cp8	reset
U16p7	ground	R9
U16p12	U61Ap4	A out
U16p1	U61Ap6	BCD in
U16p9	U18p3	B out
U16p8	U18p6	C out
U16p11	U18p7	D out
U18p16	Plug-T	A out
U18p15	Plug-U	B out
U18p10	Plug-V	C out
U18p9	Plug-W	D out
U18p2	ground	A in
U61Bp1	Plug-18	up
U61Bp3	U17p5	up
U61Bp2	U61p11	D out
U61Bp2	U61Cp12	D out
U61Cp13	Plug-19	down
U61Cp11	U17p4	down
U17p14	U16p3	reset
U17p11	U63Bp12	load
U17p13	Plug-22	borrow
U17p12	Plug-21	carry
U17p3	U19p2	A out
U17p2	U19p3	B out
U17p7	U19p6	C out
U17p6	U19p7	D out
U17p7	Plug-N	A out
U19p16	Plug-P	B out
U19p10	Plug-R	C out
U19p9	Plug-S	D out
U62Dp12	V_{cc}	transfer
U62Dp13	U63Cp8	transfer
U62Dp11	U19p4/13	transfer
U19p4	U18p4/13	transfer
Plug-Y	+12 bus	amplifier V_{cc}

table 5. Connections on the count board. See text regarding similar connection to each decade.

from	to	purpose
Plug-A	V_{cc} bus	+ count
Plug-21	U22p5	up
Plug-22	U22-4	down
Plug-D	U70Cp13	reset
U70Cp11	U22p14	reset
U22p14	U23p14	reset
U23p14	U24p14	reset
U24p14	U25p14	reset
U70Cp12	V_{cc}	unused
Plug-L	U70Bp4	transfer
U70Bp4	U70Dp10	transfer
U70Bp5	V_{cc}	unused
U70Dp6	U22p4/13	transfer
U22p4	U23p4/13	transfer
U70Dp9	V_{cc}	unused
U70Dp8	U24p4/13	transfer
U24p4	U25p4/13	transfer
Plug-20	U22p11	load
U22p11	U23p11	load
U23p11	U24p11	load
U24p11	U25p11	load
U22p13	U23p4	borrow
U22p12	U23p5	carry
U23p13	U24p4	borrow
U23p12	U24p5	carry
U24p13	U25p4	borrow
U24p12	U25p5	carry
U25p12	Plug-M	count out
U22p3	U26p2	A out
U22p2	U26p3	B out
U22p6	U26p6	C out
U22p7	U26p7	D out
U26p16	Plug-16	A out
U26p15	Plug-17	B out
U26p10	Plug-18	C out
U26p9	Plug-19	D out
U27p9	Plug-15	D out
U29p10	Plug-6	C out
U29p9	Plug-7	D out

volved breaking the +5-volt supply to the AND gates on the count board, breaking the supply to the time decoders and read-outs and breaking the +5-volt supply for counting.

potpourri

The possibility of rf interference to the counter has been mentioned. A completely closed cabinet or chassis might be useful, but may not be effective unless the 117-volt ac supply and other leads from the unit were suitably treated. In the presence of substantial capacity on input and output circuits, and IC count input and output circuits do not always toggle properly.

Interference from the counter was reduced materially by placing a 0.02-μF capacitor directly across the input of each LM309K and LM336 voltage regulator. Interference was also reduced by reversing the power plug – which suggests that a statically shielded power transformer might be useful. There was also some leakage of 1-MHz harmonic output, modulated nearby by 1 kHz, which did not occur in the earlier counter which used a double switch to prevent leak of the calibrator signal to the receiving antenna.

Shielding is needed to avoid addition of receiver birdies and other noise into a counted oscillator. This is more likely to occur with the direct up/down counting method (unless an IC amplifier reduces it)

table 6. Connections on the read-out board.

lug	to	purpose
V_{cc}	Plug-A	+5 volts
ground	Plug-Z	-5 volts
Plug-M	U52p14	7490 in
U52p12	U52p1	A-BCD
U52p11	U51Ap1	count
U51Ap12	U51Bp5	count
Plug-D	U80Ap1	reset
U80Ap1	U51Ap2	reset
U51Ap2	U51Bp6	reset
U80Ap2	V_{cc}	unused
U80Ap3	U52p2	reset
Plug-L	U80Bp4	transfer
U80Bp6	U53p4	transfer
U53p4	U53p13	transfer
U53p13	U54p4	transfer
U54p4	U54p13	transfer
U52p12	U53p2	A out
U52p9	U53p3	B out
U52p8	U53p6	C out
U52p11	U53p7	D out
U51Ap12	U54p2	A out
U51Bp9	U54p3	B out
U54p6	ground	no C
U54p7	ground	no D
U53p16	U45p7	A in
U53p15	U45p1	B in
U53p10	U45p2	C in
U53p9	U45p6	D in
U51Ap12	U46p2	A in
U51Bp9	U46p3	B in
Plug-K	U35p9	decimal
Plug-22	U34p9	decimal
Plug-21	U33p9	decimal
Plug-X	U32p9	decimal

table 7. Wiring connections for the mode switch and bandswitch, including provision for synthesized mixing board and five-band programmed correction.

lug	to	purpose
MS1a	M plug	hf mixer
MS1b	phono	transmitter hf
MS1c	phono	receiver hf
MS1d	MS1c	receiver hf
MS2a	M plug	vf mixer
MS2b	phono	transmitter vf
MS2c	phono	receiver vf
MS2d	MS2c	receiver vf
MS3a	M plug	bf/if mixer
MS3b	phono	transmitter bf
MS3c	phono	receiver bf
MS3d	phono	receiver i-f
MS4a	IT plug-X	rf in
MS4b	M plug	amplifier out
MS4c	MS4b	amplifier out
MS4d	MS4c	amplifier out
MS4e	phono	Racal vfo
MS4f	phono	counter
BS1a	M plug	mixer out
BS1b	M plug	2 - - 3 MHz
BS1c	M plug	3.5 MHz
BS1d	M plug	5 MHz
BS1e	M plug	7 MHz
BS1f	M plug	10 MHz
BS1g	M plug	14 MHz
BS1h	M plug	21 MHz
BS1i	M plug	28 MHz
BS2a	ground	control
BS2b	IT plug-19	down count
BS2c/j	IT plug-18	up count
BS3a	IT plug-M	load control
BS3b	open	load
BS3c/j	ground	no load
BS4a	IT plug-K	program
BS4b/J	reserve	load

than with the synthesis of the operating frequency by the mixer method.

Since building the unit and writing this article, I have found that the power input to the LM309K regulator that most required the 0.02-μF capacitor across the input had a substantial saw-tooth wave. This mostly was eliminated in the regulator but there were still some small spikes in the output. These may have been caused by the input waveform, or may have come down from the counter, though synchronous with 60-Hz power.

In any event, while the spikes did no harm when counting rf, they occasionally caused irregular counts at audio frequencies. In fact, I suspect that this noise is responsible for the problem described above in gating the very first FF of the counter, which led to the unusual gating circuitry. Also, it appears to place a limit on how much coaxial cable capacitance can be present on the interval-timer board, to the switch, to the phono plug and beyond the chassis to the receiver. While RG-62A/U cable reduces capacitance, so does the length of the cable. This will be investigated further, with a view to putting the count gate ahead of the A section of the first count decade.

If the bypass capacitors do not eliminate the tendency of switching spikes occasionally to step up the digital clock, to consideration can be given to using a shorting-type switch. If the AND gates cause a spike in the V_{cc} line when it is switched on and off the AND gates, then these gates can be controlled with an input line while leaving the V_{cc} on them.

conclusion

There have been many tests, experiments, substitutions, and the like, in the construction of this unit. However, the results have been worthwhile, making a pleasant addition to operating the station. The unit has been a help in Official Observer and Intruder Watch work, particularly in the ease with which accurate frequencies and fsk shifts can be determined. As stated initially, the facility with which digital IC equipment can be built makes them particularly adaptable for homebrew and self-designed items in the amateur station.

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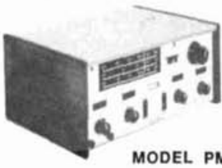

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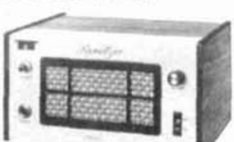

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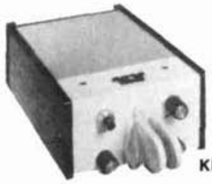

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More Details? CHECK—OFF Page 110

audio-actuated in-line squelch... the squelcher

A new twist
to an old idea
that can be added
to any receiver
in one evening
without
major modification

Gene F. Greneker, K4MOG, 2546 Wilson Woods Drive, Decatur, Georgia 30033

While the avc-operated squelch has been around a long time, there's something to be said for the audio-actuated in-line squelch, and the Squelcher is the last word in in-line squelch circuits! Traditionally, the squelch circuit has been used to silence receivers during inactive periods. The Squelcher has other important functions other than receiver muting during periods of inactivity. For example, the Squelcher makes possible clear channel operation even in 20 dB of noise, if the received signal is at least 5 dB above the noise level. There will be some noise under the received signal, but the ear, an amplitude-type detector, hears the audio output of the receiver go from a zero level during the squelched period to a maximum during transmission; the effect is to create an auditory illusion. The desired received signal seems much stronger than it actually is. In short, the Squelcher can mask a great deal of background noise between words and sentences that contributes to operator fatigue during long operating periods.

The Squelcher is basically an audio-actuated switch that closes a set of relay contacts in series with the speaker each time the receiver output exceeds a pre-set level. As long as the audio level stays above the pre-set threshold, the relay stays closed, keeping the speaker connected to the receiver output. However, when the receiver output falls below the pre-set level, and after a time delay determined by the time constant of a capacitor (C3), the relay contacts open and silence the speaker.

While most squelch circuits rely on a change in avc voltage to achieve squelch action, the Squelcher operates on the change in the audio output of the receiver. The addition of the agc squelch circuit to an existing receiver can be a custom project with as many variations in circuitry as there are different makes of receivers. The Squelcher, on the other hand, can be added to any existing receiver with an output impedance of 4 or 8 ohms and will achieve the same results.

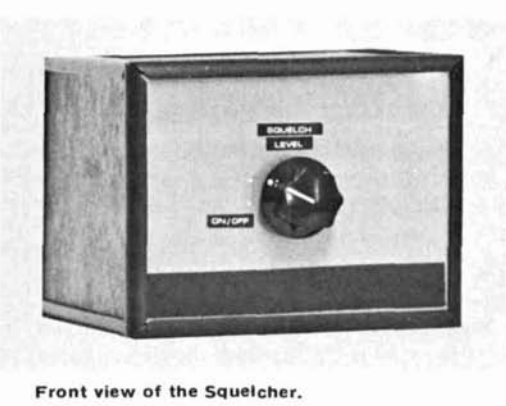
theory

The Squelcher consists of an internal rectifier bridge that converts 6.3 Vac to dc to operate an amplifier stage and a relay driver stage. Diodes CR1, CR2, CR3 and CR4 comprise a standard full-wave bridge rectifier whose output is filtered by capacitor C4. Resistor R6 serves to limit the current flowing through zener diode (CR7) to a bias point that allows the zener to regulate the voltage to 8.2 volts regardless of load.

Transformer T1's primary is connected directly across the receiver output. During periods when the threshold is too low to allow the receiver output to be switched to the speaker, T1 presents a constant 8-ohm load to the receiver. When the output rises to a level sufficient to switch in the speaker, the low-impedance input of T1 keeps the reference level to the amplifier fairly constant regardless of the additional speaker load.

The secondary of T1 is fed into the high side of the potentiometer (R7) which serves as the squelch or threshold-level control. Capacitor C1 passes the ac component into the 2N2925 amplifier stage, which amplifies both positive and negative peaks in linear fashion. The output of the transistor amplifier stage (Q1) is coupled through C2 to a negative peak clipper (CR1) and a half wave rectifier (CR2) whose output is averaged by capacitor C3. The value of C3 determines the time constant or hold-in time of the relay driver circuit. For shorter hold times, decrease the value of C3. The voltage stored by C3 is applied to the base of transistor Q2 through resistor R5. When the voltage applied to the base of Q2 reaches a sufficient level to cause conduction, relay K1 closes, connecting the speaker to the receiver.

Switch S1 is mounted on the threshold potentiometer. In the off position, S1 shorts the open contacts of K1 connecting the speaker directly to the output of the receiver, taking the squelch circuit completely out of the circuit. This action also opens the 6.3 Vac input line, disconnecting the Squelcher from the power supply.



Front view of the Squelcher.

