

A Practical Weather Satellite Receiving System, Part 2

Software and interfacing with the PC.

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Last month we covered the setting up of a weather satellite receiving and decoding system for polar orbiting satellites, the pictures from which can be displayed on a PC using a shareware package called JVFAX 6.0. Part 1 covered the antenna, preamp and receiver requirements, and the decoder unit.

This month we will cover the parallel I/O card to link the decoder to the PC, PC requirements, and the JVFAX 6.0 display software.

Weather Satellite Display Systems—A History

I remember seeing, in 1965, a hardware design from Fairchild for a 2400 Hz time-base divider. It used, can you believe it, gas discharge tubes to provide the numeric division to divide the 2400 Hz satellite signal to 0.5 Hz for synchronizing the early TIROS satellite signals. Have we ever come a long way since then!

Early display systems included direct exposure of scan lines from a CRT onto a camera, a line at a time. The camera shutter was held open for the duration of a satellite pass, where the variable intensity "flying spot" traversed a (preferably large) CRT side to side, top to bottom, thus integrating the picture onto film. The shutter was then closed, and the film developed to get a picture. Excellent results were possible with careful adjustment, but the system was slow, clumsy, and one could never see the picture in real time to make adjustments. Anyway, how many of us have access to darkroom equipment?

Later systems included fax-type printers that exposed photosensitive or electrosensitive film attached to a rotating drum, the speed of which was synchronized to the spacecraft horizontal line rate. The optical assembly was attached to a traveling horizontal lead screw, which traversed the paper incrementally, synchronized to the spacecraft vertical line rate. Using a modulated and focused light source, it would focus a dot onto photosensitive paper to produce the image. The other method used a current-driven stylus resting on electro-sensitive (conductive) paper, which burnt off the white outer coating, exposing the black undercoating, much

like the way our current fax machines work. Varying the stylus current gave a good approximation of gray scale. An audio tape recorder was usually used to store received pictures for later playout, but archival picture quality was very dependent on tape quality and the way the audio tape recorder was maintained.

With the advent of microprocessor-based integrated circuitry, such pictures can be received and stored digitally, and permanently stored on hard disks or floppies, with absolutely no degradation of picture quality. Suddenly, the limiting factor on displayed quality is in the speed of the microprocessor (can it capture hi-res pictures fast enough?), the amount of digital storage available (for hi-res pictures you need lots of disk storage space), and not least, the video display system used.

Display Systems

One of the interesting things about digitally-based weather satellite displays has always been the trade-off between spatial resolution (the number of pixels per line able to be displayed on the screen) and the number of gray scales displayed. The two are directly related because multiplying one (the number of bytes per pixel) by the other (the number of pixels per line) gives the total storage requirements per picture (see below). Matjaz Vidmar YU3UMV states in his 1982 article in *VHF Communications* that he considers radiometric resolution (the number of gray scales displayed) to be far more important than the spatial resolution (the number of dots per line). In other words, if you have to make the choice in a trade-off, it is better to display more gray scales than more dots per line. I agree. In my experience, the absolute minimum number of gray scales for an acceptable picture quality is 16. Below this, you lose detail fast. I consider the absolute minimum number of pixels per line that can be displayed horizontally to be 256; again, below this you lose detail. Since the number of gray scales and the number of pixels have a direct relationship to memory storage required in a PC, usually some compromise has to be reached. For instance, 256 pixels per line at 4 bits (16 gray scales) will allow

information for two pixels to be stored in a single 8-bit memory byte. In a 256-pixel line x 16 gray scale picture x 256-line picture, the number of bytes of memory storage needed is $(256 \times 256) / 2$, or only 32K of memory. If you consider the other end of the scale, a picture of 1024x800 pixels, a GOES picture at full resolution of 8 bits per pixel (256 gray scales), will need nearly 820K of memory per picture!

The original display system I built was the design from Matjaz Viroslav YU3UMV. This gave a 256-pixel x 256-line display, with 64 gray scales displayed on a black and white TV monitor. This hardware labor of love had about 60 TTL and DRAM chips on three PC boards, with 64K of dynamic memory and took a long time to debug and get working. Although picture quality was very acceptable, the system could only save to audio tape, and pictures could not be manipulated or printed at all after reception. In its day (11 years ago), it represented the state of the art. Systems that were affordable to the amateur stayed with the old technology until fairly recently, until PC hardware and software "came of age." I still use the YU3UMV system as a second display—and it works fine!

The PC Solution

Almost everyone has a personal computer of some sort at home. Many of these are based on the IBM PC. With the current price wars raging in the marketplace, prices of PCs have come plummeting down, and one can now buy systems that are excellent value for the money. For those of you who don't own a PC system, perhaps now is the time to invest!

With the correct programming, the PC offers flexibility in displaying, manipulating, printing, and saving pictures that hardware-based solutions just can't offer. Because the system is software-based, any upgrade is relatively cheap; you don't have to modify hardware, you just plug in another program or upgrade. The recent decrease in price of VGA display systems allows the display of 256 gray levels on a monochrome monitor. In these systems, 1024x768 display pixels is usual; this makes possible really sophisticated display systems at affordable prices. Such

