TIME CODE HANDBOOK

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TIME CODE HANDBOOK

A Guide for the User
from Fundamentals to Technical Specifications

cipher digital, inc.

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TABLE OF CONTENTS

INTRODUCTION TO TIME CODE

THE TIME CODE TECHNICAL MANUAL

PREFACE

Since the creation of Videotape, the TV industry has worked to develop an accurate, standard system of frame identification. The most accurate method available today is Time Code.

Time Code labels each video frame with a unique identifying Address that cannot slip. Each frame always retains its original identity, making production functions such as editing and logging more efficient and frame accurate.

This handbook covers the two major types of Time Code.

Time Code recorded on an audio or cue channel is usually referred to as SMPTE Time Code or SMPTE Code for the Society of Motion Picture and Television Engineers who standardized the Time and Control Code for the communications industry.

A second type of Time Code, recorded in the video signal, is called VITC Code (pronounced Vit-See) for Vertical Interval Time Code.

This Handbook is designed to be an easy reference, and is divided into two sections. Section I describes Time Code basics and applications. Section II provides advanced engineering information including technical guidelines and specifications.

All technical information in this Handbook is in accordance with the SMPTE recommended standard as published by the American National Standards Institute, ANSI/SMPTE 12M-1986.

VITC information follows the SMPTE proposed standard RP 108 for Vertical Interval Time and Control Code, 1981.

EBU information refers to Tech 3097 — E, Second Edition — June 1980.

INTRODUCTION TO TIME CODE

cipher digital, inc.

THE HISTORY OF TIME CODE 1

VIDEOTAPE

In its early years, television was LIVE. Programs were broadcast directly from TV studios, and all across the country, people watched the same programs at the same time. But the TV industry wanted to delay programs for broadcast on the West Coast.

In 1956 this problem was solved by the development of the first videotape recording machine (VTR). Programs were produced live in New York, recorded on videotape and fed later to the West Coast. TV had discovered a new flexibility and a growing number of programs were Pre-Recorded.

As more complex productions were planned, the industry developed new methods to log and index the material on the recorded videotape reels, and pioneered techniques to edit the "taped" programs accurately.

FINDING THE MATERIAL

At first, recorded material was located by setting the mechanical footage counter on the videotape machine to a fixed reference point. This method wasn't very accurate, however. There are no sprocket holes on videotape, as there are on film, to keep the frame count consistent. The footage counter can slip, and the videotape itself stretches with use, adding to the possible error.

Material can also be located by counting Control Track pulses. The Control Track is a series of equally spaced, identical electronic "pulses" that are recorded on the videotape and used to synchronize the VTR machine internally when the tape is played back — a sort of "electronic sprocket hole".

But, like a footage counter, counting the Control Track pulses also depends on a fixed reference point. If the videotape machine loses count due to noise or distortion in the pulse signal, the reference point is lost and the videotape must be taken back to the original start point and re-set.

EDITING VIDEOTAPE

In the 50's, videotape was edited like audio tape, by physically splicing the tape together. Material was located with the mechanical footage counter; the tape was examined under a microscope to find an edit point between frames; the tape was cut with a razor blade and then spliced together.

These edits could be very sloppy, sometimes causing picture break-up or roll-over at the cut, and there was no way to preview an edit decision before cutting the tape.

Nevertheless, videotape splicing was the standard until electronic editing was introduced. Using this new technology, the original source reels of videotape were no longer cut apart. Instead, the source material was electronically re-recorded onto a clean reel of videotape to assemble the final edited program.

The early electronic editing methods were haphazard at best and were nick-named "Edi-Crash" since it was almost impossible to tell exactly where the edit would occur.

In 1963, Ampex Corp. refined electronic editing and introduced Editek, a system that controlled the edit point electronically.

The Videotape Operator would press a button which recorded an audible tone or "cue beep" in an audio channel of the videotape at the desired edit point. The VTR machines were cued back and the edit was electronically performed by the Recording VTR when it read the cue beep.

But, Editek wasn't frame accurate, and the process was slow, sometimes requiring that a cue beep be erased before another beep was recorded for the next edit.

A problem common to these early electronic editing systems was that they relied on the Control Track pulses mentioned earlier. Any difficulty with the pulses meant problems in the edited materials.

