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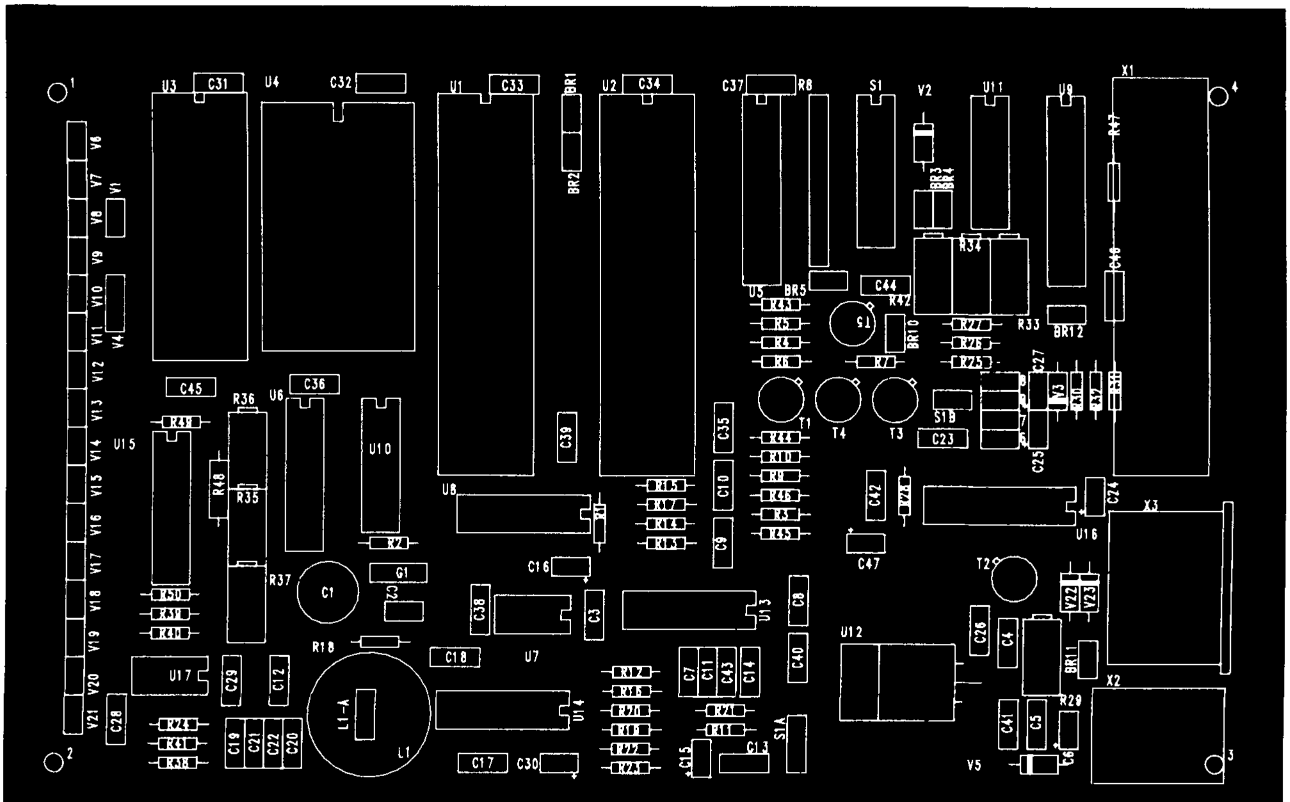
QEX 120 with Gateway

ARRL Experimenters' Exchange

FEBRUARY 1992



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Purpose 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

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Both theoretical and practical technical articles are welcomed. Manuscripts should be typed and doubled 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*.

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Empirically Speaking...

Digital Communications and Futures Systems Committees

In case you missed it in Minute 30 of the July 1991 Board of Directors Minutes in September 1991 QST, the Committee on Amateur Radio Digital Communications, perhaps better known as the Digital Committee, has a new charter:

"The Committee shall monitor the progress of Amateur Radio...digital communications, foster the development of a modern data network, encourage close cooperation between the League and volunteers operating the network, and recommend policy in this area to the Board. The Committee shall be composed of up to seven members selected by the President, based on their knowledge of the operation of the Amateur Radio data network throughout the United States and expertise in data communications technology."

President Wilson has appointed Ed Juge, W5TOO, as Chairman and Dr. Tom Comstock, N5TC, as Board Liaison. The others appointed to this committee will be announced shortly, but look for the selection to be operationally oriented.

Early on the plate of the new Digital Committee, per Minute 65 of the January 1992 Board Meeting, will be analysis of the survey now under way for amending the FCC Rules with respect to HF digital communications (January, 1992 QST, p41) and developing recommendations to be provided to Board Members by May 30, 1992.

Also at the July Board Meeting, a new Future Systems Committee was established, with the following Terms of Reference:

"The committee shall concentrate on technology issues in the five to fifteen year time frame, monitor technology trends, work toward improving the environment for Amateur Radio research and development, develop system objectives and concepts, and advise the Board concerning these matters. The Committee shall be composed of up to five members selected by the President, based on their knowledge of telecommunications system development."

President Wilson has appointed Paul Rinaldo, W4RI, to head this committee and Frank Butler, W4RH, as Board Liaison. Other committee members will be identified soon.

The Amateur Services cannot simply rest on their past technical accomplishments, which have been many. Retention of our frequency allocations depends, in no small part, on continued contributions to the state-of-the-art and maintaining high technical standards. In past years, technology was a limiting factor. Recently, however, the technological options have grown so greatly that the challenge is to make some hard choices among those options. If we want something to happen (say) 10 years from now and it has a 10-year lead time, someone should start working on it now. It has taken about 12 years for amateur packet radio to develop to its present state, for example. It took longer than that to get from OSCAR I to PACSAT.

Please bear in mind that these and other League committees welcome your inputs in carrying out their assigned work. The best way to make your views known is by letter addressed to the committee concerned c/o ARRL HQ. The staff will handle distribution to the committee.—*W4RI*

AMC—The AMTOR Controller

By Armin Bingemer, DK5FH
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6457 Maintal 1, Germany

Translated by Don Moe, KE6MN/DJ0HC

Reprinted from the December 1990 issue of cq-DL, *published by the German Amateur Radio Club.*

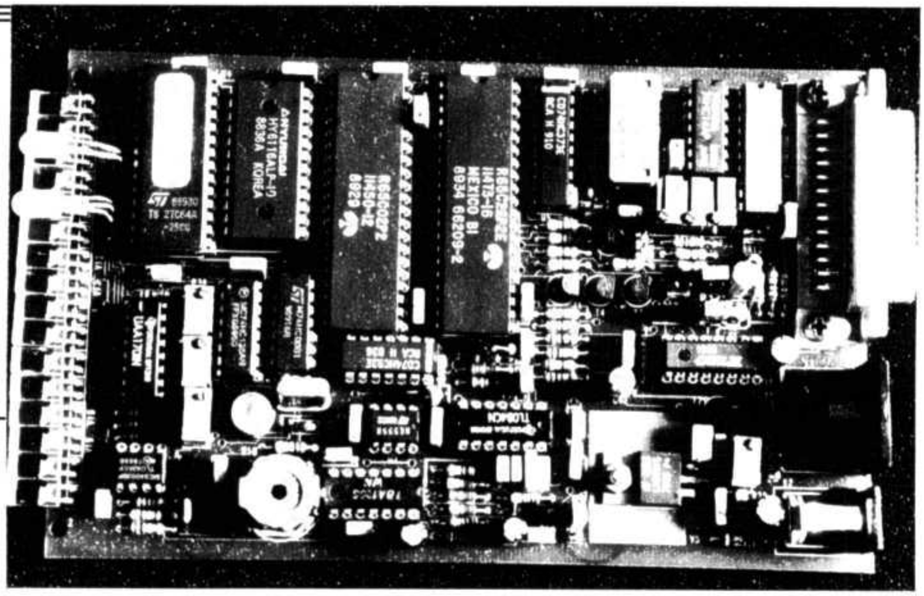


Fig 1—A complete AMC on Euro-card.

An inexpensive and easily duplicated unit was needed for AMTOR, similar to a TNC for Packet Radio. Kudwin, DF8PD, wrote the software and developed the radio-teletype interface for the 6502 CPU. Based upon this work, Martin, DL1ZAM, Peter, DF5ZI and I implemented an AMTOR controller.

The result is a Euro-Card (Fig 1). It contains the converter, AFSK, terminal interface (RS-232) and processor section as well as a 16-segment LED tuning indicator. The software supports AMTOR (ARQ, FEC, Listen), RTTY (Baudot, ASCII) and CW (send). The commands are similar to those of the AMT-1. Additional features such as statistics were added. A complete article by DF8PD describing the software will follow later. Nevertheless, the command list at the end of the description should give a first impression.