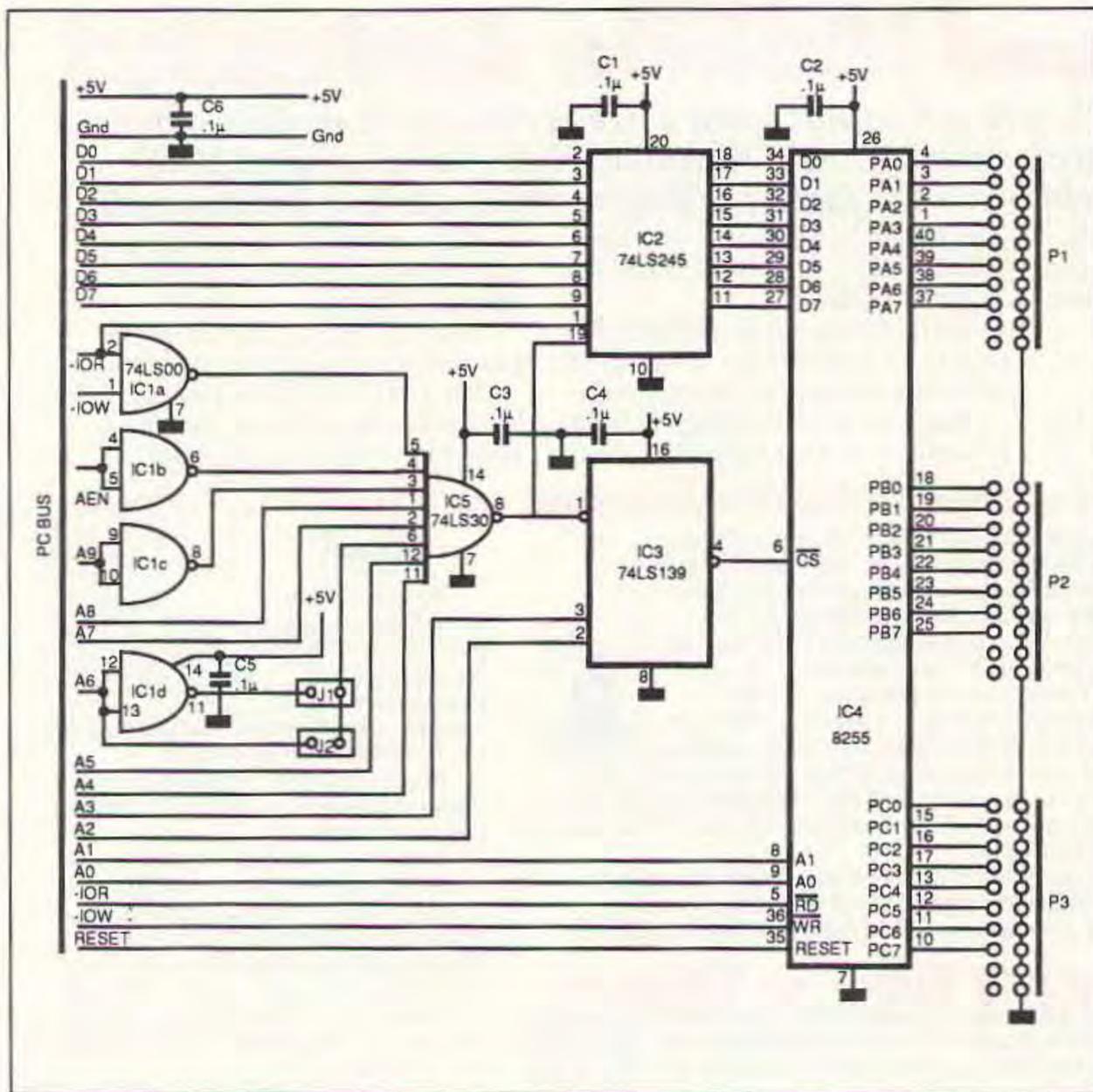


Figure 1. Circuit diagram of the parallel interface card.

systems can store satellite data at the theoretical maximum resolution possible. JVFX 6.0 is capable of doing this.

Hardware Requirements for the JVFX 6.0 Software

Minimum requirements are a PC XT or AT, with a minimum of 640K of memory, a hard disk drive of 20 Mb or more, and a 5-1/4" 1.2 Mb or 3-1/2" drive. A Hercules, CGA, EGA, or VGA display will work. I must say that results using other than EGA or VGA are marginal. If you have more than 640K of RAM, use the HIMEM.SYS utility so that JVFX 6.0 will recognize the extra memory. This is useful for the movie option and the q(quick) save option (see below).

Preferred: A fast 286 (min 16 MHz clock), or a 386/486 with a minimum of 2 Mb RAM, VGA mono or color monitor. A VGA display controller with Trident, Tseng, Genoa, Paradise, Video 7, or VESA compatible chipset is preferred. All these controllers should be able to display SVGA 16 to 256 gray scale mode. For this mode, you should have at least 1 Mb of video memory on your display card. If you are rich or lucky enough to own one of the super super VGA controllers, you can store and display 1024 x 768 x 256 gray scales for superb results.

However, the standard VGA display mode of 640x480x16 gray scales (or colors) on a standard VGA card is very acceptable, as JVFX 6.0 "dithers" the 16 gray levels to display an effective 64 gray levels on screen.

Remember, what is stored in memory and what is displayed can be different. For instance, you might elect to store pictures at 800x800x256 gray scales, but you might only be able to display at 640x480x64 resolution. However, if you elect to magnify the picture, you will achieve far better results if you save at the higher resolutions.

A word about monitors: If you are upgrading to a VGA monitor, there are very cheap VGA black and white monitors available right now that offer superb value; they display 256 gray scales beautifully. In South Africa, the street price right now for a 14" B/W VGA monitor is under \$100, a good value.

The PC Interface

The 8-bit parallel video signal from the decoder described in last month's article is fed to a plug-in parallel I/O card. This card contains an 8255 peripheral interface adapter chip, and a variety of common TTL chips that do the address decoding and data buffering. Figure 1 shows the circuit diagram of this parallel interface card. IC1 is a 74LS00 that, together with IC5, a 74LS30, decodes either address 1B0 (Hex) or 1F0 (hex), depending on where jumpers J1 and J2 are set. I usually use address 1B0. IC2, a 74LS245 buffers the data when writing to the PC data bus. IC3, a 74LS139, is an address selector. IC4 is an 8255 IC, which can be programmed so that any of 24 output lines can be set as an input or output. We will be using

the PA0-PA7 lines as inputs. We have the advantage that the 8255 on power-up initializes its registers to bring up PA0 to PA7 as input lines, so the line direction control registers do not need to be set first. In other words, when you switch on, PA0-PA7 are ready to accept TTL inputs, perfect for our application. The two other ports can be used as control lines for other applications, if you are prepared to put a bit of programming into it.

The data and control registers of the 8255 are:

- \$1B0: Port 1a Read/Write buffer
- \$1B1: Port 1b Read/Write buffer
- \$1B2: Port 1c Read/Write buffer
- \$1B3: Port 1 Control register

We are only required to place data into port \$1B0 from the decoder; the computer reads from address 1B0 whenever it needs to fetch a pixel value from 0 to 255. You can of course use ports \$1B1 or \$1B2 if you wish to. I happen to use port \$1B1, or port 1b (PA1 to PA7). If you set the card to \$1F0, then addresses run from \$1F0 to \$1F3.