For example, if the playback VTR machine mis-read its pulses during the pre-roll, it might drift out of sync with the record machine and the resulting edit would be incorrect. Even under the best conditions, this type of editing was not frame accurate. The source material could slip, creating a potential error of several frames for each edit.

TIME CODE

In 1967, a new editing method was developed to avoid Control Track editing problems. This method used Time Code to define and identify each video frame with a unique identifying number broken down into **HOURS:MINUTES:SECONDS:FRAMES.**

Time Code made videotape editing more efficient than it had ever been before. In addition to speeding up the editing process, Time Code Editing was frame accurate. It allowed each edit to be previewed and repeated, with all materials remaining in sync.

The editing process was further refined in 1972, with the introduction of computer controlled systems. The most sophisticated computers identified edit points with Time Code numbers, stored lists of edit decisions in memory and performed these edits automatically from the stored Time Code information.

Today's editing technology is based on this use of Time Code.

THE BASICS OF TIME CODE

2

THE TIME CODE SIGNAL

SMPTE Time Code is an electronic, digital signal that is recorded along the length of an audio channel or cue track of a videotape in the same way an audio or sound track is recorded. The Code is electronically synchronized to the beginning of each video frame, making it impossible for the Code to slip.

Each video frame is tagged with a unique identifying number called a Time Code Address. This Address is an 8 digit number representing **HOURS:MINUTES:SECONDS: FRAMES.** The Code also contains other information that will be discussed later.

The total of all Time Code information recorded for each video frame is called an electronic Time Code "word". Each word is divided into 80 equal segments called "bits", numbered "0" to "79". These 80 bits are spaced evenly over the entire video frame, so for every frame of video, there is a corresponding Time Code Address.

Information is written in the Time Code by defining the bits as binary "Ones" or "Zeros". It is this binary arithmetic that a Time Code Reader detects to display the recorded information.

Electronically, the bits are created by fluctuations or shifts in the voltage of the Time Code signal. In Figure 1, the signal appears as a toothed line called a Square Wave.

By definition, a new bit, equal to a binary Zero, is created when the signal shifts either high or low, up or down.

Every bit in Figure 1 is a binary Zero. There is only one shift of voltage to create each bit in a single bit period. (or)

Figure 2, on the other hand, has a pattern of binary Ones and Zeros in its signal. To create a binary One, there is a second voltage shift halfway through the bit period. (or)

This unique method of encoding information is called bi-phase modulation and allows the code to be read forward or reverse, at fast or slow speeds.

Figure 1

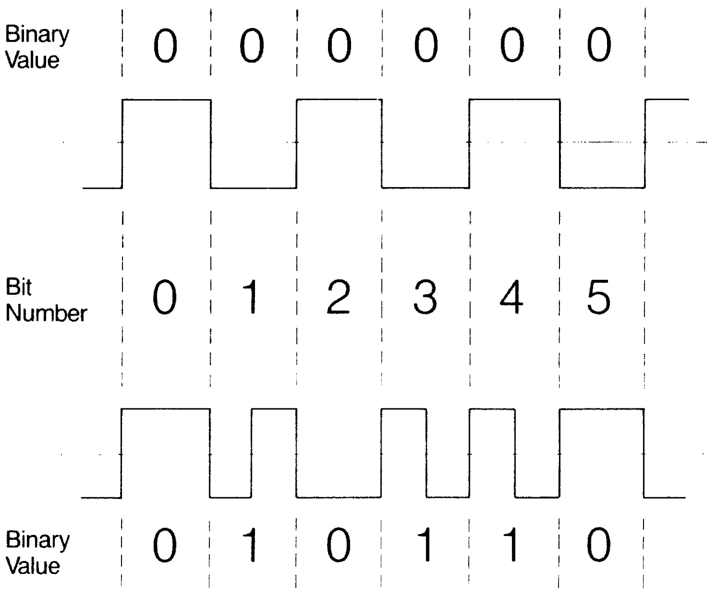


Figure 2

The 80 bit Time Code word is divided mainly into groups of 4 bits to represent different coded information. See Figure 3. Each 4-bit group is coded to form a decimal number (0 to 9), a method of coding called "BCD" or Binary Coded Decimal.

