Slow Scan Television

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ORIGINAL STANDARDS:

Slow scan television was an original amateur radio development that was started in 1958 by a small group of hams led by Copthorne Mcdonald, VE1BFL. The idea of slow scan television was to reduce the bandwidth of a television signal so that it could be transmitted on the HF ham bands. This meant that a typical 3 MHz television signal must be reduced to about 3 KHz; a 1000 to 1 reduction in bandwidth. To accomplish this reduction both the horizontal and the vertical scanning rates were reduced to as low a frequency as possible. At the outset it was decided that the line and the frame frequency could be conveniently derived from the a.c. power mains (60 Kz). The line speed is 15 Kz (66 ms) and the lines per frame is 120. The line frequency is obtained by dividing the 60 Hz a.c. frequency by three, and the frame rate is obtained by dividing 60 Hz by 360. This gave the original black and white SSTV a frame rate of 8 seconds. It had an aspect ratio of 1X1, the horizontal scan was from left to right (128 pixels), and the vertical scan was from top to bottom (120 lines). The horizontal sync pulse was 5 ms, and the vertical sync pulse was 30 ms. For the subcarrier frequency the sync was 1200 Hz, black was 1500 Hz, and white was 2300 Hz; this requires a bandwidth of from 1.0 to 2.5 KHz, and will fit on a standard SSB signal. The original slow scan monitors were long persistance radar cathode ray tubes (P7 tubes). A sampling camera or a flying spot scanner were used to generate a picture in those early days of slow scan.

EVOLUTION OF SSTV:

Originally all slow scan was 8 second, Black and white frames. The received picture appeared on a long persistance P7 CRT monitor one line at a time like a window shade being pulled down, and it faded away quickly. The next advance was the digital scan converter, that displayed on a fast scan monitor. A SSTV scan converter converts the analog slow scan tones to digital data, and then stores this data in a random access memory bank. It then reads the digital data out, converts it back to analog at the proper speed for display on a fast scan monitor. The scan converter also takes in video from a camera, stores the data in the RAM bank, and then converts the output analog tones for SSTV transmission. There are many designs for scan converters. In a ham station, the receiver audio is connected to the scan converter input, and the output of the scan converter is connected to the microphone input of the transmitter. A monitor, or a TV set, connected to the scan converter displays the SSTV pictures. Over the years of operating SSTV on the HF ham bands, it was found that under differing propagation conditions, different speeds and modes were necessary to achieve good solid picture reception. Generally under the best conditions, the shortest transmission times are satisfactory; but under poor conditions the longer transmission times are necessary. Under different band conditions one type of transmission, like Robot or Scottie, may be best suited for the present conditions. So many modes and speeds have been developed to meet the conditions found on the ham bands.

Color slow scan pictures were first achieved by using digital scan converters with three memory banks. The color picture was broken down into three black and white frames, one each containing the red, green, and blue information. Each of these frames was transmitted sequentially as black and white slow scan pictures. The receiving scan converter put each frame into its appropriate memory, then combined the output into a single color picture. A black and white camera overlaid with red, green, and blue filters was used to produce the three frames.

This early RGB frame sequential system later evolved into a line sequential system (red line, green line, blue line) for a single frame color system. All three lines of red, green, and blue are then combined to produce a color line at the receiving converter.

In the early 1980's Robot Research, Inc. introduced the Robot Color System. In this system, black and white picture information as well as chromance and luminance information is sent for each picture line. A single line is sent for each line of the picture. A more recent entry is the Amiga AVT mode introduced in the late 1980's. Other currently used line sequential modes include the WRAASE, SCOTTIE, and MARTIN modes. Each of these has many frame rates (speeds) available.

THE ROBOT 1200C

In 1985 the Robot 1200C high resolution color scan converter was introduced by Robot Research Corporation, and it quickly became the standard for SSTV. The original 1200C operates with Robot single frame color, or black and white pictures. It has four different frame rates for both color and black and white, can store one high resolution color picture, or two low resolution pictures, or six black and white pictures. The high resolution format is 256 pixels wide by 240 lines by 262,144 colors. The Robot scan converters all employ vertical initial signaling (VIS); which is a signal encoding technique to automatically switch the receiving Robot from standby into the correct receiving mode and speed. At the conclusion of a picture transmission, the Robot is switched back into standby. In this fashion these scan converters receive SSTV pictures automatically. Today's SSTV systems are mostly copies of the Robot 1200C, or extensions and expansions of the unit. The VIS system is also widely copied in other systems. The heart of the 1200C is an Intel 8031 microprocessor. The unit is a self contained, firmware controlled (EPROM), dedicated slow scan converter that is easily interfaced to and controlled by a digital computer. The computer interface is usually done by mateing the 1200C parallel port to an input/output card in the computer. Computer programs written for the 1200C/MS-DOS, Amiga, and other computers are readily available from the authors of the software. The 1200C firmware, contained in an EPROM, has been enhanced over the years by various hams. Today the 1200C can be refitted with a new EPROM and larger RAM chips so that the unit will hold four high resolution pictures, and operate in any of six different modes with eight different speeds for each mode. The video output can be viewed on a RGB analog monitor, a composite monitor, or a TV set. Pictures are received and displayed in real time. They can be snatched using a black and white camera, or a color camera like a camcorder.

