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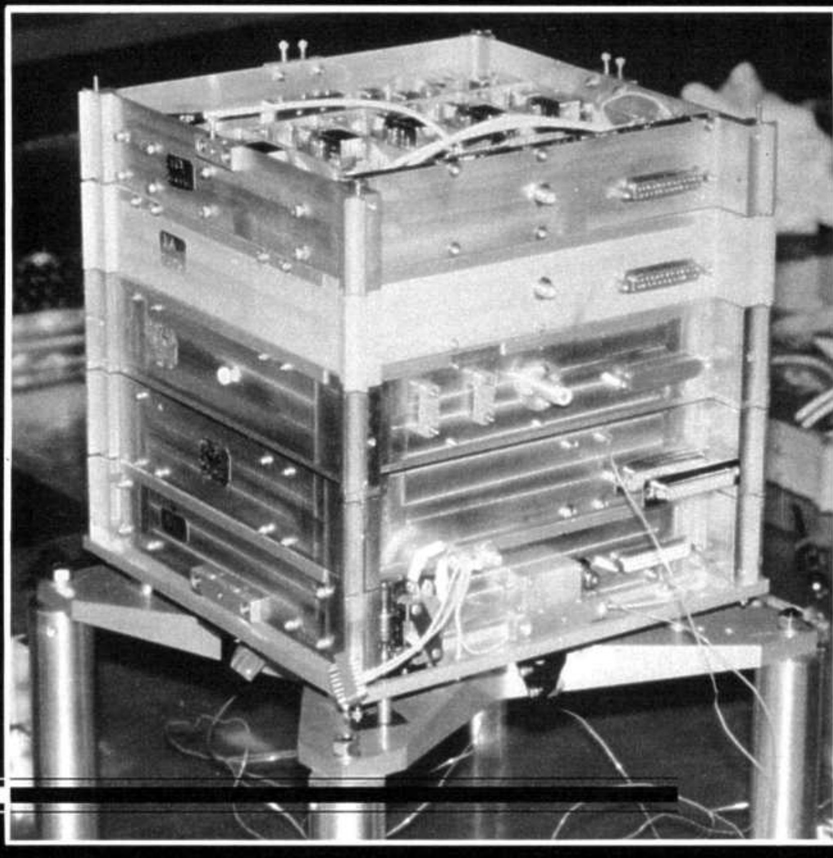
QEX 94

ARRL Experimenters' Exchange

DECEMBER 1989

MICROSAT MODULES

Stacked in final configuration



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David Sumner, K1ZZ
Publisher

Paul L. Rinaldo, W4RI
Editor

Lori Weinberg
Assistant Editor

Mark Forbes, KC9C
Geoffrey H. Krauss, WA2GFP
Bill Olson, W3HQT
Contributing Editors

Chetty Tardette
QEX Circulation

Michelle Chrisjohn, WB1ENT
Production Supervisor

Sandra L. Damato
Typesetter/Layout Artist

Sue Fagan
Graphic Design Supervisor

Dianna Roy
Hilary Vose
Technical Illustrators

Technical Department
Charles L. Hutchinson, K8CH
Manager
Gerald L. Hall, K1TD
Deputy Manager

Production Department
Mark J. Wilson, AA2Z *Manager*

Circulation Department
Debra Jahnke, *Manager*
Kathy Fay, KA1UGB, *Deputy Manager*

Offices
225 Main St, Newington, CT 06111 USA
Telephone: 203-666-1541
Telex: 650215-5052 MCI
FAX: 203-665-7531 (24 hour direct line)
Electronic Mail: MCI MAIL ID:215-5052
(user name ARRL)
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Purposes of *QEX*:

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

All correspondence concerning *QEX* should be addressed to the American Radio Relay League, 225 Main Street, Newington, CT 06111 USA. Envelopes containing manuscripts and correspondence for publication in *QEX* should be marked: Editor, *QEX*.

Both theoretical and practical technical articles are welcomed. Manuscripts should be typed and double spaced. Please use the standard ARRL abbreviations found in recent editions of *The ARRL Handbook*. Photos should be glossy, black-and-white positive prints of good definition and contrast, and should be the same size or larger than the size that is to appear in *QEX*.

Any opinions expressed in *QEX* are those of the authors, not necessarily those of the editor or the League. While we attempt to ensure that all articles are technically valid, authors are expected to defend their own material. Products mentioned in the text are included for your information; no endorsement is implied. The information is believed to be correct, but readers are cautioned to verify availability of the product before sending money to the vendor.

Empirically Speaking. . .

Looking to the Future—Public Land Mobile and Amateur

October 23 through November 8, 1989, the International Radio Consultative Committee (CCIR) Study Group 8 (Mobile and Amateur Services) held its final meeting for the 1986-1990 study period in Geneva. The results of the final meetings of all the Study Groups will be published in the CCIR "Green Book" sometime in 1990 when all the editorial work and translations are completed.

A significant part of the recent round of final meetings was devoted to CCIR preparation for the 1992 World Administrative Radio Conference (WARC-92). Some of the eleven Study Groups will have Interim Working Parties (IWPs) to consider the needs of invidual radio services as part of CCIR WARC preparation. In addition, several Joint Interim Working Parties (JIWPs) have been set up to discuss frequency-sharing and other concerns between radio services. At the end of the process will be an overall group called JIWP-WARC-92 to complete the report of the CCIR to the WARC.

Bear in mind that the CCIR is the part of the International Telecommunication Union (ITU) charged with considering technical and operational characteristics of different radio services. It plays only an advisory role in WARCs, which are the bodies usually given the power to reallocate the radio spectrum. Nevertheless, CCIR is well respected, and its reports are taken seriously by WARCs. While the CCIR is not empowered to allocate spectrum and must be careful not to overstep its bounds, it is competent to state the need for *n* kHz, MHz or GHz of bandwidth for a new service or a new system within an old service. The CCIR can even say where in the overall radio spectrum that bandwidth would best be located to satisfy propagational considerations.

A case in point is the Future Public Land Mobile Telecommunication System (FPLMTS). As an aside, it's customary to agree on a pronounciation for abbreviations, so this one came out as "flumpts," for short. There's a 99.9% certainty that the CCIR report to WARC-92 will say that FPLMTS will need 200 MHz of spectrum in the 0.5-3 GHz range. There are three amateur bands within this range: 902-928 MHz in Region 2, 1240-1300 MHz worldwide, and 2300-2450 MHz worldwide with a 2310-2390 MHz chunk removed in the US. Obviously, the ARRL is monitoring this one closely, as are other services, to see where FPLMTS might find the 200 MHz of their desires.

Just to put FPLMTS in context: The present system serving this requirement is (analog) cellular telephone. Its replacement will be a digital cellular system maybe going on the air in the next few years. Then FPLMTS is expected to replace that system, toward the end of the century. At the moment, FPLMTS is a piece of paper which outlines a system concept and a description of services that such a system can provide for the public. It is at least one, possibly two, generations away from the level of specifications needed to engineer the system. Nevertheless, the concept is so compelling, and has gathered such strong international support, that there is little doubt it's going to happen.

Some lessons can be drawn from FPLMTS: (a) the system conceptual engineering is well done and the brain child of many of the world's best qualified telecommunications engineers; (b) it is possible to generate a broad international consensus on a new revolutionary telecommunication concept, but the jury is still out on whether the implementations in North America, Europe and Japan will be the same; and, (c) it seems almost certain that WARC-92 will take seriously the stated requirement for 200 MHz of spectrum for this new system, although FPLMTS is simply a concept and not a field-tested system.

FPLMTS is only one, perhaps the best, example of new digital radio systems likely to be seen early in the next century. The Amateur Services have a number of developments underway or under discussion. Packet radio, small satellites, geostationary satellites, digital signal processing, spread spectrum, some neat bells and whistles for existing systems, and other developments can be cited as state-of-the-art. Nevertheless, there's nothing as powerful as an overall plan representing a broad consensus of both the creators and prospective users. That's what FPLMTS appears to be within the land mobile industry.

Wouldn't it be nice to have such a plan for what the overall Amateur Radio "system" will look like early in the next century? Wouldn't a plan help to convince other radio services that hams (a) are technically competent, (b) are pushing the state-of-the-art, (c) have a robust system capable of operating during disasters when other services are down or seriously overloaded, and (d) are effectively using the spectrum allocated to us?—*W4RI*

Searching for Information

By Ray Mote, W6RIC
3610 Oarfish Lane
Oxnard, CA 93035

Does this sound familiar? You find a really interesting technical article in an amateur magazine and want to know more. The only problem is that the references at the end of the article are either books that are older than you, references to obscure government technical reports, or cryptic notes in some sort of gibberish like "Proc IRE June 1935!" The references to amateur articles are easy, but the rest suddenly seem very remote and inaccessible and your enthusiasm quickly disappears. Don't give up! With a little persistence, you *can* get access to this material.