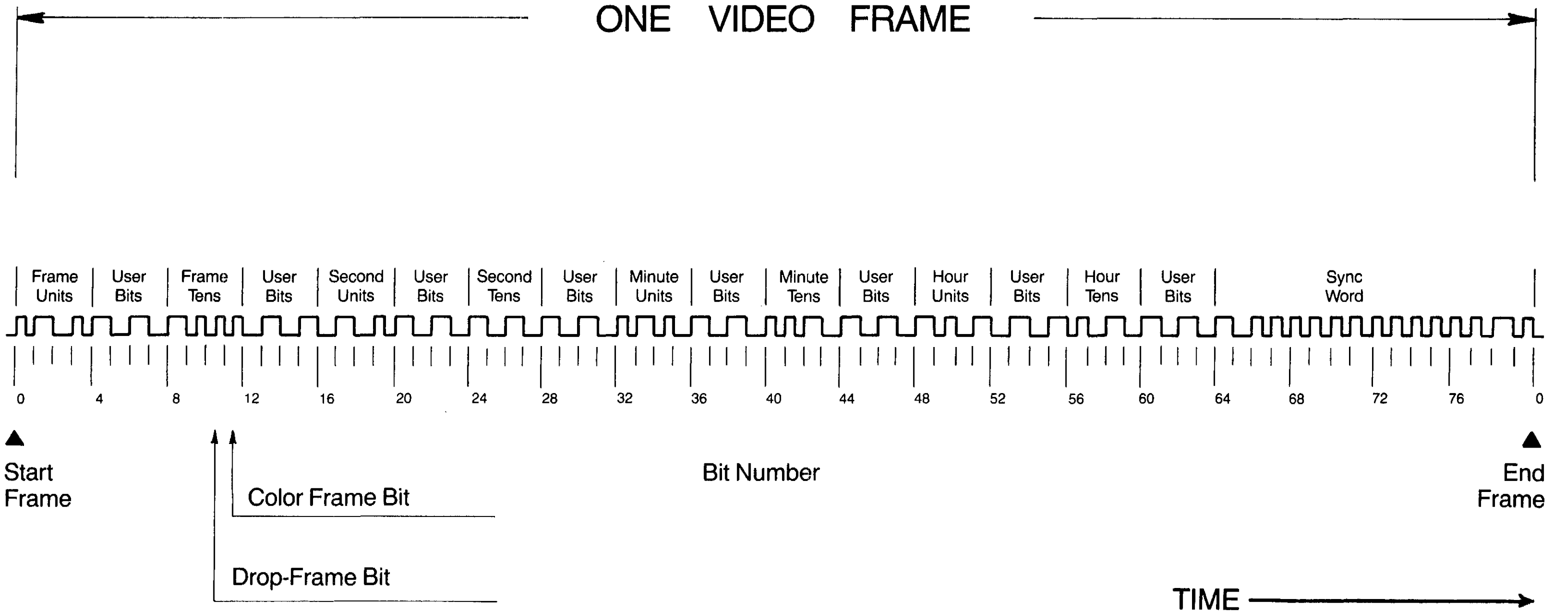


Figure 3
80 BIT TIME CODE WORD
Address Number — 12:35:08:29

When a Time Code Reader detects the pattern of binary Ones and Zeros in a 4-bit group, it reads the information as a single decimal number. Eight of these decimal numbers together form the 8 digit Time Code Address, written in an **HOURS:MINUTES:SECONDS:FRAMES** format.

In addition to the Time Address information, there are two other types of information coded into the Time Code word, User Information and Sync Information.

The features of the three types of coded information are discussed in the following pages. For a detailed examination of the Binary encoded data, refer to Chapter 6.

TIME ADDRESS INFORMATION

As described earlier, each video frame is identified by a unique, 8 digit Time Code Address, representing **HOURS:MINUTES:SECONDS:FRAMES.**

The Time Code Address was given an 8 digit "time" format because this format provides a number of advantages in producing and editing video materials.

First, the Address can represent the actual clock time when that particular material was recorded. This is helpful when making a "shot list" or writing a chronological production report.

(It is important to note that Time Code can be used as an accurate clock only if the Code signal is altered. See the discussion of Drop-Frame Time Code on Page 21.)

Second, the duration of a scene or completed program can be calculated with frame accuracy using simple arithmetic.

Third, individual scenes or takes can be identified by programming a specific number in the Time Code Address. For example, when Scene 11 is shot, the Address can be pre-set to 11 hours — 11:00:00:00.

The Time Code Address numbers are recorded in sequence; for each video frame, the Time Code number is advanced by one frame "count".