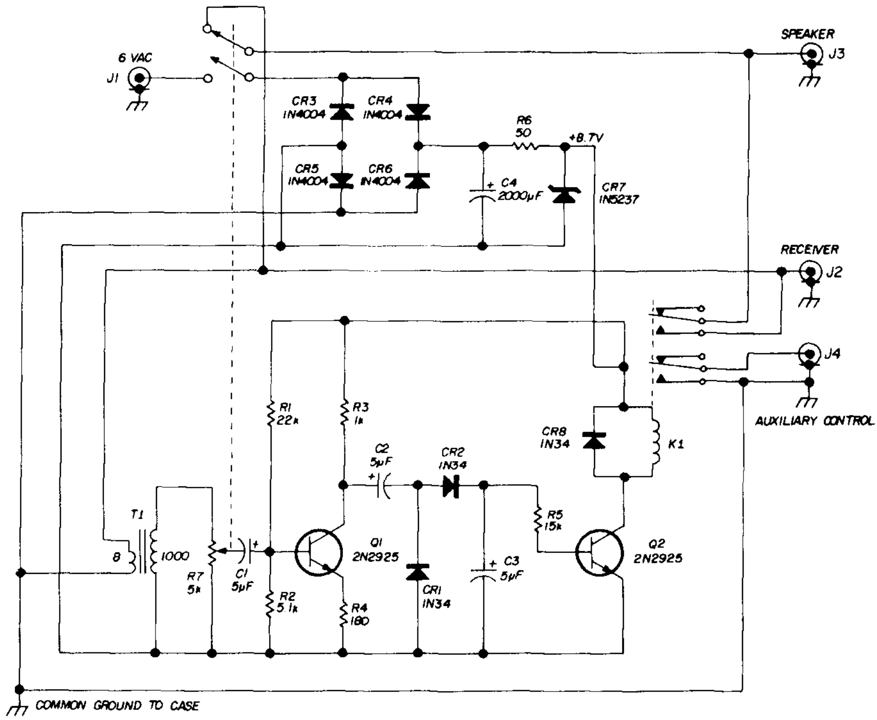
construction

The parts layout is not critical. However, for ease in assembly, it may be best to make your own printed-circuit board or to purchase the ready-made board.* If you use the pc board, parts should be mounted as shown in the photograph, with the exception of capacitor C4 and potentiometer 1 – these will be mounted later. When all the other parts have been mounted, check to insure all leads were clipped close to the foil on the pc board.

Mount the potentiometer first. The three leads of the potentiometer are designed to be soldered directly to the board. Solder the three leads of the potentiometer to the foil side of the board and trim any excess leads. Make sure the potentiometer is *flush against the component side of the board*, or the board may crack during final tightening of the mounting nuts. Next, solder 1½-inch pieces of wire to the switch portion of the potentiometer.

When installing capacitor C4, be care-

*All components, including cut and drilled printed-circuit board, pre-drilled Eico Flexi-Cab cabinet, and the input transformer are available for $19.95 from H & L Electronics, Box 9707, Atlanta, Georgia 30319. The printed-circuit board alone is $2.95, and the transformer is $1.00 from H & L.



K1	dpdt reed relay, 12 Vdc coil (Allied Control RF-2A)
R7	5k, ½ W potentiometer with S1 attached (Clarostat A42-5000K-6140 with type 21 switch attached)
S1	two, spst switches, one on and one off per throw (Clarostat type 21 switch attached to R7)

fig. 1. Schematic diagram of the Squelcher. All capacitors are rated at 25 Vdc, all resistors are half watt.

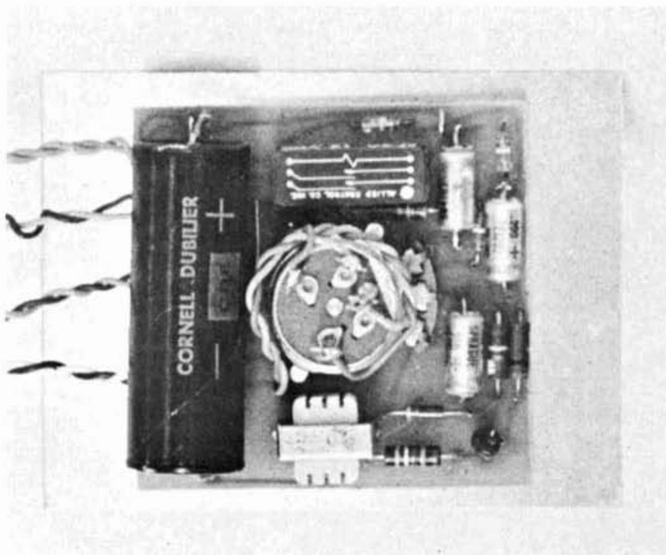
ful to observe the correct polarity. The positive lead goes to the relay side of the board.

When mounting the potentiometer and pc board inside a cabinet, use two lock nuts as spacers to prevent the cabinet from shorting the foil side of the printed circuit. I housed my Squelcher in a 4¼ x 3¼-inch box with the potentiometer mounted in a 7/16-inch hole in the center of the front panel. Construction is completed with the wiring from the pc board to four phono jacks mounted on the back panel. These jacks provide for all interconnections between the Squelcher and the rest of your station.

installation

Two pairs of wires must be brought out of the receiver. Find a pilot light or other source of 6.3 Vac and attach the leads to a phono plug to mate with J1. Be certain to connect the ground side of the plug to a good receiver ground. If your receiver filaments are 12 volts, change R6 to 330 ohms.

Next, the output leads that normally go to the speaker should be connected to a phono plug to mate with J2. The station speaker should be connected to J3 through another mating phono plug. I recommend using shielded cable for these connections to insure a good common ground throughout and to minimize hum pickup. Through J4, you can connect any other unit which you want to control with the normally open contacts of the relay.



The pc board wiring. The potentiometer must be mounted flush against the printed-circuit board.

With the Squelcher connected to your receiver and speaker turn the receiver on. Assuming there is no problem, turn the volume up to a point just above the level that is usually considered comfortable.

Next, turn the Squelcher threshold control clockwise just past the point where the switch clicks on. Tune to a quiet frequency and advance the threshold control until the speaker becomes silent. At this point the receiver is squelched. Tune across the band until a signal shows on the S meter, simultaneously the audio should be heard in the speaker. By varying the setting of the threshold control, the minimum level required to break the squelch can be controlled quite accurately.

additional hints

Receivers having agc circuits with a dynamic range of 30 or 40 dB will cause some problems with the Squelcher unless the rf gain control is turned down to a point where the agc action is not noticeable. Otherwise, a signal reading S-9 on the S meter will have the same relative audio output level as a 40 dB over 9 signal. Since the Squelcher detects audio rather than signal level, the audio must be relative to signal strength. Therefore, by setting the receiver audio output for a comfortable level and retarding the rf gain control, the Squelcher will operate dependably.

The optional contacts of the relay will find numerous uses. By changing capacitor C3 to a lower value the reed relay can be driven by moderate to fast CW. By connecting the spare contacts of K1 to a code practice oscillator it is possible to obtain QRM-free copy on strong CW signals, by keying the oscillator in repeater fashion. No doubt, other uses have already come to mind.

After some playing around with the Squelcher, it will be noticed that extremely fine levels in signal change can be detected. As a bonus, operator fatigue will decrease due to squelched noise and interference during lulls in the contact.

Because the Squelcher is somewhat audio-level dependent, it will take a few minutes to determine the proper balance between the receiver audio and rf gain controls. Once these are set, the squelch level will be determined by the threshold control. With time, the Squelcher will become an interference rejection tool for your receiver equal to the Q multiplier, crystal filter and noise limiter.

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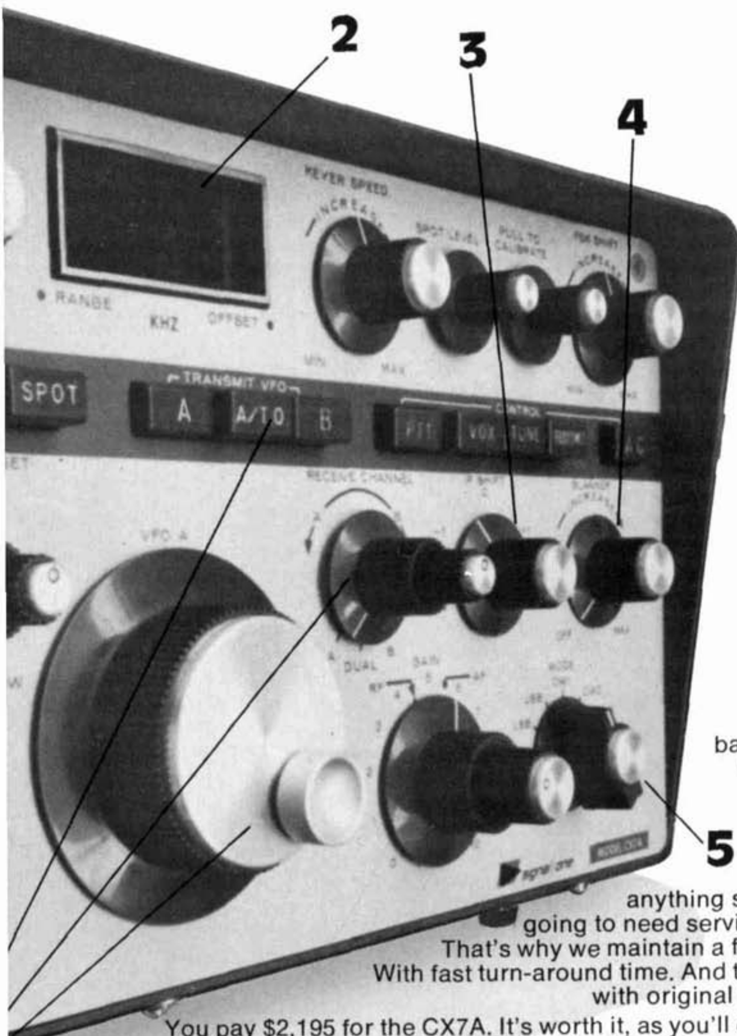
1
PA TUNING
BROAD BAND
MANUAL
LOADING
METER
CLIPPING
DRIVE
PLATE
REV PWR
PRESELECTOR
CLIPPING
OUTPUT
TRANSMITTER
DOWN
OFF
VFO B
MHZ
PHONES
MIKE
6
7
8
9
10

Is your amateur station a serviced station?



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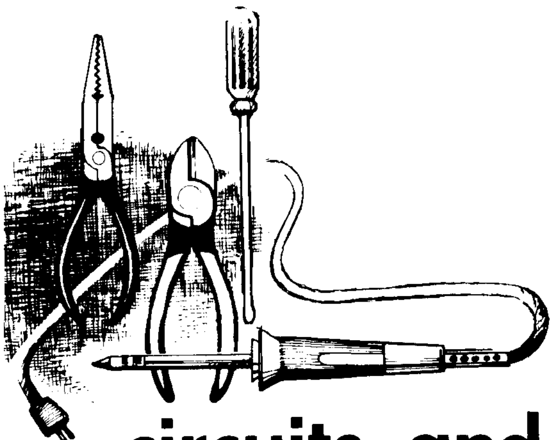

circuits and techniques

ed noll, W3FQJ

digital integrated circuits

One of the exciting side effects of computor technology has been the involvement of a different mathematical form in electronic circuit design and application. The versatility of the true-false (1,0) concept is phenomenal.

Last month we considered inverter, OR, AND, NAND and NOR logic functions and circuits. The basic Boolean expressions for these functions are:

OR	$A+B$
AND	$A \cdot B$
NAND	$\overline{A \cdot B}$
NOR	$\overline{A+B}$

There are quite a number of Boolean theorems and relations. One of the most important is known as the DeMorgan theorem. In practice this theorem proves the validity of a very common form of digital integrated circuit known as the NAND gate. This one type of integrated circuit includes NAND, AND and OR functions. Furthermore, some typical negative-logic NAND gates can also be operated as positive-logic NOR gates. Thus a single digital IC can provide a number of logic functions.

Recall the NAND circuit symbol and truth chart, **fig. 1**. When both A and B are true, the output is false. However the signal is logically inverted as indicated by the line above the expression in the NAND function equation:

$$X = \overline{A \cdot B}$$

The NAND function can also be written:

$$X = \overline{A} + \overline{B}$$

It is DeMorgan's theorem that equates these two relations.

$$X = \overline{A \cdot B} = \overline{A + B}$$

There are several ways of proving DeMorgan's theorem. Perhaps the most

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

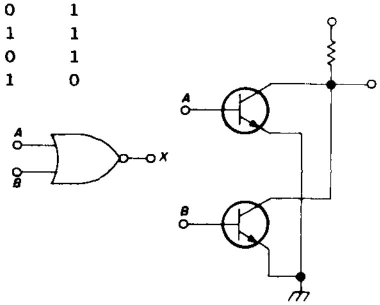

fig. 1. Basic NAND function using negative logic.

obvious uses the truth tables in **fig. 1.** First we set down the truth table of an OR function. However, the relationship we are trying to prove indicates that the A and B terms have been logically inverted as per the second truth chart. Next set down the truth chart for the NAND function. Note that the output values are identical and therefore:

$$\overline{A \cdot B} = \overline{A} + \overline{B}$$

You can go a step further and invert the logic of the output of the NAND circuit, **fig. 2.** The fourth chart shows this inversion. Note that the output expression now contains double lines above A and B. These indicate that the signals have been inverted twice. This restores the original logic just as any signal twice inverted is returned to the original polarity. Most importnat, note that the output of the inversion corresponds to the output of an AND circuit. It is readily understandable how a single digital IC can be constructed to include a variety of logic possiblities.

