The Romscanner

Here's an easy-to-build, low-cost source for SSTV images!

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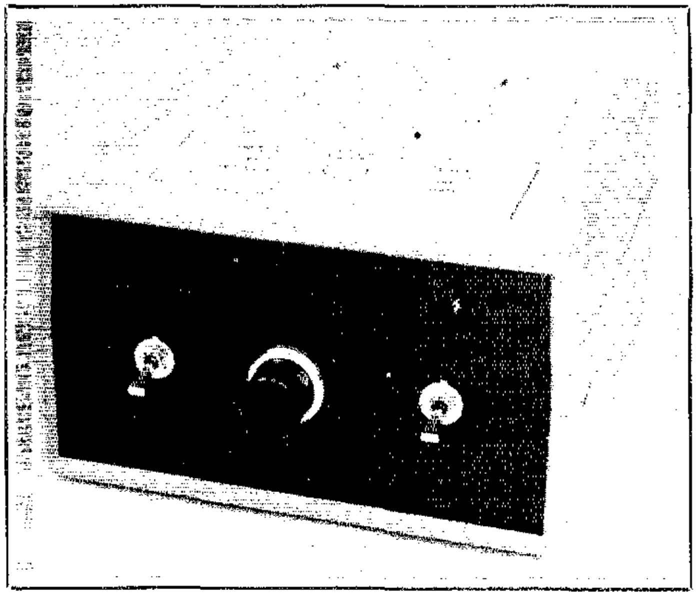

A few minutes spent tuning around 14.230 MHz on 20 meters will confirm the extent to which full-color operation in both standard and high-resolution formats has captured the fancy of the SSTV community. Currently available commercial equipment for SSTV, in the form of the Robot™ Research 450C and 1200 digital scan converters, provides operating features undreamed of only a few years ago. Unfortunately, while such equipment performs flawlessly, the cost of this technology, coupled with the price of color monitors and cameras, appears to limit the options for those who would like to start SSTV in a modest way.

Alternatives for multimode SSTV reception do exist in the form of microcomputer-assisted SSTV scan converters that are far less expensive than their commercial counterparts.[1] While such systems do an excellent job of displaying SSTV, their capabilities for transmission are typically limited to retransmitting an image already in memory, or relatively simple graphics for call signs, CQs, etc. Upgrading to "live" camera operation involves additional hardware, and, of course, a standard TV camera that serves as the source from which the digital circuits capture or "snatch" the SSTV image. The time-honored option for new operators is to have an active SSTV station prepare a set of taped images using pictures supplied by the newcomer. This provides basic image material for the new station, but tape handling is clumsy (you have to locate the precise picture you want), tapes decline in quality with continued use and RF feedback is an ever-present possibility because of the minimal shielding of small cassette recorders.

Newcomers to SSTV are not the only ones with problems. The casual or part-time operator needs a source of pictures for occasional QSOs without the fuss and bother of firing up the camera, adjusting the lights and composing a good-looking picture. Many operators have such a small area devoted to the station that it is impractical to have lights and cameras out and ready at all times for the sake of an occasional contact. As a consequence, many—perhaps most—SSTV-equipped stations simply "look in" without actually getting on the air. There is even a problem with the *gung-ho* SSTV types who have the latest in color scan converters. The average amateur may not feel particularly colorful, and there is a tendency to transmit flashy color pictures rather than pictures of the operator, shack or family. This is unfortunate because Amateur Radio represents people-to-people communications, and it seems a shame not to see the operator on the other end, particularly in the case of a first QSO.

The Romscanner is a device created to meet all these problems. Basically it is a digital "black box" that performs a single function—the transmission of standard-format SSTV images (128 line/8.5 seconds) that have been preprogrammed into *r*ead *o*nly *m*emory (ROM). The Romscanner can handle as many such canned pictures as you wish, and since the images are stored permanently, they are available for immediate transmission at the flick of a switch. For the newcomer or casual SSTV operator, the Romscanner can provide the primary source of pictures. For the fully equipped operator, it holds all the basic CQ and ID images and pictures of the operator, shack or family. Any of these can be sent at a moment's notice, while the station camera is devoted to color material. The Romscanner is a stand-alone unit that will function with any SSTV station, from a simple P7 monitor to the most elaborate camera/color-scan-converter system.[2] It is extremely simple to construct, with only eight ICs plus a ROM for each picture you wish to store. Finally, it incorporates all of the fundamental principles of digital-image storage and thus provides a good lesson in digital SSTV fundamentals at a low cost.

Circuit Description

Refer to Fig 1. Five circuit modules, or subsystems, will be described—the memory, clock and address counters, sync circuits, data output and subcarrier modulator.

Memory

The "standard" SSTV format uses a 128-line picture that is transmitted at the rate of 15 lines/second for a total frame time of 8.5 seconds. To provide acceptable resolution in the basic format, each line is digitized into 128 picture elements (pixels), each of which is coded as one of 16 possible gray-scale values ranging from 0 through 15. The memory capacity required to store one SSTV picture is related to the total

[1]Notes appear on page 27.