Circuit Description

The converter consists of three subgroups: input filter, demodulator and tuning indicator. The audio filter (Fig

Table to Fig 2

Bev	*Vcc*	*GND*	*+12 V*	*Body*
U1	8	21.1	—	40P
U2	20	1	—	40P
U3	28	14	—	28P
U4	24	12	—	24P
U5	20	10	—	20P
U6	16	8	—	16P
U7	8	1	—	8P
U8	5	10	—	14P
U9	7	6.9	—	20P
U10	14	7	—	14P
U11	14	7	—	14P
U12	—	—	—	T220
U13	—	11	4	14P
U14	—	1	11	14P
U15	—	1	10	16P
U16	—	12	4	16P
U17	—	4	8	8P

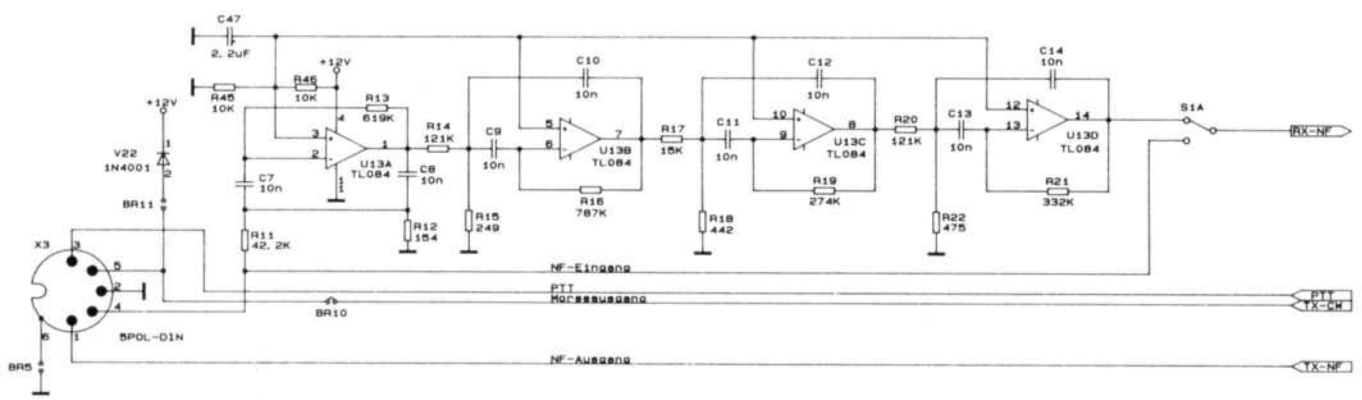


Fig 2—Schematic of the audio filter.

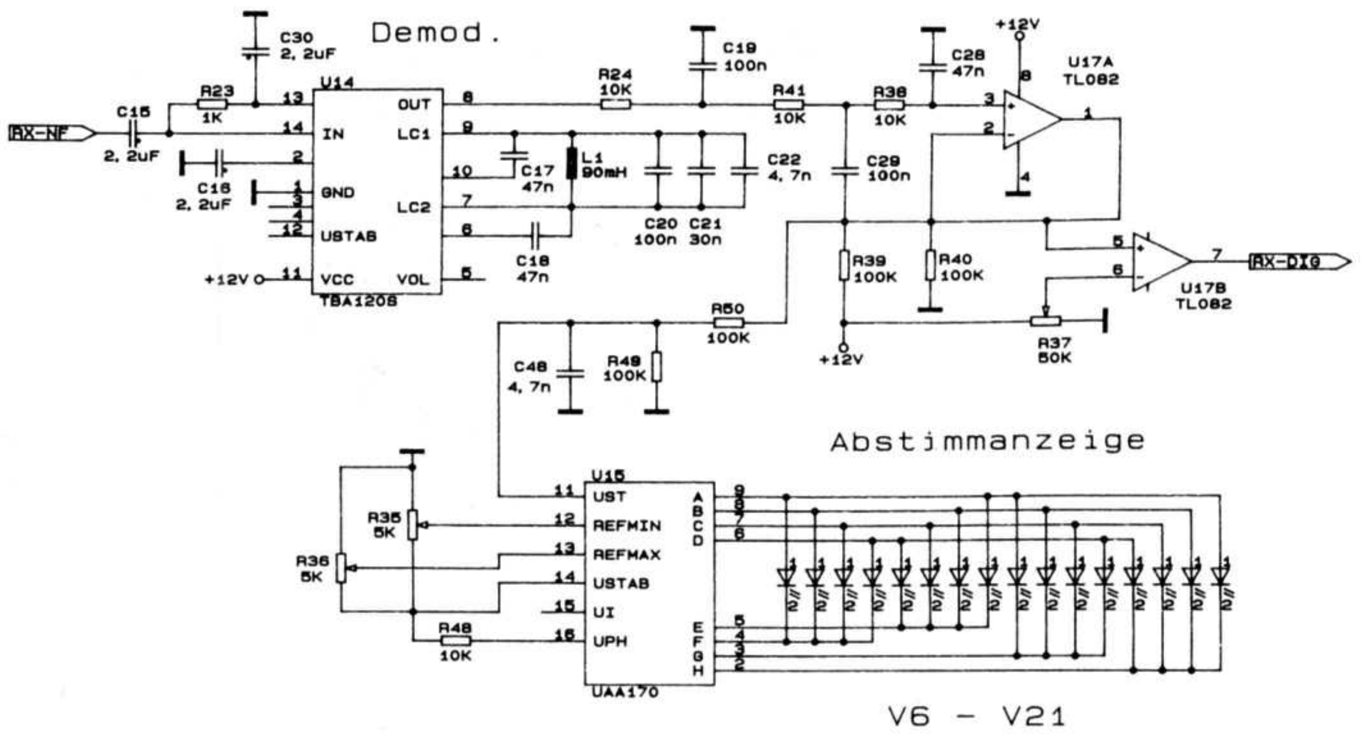


Fig 3—Demodulator schematic.

2) is a four-stage, second-order bandpass using multiple feedback and having a bandwidth of nearly 300 Hz with a middle frequency of 1360 Hz. The circuit was built around a four-segment operational amplifier and was optimized with help of a computerized simulation.

The bandwidth limited audio is fed to a coincidence demodulator (TBA120S) for demodulation (Fig 3). This type of demodulator is more complicated than others due to construction of the coil, but in actual operation on shortwave it is significantly superior to other designs.

The resonant circuit resonates at a middle frequency of 1360 Hz between mark and space.

AMC COMMANDS

Control Commands

Ctrl-A	Start a ARQ call (in AMTOR mode)	
Ctrl-B	FEC transmission	
Ctrl-C	Transmit	
Ctrl-D	Receive or QRT in AMTOR (after emptying buffer)	
Ctrl-E	Display status	
Ctrl-F	Listen mode (in AMTOR mode)	
Ctrl-H	Display statistics (for ARQ)	
Ctrl-N	Reset statistics (anytime)	
Ctrl-O	Inform remote station of timing (for ARQ)	
Ctrl-P	Inform remote station of statistics (for ARQ)	
Ctrl-R	followed by: Ctrl-A	Errors
	Ctrl-B	Requests
	Ctrl-C	OKs
	Ctrl-D	Idles
	Ctrl-F	Total
	Ctrl-G	Traffic flow in %
	Ctrl-H	Receive delay
Ctrl-T	Display timing (for ARQ)	
Ctrl-X	Clear transmit buffer	
Ctrl-Y	Clear receive buffer	

Escape Commands

ESC-A	AMTOR
ESC-B	Set baud rate
ESC-C	Transmit CW
ESC-D	ASCII
ESC-F	0/1 FEC standby off/on
ESC-H	Alignment help
ESC-I	Set slave SELCAL
ESC-L	0/1 Local off/on
ESC-N	0/1 Newline off/on
ESC-P	Set ASCII parity: E/O/L/H
ESC-Q	Display parameters
ESC-R	RTTY
ESC-S	Set CW speed in WPM
ESC-T	Set timeout limit
ESC-U	Statistics from last ARQ QSO
ESC-V	Set delay times
ESC-Z	Author