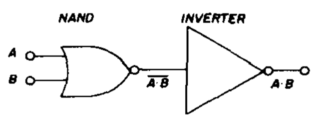

fig. 2. NAND to AND inversion.

A NOR gate, like a NAND gate, can also provide the AND and OR functions. The addition of an inverter (NOT circuit), permits an OR output. The first truth chart of **table 2** is that of an AND fuction. An inversion of its logic produces the logic of chart 2. Note that the output is the same as that of a NOR function circuit, chart 3. This proves the validity of the DeMorgan theorem and the following equality can be stated:

$$\overline{A} + \overline{B} = \overline{A} \cdot \overline{B}$$

If the output of a NOR circuit is followed with an inverter, you obtain the results shown in the fourth chart. Note that this corresponds to the output of an OR truth chart.

table 1. Validity of DeMorgan's theorem and inversion of NAND to AND function.

OR

$\overline{A}$	$\overline{B}$	$\overline{A}+\overline{B}$
0	0	0
0	1	1
1	0	1
1	1	1

(1)

OR INVERTED

$\overline{A}$	$\overline{B}$	$\overline{A}+\overline{B}$
1	1	1
1	0	1
0	1	1
0	0	0

(2)

NAND

A	B	$\overline{A \cdot B}$
0	0	1
0	1	1
1	0	1
1	1	0

$\overline{A \cdot B} = \overline{A}+\overline{B}$

(3)

NAND INVERTED

$\overline{A \cdot B}$	$\overline{\overline{A \cdot B}}$
1	0
1	0
inverted	AND out
1	0
0	1

$\overline{\overline{A \cdot B}} = A \cdot B$

(4)

In fact, suitable circuits based on the truths of the various Boolean theorems can permit a variety of logic functions. You can use the circuit of **fig. 3** as an example. Basically, it is a NAND configuration. Base biasing (resistors R1, R2 and R3) is such that the transistor conducts when logic 1 (positive logic) voltage is applied to both inputs. Under this condition the output will be logic 0. When logic 0 voltage is applied to both inputs or to either input, the transistor is turned off, producing logic 1 voltage at the output. Tied in with a follow-up

table 2. Validity of DeMorgan's theorem and inversion to OR function.

AND

A	B	$\overline{A \cdot B}$
0	0	0
0	1	0
1	0	0
1	1	1

(1)

AND INVERTED

$\overline{A}$	$\overline{B}$	$\overline{A} \cdot \overline{B}$
1	1	1
1	0	0
0	1	0
0	0	0

(2)

NOR

A	B	$\overline{A+B}$	
0	0	1	NOR
0	1	0	in
1	0	0	
1	1	0	

$\overline{A+B} = \overline{A} \cdot \overline{B}$

(3)

NOR INVERTED

$\overline{A+B}$	$\overline{\overline{A+B}}$	
1	0	OR
0	1	out
inverted		
0	1	
0	1	

$\overline{\overline{A+B}} = A+B$

(4)

inverter (NOT circuit), the arrangement can be made to operate as an AND circuit.

The same circuit functions as a NOR gate by changing the polarization of the

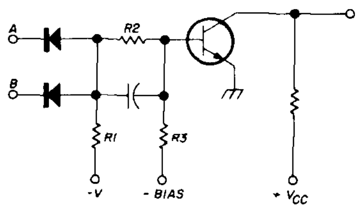

fig. 3. Basic NAND gate.

input diodes and changing the bias level established by the base voltage-divider resistors. In this case, when either or both inputs are at logic 1 voltage, the transistor is turned on to produce a 0 logic output. With both inputs at logic 0, the output is logic 1 because the transistor remains cut off. A follow-up inverter is used to establish an OR function operation.

standard integrated circuits

Digital integrated circuits are found in a number of standardized configurations. The transistor-transistor logic combinations, abbreviated TTL or T^2L, are very common. A basic circuit, **fig. 4**, is a pair of direct-coupled transistors. The input transistor has a dual-emitter, a separate one for each input gate. This circuit operates as a NAND gate.

When logic 0 voltage is present on either or both input gates, the corresponding emitter-base diodes are forward biased. However, no significant collector current exists because of the reverse biasing of the base-emitter of transistor Q2. Stated another way, the saturation current of transistor Q1 is not high enough to forward bias transistor Q2. Therefore transistor Q2 output is logic 1 (positive logic).

The emitter-base diodes of Q1 are shut off when logic 1 voltage is applied to both. In so doing, the collector junction is forward biased. Base current magnitude and direction in Q1 is now such that the base of transistor Q2 is forward biased. Transistor Q2 is now turned on and the collector voltage drops to the 0 logic level.

A complete diagram of an integrated circuit NAND gate is shown in **fig. 5**. It is referred to as a dual 4-input positive NAND gate. Note that two circuits similar to that of **fig. 4** are included in the chip. There are four NOR input gates instead of two. A more elaborate output circuit is included to provide higher output to low-impedance loads and to obtain the capability of driving up to 30 loads (high fanout).

I mentioned previously that the AND function can be obtained by the addition of an inverter after the NAND gate. It should also be mentioned that a NOR function can be obtained by cascading two NAND gates. By including multiple gates on an IC chip, any number of common and special logic functions can be established by appropriate external wiring.

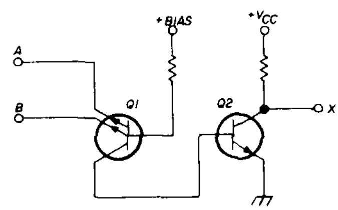

fig. 4. Basic TTL NAND gate.

The diode-transistor logic (DTL) is also common and similar to the TTL ICs. The DTLs are not as adaptable to complex functions and do not have the speed and capability of driving low-impedance loads as the TTLs. The input NOR switches are diodes, **fig. 6**. They are followed by an inverter stage. When both inputs are at logic 1 positive voltage, the diodes are reverse biased. The series or offset diode, however, is forward biased. Current holds the transistor in saturation and its low collector voltage corresponds to logic 0.

The application of logic 0 to any one

or both of the input diodes results in conduction, dropping the voltage at the anode of the series diode to a level that

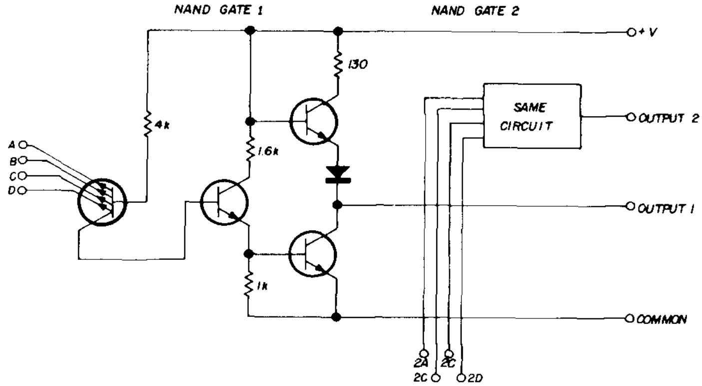

fig. 5. Dual 4-input positive NAND gate (Texas Instruments SN7420).

reduces the base current of the transistor to cutoff. Therefore, positive logic 1 output voltage is present at the collector.

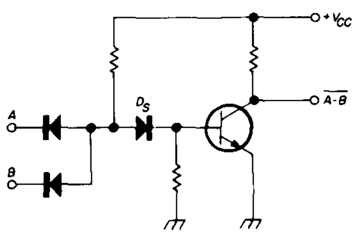

fig. 6. Basic DTL NAND circuit.

A similar family with higher supply voltages and greater power dissipation are known as the high-threshold logic (HTL) group.

Some of the very first IC types were *resistor-transistor logic* (RTL), **fig. 7**. This is a basic NOR circuit. These circuits are limited in switching speed and fanout capability. Though economical and adapatle to numerous applications, they have relatively poor noise immunity. Capacitors across the input resistors convert circuits to higher-speed resistor-capacitor-transistor logic (RCTL) types.

An increasingly popular family is the emitter-coupled logic (ECL) digital ICs. These provide the highest speed of all and include such favorable characteristics as low output impedance, high fanout and acceptable noise immunity. The high speed of operation is a result of limited voltage swing in a manner of operation similar to linear types and the non-saturated operation of transistors. These types perform up into the hundreds of megahertz.

In a typical NOR circuit, **fig. 8**, the emitters connect to a common emitter resistor. This connection prevents saturated operation. Transistor Q4 is used to set the threshold voltage at the input. A

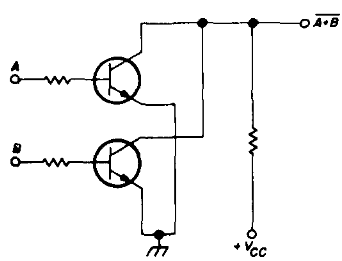

fig. 7. Basic RTL NOR circuit.

succeeding follow-up emitter follower insures low output impedance and good fanout.

The use of *metal-oxide semiconductor* field-effect transistors (mosfets) in digital integrated circuits adapts them to elaborate, multi-stage and highly-repetitive operations. Complex logic circuits can be incorporated into tiny chips. In a basic NAND circuit, **fig. 9**, negative voltage establishes logic 1 at the input, and both input gates conduct. The output voltage switches to the logic 0 value. When either or both of the input gates are set to 0 logic voltage, there is an open in the source circuit of the output mosfet and the output is at logic 1 level.

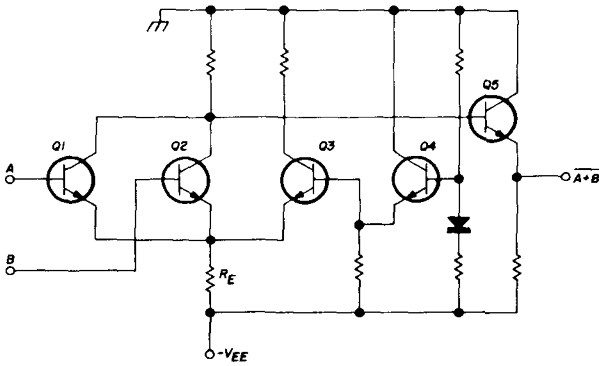

fig. 8. Basic ECL NOR gate.

schedule

The digital IC series will be interrupted next month but will resume the following month with discussions of flip-flops and frequency counters. Instructions will be given on how to set up a small experiment board so you can watch them operate on an oscilloscope and hear them on your receiver. Next month's column will be devoted to antennas to complement *ham radio's* popular antenna issue.

available vfo signal

Here is part of a note from James W. Harrison, Jr., WB4TEX: " . . . I use a Heath SB300 and SB400 cabled up for transceive. Under this arrangement, the receiver feeds its 5- to 5.5-MHz vfo output into the transmitter for frequency selecting, both for receive and transmit. No doubt many other hams use similar setups.

It occurred to me that the receiver vfo should be capable of serving as a tunable oscillator for a QRP transmitter, if such a transmitter included a proper mixer. It appears to me that such an arrangement would make a dandy QRP transceiver setup. I should imagine there are numerous integrated-circuit units capable of handling these functions as part of a QRP CW transmitter . . . "

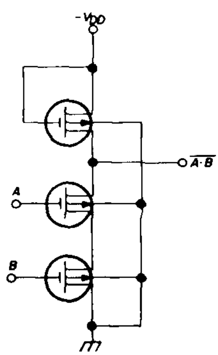

fig. 9. Basic mosfet NAND gate.

Here is a challenge for some of you QRP buffs. Is this not a good opportunity to come up with a vfo-controlled multiband QRP transmitter that you can operate transceive with your big receiver? Thank you, Jim.

ham radio

More Details? CHECK—OFF Page 110

beam antenna headings

An inexpensive guide to accurate antenna beaming for within the United States and around the world

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

Have you ever wondered what direction your beam *really* should be turned to work that elusive station? Have you ever been in a 3-way contact and wondered what heading would catch the other stations on some decent compromise heading? Information is available for beam headings from the central part of the U. S. A. (usually Chicago), and at times from other major cities. This may not help you to any reasonable extent, and the information is pretty much worthless for knowing where to set the antenna for stations here in the U. S. A.

I have wanted accurate beam heading information as much as anybody else, and went so far as to laboriously plot a number of representative cities throughout the U. S. A. on an aeronautical chart. This was quite helpful, and I used the list frequently. I am only a few miles from San Francisco, so the list of foreign beam headings published in the *Foreign Callbook* for that city worked well for me.

While developing a computer-controlled program for aeronautical inertial navigation systems, I decided to use that information to provide a supplementary beam heading program. This is now available, and comes in two lists – the first has 90 domestic cities at well-known places in the United States, the second list has 309 entries of various foreign countries and 10 U. S. cities representing each call district. Thus the program would be useful to stations outside the United States.