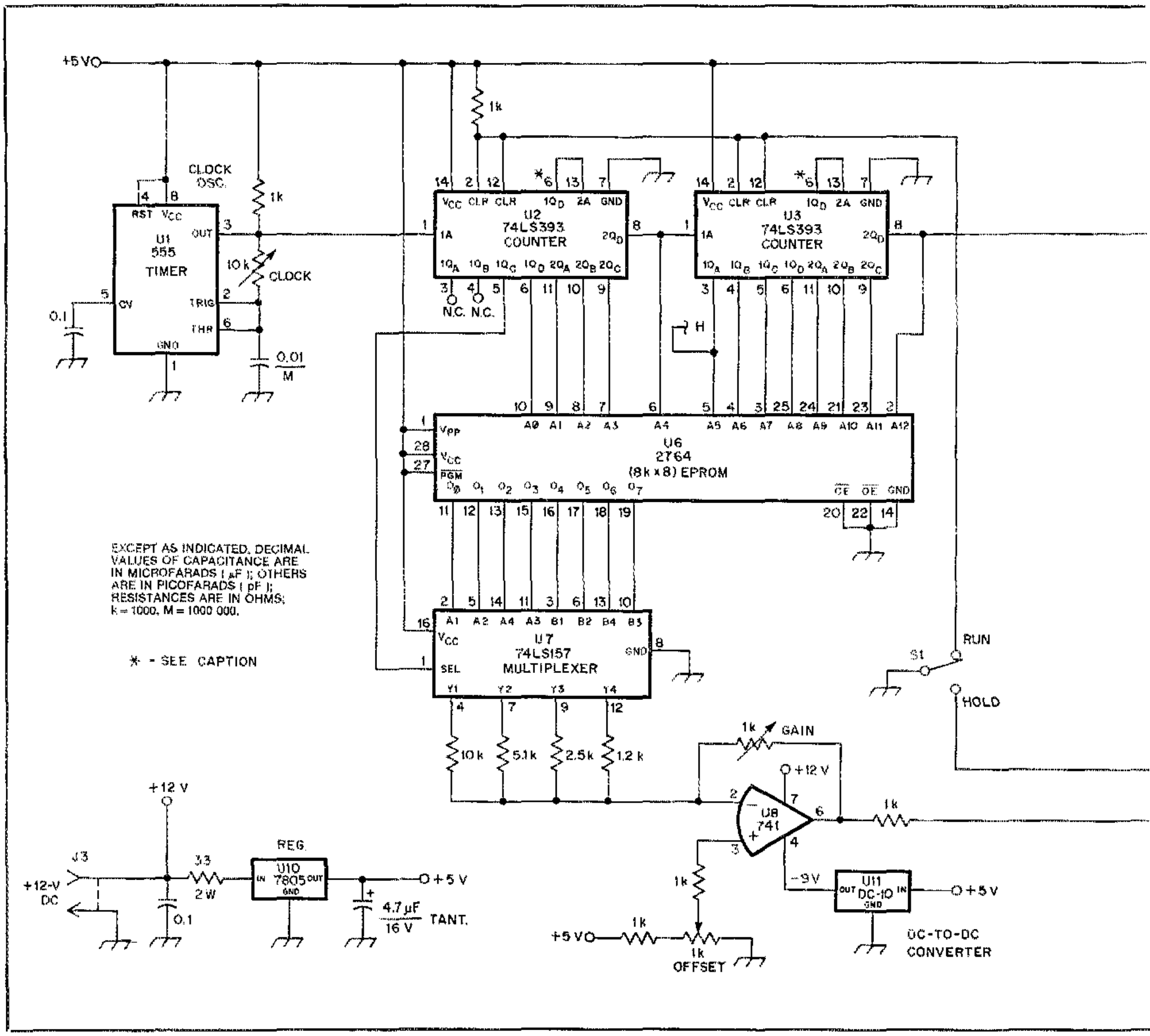

Fig 1—Schematic diagram of the Romscanner circuit. Individual IC bypass capacitors are not shown (see text). An * next to an IC pin number indicates that the number is repeated for clarity. Look for the same pin number elsewhere on the same IC diagram.

U1, U4, U5—NE555 timer.
U2, U3—74LS393 dual 4-bit binary counter.
U6—2764 (8K × 8) UV erasable PROM.
U7—74LS157 quad 2-line to 1-line multiplexer.
U8—741 op amp.
U9—EXAR 2206 monolithic function generator.
U10—7805 5-V regulator.
U11—Mostek DC-10 voltage converter.

number of pixels in the image, and the number of bits required to code the gray-scale value for each pixel. The total number of pixels is 128 (pixels/line) × 128 (total number of lines) or 16,384. The 16-step gray scale requires 4 bits/pixel, so the total memory requirement is 4 × 16,384, or 65,536 bits. The Romscanner uses *e*rasable *p*rogrammable *r*ead *o*nly *m*emory (EPROM) that is typically organized in terms of 8-bit units (bytes). Our storage requirement, expressed in bytes, is thus 65,536/8 or 8192 bytes/image.

Two available EPROM chips, the 2764 and 68764, both meet this requirement exactly since they contain 8192 × 8 memory cells, and thus will hold one SSTV image. The 68764, a 24-pin device, was used in the prototype, since they were available as leftovers from another project. This chip presently costs about $14 in unit quantities, compared to only $5 for the 28-pin 2764. Fig 1 shows the circuit based on the 2764 chip. Table 1 shows the equivalent pinouts for the two devices. Functionally the two chips are identical.

Each byte of EPROM will store data for two pixels, since only 4 bits are required for each pixel. Each pixel pair is formatted as follows with reference to the eight data-output lines of the EPROM.

