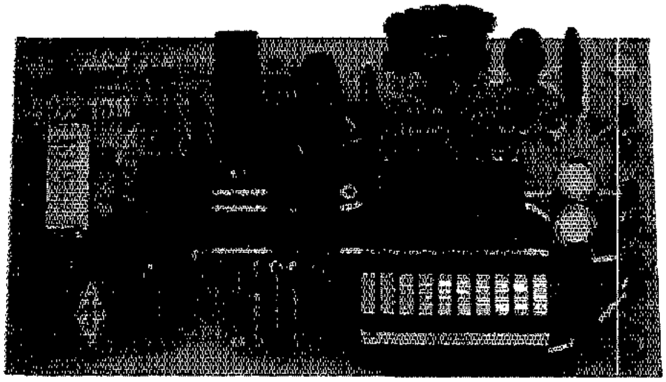
Real-Time HF WEFAX Maps on a Dot-Matrix Printer

With this simple computer interface and machine-language program, you've got weather maps—and more—on paper!

By Keith Sueker, W3VF
110 Garlow Dr
Pittsburgh, PA 15235



Amateur Radio is a multi-faceted hobby. You'll find amateurs using their unparalleled freedom to do everything from operating radio-controlled models to putting satellites into space. Keeping an eye on weather conditions the world over is an interest of many radio amateurs.

Years ago, a general-coverage receiver was considered a "that'd be nice" addition to the ham shack. Today, most amateur transceivers being manufactured have built-in general-coverage receivers. This makes it easy for the amateur to roam the frequencies outside the amateur bands and make new discoveries. The information presented by Keith Sueker in this article should prove interesting to many. We hope it will encourage others to modify and expand on this work.

Much of the information available to the local TV weather forecaster is also available to the public through facsimile (FAX) weather broadcasts on HF radio circuits. Other articles have featured techniques for presenting weather maps on computer displays in real time, but this article describes a system for printing facsimile maps on a dot-matrix printer in real time.[1,2] Maps can be printed continuously as long as the ribbon and paper supply holds out! The "how" of all this is an interesting marriage of radio receiving and computer-programming techniques that are not difficult to duplicate. The software is written for the Apple® II series of computers and an NEC PC-8023A-C dot-matrix printer, but with reasonable effort can be adapted to any 6502-based computer and accompanying printer.[3] The techniques themselves are applicable to nearly any computer and dot-matrix printer that can operate in the graphics mode.

Radio Facsimile

Most maritime nations broadcast facsimile weather maps to ships at sea. The maps cover a wide range of weather-related phenomena, including surface synoptic maps, pressure/altitude maps, forecasts, satellite pictures, surface precipitation summaries and a wealth of other information. In the US, transmissions are made primarily from NAM in Norfolk, Virginia, through the facilities of the Naval Fleet Weather Service. West Coast weather is broadcast by NMC at San Francisco, California, and Gulf of Mexico weather by WLO, Mobile, Alabama, through the facilities of the National Weather Service. Canadian weather transmissions are made by CFH from the Canadian Forces Metoc Centre in Halifax, Nova Scotia, and from CKN by the Maritime Forces Pacific Metoc Centre in Esquimalt, British Columbia. Other services broadcast in both countries, and many foreign countries broadcast compatible maps. A short list of major stations is shown in Table 1. More are listed in Robert Grove's book.[4]

Table 1
Principal Weather Facsimile Stations for North American Reception

Location	*Frequencies (kHz)*	*Agency*
Washington, DC	3357 4975 8080 10,865 16,410	US Navy FWS
San Francisco, CA	4346 8682 12,730 17,151	USCG/NWS
Halifax, NS, Can	4271 6330 9890 13,510 17,560	CF Metoc Ctr
Esquimalt, BC, Can	4268 6946 12,125	MFP Metoc Ctr
Mobile, AL	6852 9157 11,145	NWS
Additional Stations		
Pearl Harbor, HI	4803 9440 9445 12,362 16,398 16,400 21,785	
Guam	4975 7645 10,255 13,807 18,620 23,880	
Bracknell, UK	4610 4782 8040 9203 11,086 14,436 14,536 14,582	
Rota, Spain	3713 5206 7626 8100 12,184 12,903 15,941	
Tokyo, Japan	3622 3365 4902 5405 7305 9438 9970 13,597 14,682 18,130 18,220 22,270	
Darwin, Australia	5755 7535 10,555 15,615 18,060	
Pretoria, RSA	4014 7508 13,773 18,238	
Buenos Aires, Arg	5185 10,720 18,093	
Oslo, Norway	4642 5945 8057 11,097	
Cairo, Egypt	4526 5127 9043 10,123 10,560 17,365	

Note: These frequencies are subject to change from time to time. Also, FAX broadcasts might not be transmitted on a 24-hour schedule.

[1]Notes appear on page 20.