If you wish to program the other ports, I strongly suggest that you get the programming data sheets on the 8255 from your friendly chip supplier. Setting bits on port \$1B3 will program the three ports for input or output.

Building the Interface

This is pretty straightforward if you follow the component overlay in Figure 2(a). I strongly suggest that you follow the procedure of first checking for shorts on the power lines with an ohmmeter, plugging in the board, then checking for correct voltages on the power supply pins on all ICUs (+5V) at the sockets. Only then should you plug in your ICUs. The overlay plainly shows the orientation of the IC sockets and the ICUs— notches on the ICUs are plainly visible. Some ICUs have a dot at pin 1.

On this PCB overlay, only the traces on the component side are shown for clarity, since this is a double-sided board. If you elect to make your own PCB, remember to buy high profile sockets so that you can reach the socket pins on the component side, as you will have to solder all pads on both sides of the PCB. You will also have to stake through all feedthrough pads with off-cut wire. The kit PCB is plated through, so you will only have to solder one side.

Testing the Interface

Using GW BASIC, enter and run the following simple program. First select port PA0, PA1, or PA2 for testing when requested. We will use only port PA0 for our project. Use a voltmeter to check for 0V on each line when prompted, and for 5V on each line when prompted to enter the bit number. Measure on the appropriate 8255 IC pins by referring to the circuit diagram. Make sure that you use a sharp-pointed probe so that you do not bridge IC pins when measuring.

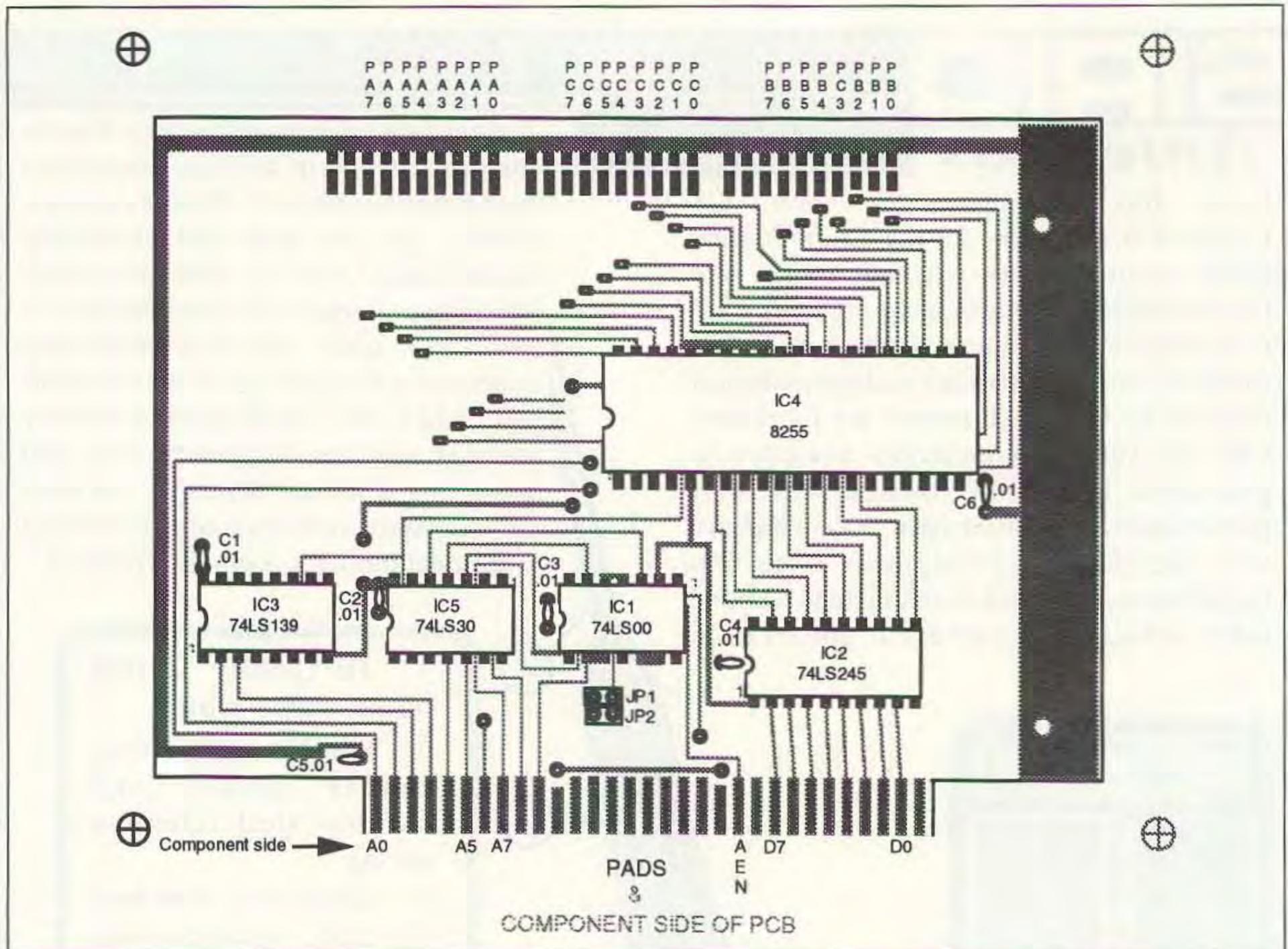


Figure 2. 1:1 PCB component overlay.

