A Compatible Slow-Scan Color-Television System

New techniques, plus SSTV technology, equals color pictures for the radio amateur.

By Don C. Miller,* W9NTP

The SSTV system described here will permit the transmission of color images in the same bandwidth and transmission time as that being currently used for sending black-and-white images. It is patterned after U.S. and Canadian color television (NTSC) standards.

To understand the system, let us consider the image storage and transmission method that is used. A digital memory, limited in resolution by 128 × 128 × 4 MOS memory elements, is utilized. There are 128 pixels in each horizontal line (a pixel is a sampling point) and 128 lines in each field. The gray-scale (luminance) resolution is 4 binary bits and, therefore, is capable of representing 16 shades of gray.

The required bandwidth for this video system can be determined easily by calculating the amount of data that is necessary to be transmitted in a given period of time. Eq. 1 is used universally to give an estimate of required bandwidth. (Since the image will be sent using Amateur Radio equipment, the maximum bandwidth that may be used is less than 3 kHz.)

Bandwidth (Hz) = (pixels/line ÷ 2) × lines/field × fields/sec (Eq. 1)

By entering the resolution data for our system into Eq. 1, we find that the bandwidth and field rate are related by:

Bandwidth (Hz) = 8192 × fields/sec (Eq. 2)

Most Amateur Radio transmitters cannot handle subaudible frequencies. This means that if low-frequency field rates are to be employed, it will be necessary to place the video information on a subcarrier so that it will pass through the transmitter as medium-frequency audio signals. Many years ago, it was agreed that the SSTV system should operate as an fm system. (The noise immunity properties of fm made it preferable to a-m.) Standards for the fm system are shown in Table 1.

Base video bandwidth chosen is 960 Hz. Entering this value into Eq. 2 to determine the time required to transmit a single picture, we get:

960 Hz = 8192 × fields/sec
fields/sec = 960 ÷ 8192 = 0.1172
sec/field = 8.53

The frequency spectrum of a typical SSTV signal is shown in Fig. 1. Most of the signal is above 1200 Hz. Spectrum analysis and observation prove that there is little energy in the low end of the audio range.

Compatible color television is possible, in part, because less resolution is required by the eye for color pictures than for black and white. The NTSC and other color TV systems utilize overlapping frequency spectrums. The same techniques may be used to modify the standards of slow-scan television to permit the transmission and recording of a color SSTV image in the same bandwidth and transmission time as required for a black-and-white image.

Three color signals, Y (luminance), R − Y (red minus Y) and B − Y (blue minus Y) are recovered from a color camera, TV monitor or a specially built decoder (see Fig. 2). It will be necessary to bandwidth-limit all three signals before they are converted to digital information and stored in memory. The bandwidth of the two color-difference signals should be half that of the luminance signal; i.e., 500 Hz. The three video signals, after bandwidth filtering, are fed to separate analog-to-digital (A/D) converters. The digital signals are then stored in memory. Since the color-difference signals are handled as narrow-bandwidth signals, it is possible to use much less memory for them than would otherwise be required.

Once the three signals are placed in memory, they can be read out simultaneously at the same rate as that used for normal black-and-white SSTV pictures. The output of each memory is fed through a digital-to-analog (D/A) converter, producing three analog SSTV signals.

The Y signal is connected to an fm oscillator, as in the present system, and

Table 1
SSTV Standards

Sync subcarrier frequency	1200 Hz
Black video frequency	1500 Hz
White video frequency	2300 Hz
Sync pulse width	5 ms (horizontal), 66 ms (vertical)
Line frequency	15 Hz (U.S. standard)

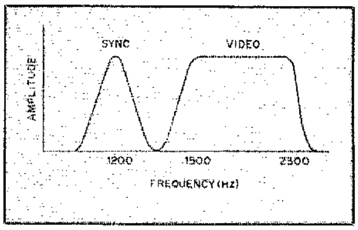

Fig. 1 — Frequency spectrum of a typical black-and-white SSTV signal. Black level is 1500 Hz; white is 2300 Hz.

