TELEPRODUCTION AND AUTOMATIC PROGRAMMING SYSTEM FOR LOW-COST CASSETTE AND OPEN-REEL VTRS

C. Robert Paulson
Television Microtime, Inc.
Bloomfield, Connecticut

The modern-day Japanese made television receiver with a Sony Trinitron picture tube is the world's finest time base corrector. Connected directly to the output of a low-cost cassette or open-reel VTR, the receiver's fast-acting lock up

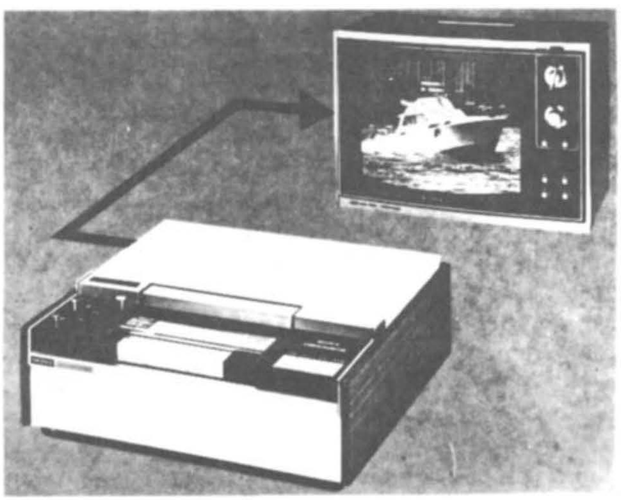

Fig. 1. World's best TBC Combination

circuits track the sync and subcarrier frequencies from the VTR, and mask head switch point skew tension errors of many microseconds. Just about the only problem the receiver can't handle is the inability of the VTR to track an improperly recorded interchanged tape.

Substitute an older, marginally maintained receiver, or even a new unit with long time constant AFC circuits designed for fringe area reception, and the picture changes. There's flagwaving at the top of the picture, perhaps vertical jumpiness, and the color may not lock up.

Precisely the same picture chaos results in a teleproduction application, when an attempt is made to mix the VTR output with a camera locked to it through even the most expensive of proc amps. Assemble or insert editing of tape segments into a second generation edited master has also been impossible, and even second generation dubs of continuous tape recordings lose all of the first generation's color freshness and pick up almost intolerable noise and jitter.

It has become fashionable in CATV circles to believe that adding a "time base corrector" in the VTR output channel--especially a revolutionary new "all-digital"

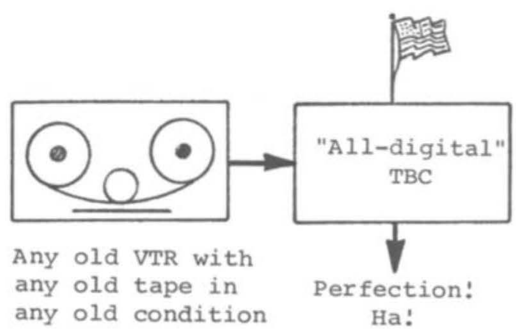

Fig. 2. No TBC offers a cure-all for bad recordings, uncorrected dubs, careless tape storage, and cheap, poorly maintained VTRs.

unit--will immediately eliminate all the problems. It is then quickly discovered that no TBC is a cure-all for all the problems that are created in the taping and dubbing activities described above. No TBC can do anything about the signal's time base, amplitude and sync/subcarrier phase problems recorded in to a tape from earlier generations. Further, getting the VTR's free-wheeling output under control and integrated with other VTRs and camera picture sources in a teleproduction or automatic programming system is a complexly related three part problem. It requires a system solution, and cannot be accomplished by adding a "standalone/wide-window/universal color box for all reasons" to the system, or any other excitingly described and uniquely heralded TBC, for that matter.

In order for any two NTSC color composite video signals to be mixed together through a switcher or special effects mixer, their transmission to and time of arrival at the mixing point must be arranged so that:

1. Their vertical sync pulse timing is coincident well within ±1/2 H line (±30 microseconds);

2. Their H sync pulse timing must be coincident within a nominal 1 microsecond, with a relative jitter at least below 100 nanoseconds, and preferably under 50 nanoseconds, peak to peak;

3. The two burst signals must be identical in frequency, with a relative phase difference, referenced to an arbitrary external subcarrier source, of substantially less than ±10 nanoseconds (±13° of subcarrier phase).

Compare the differences between a color camera composite video signal generated from a broadcast stable color sync generator and the output of a typical low cost cassette or open-reel VTR, in Subcarrier Frequency (SC), Horizontal Frequency (H), and Vertical Frequency (V):

	Broadcast Stability Requirement	Typical Low-cost VTR Output*
(SC)	3,579,545 Hz ±10 Hz "Reference 3.58 MHz"	Free-running frequency somewhere near Reference 3.58
(H)	15,734.--lines/sec. (3.58 MHz ÷ $\frac{455}{2}$)	Free-running slipping, jittering, discontinuous signal somewhere near 15,734
(V)	59.94 fields/sec. (15,734.-- ÷ $\frac{525}{2}$)	Stability problems like H, but 2:1 coherent, as long as the signal originated in a picture source driven by 2:1 sync

*It is testimonial to the capabilities of the modern-day color receiver that it can make an acceptable color picture even if all three sync references are independently varying and far removed from broadcast-spec frequencies.