References generally fall into three major areas: books, periodicals, and industry or government reports. You will be going to different sources for each type, but the approach is always the same. If you can't get it from the original publisher, try all of the potential alternate sources. I've included my own list of major publishers, reprint houses, book search firms, used book stores, government agencies, the IEEE, and several industry information sources. Don't overlook the obvious local sources, such as bookstores, libraries, and even hamfests. Some of my better "finds" were purchased at the monthly TRW Amateur Radio Club swapmeet in Los Angeles.

Books

The obvious first step here is to try the publisher, but you're not likely to find these people listed in your local phone directory. A better approach is to call or visit your local book store. They should have a copy of *Books In Print*, which will tell you if the book is still available through normal channels. They should also have the addresses and telephone numbers of all the major publishing companies. If the book is out of print, you need to call the publisher and ask if they have any copies left in the warehouse. If that fails, ask if they have a reprint agreement on that book with one of the publishing houses specializing in reprints, and get the name and phone number. The next possibility is the used book stores. If you still have no luck, you need to try one of the book search firms. These folks are usually interconnected by a national telex network, and can query similar firms to see if anyone has that title. If you are unable to find a copy that you can buy, it's time to consider the libraries. A large university library is your best bet, but even the local public library may surprise you occasionally by having just what you're looking for. You can then read it at your leisure, and photocopy the information you need. (*Hint*: If your local public library is part of the national network of libraries, they can often search out a copy of the book for you and borrow it from the library where it was found.)

If you insist on owning your own copy, you last resort is the Library of Congress. If they have it, their photoduplication service can copy it for you. This service is expensive (45 to 50 cents per page), and they normally lay the book flat on the copying machine so you get two book pages for each fifty-cent page. There is also a $7 minimum charge. You need to write them a letter, asking for availability of the book and a cost estimate. When you receive this information they will require prepayment before duplicating the book.

Periodicals

Articles published in any amateur magazine are usually easy to obtain from the publisher for a nominal fee. Articles from technical journals can be purchased from the society that published them, or you can try the university library route or the Library of Congress. Another good source is University Microfilms International (UMI). They can provide microfiche, microfilm, or printed copies of most such material, and I've even obtained a softbound photocopy of a book from them in the past.

References to IRE, IEE, and IEEE articles are a common occurrence in amateur articles. The Institute of Electrical and Electronics Engineers (IEEE) was formed through a merger in 1963 of the American Institute of Electrical Engineers (AIEE) and the Institute of Radio Engineers (IRE). For IRE, AIEE, or IEEE articles, you need to contact the IEEE directly at the Engineering Societies Library in New York. They have a number of special interest groups which publish "transactions" in each area of interest, plus the normal IEEE "proceedings" and symposium records. They require a written request for the article, with a minimum fee of $11 per article covering up to ten pages, and an additional fee of 40 cents for each page beyond the ten-page minimum. (Articles rarely run more than ten pages in length.) The Institution of Electrical Engineers (IEE) is the British equivalent to the IEEE, and their articles are available from UMI.

Government and Industry Reports

Industry technical reports can normally be obtained only from the company which produced the report. If you don't have the company's address, check with anyone you think might have it, including friends, electronics supply houses, the League, etc. My best source of addresses has been the company listing in either the Electronic Engineers Master Catalog (EEM) or the Gold Book. Both contain advertising from many companies, plus listings of company addresses and sales representatives. The EEM is published by Hearst Business Communications, and the Gold Book is put out by Hayden Publishing Company as an adjunct to their Electronic Design magazine. These multivolume sets are normally provided free to engineers who specify or select components, but can be obtained (for a fee) on request.

Government reports can be acquired from several sources. If the report is relatively recent, you will probably be able to get a copy by contacting the agency which produced it. Older reports can be purchased through the National Technical Information Service (NTIS), although you may have to contact the publishing agency to get the "NTIS order number," which is quite different from the publishing agency's document number. If you encounter confusion during the search, remember that all of these agencies have undergone dramatic changes over the last few decades, including changes in functions, personnel, organization names, etc.

The Government Printing Office has little to offer those searching for electronics information, except for their Department of Defense telephone directory. The District of Columbia telephone information operators have always been able to provide me with the number of any agency I needed to contact. The information desk for that agency can then provide the number for the particular group handling the documents.

One more resource exists and should be mentioned. If you wish to know of additional work done on a particular topic, NTIS maintains a bibliographic data base (title, author, date, agency, etc) on all government reports published since 1964. This data base is not kept loaded in NTIS computers, but is provided on computer tape to companies which subscribe to the service and who provide access to users wishing to search the data base on-line. These companies are DIALOG Information Services, Pergamon ORBIT Infoline, and BRS Information Technologies. Costs of this on-line search capability are quite high, usually around $70 per hour plus a fee for each title found by the search. If you don't have a computer and modem, there are companies that will search the data base for you, based on your search criteria.

Summary

Lack of knowledge concerning the available resources is the greatest factor which limits our ability to acquire information. I've listed the sources encountered in my own quest, but there must certainly be many more which are unknown to me. If you know of a good source of used technical texts, professional journals, or government publications, you should consider informing the League. I'm still looking for copies of *Earth Conduction Effects in Transmission Systems*, by E. D. Sunde, Van Nostrand, New York, 1949; *Antennas, Theory and Practice*, by S. A. Schelkunoff and H. T. Friis, John Wiley and Son, New York, 1952; and *Radio Antenna Engineering*, by Edmund A. Laport, McGraw-Hill, New York, 1952.

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(will search data base for you)

ARTE—Amateur Radio Tracking Experiment

By David Babulski, WBØUKK
2677 Colony Cir
Snellville, GA 30278

Investigation of high-altitude tropospheric radio propagation in the Amateur Radio 2-meter band.

This proposal was written to solicit comment and support for the ARTE project from the Amateur Radio community and to propose inclusion of the ARTE project into the University of Alabama/Weber State College SOAR (Sub Orbital Academic Research) program.

Introduction—In 1937, Van der Pohl and Bremmer published their smooth-sphere theory of UHF radio propagation. This theory postulated that the strength of VHF/UHF signals drop off rapidly beyond the optical horizon. The theory was based on the assumption that the earth is a smooth sphere surrounded by a homogeneous atmosphere. Given these constraints, the radio radius of the earth is equal to 4/3 of its true radius. This theory of radio propagation proved accurate under standard conditions, but under nonstandard conditions many deviations to this theory were observed.

In 1934 (four years before Van der Pohl and Bremmer published their work) W1AL, located near West Hartford, Connecticut, aimed a 56-MHz antenna toward Boston, Massachusetts—over 100 miles away. Using a medium-power transmitter, he was able to contact stations in the Boston area almost at will. Although W1AL's signals often faded rapidly, the signal was still copyable and at times was even stronger than stations closer to the city!

After much research and correlation of thousands of measurements, W1AL established that temperature inversions and stratified layers of air at different temperatures, and moisture content in the troposphere could refract or bend VHF signals around the curvature of the earth. Today we know the effects observed by W1AL as tropospheric propagation or simply as "tropo." The majority of research on tropospheric propagation has been conducted with ground-based transmitters by both the professional and Amateur Radio communities. However, very little research has been conducted with transmitters placed high within the troposphere.

This proposal is for such a high-altitude radio propagation experiment. One of the determining factors in tropospheric propagation is the angle at which the radio signal strikes the tropospheric anamoly. This angle is called the "grazing angle." One of the primary objectives of the ARTE project is to investigate the effects on radio propagation of different grazing angles within the same tropospheric air column. By placing the transmitter high within the troposphere, grazing angles will change as a function of the descent rate of the transmitter instrument package. The basic hypothesis of ARTE is that reductions in grazing angle will enhance reflection from tropospheric temperature and/or moisture anomalies and possibly extend the useful range of tropospheric propagation.

The purpose of the experiment is twofold: to investigate the use of VHF tropospheric propagation in the Amateur Radio 2-meter band to deduce the fine structure of the lower troposphere, and; to involve selected high-school and college students in the Amateur Radio community and the Sub-Orbital Academic Research Group (SOAR) in a joint educational exercise which could be used as a model for future cooperative educational endeavors.