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10 REM Test 8255 I/O lines
20 CLS
30 INPUT "Select 8255 port 0,1, or
2";PN
40 PRINT
50 PORT=&H1B0
60 OUT PORT+3,&H80:'SET PORTS 0,1,&2
AS OUTPUTS
70 OUT PORT+PN,0:'SET SELECTED PORT
LINES TO 0
80 PRINT " Physically check with a
voltmeter that all lines on port
";PN;" are 0V"
90 PRINT
100 INPUT " Hit enter when
done...";ANS$
110 CLS
130 INPUT "Enter bit number to set
high(0-7)";NUM
140 OUT PORT+PN,2^NUM:PRINT
150 PRINT "Now measure with a volt-
meter that bit (*;NUM;) of port is
high"
160 INPUT " Hit enter when done,
<CTRL> <BREAK> to exit";ANS$
165 PRINT:GOTO 130

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If all works as planned, your interface is complete. The only remaining thing is to strip and tin the free ends of the interface cable and solder the correct lines to the decoder board output pins. Remember to connect at least one earth line. I would strongly suggest that you provide some form of strain relief to the cable at the decoder using a cable tie.

Setting Levels on the Decoder

On a 2400 Hz input signal, you should initially adjust decoder VR2 (offset) voltage at IC5 pin 6 so that black turns to your first gray level on screen at about 0.3V DC. Peak white should be at around 5V. On a live satellite signal, set VR1 to two o'clock and adjust VR3 (coarse gain) so that you have comfortable travel for VR1. You can fine-tune these settings when receiving your first satellite signals using JVFAX 6.0, as JVFAX 6.0 has a very useful facility that will display your instantaneous picture brightness as a number from 0 to 255 in a window on screen.

Sometimes you will get a picture on screen that looks chaotic—the gray levels do not seem to be the right values. In this case, check that you have wired bits 0-7 from the output of the decoder to the input of the 8255 in the right sequence. Be careful—the decoder board bit output pins do *not* go in a bit-0-to-bit-7 sequence. Match the output bits of the decoder (they are shown on the PCB) to the correct PA0-PA7 bits on the interface cable.

Figure 3 shows a Meteosat APT transmission, received using the decoder and display equipment described in this article. This is an example of the kind of quality achievable

from Meteosat 4 APT. It was captured on PC using JVFAX 6.0 at 800x800x256 resolution, then transferred and played out via Apple Macintosh to a laser imagesetter with minimal processing. The GIF file was 650K in size. You cannot fail to recognize the Red Sea, but particularly interesting is the detail available showing the course of the Nile river, Lake Nasser, and the desert features inland. My 10-year-old son and I had a ball with an atlas identifying relief contours in the Saharan desert. What we proved was that what you see doesn't always exactly follow the picture in the atlas! This is what makes this hobby so rewarding! Note the JVFAX real-time status display on screen showing the instantaneous pixel values. In this illustration, they are centered around 30% gray.

Figure 4 shows the current station I operate. The receiver and PLL VFO are as offered in the ZS6BNT kit, available from me (see the address at the end of this article). The receiver is a sensitive dual-conversion design, with the second IF at 300 kHz, which is optimized for weather satellite reception. The low second IF frequency is chosen to optimize noise. The VFO output frequency is locked to the stable LFO.

The tone-operated squelch is used to open receiver audio on receipt of a 2400 Hz satel-

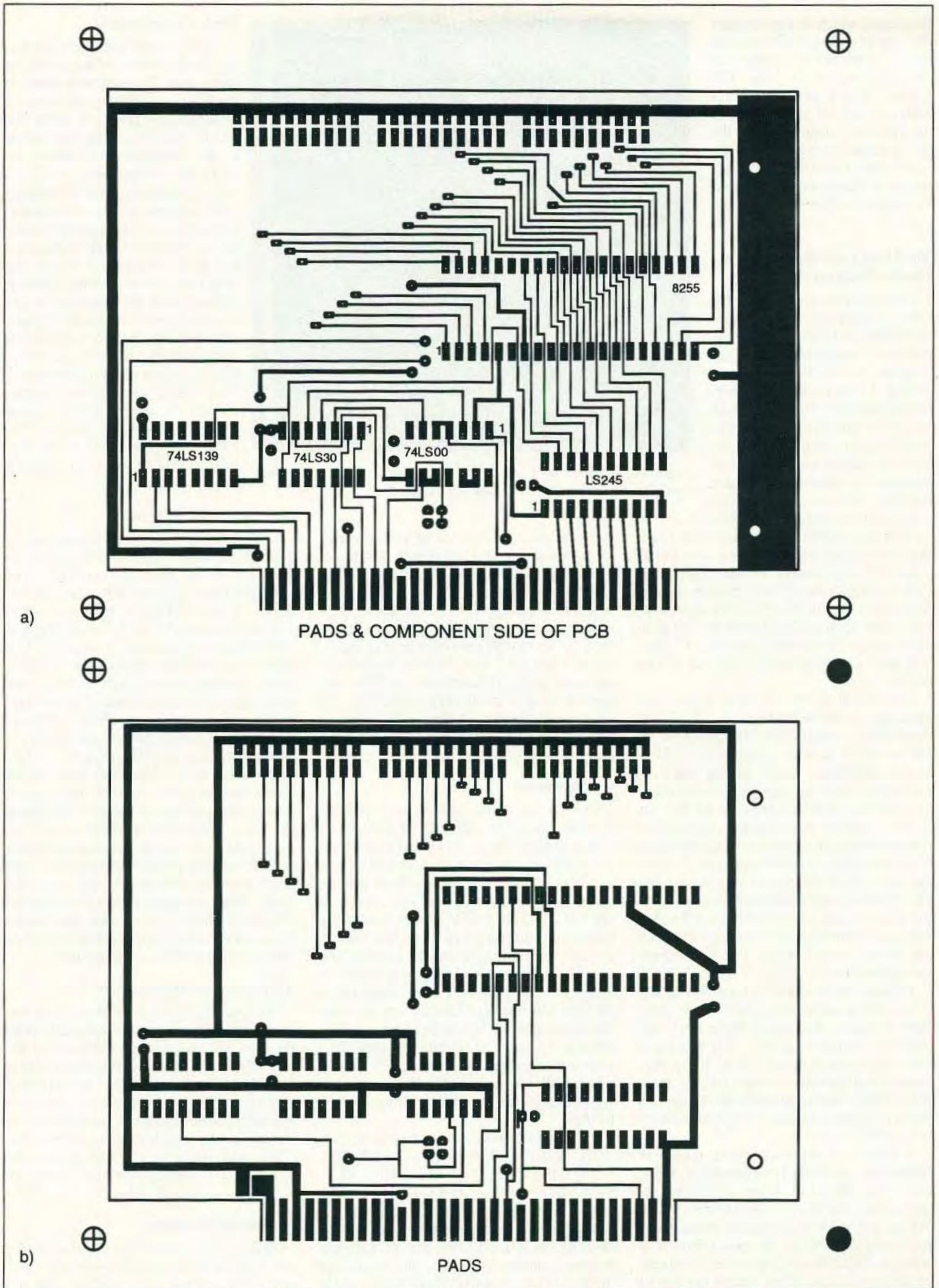


Figure 3a.) 1:1 PCB layout, component side; b) 1:1 PCB layout, solder side.