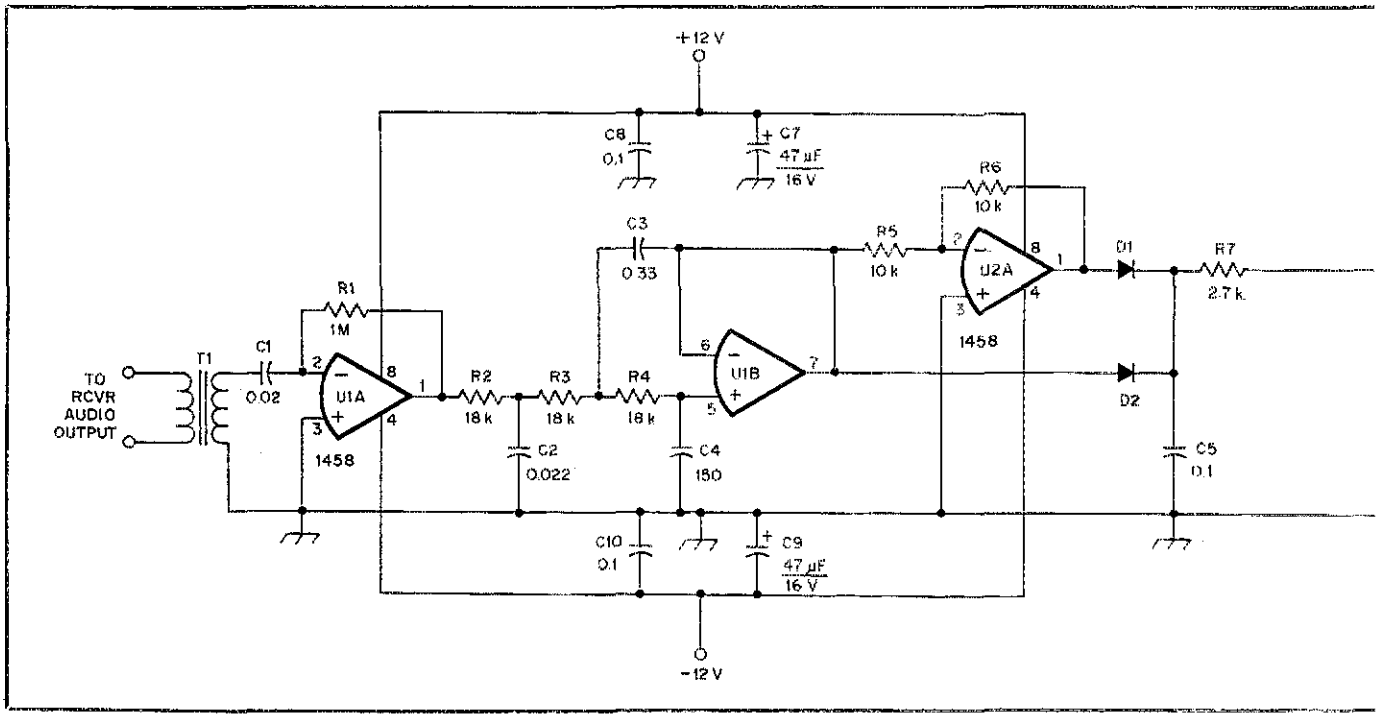


Fig 1—Schematic diagram of the HF FAX demodulator. If necessary, select the values of the resistors marked with an asterisk so that the first bar of DS2 lights when a 1200-Hz tone is present and bar 10 lights when a 2000-Hz tone is received. The output of the demodulator is connected to the Apple computer's game port, pins 2 (SWØ) and 8 (GND). Part numbers in parentheses are Radio Shack; equivalent parts may be substituted.

D1, D2—Silicon or germanium signal diode, 1N914, 1N34 or equiv.
D3—4.7-V, 500-mA Zener diode, 1N5230 or equiv.
DS1—Red LED (276-041).
DS2—LED bar-graph display, MV50164 (276-081).
T1—Audio transformer, 1-kΩ pri, 8-Ω sec (273-1380) or Mouser 42TLO13.
U1, U2—LM1458 dual op amp (276-038).
U3—LM3914 display driver (276-1707).

FAX transmissions use frequency-shift modulation similar to RTTY. Relative to a standard virtual carrier, black is 1500 Hz and white is 2300 Hz. A full gray scale is transmitted. Other modulating frequencies are used to start the motor on commercial FAX receiving machines and to synchronize receiving machines to the transmitting machine at the start of a picture. It is important to note that FAX transmissions run "open loop" in that they do not incorporate any signals analogous to the horizontal sync signals in TV transmissions.

Original maps are scanned at the transmitting site by a photosensitive detector that translates the map details into frequency shift at the transmitter. The scanner completes a scan line in exactly 500 ms and has a resolution that exceeds 1000 equivalent pixels in each line. The received picture is built up as a series of sequential lines in a fashion identical to raster generation on a TV set or monitor. A complete picture will require 5 to 20 minutes for transmission, depending on its size.

Receiving Adapter

To receive the FAX transmissions, you must have a receiver that is reasonably stable, has a BFO and, of course, can tune to the FAX frequencies. Additionally, you must be able to demodulate the incoming signal and convert it to a useful input for the computer. The demodulator circuit shown in Fig 1 is designed to provide a complete interface between the receiver and computer. After considerable experimentation, I offer it as about the simplest circuit that will yield good results.

Circuit Description

Audio from the receiver is isolated and boosted in amplitude by T1. A 24-ohm ballasting resistor may be placed across the input so that the interface can be used with the receiver speaker disconnected. U1A acts as a clipper that effectively removes any amplitude modulation from the signal. The input capacitor is deliberately made small to reduce the effects of low-frequency hum and noise. The next stage, U1B, is a three-pole, 3-dB-ripple Chebychev low-pass active filter that acts as a frequency discriminator. It has a corner frequency of 1200 Hz and a log-linear attenuation of 26 dB in the first octave. This particular configuration is chosen to provide a sharp cutoff with low-Q sections so as to minimize transient ringing.

