The SSAVI Cable Scrambling System by Mad Phone-man

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Short of the D.E.S. based Video Cypher system, one of the most sophisticated and versitile video/audio scrambling systems is the S.S.A.V.I. system. The acronym is the "Suppressed Sync Active Video Inversion". Zenith has exploited this system for years and later enhanced versions, known as Z-Tac and A-Tac have SSAVI at their roots.
SSAVI was sucessfully marketed to numerous over-the-air subscription services, most of which are defunct now. In the wake of these services, however are thousands of SSAVI decoder units being sold by a variety of companies and individuals for use on CATV systems.

There is an inherent problem in this re-marketing of STV units in that the Zenith tuner has been stripped of its VHF capability. The STV services were UHF systems. The STV SSAVI units, therefore, had no need for VHF tuning capabilitys.
There are, on the other hand, SSAVI units whose initial purpose was CATV based and which do have VHF tuning capability. The average consumer, however is hard pressed to know just what he might receive when ordering a SSAVI unit. companies employ a variety of techniques to modify the STV (UHF) units for VHF reception. There are also numerous revisions of the SSAVI units, all from Zenith, that date back to the pre-VLSI era. Most units which the author has dealt with do employ VLSI technology and therefore are minus an entire PCB which earlier models had mounted in their top shells and accomidated discreet circutry, later replaced by a single VLSI device (GATEARRAY).

The old discreet versions are the most versitile in terms of modifying, but least available in numbers. Schematic diagrams for the discreet SSAVI devices are available from Shojiki Electronics, (716) 284-2163
This article, therefore will deal with the SSAVI units at a more superficial level. There are 4-modes of operation obtained from 3 variables available to the SSAVI operator. These variables are:

1) Normal/ Suppressed sync
2) Normal/ Inverted video
3) Normal/ Suppressed audio

The 4 video modes of operation thus yield:
1) Normal video/ Normal sync
2) Normal video/ suppressed sync
3) Inverted video/ Normal sync
4) Inverted video/ suppressed sync

The first of these modes is "clear" transmission or "non-scrambled". The remaining three are designed to foil reception by standard TV receivers. In the case of mode 2, thw sync pulses are offset from their normal "Blacker-than black" position such that the front and back porch of the sync pedistal are at +80 IRE units. This action prevents the sync-seperator in a standard TV from

stripping off the sync pulses. The result is that horizontal sync is lost and the picture tends to "tear" or roll horizontaly. In addition, the AGC circutry is confused and tends to DC clamp the blackest portion of the video to the sync level.

The level used in maximum security is mode 4. In this mode, the video is inverted between each horizontal sync pulse from line 25 to line 260 of the active scan lines. The sync pulses are suppressed as described earlier, but NOT inverted. This is a clever technique to foil pirate decoders. This is because if one simply inverts the composite video, one also inverts the sync pedestal, thus inverting the chroma burst on the sync back porch. Thus the video chroma (color) will be incorrect. The successful decoder must, therefore invert the video ONLY between horizontal sync pulses, and provide an offset pulse gated to shift the sync pulses back to their normal level.

To further compicate matters, modes 1-4 may be switched between at random, under command of the head end, to foil simple static decoders which cannot automaticly track these mode switches.

Audio in the SSAVI system may also be displaced, preventing reception on a standard TV receiver. It, when desired can be shifted, SCA style, to a subcarrier. One can see that the SSAVI system provides a fairly high degree of security.

The availability of SSAVI units and their employment by unauthorized persons caused some inital grief for CATV operators. To render the SSAVI units non-usable, Zenith changed the video inversion key employed by the CATV-SSAVI units to differ from the STV SSAVI units.

The SSAVI units key on the binary level transmitted during the second half of line 20 during the vertical blanking interval. When this level is high, the comming frame is to be inverted. When this level is low, the comming frame is to be normal (non-inverted).

SSAVI cable systems, therefore, employ a couple of techniques to foil STV units which are keying on line 20. One technique involvs maintaining the video in the inverted state, but transmitting a "bogus" line 20 ke to cause the STV SSAVI units to switch states at a random, frequent rate. This results in "flashing". The picture switches between normal and inverted at a high rate producing an annoying FLASH syndrome.

Another technique used by CATV-SSAVI systems is to transmit the bogus line 20 signal as described, but to transmit the key on line 21 which then allows the video to become dynamically switched from normal to inverted once again.

Shojiki sells a manual on a circut called Z-trap. This circut foils the first of these techniques by returning control of the line 20 key to the user. The circut provides the user with a switch which selects between high and low for

insertion during line 20. The circut stops the flashing.
The more state-of-the-art systems like Z-tac use a still different inversion key. The sync suppression technique is never-the-less, identical to the SSAVI system.
It is an easy mater enough to use a STV-SSAVI unit for CATV reception. One need only to employ a "block converter" ahead of the SSAVI unit. The STV-SSAVI units can be tuned through the upper 2/3 of the UHF spectrum by means of a multi-turn pot inside the unit. The block converter will up-convert CATV frequencys into this same band of freqs. The block converters are available from Radio Shack and the likes.

The limitation in the block converter technique is that hyper-band and a large portion of the super-band signals fall above UHF channel 83 and above the SSAVI's tuning range. For systems where all premium channels are in the mid-band, however, this technique works well.

If one has need of access to super/hyper band channels a converter-to-block converter to SSAVI hook-up works equaly well with an important caveat. The converter must NOT re-modulate the video. Converters which provide mute/volume control capability are therefore not acceptable. The reason for this follows. The hook-up then, looks like this:

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CATV-> Converter -->ch 3 --> Block conv --> ch 34-36 -->SSVI -->ch 3 --> TV
         down        out       up           tunable
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The SSAVI decoder relies on a 504khz syncronizing signal derived from the carrier itself. Therefore, down converters which re-modulate destroy this reference and cause the SSAVI to malfunction. Simple hetrodyning down-converters allow the SSAVI unit access to the actual carrier of the transmitted video.
To circumvent all these frequency conversions, many resellers install small VHF tuners into the SSAVI units. Depending on the quality of the tuner, the reception may be better or worse than the multi-conversion system.

SSAVI units may also be modified to "skew" their internal timing so as to key off of line 21 so as to be compatable with systems whose real inversion key resides on line 21 as described earlier. The older discreet IC SSAVI units lend themselves to this most readily. The VLSI equipped units, never the less can also be modified to be one scan line shifted, by interuption of the 504khz reference for 32 cycles. [0m