lite signal, which in turn triggers the start of a picture recording on the PC. This allows unattended recording on a casual basis. The S-meter is just an op amp in a bridge circuit for zero setting of the meter. The demodulator is the one described in the previous article. The preamp is a mast-mounted Hamtronics unit, and the antenna is the WB8DQT design.

The JVFAX 6.0 Shareware Fax Display Program

I first came across JVFAX 6.0 when browsing through the HAMNET libraries on CompuServe. It was described as a fax program. It is all that, and more. JVFAX 6.0 was written by Eberhard Backeshoff DK8JV, and all he asks is that those who download the program operate on the shareware honor system, where a donation is requested. Sending a donation will get you the latest version of the program on disk, as well as a variety of alternative hardware interface designs for interfacing your PC to your receiving system. I implemented the system using the home-built decoder unit described last month. DK8JV offers an innovative hardware and filter design for 255 gray scales using the control lines on a PC RS-232 port! The details are at the end of this article.

JVFAX 6.0 will decode and display just about any facsimile transmission, from FM-modulated weather chart transmissions on HF or SSTV to AM transmissions from weather satellites. It will do this at all accepted line rates and aspect ratios. A variety of interface schemes are catered for. Of course, weather chart transmissions use a tone that varies in frequency (FM) to encode white to black, so a different type of interface is required between the receiver and the PC. Weather satellites present a signal varying in amplitude, so are known as AM transmissions despite the confusing fact that they are carried on an FM transmission medium in the first place!

Pictures can be stored to hard disk in real time, with a computer of sufficient speed (286 or better). Yes, that is right: While the picture is being received, your computer stores the picture to hard disk! Early programs used memory storage only to store pixel values. Storing in real time to disk gets one around the constraint of limited memory in your PC.

A variety of display monitor types are catered for, including Hercules, CGA, EGA, and VGA. However, if you want good results, you should try to stick with VGA. Within the VGA environment many VGA modes are catered for, the most common of which is 640x480x16 gray scales. A variety of set-up screens allow direct setting of VGA video card registers to implement

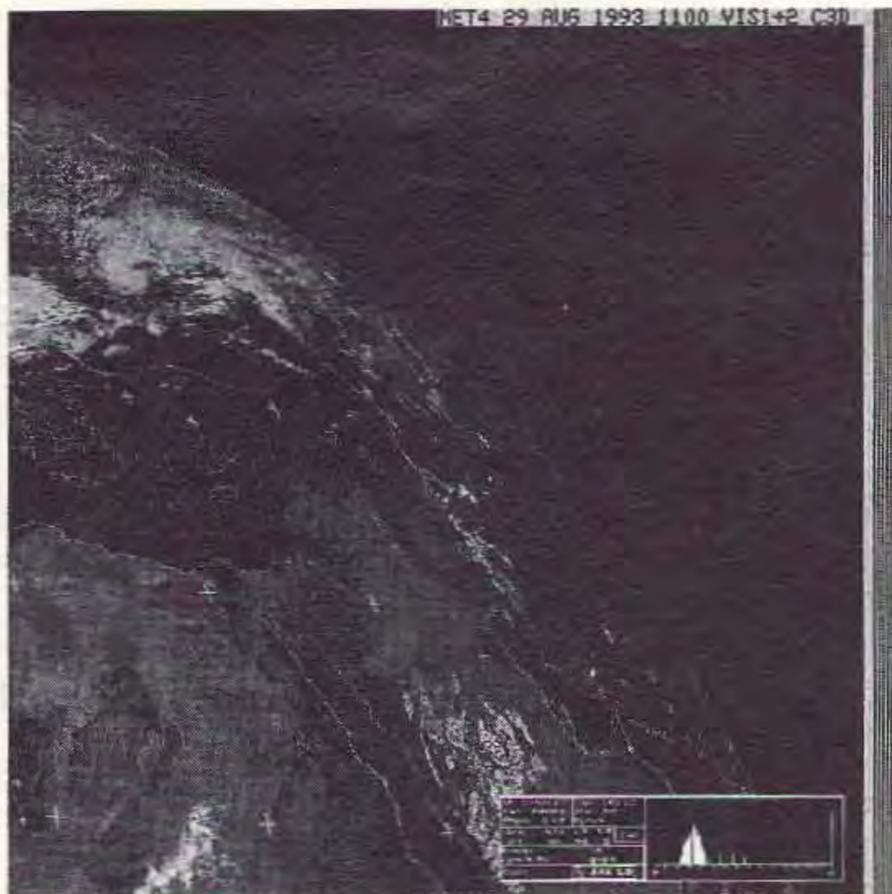


Figure 4. Meteosat APT transmission, received using the decoder and display equipment described in this article.

different modes, for those of you who like to experiment with such things. My most-used mode is SVGA 16-color (gray scales). JVFAX will actually dither the 16 gray scales so that 64 gray scales are actually represented on screen. Being lucky enough to have access to high resolution display equipment in my job, I have had fun implementing some of the VESA modes available, and have been able to display 1024x768x256 gray scales directly off Meteor, NOAA, and Meteosat transmissions, for spectacular displays.

Configuration

JVFAX 6.0 comes with a comprehensive English manual in the form of a disk file. When printed out, it gives you everything you need to know about the operation of this excellent package. We will not delve into the specifics of operational detail here, except to say that a number of things need to be set up before you can receive pictures. You need to set up your parallel interface address, the number of bits for the pixel, your monitor type, the printer, the default directory where pictures will be stored, and the satellite configuration which you will be receiving. This is all done on a configuration screen. Pictures are stored in CompuServe GIF format, which makes for easy interchange of data, as well as an efficient, compact picture storage format.

