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The ARRL Experimenters' Exchange

Agreement on Packet Radio Standards

By Hank Magnuski, KA6M
with editorial contributions by Tom Clark, W3IWI

As part of the October 10th, 1982 AMSAT (Radio Amateur Satellite Corp.) general meeting, president Tom Clark, W3IWI, invited a number of leaders of active packet radio groups to come to a special working group meeting on Friday, October 8th, to discuss the future developments in packet radio activities; specifically, this meeting was intended to discuss AMICON (the AMSAT International Computer Network) for the Phase IIIB spacecraft and to discuss a new project (tentatively called PACSAT) involving a low-altitude orbit, all digital store-and-forward transponder. To Tom's pleasure and surprise, the meeting was well supported and a number of people showed up, representing these groups:

New Jersey - Phil Karn, KA9Q;

Tucson Area Packet Radio (TAPR) - Den Connors, KD2S and Lyle Johnson, WA7GXD;

St. Louis Area Packet Radio (SLAPR) - Pete Eaton, WB9FLW;

Washington, DC (AMRAD) - Paul Rinaldo, W4RI, Dave Borden, K8MMO, Terry Fox, WB4JFI and Eric Scace, K3NA;

Pacific Packet Radio Society (PPRS) - Hank Magnuski, KA6M;

AMSAT - Tom Clark, W3IWI, Jan King, W3GEY, John DuBois, W1HDX and Bob Carpenter, W3OTC.

Even more surprising is that this diverse group managed to agree on some things. In fact, the agreement reached on adopting a common link-level protocol may prove to be extremely significant in forming the foundation for U.S. packet radio networking. The meeting which originally was supposed to iron out some AMICON details managed to have much more of an impact.

Here's some background on what happened:

A year ago, in conjunction with the '81 AMSAT general meeting, Paul Rinaldo organized the first ARRL Amateur Radio Computer Networking Conference hosted by AMRAD and AMSAT in Washington (photocopies of the excellent conference proceedings are still available from AMRAD). Many ideas and some real and paper networks were discussed. In the months which followed quite a few people got their packet radio controllers running and had a chance to experiment, read, discuss and think about various problems involved in implementing packet radio networks. The situation became discouraging. It seemed like a new protocol was proposed for each new set of Terminal Node Controller (TNC) hardware that came on the air. Each group started heading off in a somewhat different direction. The promise of compatible systems was growing remote. But in this dispersion of effort, people also found out how difficult it was to implement private protocols and how difficult the interconnection would be if common ground weren't found soon. The different groups also came to realize that there were a common set of problems to be solved and that one area's solution couldn't ignore the requirements of other users. The summer doldrums saw very little activity and not much progress, and provided the background for the AMSAT meeting. This inevitable diversity during the R&D phases for each of the groups had to be reconciled with the impending launch of the Phase IIIB satellite in early 1983.

The AMICON Network

Three major areas of concern filled the agenda of the AMICON meeting: the usage of the Special Service Channel (SSC) earmarked for digital experimentation and called "AMICON" in AMSAT planning documents; the recommended modulation methods and bit rates to be used on the Phase IIIB SSC; and the detailed link protocol to be used for linking ground stations via the satellite.

There was general agreement that standards accepted today must be regarded as developmental. It is too premature to ordain any single scheme at this time. The AMICON concept is not yet a detailed network design, but rather an opportunity to develop a new service for amateur radio. In the developmental phases we may well see many diverse techniques being tested. The meeting discussed the concept that the use of high-altitude satellites for packet radio would be sufficiently complex that it was unlikely that many individual users would be able to muster the resources for individual access. Rather, AMICON would probably evolve as a channel for linking local "concentrator" nodes around the world.

There was a lot of discussion on suitable modulation methods and bit rates that could be supported by Phase III3B. Den Connors and Lyle Johnson of TAPR, Paul Rinaldo of AMRAD, and Tom Clark and John DuBois of AMSAT presented their research findings. Many different modem types were reviewed and international requirements were discussed. After all the debate the following conclusions were reached:

1. The AMICON SSC usage should be restricted to 5 kHz bandwidth (at the -26 dB points). Modem performance must be a primary consideration for any ground station, and the modem used will probably be of a rather advanced design.

2. The use of 202-type modems using nbfm-afsk will not work.

3. The use of 202 modems using ssb-fsk will produce marginal results.

4. A 400-1200 b/s channel speed is probably optimum, as this range of speeds satisfies a variety of different constraints and requirements.

5. The psk modulation techniques developed for Phase IIIB telemetry should be explored at both 400 and 1200 b/s.

6. The AMRAD and TAPR groups are going to pursue development of a modem which employs minimum-shift keying (msk), also known as fast frequency-

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shift keying (ffsk). Msk and psk are considered to be the most promising methods at this time.

7. The SSC will have to be open for different experimental approaches until there is general agreement and experimental validation of the optimal method.

Considering all the alternatives which were discarded, the above resolutions represent a significant narrowing of focus. If that wasn't enough, more was yet to come!

Eric Scace reviewed the work which had been done by the NJ & AMRAD packeteers to adapt the international (CCITT) X.25 protocol to amateur needs. The amateur subset, called AX.25, has been specified in link- and network-level documents by Terry Fox, WB4JFI and Gordon Beattie, N2DSY, respectively. Hank Magnuski distributed a tutorial document on connectionless protocols and described work which had been done to develop Revision 4 of the TIPM and LIPM software. This is the first implementation of TNC software utilizing only amateur call signs (and not firmware encoded) for addressing.

By the evening of the October 8, the group began to recognize that only very minor differences separated the AX.25 and LIPM.04/TIPM.04 approaches. The TAPR protocol users were willing to implement an interface based on the recommendations which would come out of the meeting. The differences were resolved and led to the unanimous adoption of a subset of an internationally recognized link level protocol (specifically it is called ANSI X3.66 ADCCP-HDLC BA Class, with options 2, 4, 7, 8, & 11).

Why is this important? First, this link-level protocol allows two AMICON ground stations to construct a packet pipeline. This same protocol can be used between two stations in a terrestrial backbone net. The same protocol can also be used for terminal-to-terminal connections, whether direct or via a simplex packet repeater. It represents only a slight extension of the CCITT X.25 LAPB link level protocol. And finally, it does not restrict future development of ISO Level 3 virtual-circuit or datagram protocols.

The key feature of the new design is the adoption of a scheme for using call-sign addressing in a packet. The frame format looks like this:

FLAG1	TO CALL	FM CALL	CTL	PID/ INFO	FCS	FLAG2

where:

FLAG1 Standard opening HDLC flag byte (01111110)
TOCALL The destination call-sign (6 characters plus sub-station i-d code)
FMCALL The source call sign of (6 characters plus sub-station i-d code)
CTL Standard HDLC control byte
PID Protocol Identification byte for information frames.
INFO Information field in information frames
FCS Frame CRC check sequence
FLAG2 Standard closing HDLC flag byte

Frames to be repeated by a local-area network simplex packet repeater also contain a third address field following the FMCALL field. This third field is the call sign of the repeater. More details on this protocol will be published in the revised AX.25 specificiation document.

Collectively, the group considered that nearly every link design starts out with a statement something like this: "Holy 807's, look at all the overhead bytes you have in using call signs as addresses. I can do it with just 4 bits." We have found that these other schemes have their own defects and that the penalty for the call sign overhead is relatively small in comparison to other delays on the link and in view of the other benefits. In addition, both amateurs and their regulatory authorities are particularly defensive that the individual's call sign is sacrosanct and tantamount to being a personal name.

The AMICON session ended with promises from various representatives to try to implement the required versions of this new protocol. In the interim, LIPM.04/TIPM.04 will be available for use by AMICON ground stations until the new software is ready.

PACSAT -- A New AMSAT Satellite Project

By Den Connors, KD2S and Tom Clark, W3IWI

A new type of amateur satellite was proposed by Tom Clark, W3IWI, at the packet radio working group meetings held October 8-11, 1982 at the AMSAT laboratory in conjunction with AMSAT's annual general meeting. The working group meeting was also noteworthy in that it provided a focus for the various packet radio groups to coordinate their activities and resulted in a new unifed protocol which is described by Hank Magnuski, KA6M, in a companion document. The new satellite project has been tentatively dubbed PACSAT -- a final name is yet to be chosen, pending resolution of some potential trademark conflicts. This satellite would build upon AMSAT's experience in low-cost spacecraft development, the current upsurge of interest in digital and computer techniques, and the technology being developed for amateur packet radio applications. The basic idea is to implement an orbiting digital packet radio repeater with store-and-forward capabilites. This satellite would allow amateur "electronic mail" service with a few-hour-delivery time to anywhere in the world -- a virtual "flying mailbox" for amateur radio and computer enthusiasts.

The "straw man" system proposed by Tom and discussed during the three days of meetings, would have one or more high-speed packet radio channels, and possibly other ASCII or Baudot RTTY input/output channels. An on-board computer system would control a large amount of memory storage -- perhaps as much as one megabyte for messages. Access to the message system would be somewhat like using a more-traditional computer-based message system (CBMS) using landline dial-up capability, such as the Computerized Bulletin Board System (CBBS)(tm Ward Christensen). Using a Phase II type of low-earth orbit ("LEO"), the satellite would be available several times a day for up to 15 minutes worth of message reading and writing. Although the LEO satellites are limited in their coverage, the store-and-forward capability could extend an AMSAT-OSCAR-8 type satellite to provide global coverage.

One of the major problems with such a concept is that packet radio represented new technology to most amateurs, although we see a marked rise in amateur interest in computers. In order to make a PACSAT be a viable concept, the current packet radio "experts" will have to devote considerable efforts to making reliable ground-station hardware and software available to AMSAT's user community, and they will have to embark on a concentrated educational program to explain these new concepts -- some of the attendees at the working group meeting noted that they were around when the ssb vs. a-m "wars" were raging in the early 1950's.