The hypothesis for the Amateur Radio Tracking Experiment is as follows:

> "By placing a 2-watt VHF FM transmitter operating on a frequency of 145.55 MHz, within the lower troposphere at an altitude of 3-4 miles, tropospheric propagation will be enhanced by at least one order of magnitude, due to a reduction in the grazing angle of the radio wave, as compared to a 2-watt VHF FM transmitter on the same frequency located at ground level. The effects of increased line-of-sight communications to be factored out."

The primary objectives of the ARTE project are:

- to investigate enhancement of tropospheric radio propagation by placing a low-power VHF FM transmitter at high altitude within the troposphere,
- to investigate the logistics, engineering and administrative channels necessary to conduct high-altitude radio propagation experiments in conjunction with the Amateur Radio community,
- to provide a unique educational opportunity for high-school and college students at both the undergraduate and graduate level, and,
- to investigate the application of high altitude radio propagation operations to the study of the structure and dynamics of the lower troposphere.

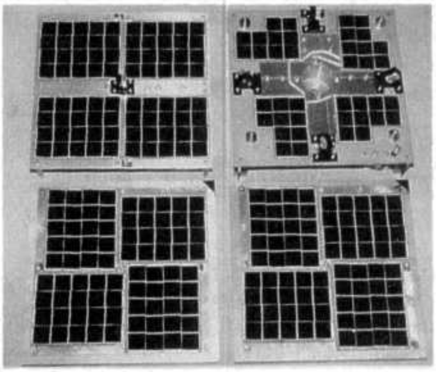
A small sounding-rocket, carrying a 2-watt, 145.55-MHz FM telemetry beacon, will be launched to an altitude of 3-4 miles (4.8-6.4 km) above ground level on a prespecified day in April 1990, from the Huntsville, Alabama, area. During parachute descent from peak altitude, a 300-baud digital telemetry beacon signal will be transmitted to ground-mounted receivers tuned to 145.55 MHz. These receivers, spread out over a 500-mile radius from the launch site, are to be manned by volunteer Amateur Radio operators. In addition to the VHF beacon signal, all the volunteer Amateur Radio operators will be networked to the launch site via a 40-meter (7.155 MHz) SSB HF link. The 145.55-MHz beacon launch will be preceded and followed by a 10-minute transmission of a similar beacon format from a ground-mounted 2-watt 145.55-MHz FM transmitter. Each volunteer radio amateur will record the output of their VHF receiver, for both the flight and ground level transmissions, on supplied log sheets. The students participating in the experiment will analyze the data from all the collected signal logs.

Project Directors are Mr David Babulski, WBØUKK (General Class) and Mr J Wayne McCain, KSØS (Extra Class). Mr Babulski holds a BA in Earth Science from California State University at Northridge and an MA in Education from the College of St Thomas, St Paul, Minnesota. He has over 20 years of experience in small sounding-rocket technology, specializing in electronic and scientific payloads. Mr McCain holds a BAE in Aerospace Engineering from Auburn University and an MAS in Administrative Science from the University of Alabama, Huntsville. He has over 20 years of experience in small sounding-rocket technology.

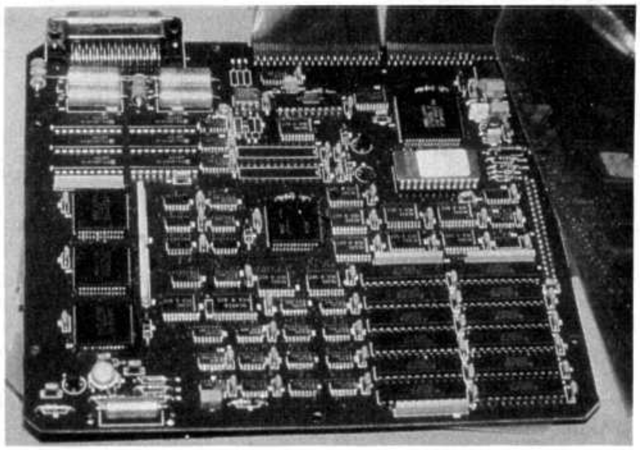
For more information and specific requirements for this project, please contact Mr Babulski at 2677 Colony Circle, Snellville, GA 30278, telephone 404-985-1020, or Mr McCain at 4209 Nolan Avenue SE, Huntsville, AL 35801, telephone 205-536-2241.

Design Team Integrates Microsats

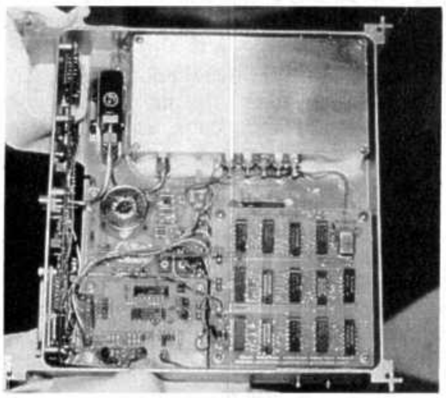
Photos courtesy of Bob McGwier, N4HY



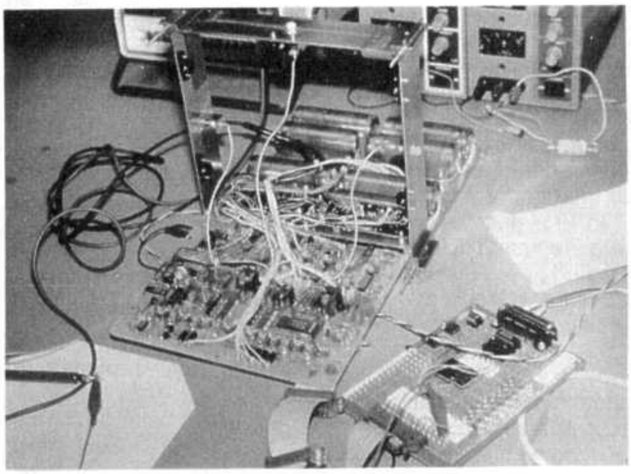
Microsat solar panels. The panel at the upper left is on top of the satellite, with the receive antenna mount in the center of the plate. The upper-right panel is for the bottom of the satellite, while the other panels are two of the four side panels.



A CPU board. The cables connect the board to the mass-memory boards.

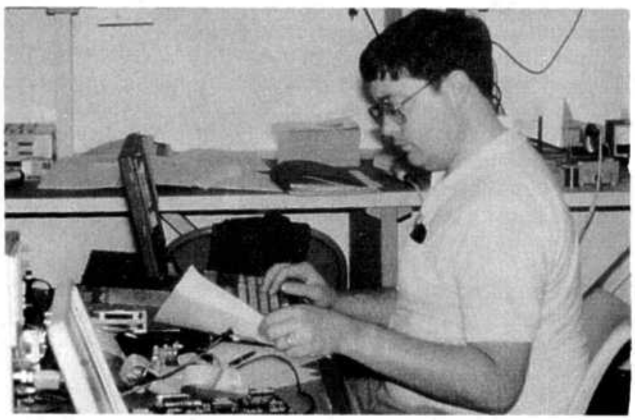


The LUSAT module.

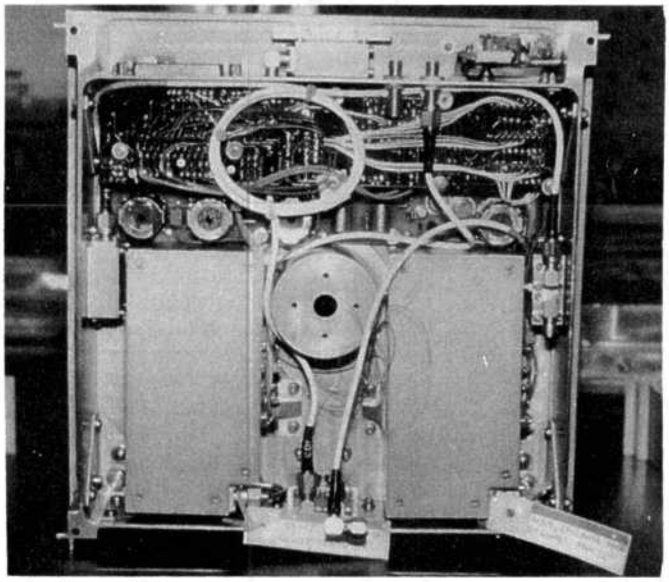


The power-control module. At the rear are the eight NiCd batteries, mounted to the 1/8-inch base plate.

Jose Machao displays the LUSAT beacon/telemetry module.

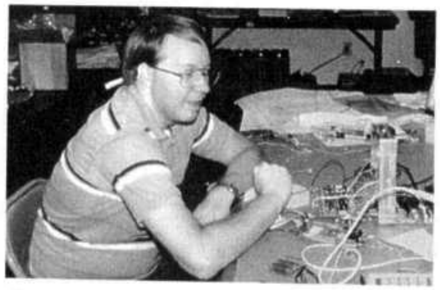


Harold Price, NK6K, working on Microsat software.