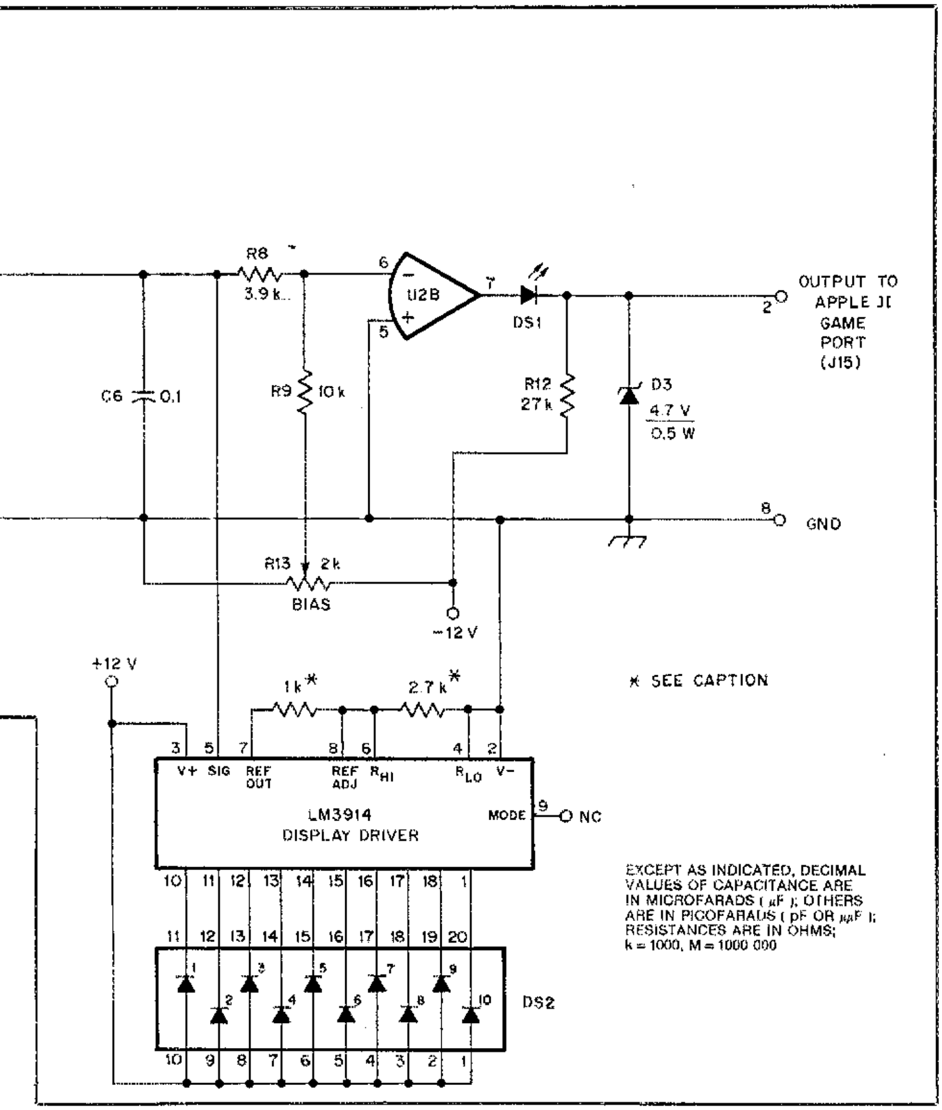
U2A is an inverter that, in conjunction with D1 and D2, provides full-wave rectification of the ac signal from the demodulator. A two-pole RC filter reduces ripple. The last stage, U2B, is a comparator. It compares the incoming demodulated, rectified and filtered signal to an adjustable dc reference. The reference is supplied through R13, which sets the bias level so as to allow adjustment of the print density. U2B transmits a TTL signal to the computer input—in this case, the Apple's game port. A series-connected LED, DS1, provides the operator with a visual aid in setting the print density. Note that U2B is driven into current limiting, which at 12 V supplies just about the right amount of current for DS1. R12 sinks current from the Apple's input (PBØ) port to assure a zero signal. A Zener diode (D3) maintains a 4.7-V maximum input level to the computer.

Tuning Indicator

Tuning in a FAX signal is not particularly easy without some sort of indicator. An oscilloscope can be used, but I have found the simple LED bar graph (DS2) is just as good. It is set up so that a 1200-Hz signal lights the first segment and a 2000-Hz signal lights the last one. Note that I've selected the received frequency range to extend from 1200 Hz to 2000 Hz rather than the usual 1500 Hz to 2300 Hz. This permits the use of the standard SSB receiver filter band-pass characteristics. The frequency range selection has no adverse effects on reception except for a slight degradation in picture resolution, but there is more detail there than we can use anyhow.

Demodulator Construction

The construction of the receiving adapter



is totally noncritical. The unit can be built on a perf, PC or prototyping board. PC boards and parts kits are available from A & A Engineering.[5,6] (An assembled A & A kit is shown in the title photo.) Supply voltages of from 10 to 15 can be used. At 12 V, the current drain is only 30-50 mA from the positive supply and 10 mA from the negative supply.

System Considerations

With the FAX signal in hand, we can consider what to do with it. Immediately, we bump into a rather fundamental limitation: Our incoming signal has over 2000 pixel equivalents per second, but our printer is rated for only 100 characters per second. That means it can print about 800 horizontal pixels per second continuously if it can ignore carriage returns. So, right off we must settle for less detail than is present in the transmitted picture. Further, we wish to operate the printer in the incremental mode rather than getting the one-dot offset that occurs with bidirectional printing; this also slows things down. But all is not lost. We are forced into a slower rate anyhow by another consideration—picture geometry.