One of the major technical problems that will have to be solved before a PACSAT (or the AMICON channel for Phase IIIB) is viable involves modems. None of the standard commercial modems seem suitable for noisy channels with doppler shift. Several alternatives were discussed during the meetings. The modulation techniques mentioned included phase-shift keying (psk) and minimum-shift keying (msk). Discussions of data rates for up- and down-links ranged from 400 baud up to 56 kilobaud; the technical constraints associated with acceptable bit error rates and practical constraints of implementation cost and difficulty plus available spectrum space led to a consensus that likely rates were in the 400-2400 baud range. Although the Phase IIIB telecommand group have implemented state-of-the-art 400 baud psk modems, and W4RI has been working on msk designs, the use of either technique will require considerable work in order to develop high reliability modems usable by the amateur community. For any digital usage of amateur satellites, it is clear that modems will be more complicated that the traditional frequency-shift-keyed systems currently used for RTTY.

The straw man design that Tom presented involved multiple uplinks and a single downlink (e.g., one calling uplink channel and per-
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haps four working channels). This built upon typical amateur net experience with the satellite acting as "NCS" on a calling-and-answering frequency. After the user calls in and establishes that he has uplink traffic (or that the satellite has a message for him), he would directed to QSY to a working message channel where the spacecraft's computer would "poll" the user until both he and the spacecraft are QRU. This design is based on the use of ALOHA-type protocols where the multiple users cannot hear each other, leading to possible collisions on the uplink channels; this, combined with Tom's assumption that "what goes up must come down" (i.e. the total message traffic up and down are about equal), led to the multiple uplink, single downlink proposal. Tom's proposal was that the uplink and downlink were full duplex (simultaneous transmission and reception) involving two bands (probably a 435-MHz uplink and a 145-MHz downlink). The design assumed that 0.5-1.0 megabyte of storage was available on board which could be treated as a "virtual disk" for planning. All messages would be "bit regenerated" (i.e., no "direct" channel exists between the users except through the satellite), and control of the communications would be by an active, on-board computer. Other functions to be performed by this computer would include the access mechanism to manage the "virtual disk" storage, handling of the protocols to allow multiple users to get their messages up and down during a single pass, and possibly interspersing of "QST" bulletins in the downlink data stream during moments of inactivity.

On Saturday, the AMSAT members attending the technical forum were allowed to hear packet radio in action on AMSAT's W3ZM (146.235/.835 MHz) repeater. W3IWI brought a microprocessor-based Terminal Node Contoller (TNC) developed by the Vancouver Amateur Digital Communications Group (VADCG), a "202A-type" afsk modem, and a standard 2-meter fm transceiver. Some 50 miles away in Sterling, VA, Dave Borden, K8MMO had his Z80 CP/M (tm's, Zilog and Digital Research, respectively) computer hooked to a similar TNC and modem. Amidst normal talk-in activities, the two packet radio terminals were sending brief data packets through the repeater so that those attending the meeting saw a game of "Adventure" being played in the squelch tails. This impressive demonstration was the first exposure for many AMSAT members of the capabilities of digital techniques in amateur radio.

As the weekend proceeded, a number of informal discussions on packet radio continued. Among the experts there grew a general agreement on the data link protocol, with the AMSAT AMICON ADDCP-HDLC definition emerging as being the best for the "LEO" PACSAT too. Arguments for and against Tom's proposal for multiple uplinks (supporting a single downlink) centered on the estimated relative traffic loading on satellite uplink and downlink. These discussions included the observations:

-- CBMS experience shows that users "browse" through stored information much more than generating new information. If the PACSAT is to be operated as a flying CBMS, then the design should be reconsidered.

-- The "QST" bulletin transmissions will be a very important PACSAT function for the users.

On Sunday, a proposal was made by Den Connors and Lyle Johnson which included a number of the above concepts. Different mechanisms for access using full-duplex uplink/downlink pairs were presented. The AMSAT AMICON (AX.25) HDLC logical link protocol was discussed in as a PACSAT standard and a number of network-related issues, including message classifications and buffer allocation/deallocation mechanisms were raised. Lyle presented another possible system block diagram, showing different input/output channels, including command, multiple CPU's and different memories for program store, file directories, buffers and message mass storage. The tasks of the CPU were further detailed, and the different algorithms needed were identified.

During this discussion, Tom Clark outlined the possibility of a truly international implementation stategy. Tom described one scenario with the system design and user education/interfacing being the prime U.S. responsibility, on-board hardware constructed in South Africa, satellite integration performed in the United Kingdom and actual launch handled by the commercial group in Texas which has recently flown a successful test mission (see <u>AMSAT Satellite Report</u> No. 41, September 13, <u>1982</u>). A part of the discussion involved the possibility that part of the US role might also include a new role for AMSAT in being responsible for the distribution of the hardware unique to packet radio unless commercial interest is seen soon; this could serve as a method for generating much-needed revenues to support all of AMSAT's activities. To help get this activity moving, Den Connors agreed to act as interim PACSAT coordinator.

The general PACSAT concept was presented at the AMSAT general meeting, and the AMSAT membership welcomed the idea, with the only caveats being expressed as "Can we afford it? Are we stretching ourselves too thin?" Tom indicated that these were AMSAT management concerns too but that the key individuals were very enthusiastic about the concept. He stated that without a dedicated "hard core" of technical volunteers, AMSAT loses its vitality.

Since no further opposition was raised, Tom indicated that further development of the PACSAT concept can be expected.

Since the meetings at Goddard, Den has accepted the position of Project Manager for the U.S. part of the PACSAT project, and several developmental efforts are in the formative stages. ZS1FE has confirmed the South African interest in pursuing the project, and G3YJO has begun "selling" the rest of the payload (which may well be called UoSAT-2). Key developments in the next few months will include ground station design, technology investigations to identify large flyable memories and modem (both msk and psk) design, planning for maximum utilization of the Phase IIIB designs, conceptual designs of the on-board communications and processing hardware and software and coordination of the roles between the various groups that can contribute to this project.

It is hoped that this satellite will not only give the packet radio experimenters a much-awaited international linking capability, but also provide a new, challenging and unique outlet to the many thousands of new hams who are quite savvy in computer techniques and utilization. The AMSAT team solicits your indications of interest and assistance. This, as with all AMSAT projects, is a volunteer effort -- can we serve as a focus for your creative ideas?

Watkins-Johnson Tech-notes: Mixers

If you're interested in state-of-the-art rf mixers, you should see a copy of "Mixers: Part 1" and "Mixers: Part 2," Vols. 8 No. 2 and 3 in the Watkins-Johnson Company's <u>Tech-notes</u> series. <u>Tech-notes</u> is a bi-monthly <u>periodical circulated to educational</u> institutions, engineers, managers of companies or government agencies, and technicians. Individuals may receive issues by sending their subscription request on company letterhead, stating position and nature of business to the Editor, Tech-notes, Watkins-Johnson Compnay, 3333 Hillview Avenue, Palo Alto, CA 94304.

Controller Chip for EPSON Matrix Printers

The trade magazines have advertised the EPSON M-150/160 series of dot-matrix printers which are designed for pocket devices. Now there is a single-chip microcomputer, to provide serial and parallel data interfaces for these printers. The FP-150 chip is packed in a 40-pin DIP, uses a +5-V supply, supports serial data inputs of 110/300/1200/2400 baud, and prints 64 ASCII characters. Single-quantity prices are U.K.£15.20 plus extra for crystal, jumper, pc board and data. Contact: Friday Partnership, 22, Wentworth Close, Rudheath, Northwich, Cheshire, WC9 7EE, England, phone (0606) 47366.

Real-Time Satellite Tracking on a Programmable Calculator

By Roy D. Welch,* WØSL

There are numerous computer programs available for use on the various popular personal computers for antenna tracking of artificial earth satellites. They are very extensive in capabilities and do a fine job. They all have one drawback however. They are run on machines that are not portable enough to carry around conveniently. Most, if not all, require a source of ac power.

Enter the personal programmable hand-held calculator. They are very portable. They run on batteries. Until a little over a year ago, however, they lacked the large memory storage capacity needed to handle the programs required for satellite tracking. One of these calculators is the HP-41C/HP-41CV.

The HP-41C basic calculator comes with 63 registers (441 bytes) of storage that can be allocated by the user for either program or data storage use. A plug-in program card reader/writer is also available for loading programs stored on small magnetic cards. Memory for the HP-41C is expandable to 319 registers (2233 bytes) with the HP-82170 Quad Memory Module which simply plugs into one of the four vacant ports on the HP-41C. The HP-41CV is a later version of the HP-41C with 319 registers already built into the calculator. Also available for use with either the HP-41C or HP-41CV is the HP-82182 plug-in Time Module which serves as a real-time calendar/clock for the calculator.

Described here are two versions of the same satellite tracking program, Satellite Orbits I (S01) and Satellite Orbits II (S02). S01 requires 197 registers of storage and is the basic program. S02 produces exactly the same output as S01 but is designed to make use of the HP-82182 Time Module for various date and time functions. S02 requires 185 registers for storage.

Both programs will provide tracking coordinates for satellites in either circular or elliptical orbits. The programs were adapted from a BASIC program written by Tom Clark, W3IWI and published in Orbit magazine for March/April, 1981, p.6. The HP-41 versions, however, provice a real-time output option which is not available on the original BASIC program.

The programs require storage of the classical Keplerian orbital parameters for each satellite tracked. Each satellite will consume approximately 13 storage registers for these parameters. Sources for obtaining updates to these parameters are covered in the program documentation.

To initiate a program run, one has only to enter XEQ ORBIT. The programs will automatically prompt with alpha messages for other input such as for the desired satellite, data, time, etc. The user is also prompted to indicate whether real-time output or batch output is desired.