The program lists the true heading, magnetic heading, distance in kilometers and distance in statute miles. It thus helps give some indication if the long path is really that much further or not. It is useful to know just how far the other station really is, as it helps give an additional feeling of knowing a little more about the person you are talking with. To further help locate the station, the continent to which it is assigned is listed. If the country is fairly large or has a best-known city, that is listed also.

Even at a normal computer terminal speed, it takes one hour to print the entire listing of domestic cities and foreign countries. As most computer time costs $20 per hour, there is no way the typical amateur could normally afford to pay for such a customized and accurate print-out. However, I made arrangements to use a high-speed printer, and I have written a fully automatic program. This service is offered to anybody interested for $2 per copy plus 25c postage and handling. Since this would give exact headings from your exact location, this should be of unusual benefit to those interested at a price small enough any amateur could afford. Certainly no profit will be made on this, but so much time has already gone into writing the program and inserting all the data needed, it seemed a shame not to make this information generally available.

I can insert latitude and longitude just as accurately as you can supply it. I already have information on some 30,000 countries, states, cities and towns in the world, but I can just as easily insert the exact coordinates of your very home, if you take the time to find out what they are.

Here is the information I need to put into the computer for your particular printout:

1. Latitude (degrees, minutes, seconds).

2. Longitude (degrees, minutes, seconds).

3. Variation in degrees and whether East or West.

4. What name you wish to appear for location.

You will note from the example for Greenville, the name "From: Greenville, New Hampshire" appears at the top of each page. In my case, I use the coordinates of my house (off the deed to the

FROM: GREENVILLE, NEW HAMPSHIRE

LOCATION	DEG. TRUE	DEG. MAGNETIC	DIST. STAT.	DIST. KILOMTR.	DIST. NAUT.
45. MONT., GREAT FALLS	292	308	1902	3062	1652
46. N.CAR., ASHEVILLE	229	245	802	1290	696
47. N.DAK., BISMARK	289	305	1415	2278	1229
48. N.DAK., FARGO	289	305	1228	1976	1066
49. N.J., NEWARK	211	227	239	385	208
50. N.J., TRENTON	213	229	286	460	248
51. N.MEX., ALBUQUERQUE	264	280	1938	3118	1682
52. N.Y., ALBANY	235	251	125	201	109
53. N.Y., BUFFALO	263	279	358	576	311
54. N.Y., NEW YORK CITY	208	224	239	384	207
55. N.Y., ROCHESTER	265	281	291	468	252
56. NEBR., OMAHA	271	287	1236	1989	1073
57. NEV., LAS VEGAS	272	288	2326	3743	2020
58. NEV., RENO	78	94	2657	4276	2307
59. OHIO, CINCINNATI	248	264	729	1172	633
60. OHIO, CLEVELAND	256	272	525	845	456
61. OHIO, COLUMBUS	250	266	630	1013	547
62. OHIO, TOLEDO	261	277	613	987	533
63. OKLA., OKLAHOMA CITY	256	272	1476	2375	1282
64. ONT., OTTAWA	303	319	224	361	195
65. ONT., TORONTO	272	288	378	608	328
66. ORE., PORTLAND	291	307	2509	4037	2178
67. PA., HARRISBURG	229	245	352	567	306
68. PA., PHILADELPHIA	215	231	311	501	270

fig. 1. An excerpt from the U. S. antenna headings chart plotted on the HAM RADIO magazine office in Greenville, New Hampshire. Antennas can be accurately oriented with an ordinary compass by the magnetic degrees heading.

FROM: GREENVILLE, NEW HAMPSHIRE

B E A M   H E A D I N G S   A N D   D I S T A N C E S

	CALL	LOCATION	DEG. TRUE	DEG. MAGNETIC	DIST. STAT.	DIST. KILMTR.
1.	3A	MONTE CARLO, MONACO (E)	60	76	3808	6128
2.	3V8	TUNIS, TUNISIA (AF)	65	81	4183	6732
3.	3W8	SAIGON, VIETNAM (A)	2	18	8670	13953
4.	4S7	COLOMBO, CEYLON (A)	34	50	8513	13700
5.	4U1	UN, GENEVA, SWITZERLAND (E)	58	74	3662	5893
6.	4U8	UN, TURIN, ITALY (E)	59	75	3759	6050
7.	4W1	SANA, YEMEN (A)	61	77	6676	10744
8.	4X4	TEL AVIV, ISRAEL (A)	56	72	5454	8777
9.	4Z4	TEL AVIV, ISRAEL (A)	56	72	5454	8777
10.	5A	TRIPOLI, LIBYA (AF)	68	84	4471	7195
11.	5B4	NICOSIA, CYPRUS (A)	54	70	5245	8441
12.	5H3	DAR ES SALAAM, TANZANIA (AF)	80	96	7598	12227

fig. 2. An excerpt from the DX beam heading chart.

house, by the way) and so on mine it says: "From: Hoff House, California." I could have said "From: Los Altos Hills, California" just as easily.

You can find your latitude, longitude and magnetic variation from your property deed (the local city hall can look it up for you), from the county surveyor who has records of all this information, or there are several other things you can do. If you are reasonably close at all to any airport or commercial radio or tv transmitter, they always know exactly what the latitude and longitude are plus the magnetic variation in that area.

You can estimate from a road map your location with respect to that landmark. If all else fails, give the name of your community, and if it is less than 10,000 population, give the name of some larger nearby community with your approximate distance and direction from there. Again, I can provide you with information just as accurate as you give me to work with.

This should give you all the information you need to get your personalized beam heading printout. Include a self-addressed stamped envelope if you ask any questions that need to be answered, as the computer is located in Texas and all the actual printouts will be mailed from there. Also, I may find this service is too overwhelming to continue, or too expensive to offer for this nominal fee, and may wish to return your money. In any event it shall only be possible to crank out 15-20 of these in one evening, probably, so be patient on getting your copy.

If ordering, provide the following:

1. Latitude.
2. Longitude.
3. Magnetic variation (if you can't find this, I know already for anywhere in the USA to the closest 1°).
4. Name of location you wish to appear.
5. SASE for possible return of money.
6. Include $2 for the printout plus 25c mailing.
7. If sending from outside the United States, mailing costs would be for 2.5 ounces.

Mail to: Irvin M. Hoff
Attn: Beam
12130 Foothill Lane
Los Altos Hills, Calif. 94022

ham radio

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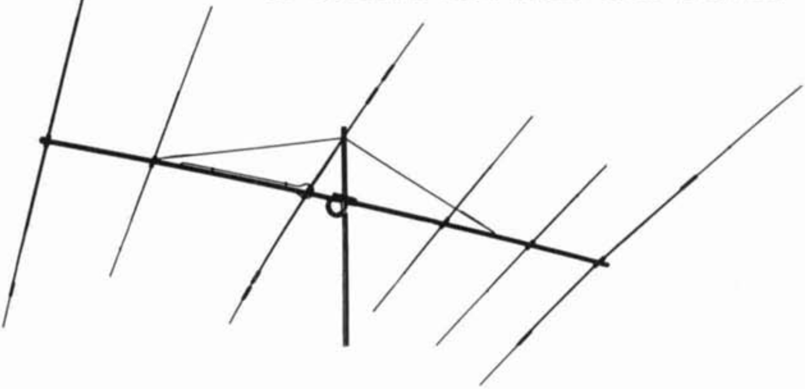

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- **Thunderbird's "Hy-Q" traps** provide separate traps for each band. "Hy-Q" traps are electronically tuned at the factory to perform better at any frequency in the band – either phone or CW. **And** you can tune the antenna, using charts supplied in the manual, to **substantially** outperform any other antennas made.
- **Thunderbird's superior construction** includes a new, cast aluminum, tilt-head universal boom-to-mast bracket that accommodates masts from 1¼" x 2½". Allows easy tilting for installation, maintenance and tuning and provides mast feed-thru for beam stacking.

  Taper swaged, slotted tubing on all elements allows easy adjustment and readjustment. Taper swaged to permit larger diameter tubing where it counts! And less wind loading. Full circumference compression clamps are mechanically and electrically superior to self-tapping metal screws.
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- Interlaced, optimum spaced elements for higher gain and better pattern control.
- 3 active elements on 20 and 15 meters. 4 active elements on 10 meters.

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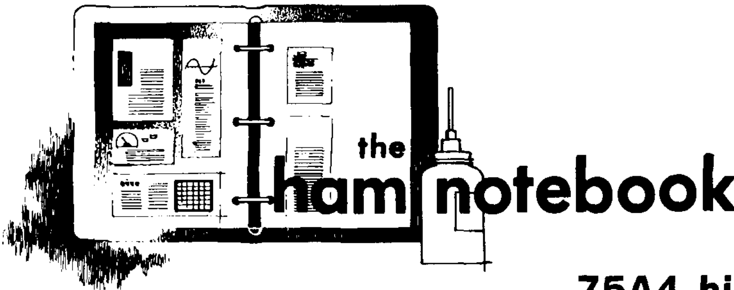

ic power

Too often, when radio amateurs start experimenting with IC packages we stop thinking like amateurs and start thinking by the book. A case in point was my own experience with a dual two-input gate which was used to build a Schmidt trigger. Briefly this is a circuit which will take almost any waveform provided it is above the needed trigger level and convert it into a form which can be used to trigger flip-flops.

The circuit was put together with an input voltage of about three volts, the output on the scope was a very nice square wave. Trying to trigger a series of flip-flops with this output was sheer frustration. Everything was wired properly, the supply voltage was on the money, but the flip-flop triggering was erratic. I finally decided to think like an amateur and measured the *output* of the Schmidt trigger and found that it was about 0.4 volts. I then powered the trigger with my variable voltage supply and found that at six volts dc applied to the IC, the output rose to 0.65 volts and the flip-flops triggered reliably. This circuit has been working very nicely for some months now with six volts, not the 3.6 as recommended. There have been no signs of failing or blowing up. Don't be afraid to think like an amateur!

A. S. Joffe, W3KBM

75A4 hints

To increase the amplitude of the 100 kHz markers on the 75A4, directly substitute a 6BZ6 in place of V1, the 6BA6 calibrator oscillator tube. If a further increase is desired, the oscillator 1-pF coupling capacitor, C5, can be replaced by a 10-pF silver-mica capacitor. The combination of the foregoing will result in a 20-dB calibration signal increase, as read on the S-meter, on the 14 MHz band. This was without any apparent degradation of the frequency stability as read on a General Radio model 1192 frequency counter.

For the convenience of having a front-panel ground of the antenna input circuit for testing, simply bend in the tip of the outside plate on the stator of the antenna trim capacitor, C18. This will short the antenna terminal to ground as the rotor passes over this one point. It means, however, that the trimming capacitor must be rotated from the opposite direction while in use. Full 360° rotation is no longer possible, but this loss is more than justified by the convenience.

M. H. Gonsior, W6VFR

wet basement alarm

Having always been concerned about plumbing leaks in my basement hamshack, I finally whipped up a combination water alarm and shut-off circuit for my well pump. Sensors placed strategically around the basement (near the well pump, washing machine and hot water heater) trigger Q1 into conduction when a water leak is detected. Q2 is then cut off, releasing the relay which breaks the line to the well pump, preventing the basement from being turned into a swimming pool. When Q2's collector voltage rises, Q1 is latched on via the 470k feedback resistor until the circuit is manually reset. At the same time, Q3 is actually more than enough to operate the relay.

I found that small pieces of pc board worked well as sensors. I used pieces about ½-inch wide and 2-inches long, double sided, with one lead connected to each side.

Al Donkin, W2EMF

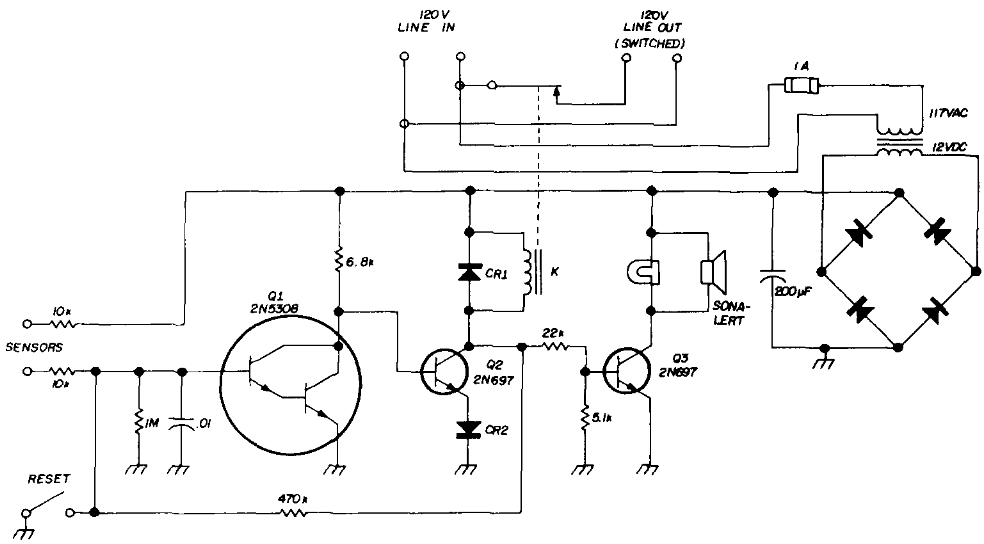

fig. 1. Schematic of the wet basement alarm. The relay is a Magnecraft 88DX3 and the alarm is a Mallory Sonalert.

turned on, sounding the alarm and illuminating an alarm lamp.