Picture Geometry

The FAX scanner at the transmitting station advances from line to line with a spacing much smaller than that of the wires in our printer's print head. Thus, if we wish to render pictures geometrically correct so that circles print as circles and so on, we must either expand our printout horizontally (print only a part of each line) or print all of a given line, but only a certain percentage of the total lines (shrink the picture vertically). (This problem also occurs with FAX screen displays and is noted and explained in the referenced articles.) In this program, I have elected to print all of the horizontal portion of the map with poorer vertical (time dimension) resolution. The program samples every third transmitted line and renders a picture that is geometrically correct.

Synchronization

Another facet of FAX should be emphasized. As mentioned earlier, the transmissions have no synchronizing pulses. The receiver is phase synchronized to the transmitter at the start of a picture and then must have a precise speed match with the transmitter. This precludes recording signals on a tape recorder. It also means our printing program must execute in exact synchronism with the transmitted signal for every printed line, but there are no sync pulses! This places some interesting constraints on programming.

There are two basic approaches to solving this problem. The first is to have a precision frequency reference that provides synchronizing pulses to the computer and thereby controls the timing. This requires a crystal-controlled timer or timing hardware on a peripheral card in the Apple. This approach also requires additional hardware to control the initial phasing. The second method, the one I chose, is to handle all timing functions in software. Earlier work I had done on screen presentation of FAX required a simpler form of timing, but it verified the approach.

In order to have precise timing of the software, the programmer must have control at all times. There can be no need to make allowance for waiting for a printer to decide it is ready to accept a character. During the development of this program, two discoveries slowly emerged that seem obvious in retrospect: (1) The normal type of printer output routines cannot be used because they wait for a "printer ready" signal, which, in turn, depends on the state of the printer; and (2) printer timing itself is not precise because the printer (at least mine) apparently does not have a crystal-controlled clock. Further, although the printer is buffered, the rate at which it can accept characters for the buffer seems to be less when the printer is executing a carriage return. I elected not to do any fundamental research on this point, however.

The way to lick the printer timing problem is to jam graphics bytes directly into the printer port, making sure, of course, that the rate is acceptable to the printer at all times. With the Apple Parallel Printer Card I use, direct output can be made with an STA instruction to location C080 + n0, where n is the slot number of the printer card. All software on the card is bypassed, and the output requires just the four machine cycles of an absolute-store instruction (STA). The printing is buffered in the program so that the printer does not have to be in synchronism with the received signal. This is the key to providing time for a carriage return, line feed and reset of the graphics inputs after each line is printed. Note that each printed line is 8 bits high and contains selected picture information from 24 transmitted lines.