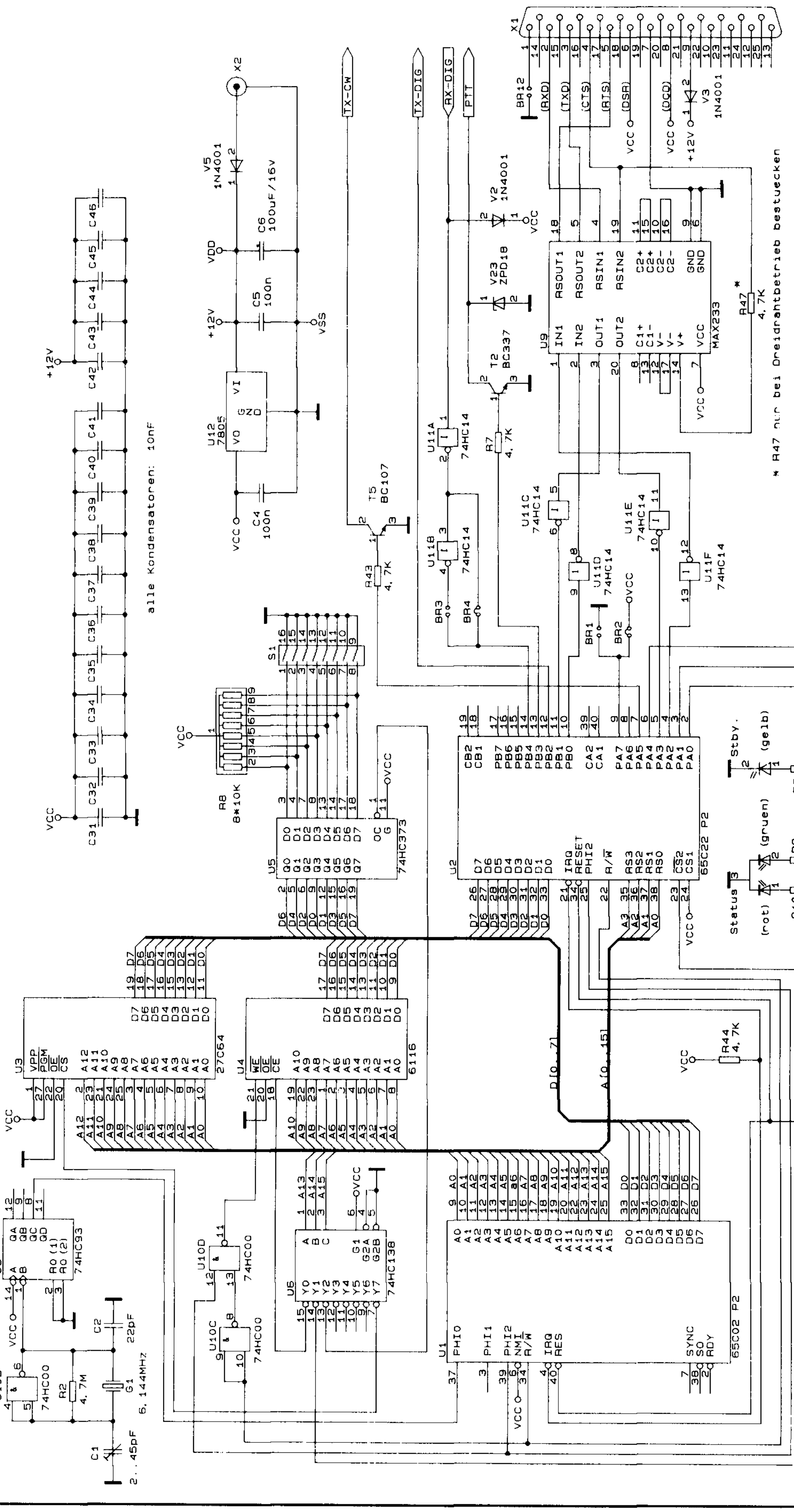


Fig 4—Schematic of processor section.

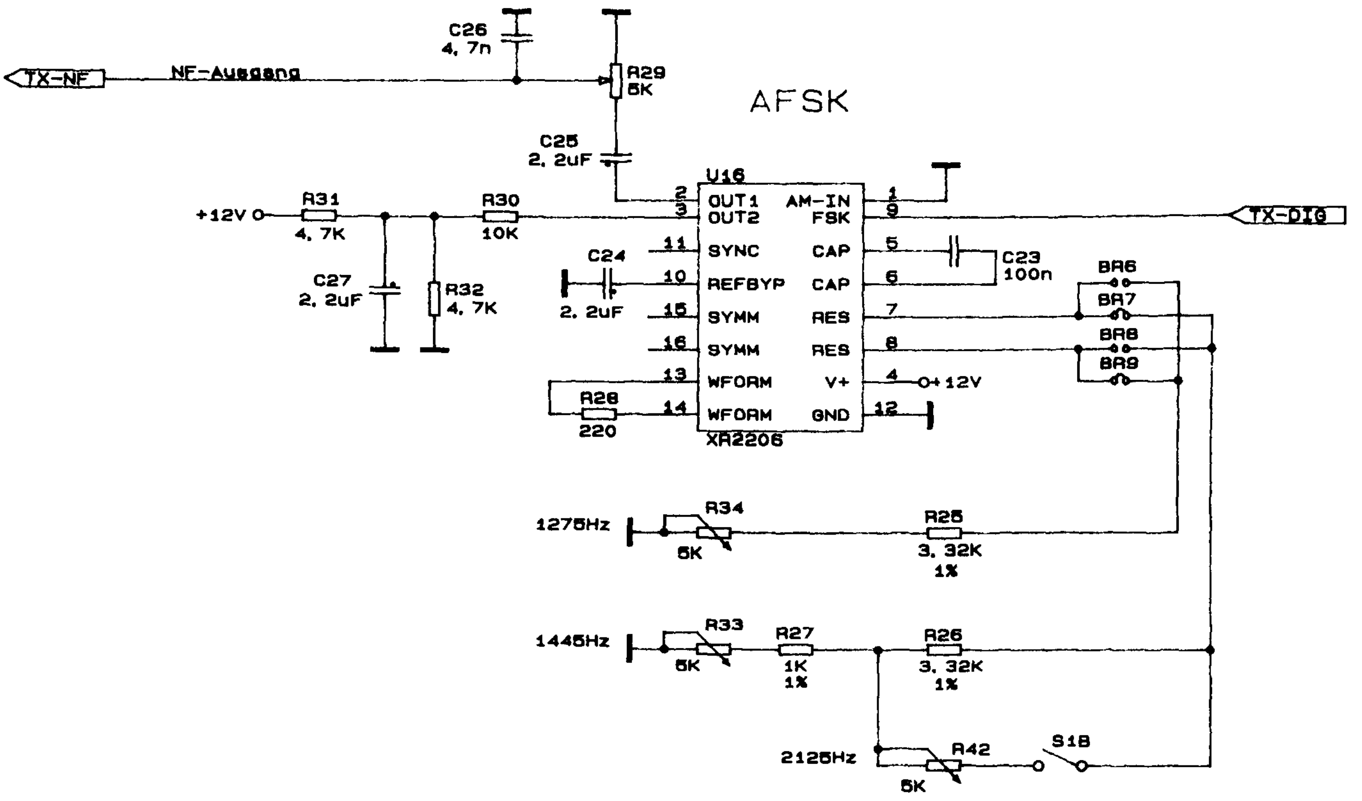


Fig 5—Schematic of AFSK section

The output from the demodulator is a rectangular signal of twice the resonant frequency with a keying ratio dependent upon the input frequency. After the low-pass (U17A), which converts the rectangular voltage into a dc level depending on the keying ratio, the signal paths separate. A voltage proportional to the audio tone is fed to the tuning indicator (U15). The frequency spectrum of the 300-Hz wide receiving channel is displayed by the LEDs after being digitized into 16 levels. The signal is also converted from analog to TTL level by a comparator (U17B). The resulting TTL signal is evaluated by the processor.

In the processor section (Fig 4), the radio teletype signal is converted to ASCII and output to a terminal via the RS-232 interface. The data arriving from the terminal are analyzed by the processor, recognized as a command and executed. Other data are converted into radio teletype code and routed to the AFSK section.

The system clock is determined by crystal G1 and divided by 4 in U8. The power-on reset is generated by the comparator/monoflop component U7. A DIP switch for setting the system parameters can be accessed via tristate latches (U5). The port component (U2) processes all processor section input and output signals. The LEDs to display the mode are driven by transistors T1, T3 and T4. The switching transistors T2 and T5 operate the PTT and CW keying. The incoming radio teletype signals are buffered by U11A and B.