High Nibble	O7—Pixel 2 (MSB) O6—Pixel 2 O5—Pixel 2 O4—Pixel 2 (LSB)	One Byte
Low Nibble	O3—Pixel 1 (MSB) O2—Pixel 1 O1—Pixel 1 O0—Pixel 1 (LSB)	

Essentially the first pixel of each pair

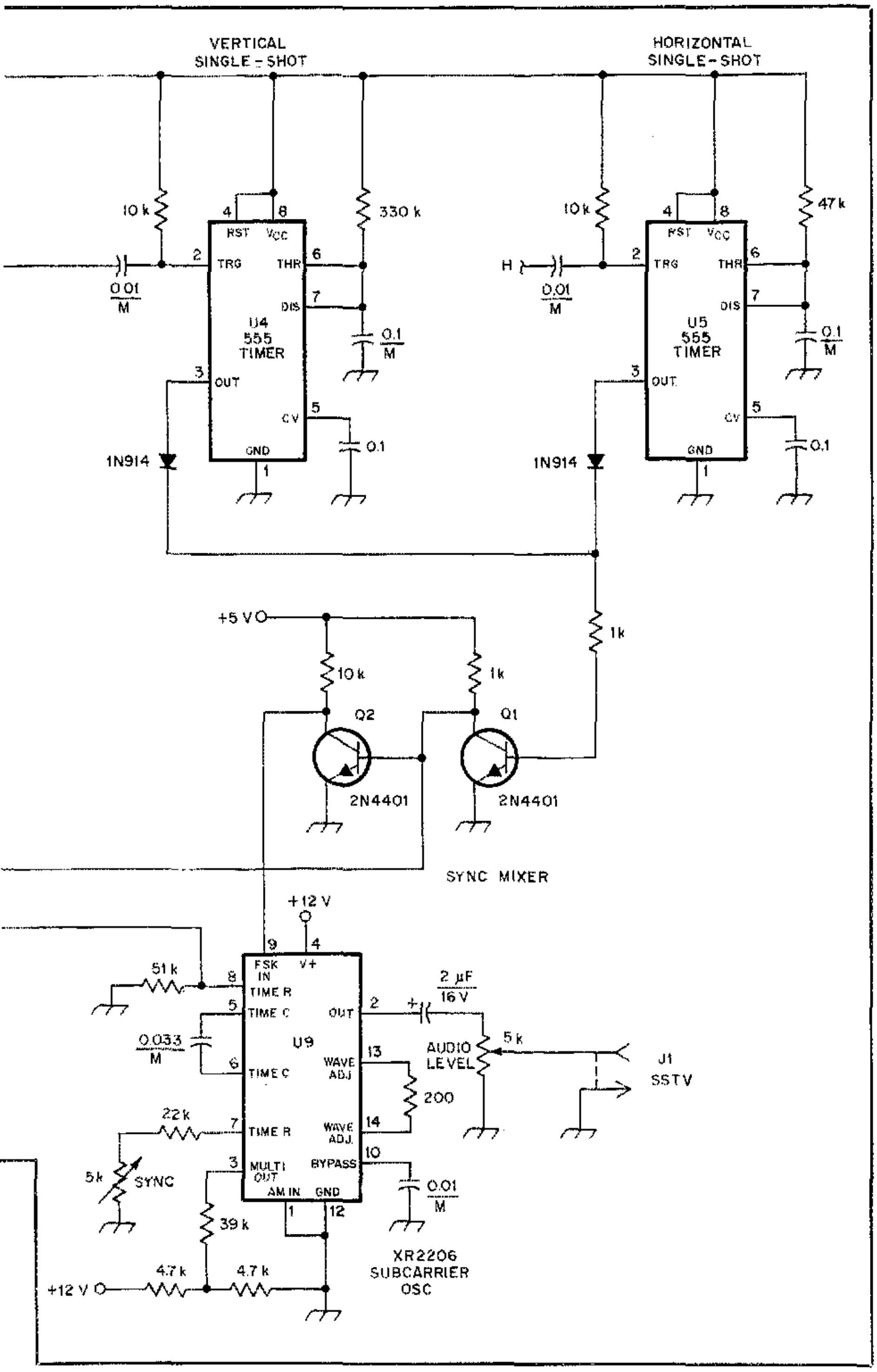

Table 1
Comparison of Pinouts for the 2764 and 68764 EPROMs

Function	*2764*		*68764*
AØ	10		8
A1	9		7
A2	8		6
A3	7		5
A4	6		4
A5	5		3
A6	4		2
A7	3		1
A8	25		23
A9	24		22
A1Ø	21		19
A11	23		18
A12	2		21
OØ	11	(DQØ)	9
O1	12	(DQ1)	10
O2	13	(DQ2)	11
O3	15	(DQ3)	13
O4	16	(DQ4)	14
O5	17	(DQ5)	15
O6	18	(DQ6)	16
O7	19	(DQ7)	17
Enable	2Ø,22		2Ø
Ground (V_{ss})	14		12
+5 V (V_{cc})	28		24

resides in the low "nibble" (4 bits) of each byte while the second pixel is in the high nibble. The pixel pairs are arranged sequentially with the first pair (upper left corner of the display) located at memory address 0 ($0000) and the final pair (lower right corner of the display) at memory address *8191 ($1FFF).*

Getting the data out of the EPROM requires a total of 13 address lines (AØ-A12), which are generated by a series of binary ripple counters. If the clock that feeds the counter chain is properly adjusted, the *output of data will be at the proper rate to* provide the required 15 lines (128 pixels) each second.