*908 Dutch Mill Drive, Manchester, MO 63011

Real-time output will produce azimuth and elevation coordinates (i.e., AZEL = AAA, EE) and automatically update these coordinates at one-minute intervals (less with S02). Using this mode the user can periodically refer to the calculator for new antenna-aiming coordinates. Coordinates are displayed even when the satellite is below the horizon, by showing a negative elevation. Anytime the elevation is positive an alerting tone will sound at each update.

The batch mode is designed for the user who wants to write an itemized list of output. The batch mode produces time, azimuth, elevation, range to the satellite in kilometers, height of the satellite in kilometers, latitude and longitude of the subsatellite point (SSP) and orbit phase. Orbit phase is an arbitrary numerical value used to indicate in what part of the orbit the satellite lies at a given time. The SSP latitude and longitude are useful in constructing a plot of the satellite path on the surface of the earth. The user has the option of specifying an increment in minutes to be used in each time update for batch output.

Both programs will run in either mode. In real-time mode, S02 will obtain date and time information from the HP-82182 Time Module. S01, however, utilizes a manually entered clock time and will internally increment this time in one-minute intervals. The program will calculate and display a set of coordinates in about 25 seconds. It will then waste the remainder of the minute by executing a timing loop before starting a new calculation. The display remains visible during this time. The timing loop is adjustable by the user to match the internal execution speed of his own calculator. Accuracy is quite good and stays within about ten seconds over an hour's time. Use of S02 and the Time Module eliminates the above loop and loop adjustment, reduces storage requirements and expedites initiating the run by eliminating the date and time prompts used in S01 in the real-time mode.

Copies of either program can be obtained from the AMSAT Software Library, P.O. Box 541, Willenie, MN 55090. An s.a.s.e. sent to this address will bring details. These programs have been made available to the library on the basis that any proceeds in excess of reproduction costs will go to AMSAT. Documentation covers about twenty pages for each program and contains equations, sample runs, procedures, program listing and other items of interest to the user.

I have used these programs extensively on my HP-41C with OSCAR 8, UoSAT OSCAR 9 and the RS satellites. They will really be useful, however, when the eliptical-orbit Phase III satellites are up. As AMSAT coordinator for Missouri I receive requests for talks from interested groups. I find the calculator to be a real help and a point of interest in most groups. It goes where you want to go, whether to field-day sites or on a DX-pedition. I hope that you can benefit from one or the other of these programs and that you have as much fun with them as I have had.

How to Design Wide-Band RF Quadrature Network

By G.W. Horn,* I4MK

Passive wide-band quadrature networks, operating at rf for the generation of ssb signals using the phasing method, as well as for other kinds of signal processing, have been seldom and barely treated by the technical literature.

In many phasing rigs the rf carriers were dephased by means of two opposite reactances (Fig. 1).[1] We all know that this phase-splitting method, as well as that based on the typical behavior of two under-coupled tuned circuits,[2] suffers from many serious drawbacks. In fact:

These circuits operate satisfactorily over a small percentual bandwidth (1% or so) and are thus limited to fixed-frequency operation. Besides, they need periodic realignment, as they are subject to thermal drift, components aging, etc.

The upper frequency limit does not go beyond 15 MHz at best, depending mostly on strays, component performance, layout, and so on.

Rf phasing for ssb-signal generation by means of coaxial cable sections has also been suggested (Fig. 2)[3]: The rf signal is split by a coaxline T arrangement, one branch of the T being 1/8th electrical wavelength of RG-62/U and the other 3/8ths. By using terminated line sections (R sub L = Zo), instead of a single quarter-wave line, the rf amplitudes at the output ends of the T remain within a certain bandwidth, and the VSWR is low. As it is well known, the coaxial cable technique is extensively used in antenna-array phasing equipment.

A more efficient wide-band rf quadrature network has been designed by R. Taylor, W1DAX (Fig. 3).[4] I haven't checked Mr. Taylor's design, but sincerely speaking, I feel that it was the result of a cut-and-try procedure, rather than the result of a theoretical investigation. Anyway, this network seems to be much better than the above-mentioned ones; however, the achieved bandwidth (13.8 - 14.6 MHz) is not enough for equipment such as general-coverage transmitters and receivers using some kind of orthogonal modulation.

A quadrature rf phasing network operating over an octave or more in frequency was designed some years ago by Jim Koehler, VE5FP/VK2BOX (Fig. 4).[5] Unfortunately, he did not disclose the network's theory nor did he give any useful detail about the procedure followed for determining the component values.

It is quite evident that the two bridges (bridge a and bridge b of Fig. 4) each provide a phase shift, thus resulting, at the output ends, in a differential phase shift of 90 degrees over a wide frequency band. Mr. Koehler states that phase error is less than 1 degree, and the amplitude difference between the two outputs is less than 0.5 dB over the whole 3 - 30 MHz range (i.e., N = 10).

Now, having engaged in the development of a general-coverage direct-conversion receiver with selectable sideband and carrier-lock provisions, [6] I decided to go deep into the theory of Mr. Koehler's design, in order to ascertain the network's behavior as well as to find out how to calculate the component values for different bandwidth and frequency ranges.

To tell the truth, the theory of this network revealed itself to be rather involved (see Appendix). Thus, Table I shows the circuit parameters for a set of bandwidths (ratios ranging from 5 to 12).

In designing the network, the starting point is therefore N = fmax/fmin. This gives α and k, i.e., the network's parameters. Then you have to choose a convient basic reactance (Xo), making it equal to Ro; Ro is the load resistance as seen by the bridge (i.e., the actual RLoad transformed into Ro by the output balun). The value of Ro cannot be too low; it must be much larger than the series loss resistance of the two tuned circuits.

At this point parameters α and k allow you to determine the inductances and capacitances in the legs to the two bridges. The schematic diagram of Fig. 5 shows how the final value of the inductances and capacitances are related to Xo by α and k. Moreover, the diagram clarifies the physical meaning of α and k. k^2 (read k squared) is the ratio between the inductance of the parallel-tuned circuit and that of the series one. α is the ratio between the frequency (foa) at which must resonate all the tuned circuits of bridge a and the center frequency fo (geometric mean between fmax and fmin, i.e., fo = $\sqrt{fmax\ fmin}$), as well as between fo and the frequency (fob) at which all the tuned circuits of bridge b must resonate.

Regarding Xo, the theory proves that Xo^2 = -X1 X2, where X1, X2 are the equivalent reactances of the series- and parallel-tuned circuits. Since Ro = Xo and Xo = $+\sqrt{Lo/Co}$ (see Fig. 5), it is well justified to define Ro as the network's "characteristic impedance.

Table I also gives the phase error dØmax (i.e., the deviation from 9P degrees) for the different frequency ratios. As shown, at N = 10, dØmax = 1 degree 4,985", in good agreement with Mr. Koehler's statement.

Differing from what Mr. Koehler says, the output signal's (Ea, Eb of Fig. 4) amplitude does not vary with frequency, provided that the load resistance is exactly matched, i.e., Ro = Xo. Anyway, a slight mismatch does not degrade too much the constancy of the output signal's amplitude; as the diagram of Fig. 6 shows, a 2% deviation of Ro from its nominal value Ro = Xo causes an amplitude variation not greater than 0.18 dB. In addition, the diagram of Fig. 7 shows how Ro tolerance affects the phase error dØ: when Ro differs from Xo, the phase response becomes unsymmetrical with respect to fo and, dØ being the same, the network's bandwidth becomes narrower.

Surprisingly enough, the theory shows that the source resistance Rs (as seen by the bridge)(for conventience made equal to Ro) does not interfere with the phase/amplitude response, always provided that Ro = Xo.

The general phase response of the network is shown in Fig. 8, where the frequency scale has been normalized with respect to fo set equal to unity (i.e., fo = 1). The actual frequencies at which the phase error is zero (dØ = 0), respectively max (dØ = ±dØmax) are then easily deter-

*17, via Pio IX, 40017 S. Giovanni Persiceto, Bologna, Italy

mined by multiplying the actual fo by xa...xd, respectively x1...x5 as reported in Table I.

The two output transformers should be built as wide-band baluns (1:4 for RLoad = 50 ohms x Ro = 200 ohms). Small toroids or dual-hole balun cores (for example Neosid 1050/1/F14) are well suited. If dual-hole baluns are used, twist together three lengths of 26- or 30-AWG enameled copper wire at about two twists every 3/8 inch. Three turns will be enough.

Although the input resistance of the two parallel-connected bridges is one half the output resistance of the single bridge (Ro), the input transformer can be built like the output transformers. As previously stated, this is because the source resistance Rs does not affect the network's behavior (except for attenuation).

It is of paramount importance to absolutely avoid coupling between the tuned circuits in each leg of the bridge, as well as that between the two bridges. In addition, the Q of each coil must be at least 100. Consequently, toroids are suggested there, even if standard coild forms (with ferrite cup cores) are shielding cans might be used successfully.

Each leg should be assembled separately by adjusting inductances and capacitances by means of a Q meter or an impedance bridge. Obviously, a network analyzer would make the task much easier. If this test equipment is not available (as certainly happens in most ham shacks) the inductors may be adjusted, by means of a dipper, to resonate with their capacitors at the relevant frequency (i.e., bridge a : foα; bridge b : fo/). To do this, each series arm can be temporarily connected as a parallel-tuned circuit to allow adjustment. As Mr. Koehler states, even with this simple test procedure, reasonable accuracy may be obtained.

An obvious question is: could the investigated network operate at vhf too? If assembled with lumped-constant components, as shown in Fig. 4, the upper frequency limit would probably lie around 30 MHz; beyond this limit, strays, losses and layout should obviously degrade the system performance. Besides, the inductances would be impractically small.

However, there is no reason why the tuned circuits could not be replaced by coaxial-cable sections or even strip lines. An investigation in this direction is beyond by objective, but it would be worthwhile to be carried out by someone else.