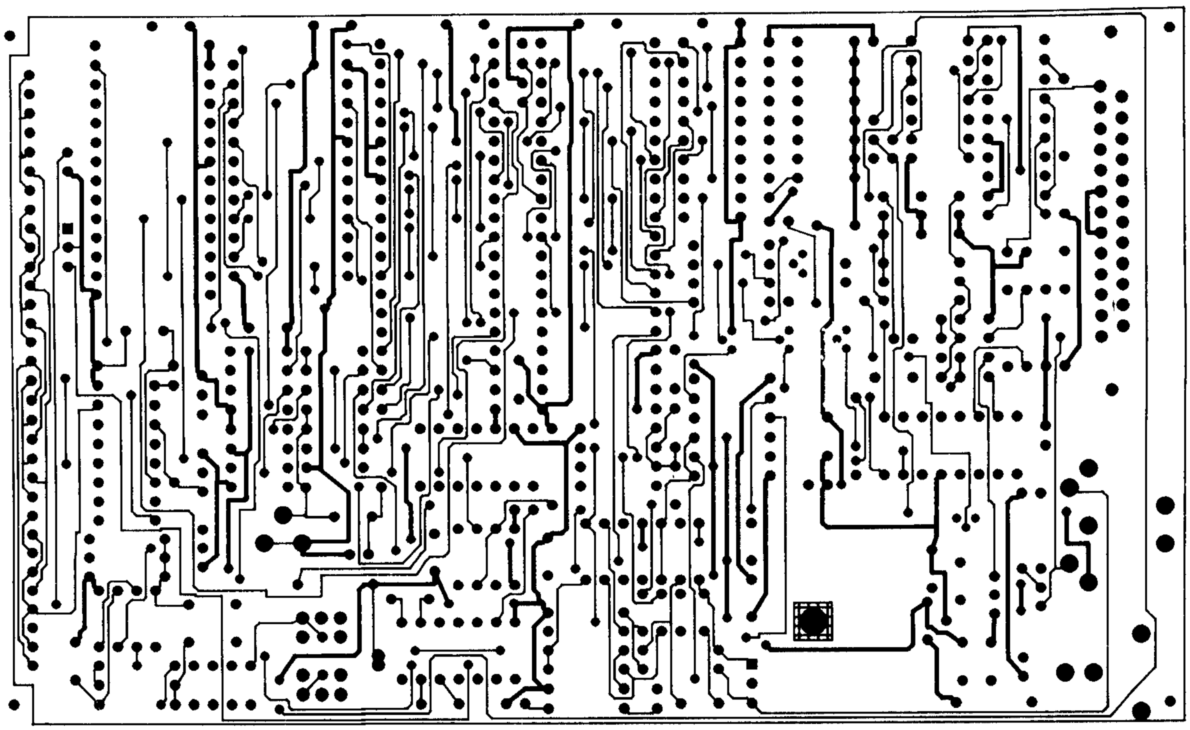
U2 pin 12 drives the AFSK generator. The port component also generates the RS232 interface signals. The transmit and receive data (TXD, RXD) and the handshaking signals (RTS, CTS) are converted by U9 between TTL level on the processor side and RS232 level.

The AFSK section (Fig 5) is equipped with an XR2206 and supports a shift of 170 Hz for HF operation as well as 850-Hz shift for VHF/UHF operation. The frequency determining elements are capacitor C23 and the resistor combinations on pins 7 and 8. If a shift of 850 Hz is desired for VHF, switch S1B can be activated, and S1A bypasses the input filter. If only HF operation is intended, the switch can be omitted. Changing the logic level on pin 9 generates frequency-shift keying. The audio output signal (AFSK) is available on pin 3.

The AMC is powered from a regulated and hum-free dc source from 12 to 14 volts. The current consumption is around 140 mA. The supply voltage can be applied over the designated jack, X2, or via X1 pin 9, or via X3 pin 5 (set BR 11, remove BR 12). The inputs are decoupled and protected against reverse polarity. The regulated 5 volts for the processor section is provided by U12.

Assembly

The AMC is assembled on a double-sided pc board in Euro-Card format (100 × 160 mm). In order to simplify the assembly as much as possible, a circuit board should be used that has plated-through holes, component placement labelling and double-sided solder mask.



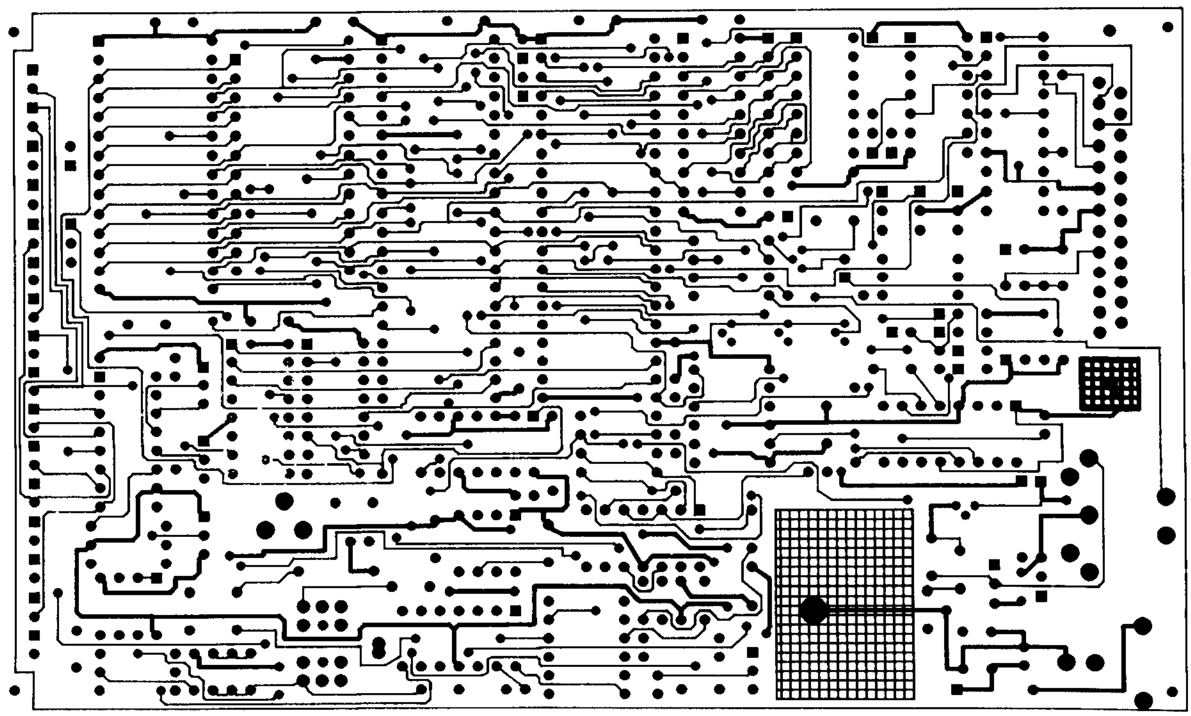


Fig 6—Circuit board layout.

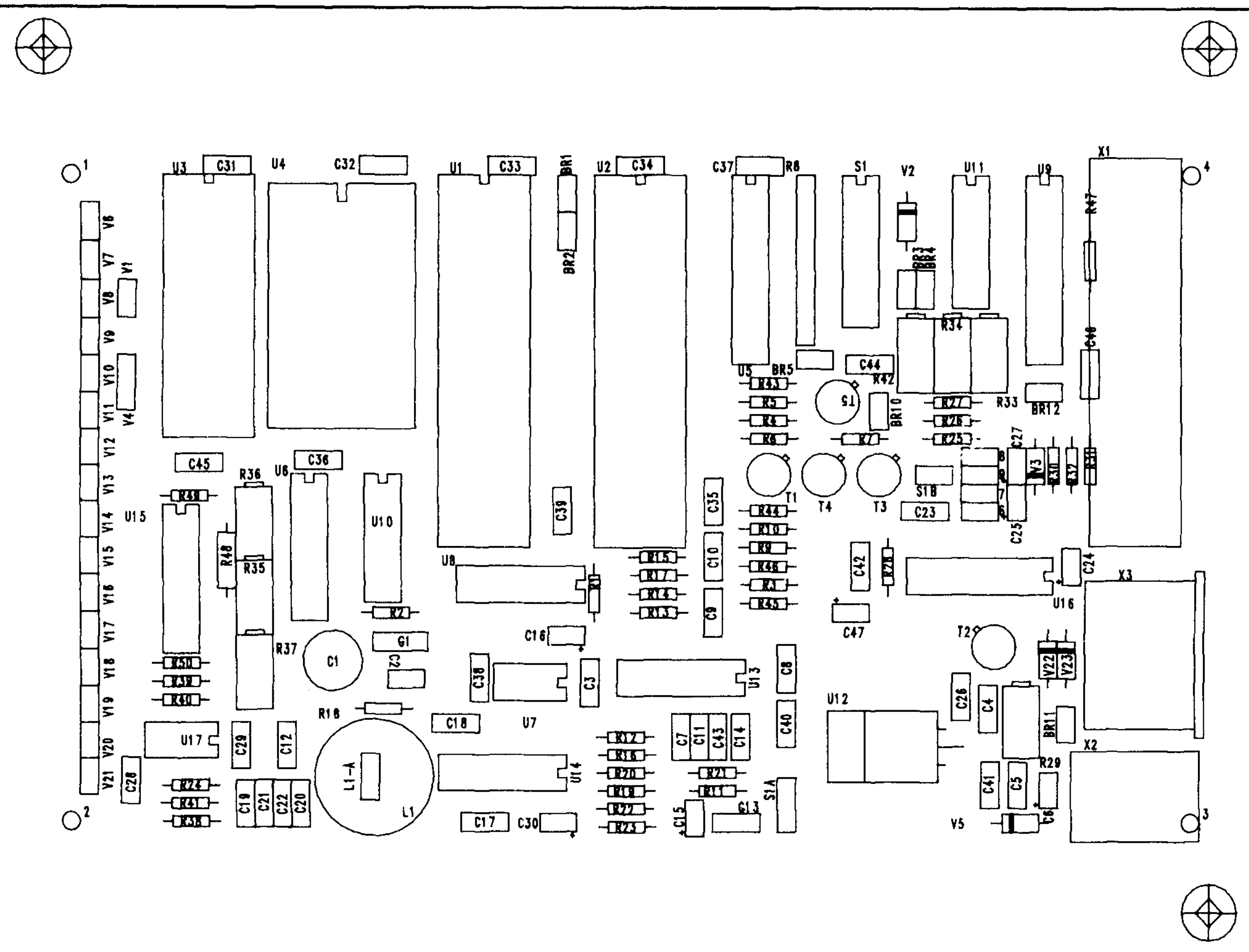


Fig 7—Component placement.