In the American TV system, there are 30 (or approx. 30) video frames per second (Fr/s) therefore the Time Code Address counts Frames from "00" to "29" and returns to "00" when the Seconds column advances.

In the European system, or a TV system using 25 Fr/s, the Time Code counts frames from "00" to "24" before the Seconds advance.

Time Address information is written into 26 of the 80 bits in the video frame's Code word. Because Time Code runs on a 24 hour clock, there are no hours larger than 23, no minutes or seconds above 59 and no frames above 29. This means the bits assigned to 4-bit Time Address groups are not all needed to encode the Address information. The remaining 6 bits in the Time Address groups are discussed on Page 21.

USER INFORMATION

In addition to the Time Code Address used to index each video frame, there are 32 bits in the Code word set aside for anyone using Time Code to enter their own information.

These "User Bits" were made available for any data the User may require, with no restrictions imposed by the Standards Committee.

User Bits are currently being used as static identification tags for Reel Numbers, Shot or Take I.D., Location, Date or Personnel Data.

But, because Time Code equipment handles User Data with the same techniques as Time Address Data, the User format is limited to 8 digits, and each User digit is limited to the numbers "0" to "9". It can be difficult to encode all the required User information in this limited format.

For example, 12 04 03 28 may represent Reel #12, shot at Location #4, Scene 3, shooting on the 28th day of the month. Once set, this particular User data would be encoded into every Time Code word unless manually re-set by the operator.

With a more sophisticated system, each User digit is expanded to a total of 16 possible characters by including both "0" to "9" and the letters "A" to "F". However, the format is still limited to only 8 digits — 2E 36 A4 07.

(The use of four binary numbers in a format to indicate 16 characters is called Hexadecimal Notation.)

Some proposed methods of encoding and decoding User Bit Data will make it possible to go beyond these limitations. For example, User Data may be stretched out over the User Bits in any number of frames until all the required information is encoded.

Larger data capacity will also make it possible to program complete text information, captions, instructional materials, etc., into the Code.

Work is currently underway to propose standard methods of encoding and decoding this expanded data capacity in the User Bits.

SYNC INFORMATION

The third type of information in a video frame's Code word is called "Sync" data. It is an integral part of the Time Code signal and performs two major functions.

The Sync Bits define the end of each frame of Time Code, and because Time Code can be read in either direction, the Sync data notes whether the videotape is moving forward or reverse.

The operator has no access to Sync information, which is controlled by the Time Code Generator. Sync data occupies the last 16 bits of the 80 bit Code word.

UNASSIGNED BITS

By the current count, 26 Time Address Bits, 32 User Bits and 16 Sync Bits, there are still 6 bits remaining to complete the 80 bit Time Code word. Four of these 6 bits are unassigned and are defined as permanent binary Zeros.

These Unassigned Bits are available if the need to indicate some standard "mode" of operation occurs in the future.

Since Time Code was first introduced, two modes of operation have been defined and assigned their own bits. A binary One in Bit 10 indicates "Drop-Frame" mode and a binary One in Bit 11 indicates "Color Frame" mode.

DROP-FRAME TIME CODE

As detailed earlier, the Time Code signal is locked to the advancing video frames, that is, Time Code and video frames advance at exactly the same rate.

For Black and White (Monochrome) video signals, this rate is 30 Frames per second. If a Monochrome TV Program is measured by Time Code, everything will agree: the program length, the Time Code display and most importantly, the clock on the wall.

However, Color Video signals do not run at the same speed as Monochrome. The National Television Standards Committee set the Color rate at approx. 29.97 Frames per second (Fr/s).

This means that a Color program, clocked at 30 Fr/s picks up an extra .03 Fr/s every second. Over the course of an hour, the Color program's length expands by 108 video frames, a total of 3.6 seconds.

This accumulated error means that a one hour Color show, measured by Time Code frame count, actually runs 3.6 seconds longer than an hour. There is no agreement between the Time Code display and the clock.

To restore the agreement, the TV industry has developed a way to adapt Time Code to make it match the slower running 29.97 Fr/s Color video signal.

The problem is how to lose 108 video frames every hour and still run the Time Code at a consistent speed. The solution is Drop-Frame Time Code.

Instead of the Time Code Address numbers always advancing by one frame, the counting is altered so that whenever the Time Code ends a minute, it drops the first two frames beginning the next minute.