Program Information

Table 2 is presented in an effort to clarify the data-handling techniques in this program. Since the program itself must

```
FAXPNT.OBJØ

2ØØØ-   AØ ØA       LDY   #$ØA
2ØØ2-   B9 74 21    LDA   $2174,Y
2ØØ5-   2Ø 21 21    JSR   $2121
2ØØ8-   88          DEY
2ØØ9-   DØ F7       BNE   $2ØØ2
2ØØB-   A9 1B       LDA   #$1B
2ØØD-   2Ø 21 21    JSR   $2121
2Ø1Ø-   A9 24       LDA   #$24
2Ø12-   2Ø 21 21    JSR   $2121
2Ø15-   A9 1B       LDA   #$1B
2Ø17-   2Ø 21 21    JSR   $2121
2Ø1A-   A9 53       LDA   #$53
2Ø1C-   2Ø 21 21    JSR   $2121
2Ø1F-   A9 3Ø       LDA   #$3Ø
2Ø21-   2Ø 21 21    JSR   $2121
2Ø24-   A9 37       LDA   #$37
2Ø26-   2Ø 21 21    JSR   $2121
2Ø29-   A9 35       LDA   #$35
2Ø2B-   2Ø 21 21    JSR   $2121
2Ø2E-   A9 3Ø       LDA   #$3Ø
2Ø3Ø-   2Ø 21 21    JSR   $2121
2Ø33-   A9 ØØ       LDA   #$ØØ
2Ø35-   8D FD 21    STA   $21FD
2Ø38-   8D FE 21    STA   $21FE
2Ø3B-   8D AØ 2Ø    STA   $2ØAØ
2Ø3E-   A9 15       LDA   #$15
2Ø4Ø-   8D A1 2Ø    STA   $2ØA1
2Ø43-   AD ØØ CØ    LDA   $CØØØ
2Ø46-   1Ø Ø8       BPL   $2Ø5Ø
2Ø48-   AD 61 CØ    LDA   $CØ61
2Ø4B-   3Ø FB       BMI   $2Ø48
2Ø4D-   8D 1Ø CØ    STA   $CØ1Ø
2Ø5Ø-   A9 ØØ       LDA   #$ØØ
2Ø52-   8D 5F 2Ø    STA   $2Ø5F
2Ø55-   A9 1Ø       LDA   #$1Ø
2Ø57-   8D 6Ø 2Ø    STA   $2Ø6Ø
2Ø5A-   AD 61 CØ    LDA   $CØ61
2Ø5D-   2A          ROL
2Ø5E-   6E EE 12    ROR   $12EE
2Ø61-   2Ø 3Ø 21    JSR   $213Ø
2Ø64-   2Ø 6D 2Ø    JSR   $2Ø6D
2Ø67-   9Ø F1       BCC   $2Ø5A
2Ø69-   4C 8F 2Ø    JMP   $2Ø8F
2Ø6C-   EA          NOP
2Ø6D-   18          CLC
2Ø6E-   EE 5F 2Ø    INC   $2Ø5F
2Ø71-   DØ Ø3       BNE   $2Ø76
2Ø73-   EE 6Ø 2Ø    INC   $2Ø6Ø
2Ø76-   A9 12       LDA   #$12
2Ø78-   CD 6Ø 2Ø    CMP   $2Ø6Ø
2Ø7B-   DØ ØA       BNE   $2Ø87
2Ø7D-   A9 EE       LDA   #$EE
2Ø7F-   CD 5F 2Ø    CMP   $2Ø5F
2Ø82-   DØ Ø8       BNE   $2Ø8C
2Ø84-   38          SEC
2Ø85-   BØ Ø7       BCS   $2Ø8E
2Ø87-   EA          NOP
2Ø88-   EA          NOP
2Ø89-   EA          NOP
2Ø8A-   EA          NOP
2Ø8B-   EA          NOP
2Ø8C-   EA          NOP
2Ø8D-   18          CLC
2Ø8E-   6Ø          RTS
2Ø8F-   A9 Ø5       LDA   #$Ø5
2Ø91-   CD FE 21    CMP   $21FE
2Ø94-   FØ Ø9       BEQ   $2Ø9F
2Ø96-   EE FE 21    INC   $21FE
2Ø99-   2Ø 6Ø 21    JSR   $216Ø
2Ø9C-   4C 5Ø 2Ø    JMP   $2Ø5Ø
2Ø9F-   AD 1E 15    LDA   $151E
2ØA2-   2Ø 21 21    JSR   $2121
2ØA5-   EE AØ 2Ø    INC   $2ØAØ
2ØA8-   DØ Ø3       BNE   $2ØAD
2ØAA-   EE A1 2Ø    INC   $2ØA1
2ØAD-   EE FD 21    INC   $21FD
2ØBØ-   A9 FA       LDA   #$FA
2ØB2-   CD FD 21    CMP   $21FD
2ØB5-   DØ E8       BNE   $2Ø9F
2ØB7-   A9 ØØ       LDA   #$ØØ
2ØB9-   8D FD 21    STA   $21FD
2ØBC-   A9 17       LDA   #$17
2ØBE-   CD A1 2Ø    CMP   $2ØA1
2ØC1-   DØ ØA       BNE   $2ØCD
2ØC3-   A9 EE       LDA   #$EE
2ØC5-   CD AØ 2Ø    CMP   $2ØAØ
2ØC8-   DØ Ø3       BNE   $2ØCD
2ØCA-   18          CLC
2ØCB-   9Ø Ø6       BCC   $2ØD3
2ØCD-   2Ø 36 21    JSR   $2136
2ØDØ-   4C 5Ø 2Ø    JMP   $2Ø5Ø
2ØD3-   A9 ØØ       LDA   #$ØØ
2ØD5-   8D E6 2Ø    STA   $2ØE6
2ØD8-   8D E9 2Ø    STA   $2ØE9
2ØDB-   A9 1Ø       LDA   #$1Ø
2ØDD-   8D E7 2Ø    STA   $2ØE7
2ØEØ-   A9 15       LDA   #$15
2ØE2-   8D EA 2Ø    STA   $2ØEA
2ØE5-   AD EE 12    LDA   $12EE
2ØE8-   8D EE 17    STA   $17EE
2ØEB-   EE E6 2Ø    INC   $2ØE6
2ØEE-   EE E9 2Ø    INC   $2ØE9
2ØF1-   DØ Ø6       BNE   $2ØF9
2ØF3-   EE E7 2Ø    INC   $2ØE7
2ØF6-   EE EA 2Ø    INC   $2ØEA
2ØF9-   A9 12       LDA   #$12
2ØFB-   CD E7 2Ø    CMP   $2ØE7
2ØFE-   DØ E5       BNE   $2ØE5
21ØØ-   A9 EE       LDA   #$EE
21Ø2-   CD E6 2Ø    CMP   $2ØE6
21Ø5-   DØ DE       BNE   $2ØE5
21Ø7-   2Ø 4B 21    JSR   $214B
21ØA-   A9 1B       LDA   #$1B
21ØC-   2Ø 21 21    JSR   $2121
21ØF-   A9 24       LDA   #$24
2111-   2Ø 21 21    JSR   $2121
2114-   A9 ØD       LDA   #$ØD
2116-   2Ø 21 21    JSR   $2121
2119-   A9 ØA       LDA   #$ØA
211B-   2Ø 21 21    JSR   $2121
211E-   4C ØB 2Ø    JMP   $2ØØB
2121-   8D FC 21    STA   $21FC
2124-   A9 2Ø       LDA   #$2Ø
2126-   2Ø A8 FC    JSR   $FCA8
2129-   AD FC 21    LDA   $21FC
212C-   8D 9Ø CØ    STA   $CØ9Ø
212F-   6Ø          RTS
213Ø-   A9 ØD       LDA   #$ØD
2132-   2Ø A8 FC    JSR   $FCA8
2135-   6Ø          RTS
2136-   A2 Ø1       LDX   #$Ø1
2138-   A9 FE       LDA   #$FE
213A-   2Ø A8 FC    JSR   $FCA8
213D-   CA          DEX
213E-   DØ F8       BNE   $2138
214Ø-   A9 B7       LDA   #$B7
2142-   2Ø A8 FC    JSR   $FCA8
2145-   A9 11       LDA   #$11
2147-   2Ø A8 FC    JSR   $FCA8
214A-   6Ø          RTS
214B-   A2 Ø1       LDX   #$Ø1
214D-   A9 EC       LDA   #$EC
214F-   2Ø A8 FC    JSR   $FCA8
2152-   CA          DEX
2153-   DØ F8       BNE   $214D
2155-   A9 85       LDA   #$85
2157-   2Ø A8 FC    JSR   $FCA8
215A-   A9 ØE       LDA   #$ØE
215C-   2Ø A8 FC    JSR   $FCA8
215F-   6Ø          RTS
216Ø-   A2 Ø6       LDX   #$Ø6
2162-   A9 FD       LDA   #$FD
2164-   2Ø A8 FC    JSR   $FCA8
2167-   CA          DEX
2168-   DØ F8       BNE   $2162
216A-   A9 74       LDA   #$74
216C-   2Ø A8 FC    JSR   $FCA8
216F-   A9 ØD       LDA   #$ØD
2171-   2Ø A8 FC    JSR   $FCA8
2174-   6Ø          RTS
2175-   ØD ØA 36    ORA   $36ØA
2178-   31 54       AND   ($54),Y
217A-   1B          ???
217B-   5B          ???
217C-   1B          ???
217D-   45 1B       EOR   $1B
```