We have not discussed how the image data get into the chip to begin with. We will cover this later in the Image Programming section.

Clock and Address Counters

The system clock and address counters are extremely simple, but effective. U1 is used in an astable configuration and adjusted to a frequency of 7680 Hz by the 10-kΩ CLOCK potentiometer. This signal is routed through a total of 16 binary divider stages contained in two counters, U2 and U3. The outputs of the first two counter stages (pins 3 and 4 of U2) are not used. Output 3 (pin 5 of U2) provides a 960-Hz signal that is used to differentiate the individual pixel data in the output multiplexer (see Data Output). Output 4 (pin 6 of U2) is the basic byte clock frequency (480 Hz) *and functions as address line AØ with all* of the remaining outputs providing lines A1 through A12. The address counters are controlled by the HOLD/RUN switch, S1. In the HOLD position, the counter reset lines are pulled high by a 1-kΩ resistor. To retrieve a picture, the switch is set to RUN, *which pulls the reset lines low and triggers* the counters. This arrangement assures that you always start at the beginning of the image in memory. As long as the switch remains in the RUN position the image data will output continuously, beginning with the first memory location and proceeding to the last, after which the cycle will repeat until the switch is returned to the HOLD position.

Sync Circuits

The standard SSTV format requires that the signal have a 5-ms burst of 1200-Hz horizontal sync at the start of each line (15-Hz rate) and a 30-ms burst of 1200-Hz vertical sync at the start of each frame. Address line A5 toggles at the required 15-Hz line rate and drives a 5-ms single shot (U5) that provides a TTL high at the start of each line. Address line A12 toggles once every 8.5 seconds (0.117 Hz) and drives a 30-ms single shot (U4) that produces a 30-ms TTL high at the end/beginning of

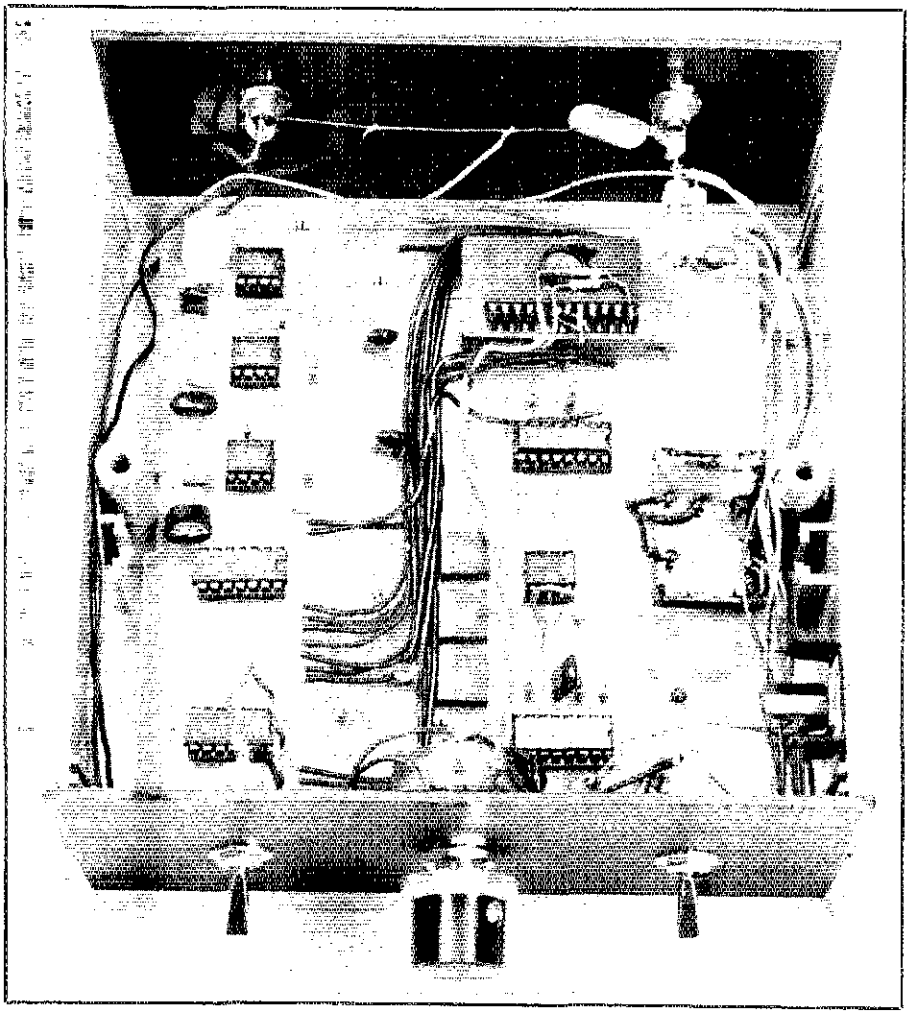

Fig 2—An internal view of the prototype unit showing the general parts layout and the simplicity of the overall circuitry. The rear apron has only two jacks—one for +12- to 14-V dc and the other for SSTV output. Front-panel controls include an image selector switch on the left, a central LEVEL control and the HOLD/RUN switch on the right. The clock oscillator, single shots and address counters are aligned along the left side of the board, and most of the visible wiring represents the 13 address lines for the EPROM bank. Two stacked EPROMs, in a zero insertion force socket, are visible in the upper right. The output multiplexer is immediately below the EPROM stack—below that are the op amp and subcarrier generator. The large, square black module is the Mostek DC-10 voltage converter that supplies negative voltage for the op amp.

each memory scan or frame. The two TTL sync pulses are mixed by Q1 and Q2 to provide a composite TTL signal that is high for the duration of both the 5-ms horizontal and 30-ms vertical sync pulse intervals. This composite signal provides the sync drive to the subcarrier modulator (U9).