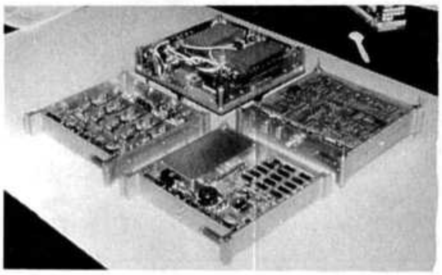


A close-up view of a transmitter module. The circular structure in the center of the module is used to connect the bolt that attaches the satellite to the launcher, as well as the spring that ejects the satellite when the bolt is cut.

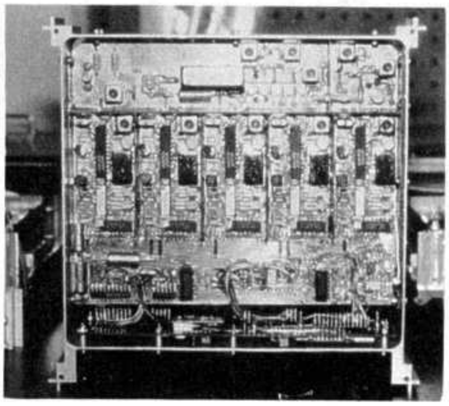
Jan King, W3GEY. It has been a long project for Jan! Blessing the hardware helps.



Jon Bloom, KE3Z, testing one of the power control modules.



Clockwise from top: transmitter module, power-control module, LUSAT module, receiver module.



Close up view of a receiver module, showing the five channels. The silver rectangular box near the top of the module is a helical filter in the receiver front end.

Bob McGwier, N4HY, cleaning one of the modules in the clean room at the Microsat Lab in Boulder.

Dick Daniels, W4PUJ, testing one of the receiver modules.

Jeff Zerr of AMSAT, and Chris Williams, WA3PSD, of Weber State College, test one of the power modules.

Correspondence

I was extremely pleased by the publication of Mike Grierson's, G3TSO/KD3CL, article "Modular Multiband Transceiver" in the September 1989 *QEX*. The design reflects careful use of modern components to meet the needs of home construction. In reviewing the design, I had some thoughts to share with you.

The modular design makes improvement easy. One thought is to replace the classic VFO with a synthesized design. I believe the chips to do this have been available for some time. The key problem was the high cost of the digital shaft encoder needed as the input device. Now, low-cost shaft encoders are available, so a synthesized design may be practical.

Another alternative is to design the band-pass and low-pass filters to cover the frequency range by half octaves. In this manner, almost continuous frequency coverage of the 1.5- to 30-MHz range may be obtained. For the current design, selection of the crystal-oscillator frequency would be made independent of the frequency-range selection. If a frequency synthesizer is developed, it would probably replace modules 2 and 3. Cleverly done, it would also select the correct filters in modules 4 and 5. The only compromise would be to avoid operating near the 9-MHz exciter frequency or its harmonics.— *Ken Heitner, WB4AKK/AFA2PB, 2410 Garnett Court, Vienna, VA 22180*

Notes on the G3TSO Modular Transceiver

My "Modular Transceiver" article, August and September 1989 *QEX* (which originally appeared in *Radio Communication*), contained a number of unfortunate errors due to a variety of reasons. As a result of the large amount of interest shown in the UK, I have produced an errata list containing all the errors found to date. If in doubt, the circuit diagrams should be regarded as the master references, as they are correct. The PCB layouts are also correct, but have suffered from ink run in the original printing. I have also produced a list of modifications required to cover the WARC bands.

So far, approximately 130 amateurs in the UK are in the process of building the Modular Transceiver. I have worked seven myself and there have been few problems in reproducing the design.

In view of the high demand, I have had complete sets of PCBs professionally made. They are tinned and drilled on glass fiber board, the set comprising five single-sided and two double-sided (continuous ground plane on upper side) as per the drawings in the article. The cost of the PCBs in the UK is £34, approximately $53. For larger quantities I could get a reduced price. If there is a requirement for PCBs in the United States, I could probably transport them personally on one of my visits.

If I can provide you with more information, such as the original article on the PA kit, or photographs, please let me know.

The ideas put forward by WB4AKK regarding a synthesiser are something I am considering, but the production of a good home-brew synthesiser is still a little complex. As I do not have a digital upbringing, I am looking at analog ideas such as the Barlow Wadley loop.—*Mike Grierson, G3TSO, Woodlands, 9 Coneygar Road, Quenington, Cirencester, GL7 5BY Great Britain*

For a copy of G3TSO's errata, send a 25-cent SASE marked G3TSO errata to: ARRL, c/o Lori Weinberg, 225 Main Street, Newington, CT 06111.

Bits

Artech House Books

Available from Artech House.

GaAs MESFET Circuit Design. Combines theory, practical tips and design examples in a how-to format. Hardcover. 580 pages. 1988. Order # D01267 $79.00.

Modern Microwave Measurements and Techniques, by Thomas S. Laverghetta. Hardcover. 300 pages. December 1988. Order # D01307 $72.00.

Microwave Measurements and Techniques, by Thomas S. Laverghetta. Hardcover. 395 pages. 1976. Order # D01039 $60.00.

Microstrip Antenna Design, K.C. Gupta and Abdelaziz Benalla, Editors. Softcover. 384 pages. November 1988. Order # D01155 $66.00.

Computer-Aided Design of Microwave Circuits, by K.C. Gupta, Ramesh Garg and Rakesh Chadha. Hardcover. 410 pages. 1981. Order # D01081 $79.00.

Microwave Transmission Design Data, by Theodore Moreno. Hardcover. 256 pages. January 1989. Order # D01346 $50.00.

Microwave Filters, Impedance-Matching Networks, and Coupling Structures, by G. Matthaei, L. Young and E.M.T. Jones. Hardcover. 1096 pages. 1980; 7th printing, 1985. Order # D01074 $79.00.

Microwave Integrated Circuit Design Handbook, by Reinmut K. Hoffmann, English translation edited by Harlan Howe. Hardcover. 527 pages. 1987. Order # D01140 $74.00.

Microwave Mixers, by Stephen A. Maas. Hardcover. 357 pages. 1986. Order #D01148 $66.00.

Microwave Transmission Line Couplers, by J.A.G. Malherbe. Hardcover. 225 pages. September 1988. Order # D01300 $72.00.

Nonlinear Microwave Circuits, by Stephen A. Maas. Hardcover. 600 pages. 1988. Order # D01251 $72.00.

Mail orders to Artech House, Inc, 685 Canton Street, Norwood, MA 02062 USA. Telephone orders accepted 9 AM to 5:30 PM EST Monday-Friday. Call toll free in USA 800-225-9977, ext 4002. In Massachusetts and outside USA, call 617-769-9750, ext 4002. In USA, add $4 for shipping and handling for the first book, $3 for each additional book. Canada, add $5 for the first book, $4 for each additional book. MA residents add 5% sales tax. Free 1989 Artech House Catalog available.

Low-Priced Workstation

Hewlett-Packard Company, Apollo Division, has introduced a new low-priced desktop graphics workstation. US list price is $3,990. For more information contact: Hewlett Packard, Inquiries, 19310 Pruneridge Avenue, Cupertino, CA 95014.

ARRL Morse Code Shaper

By Ed Hare, KA1CV
ARRL Laboratory Engineer

When the ARRL staff decided to produce the latest version of *Tune in the World with Ham Radio,* we decided to produce a new set of Morse code training tapes to go along with it. We received a few comments from the field about the harsh and "clicky" sound of the old tapes, so we needed to devise a way to use our existing IBM®PC software to produce better sounding tapes. I designed the hardware to properly shape and filter the rather raucous sounding audio output of the IBM computer. The resulting circuit is shown in Fig 1.

The circuit is designed to work from the cassette port of an IBM computer, but it works well with about 100 mV of audio from any source. The frequency is not critical; audio from about 200 Hz to 5 kHz works just fine with this circuit. The line output is suitable for driving the input of a tape recorder or amplifier. A 1-W power amplifier was added to this circuit to allow the use of an external speaker. Each output has a level control.