The video display modes catered for are CGA, Hercules, EGA-Hires, EGA 640x200, EGA 640x350, AT&T 640x400, VGA 640x480x16 colors, and SVGA 16 and 256 colors. A useful feature is being able to customize SVGA parameters by directly addressing the AH, AL, BH, and BL registers in your computer to set the video mode. For instance, I can set 640x480x16 SVGA mode 58 by setting the AL register to 58.

Mode Configuration

A database of satellite or fax type can be set up on a Mode configuration screen. This contains details of the lines per minute, the Index Of Co-operation (IOC is a rather academic way of stating the picture height-to-width ratio—I cannot believe the obtuse way academic types describe the simplest things!). Also required are the resolution in pixels per line, the number of intensity levels, and details of the satellite or fax transmission start and stop tones for automatic phasing, starting, and the stopping of any transmission. Each mode of transmission can be separately stored and called by name and changed on the fly when receiving pictures. Note that on some slower computer systems such as 8086 XT-based systems, the 120 LPM and 240 LPM line speeds only work when you choose lower screen resolutions.

Setting up Sync

One of the more important adjustments required is to set the line clock rate in JVFAX 6.0 to match exactly the spacecraft line clock rate. Otherwise, pictures will appear slanted on-screen, and if the timing is far enough off, the pictures will not be recognizable at all! As PC clock speeds vary widely, and the receive sync is controlled by the computer clock, you will have to make an initial set-and-forget adjustment to lock the spacecraft line rate to your computer. JVFAX 6.0 has a novel way of setting this. By pressing a key when viewing a picture, you get a vertical line which you can slant using the keyboard arrow keys so that it parallels the angle of slant of the sync line on the received picture. Hit "save," and that's all there is to it. You never have to set it again for the same spacecraft. It is stable too, because the sync is derived from the computer crystal-controlled clock. Other packages I have used required software timing loops to lock sync, which produced dreadful results because every time I reloaded the software, sync drifted.

Automatic and Manual Sync

On spacecraft that have start, sync, and stop tones, JVFAX can automatically place the sync line on the correct side of the picture. With the continuously transmitting NOAA satellites, sync pulses are very short and are difficult to decode, so you must manually move the picture sync bar to the left or right to display a whole picture. With GOES and Meteosat, phasing, picture start and stop are entirely automatic when the software is set up correctly.

Automatic Reception

JVFAX 6.0 can use time and date data in the PC clock to go into an unattended reception mode, and store the results to disk in a

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series of picture files. If you have set up the start and stop tones of JVFX correctly, the software will recognize this, and close off picture file storage at the appropriate time. This is fine for GOES, Meteosat, and many fax transmissions which have clearly-defined start and stop tones, but not very useful if you are trying to receive continuous transmissions from the polar orbiters. In this case, reception starts at the satellite AOS time (as defined in JVFX 6.0), and closes at the LOS time. You should set the AOS time a minute or two after the satellite rises above the horizon; this way you get the best picture quality and the smallest file size because you avoid the signal fades that occur right after satellite AOS when the bird is just above the horizon.

Because you can set an individual reception mode at any time, you can automatically switch modes after every picture received. JVFX 6.0 also has the ability to execute a separate program just before it switches to automatic receive. In my case, this would usually be a program written in BASIC. It sets up receiver frequency via the parallel interface, using port PA1 on the 8255. You could also use the 8255 to switch receiver audio lines as well.

Fax Transmissions

The software will transmit displayed pictures in WEFAX 288, WEFAX 576, Ham 288a, and Ham 288b format. The easiest option is to take the modulated output off the PC speaker, in which case some low-pass filtering and signal attenuation will be needed to clean up the waveform before feeding to the TX input of your rig at the correct level.

Movie Option

You must have seen the animated weather pictures on your local TV station, which show cloud patterns moving across a stationary map. CNN does this, and the British Sky News has spectacular 3-D cloud views in their weather slots. JVFX 6.0 will store multiple pictures of one GOES or Meteosat quadrant, which are only separated in time. The ground features appear to be standing still, but the clouds move! You will need access to your local GOES or METEOSAT transmission schedule. You then set up automatic reception times for the same quadrant (picture) based on the schedule. Fifteen seconds before due time, JVFX 6.0 will switch to reception mode and await a satellite picture start tone, then store the results in a sequentially-numbered disk file. When displayed, these files are sequentially loaded into RAM on the fly (so the more memory you have, the better).

Receiving Pictures and Adjusting Your Decoder

From the main screen, selecting the FAX option will put you into reception mode, and the software awaits the first picture line. This builds up line-by-line from the bottom of the screen. When the line reaches the top of the screen, the whole picture scrolls downwards. Hitting the RCS key while receiving will bring up a window that shows a histogram of the white-to-black instantaneous picture values. This allows you to adjust the histogram so that most of the black-to-white energy is displayed in the middle of the X-axis on the graph, thus optimizing your black-to-white ratio. An option allows for display of the instantaneous 0-255 value of picture intensity as well. This is useful for setting up your interface. Simply feed a constant 2400 Hz tone to your decoder, adjust VR1 to 2 o'clock, and adjust offset pot VR3 for a value of

255—when the peak white LED just begins to light. No signal should give a value of 0.5 on the display. You can also adjust peak levels while receiving pictures, if you have GOES or Meteosat receiving capability. On these satellites there are lots of transmissions with 10 seconds or more of continuous peak white or full black. This allows adequate time for you to get that adjustment screwdriver in there. With NOAA transmissions this is a little more difficult, as white and black pictures are transmitted side by side, and so your peak white and peak black values do not stay there long enough to allow definite measurement. In this case, experiment for best results.

