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The ARRL Experimenters' Exchange

Call for Digital Communications Papers

The Fifth ARRL Amateur Radio Computer Networking Conference will be held during the weekend of March 7-9, 1986, in Orlando, Florida, in conjunction with the Florida State Convention. The Florida Amateur Digital Communications Association (FADCA) will host the conference.

Technical papers are invited on all aspects of amateur digital communication including packet radio, RTTY, AMTOR, modems, computer-based message systems, terrestrial networking, gateways, teleports and satellites, and meteor scatter. Topics of interest are protocols and standards, network and system architecture, hardware, software, and applications.

The **deadline for camera-ready papers is February 1, 1986.** If you plan to present a technical paper, please request an author's kit from Paul Rinaldo, W4RI, at ARRL Hq, 225 Main Street, Newington, Ct 06111.

Incidentally, printed copies of the papers presented at the first through fourth ARRL Amateur Radio Computer Networking Conferences are available from ARRL Hq. About the time you read this, an anthology of the proceedings of all four conferences should be available as a single book. It's called **ARRL Amateur Radio Computer Networking Conferences 1-4** and is $18.00. As a bonus, the book also contains a reprint of all ARRL **Gateway** amateur packet-radio newsletters up to September 1985.

Individual conference proceedings are to be discontinued as the stock is depleted. As this is written, individual proceedings for the third and fourth conferences are still in stock at $10.00 each; the first and second are out of print.

1.7 Miles High and Talking About Space

On November 9, AMSAT will hold its Third Annual Space Symposium at the Westin Hotel in Vail, Colorado. The Annual Meeting and Awards Banquet will follow the Symposium.

Bookings should be made with the hotel at 303-476-7111 and mention that you are with the AMSAT meeting. Rooms are $62/night, single or double; roll-away beds $15 extra.

Vail is about a 90-minute drive west of Denver on Interstate 70. Transportation from Stapleton Airport (Denver) will be by AMSAT van or group limo. Scheduled airline flights are available from Denver to Vail.

The Vail repeater WØKEA, 146.01, will be used for talk-in. To preregister, send a $45 check, payable to AMSAT, to Molly Hardman, N3CHZ, P. O. Box 8005, #281, Boulder, CO 80306.

Finally, Some Respect

The September 1985 issue of **Microwaves & RF** carried a four-page news article by its Chief Editor Barry Manz, WB2TSY, entitled, "Microwave experimenters finally get a handbook." Before you whip out your checkbook, however, this article is about a microwave book that has been in the works for a while and will take until early 1987 to complete. The article has some good things to say about Amateur Radio microwave experimentation, some of the hardware that will be featured in the microwave book and the ARRL effort.

Microwaves & RF is published monthly, except for two issues in October, by Hayden Publishing Co, Inc, 10 Mulholland Dr., Hasbrouck Heights, NJ 07604. — W4RI

Correspondence

Packet Radio With the Tono EXL-5000E Communications Terminal

A complete stand alone VHF/HF Packet, AMTOR, RTTY and CW terminal is accomplished by combining the Kantronics Packet TNC with the Tono EXL-5000E communications terminal. How is this done? Steps one through nine can explain!

[1] Wire the RS-232-C cable supplied with the Kantronics unit as follows: Brown and white wires should be connected to the individual phono-plug tips. Connect the shield and black wire together, then attach this to the previously wired phono-plug shields. The other wires are unused.

[2] Connect the **brown** wire phono plug to the EXL-5000E TTL jack and the **white** wire phone plug to the FSK jack (on the rear panel).

[3] **Very important:** Carefully remove the front panel of the Kantronics unit and move the jumper from RS-232-C to TTL (see manual).

[4] Set all the front panel buttons to OFF **except** push in the TTL-IN and ASCII button. Turn the EXL-5000E on and set the speed to 300.

[5] Turn the Packet TNC on and, following the Kantronics instruction manual, hit 'SHIFT*'. The Packet TNC will identify.

[6] **Very important:** Use the CTRL and "M" at the same time to generate the CR main control signal required by the Packet TNC. **Do not** use the CR/LF (crooked arrow) on the EXL-5000E keyboard as the control.