Computer control of the 1200C is accomplished by interfacing its parallel port to an input/output card in the computer. Software written by many hams is available which allows the computer to control the 1200C through its built in command set. The computer can read from, and write to, the 1200C. Pictures can be transferred from the 1200C to the computer memory in digital form for image processing or saving to disk. Pictures on disk can be retrieved and sent back to the scan converter. This provides for very innovative handling of the video material.

Clones of the 1200C have been produced with much success. The first of these was the Ribbit clone from Canada. The LM-9000 was developed in Australia, and the NS-88 was developed in Japan. All of these are home made copies of the 1200C. PC boards for building these units are available from the hams who originally developed these clones.

SCOTTIE MODE

The 1200C can be fitted with a "Scottie" EPROM. This chip will give the ability to operate in Robot, Wraase, and Scottie modes. The Scottie mode is GBR line sequential, with a 4x3 aspect ratio. It is a synchronous system (like FAX) and is more noise immune than those that depend on line sync pulses. This EPROM contains a complete paint program, screen graphics, image processing, cut and paste routines, and is completely mouse controlled. It allows the 1200C RAM to be upgraded with 256K chips so that four high resolution pictures can reside in memory. A multi-eprom pc board with a software switch is also available to allow up to six different EPROMs to be selected.

MARTIN MODE

The "Martin" EPROM will allow the 1200C to operate in Robot, Wraase, Martin, Scottie, and AVT modes. The Martin mode is GBR line sequential, has 4x3 aspect ratio, and is a synchronous system. This chip allows access to the Robot screen graphics by use of the unit's front panel touch pads. It also allows the RAM chips to be upgraded in order to handle four high resolution pictures in RAM.

THE AMIGA AVT MODE:

The Amiga computer with its extensive graphics capabilities has been used as the platform for an excellent computer based SSTV system. Software and a parallel port interface box developed by Ben Blish Williams, AA7AS, allows the Amiga to emulate the 1200C, and also provides a new mode, AVT. AVT is a synchronous system with no sync pulses. It has all of the advantages of using a computer, such as saving pictures to disk, image processing, and graphics. It is a bit more complicated to operate than a dedicated unit like the 1200C. The addition of a frame grabber to the Amiga gives the system the ability to snatch pictures. The number of pictures that can be held in memory is limited by the amount of RAM installed in the computer. Pictures can be saved to disk, and then retrieved easily. In some AVT modes the Amiga does afford higher resolution (320X200) than does the 1200C. The video display of this system can be as good as the 1200C when it is equipped to display 262,000 colors. A received picture scrolls down the screen in its black and white format; then the software converts it to a full color picture. The software is laid out so that windows are pulled down, or up, to select the available functions and operating modes. A mouse is used to click on icons to make the selections in the program. The current software will support all of the current SSTV modes, and also provides all of the previously used modes (55 modes). It uses the VIS codes for automatic picture reception, and the AVT modes have a header for the same purpose.

COMPUTER SSTV :

The earlier IBM/MS DOS computers were not as adaptable to SSTV because the display of these machines did not have a sufficiently large color pallet. These computers have long been used effectively with various programs for black and white slow scan. Today VGA display adapters with 15 bits/pixel now provide 32,768 different colors and 24-bit color boards are now available.. Current software [ViewPort VGA by John Montalbano - KA2PYJ] is now near the Robot 1200C for color SSTV quality. Commercially available multi-mode interface units are obtainable, and software to run color SSTV is also available. Previously these units did not allow for the same picture quality as the 1200C [18 bits/262,144 colors] or the Amiga AVT because of a limited color pallet. of the display. However, today the computer expanding color graphics video capabilities appears to provide a cost effective trend for increasing SSTV applications.

Other computers like the Radio Shack TRS-80, the Tandy Color Computer, the Commodore 64/128, and the Atari computers can all be used as stand alone SSTV systems when run with the appropriate slow scan programs for each computer. Generally all of these are black and white only systems because of memory limitations of these computers. Some computers like the Atari are being used for color slow scan, but have lower resolution. The Apple Macintosh computer is very well suited for SSTV, but no one has authored appropriate software for it yet. In Europe the British Spectrum computer, and the BBC computers have been used extensively for black and white slow scan.

THE SC-1 & SC-2 SCAN CONVERTERS :

These are commercially built German scan converters designed by Volker Wraase, DL2RZ, and the units are marketed by Wraase Elektronik. These have become the standard scan converters in Germany, and in most of Europe. Both are high resolution full color converters. The earlier SC-1 contained the first line sequential single frame color mode (GBR); thus that mode is called "Wraase" or "SC-1" mode. The newer SC-2 operates on all of the Wraase modes, as well as black and white, and the Martin modes. These units can be equipped with a companion keyboard for adding graphics to the pictures.