This project is not suitable for beginners. In the case of a placement error, the components are almost impossible to unsolder without destroying the circuit board.

Information regarding sources for components, complete kits as well as assembled and tested units can be obtained by sending the author a self-addressed envelope with adequate return postage (IRCs).

When choosing the components, please refer to the component list. Coil L1 cannot be substituted by a "common" standard coil since its Q is too low. The dc resistance of L1 should be no more than 10 Ω. Since the filter capacitors must match the prescribed values (10 nF) exactly, measure and select them carefully. The 5-volt regulator does not need a heat-sink if CMOS components are used in the processor section. The 25-pin sub-D jack should have a plastic carrier or be mounted using plastic insulating washers.

Capacitors C20, C21 and C22 are installed during alignment. The ICs should all be provided with sockets. For the jumper and switch connections, header strips are highly recommended.

The light-emitting diodes for the tuning indicator (V6 to V21) should be soldered in place so that the anode (longer lead) is on the right when viewing the display from the front. The square solder eyelet is for the cathode of the LED. From the same point of view, the anode of LED V1 is on the left. The shortest lead (red) for the dual-LED (V4) goes to the square eyelet on the left.

The resistor network is installed with pin 1 in the square eyelet closest to the edge of the circuit board. This pin is also marked with a bar or dot on the board.

The ICs are sensitive to electrostatic discharges and should be handled with appropriate precaution.

If only HF operation with 170-Hz shift is desired, S1 can be omitted, but the middle pin of S1A must be jumpered to the inner pin so that the filter is activated.

Alignment

An oscilloscope, a digital voltmeter and a frequency counter should be available for alignment. There are several approaches possible, including alignment after partial assembly. That decision is left up to the expe-rienced hobbyist.

I will describe the alignment of a completely and correctly assembled board. The supply voltage (12-14 V) used in later operation should be applied to the PWR jack.

Table 1—Meaning of Jumpers

Open	Closed	Meaning
BR2	BR1	RS-232 parity: Odd
BR1	BR2	RS-232 parity: Even
BR4	BR3	Receive polarity: reverse
BR3	BR4	Receive polarity: normal
	BR5	Shield of DIN jack grounded
BR7,9	BR6,8	Transmit polarity: normal
BR6,8	BR7,9	Transmit polarity: reverse
BR11	BR 10	CW output on DIN jack
BR10	BR 11	Power input possible via DIN jack
	BR12	Shield of RS-232 jack grounded

Important notice:
The jumpers listed in pairs can only be set alternatively, never at the same time. Otherwise serious malfunctions will result! For example: If BR1 and BR2 are both shorted, the 5-V supply voltage is shorted to ground. (Refer to schematic.)

EPROM ADDRESSES FOR SELCAL

Letter 1 of Selcal:	0050 (hex)
Letter 2 of Selcal:	0059 (hex)
Letter 3 of Selcal:	0062 (hex)
Letter 4 of Selcal:	006B (hex)

CONNECTIONS ON X3

Pin 1	AFSK output to the microphone input of transmitter
Pin 2	Ground
Pin 3	Transmit/receive keying of the transceiver (PTT)
Pin 4	RX audio input from the speaker output of the receiver
Pin 5	Power input or CW keying line

Assuming the specified components were installed, the current consumption should lie between 110 and 150 mA. When first applying power, the dual-LED should briefly flash orange. Then the yellow LED should light. If that happens, the program has started correctly and a reset was generated. In this state, the AMC is in standby and is waiting for a call with the Sel-Cal stored in the EPROM.

Connect the frequency counter to pin 8 of U8 and set the clock frequency to 1.5360 MHz with trimmer C1. If that fails, changing the value of C2 will probably help.

A terminal is now needed set to the following parameters: 600 bauds, 7 bits, 1 stop, parity (BR1 shorted for odd, BR2 shorted for even). If only TXD, RXD and ground are wired, resistor R47 must also be installed. Operation is recommended, however, using RTS and CTS, whereby R47 is omitted.

Table 2—Processor Switch Settings

The following parameters can be set with the DIP switch. Note: "0" means closed, "1" means open.
Delay interval between PTT activation and start of data. This delay setting is read when the system is switched on. It can be changed later with the "ESC-V" command.

S1	*S7*	*S2*	*Delay (ms)*
0	0	0	10
0	0	1	15
0	1	0	20
0	1	1	25
1	0	0	30
1	0	1	40
1	1	0	50
1	1	1	70

Automatic output of "Ctrl-E" and status byte whenever system status changes:

S8	
1	on
0	off

Delayed Copy (echo) is likewise a status value. It can be changed later with the "ESC-L" command.

S6	
1	on
0	off

Software switches are always set to 1 in the AMC system:

S3	*S5*	*S4*
1	1	1

The computer section can now be tested. Press Escape to enter the command mode. If the command "q" is entered, the parameters are displayed. If this works, the digital section is running.

To align the AFSK section, remove jumpers BR6 to BR9. Then short out only BR9. Set the trimmer potentiometer R29 to the maximum audio output level by turning the wiper to the pin furthest from ground. Using a frequency counter on X3 pin 1, measure and set the frequency to 1275 Hz with R34. Remove jumper BR9 and close only BR8, open S1B if present. Set the frequency to 1445 Hz with R33. Close S1B (with jumper). Set the frequency to 2125 Hz with R42.

At the point where S1A is attached, install a jumper that shorts the middle pin with the outside pin in order to bypass the filter.

Alignment of the demodulator requires two steps. First we set the resonant frequency, then the switching threshold of the comparator. Remove jumpers BR6, BR7 and BR8 and install BR9. Set R29 to maximum audio level.

Connect pin 1 to pin 4 on X3. On this jumper the frequency can be measured that is set to 1360 Hz by R34.

COMPONENT LIST

Semiconductors:	
U1	65C02P2
U2	65C22P2
U3	27C64 (programmed)
U4	6116
U5	74HC373
U6	74HC138
U7	NE555
U8	74HC393
U9	MAX233
U10	74HC00
U11	74HC14
U12	µA7805
U13	TL084
U14	TBA120S
U15	UAA170
U16	XR2206
U17	TL082
T1,3,4	BC557
T2,5	BC337
V1	LED yellow (5mm)
V2,3,5,22	IN4001
V4	Dual-LED red/green (5mm)
V6-21	LED red V510 (flat)
V23	BZX18
Capacitors:	
C1	2-45 pF trimmer
C2	22-pF ceramic
C3,4,5,19,20,23,29	100 nF
C6	100 µF/16 V
C7-14	10 nF (measured)
C15,16,24,25,27,30,47	2.2 µF/16 V tantalum
C16,18,28	47 nF
C21	33 nF
C22,26,45	4.7 nF
C31 - 44,46	10 nF
Resistors:	
R1	1 MΩ
R2	4.7 MΩ
R3	180 Ω
(Resistors, continued)	
R4,5,6,7,31,32,43,44,47	4.7 kΩ
R8	8x10 kΩ array
R9	100 Ω
R10,28	220 Ω
R11	42.2 kΩ 1%
R12	154 Ω 1%
R13	619 kΩ 1%
R14,20	121 kΩ 1%
R15	249 Ω 1%
R16	787 Ω 1%
R17	15 kΩ 1%
R18	442 Ω 1%
R19	274 kΩ 1%
R21	332 kΩ 1%
R22	475 Ω 1%
R23	1 kΩ
R24,30,38,41,45,46,48	10 kΩ
R25,26	3.32 kΩ 1%
R27	1 kΩ 1%
R29,33-36,42	5 kΩ trimpot
R37	50 kΩ trimpot
R39,40,49,50	100 kΩ
Miscellaneous:	
G1	Crystal, 6.144 MHz, HC18
BR1-12	header strips, jumpers
S1	8-pol DIP switch
X1	25-pin sub-D angle jack
X2	2-pin low-voltage jack
X3	5-pin DIN jack
L1	90 mH, apprx 190 turns, CuL 0.13 mm

(Siemens:
shell core set N41:B65541-K-R41
coil body: B65542-B-T1
retainer: B65545-B9)
Housing special cabinet
PCB: AMC, double-sided, plated-through, solder mask, placement
Info regarding components, kits and completed units available from author with SASE.