[7] Change the Kantronics packet "ECHO" to OFF. Follow the instruction manual.

[8] **All** other commands are standard and correct from the keyboard.

[9] Follow the Packet TNC manual instructions for other interconnections, and so on.

That is all there is to it! -- John W. Gregory, W4QF, 6495 Killian Dr., Miami, FL 33156.

Timex 1000 Program Correction

I just looked through the July 1985 issue (no. 41) of **QEX** and noticed an error on page 8 in line 660 of the series line matching program. The correction should read: "L2 (FT) = ", etc. -- R. H. Knaack Jr., W7FGQ, 11415 28th Ave. SW, Seattle, WA 98146.

Assistance for ACSSB Builders and Groups

After reading Bill Tynan's, W3XO, column in **QST** on ACSSB (Jan 1985, p 63), I was reminded about the previous **Ham Radio** paper (Dec 1980, p 48) by James, Eagleson, WB6JNN. Somehow all of this seems familiar, like somebody "reinventing the wheel!"

Fifteen to eighteen years ago during the last years of AT&T Long Lines HF radio circuits, they installed a "Linkoplex" system that was developed in England. A pilot carrier was always used for AFC, but this provided AGC and bandpass shaping as you described in the ACSSB system. This, of course, improved the communication quality of the circuits. If the chaps working on this for Amateur Radio know any AT&T Long Lines engineers of that era, they might be of some help.

Since I was involved with promoting amateur SSB at the start some 35 years ago, this ACSSB looks interesting enough to help it get started, especially on OSCAR 10 and possibly the HF bands. If you know of someone I could contact (individuals or groups), that could be of mutual assistance to either or both construction and operation, I would appreciate it. -- Wayne W. Cooper, AG4R, 9320 NW 2nd Place, Miami Shores, FL 33150.

The Japanese 2S System

Unlike the American 2Nxxxx series, there is some reasoning behind the Japanese 2S system.

2SA	PNP	RF
2SB	PNP	Audio
2SC	NPN	RF
2SD	NPN	Audio
2SK	FET	
3SK	Dual-Gate FET	
2SG	SCR	

An audio transistor is designated as having an upper frequency limit of about 5 MHz. So, it is not uncommon to see RF transistors in audio sections, but not vice versa. -- Kent Britain, WA5VJB, 1626 Vineyard, Grand Prairie, TX 75052.

Composition Resistors — A Dying Breed?

I was interested in Albert Weller's article on composition resistors in the July 1985 **QEX**. The reason I am writing is to add some confirmation to his findings that 5% composition resistors he purchased were out of tolerance.

I am an RF engineer with the Linear Corp. in Carlsbad, California. We market radio control products for things such as security systems and garage door openers, among other things. My main area of concern is the design of Part 15 equipment

(continued on page 5)

A High Performance DTMF Decoder Simplifies Control of Remote Base Stations

By Eric J. Grabowski, WA8HEB
17020 Snyder Rd., Chagrin Falls, OH 44022

Introduction

The need for a compact, low power, and maintenance free DTMF decoder resulted in the design described here. It replaced an existing circuit which used several NE-567 decoders and required regular tweaking for satisfactory operation. The primary application was to control various functions of a VHF base station by using DTMF signals received on either the telephone line or an auxiliary receiver.

To keep the circuit as small as possible, printed circuit board construction was used.[1] The board measures 2.0 x 3.6 inches; that is less than 20% of the size previously required by the NE-567 board.

Circuit Description

Refer to the schematic diagram in Fig 1. The design centers around two LSI CMOS integrated circuits, the American Microsystems S3525A bandsplit filter and the Mostek MK5102 DTMF decoder. Together, these devices contain an incredible amount of circuitry which permit building a high-performance DTMF decoder with a minimum of parts. A color burst TV crystal controls all of the digital timing functions; therefore, no critical, interactive adjustments are required.

An audio input signal between 50 mV and 1.0-V P-P is needed to drive the circuitry. Input Z is about 1 Megohm. When a valid digit is received for 30 ms, the data is latched onto the output lines driving the appropriate lines active high. Then the output strobe goes active high for 35 ms. Data remains latched until the next digit is received.