Example

You want to build a network operating between 3.0 and 30.0 Mc/s. Then :

f_{min} = 3.0 Mc/s $\qquad$ f_o = 9.486833 Mc/s
f_{max} = 30.0 Mc/s $\qquad$ R_o = 200 Ω
N = 10 $\qquad$ X_o = 200 Ω

Therefore L_o = 3.355 µH
C_o = 83.882 pF

From Table I we get

$d\phi_{max} = \pm 1° \; 4{,}985'$
α = 1.985821
k = 3.626855

Then, as per fig.4 and 5

$L_{sa} = L_o/k\alpha$ = 0.466 µH $\qquad$ $L_{sb} = L_o\,\alpha/k$ = 1.837 µH
$C_{sa} = 0_o\,k/\alpha$ = 153.200 pF $\qquad$ $C_{sb} = C_o\,k\alpha$ = 604.142 pF
$L_{pa} = L_o\,k/\alpha$ = 6.128 µH $\qquad$ $L_{pb} = L_o\,k\alpha$ = 24.166 µH
$C_{pa} = C_o/k\alpha$ = 11.647 pF $\qquad$ $C_{pb} = C_o\,\alpha/k$ = 45.928 pF

The frequencies at which the phase-error is max (1° 4,985') are given by the x_i reported in Table I

x_1 = 0,316 $\quad$ f_1 = 3.000 Mc/s (i.e. f_{min})
x_2 = 0.459 $\quad$ f_2 = 4.354 Mc/s
x_3 = 1.000 $\quad$ f_3 = 9.486 Mc/s (i.e. f_o)
x_4 = 2.179 $\quad$ f_4 = 20.668 Mc/s
x_5 = 3,162 $\quad$ f_5 = 30.000 Mc/s(i.e. f_{max})

while that at which $d\phi = 0$ are

x_a = 0.350 $\quad$ f_a = 3,322 Mc/s
x_b = 0.664 $\quad$ f_b = 6.298 Mc/s
x_c = 1.506 $\quad$ f_c = 14.290 Mc/s
x_d = 2.855 $\quad$ f_d = 27.090 Mc/s

The frequencies at which resonate the tuned circuits are

$f_{oa} = f_o\alpha$ = 18.779578 Mc/s
$f_{ob} = f_o/\alpha$ = 4.762178 Mc/s

Appendix

The data of Table I bave been computed by means of the following equations :

$$N = f_{max}/f_{min}$$

$$x = f/f_o$$

$$y = x + 1/x$$

$$y_{bw} = \sqrt{N} + 1/\sqrt{N}$$

$$\gamma = \alpha + 1/\alpha$$

$$\gamma^2 = (2-y_{bw}) + \left\{(2-y_{bw})^2 + 2\,\frac{\sqrt{2y_{bw}}\,\left[(y_{bw}+2)^2 + 8y_{bw}\right] + 8y_{bw}(y_{bw}+2)}{(\sqrt{y_{bw}} + \sqrt{2})^2}\right\}^{\frac{1}{2}}$$

$$k^2 = 2\,y_{bw} + (\alpha+1/\alpha)^2$$

$$\text{tg } d\phi_{max} = \frac{4 - \left[(\alpha-1/\alpha)^2(k^2+2) - 2(k^2-4)\right] + y_{bw}^2}{2\,k\,(\alpha-1/\alpha)(y_{bw}+2)}$$

$$y_{d\phi} = d\phi_{max} = \sqrt{2\,y_{bw}}$$

$$y_{d\phi=0} = \frac{1}{\sqrt{2}}\left\{(\alpha-1/\alpha)^2(k^2+2)-2(k^2-4) \pm\sqrt{\left[(\alpha-1/\alpha)^2(k^2+2)-2(k^2-4)\right]^2-16y_{bw}^2}\right\}^{\frac{1}{2}}$$

$$x_i = \frac{1}{2}\left(y_i \pm\sqrt{y_i^2 - 4}\right)$$

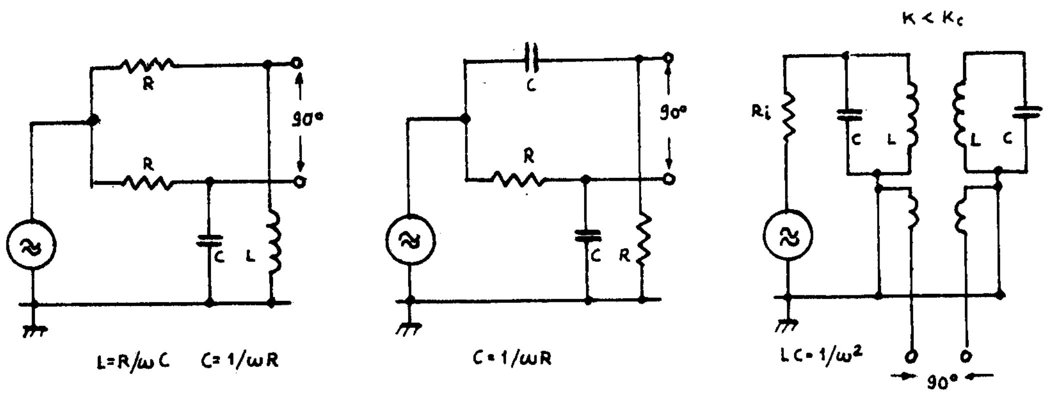


Fig. 1 - Simple rf quadrature networks as employed in the early phasing exciters

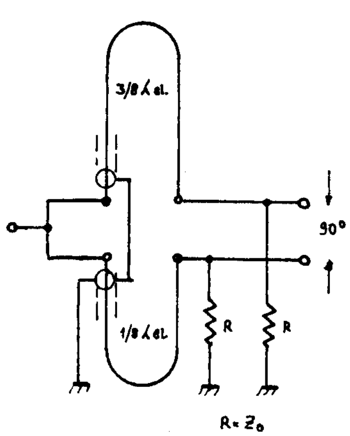


Fig. 2 - Rf quadrature done by means of two coaxial-cable sections, as suggested by W2WZR and K2QCX

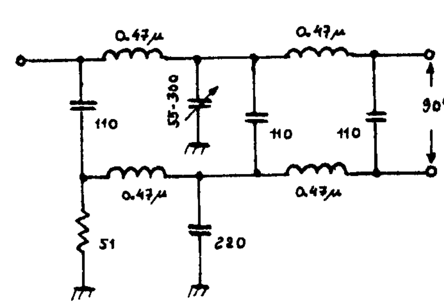


Fig. 3 - Rf quadrature network designed by W1DAX

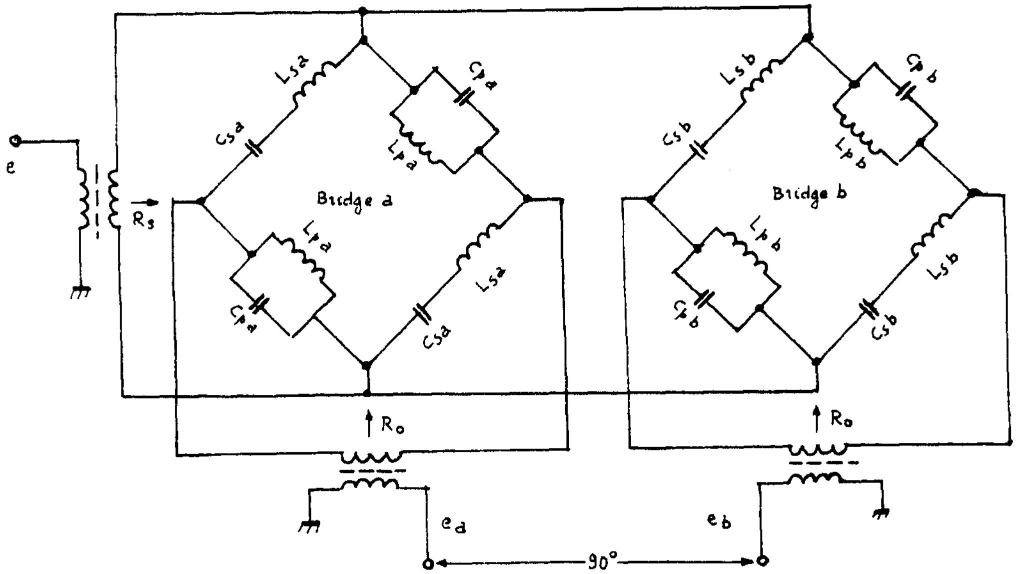


Fig. 4 - 3-30 MHz quadrature network designed by VE5FP/VK2BOX; the original component values Lsa = 0.465 uH, Csa = 153 pF, Lpa = 6.13 uH, Cpa = 12 pF, Lsb = 1.84, Csb = 604 pF, Lpb = 24.2 uH, Cpb = 46 pF, Ro = 200 ohms are in good agreement with the theory developed by the author.