U1a functions as a preamplifier and squaring circuit. The input network of R1, R2, C1 and C2 was added to eliminate the high frequency pulses that were present on the output of the IBM cassette port. U1b and the 1N914 diodes are a full-wave rectifier, turning the audio envelope into a dc keying pulse. U1c is a clipper that removes the filtering ripple from the waveform. U1d and U2 shape the dc keying pulse into a dc envelope with controlled rise time and fall time. A front-panel control (R5) allows a wide range of adjustment of keying characteristics. U3 is a free-running 725-Hz oscillator. U4 is the keyed stage. The shaped dc keying envelope is applied to the 2N5486 FET. U4 shapes the signal from the free-running oscillator, from full "off" to full "on." The resulting keyed audio has a nicely shaped keying characteristic. It is run through the 1N914 diodes to improve the signal-to-noise ratio. The keyed audio signal is connected to the output level control and to the speaker amplifier.

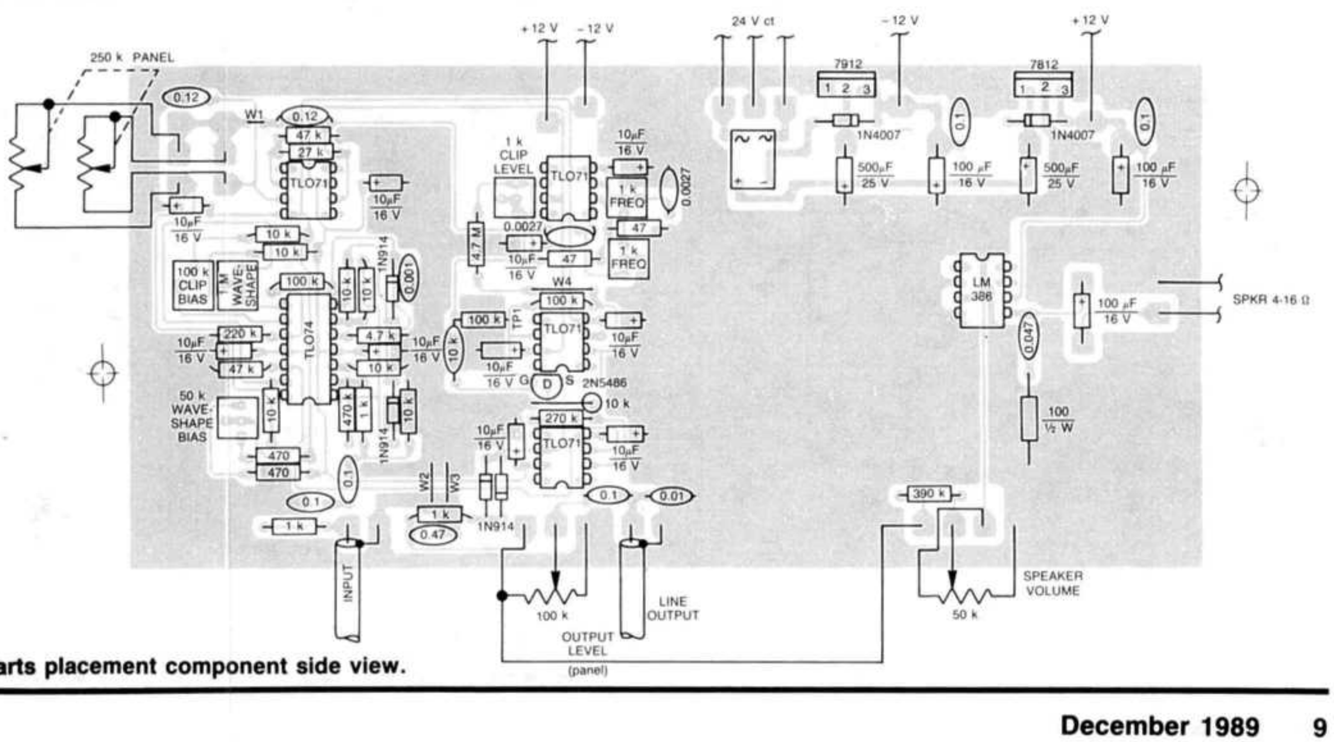
The power supply is straightforward, using 3-terminal regulators to obtain ± 12-V dc. The 10-μF capacitors have been placed at various locations on the printed circuit board. To obtain the best bypassing, tantalum capacitors should be used, but standard electrolytic capacitors will work.

The circuit is somewhat tricky to adjust. R7 and R8 set the frequency of the free-running oscillator. They should be set to approximately the same value. R6 sets the waveshape of the oscillator. The three controls interact, so it will be necessary to alternate adjustments until the desired frequency is obtained with no clipping of the waveform. R6 can be adjusted to stop the oscillator, so if the oscillator does not oscillate, set R6 for maximum resistance. TP1 can be used with a high-impedance oscilloscope or frequency counter to facilitate adjustment.

A keyed source of audio should be applied to the input. If necessary, the waveshapes shown on the schematic can be used as a guide if signal tracing is used to troubleshoot a problem. R2 sets the clipping bias for U1c. Set it to the midpoint of the range that shows square waves of the keying envelope on the output of U1c. R3, R4 and R5 all are adjusted to give a properly shaped envelope at TP2. I set R5 to about 25% rotation, and adjusted R3 and R4 until I saw a proper and symmetrical rise and fall time. These adjustments interact, so be prepared to do quite a bit of tweaking.

A parts-placement diagram and a 1X copy of the printed circuit artwork is shown. The components are readily obtainable, either as specified or as replacements (ECG, SK, etc). Consult Chapter 35 of the *ARRL Handbook* for a list of possible parts sources.

This project can make for some very nice-sounding code practice tapes or sessions. The ARRL is using this box to produce its new code tapes, and the ARRL VEC is using it to make the new code tests. Your club can construct this device to greatly improve the sound of most computer-or keyer-generated code.



Parts placement component side view.