A jumper wire, four-station DIP switch, or digital logic signal can be used to select the format of the output signal. The choices are: ground to inhibit output; 5 V to produce 4-bit binary output; and leave floating to product dual, 2-bit, row/column output.

The circuit requires a power source capable of supplying 12.5-V dc at 40 mA. Voltage regulation is provided by a 12-V Zener diode shunt regulator and a three terminal 5-V regulator.

Adjustment

Tune up consists of a single gain adjustment. Connect the input of an oscilloscope to TP6. Apply a DTMF signal to the input and adjust trimmer R2 until a 200 mV P-P signal is achieved. Excessive gain causes a notch to appear in the decoder input channels. This can be seen by observing the signal at points A and B.

References

[1] The following are available from Proham Electronics, Inc., 7181 Industrial Park Blvd., Mentor, OH 44060-5327:
Bare board (P/N 2009) and manual $9.95;
Chip set (S3525A and MK5102) $35.00.

	4-Bit Binary				Row		Column	
Digit	D1	D2	D3	D4	D1	D2	D3	D4
1	0	0	0	1	0	1	0	1
2	0	0	1	0	0	1	1	0
3	0	0	1	1	0	1	1	1
4	0	1	0	0	1	0	0	1
5	0	1	0	1	1	0	1	0
6	0	1	1	0	1	0	1	1
7	0	1	1	1	1	1	0	1
8	1	0	0	0	1	1	1	0
9	1	0	0	1	1	1	1	1
0	1	0	1	0	0	0	1	0
*	1	0	1	1	0	0	0	1
#	1	1	0	0	0	0	1	1
A	1	1	0	1	0	1	0	0
B	1	1	1	0	1	0	0	0
C	1	1	1	1	1	1	0	0
D	0	0	0	0	0	0	0	0