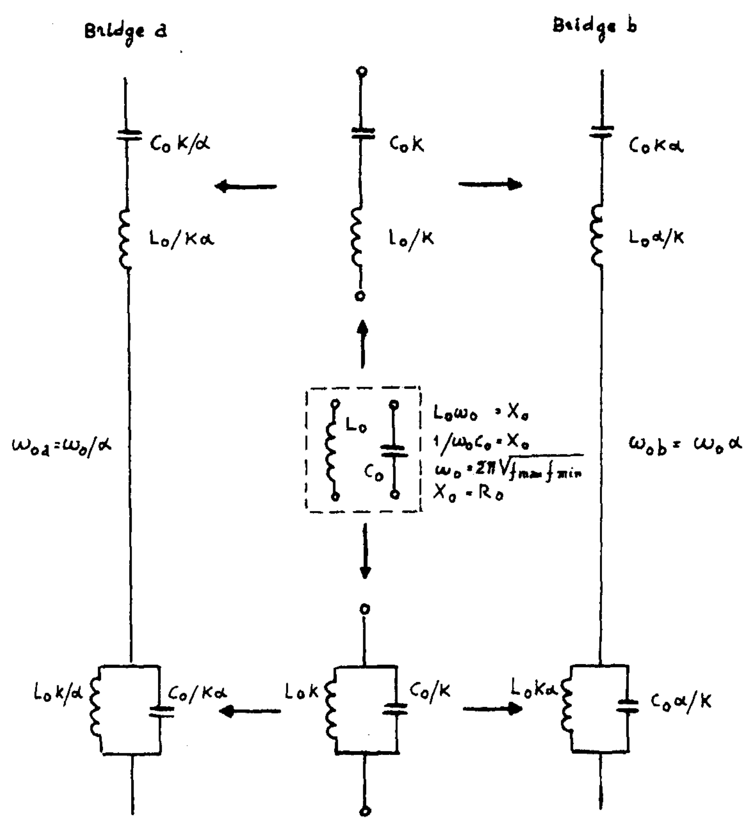


Fig. 5 - Diagram showing how Ls, Cs, Lp, Cp, a and b are related to Xo by parameters α and k

Fig. 6 - Effect of Ro mismatch on the amplitude response of the two bridges (at N = 10)

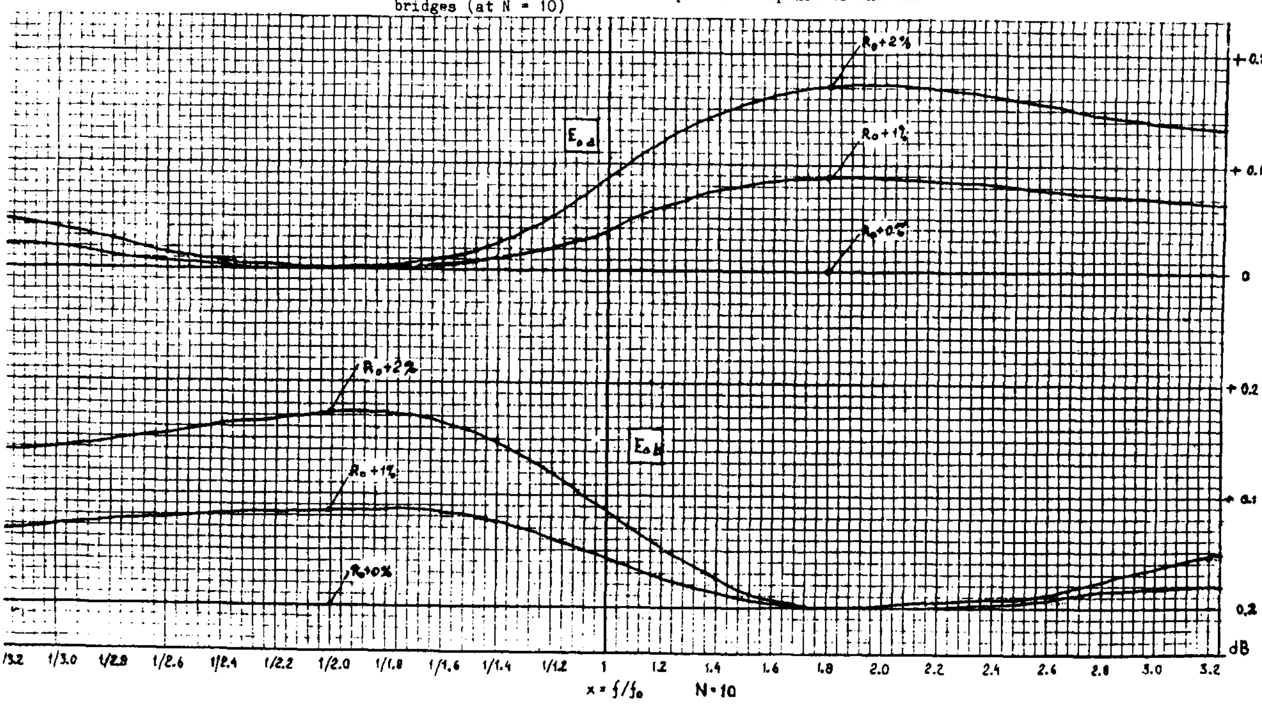
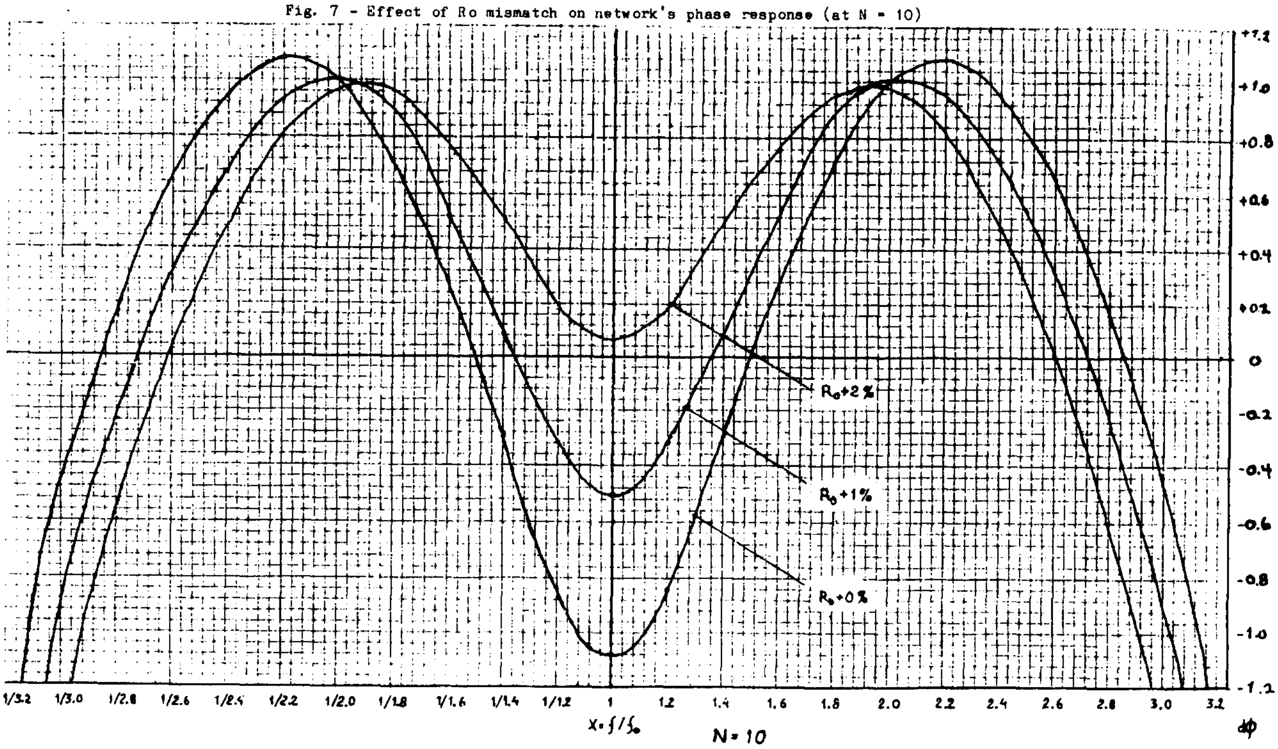


Fig. 7 - Effect of Ro mismatch on network's phase response (at N = 10)



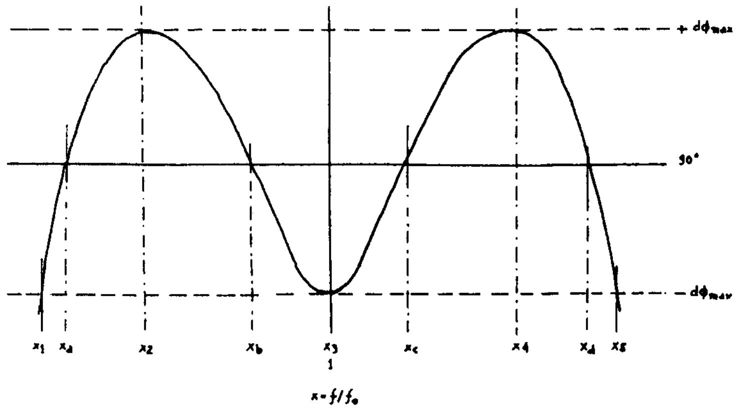


Fig. 8 - Network's typical phase response. Frequencies are normalized with respect to fo.

Table I - Network's parameters computed for a set of frequency ratios

N	2	3	4	5	6	7	8	9	10	11	12
$d\phi_{max}$	0°0,947721'	0°4,441720'	0°10,342073'	0°18,540194'	0°27,220935'	0°36,449224'	0°45,918199'	0°55,464421'	1°4,985340'	1°14,421117'	1°23,724067
α	1,847572	1,869479	1,890590	1,909965	1,927692	1,943939	1,958927	1,972839	1,985821	1,997995	2,009463
K	3,154222	3,224885	3,294603	3,359859	3,420611	3,477205	3,530149	3,579901	3,626855	3,671343	3,713643
x_1	0,707107	0,577350	0,500000	0,447214	0,408248	0,377964	0,353553	0,333333	0,316228	0,301511	0,288675
x_2	0,783591	0,681250	0,618034	0,573792	0,540472	0,514134	0,492586	0,474498	0,459009	0,445534	0,421974
x_3	1,000000	1,000000	1,000000	1,000000	1,000000	1,000000	1,000000	1,000000	1,000000	1,000000	1,000000
x_4	1,276176	1,467890	1,618034	1,742792	1,850234	1,945019	2,030103	2,107491	2,178605	2,244498	2,369814
x_5	1,414214	1,732051	2,000000	2,236068	2,449490	2,645751	2,828427	3,000000	3,162278	3,316625	3,464102
x_a	0,726311	0,693079	0,527786	0,478118	0,440231	0,410738	0,386873	0,367035	0,350197	0,335671	0,322964
x_b	0,876860	0,813806	0,894708	0,743562	0,721331	0,703122	0,687971	0,675068	0,663878	0,654013	0,645230
x_c	1,140433	1,228794	1,286969	1,344877	1,386326	1,422228	1,453549	1,481332	1,506301	1,529022	1,549835
x_d	1,376821	1,658158	1,894708	2,091535	2,271537	2,434643	2,584830	2,724537	2,855534	2,979105	3,096322

Modifications to A Secondary Time Standard - Clock

By John R. True,* N4BA

Based on 6 months more experience with the Secondary Time Standard - Clock described in QEX #8, I recommend the following:

1. Be sure to feed the 560-ohm heater resistor from the **regulated** side of the 10-volt regulator rather than the filter side. The frequency of the oscillator is several cycles more stable on that side because the filter side is subject to power-line fluctuations.