The oscilloscope is attached to pin 8 of U14. It will display an undefined random oscillation. By installing C20, C21, and C22, this oscillation will be optimized into a rectangular waveform with a frequency of 2720 Hz and a keying ratio of 1, ie, the upper trace is the same length as the lower. By trying various parallel combinations of capacitors in the range of 100 to 130 nF, the desired results can usually be achieved.

In the second alignment step the comparator threshold is set. The measurement equipment remains attached as described above, the 1360-Hz frequency is applied and the tuned circuit of the demodulator is aligned. The oscilloscope is connected to pin 7 of U17. Here a dc voltage from under 1 V (low) to over 4 V (high) should be measured. R37 is adjusted until the signal is on the transition between low and high.

Following this alignment, the frequency should be changed with R34 from 1360 Hz to 1275 Hz.

To align the tuning indicator, remove jumpers BR6, BR7 and BR9. Install BR8, pins 1 and 4 of X1 should still be connected. R34 has been reset to 1275 Hz. Measure the voltage on pin 11 of U15. Now attach the DVM to pin 12 of U15 and using R35 set the voltage to 400 mV less than the value measured on pin 11. The third LED from the left end should light; if not, correct slightly with R35.

Now remove jumper BR8 and set BR9. Measure the voltage on pin 11 of U15 again, attach the DVM to pin 13 and using R36 set the voltage to 400 mV higher than pin 11. The third LED from the right end should light; if not, correct slightly with R36.

Table 3—Meaning of System Status LEDs

Status LED	*ARQ Mode*	*ARQ Listen*	*FEC Receive*	*FEC Transmit*	*Baudot*	*ASCII*	*CW*
flashing red	syncro-nizing	100Bd signal recognized	—	—	—	—	—
red	invalid characters received (ERROR)	invalid characters heard	like ARQ Listen	—	incorrect stop bit	—	
orange	receive error at remote station (RQ)	station repeats character group	—	—	—	—	—
green	error-free data flow(OK)		like ARQ Listen	Data being transmitted	like FEC	like FEC	like FEC
flashing green	error-free transmission no data (IDLE)		like ARQ	No data being transmitted	like FEC	like FEC	like FEC

Open the connection between pin 1 and pin 4 of X3 and change the jumper on S1A.

For actual operation, the level to the transceiver still must be adjusted. The AFSK audio signal must correspond to the required transmitter input level. Set the audio level to minimum with R29 (wiper to ground). After wiring the audio lines, activate the PTT and raise the audio level until the ALC gauge shows a reading or the HF output power in SSB mode no longer increases. Then reduce the level by approximately 10%.

This completes the alignment procedure for the AMC.

Literature

[1] L. Monz, J. Wollweber, “Fernschreibverfahren (2),” *cq-DL* January 1986 (“Radio Teletype Techniques”).

[2] A. Clemmetsen, “10 Jahre AMTOR,” *cq-DL* October 1989 (“10 Years of AMTOR”).

[3] A. Bingemer, “AMTOR Betriebstechnik,” *cq-DL* December 1989 (“AMTOR Operating Techniques”).

Correspondence

Digital Communications Protocol

I am writing in response to the recent request in *QEX* (May 1991) for comments on a new protocol for digital communications by amateurs in the HF band. Although the *QEX* request is in the context of AMTOR, I understand the ARRL's overall interest to include development by amateurs of new and effective methods of digital HF communication in general (subject perhaps to the restriction to 8-bit source codes), so I'll put my comments in that framework.

I work at the MITRE Corporation, where we've developed several simulations of digital HF networks and fielded two experimental ones, with more no doubt to come. These projects have required understanding and analysis of channel simulation (mainly with IONCAP), several data and automatic link establishment (ALE) modems, antennas, routing protocols, forward error correction (FEC), automatic repeat request protocols (ARQ), storage and forwarding of messages, and so on.

During the course of this work and in connection with discussions of amateur packet radio with hams at MITRE and elsewhere, I've thus had many opportunities to think about the digital HF modem project. My comments, which follow more or less in the order of the *QEX* questions, are thus based on some experience in the field.

I should of course emphasize that despite my background, I haven't come to a final view on several of the questions. (To do that will require a lot more simulation and operation of actual networks.) Furthermore, my views are given as those of a ham and should not be construed as official positions of the MITRE Corporation.

1. To the extent that compatibility with older equipment (assuming that is important) allows it, I believe that frame lengths and frame window (groups of frames) sizes should be adjustable in adaptive response to changing channel conditions—as reflected, for example, by the bit error rate (BER), number of NACKs, etc. This will give interested hams the chance to write their own adaptive error control protocols, some of which will no doubt involve changing frame and window sizes. In connection with this, published analyses (as you probably know) have shown that the success of most ARQ schemes depends on BER, frame length and window size.

2. Likewise, the bit or symbol rate for digital HF is a parameter that should be changed in any link-layer protocol that adapts effectively to changing channel conditions. I suspect that protocols that can raise the data modem's bit rate when the SNR or BER indicates that the channel has improved will turn out to be *very* effective in terms of link (and network) throughput.

3. Inexpensive DSP software should soon allow one to pick modulations from the node terminal, so the choice of modulation type (BFSK, MFSK, MPSK, QAM, etc) should probably not be fixed. What will need to be worked on are methods for exchanging information between stations on what modulation to use on a particular link.

4. Error control is also an area where a large scope for experimentation should be allowed in these early stages; the temptation to induce compatibility with a standard that restricts freedom to experiment should be resisted as long as possible, in my opinion, since the best way to do digital HF is still far from clear even to those who have been working on it professionally for several years. At the moment, the (23, 12) Golay code seems to be popular, but other codes and combinations of FEC and ARQ, possibly with adaptive adjustment (automatically, or from the keyboard) of the error *detection and correction* capabilities of the FEC code may turn out to be much more effective than a fixed FEC scheme.

5. I guess the solution to the call sign problem depends on our willingness to change the frame format for AMTOR to allow longer address fields. Is that too disruptive to contemplate? (I don't know the answer to that.)

6. The easiest and most effective way to introduce (more) diversity—in addition to that provided by AMTOR's current repetition scheme—may be to use more powerful forward error correction, which is of course also a diversity technique. Cheap software (on DSP chips?) for interleaving may also be available soon if it isn't already; interleaving will give additional diversity for fading channels.

7. The backward compatibility problem is of course an important one for hams (and others!) who can't afford to buy new equipment every time a manufacturer dangles it in from of them. However, the way developments—and prices—in DSP and software in general seem to be going, we can be fairly hopeful that manufacturers will be able to provide us with modems that can do the new link-layer protocols we develop as well as be compatible with the current AMTOR at affordable prices. (They did it with the current crop of "multimode" controllers.) What will be crucial is that amateurs, led by the ARRL, I trust, proceed in a unified way to make their new ideas clear. (I suppose it can be said that the developments by manufacturers of packet modems that can handle the KISS mode and NET/ROM should give us hope.)

Two final remarks:

1. I think the greatest contribution amateurs can make

to developments in HF digital radio is to provide the field—as they are starting to do—with a vast and inexpensive testbed for analysis of waveforms, error control coding, routing techniques and adaptive networking in general. Testbeds for commercial and governmental networks, even though they may involve some hardware that is not yet available to hams, are almost always expensive and time consuming to set up, and data collection and analysis can also be complicated and expensive, since it's done by people on payrolls. Amateurs work for fun and for free, and can provide far more data than a commercial or governmental network can ever hope to get. I'd like to see the ARRL continue to take the lead in organizing our efforts in the emerging HF digital field.

2. Although I don't know much about the status of its availability for amateur use (which probably depends a lot on governmental and the big manufacturers' strategies), it would put amateur digital HF experimentation in a very effective position if hardware to perform automatic link establishment (ALE) according to the new Federal Standard 1045 became available soon at a reasonable price.

I hope these remarks will be useful.—*Ken Wickwire, KB1JY, 232 North Road, Apt 17, Bedford, MA 01730*

Comments on Measuring the Mass of the Earth

In the September 1991 issue of *QEX*, Dr. H. Paul Shuch discusses interesting applications of EME (Earth-moon-Earth) measurement data in determining, among other things, the mass of the earth. The article also illustrates how imaginative teachers can motivate their students (and readers of *QEX*) by applying common knowledge in unusual ways. However, there are some minor errors in the article regarding the earliest accurate measurement of the Earth's circumference which I wish to correct.