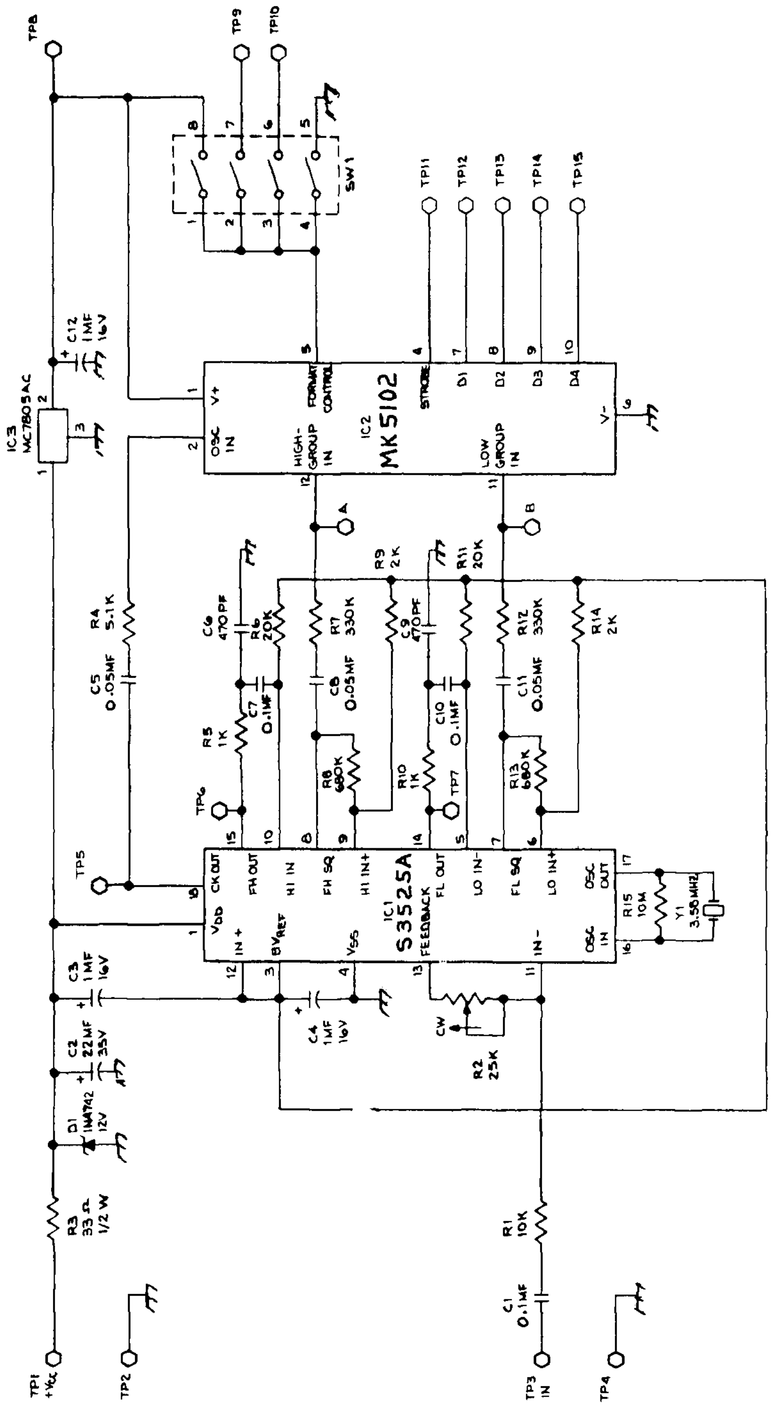


Figure 1 DTMF decoder schematic.

(continued from page 2)

in the 250-420 MHz region. We have been steadily reducing the amount of 5%, 1/4-watt, carbon composition resistors we use for several reasons:

[1] The cost of a composition resistor compared to an inexpensive carbon film unit is as much as five times greater, and climbing every day.

[2] Our purchasing people in Hong Kong tell us that the number of companies manufacturing composition units is down to a small handful (they only know of two in the Orient).

[3] We have noticed that the tolerance of 5% marked composition resistors can be as great as ±22 percent! This has caused us a small number of production problems where these resistors were used in our superregenerative receivers' bias section, resulting in widely out-of-spec quench frequencies.

[4] I have found very little difference in circuit behavior using carbon film resistors over composition units. The most marked difference is at higher (>22k) resistances. The carbon film units are repeatable and (mostly) predictable. There appears to be greater parallel capacitance in the composition units, probably relating to the packing of the carbon granules, and greater variation in behavior at high frequencies.

I would be interested in seeing someone do a more comprehensive study of the effects of composition versus film (not expensive metal film) resistors in VHF and higher frequencies. This affects most of us when we attempt to duplicate a construction article from **The ARRL 1985 Handbook** or other sources of homemade equipment. Most of Doug DeMaw's, W1FB, articles I have seen in **QST** over the years call out carbon composition resistors. Maybe the time has come to stop that once routine practice.

I am a great respector of the effects of lead inductances on the repeatability of circuits. Even though I have access to chip or leadless resistors, I sometimes hesitate to use them in duplicating a circuit that appears to depend on lead inductance or other parasitic elements for proper operation of the circuit. The answer would appear to be more widespread use of carbon film units in homemade articles because of the availability of them at Radio Shack and other over-the-counter shops. What do you think? — Dave Andrus, WB6VYN, 1186 Drifting Circle Dr., Vista, CA 92083.

Cheap Moonbounce

By Rick Wilson, WØKT
2221 Maple St., Quincy, IL 62301

Many radio amateurs are interested in moonbounce operation, but are precluded from participation because of real estate or budget restrictions. A communications method that uses computer power, rather than high power and high gain setups, may be just the ticket for such people. Of course, the laws of physics must be considered, and something must be sacrificed if power and antenna gain are lowered. That means bandwidth and the subsequent speed of communications. Most typical moonbounce QSOs aren't exactly ragchews — contacts are generally made near the noise level via slow CW.

Description

The station I am about to describe is hypothetical. I get as much satisfaction from dreaming up something and deciding that it should work as I would get from actually building the gizmo. And why not? Many breakthrough discoveries started off the same way. Maybe a **QEX** reader will experiment with this system to create an actual working model.