2. Reduce the current-limiting resistor in the power supply to 100 ohms vice 1,000. This will boost the battery quickly when power returns, yet not waste too much of the regulated output voltage. The internal resistance of the transformer helps to limit this current on relatively high loads.

3. The NiCd (8.4-V) transistor-type battery requires a peak charging voltage of 7 (cells) x 1.5 (V) = 10.5 (V) to completely load it for 100 mAh discharge. So set your uA 713 output to provide 10.5 V at the **battery plus terminal** when completely charged, or it will **not** be able to deliver full 100 mAh when power fails. On battery only, my load is 13 mA; it should last for 7 to 8 hours if fully loaded. A new battery may need 2 or 3 charge/discharge cycles.

*10322 Georgetown Pike, Great Falls, VA 22066.

Radio Shack Educational Grants Program

Radio Shack is setting the subject for proposals in the fourth submission cycle of the company's Tandy TRS-80 (tm) Educational Grants Program as "Uniques and Innovative Microcomputer Applications in Education." The deadline for submissions is March 31, 1982.

The program is designed to encourage application of microcomputer technology in U.S. educational institutions. Hardware, software, courseware and related products totaling $500,000 per year will be awarded to individuals and non-profit organizations whose proposals are selected in four quarterly cycles as providing the greatest benefit to the American educational community under selected proposal themes. Equipment is allocated based on the recommendations of an impartial Educational Grants Review Board comprised of a number of distinguished educators

Information kits are available by written request only from: Tandy TRS-80 Educational Grants Program, Radio Shack Education Division, 400 Tandy Atrium, Fort Worth, TX 76102.

Preamp in a Pipe

By John L. McDonald,* W6SDM

Here is a gadget, which is nothing unusual in circuitry but is off the beaten path in packaging, being some place between laboratory and atomic submarine in its adaptability to the real world.

I originally built it to hop up my hand-held DSI counter because I wanted something small and easily connected and disconnected. I had built up my own battery pack, so the placement of the Teflon feed-through seemed optimum as shown.

It worked very well over the vhf and uhf regions and enabled lockup on the counter with far less signal. I decided to see what happened if I put it ahead of a 432-MHz converter. I could not believe how well it worked. Likewise at 144 MHz - even better at hf - clear on down to 2000 kHz.

I went so far as to take it to a uhf gathering and had someone run a noise figure measurement on it (as a joke). The original noise figure was 2.0 (later corrected to 2.5) dB, which isn't too shabby for such a gadget.

It will not replace the GaSFET, nor even the high-priced bipolars, but if you have a situation where a little more rf gain is nice, it sure does work well.

I built 5, two for me and the rest for others including the local utility company noise-locating man who swears by it. The Corning units were acquired in a salvage deal and were use for dc blocking for this article. In my own case, I found it much easier to install dc blocking capacitors on my receivers than trying to find a capacitor small enough to get down inside the BNC plug.

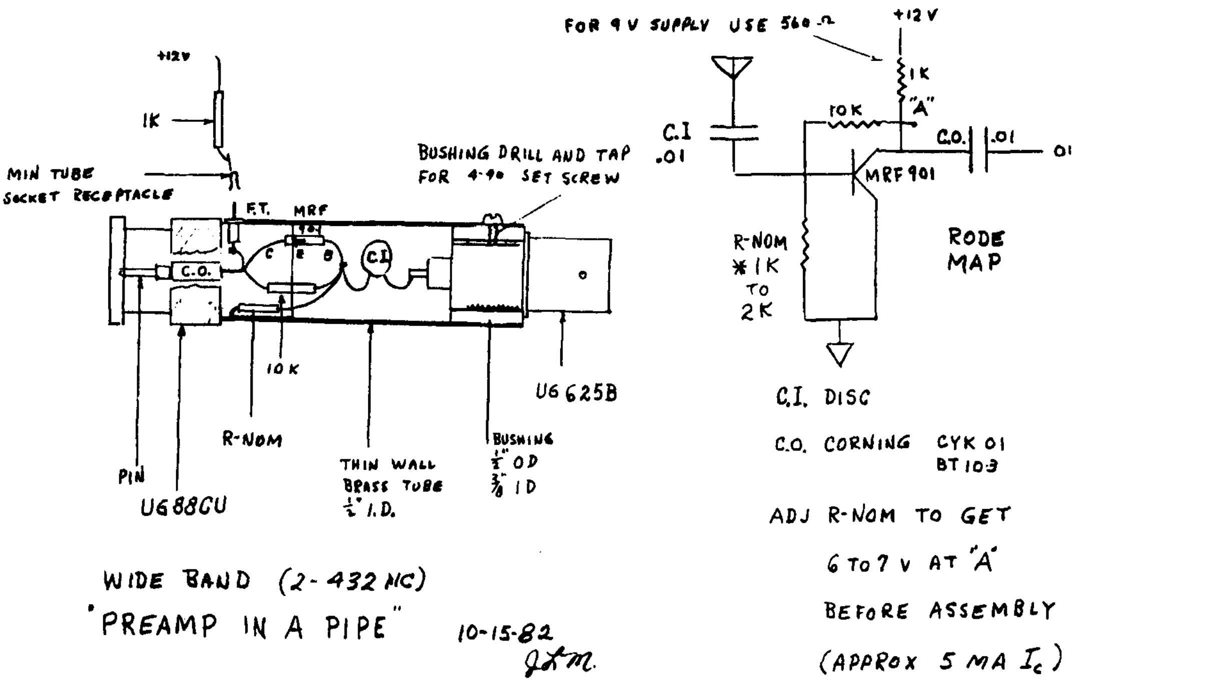
To insure a snug press fit of the tube over the plug, tin one side of the rear portion of the plug, then remove solder as necessary. Drill a hole for the feed-through near the bottom of the well, but clearing the taper at the bottom. Notch the end of the tube so that it will surround the flange of the Teflon feed-through. Be sure that the adapter fits snugly over the threads of the receptacle and that the tube slides freely over the outside of the adapter. Drill a hole and tape it so that a set screw will contact the flat on the receptacle, approximately in the middle.

Solder the Corning capacitor to the pin of the plug so that the body of the capacitor is against the solder well of the pin. Insert the pin the in the plug to the proper depth, and solder the loose end of the capacitor to the pin of the feed-through. Tin the edge of the plug well where the emitter leads are to be soldered, then insert the MRF901, on edge, into the well, leaving room for 10-kiloohm and R Nom resistors. Solder the emitter leads to the well edge, collector and one end of the 10-k resistor to the pin of the feed-through. Temporarily connect R Nom to the base of the MRF901 and plug well. Adjust the value of R Nom until the MRF901 draws 5 mA, with the 1-k collector resistor as shown, making sure that the lead between the resistor and the feed-through pin is not over 0.5 in. to prevent possible instability. After the proper value of R Nom has been determined, insert it down in the well, solder one end to the base of the MRF901 and the other end to the edge of the well. Solder C.I. to the Base of the MRF901 and the pin of the receptacle. Slide the tube over the complete assembly and tighten the set screw.

*24 N Glenbrook Ave, Camarillo, CA 93010.

Material Required

Thin-walled brass tube 0.5 in ID by 1.5 in long (available at hobby shops in 12-in. lengths)
BNC fittings per sketch (be sure that the flange of the receptacle is not over 0.5 in diameter)
1 MRF901 transistor
Resistors per sketch
1 Corning CYK 01 BT 103 or equal (0.01 @ 50 V)
1 Ceramic disc 0.01 @ 50 V
1 Teflon push-in feed-through, smallest
1 Adapter, metal, 0.5 in OD by 3/8 in ID
1 Contact from miniature tube socket (push-on connector for pin of feed-through)



Data Communications

Conducted by
David W. Borden,* K8MMO

HF Networking

I received a letter proving that someone actually reads this column. This person wrote and suggested that I really did not have a legal problem on 10 meters with my networking scheme as the simplex repeater could be construed as a relay and not a repeat. I wish he were right. W3IWI in Maryland and N5AHD in Texas have been holding weekend QSOs in packet on 10 meters with good success. I could activate my two-port device and anyone calling in on two meters on the AMRAD machine (147.81/21 MHz, McLean, VA) would go out on 10 meters and vise versa. But, alas, the FCC thinks the simplex machine is a repeater. I think the answer is to ask the FCC for an Special Temporary Authorization (STA) to use the cross-band technique. My two-port 8273 S-100 wire-wrapped packet board is coming along well. When it is finished, I will be wanting to try it on some worthwhile project like hf-vhf. To begin it could just link the two local packet machines, 147.81/.21 voice/packet repeat and 147.585 packet repeat.