Although my installation controls a well pump, a solenoid in the water main supply could be used by the city dweller. Variations on this circuit design may be made to suit the builder's junk box, but a few cautions should be observed. Q1 (2N5308) is a dual transistor internally connected as a Darlington circuit, resulting in high current gain which produces a sensitivity in excess of one megohm for the sensor. The .01-μF capacitor and 10k resistors at the sensor inputs serve as an rf filter to prevent my transmitter from energizing the alarm. The relay I chose is a model with heavy duty (50 A) contacts and a 24-Vdc coil. The power supply produces about 22 volts under load,

s-line spinner knob

S-Line users will find that a small amount of weight added to the receiver tuning knob will materially increase the ease of tuning because of the added inertia of the system. This may be easily accomplished in several ways.

Apply RTV or any other adhesive mixed (such as bathtub caulking) with lead shot, or similar material, to the cavity in the knob. If you put too much weight in the knob, you can remove it with a hobby knife. Alternatively, a metal insert may be fitted into the cavity. For those wishing to splurge, Collins will supply a weighted spinner tuning knob. The part number is 547-1824-003, and the price is ten dollars.

M. H. Gonsior, W6VFR

logic monitor

I call this unit the logic monitor, and it is capable of monitoring logic circuits for dc levels (zero or one logic state) or detecting either positive or negative going pulses. The unit is very simple to make, requiring only a few simple parts and two inexpensive integrated circuits.

The circuit consists basically of an inverter operating into two mono-stable multivibrators. The first monostable operates for positive-going signals and the second one operates for negative-going signals. In detecting negative-going signals, the first monostable acts as an inverter only. Each monostable will operate for its own particular pulse polarity for the length of time set by the R-C time constant of each stage. The time constant of each stage is designed to be long enough to allow the indicator lamp to turn on when a pulse is detected. As the frequency is increased the lamp will glow, but at a reduced brightness.

The logic monitor is invaluable in checking out digital projects, particularly if you do not possess an oscilloscope. This little unit will make short work of checking out a digital keyer, counter or voltmeter. It can determine if flip-flops are toggling or if gates, switching or shift registers are shifting. It is even capable of detecting pulses which many oscilloscopes can not. This is possible since the monitor is designed using medium speed logic classified as DTL – diode transistor logic – which is capable of faster operation than average oscilloscopes.

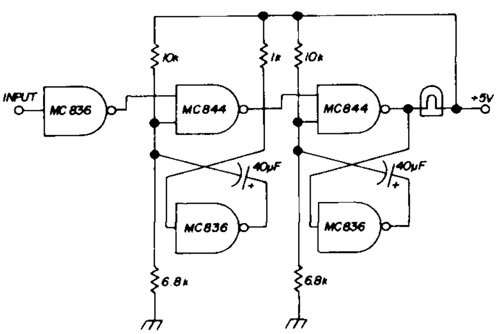

fig. 2. The 844 is a dual 4-input expander with all unused inputs tied to 5 volts with the exception of the expander input.

I believe the logic monitor is a very worthwhile investment. It can be built as a logic probe by installing the unit in a length of tubular plastic or it may simply be contained in a small aluminum box. The unit is designed for five volts and should not be used for logic levels greater than this.

The indicator lamp can be any five-volt lamp which draws 50 mA or less. The monostables are designed using a MC844 which enables the second monostable to also act as a lamp driver, thus reducing the necessity for an additional transistor.

W. L. McGehee, WA5SAF

vectorbord tool

Reader's of W6CMQ's article in the August, 1971 *ham radio* might be interested in a commercial tool to accomplish a similar task. Designed for isolating terminal points from a surrounding copper-clad surface, Vector offers two tools to do the job. W6CQM gave many applications for the technique, and Vector points out another – use of inexpensive uninsulated push-in terminals rather than the more expensive insulated standoffs.

The Vector tools are intended for cutting rings through the copper surrounding a prepunched hole. Two sizes are available, the model P116 for ¼-inch diameter circles and the P116A for 3/16-inch diameter circles. They sell for $2.32 and $2.48, respectively. Unlike W6CMQ's version, these commercial tools have a centering pin which limits their use to prepunched or drilled boards. However, to use them with inexpensive, surplus copper-clad board, you would simply have to first drill a small pilot hole for the tool.

The Vector Pad Cutter Tools are available through the Allied catalog and are made to fit most common electric drill chucks.

Douglas Stivison, WA1KWJ

SBE

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Been denying yourself all that great fun so many other amateurs are having with their rock-solid, through-the-repeater contacts?

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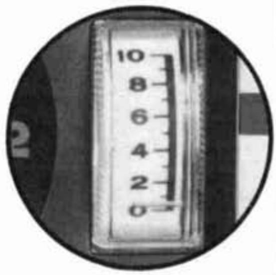

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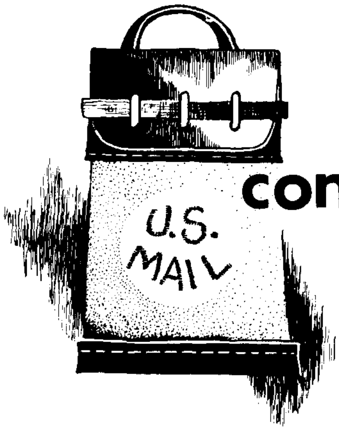


comments

trapatt diodes

Dear HR:

While employed by Boeing Aircraft during the early months of 1970, I was doing research on Trapatt (for TRApped Plasma Avalanche Triggered Transit) and Impatt (for IMPact Avalanche Transit Time) oscillators and amplifiers. Co-workers and I were using diodes developed in the Boeing Silicon Laboratory.

I discovered that most common silicon signal diodes tried would oscillate in the Trapatt mode. In fact, while not performing as well as Boeing diodes, signal diodes did tend to "drop" into the Trapatt mode with less tuning. A fixture was then designed and built which involved very little metal work and cost. A summary of the results obtained with this circuit is given in **table 1.**

In all cases pulse lengths were 0.5 μsec with a pulse frequency of 1 kHz. The pulse frequency probably could have been increased an order of magnitude: pulse lengths much greater than 1.0 μsec would probably result in burnout.

The power output and efficiencies are lower than those listed in *"A Second Look"* for October 1971. The frequencies are higher and, in most cases, located in amateur bands. My feelings at the time were that CW operation in the Trapatt mode with inexpensive diodes would be most difficult if not impossible. I therefore concentrated my efforts to obtain operation in the 2.3-GHz band and higher — where pulsed operation is allowed. Even with properly designed diodes, the difficulty in achieving good Trapatt results increases rapidly with frequency. This becomes evident when comparing the results obtained with the same FD600 diode at 2.3 GHz and at 3.34 GHz.

The Impatt pumping frequency of the diodes in this circuit was as high as 11.4 GHz in some cases. The circuit may be used with the signal diodes as an Impatt oscillator merely by using a different tuning technique. The circuit did not appear to be as efficient in the Impatt mode as waveguide designs. Outputs were obtainable, however, from S-band to X-band using this circuit.

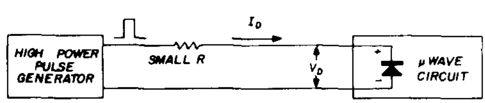


fig. 1. Bias diagram of the Trapatt experimental setup.

Trapatt mode operation is easily identified not only by sudden increase in output power but also by dramatic and exciting increases in diode current and "drop" in diode voltage. A bias diagram will help to describe the phenomenon. The diode is reverse biased.

The pulse amplitude is increased until a certain pulse current is achieved. This varies considerably, but is about 500 mA for most signal diodes. The microwave circuit is then mechanically tuned. When tuning is adjusted such that the diode sees the proper impedances to support the Trapatt mode, the diode voltage V_d will suddenly decrease and the diode current table 1. Summary of various diode performance in the Trapatt mode.

diode	1N914	1N3064	1N4148	FD333	FD600	FD600
power out (watts) (peak pulse)	3	26	8	22	4	1.2
frequency (GHz)	2.25	1.2	1.2	1.7	2.4	3.34
efficiency (percent)	1.1	10.0	8.5	14.5	4.9	1.8
V_B (volts	120	100	120	200	90	90

suddenly increase. An increase from 200 mA to 1100 mA in diode current was observed with one FD333 diode. More typical values are a voltage decrease and current increase by a factor of two. A sketch of diode voltage, current and rf pulses is shown in **fig. 2.**

A current and voltage change may occur without a subsequent rf output pulse, a phenomenon peculiar to signal diodes. None of the Boeing avalanche diodes tested displayed this mode. Neither types of diodes oscillated at subharmonic frequencies or at Trapatt efficiencies without the current and voltage change.

It is important that the experimenter include in his data reverse capacitance vs voltage plots for each diode tested. The C vs V curve published by the diode manufacturer may be used but is not as useful since C vs V curves are different from diode to diode. C vs V data should be plotted on log-log paper with capacitance on the dependent axis. The slope charactertistics and value should be noted for each diode. Slope is measured on the graph by using a *linear* rule to measure the ratio of rise to run.

An ideal 1- to 3-GHz Trapatt diode will have a slope value approaching 0.5, the theoretical maximum. Higher breakdown voltages usually signify lower frequency operation. Approximately 100 volts is optimum for 2.0 GHz. A tendency for the slope to decrease suddenly at a reverse voltage 1/3 to 2/3 of V_B is considered desirable; however, the only signal diode found to have this characteristic failed to operate in the Trapatt mode! Many exceptions to these guidelines will be found, but they may serve as a beginning point.

It is my belief that an enterprising amateur, by experimenting with different circuits and inexpensive diodes, could make significant contributions in the field of transit-time microwave devices, even possibly discovering new modes. For example, I am not convinced that all the results obtained in various labs throughout the country qualify to be lumped into one giant Trapatt mode category. It is very likely different labs are calling seemingly similar results operation in the Trapatt mode, when possibly more than one phenomenon is being observed. Why did signal diodes operate with much lower efficiency than Boeing diodes, but tune into the Trapatt mode with greater ease? Why did some 1N4148 diodes with nearly flat C vs V curves operate better than an FD333 with an ideal curve?

I would be most happy to provide assistance to anyone wishing to experiment in this very exciting area. The circuit used in these tests is available to anyone seriously interested in experimentation.

Randall W. Rhea, WA7NLA
920 W. Indian School
Phoenix, Arizona 85013

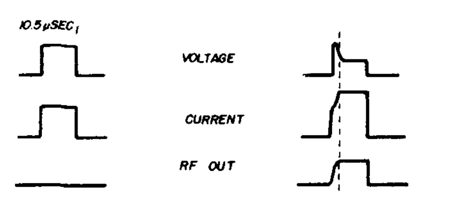
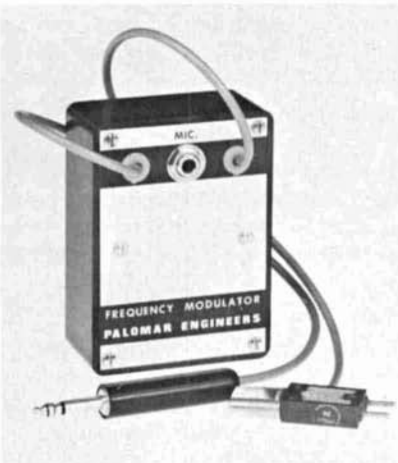


fig. 2. Typical diode voltage, current and rf pulses observed by WA7LNA.

new products

fm adapter for the Communicators



The Gonset Communicators have been among the most popular two-meter transmitter-receivers of all time. But they are a-m rigs and two meters is now heavily fm.

Palomar Engineers' new *frequency modulator* puts the Communicators on fm without any modification or rewiring. The microphone plugs into the *frequency modulator.* One of the cables coming out of the *modulator* plugs into the Communicator's microphone jack and carries the push-to-talk line, but no audio. A second cable has the crystal plug. It plugs into any one of the Communicator crystal sockets and the crystal plugs into it. A variable capacitance diode in the crystal plug frequency modulates the crystal and the frequency multipliers in the Communicator increase the deviation to about 8.5 kHz at the output frequency.

The *frequency modulator* works with the Communicator I, II, III, IV and GC-105. There are no tuned circuits in the *modulator* so operation is not restricted to the two-meter amateur band alone. Built-in tone burst is available for use with repeaters. The half-second tone burst is keyed by the push-to-talk switch. A carrier frequency adjustment allows the frequency to be set exactly.

Other modulation, such as frequency shift keying, can be applied to the *frequency modulator.* An audio level of 10 mV is required. The frequency response of the *modulator* is 200 to 3500 Hz. Clipping on voice is approximately 7 dB.