Since the vertical sync pulse is produced at the end of each memory scan, the first image out of memory would normally lack a pulse to reset the display at the other end. This is prevented by using the HOLD contact of S1 to ground the collector of Q1 and the base of Q2 when the switch is in the HOLD position, forcing the subcarrier oscillator to 1200 Hz (sync). This ensures that the display system at the receiving end will be reset at the start of the first image scan when the HOLD/RUN switch is set to RUN.

Data Output

Each time the address lines toggle by one count (referenced to AØ), eight bits of output data are available from the new memory location on lines OØ-O7. These eight data bits represent two pixels of image data and must be sorted out if we are to reproduce the image as stored in memory. This is achieved using an 8- to 4-bit multiplexer (U7) that is connected to the memory data lines. This chip functions as a 4PDT switch, controlled by the 960-Hz signal applied to pin 1 from the timing chain. Wired as shown, the lower four bits of each output byte (pixel 1) are routed to the four output lines during the first half of each byte cycle while the upper four bits (pixel 2) are routed to the output lines during the second half of each address cycle. The required digital-to-analog conversion is accomplished by a summing amplifier (U8) that is driven by the four multiplexed output lines through a weighted resistor network. The output of U8 is thus one of 16 possible discrete voltage levels, based on the coding of the 4-bit pixel data. Gain and offset of the summing amplifier are adjustable to provide the voltage required to swing the subcarrier modulator from 1500 Hz (black) to 2300 Hz (white).

Construction

The circuit is extremely simple, by digital SSTV standards, and can be constructed using perf board. There is nothing particularly critical about layout, since everything operates at mid-range audio or lower. The CLOCK, GAIN, OFFSET and SYNC potentiometers should be mounted on the board and the LEVEL potentiometer located on the front panel. Ideally, the LEVEL control should be an audio-taper unit to minimize level-setting sensitivity. The other essential front-panel control is the HOLD/RUN switch as well as a selector switch if you want multiple EPROMs (see Multiple EPROM discussion that follows). The use of a zero insertion force socket for the EPROM is recommended so that EPROMs can be checked out without damaging either the chips or the socket with repeated removals and insertions.

The prototype unit is powered from a 12- to 14-V dc supply with the +5 V provided by a 7805 (LM340T-5) regulator. The prototype, with two 68764 EPROMs, draws approximately 170 mA, and a 33-ohm, 2-W resistor was placed in series with the 7805 to reduce regulator power dissipation to the point where a small heat-sink was sufficient for cooling. Using multiple EPROMs will increase the current demand. The proper value for the series resistor should be calculated, based on the current drawn, to provide approximately 7 V at the regulator input. The accuracy of your calculation is not seriously affected if you assume that all the indicated power supply current is drawn by the 5-V bus since only a few milliamperes at 12 V is required by the 741 and the subcarrier generator. The −9 V required to bias the 741 op amp (U8) is obtained using the Mostek DC-10 voltage-conversion module operating from the +5-V line. Since the output voltage swing of U8 is entirely positive, you may be able to get by with simply grounding pin 4, but I included a negative supply for greater flexibility later, should I desire to experiment with additional circuit configurations.

Adequate bypassing is critical for stable operation. In addition to the bypass capacitors indicated in Fig 1, each chip should also be bypassed at the supply pin with a 0.01- or 0.1-µF, 50-V disc capacitor. You may be able to get by with fewer bypass capacitors, but don't be surprised if you have instability or digital noise effects if you scrimp too much in the bypass department. If you bypass each chip, the system will be unconditionally stable and immune to RFI, even in an unshielded cabinet. The prototype Romscanner was packaged in a small plastic utility box as shown in Fig 2.

Setup

The only setup adjustments for the Romscanner involve setting the clock and subcarrier frequencies. Wire a 28-pin header plug as shown in Fig 3A and insert it into the EPROM socket. If you are using a 68764 layout, use a 24-pin header wired by consulting Fig 3A and Table 1. The switch in the header circuit will allow you to switch the system output from black to white levels and greatly speeds the setup procedure. Connect a 12- to 14-V dc supply to the POWER jack, (J2). If a frequency counter is available, proceed as follows:

1) Connect the counter to pin 3 of U1 or pin 1 of U2 and adjust the CLOCK potentiometer for a frequency of 7680 Hz.

2) Transfer the counter to the SSTV output (J1) and set the LEVEL control for maximum output.

3) Set the HOLD/RUN switch to HOLD and adjust the SYNC control for a frequency of 1200 Hz.

4) Set the HOLD/RUN switch to RUN and preset the GAIN control for minimum resistance between pins 2 and 6 of U8.

5) Set the test header switch to black and adjust the OFFSET control for a frequency of 1500 Hz.

6) Set the test header switch to white and adjust the GAIN control for a frequency of 2300 Hz.

Note: Go back and forth between steps 5 and 6 several times, as there will be some control interaction.

At this point you can connect the SSTV output to a display system, and you should be able to shift the display from black to white by toggling the header test switch.

If no frequency counter is available, align the system using your SSTV display. Proceed as follows:

1) With the HOLD/RUN switch in the HOLD position, adjust the SYNC control for maximum indication on your SSTV tuning indicator.