TYPES OF TRANSMISSIONS (MODES) :

1) Black & White 8, 16, 32 - Seconds per frame
2) Frame Sequential Color - red, green, then blue frames
3) Robot 8/12, 12/24, 24/36, 36/72 - B&W/Color Robot speeds
4) Wraase 8/24, 16/48, 32/96 - B&W/Line sequential color
5) Scottie S1, S2, S3, S4, DX mode - RGB line sequential
6) Martin M1, M2, M3, M4 - GBR line sequential color
7) AVT 24, 90, 94, 188 - RGB line sequential color, 125 sec B&W

Note: The B&W and Wraase modes are 1x1 aspect ratio
Robot, Scottie, Martin, and AVT are 4x3 aspect ratio

SLOW SCAN FREQUENCIES IN THE HAM BANDS :

3.845, 7.171, 14.230, 14.233, 21.340, 28.680, & 144.5 MHz
SSTV Nets meet Saturdays on 14.230 at 1500 GMT and 1800 GMT

TYPES OF SLOW SCAN EQUIPMENT

Robot 70/80, SBE Scanvision, Venus SS2 - P7 8second B&W gear.
Robot 300, 400 - B&W 8 second low resolution scan converters.
Robot 400C, 450C - Color low resolution scan converters.
Robot 1200C - Color high resolution scan converter. Clones of the 1200C are the Ribbit, LM-9000, and NS-88
Amiga AVT - Color high resolution computer based system.
IBM/MS-DOS - B&W or medium resolution color computer systems.
ATARI Computers - B&W, or medium resolution color systems.
Commodore 64/128, TRS-80, Tandy Coco - B&W low resolution

NOTES :

1- Robot Research Corporation
5636 Ruffin Road, San Diego, CA 92123

2- A suitable I/O card for the IBM/MS DOS computers is the Metra Byte PIO-12 card available from :
MetraByte Corporation, 440 Myles Standish Blvd.
Tauton, MA 02780
Other sources for I/O cards : G3OQD and VE3DUO

3- 1200C/MS DOS Software available from :

"HI-RES"
Tom Jenkins N9AMR
5968 South Keystone Ave., Indianapolis, IN 46227

"GEST"
Torontel Technology Systems, Ltd.
94 Sackville Street, Suite A, Toronto, Ontario
Canada M5A 3E7

"SCAN"
Bert Beyt W5ZR
301 Tampico Street, New Iberia, LA 70560

"SSTV by KC5VC"
Garnett Bebermeyer WB0UNB
15 Almeda Court, Fenton, MO 63026

"IMAGE"
George Isley WD9GIG
746 Fellows Street, St. Charles, IL 60174

4-1200C/Amiga Software to control 1200C with Amiga:
Tom Hibben KB9MC
Mule Hollow Road, Box 188, DeSoto, WI 54624

5- Scottie EPROM available from :
E. T. J. Murphy GM3SBC
65 Silverknowes Crescent, Edinburgh EH4 5JA
Scotland U.K.

6- Martin EPROM available from :
Martin Emmerson G3OQD
6 Mounthurst Road, Hayes, Bromley
Kent BR2 7QN, England U.K.

7- Ribbit scan converter boards from :
Brian Summers VE3DUO
336 Goodram Drive, Burlington, Ontario
Canada L7L 2K1

8- LM-9000 scan converter boards from :
John Wilson VK3LM
R.M.B. 4201A, Tallangatta Valley 3701
Australia

9- NS-88 scan converter boards from :
Munaki Yamafuzi JF3GOH
P.O. Box 670, Osaka 531, Japan

10- Amiga AVT system available from :
Advanced Electronic Applications, Inc.
P.O. Box C2160, 2006 196th Street S.W.
Lynnwood, WA 98036

11- Computer stand-alone SSTV software available from :

Kinney Software C-64, C-128, IBM/MS DOS, Tandy
974 Hodson Road, Pownal, ME 04069

Software Consulting Group IBM/MS DOS
1303 South Ola Vista, San Clemente, CA 92672

John Tuttle K1UTI IBM/MFJ-1278 color
Barrington, NH 03825

John Montalbano KA2PYJ [ViewPort VGA] IBM/MS DOS
10646 106th Place, Carmel, IN 46033

A & A Engineering Interface for KA2PYJ program
2521 West LaPalma, Unit K, Anaheim, CA 92801

John Langer WA2OYT Atari color
115 Stedman Street, Chelmsford, MA 01824

Robert Gendron VE2BNC Atari color
315 6025 Croissant Brodeur, Brossard, Longueuil
Quebec J4Z 1Y8, Canada

Atari Microcomputer Network Atari
John Adams KC5FW
17106 Happy Hollow, San Antonio, TX 78232

12- SC-2 scan converter available from :
Wraase Elecktronik
Kronsberg 10
D-2300 Altenholz, Germany