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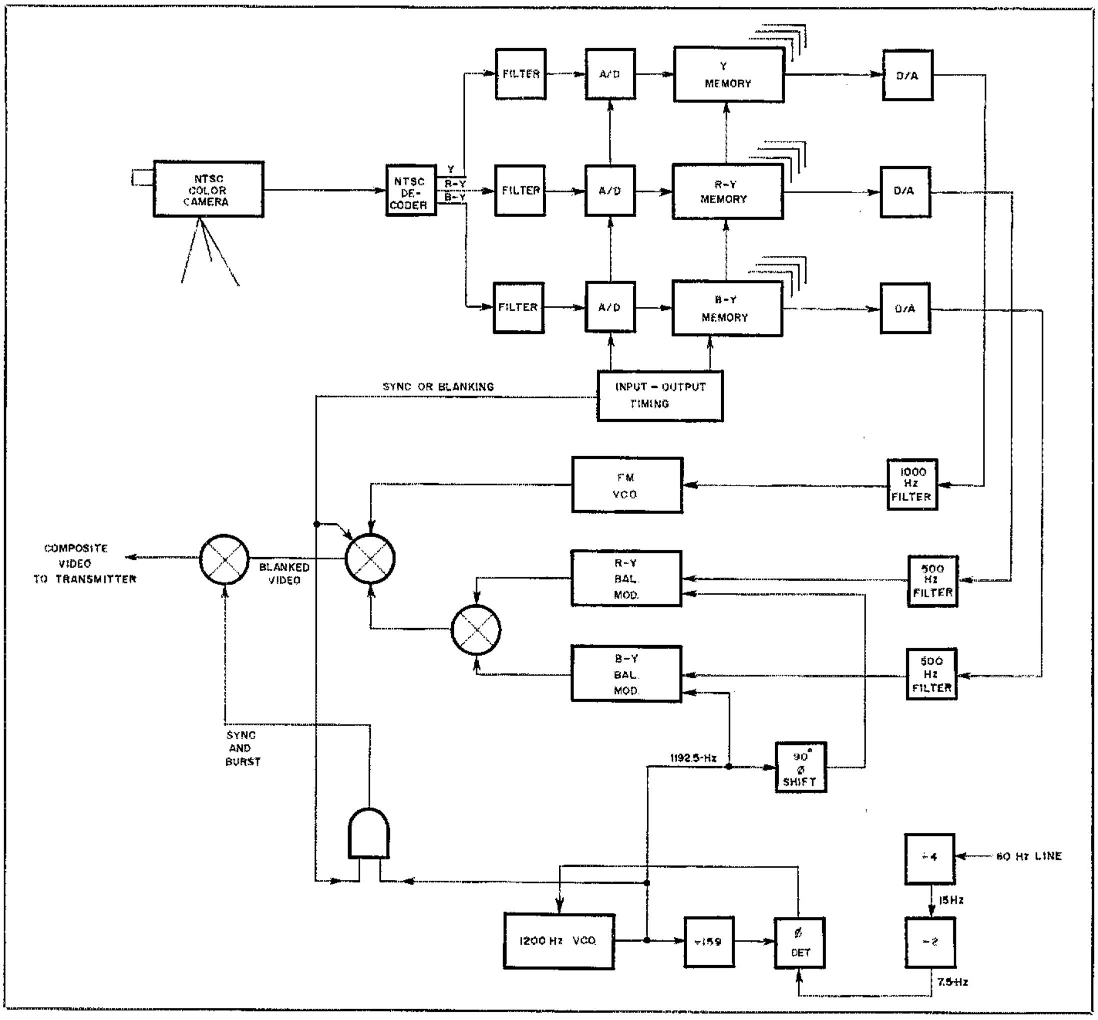

Fig. 2 — Color SSTV transmitting system.

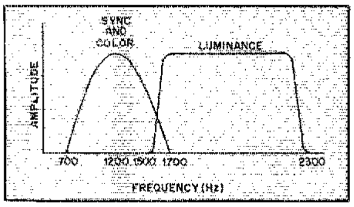

Fig. 3 — Spectrum of a typical color SSTV signal.

swings the frequency between 1500 and 2300 Hz. The sync signal (1200 Hz) is not produced in the normal way. It is generated by making it an odd multiple of one half the 15-Hz horizontal line rate. Horizontal sync is usually derived from the 60-Hz power line. The sync subcarrier (1192.5 Hz) is gated by the normal SSTV sync signal and appears at the output as before.

As in the case of NTSC color TV, the 1192.5-Hz carrier is 90 degree phase-shifted and, together with the zero-degree signal, is fed to a pair of balanced modulators. Each of the two color-difference signals will also feed the respective balanced modulators. This produces a pair of dsb spectrums, centered on the 1200-Hz signal; they occupy approximately 700 Hz to 1700 Hz. This also produces a slight overlap with the luminance spectrum between 1500 Hz and 1700 Hz (see Fig. 3). It is important that the dsb spectrums have symmetrical sidebands. Some sideband filters in Amateur Radio transceivers may give trouble with low-frequency roll off. In that case, equalization must take place before the three color signals are detected.

It may not be necessary to make the sync frequency an odd multiple of one half the horizontal line frequency. Under normal operation, it is very probable that the overlapping energy will not cause much picture degradation.

Fig. 4 is a block diagram of the receiving system. It functions in much the same manner as the transmitting system, only in reverse. Of course, further refinements to the receiving system are possible. Recently developed comb filters could be used to completely remove the crosstalk between the luminance and color-information channels.

This system produces completely compatible color-TV signals. It can be used with the popular multiple-memory, color-scan converters. Transmission time and bandwidth is the same as for black-and-white transmissions.