For example, 12:25:59:29 advances to 12:26:00:02. Code numbers 12: 26:00:00 and 12:26:00:01 don't exist.

This omission doesn't affect the video pictures. The video frames still progress in a continuous sequence at 29.97 Fr/s. Only the Time Code's number count has been altered; it drops frames in order to run at the same rate as the clock.

However, if 2 frames are dropped every minute for a full hour, 120 frames are lost. Since the goal is to lose only 108 frames an hour, a compromise is necessary — the Time Code is allowed to include the first two frames, but only every tenth minute.

For example, 12:29:59:29 advances to 12:30:00:00 just as it always has.

To summarize, Drop-Frame Time Code eliminates two frames each minute except for minute 00, 10, 20, 30, 40 and 50.

Drop-Frame allows the Time Code to run at almost exactly the same speed as the clock. Any calculations of program length based on Drop-Frame Code will give the correct running time, and both the program length and Time Code display will agree with the clock on the wall.

Because the Color TV signal is not exactly 29.97 Fr/s, Time Code running in the Drop-Frame mode still accumulates a slight error, a maximum of 75 milliseconds (75 thousandths of a second) over the course of 24 hours. This error is within the timing requirements of the average production or broadcast facility. For information on Short Term Error in Drop-Frame Time Code refer to Chapter 6.

The old style, continuous Time Code is now called Non-Drop Frame Time Code and Bit 10 of its Code Word remains a binary Zero. Drop-Frame Time Code has an indicator flag built-in by encoding Bit 10 as a binary One.

COLOR FRAMING

Because of the complex way that color information is encoded in a full bandwidth, color video signal, all video frames are not alike. Put simply, video frames have an alternating "characteristic" that can be described as plus or minus, "A" or "B".

When color video material is being edited together, this alternating A-B-A-B sequence of frame characteristics must be maintained.

If an attempt is made to edit frames together out of sequence, that is A-A or B-B, the videotape machine will correct the error by displacing the video picture horizontally. In effect, the Horizontal shift or "H" shift is caused by the system changing the incoming video frame's A or B characteristic to make it fit the A-B-A-B sequence.

Normally, the "H" shift is not visible because it occurs at an edit point between two different shots and the changing picture content obscures the small shift. On the other hand, if the "H" shift is recorded at an edit point in which the picture content does not change, such as a "Match Frame", the shift is visible on the TV picture.

To avoid these visible "H" shifts, it is necessary to identify the characteristics of the video frames involved in each edit. Unfortunately, measuring the A or B of a given frame directly from the color video signal is made very difficult by the distortions present in VTR recording.

For this reason, a Time Code "Color Frame" standard was developed to allow a Videotape Editor to make the A-B frame identification from an easier source — using the video frame's Time Code Address number instead of the video signal.

A Time Code Address ending in an even number is defined as a video frame having an "A" characteristic. An Address ending in an odd number is defined as a "B" video frame.

Once the A or B characteristic of recorded video material is identified, the videotape can be synchronized to a stable reference signal such as the house Sync Generator. This allows the Computer Editing System to insure that the A and B values of incoming video material will match the A-B-A-B sequence already recorded on the edited Master tape.

Whenever a Time Code Signal identifies this A-B color frame characteristic, a flag is raised by encoding Bit 11 of the Time Code Word as a binary One.

TIME CODE APPLICATIONS 3

PRODUCTION AND BROADCAST OPERATIONS

Time Code equipment is light and portable, providing an accurate reference in the studio and on location.

Code can be generated at Time-of-Day (TOD) as a substitute for clock time, or any specific time can be set on the Time Code Generator as required for sequential, multiple-reel productions.

Within a given reel, Time Code simplifies logging and indexing since the Time Code number is always the same for its corresponding video and audio information. Shot and Take notes can be extremely accurate. Lapsed time and time remaining on the reel are easier to determine, and final lengths are available with a frame accurate count, well beyond the limits of a stopwatch.

Time Code is especially important to TV news operations where recorded material must be handled rapidly to meet daily deadlines.

Specific shots and takes are located quickly in the mass of raw footage from the field using a list of Time Code Address numbers; frame accurate "In" and "Out" points are chosen; the news segment is edited and its final duration is logged. The segment's "In" Address then becomes cueing information for the Videotape operator.

Time Code also serves news and other production operations as a library index for storing historical footage.

VIDEOTAPE EDITING

Once program material is recorded, Time Code is the tool used "Off-Line" to prepare for Computer Editing and to actually perform the "On-Line" computer program assembly.