2) Set the HOLD/RUN switch to RUN.

3) Beginning with the maximum setting of the CLOCK potentiometer, adjust the control until the interval between vertical sync pulses is 8.5 seconds. The adjustment can be fine tuned by "tweaking" to obtain a picture of normal width on your display once alignment is complete.

4) With the GAIN control set to minimum and the test header switch to black, connect a high-impedance voltmeter to pin 6 of U8 and adjust the OFFSET potentiometer for a reading of 2.25 V.

5) Toggle the header switch to white and adjust the GAIN potentiometer for a reading of 1.9 V.

6) Repeat steps 4 and 5 several times to minimize control interaction.

7) Connect the SSTV output to your display and repeat steps 4 through 6, tweaking for a good black to white shift as you toggle the header switch.

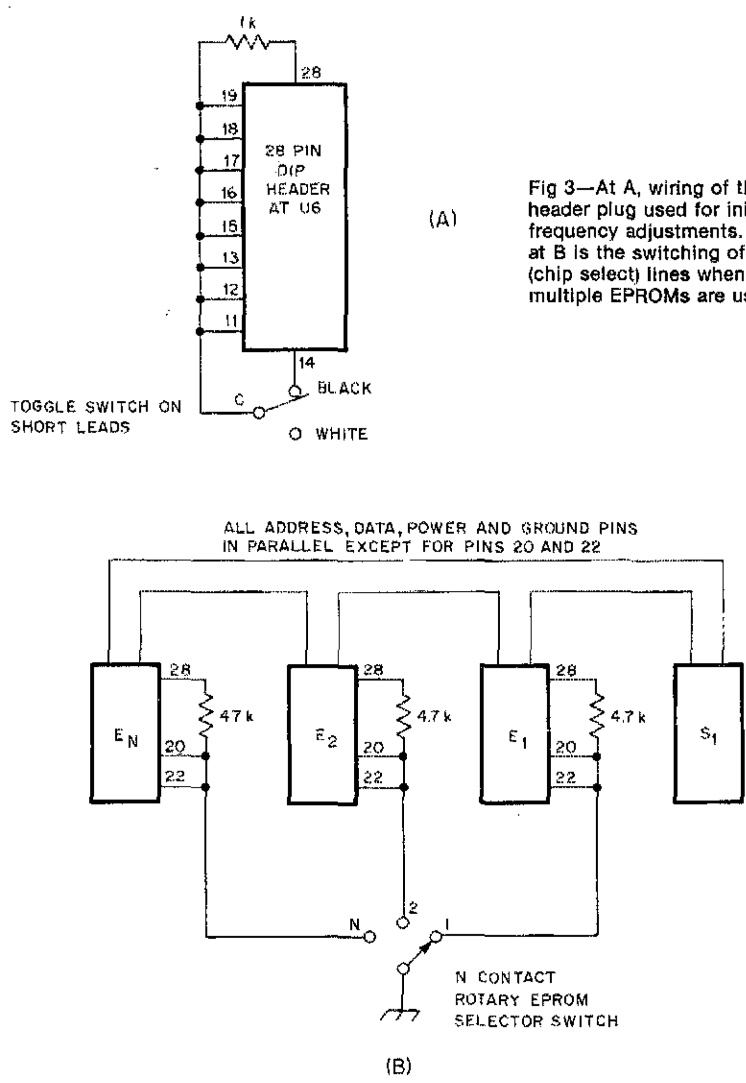

Fig 3—At A, wiring of the test header plug used for initial frequency adjustments. Shown at B is the switching of Enable (chip select) lines when multiple EPROMs are used.

Once you have your first programmed EPROM installed, you can tweak the GAIN and OFFSET controls as required to obtain the same contrast range obtained when the original taped version of the image is played into your display.

Multiple EPROMs

Up to this point we have assumed that the system has only a single EPROM (U6), but there is no real limit to how many you can use. A small board can be wired to contain multiple EPROM sockets (28- or 24-pin sockets depending on the device chosen), with all address, data, ground and 5-V lines in parallel. A small 28- or 24-conductor ribbon cable, equipped with header plugs at each end, can then serve to interconnect the EPROM socket on the main circuit board with one of the sockets on the EPROM board. The only pins that are not paralleled are pins 20/22 (the chip select or enable) of the 2764 (see Table 1 for the 68764 equivalent). The enable pins should be pulled high with a 4.7-kΩ resistor to +5 V on each EPROM socket. Run a wire from the enable pins of each socket to a selector switch (typically a rotary type) on the front panel as shown in Fig 3B. The switch is used to ground the enable pins of the selected EPROM, making it the active chip. The other chips will simply "float" on the address and data lines in a high-impedance state and will not affect image output.

If you require only a few programmed chips, another alternative is available. Once the chips have been verified for proper image output, bend out the enable pins and stack your chips so that the pins overlap. Carefully solder the pins together and install a 4.7-kΩ resistor and switch lead to each enable pin. The +5-V side of the resistors can be tied together and returned to the common V_{cc} (+5 V) pin of the chip stack. This will be pin 28 for the 2764 or pin 24 for the 68764. The enable-pin switch leads can then be routed to a selector switch that will ground the enable pin(s) of the chip you want. The entire chip stack is then inserted into a single EPROM socket on the main circuit board. My unit contains two chips (a CQ/ID image and my picture), and the chip stack can be seen in Fig 2. This arrangement works well for a modest number of chips (2 to 4) if you know you will use the programmed chips for some time. It is inconvenient, however, to unsolder the stack to remove a specific chip for erasing and reprogramming, so you should go this route only if you are perfectly satisfied with each programmed image.

