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Slow-scan television

Slow-scan television (SSTV) is a mode of communication designed for image transfer. Because SSTV is a narrowband mode, it can be transmitted via voice channels with a standard SSB transceiver on all radio amateur frequency bands. Worldwide communication is also possible during good conditions on high frequency bands.

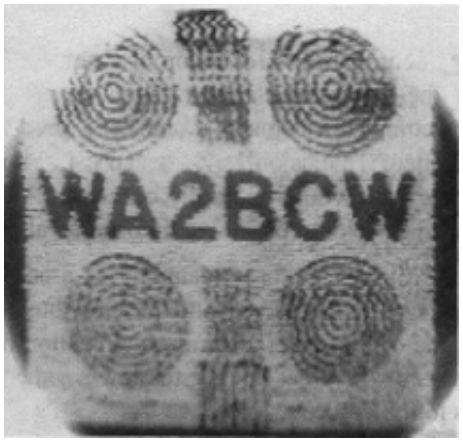
2.1 The beginnings

In 1957 a student at the University of Kentucky, Copthorne "Cop" Macdonald (*1936 – †2011), WA2BCW (later VY2CM) found an article about a device developed by Bell laboratories for image transmission via telephone lines. The communication system fascinated the ham radio enthusiast because it needed a bandwidth as narrow as that of voice broadcast and could be transferred by regular ham radio transmitters.

Another image mode the radio fax (facsimile) was available then, but it required a long duration (about 20 minutes) for a high-resolution image transfer. Such a duration length could not provide an impression of time consistency during a QSO and it also needed an intricate mechanical printer and electrosensitive paper. It was necessary to invent something else.

There was an idea to transfer images coded into audio signals and display them on long persistence displays (CRTs used in radars or slow-scan oscilloscopes).

Then Copthorne started to work on how to transfer images via radio waves with a common ham radio transceiver. Within six months he carried out many experiments with amplitude and frequency modulation, and it resulted in the design of slow-scan television. During the next six months he created an SSTV image scanner, so practical experiments could be done on the ham bands. The first television image crossed the Atlantic on the 20$^{\text{th}}$ of December 1959.



The first image that crossed the Atlantic, received by John Plowman G3AST.

Copthorne Macdonald's broadcast.

Figure 2.1: Early slow-scan television images.

During the next ten years, Copthorne and a group of amateurs worked on SSTV improvements and they created the basic standard for SSTV and developed a sampling camera.

Their work was completed in 1968 when the FCC (Federal Communications Commission) formally authorized SSTV operations.

A few months later ham radio magazines published the first articles about the new communication mode. It led to a huge interest by ham operators and a real SSTV boom.

2.2 Image transmission

The basic idea of SSTV is to transfer television images with the standard transceiver. However, a television broadcast requires a large bandwidth. The reduction of the television signal is achieved by lowering of horizontal (row) and vertical (image) scans, which must be reduced to a minimal frequency. This means that a typical 3MHz signal of black and white television must be reduced to 3 kHz – the reduction of bandwidth is around 1000 : 1. Nowadays the bandwidth reduction is bigger because the color image needs approx. 6 MHz. Therefore, only static images with lower resolution can be transferred due to the significant bandwidth reduction.

During experiments, it was found that an image was visible for about 8 seconds on a long-persistent CRT with P7 phosphor. So after reception of the last scanline, the first is still visible, but in a while – the image slowly disappears. For the best impression, it was necessary to view an SSTV monitor in a darkened room. Usually, several same images were transmitted in a sequence. Each consequent image slowly redrew the original which was still visible on the phosphor. So it was possible to display images for a longer time or to record it on a tape for later playback.

It was found that the ideal time for the correct detection of line synchronization pulses by electronic circuits is 5 ms and for image (vertical) synchronization it is 30 ms. Vertical synchronization initiates the automatic start-up of the image display on the CRT.

The synchronization frequency for scan-lines and frames was derived from the electric mains frequency. For horizontal scan 50 Hz divided by three – 16.6 Hz is used. And for vertical scan $1/7.2\,\mathrm{s} = 0.1388\,\mathrm{Hz}$ is used, this is the mains frequency divided by 360 (3× number of lines 120). The parameters are derived in the same way for countries with 60 Hz mains.

The video signal band was chosen in the range from 1500 Hz for black up to 2300 Hz for white. Sync pulses have a frequency of 1200 Hz and because they are "blacker than black" then they do not affect the image information.

All frequency components of SSTV are inside the low-frequency band and it is possible to transfer them via voice channels.

Other SSTV modes came out from this original standard and in most cases; they differ only in scan speed and in the addition of color transmission.