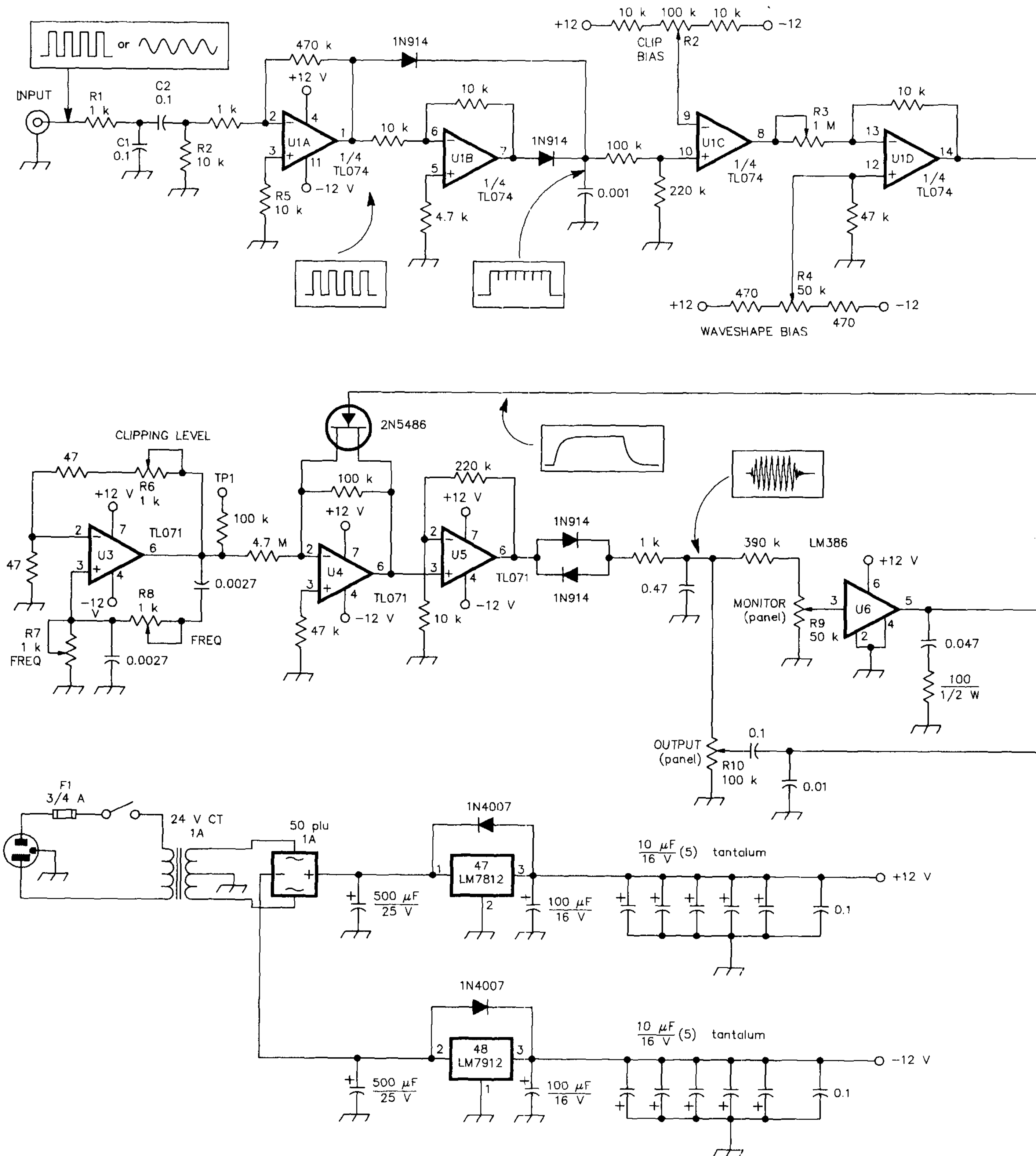
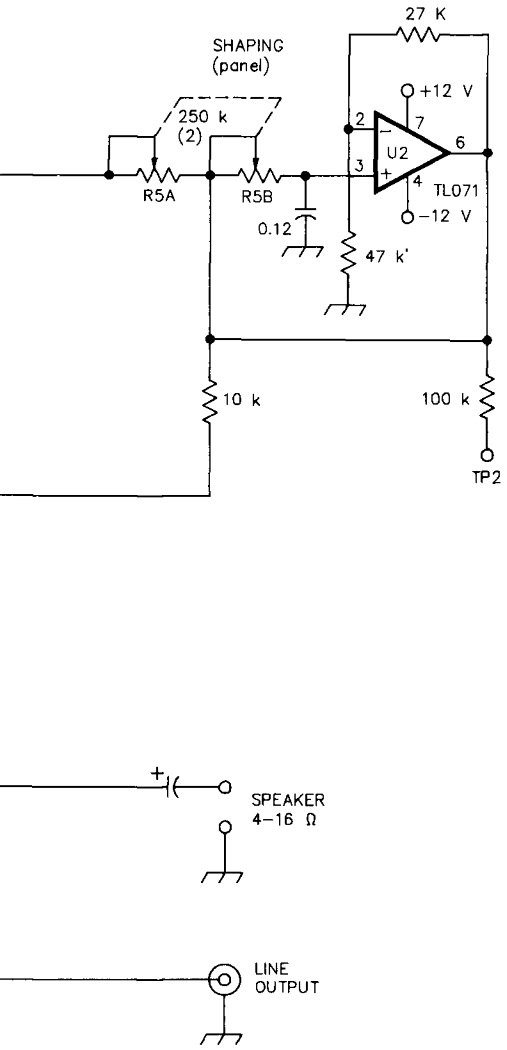
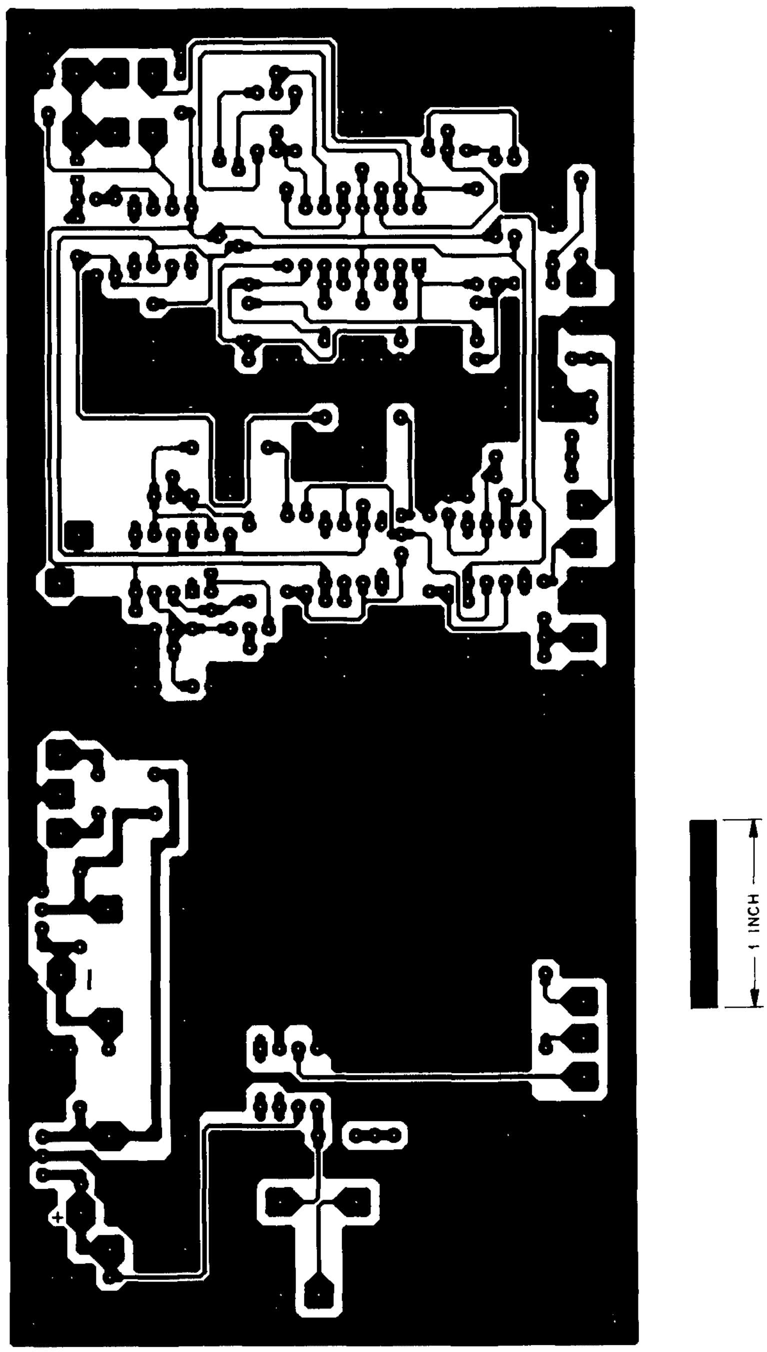

INPUT
R1 1 k
C1 0.1
C2 0.1
R2 10 k
1 k
470 k
+12 V
U1A
1/4 TL074
-12 V
R5 10 k
1N914
10 k
U1B
4.7 k
100 k
0.001
220 k
+12
10 k
100 k
-12
CLIP BIAS
R2
U1C
R3 1 M
U1D
47 k
R4 50 k
470
WAVESHAPE BIAS
2N5486
CLIPPING LEVEL
47
R6 1 k
+12 V
TL071
U3
R8 1 k
R7 1 k FREQ
FREQ
0.0027
TP1
4.7 M
U4
47 k
220 k
U5
1N914
0.47
390 k
LM386
MONITOR (panel)
R9 50 k
U6
0.047
100 1/2 W
OUTPUT (panel)
R10 100 k
0.01
F1 3/4 A
24 V CT 1A
50 piv 1A
1N4007
47 LM7812
500 µF 25 V
100 µF 16 V
10 µF 16 V (5) tantalum
+12 V
48 LM7912
-12 V

Fig 1





Printed circuit board solder side.

Components

By Mark Forbes, KC9C
PO Box 445
Rocklin, CA 95677

Spectrum Digital Signal Processing

Last month we briefly looked at digital signal processing. This month I'm featuring the tools necessary for a PC to develop circuits using DSPs. Spectrum Signal Processing, Inc has an extensive product line for the most popular DSPs. Their products comprise complete development systems, DSP system boards, DSP processor boards, and peripheral boards—all embodied in IBM® PC-compatible plug-in boards.

The development system is for Texas Instruments TMS 320C1x first-generation DSPs. It will support the TMS320C10, TMS320C15, TMS320C17, and the new TMS320C14 microcontroller. Features include a window-based software development system with debugger, monitor, assembler, editor, and simulator. Hardware includes an in-circuit emulator, and an EPROM programmer is also available for the EPROM versions of the DSPs.

The DSP system boards are a complete single-board signal processing system with on-board analog I/O, DSP, and memory. DSP link peripherals can also interface to the system boards. Available system boards cover the Texas Instruments TMS320C25, Motorola DSP56001, and Analog Devices ADSP-2100. A block diagram of the DSP56001 system board is shown in Fig 1. Prices range from $2500 to $3500. There are special prices available for universities.

The DSP processor boards are a lower-cost option to developing signal processors on the PC. They are similar to the system boards, but do not have the analog I/O and may have a smaller memory. I/O can be added with the link peripherals. The processor boards are available for the TMS320C25 and the DSP56001. Price is $1500 to $2000.