EPROM Programming

If you already have a microcomputer integrated into your SSTV station, programming the chips can be educational, and even fun. If you have little or no computer gear, or the wish to use it, you can link up with a local hacker for some assistance at this point.

Programming requires a microcomputer, an EPROM programming system compatible with the computer and a hardware/software system for transferring an SSTV image into memory in the proper format. Scan converters that use a microcomputer as part of the display system are ideal, since the image data are already in the computer memory as part of the normal system operation. In the case of the K6AEP system described in reference 1, the image is already in the proper format. In the case of recent-vintage commercial scan converters, such as the Robot 450C and 1200, the units are designed for easy computer interface and programming, and it is a relatively easy task to move the image from the scan converter memory to the computer memory. In principle, the programming of a chip involves the following steps:

1) Display the primary image using the scan converter.

2) Reformat (if required) in the case of a microcomputer scan converter, or transfer and format in the case of a scan converter interfaced with the computer.

3) Save the image data to tape, or disk, in the form of a machine-language program.

4) Configure the computer with the EPROM programming hardware and software.

5) Load the image machine-language program.

6) Program and verify the EPROM.

How each of these steps is accomplished in practice will depend on the type of computer, scan converter and EPROM programmer used. A program listing for the Robot 450 scan converter using the Radio Shack Color Computer™ is available from the ARRL Technical Dept. Send a business-size SASE to ARRL-TD, 225 Main St, Newington, CT 06111, and ask for "Romscanner."

For those who wish to avoid the hassle completely, I will provide a chip-programming service. I am equipped to program images from standard SSTV tapes and can also generate CQ and ID images and other graphics material. I will be happy to furnish details if you contact me, and include an SASE.

Color

The Romscanner can be used to transmit frame sequential (RGB) color pictures by storing each color separation image in its own chip, with provisions to switch the enable lines in sequence. To transmit color, simply transmit the desired number of frames of the red image, switch to green and repeat the process, and then finish with the desired number of frames of blue.

Graphics

To say that most of the alphanumeric graphics used on SSTV today are crude is a great understatement. The primary lett(
and number symbols used by most com
puter and dedicated SSTV terminals wer
developed when memory was scarce an
expensive so the symbols are quite elemen
tary in form. One interesting aspect of th
Romscanner is that you can develop
programs with much more perfectly
formed letters and numbers to create a
more pleasing effect when used on ID slides
and the like. It takes some effort to develop the character fonts, but the programs can be written in BASIC to create your ID slides and other material. If the program is set up properly, it will place the graphic image precisely where you want it in memory so that you can create your machine-language program directly from the graphics program. A little ingenuity here will go a long way toward improving the stick-type letters and numbers you see so often on the bands today. A modest example of such enhanced graphics can be seen in Fig 4.

Results

The image output of the Romscanner is essentially identical to the source image and cannot be distinguished from direct camera output. Figs 4 and 5 show an example of a CQ slide created by one of my graphics programs and burned into EPROM. The Romscanner output is shown as displayed on a Robot 450C monitor in Fig 4. Fig 5 shows the same signal displayed on an old P7 analog SSTV monitor. A continuous-tone image is shown in Fig 6, as displayed on the Robot 450C, and Fig 7 shows the same continuous-tone image displayed on the P7 monitor. As you might expect, digitization effects are evident on the Robot display, enhanced slightly because the 128 pixels generated by the Romscanner can never precisely match the 128 samples taken by the Robot. In contrast, the image on the P7 monitor looks as if it were derived from an analog source because of the roll-off effects of the analog monitor circuits.

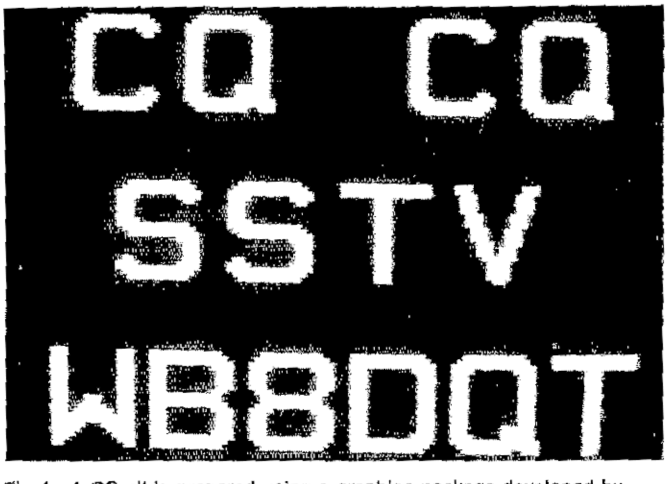

Fig 4—A CQ slide prepared using a graphics package developed by the author to provide a more pleasing alphanumeric display, as shown on a Robot 450C display.

Fig 5—The CQ slide of Fig 4, as shown on an analog P7 monitor.

Fig 6—Romscanner output of a continuous-tone image displayed on the Robot 450C scan converter. This picture of the author was created using the 450C. The image was transferred from the scan converter to a Radio Shack Color Computer™ and programmed into EPROM.