My hypothetical station uses circular polarization, with its handedness modulated at a rate of one bit per eight seconds. The antenna is a crossed Yagi beam of about 14 elements each way on a 16-ft boom, and the power is three watts or more. Some other RF hardware, a computer, and a communications program are all that is needed for moonbounce contacts. Fig 1 shows the block diagram for the station. Coaxial cable from the vertical and horizontal elements goes to K1, the TR relay.

The setup must be able to reduce the bandwidth to an incredibly small increment and be able to handle frequency stability and doppler shift requirements. The power required and the cost should be easily within the operator's budget (let's say no more than $250 over the cost of a moderate 2-meter multimode station, assuming that the operator already has a suitable home computer). The antenna should use a boom no longer than 16 feet.

Moonbounce contacts can indeed be made even with these constraints. Several other system features are desirable. Copying and sending should be performed by the computer. Doppler shift and time delay should also be handled by the computer. The deleterious effects of Faraday rotation should be cancelled.

Orr claims that for a Ø-dB S/N ratio with the moon at perigee, a moonbounce station on 144 MHz needs 600 watts at the antenna, an antenna gain of 21 dBd, and a 100-Hz bandwidth on receive.[1] Since the S/N ratio improves 3 dB for each halving of the bandwidth, the need for "oomph" can be reduced accordingly. For a Ø-dB S/N ratio with less power and a smaller antenna, one such combination is as follows:

	Power (W)	antenna gain (dBd, dBc)	bandwidth (Hz)
Orr's criteria	600	21	100
Modest station	3	12	0.0625
dB advantage of modest station	−23	−9	32

= Ø dB advantage

This means that I have lost 23 dB on power and 9 dB on antenna gain, but have picked it up again by reducing my bandwidth. The terms dBd and dBc refer to gain over a dipole or over crossed dipoles (which compare to the gain of a dipole).

Transmit

One coaxial cable goes directly to the transmitter combiner, while the other cable goes through relay K2. This allows the operator to choose left-hand circular polarization or right-hand circular polarization. The total coaxial lengths for the vertical and horizontal antennas must always differ by 90 degrees to obtain circular polarization. This is assuming that the driven elements are in the same plane. Modulation of the polarization handedness is performed by computer control of K2 and the transmitter (the relay is switched with no RF present).

Circular polarization has both drawbacks and advantages. The main disadvantage is that it requires twice as many elements for the same amount of gain (the signal strength of comparable yagi setups for linear and circular polarizaton is the same). Also, the supporting mast should be nonmetallic, and the feed lines should be positioned so as not to interfere with the operation. Natural sources and interfering stations do not normally exhibit circular polarization, they pick it up equally well with either handedness; therefore, linear polarization can be selectively eliminated. The most important advantage of circular polarization is that it eliminates the harmful effects of Faraday rotation.

Receive

In the receive mode, the signals from the vertical and horizontal arrays are fed to separate, low-noise preamplifiers and then to a receiver combiner. In the case of one feed line, a