The link peripherals allow expansion of the system or processor boards. These devices include 4-, 16-, and 32-channel analog I/O boards, Pro-audio boards (with and without MIDI interface), dual processor comm module, and a prototyping wire-wrap module.

Additionally, you can buy a speech synthesis/recognition board and a 40-MIPS dataflow processor. For complete information on the Sprectum line, contact Spectrum Signal Processing, Inc, 264 H Street, PO Box F110-25, Blaine, WA 98230. Phone 800-663-8986.

MuRata/Erie Crystals and Oscillators

Many of the traditional crystal suppliers from the past are no longer with us. However, there are some newer manufacturers that have taken their place. MuRata/Erie has an extensive line of crystals, as well as oscillators and ceramic resonators. Crystals and oscillators range from 10 kHz to 500 MHz. Crystal filters range from 100 kHz to their "Gigafil" filters for microwave and cellular phone applications.

To get information on any or all of their products, contact MuRata/Erie North

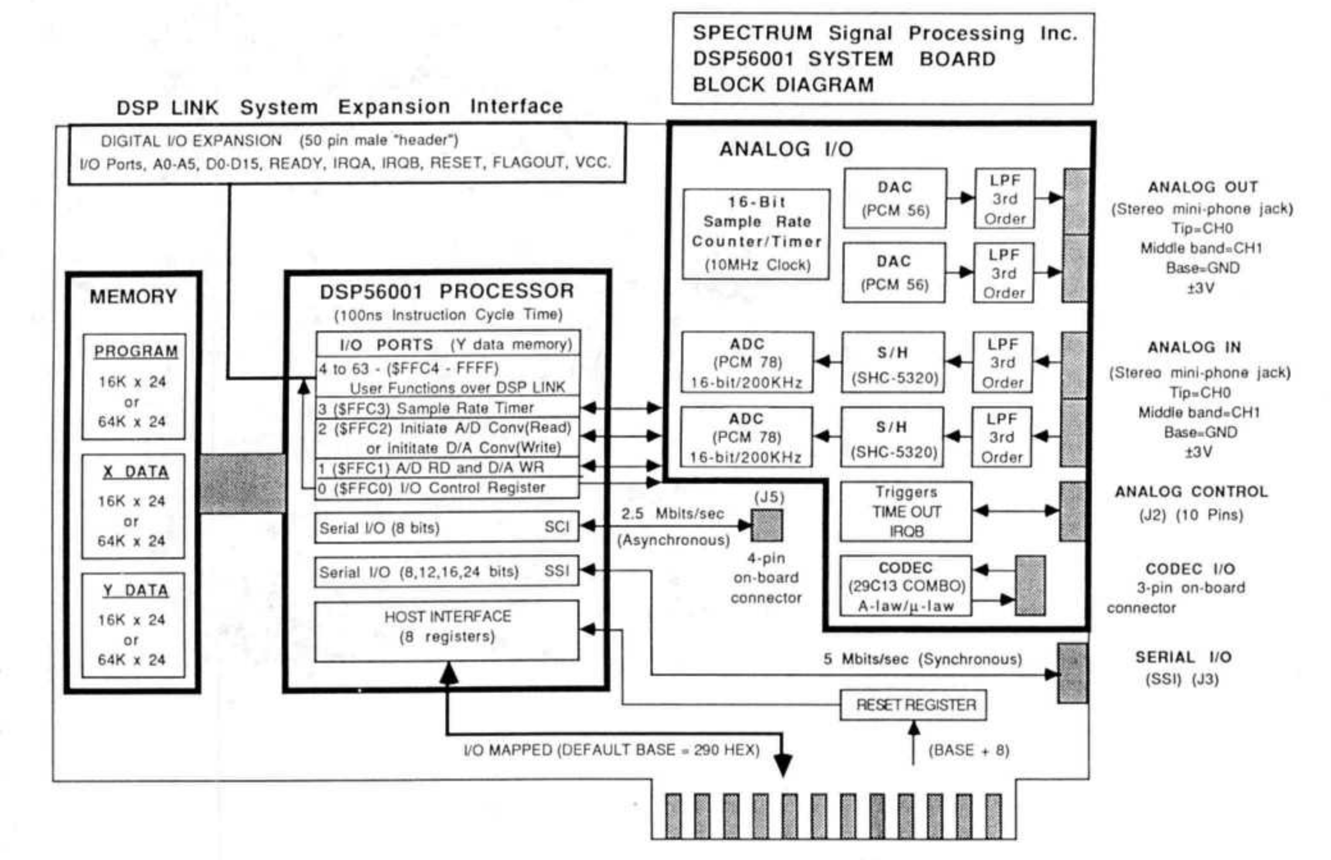


Fig 1

America, 1900 W College Avenue, State College, PA 16801, or call 800-356-7584.

American Microwave Attenuator and Pulse Modulator

American Microwave Corporation offers a number of microwave modules, among them attenuators and modulators. The voltage-controlled oscillator, AGT series, operates from 300 MHz to 18 GHz, and provides up to 60-dB attenuation range. The attenuation flatness is ± 3 dB for 50 dB of attenuation, the slope is 10 dB/volt (nominal), and VSWR is 2.2:1 maximum.

The pulse modulator is capable of producing modulating pulses as short as 2 ns. Operating range is 300 MHz to 18 GHz, and isolation ranges from 45 dB at 1 GHz to 85 dB at 12 GHz. Typical VSWR is 1.9:1 or less.

For more information on these and other products, contact American Microwave Corporation at 7311-G Grove Road, Frederick, MD 21701. Phone: 301-662-4700

VHF+ Technology

By Geoff Krauss, WA2GFP
16 Riviera Drive
Latham, NY 12110

State-of-the-Art: 2300-2450 MHz

Even though the FCC not too long ago removed a sizable chunk out of the center of our 13-cm band, by the weight of the evidence, the 13-cm band is presently the most dynamic VHF+ band, at least in North America. What evidence? In addition to the number of VHF/UHF contest entrants reporting band-by-band usage and the number of QSOs made by several multioperator contest groups in this band, I took a scale to my "Articles Saved Boxes" (big cartons in which I save printed materials by subject matter—one box per band, in this case). Not only was the poundage higher for 2304-MHz materials, but a brief reading seems to show that a much larger percentage of the total articles published each year is coming from North American writers, as opposed to former years in which very high percentages originated in Europe. That's right, up until a very few years ago, 90% of the 2304-MHz articles published each year came from England and Germany. Thus, it should not be particularly surprising to note that, until this year, the only commercially available transmitting transverter and receiving converter units were made in (you guessed it!) Europe.

Now there are basically three suppliers in the US of 2304-MHz equipment, and one of these suppliers (Hi-Spec, Jupiter, FL) makes only power amplifiers of the vacuum-tube (3CX100A7/7289) type. The other two suppliers that I am aware of are: SSB Electronics (K3MKZ, 124 Cherrywood Drive, Mountaintop, PA 18707), and; the duo of Down East Microwave (W3HQT, Box 2310, RR 1, Troy, ME 04987) and SHF Systems (WA3ETD, PO Box 666, Nashua, NH 03061). SSB Electronics apparently imports the European line of amateur microwave equipment (solid-state transverters and a single-tube amplifier) offered by a company of the same name. The company has been around for a while and I have seen, although never used or tested, their 2304, 3456 and 10,368-MHz solid-state transverters. They also have a single-tube 2300-MHz power amplifier, again using the ubiquitous 2C39 family of gridded lighthouse tubes. The SHF Systems/Down East Microwave group is offering solid-state transverters (assembled or in various kit forms) for the 902, 1296, 2304 or 3456-MHz bands. These are relatively recent designs by Richard Campbell, KK7B, (902/1296) and Jim Davey, WA8NCL (2304/3456). The pair are also offering the WA5LUA preamplifiers (PC boards, devices, assembled units, etc) for 2.3/3.4/5.6/10.4 GHz. Down East Microwave also has a line of solid-state power amplifiers and loop yagi antennas for (at least) the 13-cm band.