Time Code exists in the original material as an electronic signal on the audio or cue track, and the first step in Off-Line editing is preparing work materials that include the Time Code numbers.

The original material is dubbed, usually to 3/4" videocassettes, recording the corresponding Time Code on the outside audio track or Audio 1, and the program sound on the inside track, Audio 2.

At the same time, a Character Inserter, usually built into the Time Code Reader, records a visible display of the Time Code over the picture on the videocassette, as shown on this Handbook's front cover. The size and placement of this "burned-in" Time Code display is selectable and the Time Code numbers are usually surrounded by a dark "box" to help them stand out from the video picture.

The resulting videocassette now contains every frame of video/audio, identified by its permanent Time Code number both visually and in an audio track. It is a work picture in which the video frames and their Time Code Address numbers are identical to the original material.

Post Production editing is performed using the work videocassettes with the burned-in Time Code display. This is the most economical method of video editing, since at current prices, an hour Off-Line with a 3/4" videocassette editing system costs less than 1/3 the price of an hour On-Line in a professional Computer Editing Suite for 1" or 2" videotape.

The actual edits performed by most 3/4″ videocassette editing systems are not frame accurate, but that is not a factor in the final assembly of the program On-Line.

Frame accuracy comes from the burned-in Time Code display on the videocassettes. This display can be read easily at slow shuttle speeds and in still-frame, making the Time Code Address numbers a quick reference.

The production team takes careful notes from the display to develop a list of Address numbers that accurately reflect each edit.

This list of numbers is called the Edit Decision List or Edit List. If the videocassette editing system is not frame accurate in a particular edit, the error can be corrected on the Edit List.

When the Edit List is programmed into the On-Line Computer Editing System, all the final program edits will be frame accurate, exactly as they are written in Time Code Address numbers.

COMPUTER TIME CODE EDITING

Before editing can begin, a reel of videotape must be prepared to record the final edited program.

Time Code and other reference material known as "Basic" or "Edit Black" is recorded along the entire length of the Master videotape with no gaps or breaks in the signal. The "Basic" Time Code numbers will become the final identifiers for every frame of video recorded into the completed program.

Next, the edit list is typed into the Computer Editing System's memory on a computer keyboard and any obvious problems in the list are cleaned up.

Given the proper instructions from the Videotape Editor, the computer-controlled 1″ or 2″ editing system refers to Time Code to perform each operation. The computer synchronizes all the equipment being used, controls multiple previews for edit rehearsal, pre-rolls all videotape and audio machines, rolls the machines in sync, performs the edit with frame accuracy and re-plays the edit for final approval.

Most computer editing systems operate in two modes. One provides manual control for each edit. The second mode called Automatic Assembly, will continue editing, working through the Time Code Edit List until told to stop.

The newest editing systems use Time Code Address numbers to control switchers, character generators and other equipment.

Program Materials can be edited; recording both video and audio, or the video can be completed first and the audio added later in a Time Code synchronized pass for sound mixing.

AUDIO RECORDING

Time Code is a recent addition to audio production facilities where it is used as an accurate sync reference for audio recorders and an index for locating sound recorded on audio tape.

Many audio studios synchronize multiple machines with Time Code. It is also used as a reference in multi-track recording and to prepare cue sheets for later mix-down of the final product.

Audio studios handling film, TV, and soundtrack work use Time Code to synchronize picture and sound for lip-syncing, overdubbing narration, music or sound effects.

In audio editing situations, Time Code provides the ability to preview audio edit decisions, and make accurate on-the-word edits.

FILM PRODUCTION AND POST PRODUCTION

Applications for Time Code in the film industry are still largely experimental, although a number of possible uses are being investigated.

Time Code Generators built into film cameras and sound recorders are one option, allowing the Time Code to be laid on the film in the optical or mag stripe, and on a sync or audio channel as the film sound is recorded.

The camera and sound recorder must be synchronized at the beginning of each day's shooting and run on Time-of-Day Time Code, allowing anything shot or recorded all day to be synced to their common TOD Time Code Address.

Another proposal is to use the Time Code as a sort of electronic latent edge numbering. This version of Time Code doesn't include frames, but both picture and sound will still have the Hour:Minute:Second Code in common for syncing.

A third option is to edge number the film as it always has been done, but instead of editing the film itself, the raw footage is transferred to videotape.