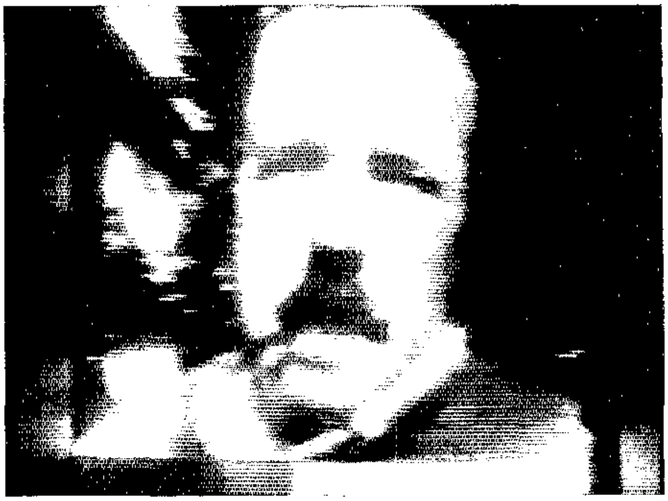

Fig 7—The continuous-tone image of Fig 6 as displayed on an analog P7 monitor. Note the gray scale at the bottom of the image. The 450C creates a 120-line image, while the standard format is 128 lines. An author-developed image transfer program inserts an 8-step gray scale in the final eight lines not used by the Robot format. The gray scale is not visible when displayed on Robot 450C or 1200 scan converters, but is visible on all other display systems that use all 128 lines of the standard format.

In operation, the HOLD/RUN switch is normally kept in the HOLD position when not transmitting pictures. This will cause a 1200-Hz tone output from the unit. If your Romscanner output is routed to the transmitter, you can use the LEVEL control to set the proper audio-drive level for the transmitter. To transmit an image, simply select the desired chip, key in the Romscanner and set the HOLD/RUN switch to RUN. The frame will start at the beginning and will repeat until you set the switch back to HOLD. If the switch is cycled to HOLD and back to RUN during a transmission, the frame will reset and begin again. If you change the image-selector switch during a transmission, the unit will simply switch from one picture source to the other. Depending on the pictures you have in memory, this can create interesting special effects such as call signs at the top or bottom of photographs, etc.

The Romscanner is an extremely useful SSTV accessory, and you will soon wonder how you got along without one. My present mode of operation is to get on the air with the unit, and only in the case of an extended QSO do I take the time to fire up the lights and camera. I also find it very useful for contests as well as vacation portable operation, since the amount of gear that is transported is quite reasonable. Lest you think that SSTV is a kilowatt activity requiring a huge antenna farm to counter band conditions and QRM, I should explain that all of my HF operating is with a 5-W Ten-Tec Argonaut using dipoles and long-wire antennas. On SSTV this has netted me 36 confirmed states and 13 countries, with most of that on 20 meters! If you have a sideband station of any sort, SSTV represents a logical extension into the "video age."

While it may appear that higher-resolution formats are now the dominant mode, standard 128-line monochrome pictures have a number of operating advantages. The short time required to transmit a single image (8.5 seconds) makes it more feasible to dodge QRM, compared with the longer frame times required for color and high-resolution formats. With modern gear, 128-line images can be of quite good quality, meeting the needs of most amateurs, and the gear itself can be fairly simple and quite inexpensive. There is a tremendous amount of 128-line equipment available, ranging from P7 monitors and sampling cameras to the Robot Model 400 scan converters. All of the newer equipment, regardless of its color and high-resolution capabilities, can handle standard-format imagery. If you can find some of this gear, or have it on hand, by all means get on the air! There is very little activity on 15 and 10 meters, yet these bands are superb for SSTV with very little QRM when open. If you would like more information on SSTV and the many operating options now available, check in or listen to the SSTV net on 14.230 MHz at 1800 UTC every Saturday.

There is no doubt that SSTV is now a fully digital mode. What is needed is more basic, easy-to-construct SSTV gear to encourage new operators, both here and abroad. The Romscanner is one step in this direction.

Notes

[1]C. Abrams and R. E. Taggart, "Color Computer SSTV, Part 1," *73 Magazine*, Nov 1984, pp 10-21.

[2]The term "P7" refers to the type of high-persistence phosphor used in CRTs originally adapted to SSTV. The P7 phosphor could hold an image for the 8.5 seconds required for a single frame.

Strays

I would like to get in touch with...

☐ any hams with a portable OSCAR station willing to give Amateur Radio demonstrations to the general public at the Neil Armstrong Air and Space Museum's annual Festival of Flight in Wapakoneta, OH in July. Contact John Zwez at the Neil Armstrong Air and Space Museum, I-75 and Wapak-Fisher Rd, Wapakoneta, OH 45895.

☐ anyone using a Magicom RF speech processor and a Kenwood TS-130S. Russ Smith, W6ONK/7, PO Box 141, Brownsville, OR 97327.

☐ anyone with a manual or circuit diagram for an EICO 239 solid-state FET-TVM. E. H. Strieter, W6FZO, 3040 Rohrer Dr, Lafayette, CA 94549.

☐ anyone who can help identify an H. H. Scott receiver with a missing model number. Dave Schoepf, WØOZG, 418 Lake Forest, Vicksburg, MS 39180.

☐ anyone with a service manual for a Measurements Corp 84-R standard generator, or information on converting a T-282 GR army transmitter for operation on 450 MHz. Bob Sondack, VE2ASL, 260 Bellerive, Ile Ste Helene, St Luc, PQ J0J 2A0.