Fig 2—Disassembled listing of the HF WEFAX machine-language program for the Apple II computer. Enter this program using the Apple's built-in monitor or the miniassembler, then save it to disk with the command: BSAVE FAXPNT.OBJØ, A$2ØØØ, L$17F. The printer setup table lies between $2175 and $217E; ignore the mnemonics, "instructions" and question marks at these locations in the listing, they are a peculiarity of the Apple's disassembler. To get the program operational, you can then use the BASIC program loader of Fig 3 or BRUN the program from disk. If the program is already in memory, simply CALL 8192 from BASIC or enter 2ØØØG from the monitor. For those of you uncomfortable with machine-language entry, a BASIC program listing using POKEs and DATA statements to enter this program is available from the ARRL. A commented source-code listing may also be obtained from the ARRL. Please address your request to the Technical Department Secretary; include $1 for the BASIC listing, $2 for the source-code listing and a business-size SASE for each listing. Identify your request as Sueker WEFAX BASIC Listing/QS-3/86 or Sueker WEFAX Source Listing/QS-3/86. See note 5.

necessarily be machine and printer specific, I would prefer to present in some detail the logic and data flow so that you can adapt the program to your equipment. The main program listing is shown in Fig 2, and a BASIC startup program is presented in Fig 3.

Let's assume a picture transmission has started with line number 1. Our program repeats in sets of 24 received lines, so we can jump in with the start of set two at line 25. The reason for doing this is that the processing and printing of data are a full set out of sync, and it is confusing to start at the beginning. Such is often the case with iterative processes; it is easier to see the logic once the starting transients are gone.

The program uses the game port location PBØ to take 750 samples from line 25. If the sampled bit is a 1, it sets the carry flag; if a Ø, it resets the carry. The carry flag is then rotated into the appropriate byte of a 750-byte picture (PIX) buffer. Each byte will ultimately have a one-to-one correspondence with the printed graphics byte in one print-head pass. At the end of sampling line 25, the program generates a time delay of about 1000 ms so that the next sample will be taken precisely at the start of line 28. This process is repeated for the first 15 received lines. During this time (7.5 seconds), the printer is allowed to complete carriage-return and line-feed operations. Line 40 is received and processed in the same fashion, but at the end, 250 graphics bytes are sent to the printer. These bytes are the first 250 from a 750-byte printer buffer that represents the previous set of lines (1-24). We sample only every third line, so we have a full second to send the 250 bytes to the printer. They are sent out with a fixed time delay that is

Table 2
Program Action

Picture Line No.	Action
23	(prior set)
24	. . .PNTR buffer | Do resets | CR LF | TD*
25	Sample 750 pixels—write bits to PIX buffer
26	then start time delay
27	to total 1500 ms from start of line 25
28	Sample 750 pixels—write bits to PIX buffer
29	then start time delay
30	to total 1500 ms from start of line 28
31	Sample 750 pixels—write bits to PIX buffer
32	then start time delay
33	to total 1500 ms from start of line 31
34	Sample 750 pixels—write bits to PIX buffer
35	then start time delay
36	to total 1500 ms from start of line 34
37	Sample 750 pixels—write bits to PIX buffer
38	then start time delay
39	to total 1500 ms from start of line 37
40	Sample 750 pixels—write bits to PIX buffer
41	Send first 250 bytes to printer from PNTR buffer then
42	start time delay to total 1500 ms from start of line 40
43	Sample 750 pixels—write bits to PIX buffer
44	Send second 250 bytes to printer from PNTR buffer then
45	start time delay to total 1500 ms from start of line 43
46	Sample 750 pixels—write bits to PIX buffer
47	Send final 250 bytes to printer from PNTR buffer then
48	write PIX buffer to PNTR buffer | Do resets | CR LF | TD* |
49	Sample 750 pixels. . .
50	(next set)

**TD—Time delay to total 1500 ms from start of second prior line. Lines 25 through 48, inclusive, represent one printed line eight bits high.*

```
 100   REM   APPLE FAXPRINT PROGRAM
 110   REM   BY K. H. SUEKER, W3VF
 120   REM   110 GARLOW DRIVE
 130   REM   PITTSBURGH, PA 15235
 140   REM   412 793 8909
 150   REM   REFER TO QST, MARCH 1986 FOR DETAILS
 160   HGR : PRINT  CHR$ (21): TEXT : HOME : VTAB 10
 170   PRINT "RESET PRINTER AND PRESS ANY KEY TO BEGIN"
 180   HTAB 18: PRINT "---> ";: GET X
 190   VTAB 10: PRINT "PRESS <RETURN> FOR 120 SCANS/MINUTE,"
 200   PRINT
 210   PRINT "PRESS ANY OTHER KEY FOR 60 SCANS/MINUTE."
 220   GET X$
 230  T$ = "120 SCANS/MINUTE": IF X$ <  >  CHR$ (13) THEN
      T$ = "60 SCANS/MINUTE"
 240   PRINT : PRINT "YOU CHOSE ";T$
 250   PRINT : PRINT "WAIT FOR PROGRAM TO PRINT."
 260   PRINT  CHR$ (4);"BLOAD FAXPNT.OBJ0"
 270   IF X$ =  CHR$ (13) THEN  GOTO 430
 280   REM
                 POKES FOR 60 SCANS/MINUTE

 290   POKE 8497,20
 300   POKE 8503,07
 310   POKE 8505,255
 320   POKE 8513,213
 330   POKE 8518,07
 340   POKE 8524,07
 350   POKE 8526,255
 360   POKE 8534,142
 370   POKE 8539,16
 380   POKE 8545,12
 390   POKE 8547,255
 400   POKE 8555,140
 410   POKE 8560,06
 420   REM
                START THE PROGRAM

 430   CALL 8192
```