The unit is priced at $34.50 postpaid. Built-in tone burst is $10. Communicator model and tone-burst frequency must be specified with order. For more information write to Palomar Engineers, Box 455, Escondido, California 92025 or use *check-off* on page 110.

improved signal one

Computer Measurements, having taken over Signal/One, has announced an improved version of the CX7 transceiver. The new radio, designated the CX7A, incorporates a series of modifications found desirable after years of use of the CX7 in the field. The major modifications include power supply protection to eliminate transients and surge problems which have destroyed sensitive solid-state circuitry in the CX7. The audio passband in both transmit and receive has been broadened to enhance the lower-frequency response. Vox turn-on has been changed to cure the syllable-clipping problems old owners have complained about. TVI and spurious outputs have been reduced by changes to the rf driver circuitry. A few minor changes have also been incorporated in the new CX7A.

Signal/One sells the CX7A for $2195,

More Details? CHECK—OFF Page 110

the same price as the original CX7. Owners of the older model can have all the factory modifications incorporated in their transceiver for $69.50. The entire set of modifications, besides improving overall reliability, is said to give the unit a new sound.

For more information on the new CX7A or on modification for A CX7, write to Signal/One, 1645 West 135th Street, Gardena, California 90249.

rf fet design kit

A special rf fet design kit is being offered by Siliconix to help familiarize amateur experimenters and professional designers with the capabilities of rf fets. The kit includes three E300s suitable for fm preamps, two 2N5397s for mobile rigs, two U310s for community antenna television amplifiers, two UT100s for uhf preamps, one 2N5912 for a uhf/vhf mixer, a set of fet design ideas, application notes and data sheets and a copy of the *FET Handbook.*

The regular retail price of the kit would be $55.15, but it is being offered as a package for $19.95 from local Siliconix distributors. It is also available by mail for an additional $1.50 postage and handling fee from Siliconix Incorporated, Attention: Mr. B. Siegal, 2201 Laurelwood Road, Santa Clara, California 95054. More information is available from this address or by using *check-off* on page 110.

worldradio

Wordradio is a new amateur-radio newspaper published every three weeks by Armond Noble, WB6AUH. Completely non-technical and non-political, *Wordradio* covers public service, humanitarian and international aspects of the hobby as well as FCC news. Service nets, ham expeditions, unusual amateurs, amateur connected rescues and mercy missions are all reported in the new newspaper. For a sample copy write to *Worldradio,* 2509 Donner Way, Sacramento, California 95818.

digital clock

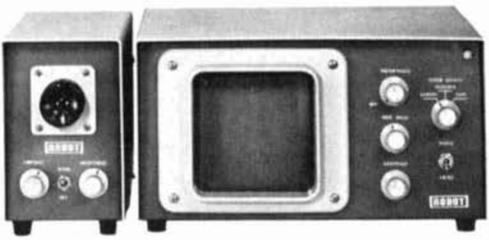
Aero-Metric is now offering their new, all solid-state digital clock in both a 12- and a 24-hour version. Time display is in hours and minutes, using bright red neon readout tubes rated at 200,000 hour life (over 22 years). The circuit uses TTL logic and includes 15 integrated circuits, 4 transistors and 7 diodes.

The time base of the logic circuit is taken from the 117-volt power line frequency of 60 Hz so accuracy is based on the United States power grid 60 Hz standard of within 3 seconds per year. The power supply has a built-in, rechargable battery which holds time in the logic circuit during short interval power line failures up to 5 minutes.

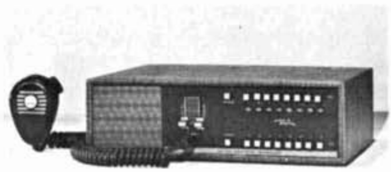
The 24-hour clock has a station-identification feature for amateur operators which consists of a bright red neon light which flashes for 30 seconds every 10 minutes. This serves as a reminder to transmit the station call letters as required by FCC regulations. This station-identification feature can be switched off.

The 12-hour clock is $93.00, and the 24-hour clock is $99.00 with standard metal cabinets in a choice of black or gold. A choice of walnut or maple cabinets is available at $9.00 extra. These clocks are unconditionally guaranteed for one year on all parts and labor, under normal use.

Clocks can be purchased direct from the factory with BankAmericard or Master Charge (include card number), C. O. D. ($20.00 down), check or money order. All postage is prepaid except C. O. D. For free literature write to Aero-Metric General, Inc., 155 Franklin Street, Dayton, Ohio 45402 or use *check-off* on page 110.



scanning fm transceiver



Regency Electronics is now marketing their Transcan* base and mobile transceivers for the 2-meter fm band. Units are in production and are being distributed throughout the country.

Regency calls Transcan a new reception concept in fm transceivers. The receiver section of the transceiver scans as many as 8 crystal-controlled channels anywhere in the band. Upon reception of a signal, scanning stops, and the receiver monitors the frequency being used. At the end of the transmission the receiver resumes scanning at the rate of 15 channels per second. Each channel can be quickly programmed in or out of service by the push of a button so the receiver will not be locked onto one frequency if the channel is tied up.

All eight transmit channels are also pushbutton selected. When a transmit button is pushed the receiver stops scanning and locks on the receiver channel paired to the selected transmit frequency. Both transceivers – the HR-2S 117-Vac base transceiver and the HR-2MS 13.6-Vdc mobile transceiver – are American made and are fully solid state.

The receiver boasts 0.35 μV sensitivity for 20-dB quieting, selectivity at 6 dB down of ±16 kHz, 45-dB image rejection and 60-dB spurious rejection. Modulation acceptance is ±15 kHz and audio output is 5 watts into a built-in front panel speaker.

The transmitter runs 15 watts output across the entire 144- to 148-MHz band and has adjustable deviation zero to 15 kHz. Spurious and harmonic emissions are measured at 55 dB or more below the

*Transcan is a trademark of Regency Electronics, Inc.

More Details? CHECK–OFF Page 110

carrier.

The mobile HR-2MS sells for $319, and the base HR-2S sells for $349 including a ceramic push-to-talk microphone and crystals for 146.94 MHz Simplex.

For more information write to Regency Electronics, Inc., 7900 Pendleton Pike, Indianapolis, Indiana 46226 or use *check-off* on page 110.

parts kits

Assortments of the most widely used Centralab electronic components are offered in eight new service kits designed to provide hams, experimenters, service dealers and designers with a well-balanced supply of their component requirements. Briefly described, the new kits are: Kit-10F, Fastatch II controls; -20W, miniature wire-wound controls; -30T, miniature trimmer controls; -50A, axial lead electrolytics; -55P, pc lead electrolytics; -60D, general purpose capacitors; -70H, high voltage capacitors and -100P, packaged electronic circuits.

Each kit is housed in a rugged steel frame cabinet with 15 plastic drawers. Cabinet size is 10 x 8 x 6¼ inches, and the cabinets are portable with convenient handles. The cabinets may be stacked in groups or wall mounted. All kits are supplied completely ready to use with components functionally arranged in drawers by value, type and size. Each drawer is prelabeled clearly showing contents. The latest edition of H. W. Sams "Replacement Control Guide" is included in the 3 control units (Kit-10F, -20W, -30T).

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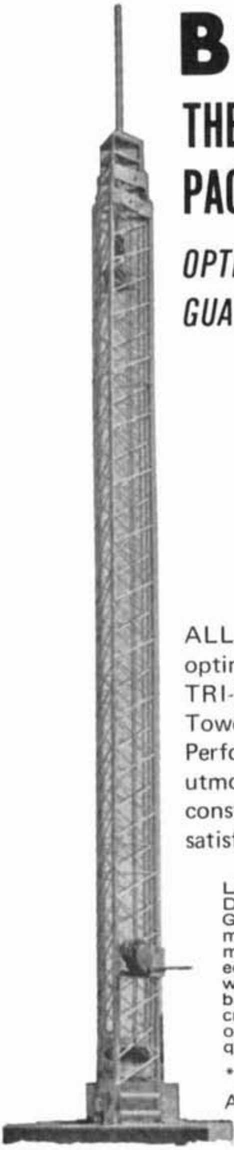

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HY-GAIN TH3MK3	**$610**
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Complete information on these eight new service kits is available from Centralab distributors, or by writing directly to Distributor Products, Centralab, the Electronics Division of Globe-Union Inc., 5757 North Green Bay Avenue, Milwaukee, Wisconsin 53201, or using *check-off* on page 110.

wire stripper

Radio Shack is offering a new automatic wire stripper and cutter in their line of Archer tools. The new tool strips number 24 to number 12 gauge wire in a second. To operate the wire stripper you insert the wire, squeeze the insulated handles and release. Insulation is removed cleanly and completely without nicking or breaking the wire. A strip gauge guides the wire to the correct portion of the blade and assures a uniform stripped length every time.

The Archer automatic wire stripper and cutter is priced at $4.95 and is available exclusively through Radio Shack's more than 1100 stores or by mail from Allied Radio Shack, 2400 West Washington Boulevard, Chicago, Illinois 60680. More information is available through *check-off* on page 110.

light-emitting diodes

The ham and experimenter can now get four different light-emitting diodes in the Motorola HEP line. The new diodes lend themselves to digital displays, burglar alarms, panel lights, digital clocks, frequency counters and other digital readout circuits in which the low power requirements and long life of the light-emitting diode offer new design possibilities.

The new Motorola LEDs include three visible red diodes (P2000, P2001 and P2003) and one infrared diode (P2002). They are available through any HEP dealer. More information is available from Motorola HEP Semiconductors, Box 20924, Phoenix, Arizona 85001 or use *check-off* on page 110.

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THE SCRUBBER

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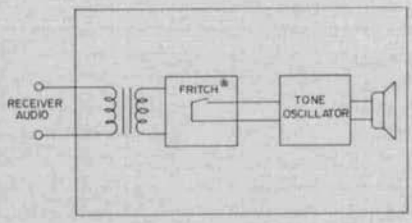

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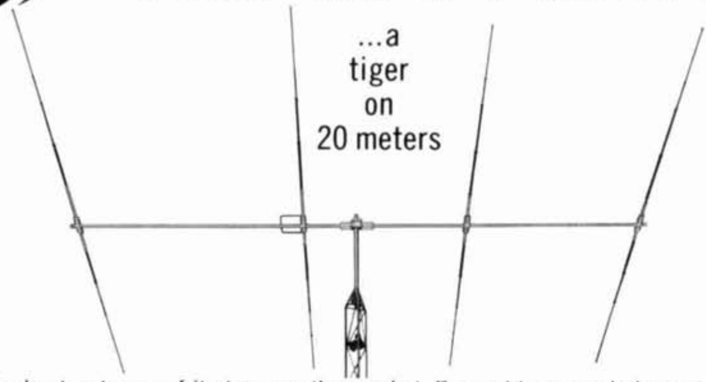
for the most advanced antennas under the sun!

HY-GAIN 204BA MONOBANDER



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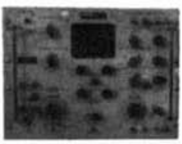

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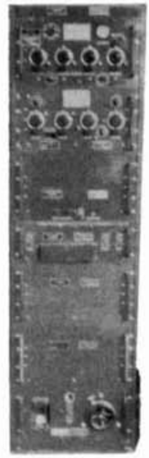

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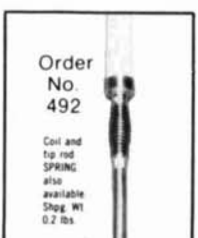

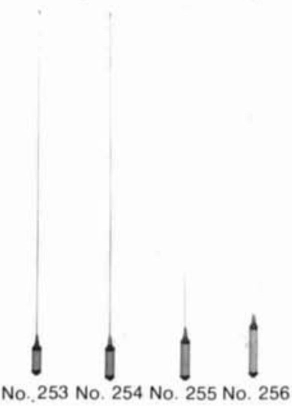

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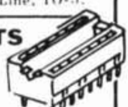

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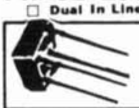

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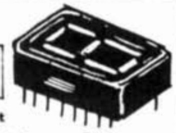
INCANDESCENT

ALPHA-NUMERIC 7-SEGMENT READOUTS 3.95



Buy any 3 — Take 10% Discount

A Poly Pak exclusive! Two different types. Both compatible with SN7446, SN7447, SN7448, SN7475, SN7490 and SN74192 IC's. Both with decimals, 0 to 9 numerals and 10 letters. With specs & hookups.

☐ 16-PIN MICRO MINIATURE

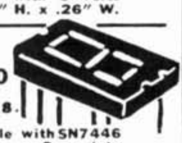
Fits into 16 pin dual in line socket. Life: 250,000 hours. Delivers 700-ft. Lamberts briteness with 5 volts 8 mils per segment. Characters .362" H. x .197" W

☐ 9-PIN TUBE TYPE

For printed circuit board or socket. Life: 100,000 hours. Delivers 6,000-ft. Lamberts with 5 volts 23 mils per segment. Characters .47" H. x .26" W.

7-SEGMENT ALPHA-NUMERIC LED READOUT

☐ $6.50 3 for $18.