What kind of performance can you expect from average equipment on 13 cm? One story I am fond of telling concerns some early 1980s contest work done by the W2SZ/1 group. The base station was a 500-*milli*watt output CW transmitter, bolted to the back of a six-foot solid dish, which was illuminated, off-axis, by a simple coffee-can feed horn (details follow). The result was, at that time, a fairly respectable signal for 13 cm, especially from the top of an isolated mountain. QSOs over 200+ mile paths were difficult, with signals down in the noise, but not impossible. The group built a number of very simple field units, which are still in use. A transmitter is set up at a selected frequency higher in the band, ie, offset from the main station frequency by the field station IF frequency (see Fig 1); manual switching is used between the transmitter and receiver, which has a low-frequency IF strip (we used 5.595 MHz because we got a good deal on a bunch of crystal filters at that frequency) and a simple 3-dB hybrid mixer. The mixer, built on G-10 PC board, has lots of loss (over 14 dB) and a very high noise figure; it received 7 dBm of transmitter power for Local Oscillator use, and receive the incoming signal through six feet of RG-58C/U (a bunch of dBs of attenuation!) from a coffee-can antenna. Resulting noise figure is high, and I've never had the nerve to actually measure it. But, . . . in any number of contests, in the summer months, field stations out to 70, 80 or even 90-miles distant have received the main station so strongly that a standard operating hint is: if the signal is too strong, turn the can antenna over and put the open end on the ground—if it's still too strong, put the cantenna *under* the field vehicle!

It should be possible to consistently do SSB communications over a 100-mile range with under one watt of output power, about 20 dBi of antenna gain (up in the clear) and a receiver noise figure under 2 dB.

What, then, do you need to get on the air on 13 cm? Today antennas are pretty much separated into three classes: low gain and very simple (eg, the coffee-can antenna); higher gain, but not very big (eg, one or more loop Yagis); and very

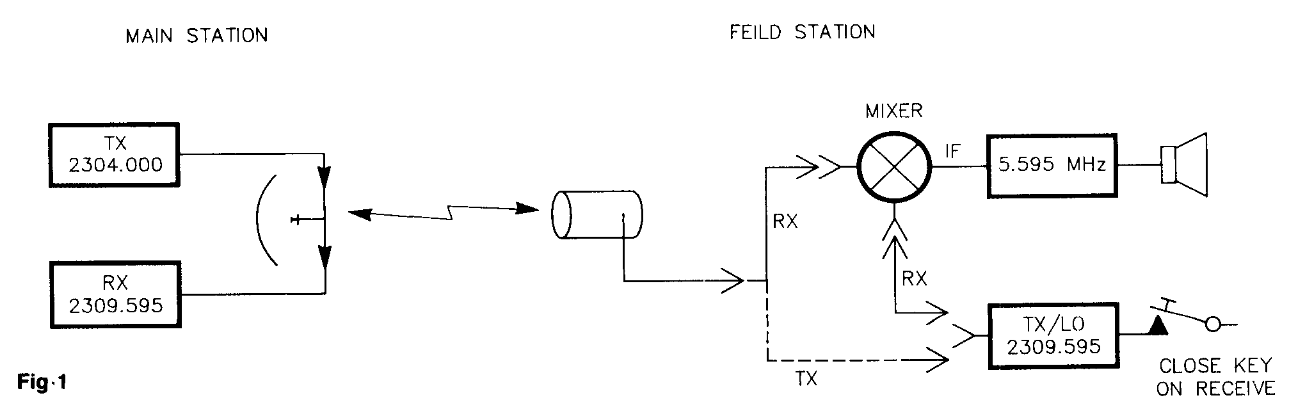


Fig 1

high gain, but large (eg, a ten-foot plus diameter parabolic dish). The cantenna, usable alone, or as the feed for a small dish, is easily built from a one-pound coffee can. By some stroke of luck, the standard US one-pound coffee can has five grooves; the groove nearest the closed end (in an empty can, of course) is at just the right distance for a probe (see Fig 2). Drill a hole through the can wall, in the first groove, to allow the end of a BNC or N connector to pass. File off the paint around the hole and solder the connector to the outside of the can. Add a length of no. 12 wire, extending into the can a bit over half way across the can diameter (if you have access to equipment for measuring Return Loss, trimming the wire length can get up to 30-dB RL, or less than 1.1:1 VSWR); at low power, a higher VSWR will not matter and will let you get started on the air. While this cantenna can be used as a dish feed, the radiation pattern is not circular and some portions of the dish will be under illuminated. Since this will decrease gain (which is the opposite of the basic reason why you want to use a dish), a better feed is needed. Choke flanges can be used on the cantenna to even out the pattern, or a splasher feed can be built (see any of the amateur UHF + books currently available). I have seen at least one commercially built splasher feed for 13 cm, but was underwhelmed by its ruggedness; I prefer to build my own. Dishes are not normally affordable on the new-equipment market, but 13-cm loop Yagis and loop Yagi arrays are (Down East Microwave). No matter what antenna you use, a low-loss feed line is extremely desirable. It cannot be over-emphasized—more QSOs are lost, above 1 GHz, because of feed line loss than due to any other single factor. At a fixed medium-to-high performance station, use of ½- or 7/8-inch hardline is probably a minimum requirement.

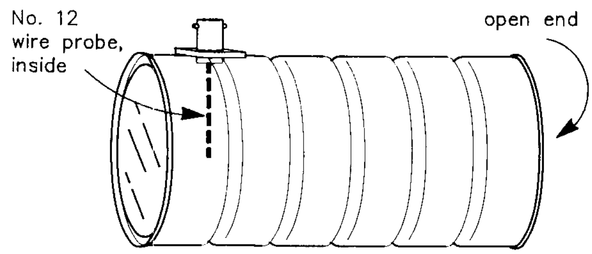


Fig 2

A receiving converter/transmitting transverter combination, such as available from either of the above-listed sources, will have a separate common oscillator module for supplying LO power to the separate mixers of a transmission up-converter and a reception down-converter. Both use a common 2-m (144-MHz) IF, so that a low-side LO frequency of 2304 − 144 = 2160 MHz is needed. Unfortunately, the two suppliers do not use a common scheme: The European modules require the direct 2160 LO; and the US modules accept LO/4 (540 MHz) and each module has an arrangement of quadrupler, filters and amplifiers to finally obtain the internal 2160 signal. Thus, the US LO module can be used with the European converters if a common 4 x multiplier/amplifier/filter/splitter is built by the users; under normal circumstances, the European module cannot be used with the conversion portions of the US unit. Even worse for commonality, the SSB Electronics units I've seen have separate RX and TX modules, while the US transceivers have a single up/down conversion board. A lot of these differences are due to the differences in semiconductors and techniques which were available at the time when the units were designed. Some knowledge of where the state-of-the-art has been in the last ten years should be helpful to anyone looking at 13-cm equipment in the future. For at least the past ten years, the only redily available vacuum tubes for 2 GHz were the power triodes, so all low-level work has been done with solid-state devices. Very limited types of transistors and multiplier diodes were available in 1979 with any sort of reasonable efficiency. Because prices were high, each stage tended to be a separate module to allow replacement with a more efficient stage as newer devices became available. My 0.5-watt TX/2-dB NF RX CW station, mentioned above, had over 20 separate modules, all cabled together in a 20 × 14 × 12-inch sealed box (an another similar box for power supplies, metering, etc). It took four years (and several thousand dollars) to get it all working. About seven years ago (1982), better and more uniform active (bipolar) transistors became available and the Europeans found ways to put several stages together in the LO, RX or TX modules; relatively high costs were incurred, but relatively high module efficiencies resulted. Three years ago (1986), monolithic microwave integrated circuits (MMICs) started to become available to the general public at prices that amateurs could afford. The newer transceiver designs use MMICs to reduce cost, stage parts count and size, but require that you think about SHF equipment with a slightly different mind-set because overall efficiency may be somewhat less than in the past.

While communications can be carried out with a basic transceiver module, even better results can be achieved by upgrading with the addition of low-noise receiving preamplifiers and/or higher-power transmission power amplifiers. One problem still to be addressed properly is the RF switching necessary to allow proper introduction of add-on stages, but this can be negated if you set up your transceiver with separate 2304 RX input and TX output. Some version of each of these add-on stages is available commercially, and others are written up in the literature. A reception noise figure of under 0.5 dB is possible, as is a transmission output power in excess of 20 watts from a solid-state PA and in excess of 40 watts from a single-tube unit (one very nice example, often selling in the $100 range, is from the military surplus TRK-29, a 1.7- to 2.4-GHz unit with a 7289, in the almost universal grounded-grid configuration). Another highly desirable power amp is any of the TWTAs occasionally available as surplus; most have the added advantage of being 2- to 4-GHz units (therefore usable at both 2304 and 3456 MHz), and many have rated output powers of 10.20 or even 50 watts over the entire octave band, and actual power output several times the rated value at spot frequencies.

Thus, for the first time, not only is there lots of information available but almost everything in the way of hardware you need to get on the air, from a low-power setup to a state-of-the-art contest station, is available, frequently as assembled equipment, if you want to go that route. There are so many alternatives of good, simple and cost-effective equipment for the builder, with easily available devices, that anyone with the desire to get on 2304 today can. C U on 13 cm soon.