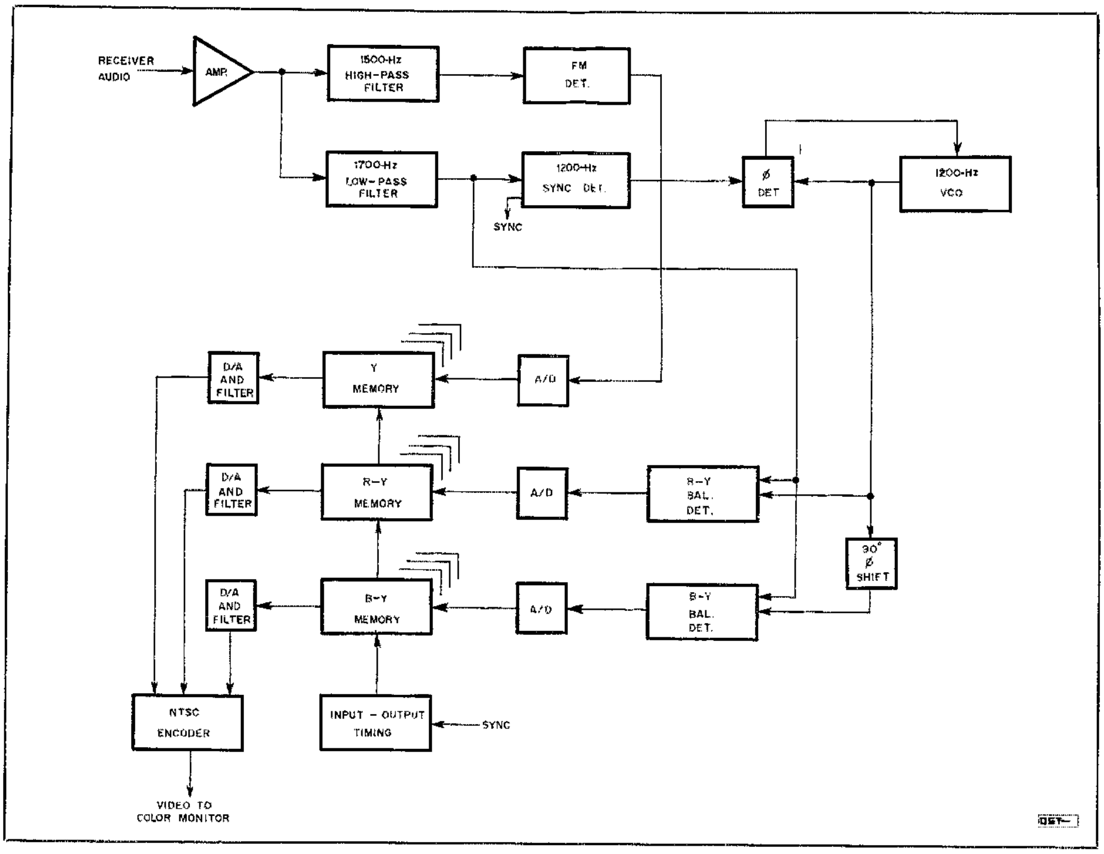

Fig. 4 — Color SSTV receiving system.

Strays

JOHN DiBLASI, W2FX, CO-FOUNDER OF QCWA

On January 13, 1982, John DiBlasi, W2FX, of Great Neck, New York, became a Silent Key. First licensed way back in 1912 or 1914, W2FX spent his entire life in electronics, both as a business and as a hobby. He remained active on the air until about eight years ago, when he was left paralyzed and bedridden by a stroke.

John was one of the founders of the Quarter Century Wireless Association in 1947, and was QCWA's first president, a position he held for 17 years. A member of ARRL and an avid collector of *QST,* W2FX was especially active on 20-meter ssb in his later years. He maintained regular schedules with many hams, including a group in Italy, which he called the "spaghetti net."

W2FX is survived by his wife, Anna, two sons and a daughter, and numerous grandchildren. — *John Facella, K9FJ/G5CYM, Bracknell, Berks, England*

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□ Papers are invited for the 1983 IEEE International Conference on Vehicular Technology to be held in Toronto, Ontario, on May 25-27, 1983. Topics in vehicular communication include trunking, cellular systems, ssb and packet switching. Abstracts of 500 words should be submitted by September 15, 1982 to N. J. Haslett, Telecom & Electronics Unit, Metropolitan Toronto Police, 2050 Jane St., Weston, ON M9N 2V3, Canada.

ARRL Foundation President Robert York Chapman, W1QV (right) presents a Satellite Booster plaque to ARRL President Vic Clark, W4KFC, in recognition of Vic's outstanding support of the Foundation's Twentieth Anniversary Satellite Fund Drive. The presentation was made in March at the Board of Directors meeting at Hartford, Connecticut.