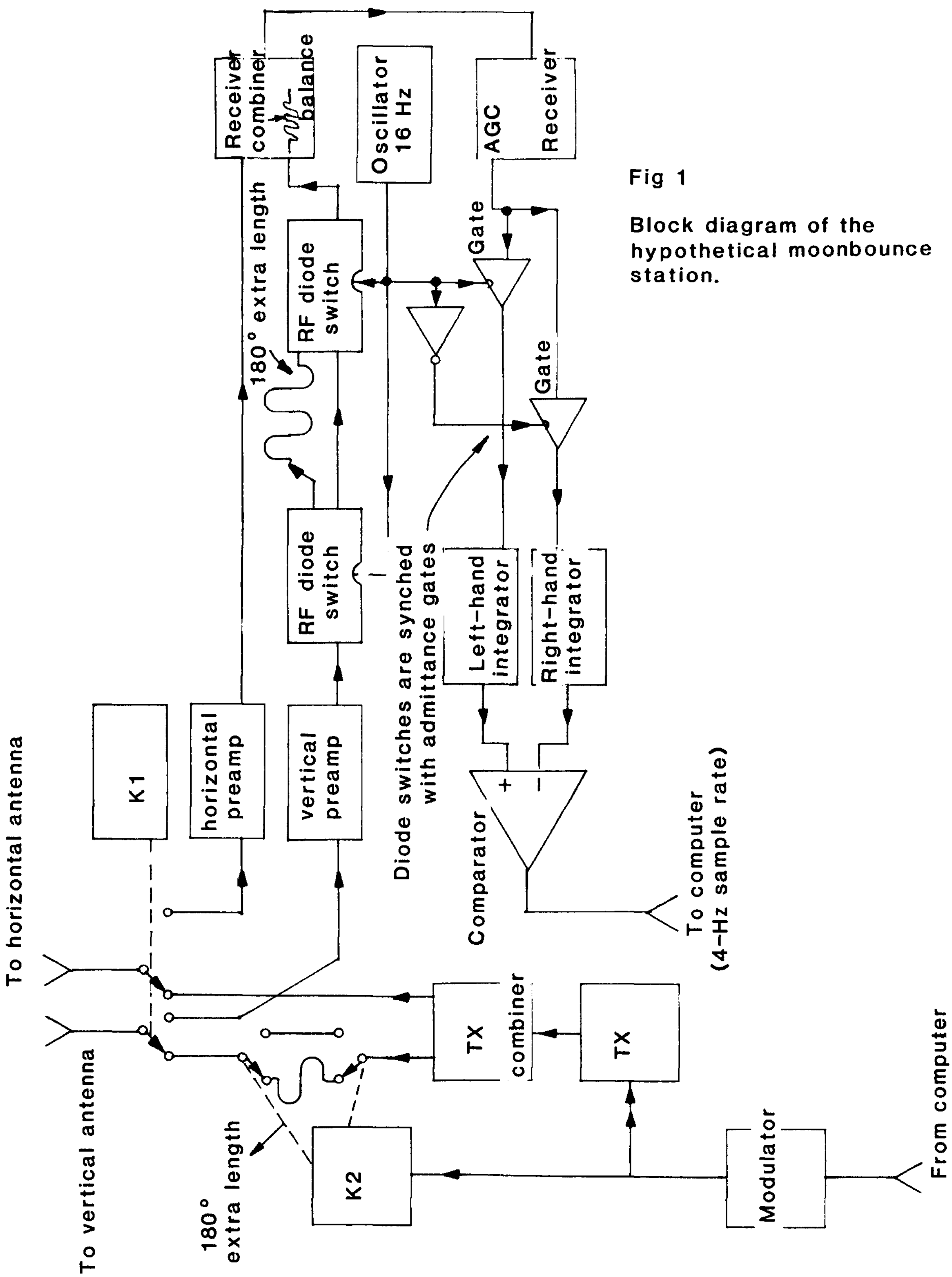


Fig 1

Block diagram of the hypothetical moonbounce station.

pair of RF diode switches electrically lengthens the line length by 180 degrees in step with a clock signal. The receiver uses a 2.1-kHz IF bandwidth; the derived AGC voltage seems to follow the noise, although an almost imperceptible AGC change should occur between the two states of the clock if the antenna is beaming at a circularly polarized signal source.

The AGC voltage must have a fast time constant. Two admittance gates route the AGC voltage alternately to two integrators which filter out the clock frequency and integrate the voltage over time. A comparator continuously samples the two processed AGC voltages, and its output depends on the difference of the two integrators. Note that one integrator is designated left hand and the other right hand. The left-hand integrator sees AGC voltage only when the RF diode switches configure the transmission line for left-hand circular polarization, and the right-hand integrator, likewise, sees AGC voltage only during periods of right-hand circular polarization. The output of the comparator is sent to the computer, which engages a routine to extract information out of the data stream. If the bits are synchronous (not difficult with eight-second long bits), the routine can be much simpler than for asynchronous reception.

You ask, "How do I get my 0.0625-Hz bandwidth if my IF filter is 2.1-kHz wide?" The integrators that sample the AGC voltage are really low-pass filters. The computer program samples and integrates slowly, decoding one bit every eight seconds (two bits per one Hz). A 2.1-kHz IF bandwidth is common and wide enough to allow for doppler shift and drift (the predicted doppler shift can also be computed), but detects other signals that I don't want. Because of the handedness modulation, I eliminate all but circularly polarized signals, and the extreme slowness of the detection system (narrow bandwidth) hopefully filters out random variations.