Zooming, Rotating, and Colorizing Pictures

In the view mode, you can recall and display any stored picture. All pictures received casually are stored in a temporary file called TMPPIC.GIF on disk, which can be renamed if required. Each succeeding picture overwrites the temporary file. In this way, you do not require limitless disk space and you can extract your best pictures by renaming them. A Q(U)ick save facility on screen will ask for a filename. In real time, you can only see part of the unfolding picture on screen but the whole picture is stored, and on a 15-minute NOAA pass this can occupy over 2.7 Mb of disk space! When in view mode, JVFX 6.0 allows you to zoom into any part of a stored picture. You simply frame the area required to be enlarged by using keyboard keys and it zooms in to fill the whole screen. So, the smaller the frame, the bigger the magnification. Too much magnification will bring it to a point where the pixels become very "blocky"—they appear to be square. This is caused by the dithering technique used. You can zoom the picture 10 times, but a practical maximum is about four times; with greater magnification than this viewing results generally become unacceptable.

You can rotate or invert pictures. If you use the SVGA 255 color mode, you can colorize the picture with red, green, and blue in various intensities to create very natural-looking color displays, which seem to be optimized for a natural-looking picture—for instance, ocean colors could be blue, ground is brown or green, and clouds are white. A graphical sliding pointer allows for easy setting of color values.

Using a feature called JVcolour, a fairly natural false color image can be displayed while received, with seas deep blue, land blue or green, and clouds white.

How Do I Print My Pictures?

There are a number of printer formats set up for JVFX 6.0, which work on printers connected to the PC's printer port(s). Most of these are dot matrix types, following various EPSON or IBM formats. I have never been able to get a decent-looking picture off a dot matrix printer, because they are incapable of printing gray scales directly and must emulate a gray scale by clever programming;

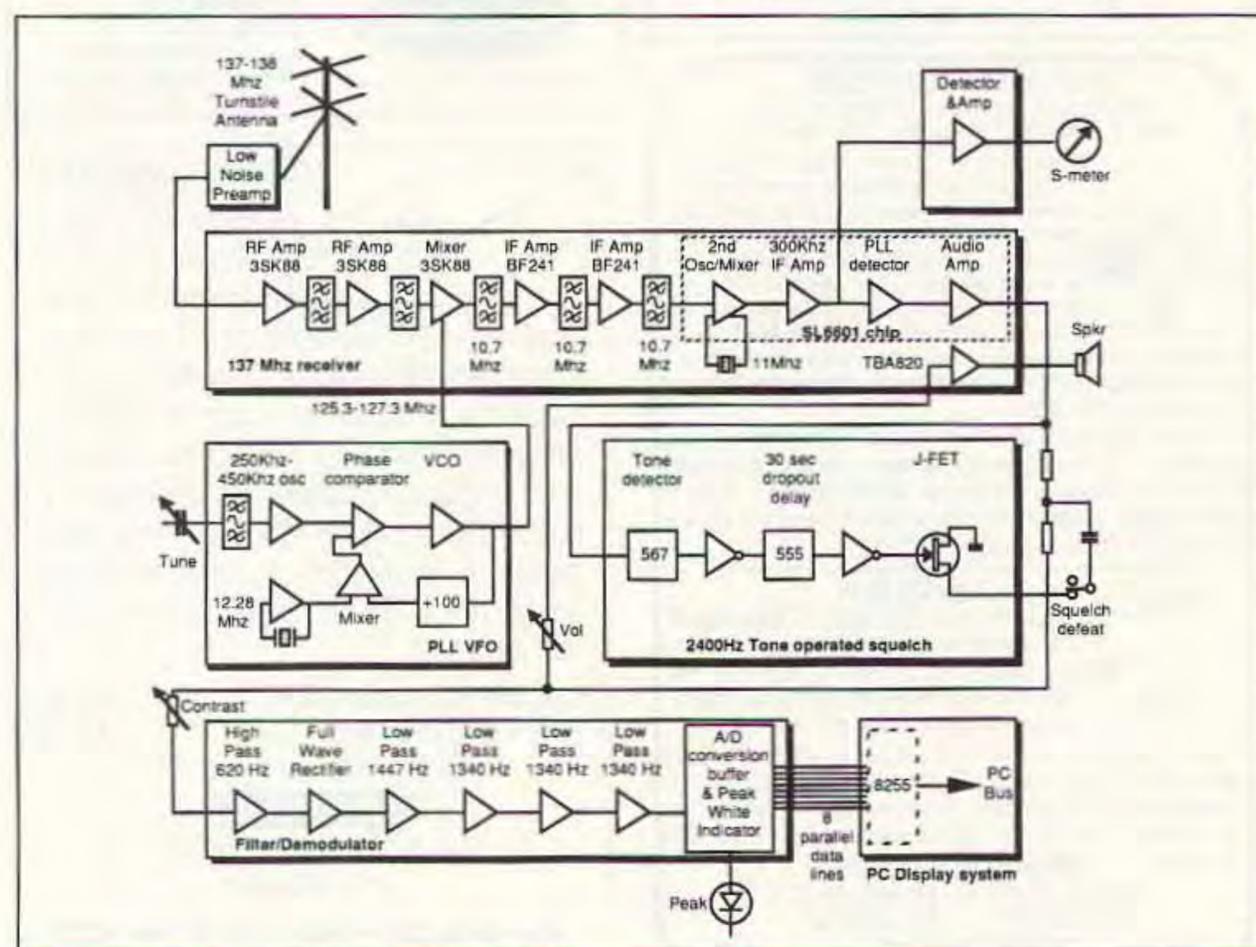


Figure 5. Station block diagram.

they print the dots further apart or closer to create the gray scale. Although I haven't used it, the HP Laserjet 500+ driver looks promising as laser printers can create limited gray scales but have 300 DPI resolution. I have used the CITH 8510 driver and it prints fine within the capabilities of a 9-pin dot matrix printer. JVFAX allows you to balance printing intensity for various levels of gray on these printers, a useful feature that allows better-looking printouts.

Confessions of a Cheat

I have to confess that I cheat. Being in the computer graphics business, I transfer my stored GIF picture files over a local area network onto an Apple Macintosh, where I enhance them if needed, and then print the pictures to a PostScript laser printer, or directly to a Laser Imagesetter. All the pictures in this article were produced this way. One of the by-products of this route is that it is easy to produce mosaics of the whole earth by automatically capturing the nine Meteosat pictures required with JVFAX 6.0 and then joining them together as a single picture using a program called Adobe PhotoShop (see picture on page 3.) Registration between spacecraft transmissions is so good that I defy anybody to spot where the pictures join! However, as there is anything up to a three-hour gap between the first and last transmissions of the nine pictures in the Meteosat transmission schedule, winds can move the clouds during that time, causing some misregistration in cloud patterns between pictures.