There are a variety of MICROTIME™ 74 teleproduction systems which can be assembled from products manufactured entirely by Television Microtime, Inc., to accomplish the desired end of assembling "a teleproduction and automatic programming system for low-cost cassette and open-reel VTRs".

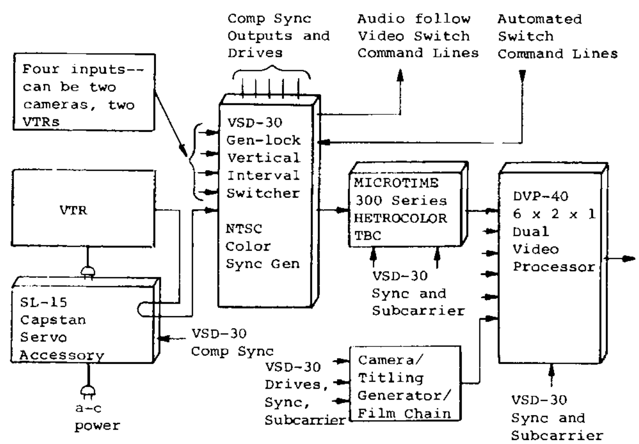

Fig. 3. HETROCOLOR '74 Teleproduction/ Automatic Programming System

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The success of the MICROTIME system design approach is based on compromise, since it is not reasonable to assume that an under $1,000, mass produced, battery-powered VTR can be induced, by either electromechanical or metaphysical techniques, to stabilize its jitters and broaden its responses to act like a $50,000 to $100,000 broadcast quad or helical scan VTR.

The three parts to the compromise solution to the three part problem are most economically achieved in a system with four coordinated-design MICROTIME products. These are the MICROTIME 300 Series HETROCOLOR™ Time Base Corrector, with a VSD-30 Video/Sync Director on its input and a DVP-40 Dual Video Processor on its output, and one or more SL-15 Capstan Servo Accessories providing vertically phase a-c driving power to the VTRs.

There are subtle differences in the sync and burst phases in the composite video output signal of this system, compared to the composite video signal at the master control output of a television broadcasting station. You won't be able to detect this difference without a $10, 000 test instrumentation system, and those old unresponsive receivers in your subscribers' homes will never know what the difference is. For the record, however:

Subcarrier (burst frequency	3,579,545 ±5 Hz;
Vertical frequency and phase	59.94 fields/sec. average, ±8 H lines even with the most rubbery of cassette VTRs on line;
Horizontal frequency and phase	15,734 lines/sec. average, with H phase drift limited to ±1/2 H line at low frequency, and relative jitter between a camera and any VTR reduced to less than 35 nanoseconds peak to peak.

The functions of the MICROTIME products which accomplish this amazing transformation of the VTR output signal are:

VSD-30--generates broadcast stable NTSC color subcarrier reference, burst, and burst flag, and coherent RS-170 composite sync;

Provides five composite sync outputs to vertically phase up to five capstan servo'd VTRs to system vertical phase;

Provides additional comp sync, comp blanking, V drive, H drive, and burst flag outputs to drive stable picture sources--cameras/titling generators/ switchers/special effect generators;

Makes vertical interval switches among its six inputs, transferring the RS-170 sync generator to gen-lock tracking of a non-synchronous VTR.

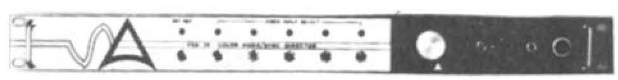

Fig. 4. The VSD-30 is an impressive multi-function unit including an NTSC Color Sync Generator, a second gen-lock RS-170 sync generator with burst flag included, a 6-input vertical interval switcher, a "coherent color" feature for dubs to quad VTRs, and 75-ohm outputs for all required drives and sync signals.

SL-15--generates a-c driving power for the VTR of the proper frequency and phase to maintain vertical phase coincidence between the VTR output and the reference sync generator, by comparing the VTR output phase continuously against the comp sync reference from that sync generator.

Fig. 5. The SL-15 corrects the tape speed and phases the playback timing of a power-line driven or capstan servo'd VTR or VDR against any external vertical sync reference.

MICROTIME 300 Series TBC--corrects the VTR output signal jitter, skew tension errors, and burst frequency/phase errors against the VSD-30 comp sync and subcarrier references, to a residual raster jitter of ±17 nanoseconds maximum against the comp sync reference, and color phase shift to less than ±4 nanoseconds relative to VSD-30 subcarrier reference.

Fig. 6. The MICROTIME 388 HETROCOLOR TBC is the most versatile in the industry, accepting any kind of color signal, from any kind of properly maintained VTR or VDR, with either RS-170 (broadcast) or RS-330 (2:1 interlace) composite sync.