Fig 3—This BASIC "HELLO" program performs several functions. It permits you to select 60 or 120 scans per minute, BLOADs the FAX program and POKEs any necessary changes into the proper memory locations.

acceptable to the printer. A time-delay routine fills out the time to exactly 1500 ms from the start of line 40. Line 43 is received next and processed, followed by transmission to the printer of the next 250 bytes from the printer buffer and an accompanying time delay. The last sample from this set, line 46, is handled in the same fashion and the last 250 bytes are sent to the printer. Now, we have sent all 750 bytes from the printer buffer and have completed all eight sampled lines from the current set of 24 to fill out our picture buffer. The final steps are to write the picture buffer to the printer buffer, get ready for the next set by doing resets where required and set the printer for the next line of 750 graphics bytes. A carriage return and line feed are also initiated. Again, a time-delay loop is used to fill out the 1500-ms period.

The BASIC "HELLO" program provides you with a selection of 60 or 120 (standard) scans per minute. If you select 60 scans per minute, several POKEs alter the machine-language routine before the program is started. The 60-scan-per-minute rate is used, for instance, by Russian FAX and by commercial radio stations sending pictures. It is possible to copy such pictures with this program.

Operating

Connect the demodulator between the receiver and computer. Use shielded wire for the interconnections. Since most computers can be expected to radiate some RF hash, a good signal level from the antenna will help reduce the effects of this interference. A random-length long wire or dipole antenna will suffice, but the better the antenna, the better the results.

Receiving conditions can be expected to vary considerably. HF-signal propagation is nothing to write home about these days, but perseverance on your part should pay off. On occasion, signal strength may be good, but multipath distortion will ruin maps. Some off-the-air pictures I've captured are shown in Fig 4. The stations listed for North America in Table 1 are on the air often enough so that one of them should be available to you nearly any time of the day or night. FAX transmissions may alternate with RTTY on some frequencies.

Load and run the program. Place the receiver in the SSB mode for FAX reception. Sideband selection and tuning should be chosen so that the first segment of the LED bar graph is lit most of the time, and the remaining segments flash with the incoming signal. The receiver audio level should be set to deliver about 500 mV to the demodulator. Use of the opposite sideband will invert black and white in the printed picture.

The start of each FAX transmission is signalled by a sync signal of about 25 lines, each of which is 95% black and 5% white. During this time, tuning-bar segments 1 and 10 should light in correspondence. The sync signal can be recognized as a steady

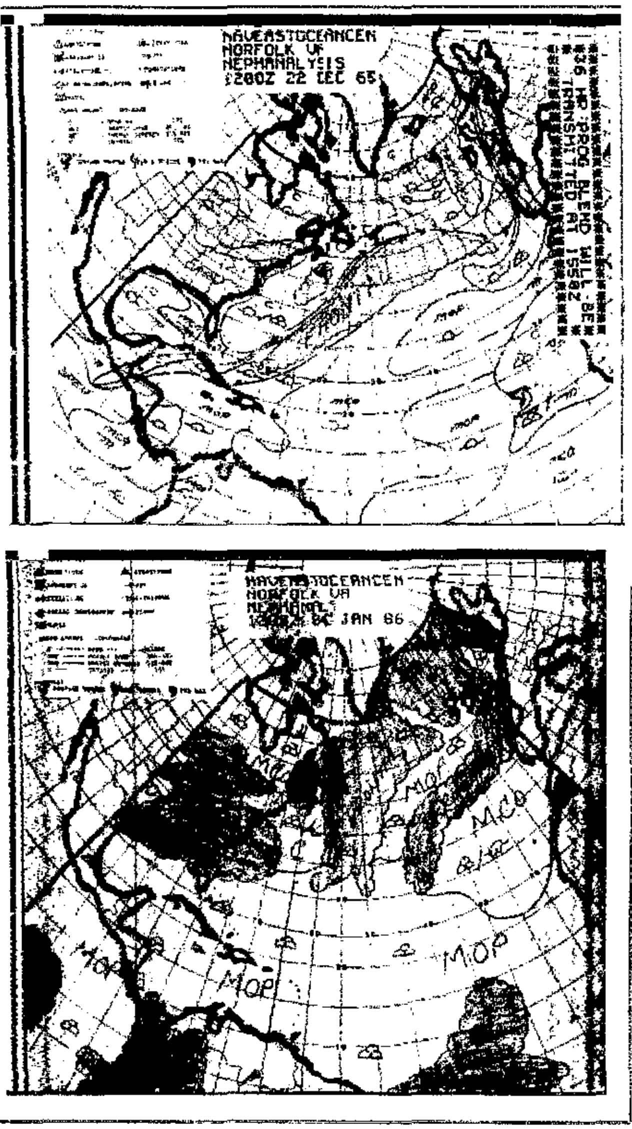
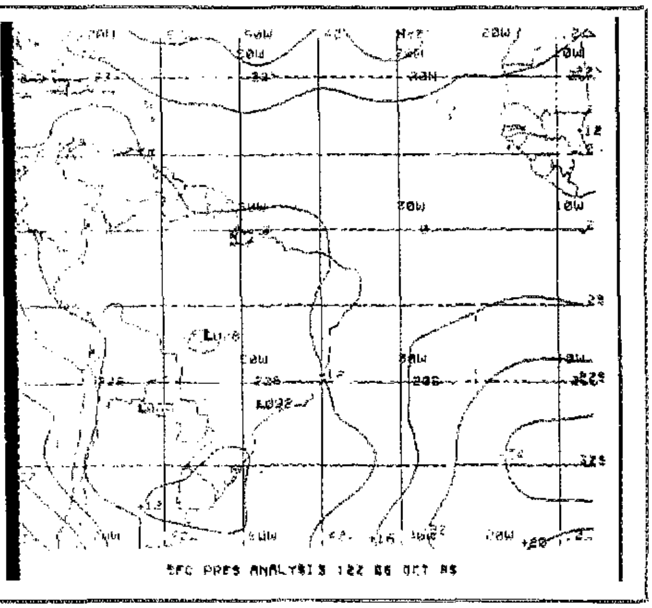