Some type of handedness balancing is necessary for proper operation. With noise or linear polarization, the comparator output should randomly change states, averaging out to 50 per cent for both states. Also, computer correction could be used. In this scheme, the computer samples four times per second, 32 samples per eight-second bit. Seventeen or greater "high" samples during a bit could be evidence for a high under perfectly balanced conditions; however, 19 or greater high samples might be needed to trigger a high decision (i.e., if the unbalance tends to favor positive samples).

If synchronous five-bit Baudot code is used (no start or stop bit necessary), a minimum valid contact could take place in less than half an hour. Given the directivity of a beam with a gain of 12 dBc, no tracking of the moon should be necessary during this time if the beam has been properly aimed.

Possible Variations

Rather than using two receivers, I have elected to use one and switch the handedness alternately to the two integrators. You could simplify things by adding a second receiver. If you do this, the AGC outputs of the receivers should match one another closely. My design is susceptible to noise, which varies in step with the clock, since the effect makes it look as if one AGC output should be increased more than the other. Two receivers would eliminate that potential problem because the operator would be able to balance one AGC output over the other.

If a transceiver, rather than a separate transmitter and receiver, is used, relay K2 and one combiner can be eliminated. The RF diode switches must be hefty enough to switch the required RF power. Balancing of the handedness can be done by adjusting the gain of one of the preamplifiers.

Computer Program

A synchronous modulation method program, which allows for transit time to the moon and back, would be relatively easy to write and use. The computer knows which samples constitute a bit, so start and stop bits are unnecessary. Since there are 32 samples per bit, 17 or greater highs (under balanced conditions), should determine that a bit is high. If forward error correction is used (bit samples are not consecutive), a register is needed to store the results of a sampled bit until it is completed. The results are then placed in the correct position for the decoding of characters.

The program uses little CPU time. Because of this, it should attempt to decode in the "right-side up" and "upside down" modes simultaneously to avoid any possible modulation mismatch problems.

A probability of correct receipt could be continuously tallied. If there are 22 or more highs out of a sample of 32, the probability of this occurring randomly is less than five per cent. If you get 17 or 18 highs in a sample it could be because of random fluctuations (assuming a perfect 50% balance in the comparator circuit).

Operation

Some upstanding amateur organization should offer a reward for the first moonbounce contact in which the operators at both ends use a power of less than ten watts and an antenna gain of less than 15 dBd/dBc (varying somewhat depending on the band used). The prize should include a long novel, such as "Some Came Running," or "The Brothers Karamozov," to be read while waiting for the QSO to be completed. If two exchanges of call letters take half an hour, not much ragchewing can take place during the ten minutes between FCC-required IDs!

References

[1] Orr, William I., W6SAI, **Radio Handbook,** (Indianapolis: Howard W. Sams & Co., Inc., 1981), p 14-15.

Bits

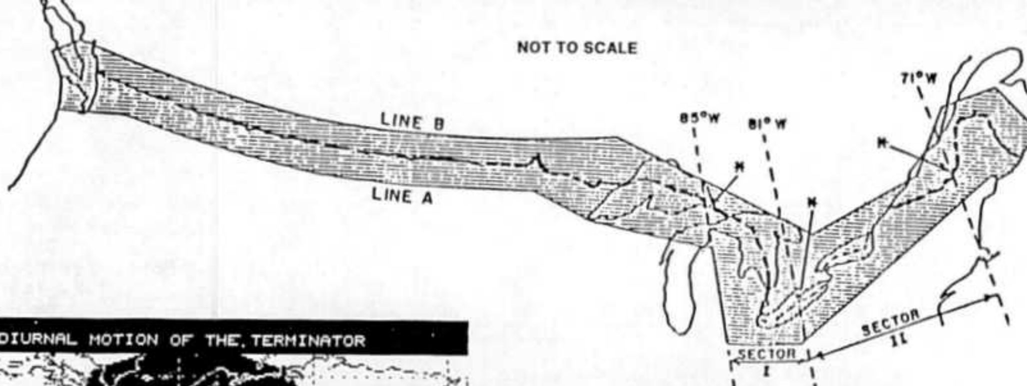
Amateurs Gain 902-928 MHz; Lose 420-430 MHz North of Line A