At that point, the latent edge numbers from the film are encoded in the Time Code's User Bits, establishing a permanent relationship between film and video frame numbers.

Once the material is video edited and the final cut approved, the video Time Code numbers are converted to film edge numbers and this list is sent to the film negative cutter to prepare the original film materials for printing.

The major problem with this option is the difference between film running at 24 Fr/s and video running at 30 Fr/s. To make each second of film equal each second of video, the film frames are scanned at an uneven rate during their transfer to videotape. This causes problems for the negative cutter, who works from an edge number list that is calculated from the Time Code.

Time Code does offer a number of advantages for film, many resulting in savings of time and money. Since Time Code is a frame accurate reference, clapstick slates are eliminated, saving on raw stock; picture and sound for dailies (or rushes) can be synced quickly and easily; preferred takes are easier to find and log; and any number of cameras and sound recorders will always be in perfect sync.

The most important applications for Time Code may be in new techniques for editing film.

The process described earlier — editing on videocassette and conforming a final film print for release — represents one possible combination of film and video technologies.

There are also editing systems that use traditional film work prints and film transports (like Steenbeck or Moviola), but play the images back through a sophisticated control panel and record the edits on videocassette.

But the most common adaption, especially in films produced specifically for TV, is to transfer the film footage to videotape directly from the original negative. The latest Telecine Cameras and "flying-spot scanners" can accept a negative image and feed a positive image that has been scene by scene color balanced. Most of these devices use Time Code as a reference.

The resulting material looks like original film, but is recorded on videotape and is Time Code identified frame for frame. Work cassettes with burned-in Time Code are usually made during the film transfer, so all picture and sound work can be performed on videotape.

Regardless of how the final picture will be seen, on film or video, Time Code is the most accurate method of producing film sound, from building dialog, music and effects tracks to syncing all the sound materials on a multi-track machine for the final mix.

This new ability to combine film and video materials means that mixed-media sync can be accomplished easier than ever before, through the use of Time Code.

SETTING UP FOR TIME CODE OPERATION

4

TIME CODE GENERATORS

A Time Code Generator is the device that creates the digital Time Code signal. The most common Generators include a front panel display for the Time Code data and a method of pre-setting and starting the Code, such as thumbwheel switches.

Normal procedure is to set the Generator to Time-of-Day Code, although on most Generators, any time can be selected from 00:00:00:00 to 23:59:59:29.

Generators may provide a remote control switch to run and stop the Time Code. This may be necessary if the Generator is to be mounted in a rack away from the studio or videotape room.

One very important feature of a Time Code Generator is the "Jam Sync" function, which allows the Generator to pre-set or "Jam" its Time Code output to an external Time Code signal. The major use of Jam Sync is "restriping", a process that replaces deteriorated or discontinuous sections of Time Code on a videotape with new Code that matches the original Address numbers and frame count.

SYNCHRONIZING THE TIME CODE

To insure that the Time Code is locked to each video frame, the Time Code Generator MUST be synchronized to the video source being recorded.

In a house system in which all equipment is "Gen-locked" to a common video Sync Generator, all that is necessary is a separate sync feed to the Time Code Generator.

If no "house sync" is available, Time Code Generators are designed to accept any continuous composite video or sync signal which is fed to the Time Code Generator from the video source being recorded.

Failure to supply the Generator with a proper reference signal will result in recording non-synchronous Time Code, which is useless for Computer Editing and most other Time Code applications.

Figure 4 shows a basic system diagram including the Time Code Generator.

DROP-FRAME AND COLOR FRAME MODES

There are two modes available for Time Code operation.

Drop-Frame Mode
Drop-Frame Time Code is the accepted standard in the majority of modern production facilities. Selection of Drop-Frame Mode is accomplished by an internal or external switch on the Time Code Generator.

Any facility using Time Code as clock time, or editing and calculating the length of TV programs should use Drop-Frame.

Audio Production facilities that at some point may synchronize sound to video should also select Drop-Frame.

Color Frame Mode
Facilities editing full bandwidth, 1" or 2" videotape should use Time Code generated to the Color Frame timing standard.

Generators capable of creating Color Framed Time Code will either require an additional "Color Frame" input fed from the house Sync Generator (normally a 15 Hz signal), or a specially adjusted "RS-170A" video feed.