On page 9, first column, third line from bottom and the top of the second column, Shuch states that "one of the earliest accurate measurements of the Earth's size (circumference) involved observing that, on the day of the Equinox at local noon in Alexandria, a stick placed vertically in the ground cast no shadow," and a stick similarly positioned in Athens (some supposedly known distance to the north) cast, at the same time, a shadow of appreciable length. Actually, I believe the description given by Lancelot Hogben in his two books is the correct version of the procedure used by Eratosthenes (BC 276?-195?) in measuring the Earth's circumference.[1,2]

First, I quote from A History of Mathematics[3] regarding the individual responsible for the measurement discussed by Shuch: "Eratosthenes was a native of Cyrene who had spent much of his early life at Athens. He achieved prominence in many fields when, in middle life, he was called by Ptolemy III to Alexandria to tutor his son and to serve as librarian of the university there. Today Eratosthenes is best remembered for his measurement of the earth—not the first or last such estimate made in antiquity, but by all odds the most successful."

According to Hogben, during the time of Eratosthenes "it was common knowledge that the noon sun's zenith distance at Alexandria on the summer solstice was 7.5 degrees. It was also on record that its image was then visible at noon on the water surface of a deep well in Syene, near the Aswan Dam of today and just on the Tropic of Cancer, whence its midsummer noon zenith distance was zero. [Note the different spelling of "Cyrene" and Syene" in these two references.] Since Alexandria and Syene lie nearly on the same meridian, it thus appears that a great circle arc of about 7.5 degrees separates them. Either from records of the mean time of route marches over level desert country or from crude maps made by the Egyptian temple surveyors for tax allocation, Eratosthenes know that the intervening distance is, in Anglo-American linear measure, about 520 miles." Knowing the distance between Alexandria and Syene, Eratosthenes estimated the Earth's circumference to be $520 \times 360 / 7.5$ or about 24,960 miles.

Thus, the second reference point was not at Athens, as Shuch states, but at Syene, "just on the Tropic of Cancer" and near the First Cataract of the Nile at the Aswan High Dam. As Hogben explains, the distance between Alexandria and Syene was known to a fair degree of accuracy. In comparison, the distance between Alexandria and Athens was much less likely to be accurately known because of the intervening Mediterranean Sea, and therefore this distance was probably not used in the calculations.

Shuch refers to the shadow measurements being made during the "...day of the Equinox..." But according to Hogben, the measurements were made during the summer solstice when the sun was directly over the Tropic of Cancer, and that is why the noon zenith distance at Syene was zero (because Syene is located on the Tropic of Cancer). Also, Shuch states that "Alexandria...is near the equator), but it is actually at the latitude of about thirty-one degrees above the equator. For comparison, the border between Alabama and Florida is at a latitude of 31 degrees, and you would hardly call that latitude "...near the equator!" For an additional comparison, Entebbe and the northern part of Lake Victoria (both in Uganda, Africa) lie almost directly on the equator and near the same meridian passing through Alexandria.

Because of the reliance placed on the technical accuracy of *QEX* and its archival value and so the errors discussed about will not be repeated, I believe it is important that the above corrections be brought to the attention of your readers. —*Ed Wetherhold, W3NQN, 1426 Catlyn Place, Annapolis, MD 21401*

You're absolutely right, Ed, the two cities in question

[1]Lancelot Hogben, *Mathematics for the Million*, W.W. Norton and Company, Inc, 1943, Fig 7, p 348.

[2]Lancelot Hogben, *Mathematics in the Making,* Crescent Books, Inc, 1960, pp 124-126.

[3]Carl B. Boyer, *A History of Mathematics*, 2nd edition, John Wiley and Sons, Inc, 1991.

were indeed Alexandria and Syene, and the experimenter in question was certainly Eratosthenes himself. I'm pleased to note that I caught the error myself and took action to correct it—see QEX *December 1991 Corrigendum.*

The one detail about which we disagree is how Eratosthenes knew the distance from Alexandria to Syene. I'm inclined to believe your source, regarding route march times over level desert. However Cornell's Professor Carl Sagan, in his pop-science book Cosmos, *states that Eratosthenes actually hired a surveyor to pace off the distance. I choose to accept this source only because it underscores the futility of pacing off the distance to Athens! Cosmic Carl is also the source of my statement about the lengths of shadows cast by sticks in the ground. Thanks for being so observant, Ed. It's nice to know somebody actually reads my articles.*—H. Paul Shuch, N6TX, Professor of Electronics, Pennsylvania College of Technology, One College Avenue, Williamsport, PA 17701

Conducted by: Stan Horzepa, WA1LOU
75 Kreger Drive
Wolcott, CT 06716-2702

FCC GRANTS FINAL EXTENSION OF UNATTENDED HF OPERATION STA

The ARRL Special Temporary Authority (STA) for unattended HF digital operation by a limited number of specified amateur stations has been extended to January 3, 1993. On December 20, the FCC Private Radio Bureau granted what it termed a final extension of the STA. A survey in January 1992 *QST* and other publications seeks information for use in developing a proposal for permanent rules regarding such operation. Unattended operation in the HF bands is not permitted except under the terms of the STA.

The following list of stations are authorized to operate under this STA:

AA2S, AA4TM, AA6TN, AD8I, AG3F, AJ6F, AL7IN, KØBOY, KØHOA, KØKBY, K1UGM, K2AAA, K4EID, K4NTA, K4TKU, K7PYK, K8MMO, KA1ZT, KA4OJN, KB1PJ, KB3X, KB5PM, KB6GOZ, KCØQJ, KC2TN, KC7CG, KD4EQ, KD5SL, KD6SQ, KD7XG, KD9WH, KE7CZ, KE7VS, KH6GPI, KH6WY, KIØQ, KI4FL, KI4XO, KJ6EO, KJ8C, KK4CQ, KK4L, KK4WR, KK9G, KL7IEJ, KL7JDR, KN5D, KP2N, KR5S, NØAN, NØHMF, N1BBT, N1CWP, N1DCS, N1DL, N1DRS, N4HOG, N4JS, N4QQ, N4RT, N4XI, N5AAA, N5OK, N6EEG, N6VV, N6YN, N7GXP, NA2B, NC5R, NI6A, NJ4S, NL7NC, NXØR, WØLJF, WØLVJ, WØRLI, WØXK, W1HAB, W1ZLG, W2HPM, W2JUP, W2TKU, W3IWI, W4DPH, W4SDL, W5TOO, W5XO, W7LUS, W8AKF, W9ZBD, W9ZRX, WAØCQG, WA1LRL, WA1WLV, WA2SPL, WA4EWV, WA4PHY, WA4SZK, WA4VMV, WA5DVV, WA5MWD, WA5QZI, WA7ARI, WA8BXN, WBØTAX, WB1DSW, WB4FAY, WB4GHL, WB5FWE, WB6IKS, WB6KAJ, WB7DCH, WB8CQV, WB9OWN, WB9TPG, WB9TYT, WDØHEB, WD4ANY, WD4NUN, WD4PPF, WD5B, WD9DHI, WD9EBQ, WN4IIV, WQØP, WV4B and WY5J.

DISASTER COMMUNICATIONS VIA PACKET RADIO IN SOUTH-EAST ASIA

VITA just received a $40,000 grant from the International Business Machines Corporation (IBM) to launch a disaster communications pilot project in the Philippines, Indonesia, and Thailand. The project, which will start early this year, will employ low-cost packet-radio, whose use VITA has pioneered in space and terrestrial environments for relief and development. The fast-response part of the system links a packet radio at the disaster site to an operation center a few kilometers away. The center can communicate via geosynchronous satellite and electronic mail to all parts of the world within ten minutes or so for mobilizing expertise and relief supplies.

Although the fast-response element figures in VITA's plans, the IBM grant provides for the development of components that would function during preparedness activities, as well as during rehabilitation that would occur days or even months after the event. For this purpose, the digital-radio ground station developed by VITA would exchange messages with the disaster site and VITA's present satellite (the PACSAT Communications Experiment). PACSAT is in low-earth orbit and passes over any given place on the earth several times a day. All the equipment needed for both fast response during a disaster and for planning, preparedness, and rehabilitation is easily portable and relatively inexpensive.

The lack of communications during the first 72 hours following a disaster has long been identified as an impediment to saving lives and the organization of relief efforts. Unfortunately, the only practical solutions to date had been extremely expensive and involved communi-cations equipment and technicians brought in from the outside. VITA's low-cost packet radio-based alternative is expected to break new ground and provide a more effective approach to disaster relief. The year-long project will be implemented with the help of local sponsoring organizations with which VITA has already worked in each of the countries, and will include installation and training in the use of the disaster communications system.