DVP-40--switches the outputs of up to six TBCs or cameras or other picture sources which are driven by the VSD-30 sync generator, to either side of a 2x1 switcher/fader, where they are combined into one output.

The system output is therefore the manually selected combination of inputs from any of the studio's picture→generating sources--VTRs, cameras, titling generators, special effects generators, even the newly emerging video disc recorders (VDRs). An additional feature of this HETROCOLOR system is that all the switching functions may be commanded remotely, either manually or under automatic programming system control! Program audio from the VTRs automatically follows video, and any synchronous inputs (camera/titling generator/film chain) can have announce mike or recorded audio sources follow their selection.

This MICROTIME teleproduction and automatic programming system meets all the FCC specifications for broadcasting of a composite video signal, as regards the frequency and stability of the burst, vertical sync and horizontal sync. (There is still a raging debate about what is really required for sync and subcarrier phase coherency.)

A broadcast engineer would describe the output of this program origination system as "non-phased color". It is a well known fact of life in the industry that many stations broadcast non-phased color tapes from VTRs and VDRs or ancient vintage and variable capabilities as a matter of convenience, and this departure from broadcasting a signal driven by the station NTSC color sync generator is not detectable on any home receiver.

In view of this confusion within the industry, we do not take any position as to whether this MICROTIME teleproduction and program origination system "meets FCC specs for broadcasting". Its output signal is technically capable of being broadcast, processing the output signals of low cost cassette and open-reel VTRs. Its output signal is certainly "broadcast quality". The system described contains four processing amplifiers, a complete NTSC color unit in the TBC and three limited function units in the DVP-40, in addition to the broadcast-spec NTSC Color Gen-lock Sync Generator in the VSD-30.

An additional signal processing capability not important in non-broadcast program origination, but frequently important in teleproduction processing, is an intriguing "coherent color" mode of operation. In this mode, the reference subcarrier frequency to the system is derived by multiplying the gen-lock composite sync H frequency within the VSD-30 by 455/2.

The H frequency will be tracking the output of the VTR or VDR, which may be capstan servo'd, a-c power line driven, or even a battery-powered. The time base corrected output of the TBC will have coherent burst and sync, but their frequencies will be floating and off spec, depending completely on the characteristics of the source VTR/VDR.

The second generation playback of this signal will be coherent at the DEMOD output of the VTR, and may be time base corrected against broadcast-spec sync and subcarrier, if the unit is appropriately equipped. There is a limitation on this transfer process, however, associated with the amount the average frequency of H (and therefore of subcarrier) is displaced from the centerline specification of 15,734 lines/sec. A 6 Hz displacement of H results in a 1300 Hz displacement of subcarrier frequency, which equates to a 30 degree hue shift of any color across each H line, with respect to stable re-inserted burst. The broadcast VTR must have a velocity error corrector in its TBC complement to remove this unacceptable color aberration from the second generation playback. At some lesser displacement of H, the hue shift error becomes tolerable, but this is a subjective judgement.

An outstanding feature of the SL-15 Capstan Servo Accessory is its ability to alter the tape speed of either a line-locked or a capstan-servo'd VTR, so that reproduced H frequency is 15,734 lines/sec average. This means that even a battery-pack tape, recorded extremely slow because of low tape voltage, may be corrected to 15,734 lines/sec average frequency by playing it back on a capstan-servo'd VTR driven by an SL-15 unit.

An additional MICROTIME 74 TBC series is now available for broadcasters and others who require the ability to produce a broadcast-stable, phased (coherent) color tape in one step from a signal reproduced on a capstan servo'd (V locked) VTR or VDR. Called the 600 Series DIGI-MATIC™ TBCs, these units utilize an all-digital signal processing technique.

Fig. 7. The 600 Series DIGI-MATIC TBC is the newest addition to Television Microtime's rapidly expanding product family.

They work with direct and heterodyne record 1-head-per-field helical VTRs which exhibit large time base errors from inherent instabilities in the tape drive and video head drive servo systems, large irreducible changes in tape dimensions manifesting themselves as skew tension errors, and/or 1/2 H-line or greater discontinuities in sync timing caused by wrong field edits in capstan servo'd VTRs.

The DIGI-MATIC TBC design features advanced proprietary automatic circuitry designed to minimize the effects of digitizing noise and quantizing errors and heterodyne processor noise found in earlier all-digital TBCs. A unique capability included in the digitizing clock function compensates for velocity errors detected in the playback of direct-record signals. With the unit interconnected to the VSD-30 input accessory, one switch selects whichever processing mode is required by the phased or non-phased characteristics of the incoming composite video signal. All units contain a MICROTIME full-color proc amp with front panel operating controls and internal maintenance adjustments described previously.

The current MICROTIME family of time base and velocity error correctors and teleproduction accessories now includes six base product series and almost a dozen accessories. A hallmark of every MICROTIME designed product is universal adaptability and a competitive price consistent with quality and reliability. Individual designs incorporate all the currently feasible time base error correction technques, alone and in combination--EVDL (Electrically Variable Delay Line), SBDL (Switched Binary Delay Line), heterodyne color sign recovery, and all-digital, to reach these objectives.