Using the System

A typical satellite pass at my station would be captured thus: I prepare a series of simple GW BASIC programs, whose file name is the satellite name. This executes by outputting a simple binary number to separate output lines on port PA1 of the 8255 chip. Each program (for each satellite) contains a different PA1 output value. For instance, program NOAA11.BAS will make only line 1 of PA1 go high, NOAA12.BAS will make line 2 only go high, and so on. Since you can call any BASIC program when calling any satellite configuration on JVFAX 6.0, switching is easy. The output line, with some suitable buffers, is used to enable an oscillator crystal in the receiver via diode switching. By executing the appropriate program, one can change receiver frequency.

Using the InstantTrack satellite tracking program, I scan the best satellite passes of the day, noting the satellite name, acquisition time (AOS) and loss of signal (LOS) time. This information is fed to JVFAX 6.0. At 15 seconds before the appropriate time, JVFAX will select the appropriate satellite, and execute the BASIC program for the satellite being received. This adjusts receiver frequency and se-

lects the specified satellite type (line rate, etc.). It will then go to receive mode, awaiting opening of the receiver squelch. At AOS squelch opens, starting picture recording. At LOS time, or on closing of receiver squelch, the computer file will close, and the software awaits the next programmed satellite AOS time.

Just be aware that you need a large hard disk capacity if you want to automate lots of passes during one session!

Where Do I Find the Satellites?

You have a PC. The easiest way to predict a satellite pass is to obtain one of the excellent satellite tracking programs to run on your PC. I like InstantTrack (available from AMSAT NA) because one of its options is a fantastic real-time world map display of the satellite pass. To update InstantTrack, you can load the latest Keplerian (orbital) elements in NASA format automatically into InstantTrack from files downloaded off CompuServe or other BBS systems. Other tracking programs abound. Look in the CompuServe "Amateur Satellites" library; there are a number there. Failing this, you can just tune your receiver to the correct frequency and wait for a signal. Because the NOAA satellites are in "Sun Synchronous" orbits, they will pass within range of a ground station anywhere on the earth's surface from two to four times a day, and at about the same time every day.

RF Interference

All PCs are "RF dirty." They emanate harmonics on all sorts of frequencies. Generally, at VHF this is not as much of a problem as HF, but when I first implemented my system I had a nasty harmonic almost slap on 137.5 MHz, one of my most-used frequencies.

By careful shielding of antenna and cables and earthing the computer box directly to a ground spike, I was able to get rid of most of the interfering carrier. I found that shielding the cable between the demodulator and the

interface gave the most reduction in interference. Although you can buy ribbon cable with shielding on one side, the easiest fix is to cut a number of lengths of aluminum kitchen foil and wrap it around the cable. Experiment with the best point at which to earth the cable.

Conclusions

I have tried to give all the information and hints necessary to allow you to build up an affordable weather satellite receiving station. My results have been very rewarding, and I would like to hear from anyone who implements this project. Write to me at the postal address given below, or on CompuServe 70272,1602. JVFAX 6.0, being shareware, gives very good value for the money, in addition to unbelievably good displayed pictures.

If you want to learn more about receiving weather satellite pictures, I heartily recommend WB8DQT's publication *The Weather Satellite Handbook*, Fourth Edition (or maybe fifth by now), available from Uncle Wayne's Bookshelf. Ralph Taggart is a genius at explaining the arcane subject of satellites and weather to laymen. Expect plain, simple-to-understand language, and a comprehensive coverage of the subject, together with easy-to-understand constructional information.

Please support DK8JV in his programming efforts by giving a donation. In return, he will send you the latest version of JVFAX, as well as a lot of interface details, including a sophisticated FM fax decoder schematic for HF use, all on disk files.

Complete kits for the parallel interface board are available from me for \$40, which includes international air parcel post and packing. For international customers, be aware that sometimes there might be customs duties to pay in your country.

JVFAX 6.0 is available for \$10, which covers the cost of the disk and international airmail postage (or you can download the earlier version from CompuServe Hamnet): Angus Anderson, P.O. Box 41544, Craighall 2024, South Africa; Tel: (business hours) country code 27, city code 11, 807-1163; Fax: (business hours) country code 27, city code 11, 807-1167; CompuServe: 70262,1702. I accept Visa, MasterCard, cash, or international money orders. No checks, please. South Africa is two hours behind GMT, six hours behind EDT, and nine hours behind PDT.

You can contact Eberhard Backeshoff DK8JV, the author of JVFAX, at Obschwarzbach 40a, D-4020 Mettmann, Germany; Tel: (49) 2058/4864 (please—only between 18:00 and 19:00 CET) ZR6UM suggests a \$25 donation. It's well worth the trouble. You get more back than you donate!

Parts List, Parallel Interface

| | |
|-------------------|--------------|
| C1,C2,C3,C4,C5,C6 | 0.01 μ F |
| IC1 | 74LS00 |
| IC2 | 74LS245 |
| IC3 | 74LS139 |
| IC4 | 8255PIO |
| IC5 | 74LS30 |

Miscellaneous:

Capacitors are disk ceramic, 16V or more.
PC board, double-sided with edge connectors (if not plated through, see comments).
1 x 20-pin DIL IC socket
2 x 14-pin DIL IC socket
1 x 16-pin DIL socket
1 x 40-pin DIL socket

(Note: Use high-profile IC sockets with exposed top pins if not using plated-through PCB. This allows soldering to IC connections on both sides of the PC board.)

3 x 20-pin PCB mount box headers, male. I suggest that you buy a strip of 70x2 pin headers and cut to suit.

1 x 20-way ribbon cable, length to suit, with a 20-way crimped female box header on one end, free cable on the other. The free ends are soldered to decoder vero pins via an optional interface socket.

2 x 2-way jumper pins and jumpers. You can use offcuts of the 20-pin box headers if you buy the box header strips and cut the number of pins to suit. The jumpers can be obtained from almost any old PC PCB.