Host Mode

I have been doing some additional work with the Host Mode project where anyone on the packet repeater can use my S-100 computer to run programs of various kinds. I have changed the CP/M 2.2 BIOS to accomodate the host mode. The packet port is used for the console I/O, and the local terminal is used to display what the computer is doing so I may monitor it. I have provided two demonstrations of the Host Mode to date, and both have worked well. The last demonstration at the AMSAT annual meeting was the best. I practiced playing chess with the computer. This revealed two problems. First, 1200 baud on the packet side of the TNC is too slow. Putting up the initial chess board on the H-19 terminal takes a minute and a half. Updates (moving one chess piece) are fairly fast, but the initial drawing is slow. The terminal runs at 9600 baud, but the apparent speed of drawing is what is evident. It will certainly be desirable to go 56 kbaud on the packet side as soon as possible. Waiting for a noisy packet to be repeated is annoying also. After some practice the night before the demonstration, I determined that chess might not make the best demonstration, so I switched back to Adventure the day of the demo. I need to make a modification to the BIOS. It became evident that the TNC on the computer side of the link was sending the line feed that terminated the packet to the computer. CP/M in the command mode would use the line feed as a terminator character (stop whatever you are doing, computer) and thus doing a intrinsic DIR command in CP/M or a TYPE command did not work correctly. The command would be started, but then the line feed character would be noticed and the execution terminated. So, I must trap the line feed after carriage return in the BIOS. I am convinced that modification of the BIOS is the correct method to use for Host Mode with the only TNC software change required being to end the monitor mode for the host and to terminate a packet on the CP/M forward arrow prompt (>),question mark(?), and colon (:). If anyone reading has Host Mode experience, please write and share it with me as I expect this addition to the local repeater will cause the largest packet radio growth in this area. A better site may have to be chosen for the computer, but the concept is sound.

*Route 2, Box 233B, Sterling, VA 22170,
703-450-5284 home.

File Transfer

After the initial thrill of the Host Mode has worn off, I am sure that people will want to remove files from my system. Jon Bloom, KE3Z and I have been discussing how best to do this and have concluded we need even more new software. The simple first approach is to use the CP/M PIP program to send the file out the console (actually packet) port and thus use PIP at the receiving end to catch the file. The problem with this is there is no error checking except what the TNCs do (CRC). I suspect we will try this very soon, and maybe no error checking will be required. Ah, you say, why do not you use the old Ward Christensen modem transfer program "MODEM7"? It was basically a BISYNC protocol, the first packets. It would send out 128 byte packets and use a simple additive checksum to error detect. The program could be modified to work I suppose, but what we really need is a good file-transfer protocol. The sender must open a disk file for reading and send the file out to the TNC board, handshaking as required when the TNC buffers fill up. The receiver must open a disk file for writing and receive the file segments from the TNC board, handshaking as required. There must be user interaction to start the transfer on the sending side and user interaction to start the catch on the receiving side. So, the receiver for example must activate a program like MODEM7 which is a smart terminal emulator. Using the program, the receiver must activate a program on my host to send the desired file to him. Then, he must switch his terminal emulator program into catching mode to grab the file as it comes across. The program on his computer and the program on my computer should actually initiate the transfer and complete it unaided. The programs should allow both ASCII transfers (like a CP/M .HEX file) and object code transfers (a CP/M .COM file). If any one reading has ideas on this subject, I am open for suggestion. It looks like a fun project, and you could assume that the packet boards would take care of the error checking and concentrate on making the use of the programs "user friendly".

Mailbox

I am still looking for a good mailbox program. I do not want a Ward Christensen/Randy Seuss CBBS. Our packet mailbox should be different. A user should send a request for his mail and receive it (if any). If he wants to leave new traffic for someone, he should have a copy of this mail program on his computer and just activate it supplying the name of the file with the message in it. The program would then contact the mail program in the Host computer and effect the transfer unaided. If anyone has a program like this running on 8080/Z80 CP/M, donate it and we will try it on our Host. Hank Magnuski, KA6M has a similar program running on his San Francisco host, but it runs only on Data General, and most hosting will be done on more personal computers. Think about the problem and write me at the above address. This mailbox program should be ready to run when the Phase III-B satellite is launched so I can come home from work and read my mail someone left me on the local mailbox.

Correspondence

Connector Standards

I am told that you are looking for a 13.5-Vdc (power) plug standard.

I suggest you look at the standard that our group adopted.

Advantages: Low cost; (plug $0.93)(P 308 CCT) (sockets $1.04)(S 308 CCT)

Ease of assembly

Dependability: in service over 10 years in a wide range of applications with no failure.

Flexibility: high current (7 amp) contact are able to handle most amplifiers--a requirement for real interchangeability of equipment.

This plug standard allows our group to mate components (swap at will) from a half dozen repeaters with each other or with many of our users. We can power the repeaters from motorcycles--power amplifiers or test equipment from many 13.5-Vdc sources.

We have the maximum number of options because of compatibility. - "JQ" Lahtinen, W6TTU, Chairman, "Two-Twenty User," 1360 Danby Ave, San Jose, CA 95132, 408-251-1407.

Ed. note: See below:

More on Connector Standards

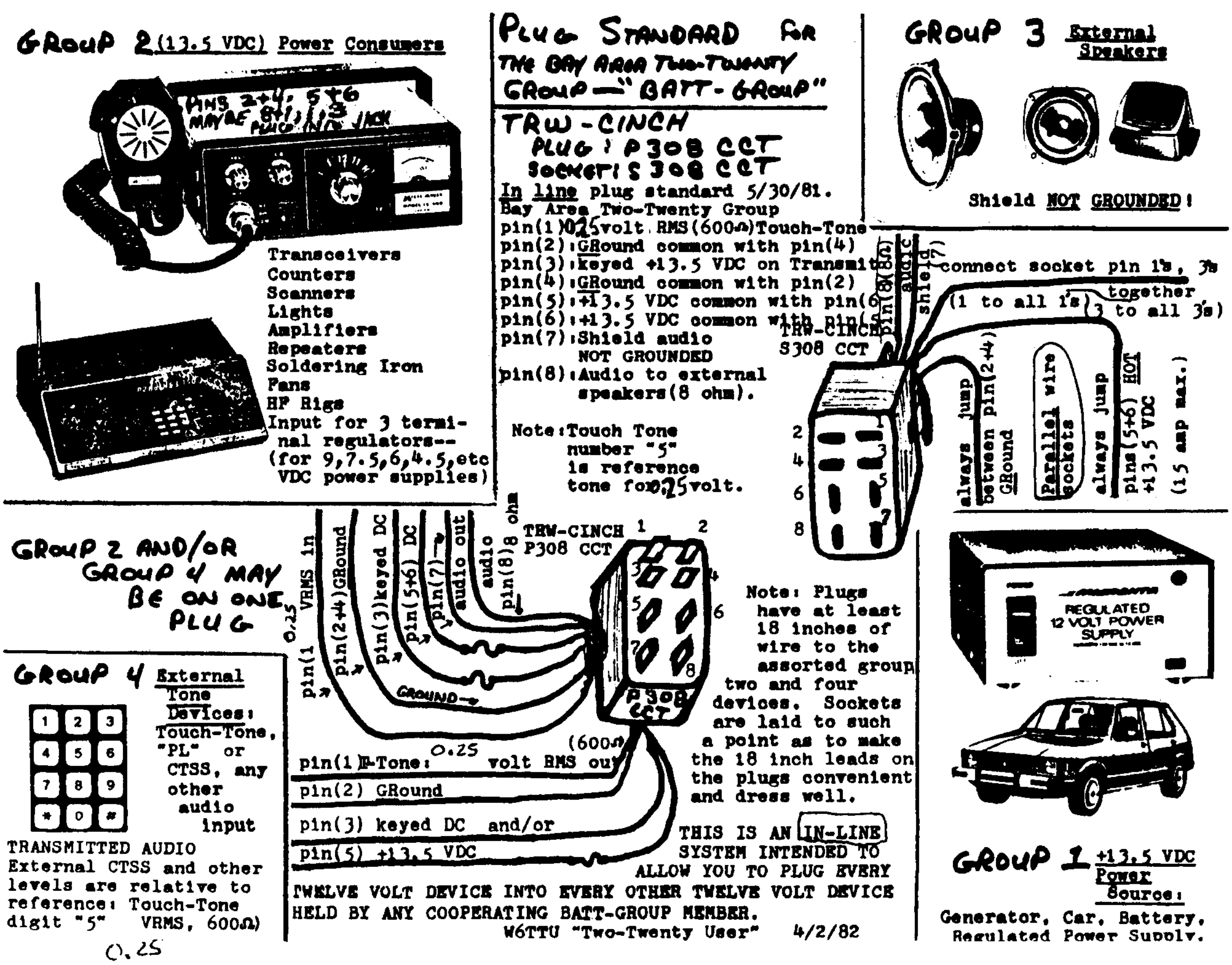
Have been enjoying QEX since the first issue. I like the format, and the articles have been interesting. Hope to have one for you someday. Mine are usually full of hard-to-duplicate circuits (lack of parts) but I enjoy home-brewing.

Your article on connector standards is why I'm writing. For 110/220 use the CEE-22 plug is the only way to go. I've been ripping the cheap zip cords out of my ham rigs and replacing them with these for some time. I highly recommend using the EMI filter modules too. My 13.8-V supply kept shutting down when using my 100-W 2-m amplifier until I got both of them filtered properly.

I suspect that you'll have difficulty with microphone standards. Some mikes have amplifiers in them; some don't. At times the Vcc is run on the audio line and sometimes not. I rewired my whole station using the 4-pin (Radio Shack 274-001/001) connectors. Pin 1 audio, pin 2 PTT, pin 3 Vcc and Pin 4 ground.

For dc connectors our local slub derived a standard after finding out that 2-m fm rigs couldn't be switched from vehicle to vehicle in an emergency. We are using the Radio Shack two-pin "Molex" 274-222. The + lead is the pointed side of the connector with the ground on the flat side. The male connector goes on the rig. The female block connects to car battery. The female block protects the leads better, and thus you are not as

(continued on page 3)



Correspondence (continued from page 2)

likely to accidentally short your battery and blow a fuse at critical time. This standard could easily be adapted nationwide. It sure has made life simpler in Sonoma Co. - Stephen T. Lund, WA8LLY, 1055 Jennings Ave, Santa Rosa, CA 95401.

Programmable Calculator Info Sought

Please consider publishing a short letter or call for info in QEX from those hams who own programmable calculators such as the HP-33E and newer HP-11C for routines that relate to Amateur Radio, or even engineering math, etc. I realize that many own home personal computers, and those programs are great. I really feel there is a large number of hams still utilizing HP-11C and HP-33C units simply because of price alone.