Fig 4—Some weather maps produced on the author's dot-matrix printer.



tone interrupted every half-second by a short burst of a second frequency. If you miss this, you will have to take pot luck on phasing and get out the glue and scissors. The map will be rendered correctly, but will wrap around the page. Synchronization can be accomplished manually by pressing any key on the computer while the sync signal is being transmitted. Print density is adjusted by means of R13, which varies the trigger point of the comparator, U2B. R13 can be used to aid in noise rejection and for optimizing the contrast on satellite photos. The satellite photos are computer enhanced with geographical features and political boundaries, but the print density is rather critical for best reproduction of these faint details.

Other Aspects

I must confess that the receiving adapter and programming form my major interest in FAX weather maps. For those of you interested in pursuing the meteorological aspects of the maps, I recommend "A Mariner's Guide to Radiofacsimile Weather Charts" by Dr. Joseph M. Bishop. It is available from Alden Electronics.[7] Alden manufactures a complete line of facsimile machines for general use. Surplus FAX machines and more FAX information are available from Atlantic Surplus Sales.[8]

Anyone with access to a high-speed printer with near-letter-quality dot density and a wide carriage may be able to print entire maps at significantly better resolution. These computer printing techniques should be adaptable to reception of weather-satellite transmissions and to amateur SSTV and FAX. This particular program does not render a gray scale, but perhaps one of you may be able to figure out a way to do this. That is the spirit of Amateur Radio!

Notes

[1]K. H. Sueker, "Apple FAX: Weather Maps on a Video Screen," *BYTE*, Jun 1984, pp 146-151.

[2]E. W. Schwittek and W. G. Schwittek, "WEFAX Pictures on Your IBM PC," *QST*, Jun 1985, pp 14-18.

[3][The C. Itoh 8510AP and Apple dot-matrix printers are essentially identical to the NEC printer. When using a printer other than an NEC 8023A, be aware that some printer-code differences may exist. Also, some printer-interface cards (like the Microtek Apple Dumpling) do not send a strobe signal automatically as does the Apple card. These differences must be taken into account when adapting the program to different equipment types as the timing loops are certain to be affected.—Ed.]

[4]Robert B. Grove, "Confidential Frequency List," Gilfer Associates Inc, Park Ridge, NJ, pp 68-71.

[5]A & A Engineering, 7970 Orchid Dr, Buena Park, CA 90620, tel 714-521-4160. (PC board only, $8.35 plus $1 shipping and handling; complete kit, $24.15 plus $1.50 shipping and handling; assembled unit, $31.40 plus $1.50 shipping and handling. California residents add 6% sales tax.) All of the programs associated with this article are available on disk from A & A Engineering for $5. These programs include a "HELLO" program with a unique billboard written in machine language, the BASIC loader, the main program and a commented source-code text file.

[6]PC-board templates *(this is a double-sided board layout)* and a parts overlay are available from the ARRL for $3 and an SASE. Address your request to the Technical Department Secretary and identify your request as the HF FAX Demodulator/QS-3/86.

[7]Washington St, Westborough, MA 01581, tel 617-366-8851. The book price is $9.95 plus $2.50 shipping and handling.

[8]"Weather FAX Guide," Atlantic Surplus Sales, 3730 Nautilus Ave, Brooklyn, NY 11224. [Some of the information contained in this guide was also published in A5, May 1982. Readers will also find occasional WEFAX coverage in *SPEC-COM* (formerly *A5*). For information, contact Mike Stone, WB0QCD, SPEC-COM Communications, Inc, PO Box H, Lowden, IA 52255-0408.—Ed.]

Keith Sueker has been continuously licensed since 1941, when he received the call W9SQZ. Other calls he's had include W0SQZ and W3TLQ. Keith obtained his Extra Class ticket in 1969. Employed by Westinghouse Electric Corp for 19 years, Keith is presently the Engineering Manager, Power Systems, for Robicon Corporation, where he's worked the past 16 years. In his present position, he is engaged in the design and manufacture of high-power SCR apparatus. Keith holds a BEE from the University of Minnesota and an MSEE from the Illinois Institute of Technology. In addition to writing for QST, *Keith's had articles published in* Ham Radio Magazine, BYTE *and* Electronics World.