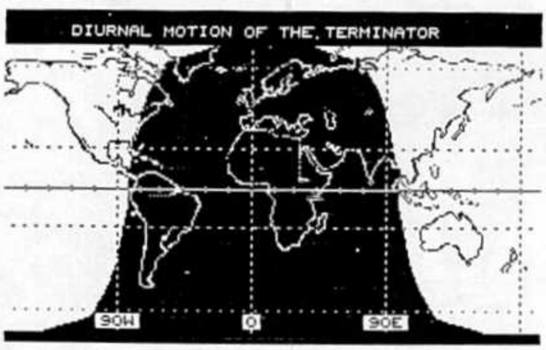
(PR Docket 84-960) The Federal Communications Commission has added amateur operations in the 902- to 928-MHz frequency band on a secondary, noninterference basis for use by all Amateur Radio operators above the Novice class. A wide range of emissions has been authorized for the new band. The band is part of the new spectrum allocated for the Amateur Radio Service pursuant to the Final Acts of the World Administrative Radio Conference (WARC), Geneva, 1979.

The FCC also removed the 420- to 430-MHz band from the Amateur Radio Service north of Line A. (Line A is an area that spans approximately 155 miles south of Canada and can be seen in Fig 1. Being geographically close to Canada, whose Amateur Radio frequencies differ somewhat from the US, the two countries must work closely together to avoid interference among services such as radar, airborne, and so on. Line A begins at Aberdeen, WA, runs through the southernmost point of Duluth, MN, and continues through the southernmost point of Bangor, ME. It terminates at the southernmost point of Searsport, ME.) This action was required by a US-Canada Arrangement entered into force April 7, 1982.

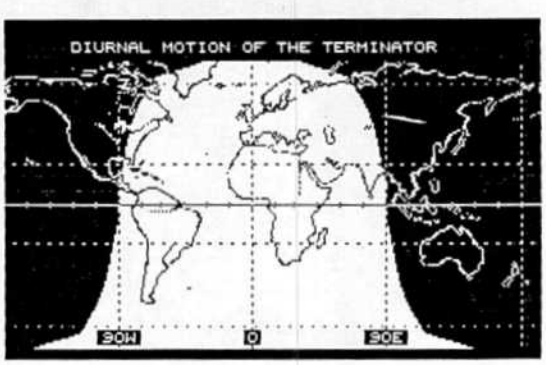
Action was taken by the Commission on August 9, 1985, by Second Report and Order (FCC 85-460). Commissioners Fowler (Chairman), Quello, Dawson, Rivera and Patrick. This action was effective 0001 UTC September 28, 1985.

CANADA/UNITED STATES SHARING ARRANGEMENT: 421 – 430 MHz BAND COORDINATION ZONE





Aug 19, 2300 UTC



Oct 26, 1200 UTC

Sunrise Sunset for the Apple //e

Do you like what you see to the left of this text? It is a display of the diurnal (daily) motion of the terminator on a Mercator map of the world. Popular among DXers, this program will enable the user to view long paths for any time of the day, any day of the year, or any year of the century. Our top projection shows August 19, 1985 at 2300 UTC. The lower one is of October 26, 1985 at 1200 UTC. If you are interested in where to obtain this program, write to W. Conley Smith, K6DYX, 67 Cuesta Vista Dr., Monterey, CA 93940. He will happy to make a copy of this for you, but you must supply your own diskette. The charge is $5.00 plus shipping and handling. — KA1DYZ

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The purposes of QEX are to:

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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Both theoretical and practical technical articles are welcomed. Manuscripts should be typed and double spaced. Please use the standard ARRL abbreviations found in the January 1984 edition of QST. Authors should supply their own artwork using black ink on white paper. When essential to the article, photographs may be included. 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 it will be when printed in QEX.

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