QEX is super - I really like the data on newer components. - Hilary McDonald Jr., N5AX, 2749 Apollo Drive, Barstow, CA 92311.

Receiver Measurement Validation

I have read recently in several publications of receiver measurements taken on MDS, dynamic range and third-order intercept which do not agree with measurements taken by myself on similar receivers of the same model. In one publication at least, reports of dynamic range exeed that theoretically possible in the bandwidth specified.

Some time ago I measured in an extremely expensive receiver, dynamic range numbers which were "too good to be true." Consideration of the error mechanism proved, alas, that they were indeed too good to be true.

If MDS is defined as that signal level resulting in a 3-dB increase in output of the receiver and dynamic range being the difference between that MDS and a mathematical function of input for third-order generation, D.R. = 2/3 (Pi-MDS) we must be careful to determine that MDS remains a constant. In my case at least, and I suspect in the others referred, reciprocal mixing of oscillator noise with the high-level signal inputs far removed in frequency raises the noise floor of the receiver to the point where optimistic third orders are measured.

One receiver, using a phase-locked oscillator was so noisy that in measuring the third order, the MDS 20 kHz removed from the nearest test signal rose from -126 dBm to -107 dBm before the third order could be detected in the -107 dBm noise. Substitution of a "clean" oscillator for the PLL reduced the dynamic range from an unbelievable 116 dB to a good but much more mundane 94 dB. How the manufacturer ever came up with a third-order intercept figure under these conditions is beyon me. Obviously a check for MDS change in the presence of signals strong enough to generate detectable third order measured a kHz or two removed from the third-order frequency is necessary to validate the two-tone test results. - Harold E. Johnson, W4ZCB, 2617 Pinewood Dr, Dunedin, FL 33528.

Pi-Network Formulas

This comment refers to Mr. Wingfield's letter in the September issue on the subject of Pi-Network Formulas.

I have no quarrel with, nor (am I) taking issue with his exercise. I do, however, object to his placing such an undeserved status to the constant, Q.

Undefinable, unavailable, unmeasurable, parasitic elements exist in all practical inductors, and, in many cases, effect the value of measured or calculated Q. The "apparent" value of Q is often the best that can be done, and is usually entirely satisfactory in guiding design, prototyping, and production. The Q-Meter is a very useful instrument but has serious limitations when called upon to furnish data for use in the referred-to exercise. It is suggested that the inductance be measured at a low frequency (e.g., 1000 Hz), and at a very low level.

In closing, let me comment briefly on the author's comments about limiting math levels in discussions directed to hams. I object emphatically to any suggestion of this nature, particularly in items published in QEX. - George J. Maki, W6BE, 1417 Pacific Drive, Santa Barbara, CA 93109, 805-965-7330.

TRS-80 Modem I for Radio Communications

Randy Brink, WDØHNF pases along this info to use the TRS-80 (tm - Radio Shack) Modem I to transmit and receive 300-baud ASCII via the radio.

Refer to catalog number: 26-1172 for the TRS-80 Modem I, Fig. 5, schematic diagram.

1. Cut the trace between U7, Pin 3 and J1-5.
2. Insert a switch across the cut.
3. Connect J4-3 to radio speaker and J4-4 to transmitter microphone input.
4. Half-duplex mode.

Mode	Switch Position	Originate/Answer
Transmit	Open	Answer
Receive	Close	Originate

- Robert W. Gervenack, W7FEN, 19701-320 Avenue NE, Duvall, WA 98019.

3.579545!

Just a comment on John True's (N4BA) excellent article on a "Secondary Time Standard-Clock," QEX, September '82.

The time base for the clock is based on the widely available color-burst crystal. Broadcast and cable television color subcarrier (NTSC*) uses a frequency of 3.579545 MHz. The author refers to 3.579540 MHz as the standard. The author uses an MM5369 to divide oscillator by 59659:

$$3.579545/59659 = 60.00008$$

$$3.579540/59659 = 60.00000$$

The clock will, I am sure, run on time, due to the ability to set the oscillator frequency by means of the 20-pF variable capacitor. Just note the oscillator will run at 3.579540, not 3.579545 as is marked on the NTSC* color subcarrier crystals.

Thank you and I look forward to future issues of QEX.

*NTSC: National Television Standards Committee set the color subcarrier frequency at 3.579545. Reasons include compatibility with older black-and-white TV sets. - Bill Bradford, K7EA, 3891 Seagull Drive, Salt Lake City, UT 84120.

Repairing 9-volt NiCd Batteries

As you know the small NiCd batteries are made up of smaller cells. In particular the little 9-volt jobs are vulnerable to one cell either shorting or venting, thus drying out and becoming non-conductive. Also, being in series, they are prone to get charged in backward polarity as the first cell to discharge has current forced through it from the other series group. In the good old American throw-away economy we just throw out five good cells with the bad one of the 9-volt group. A sharp instrument and a bit of patience can remove the top terminal strip of the 9-volt size, and the six cells pull right out. A multimeter can right away determine which cell(s) need replacing, and another "bad" battery can furnish the replacement(s). The welded tabs can be cut nearest to the bad cell, leaving long enough pieces to allow soldering the tabs together. Don't attempt to solder to the cell can, it may explode. The six dollars saved for the 15 minutes of fun seems worthwhile to me; 24 dollars per hour. A few drops of magic glue will hold the "lid" back on. - Rowland Medler, W4ANN, 1041 N.E. 20th Ave, Gainesville, FL 32601.

Ed note: Wear safety glasses, check your insurance, then proceed at your own risk.

Components

Conducted by Mark Forbes,* KC9C

The column this month is a potpourri of items from many interesting areas. Hopefully I am covering areas that traverse the wide range of interests held by you readers. If I have been overlooking something that I should be covering, please let me know. One of the items in this month's column is indicative of a trend that I am seeing in the trade journals; that is, low-cost, mass-produced microwave devices. These should yield some interesting articles from you as they will make some sophisticated microwave equipment affordable enough for the average ham to construct.

Piconics Microwave Choke

The Piconics series M chokes are available in values from 18 nH up to 1 uH and are capable of operating in frequency ranges of 200 MHz to 15 GHz depending on the value. These are broad-band air-core chokes constructed of 47 AWG wire. The self-resonant frequencies range from 1 to 28 GHz minimum. The chokes are capable of handling 100 mA and have a Q of 4 to 28. The price of most values is less than $1.00. The chokes are available from: Piconics Inc., 20 Cummings Rd., Tyngsboro, MA 01879, 617-649-7501.

Telemos CMOS Gate Array

The TM5001 gate array uses a combination of IC technologies to realize a circuit with low-voltage CMOS logic controlling 300 Vdc lateral-DMOS output transistors. The chip contains 169 uncommitted 2-input gates and 169 uncommitted 3-input gates plus 40 prewired flip-flops and 8 open-drain DMOS transistors capable of sourcing 25 mA. There are also 18 CMOS or TTL buffers, 7 pairs of p- and n-channel high-impedance transistors, up to 50 I/O channels and silicon suitable for use as up to hundreds of resistors. The price of the gate array is only $25.00 in hundred-piece lots, and information can be obtained from: Telemos Inc., 3040 Coronado Dr., Santa Clara, CA 95051, 408-727-1501.

Hamlin Miniature Solid-State Relays

Solid-state relays (SSRs) have a variety of uses in Amateur Radio such as telephone isolation and CORs in repeater systems. These relays from Hamlin are housed in 6-pin mini-DIP packages to allow maximum usage of board space. The contact current ratings of the relay range from 150 to 375 mA for dc models and 100 to 250 mA for the ac circuits. Operating current is 15 mA for these SSRs, and the OFF-state leakage is 10 uA. The dc models are the 790 series, and the ac models are the 7900 series. All of the relays can be paralleled to increase drive capabilities. Price is about $5.00, and Hamlin's address is: Hamlin Inc., Lake and Grove Sts., Lake Mills, WI 53551, 414-648-2361.

*1000 Shenandoah Dr, Lafayette, IN 47905, 317-447-4272, 2300-0230 UTC weekdays, until 0230 weekends.

Standard Microsystems COM 2661 EPCI

The Standard Microsystems EPCI (Enhanced Programmable Communication Interface) is really a USART with a programmable baud-rate generator on board. The 2661 is capable of synchronous or asynchronous operation at full or half duplex. Synchronous features include selectable 5- to 8-bit characters, internal or external synchronization, odd, even, or no parity, and a local loop-back mode for troubleshooting. Features of the asynchronous mode include 5- to 8-bit characters (plus parity), programmable baud rate, local loop back and automatic serial echo-back mode. The baud rates are programmable from dc to 1 Mbaud. The device is housed in a 28-pin package and draws only 150 uA from a single 5-volt power supply. Further details and data sheets may be obtained from: Standard Microsystems Corporation, 35 Marcus Blvd, Hauppauge, NY 11788, 516-273-3100.

Avantek Microwave Components

Aventek offers a full line of microwave components, many of which could be of use to the experimenter. While details on every component are not possible to squeeze into the "Components" column, I will list them, and information can be obtained directly from the manufacturer on the specific component of interest. In no particular order, some of the components that they have are: 3.7-4.2 GHz downconverter, line extenders/booster amplifiers, 3.7-4.2 GHz preamplifiers, miniature 5-400 MHz transistor amplifiers, 400-9600 MHz varactor-tuned oscillators, and other satellite-receiving peripherals. Catalogs can be obtained from: Avantek, 3175 Bowers Ave, Santa Clara, CA 95051, 408-496-6710.

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Victor C. Clark, W4KFC
President

David Sumner, K1ZZ
General Manager

Paul L. Rinaldo, W4RI
Editor

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1) provide a medium for the exchange of ideas and information between Amateur Radio experimenters,

2) document advanced technical work in the Amateur Radio field, and

3) support efforts to advance the state of the Amateur Radio art.

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