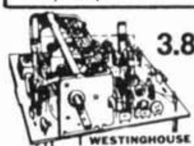


0-9numbers and 9 letters. Compatible with SN7446 and SN7447 7-segment BCD IC drivers. Snaps into dualin line sockets. Only ¾ x ¼ x ⅛". Specs: 5V 20-mils.

FAIRCHILD "VISIBLE" LED's

Buy 3 — Take 10% Discount!

☐ 79¢ Color: Red. For readouts, panel lights, etc. TO-18 case.



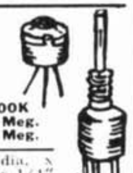
3.88 3 for $10

☐ SOLID STATE AM-FM TUNER

FM 88-108mhz & AM 550-1600kcs. Sensitive 2¾ x 2¼ x 1½" module. Can be used with 10.7mc & 455kcs IF strips & any hi-fi amp. P.C., wired. 4-gang variable supply voltage 9V 6 mils. Varactor diode for AFC. Schematics.

ALLEN BRADLEY'S 'TRANSISTOR' POTS

Any 2 for $1



Type F. Screwdriver adjust.

Ohms

☐ 100	☐ 500	☐ 2.5K	☐ 20K	☐ 100K	☐ 500K
☐ 200	☐ 1.0K	☐ 5.0K	☐ 25K	☐ 200K	☐ 1 Meg.
☐ 250	☐ 2.0K	☐ 10K	☐ 50K	☐ 250K	☐ 2 Meg.

'MICRO-POTS' 2 for $1

Type G, 1/2" dia. x 1/2" high. Mounts 1/4" hole, with shaft, linear, immersion-proof high freq.

Ohms

☐ 100	☐ 1.0K	☐ 10K	☐ 100K	☐ 1 Meg.
☐ 250	☐ 2.5K	☐ 25K	☐ 250K	☐ 2 Meg.
☐ 500	☐ 5.0K	☐ 50K	☐ 500K	☐ 5 Meg.

EPOXY SILICON RECTIFIERS *micromini

PIV	2Amp*	2Amp	3Amp
50	$.05	$.05	$.08
100	.06	.06	.12
200	.07	.07	.15
400	.09	.09	.22
600	.12	.12	.28
800	.15	.15	.39
1000	.18	.18	.45

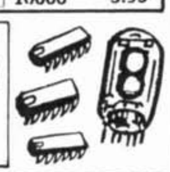
HIGH VOLT' PIV 1AMP SALE

PIV 1AMP	SALE
☐ 2000*	1.00
☐ 3000	1.35
☐ 4000	1.65
☐ 5000	2.25
☐ 6000	2.96
☐ 8000	3.50
☐ 10000	3.95

☐ COUNTING SYSTEM

Includes SN7490, decade counter, SN7475 latch, SN7441 BCD decoder driver, 0-to-9 Nixie tube, socket & instructions.

5-Pc. Kit **6.99** 3 sets for $18.



POLY PAKS

☐ 15¢ CATALOG on Fiber Optics, 'ICs', Semi's, Parts

Terms: add postage, cod's 25%. **Rated:** net 30
Phone Orders: Wakefield, Mass. (617) 245-3829
Retail: 211 Albion St., Wakefield, Mass.
C.O.D.'S MAY BE PHONED IN

P.O. BOX 942H LYNNFIELD, MASS. 01940

More Details? CHECK—OFF Page 110

21st ANNUAL DAYTON HAMVENTION will be held on April 22, 1972 at Wampler's Dayton Hara Arena. Technical sessions, Exhibits, Hidden transmitter hunt, Flea market and special program for the XYL. For information write Dayton Hamvention, Dept. H, Box 44, Dayton, Ohio 45401.

VHF NOISE BLANKER — See Westcom ad in Dec. '70 and Mar. '71 Ham Radio.

WANTED: KWM2A, mint condition, details W3HZ.

TELEPHONE EQUIPMENT: New. Touch and Rotary Dial Telephones, Decoders. Special: STYLELINE Touch Dial handsets w/wall base $49.95 if color not specified. Send SASE for catalog. Junction Distributors, 164 Cypress Lane, Nashua, N. H. 03060.

INSTANT NOISE LIMITER MODULE — Easy 20-Minute installation for Heathkit, Galaxy, Swan and most other amateur equipment; $8.95 Postpaid. Welborn Electronics, 133 Linden Street, Henderson, Nevada 89015.

GREATER BALTIMORE HAMBOREE. Sunday, April 9 at 10 a.m. Calvert Hall College, Goucher Blvd. and LaSalle Road, Towson, Maryland 21204 (1 mile south of Exit 28 Beltway-Interstate 695). Food Service, Prizes, Flea Market, $1.50 Admission, NO TABLE CHARGE OR PERCENTAGE.

AUTOMATIC MORSE CODE Copying Machine. Featured in Ham Radio Magazine November 1971. Copy up to 120 wpm without knowing Morse code. Simply hook to your receiver's audio and read printout. Send $14.95 for detailed construction plans. VMG Electronics, 2138H West Sunnyside, Phoenix, Arizona 85029.

SELL: ANTIQUES! Amplifex Loop, Murdock variometer, rheostat, variable and condenser. Amplion horn speaker. Baldwin phonograph reproducer and speaker driver. All new in original cartons. W6RXW, 341 La Mesa Drive, Menlo Park, Calif. 94025.

THE "BIRMINGHAMFEST" this year will be on Sunday, May 7 at the Exhibition Hall at the Alabama State Fairgrounds near Five Points, West in Birmingham. For entertainment, prizes, contests, net meetings, eyeball QSO's and fun for the entire family, plan to attend. For further information contact the Birmingham Amateur Radio Club — W4CUE, P. O. Box 603, Birmingham, Ala. 35201.

NEW YORK STATE QSO PARTY open to all amateurs and SWL's 1700 - April 29 thru April 30 GMT 0500, 1200 - April 30 thru April 30 GMT 2359. Stations may be worked once on fone and once on CW on each band. NY stations may work other NY stations. Exchange QSO number, RS(T), QTH — Out of state stations use ARRL sections; NY stations use counties. Suggested frequencies: CW - 1810, 3560, 7060, 14060, 21060, 28060 khz. FONE - 3975, 7275, 14285, 21375, 28875 khz. NOVICE - 3725, 7175, 2114 khz. 6 and 2 meter activity encouraged. Fone activity: Try even GMT hours. Score one point per contact on 80 - 10; two (2) points for each 160, 6, or 2 meter contact; times number of NY counties or ARRL sections. LOGS must contain date and time, band, mode station worked, QSO number, QTH's. First new contact for each multiplier numbered. Stations making over 50 contacts include a check list. Multi-op stations note calls of all participating operators. Logs, comments, photos, etc. should be sent before June 1 to: LERA ARC Contest Committee, Jeff Ronner, WB2AEQ, 35 Gottlieb Dr., Pearl River, N. Y. 10965. For results sheet be sure to include a #10 size envelope (SASE).

WORLD QSL BUREAU — See ad page 107.

DIGITONE TONE CONTROL DEVICES-New improved product line of reliable, reasonably priced, compact, solid-state, plug-in modules. Decoders, logic processors, auto-patch control, 12-button "pads", other associated devices. 12 or 24-VDC operation. Application Notes/Catalog. Write Digitone, Box 73, Bellbrook, Ohio 45305.

COLOR-CODING YOUR COMPONENTS? SEE p. 58 February issue Ham Radio; $1.00 PPD for 12 bottles of colors and thinner. Send self-addressed envelope for free specifications of twenty (house-number) IBM transistors. Cortlandt Electronics, Inc., 16 Hudson St., NYC 10013.

IMPOSSIBLE? BARGAINS IN SURPLUS ELECTRONICS AND OPTICS

SANKEN HYBRID AUDIO AMPLIFIERS AND SUPPLY KIT

We have made a fortunate purchase of Sanken Audio Amplfier Hybrid Modules. With these you can build your own audio amplifiers at less than the price of discrete components. Just add a power supply, and a chassis to act as a heat sink. Brand new units, in original boxes, guaranteed by B and F, Sanken and the Sanken U.S. distributor. Available in three sizes: 10 watts RMS (20 watts music power), 25 watts RMS (50 watts M.P.) and 50 watts RMS (100 watts M.P.) per channel. 20 page manufacturers instruction book included. Sanken amplifiers have proved so simple and reliable, that they are being used for industrial applications, such as servo amplifiers and wide band laboratory amplifiers.

- ☐ 10 Watt RMS Amplifier . . . . $ 4.75
- ☐ 25 Watt RMS Amplifier $14.75
- ☐ 50 Watt RMS Amplifier $22.50

☐ Complete kit for 100 watt rms stereo amplifier (200 watt music) including two 50 watt Sanken hybrids, all parts, instructions, and nice 1/16" thick black anodized and punched chassis $88.00

☐ Same for 50 watt rms stereo amplifier includes two 25 watt Sankens, etc. $58.00

☐ Same for 20 watt rms stereo, includes two 10 watt Sankens, etc. $30.00

SUBMINIATURE TOGGLE SWITCHES

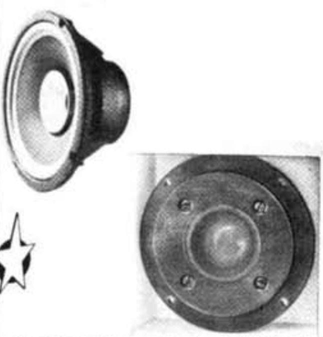
These are nice, American made switches, of a size compatible with subminiature equipment and digital control panels. Available in two electrical configurations, conventional on-off SPDT, or on-off-on momentary SPDT. Specify which type. All brand new, at 1/3 catalog price.

☐ Subminiature Switches (specify on-off or momentary)

$1.00 each
10 for $ 8.50
100 for $75.00

THIS MONTH'S SUPER SPECIAL!

JENSEN HIGH COMPLIANCE SPEAKER SYSTEMS



A local manufacturer went out of the speaker enclosure business, and we were lucky enough to buy his inventory of Jensen high-compliance (acoustic suspension) speaker systems. These systems consist of a 12" extended range woofer, a hemispheric dome tweeter, plus crossover. The dome tweeter response extends into the supersonic. The dome shape provides an ideal polar pattern response. The system is ideal for use with our Sanken Amplifier Systems, or any system capable of putting out at least 20 watts rms per channel. Full instructions for cabinet construction are included.

Single System (One Woofer, Tweeter and Crossover) . . $29.00
Shipping weight 10 lbs.

Stereo System (Two of Above) $55.00
Hi Compliance Woofer Only (8 lbs.) $22.00
Dome Tweeter only (3 lbs.) $5.75

FEATURE ITEM!

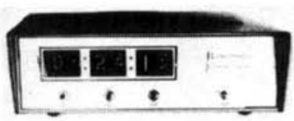
This succession of devices portrays the evolution of active components necessary for implementation of an 8-digit calculator. In 1969 the effort required dozens of bipolar devices. By 1970 the same calculator could be produced using only four MOS LSI devices, and now it has been implemented on a single MOS LSI chip.

Texas Instruments TMS-1802 "Calculator on a Cnip". This is tomorrows technology today, and at a fraction of list price. This calculator logic unit consists of a 3,520 bit read-only program memory, a 182 bit random memory, a decimal arithmetic logic unit, plus timing, control, and output decoders. The features are: eight digits • four operations • three registers • floating or fixed point decimal • constant or chain operations • automatic roundoff • leading zero suppression • internal keyboard encoding and debouncing • decoded display outputs • single phase clock operations • 28 pin DIP package • internal power on clear.

Every TM-1802 is a brand new Texas Instruments factory packaged, fully guaranteed unit. The only devices required to build a calculator are a battery, clock generator, keyboard, display drivers, and eight digits of display, all available from B & F. Full schematics, specifications and instructions from T.I. are included.

- ☐ Texas Instruement TMS 1802 Calculator Chip $29.00
- ☐ Texas Instruments keyboard $19.00
- ☐ T.I. SN25391, SN26392 Drivers, 4 required . . . 1 for $ 3.00
- ☐ All parts for clock generator . . . . $ 4.75
- ☐ Readouts, eight required . . . . 1 for $ 3.50
- ☐ Complete package, except battery $88.00

DIGITAL CLOCK KIT WITH NIXIE DISPLAY



We have well over 20,000 surplus nixies in stock, and because of this bargain purchase we can sell a complete digital clock kit for less than the usual cost of the display tubes only. We provide a complete etched and thru-plated circuit board, all integrated circuits, complete power supply, display tubes, I.C. sockets and a nice front panel with polaroid visor. We have never seen anyone offer this kit for less than $100.00 before. Includes BCD outputs for use as with timer option. May be wired for 12 or 24 hour display. Indicates hours, minutes, seconds.

- ☐ Clock Kit, complete less outside cover $57.50
- ☐ Aluminum blue or black anodized cover (specify) . . $ 4.50

To our customers:

B and F is moving to a new location: 119 Foster Street, Peabod Mass. 01960 (same address, but different building). Our apologi to any customers who experienced delays in shipments during th move. Our new expanded shipping and storage areas will allow to service your order faster than ever before. Retail customers a now welcome at all working hours (Monday through Friday, 9 5; Saturday, 9 – 3). Special few of a kind items are being cleare out, so come and visit our new location with twenty five thousan square feet of surplus bargains.