—from Gary Garriott, via CompuServe's HamNet

TAPR ANNUAL MEETING ON TAP FOR MARCH 7-8

The tenth anniversary annual meeting of Tucson Amateur Packet Radio (TAPR) will be held the weekend of March 7-8, 1992 at the Best Western Inn at the Airport, 7060 S Tucson Blvd, Tucson, Arizona, adjacent to Tucson International Airport. In addition to the usual presentations of the latest and greatest developments in packet radio, there are plans for some special features in commemoration of TAPR's tenth birthday.

Plans are to have the usual "pizza bash" and other informal activities on Friday night, March 6, with the meeting all day Saturday and an open discussion forum on Sunday morning. Registration is $15 which includes a buffet luncheon. The buffet dinner on Saturday is also $15. TAPR will have a hospitality suite where you can gather informally, join TAPR and purchase kits and software.

A block of rooms has been reserved at the special rate of $55 per night, single or double occupancy including full American breakfast and happy hour reception. For reservations, call the Inn at the Airport at 800 772-3847 or in Arizona at 602 746-0271, fax 602 889-7391 no later than February 20 (mention TAPR to get the special rate).

If you are planning to attend or have a project you would like to present at the meeting, please call or write the TAPR office. To have your paper included in the printed proceedings of the meeting, camera-ready copy should be submitted to TAPR no later than February 25.

For further information, contact:
Tucson Amateur Packet Radio
Box 12925
Tucson, AZ 85732-2925
Phone: 602 749-9479
FAX: 602 749-5636
CompuServe ID number: 71540,2364
Office hours: 10 AM to 3 PM MST, Tues-Fri

—from Bob Nielsen, W6SWE, via CompuServe's HamNet

A SNAPSHOT OF AN EVOLVING NTS

Change is nothing new to the venerable National Traffic System (NTS). Over the years, we've seen the addition of new cycles and modes designed to improve the efficiency and effectiveness of the system. It all helps to further promote its mission: the accurate and efficient movement of formatted message traffic from origin to destination as a public service, and the training of a cadre of Amateur Radio operators to handle message traffic in an organized, integrated network environment for use in emergency and disaster situations.

Recently, things have been moving along a little faster than usual. The last issue of *Field Forum* featured a presentation of the new Terms of Reference for the key system players. The TOR documents the integration of new digital message systems and new NTS Digital Coordinators who manage them above the Section level. These new systems, including the increasingly popular APLink hubs, are supplementing the traditional Transcontinental Corps (TCC) and Area Net functions, handling ARRL radiogram-formatted traffic with amazing speed, accuracy and reliability across the country for input into other levels of NTS.

At the Section level and below, we introduced the concept of NTS Section and Local Nodes (packet radio bulletin boards) that, like their traditional Section Net and Local Net counterparts, move traffic into, out of and throughout the Section and local areas under the management of NTS Net (node) Managers and the Section Traffic Manager. Official Relay Stations clear the nodes of traffic daily just as they do on the phone and CW nets. We talked about the advantages of enhanced speed, reliability and accuracy in traffic handling, and forecasted a close partnership with traditional NTS nets and participants. While this has occurred in some Sections, in others, the relationship has yet to mature.

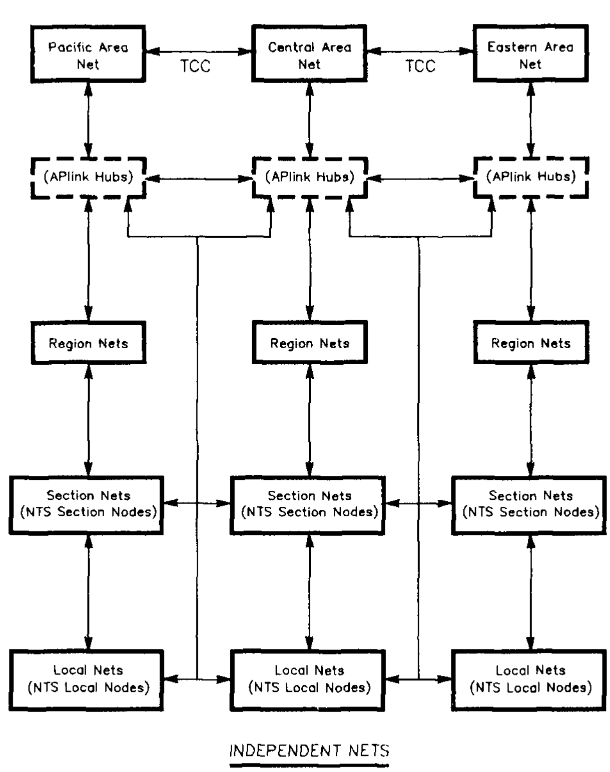
There are no arbitrary limits on the number of nodes that can be appointed to NTS. If a Section has 16 packet radio bulletin board systems that provide the NTS service, STMs can name each as Section- or local-level NTS nodes, appointing their SYSOPs (or the SYSOP's designee) as NTS Net Managers. The number is limited only by the Section's geographic size, the number of other nets and nodes operating in the Section and other factors having to do with the way the Section is organized.

NTS (Node) Net Managers function in the same manner as their more traditional counterparts do. They work under the STM in a coordinated Section traffic plan, see that the proper ARRL radiogram form is used in message handling, recruit new NTS users and provide monthly traffic reports for compilation with the regular Section activity reports for publication in *QST*.

Of course, there's a lot more to do. New systems are being developed every year and NTS needs to tap these new resources. A new ARRL Digital Committee composed of operations-oriented amateurs will help us.

All of the above leads us to the purpose of this article.

Many NTSers and others have asked us to publish a chart that shows how the NTS looks, based on the above, at this particular moment in time in simple fashion:



from *Field Forum*

LANDLINE DOORWAY TO PACKET RADIO

Todd Zabel, N9JXA, is the SYSOP of The Data Cache BBS in Milwaukee. It is a full feature BBS oriented towards Amateur Radio, science and technology. It supports IBM compatibles and Amiga computers. A unique feature of The Data Cache BBS is a packet-radio "doorway" that allows a caller to access the packet-radio network. Upon accessing the doorway, callers can send and receive packet-radio messages without a TNC and radio. The doorway is available only to verified licensed hams. The phone number of The Data Cache BBS is 414 543-9060. Its Fidonet number is 1:154/543

STRAY BITS

AEA SHIPS DSP-2232

On January 10, John Downing, N7GMF, the AEA representative on CompuServe's HamNet stated, ". . . the DSP-2232 will ship next week."

NEW W1AW BULLETIN HEADER PROPOSED

Station staff is considering changing the header format of W1AW bulletins to ensure correct computer decoding for automated systems, yet retain human readability. Please send any comments and/or sugges-tions regarding bulletin header format to W1AW Chief Operator, c/o ARRL, 225 Main St, Newington, CT 06111.

AMSAT-BELGIUM NOT ASSOCIATED WITH SARA

The December 1991 installment of this column contained an article titled "SARA: A French Amateur Radio Telescope" written by Patrick Hamptaux, ON1KHP, and Joe Kasser, W3/G3ZCZ. The article stated that SARA reception reports could be sent "to BELAMSAT (AMSAT-Belgium)." According to AMSAT-Belgium President Freddy de Guchteneire, ON6UG, this statement was in error and that AMSAT-Belgium "has nothing to do with SARA" or BELAMSAT.

RSGB CEASES PUBLICATION OF PACKET-RADIO NEWSLETTER.

The Radio Society of Great Britain (RSGB) announced recently that it has ceased publication of *Connect International*, the RSGB's monthly packet-radio newsletter. The lack of support by interested parties and contributors was cited as the reason for this action. Subscribers should contact Philip Smith at RSGB headquarters for refunds.

HAMMAN V1.01 AVAILABLE

HamMan is an Amateur Radio reference guide for hams of all levels and ages. It provides an international call sign prefix search function, an international phonetics alphabet guide, Ohm's Law calculator, on-air timer and Q-signal look-up function. All functions are accessed through a user-intuitive menu system. On-screen help is always available. *HamMan* is compatible with all IBM PC/XT/AT/386 computers and requires only 256-kbytes of RAM to operate. It is fully compatible with CGA/EGA/VGA and Hercules-compatible video displays. *HamMan* version 1.01 is now available for a $15 registration fee from John Mustain, N8NWN, 356 N Cherry St, Kenton, OH 43326.

GATEWAY CONTRIBUTIONS

Submissions for publication in Gateway are welcome. You may submit material via the US mail to 75 Kreger Dr, Wolcott, CT 06716, or electronically, via CompuServe to user ID 70645,247, or via Internet to horzepa@evax.gdc.com. Via telephone, your editor can be reached on evenings and weekends at 203-879-1348 and he can switch a modem on line to receive text at 300, 1200 or 2400 bit/s. (Personal messages may be sent to your Gateway editor via packet radio to WA1LOU@N1DCS or IP address 44.88.0.14.)

The deadline for each installment of Gateway is the tenth day of the month preceding the issue date of *QEX*.

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