ALL ITEMS (WHERE WEIGHT IS NOT SPECIFIED) POSTAGE PAID IN THE U. S. A.

CHARGES WELCOME!

Phone in charges to 617 531-5774 or 617 532-232 BankAmericard – Mastercharge. $10.00 minimum. No C.O.D. please.

B. & F. ENTERPRISES

Phone (617) 532-2323
P.O. Box 44, Hathorne, Massachusetts 01937

More Details? CHECK–OFF Page 110

FOR SALE: BC-610-I Transmitter. Good condx. with 6 tuning units and 6 coils. Extra tubes: 250th 1, 4-125 3, 3B28 2, 100th 3. William Lee, Rt. 2, Paxton, Illinois 60957.

"DON AND BOB" GUARANTEED BUYS. Motorola HEP170 epoxy diode 2.5A/1000PIV 39¢; MOT MC-1709CG OPAMP(709) 50¢; capacitors: Sangamo DCM600MFD/450V 4.95; computer grade 10000MFD/15V 1.95; vacuum 50PF/7.5KV 1.95; 6.3VCT/600MA transformer 1.95; Ham-M 99.00; TR44 59.95; Mosley CL33 114.00; CL36 134.00; Hy-Gain hyquad 99.00; Tri-Ex MW50 tower 229.00; Gladding 25, AC 255.00; Airdux 2408T coil 5.00; KY65 code identifier 5.95; Aluminum boomless quad mount, HDW 10.95; guaranteed used gear: 75A4 (clean) 395.00; 51J4 350.00; SX115 250.00; Tempo Kenwood dealer. Prices collect. Write quote note. Mastercharge, BAC. Warranty guaranteed. Madison Electronics, 1508 McKinney, Houston, Tx. 77002. 713/224-2668.

ASK HARRY FIRST. Good trades accepted. S.A.S.E. Name literature wanted. Harry's Amateur Radio Supply, 3528 Gaskin Rd. (Belgium) Baldwinsville, NY 13027. 10AM-9PM. Closed Sunday. 315-635-7452.

FREQUENCY LISTS. We stock every callbook and frequency list published. Long wave to UHF. World Radio TV Handbook $6.95. ITU, FBIS and EBU publications. Special receiving antennas and preselectors. Gilfer Associates, Box 249, Park Ridge, NJ 07656.

R1051/URR synthesized, digital, solid-state, triple conversion AM/CW/LSB/USB/ISB/FSK Z-30MHz. Best offer over $500. P. O. Box 1190, Berkeley, California 94701.

EXHIBITORS — Reserve space now for ARRL Hudson Division Convention, Oct. 21-22, Tarrytown, N. Y. Contact Hank Frankel, WB2DQP, Box 535, Bellmore, N. Y. 11711. Phone 212 394-5257.

BOONTON 260A Q METER, manual, good condition $325.00. Dumont 303A, 5in, 10Mhz scope, manual $100.00 OK. Ray Harland, Rte 1, Box 745A, Escondido, Ca. 92025.

NEW, NAME BRAND 50 OHM potentiometers linear taper, screwdriver adjustment 2 watt, .75 each; Elapsed time meters 110V 50 cycle $5.00 each; PL 259 coax connectors 7 for $2.00; Removed from new equipment UTC-A24 audio transformers 15K split Pri. 20/150/200/250/500/600 sec. $5.00 each. All plus postage. Bill Hayward, W0PEM, 1307, N.E. 57th Terrace, Gladstone, Mo. 64118.

TONE ENCODERS AND DECODERS — New line of solid state encoders and decoders compatible with any sub-audible continuous tone system. Small in size, usable from 67-250 Hz, $8.95 to $14.95. Send for literature. Communications Specialists, Box 153, Brea, Calif. 92621.

SAVE MONEY on parts and transmitting-receiving tubes. Foreign-Domestic. Send 25¢ for giant catalog. Refunded first order. United Radio Company, 56-HR Ferry Street, Newark, N.J. 07105.

AUDIO FILTERS: Knock down that background noise. KOJO SSB, AM and CW filters do the job. Write for free brochure and see how serious DX boys hear them. KOJO, Box 7774, 741 E. Highland Ave., Phoenix, Arizona 85011.

ATTENTION "H" SERIES HANDY TALKY USERS. Solid state conversion for Motorola H Series Tube Type Receivers. Three assembled and tested circuit boards for plug-in conversion. Improved receiver sensitivity and reliability. Complete kit with instructions $21.95. Creative Enterprises, Box 13253, Reno, Nevada 89507.

TRADE FOR SSB GEAR or antenna R391 receiver, CMC201B counter, NLS V35 digital voltmeter, EM regulated power supply 208B, HP425 DC microvoltmeter, CV89 RTTY converter. W4OPR, Winter Park, Florida 32789.

DRAKE R4, T4, AC4, MS4. Just factory aligned and retubed $445.00. Also Drake TC6, SC6, CPS1, $225.00. Gordon D. Scallion, 1420 Hebron Ave., Glastonbury, Conn. 06033.

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RADIATION SURVEY INSTRUMENT

Victoreen Model 710B

Measures Gamma radiation from 0.1-50 roentgens/hr. This surplus Civil Defense meter is new, guaranteed and comes with a complete manual of instructions, theory of operation, circuitry and detailed list of parts.

The 20-ua meter is calibrated in roentgens per hour, indicating the presence of gamma radiation. Three multiplier scales (Victoreen 100,000meg; 10,000meg; 1,000meg decade) matched within plus or minus 2%.

Imagine the many other uses this instrument, or its components can be put to. Wt. 3 lbs; Size 5″x4″x8½″ long. Includes shoulder strap.

Price $9.95

$10.95 With batteries

BURROUGHS NIXIE

B-7971

from discontinued read-out equipment. A fifteen segment, neon tube — all alpha and digital characters, 2½″ high; overall 4½″. Nixies carefully retested and sold on a money-back 30 day warrantee.

Price $1.95

Socket 50¢

REED SWITCHES

SPST-no .... **15¢**

SPDT .... **29¢**

KNOB, Raytheon Spinner, ¼″ ..... **75¢**

CRYSTAL, 1.000 MHz (Hoffman) **1.00**

COLOR-CODING Kit, 12 bottles RETMA Colors & thinner (see Pg 58, Feb. HAM RADIO mag.) **1.00**

Timer, ONE HOUR, 15 Amp. Switch; big current-carrying capacity; Adjustable to 60 minutes. Size 2 x 1¾ x 2¾″ long; ¼″ Shaft, w/flat; ¾″ long. **1.45**

Power XFMR; 240 volt, multi-tapped Regulated with 660 VAC capacitor; size 4 x 4 x 5½″ high; 75 W. **2.60**

TWENTY CONSTRUCTION PROJECTS

If you have an electronic hobbyist among your younger friends, we have twenty simple, but interesting, do-it-yourself kits. Priced from 69¢ to $1.95 each, with complete step-by-step, illustrated, instructions — everything included (even the solder) but no batteries or line cords. **Total cost $20.00;** Keeps the youngsters busy and interested. Write for complete information — circuits, layouts, perf. boards, components, etc.; a post-card will do.

CORTLANDT ELECTRONICS INC.

16 HUDSON ST.

NEW YORK, N. Y. 10013

More Details? CHECK—OFF Page 110

More Details? CHECK—OFF Page 110

Radio Amateurs Reference Library of Maps and Atlas

WORLD PREFIX MAP — Full color, 40" x 28", shows prefixes on each country . . . DX zones, time zones, cities, cross referenced tables . . . . postpaid $1.25

RADIO AMATEURS GREAT CIRCLE CHART OF THE WORLD — from the center of the United States! Full color, 30" x 25", listing Great Circle bearings in degrees for six major U.S. cities; Boston, Washington, D.C., Miami, Seattle, San Francisco & Los Angeles. . . . . postpaid $1.25

RADIO AMATEURS MAP OF NORTH AMERICA! Full color, 30" x 25" — includes Central America and the Caribbean to the equator, showing call areas, zone boundaries, prefixes and time zones, FCC frequency chart, plus informative information on each of the 50 United States and other Countries . . . . postpaid $1.25

WORLD ATLAS — Only atlas compiled for radio amateurs. Packed with world-wide information — includes 11 maps, in 4 colors with zone boundaries and country prefixes on each map. Also includes a polar projection map of the world plus a map of the Antarctica — a complete set of maps of the world. 20 pages, size 8¾" x 12" . . . . postpaid $2.00

Complete reference library of maps — set of 4 as listed above . . . . postpaid $3.50

See your favorite dealer or order direct.

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20 DB GAIN
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Small Size: 1¼ x 2¼ x ½ - Only $12.50

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NEW 2M PREAMPLIFIER

12 vdc powered
27 db gain (approximately)
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will bring most receivers
to .1 μv sensitivity
without appreciable noise.

Metal case. **ONLY $17.95 ppd.**

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Many thousands of you have become very familiar with the various Radio Society of Great Britain books and handbooks, but very few of you are familiar with their excellent magazine, **Radio Communication.**

It includes numerous technical and construction articles in addition to a complete rundown on the month's events in amateur radio. Surely a most interesting addition to your amateur radio activities.

We can now offer this fine magazine to you along with the other advantages of membership in the RSGB (such as use of their outgoing QSL Bureau) for $9.95 a year.

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SCANNERS (oper. 152.50 to 163.50 Mhz .002%)	$5.00
ELEMENT CRYSTALS .0005% (channel freq. changed in customer's element)	15.00
C.B. (Class D Single channel)	2.75
AMATEUR NOVICE, (HC6/U, ±1 kc, 32 mmF, Fund. 3.5-8.9 Mhz	3.00

Extras: Oven use $1.50, Subminiature 25¢, .093 pins 10¢
Postage 1-2 crystals 2 oz. each additional 1-2 crystals 1 oz.
Write for quantity discount

FACTORY FRESH SEMICONDUCTOR BARGAINS
SN7400N DIP SERIES TTL: 7400, 7401, 7402, 7403, 7404, 7410, 7420, 7430, 7440, 7451 & 7454 gates 30¢; 7441A Nixi Driver $1.60; 7442 BCD-Decimal $1.50; 7447 7 Segment Driver $1.79; 7472 F-F 50¢; 7473 Dual F-F 60¢ 7474 Dual F-F 60¢; 7475 Quad Latch $1.25; 7476 Dual F-F 65¢; 7490 Decade Counter $1.25; 7492 Twelve Counter $1.25; 7493 4 Bit Counter $1.25; 7495 Shift Reg. $1.50; 74107 Dual F-F 65¢; 74121 Monostable 75¢.
LINEAR IC'S:
709C DIP or TO-5 50¢, 10 for $4.50
741C DIP or TO-5 62¢, 10 for $5.75
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Discounts offered on large orders. Many other parts are available. Free catalog. Orders less than $10.00 add 25¢ handling. Over $10.00 postpaid.

DIGI-KEY
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More Details? CHECK—OFF Page 110

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P.O. Box 8450, Baltimore, Md. 21234

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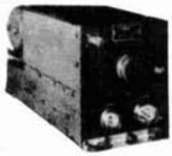

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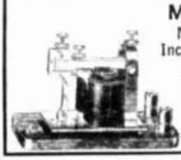

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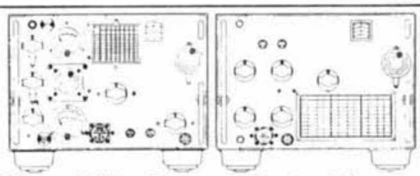

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3003	½"	16	2"	3.2	1.38
3004	½"	32	2"	13.7	1.43
3005	⅝"	4	2"	.56	1.20
3006	⅝"	8	2"	1.4	1.26
3007	⅝"	16	2"	4.9	1.38
3008	⅝"	32	2"	19.2	1.43
3009	¾"	4	3"	.94	1.31
3010	¾"	8	3"	2.9	1.50
3011	¾"	16	3"	10.9	1.56
3012	¾"	32	3"	42.5	1.76
3013	1"	4	3"	1.9	1.34
3014	1"	8	3"	4.8	1.46
3015	1"	16	3"	19.9	1.59
3016	1"	32	3"	73.0	1.71
3017	1¼"	4	4"	2.56	1.38

Model	Coil Diam.	Turns per Inch	Length	Inductance (Approx.)	Consume Net Price
	SPECIFICATION				
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3019	1¼"	16	4"	37.5	1.95
3020	1¼"	32	4"	145	2.07
3021	1¾"	4	4"	4.5	1.64
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3023	1¾"	16	4"	72.0	2.00
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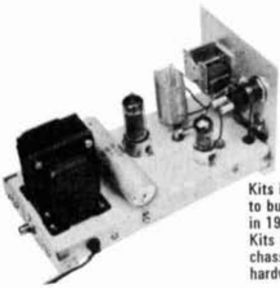

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