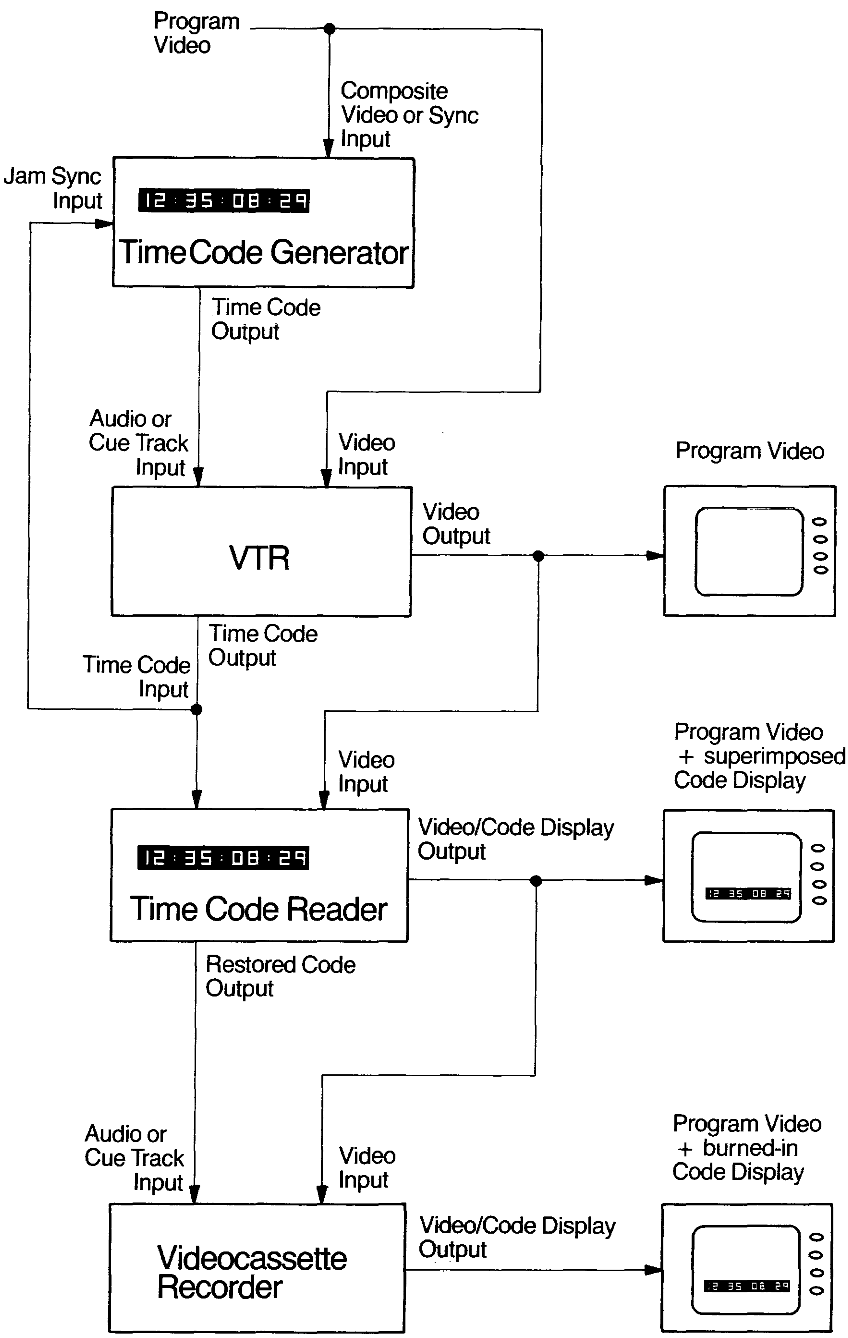


Figure 4 — SYSTEM DIAGRAM

CHOOSING A FRAME RATE

There are a variety of frame rates selectable in most Time Code Generators.

Color videotape and TV operations require the NTSC rate of 29.97 frames per second.

Monochrome (B + W) TV and some audio studios use 30 frames per second, although it is suggested that audio studios use the 29.97 color standard, for later synchronization with video.

Time Code used in connection with Film will usually run at 24 frames per second, with the capacity to vary the Code timing to match film camera speed.

European Broadcast standards require 25 frames per second to be compatible with the European TV signal.

DISTRIBUTION

Time Code may be treated like any other audio signal. It can be routed through audio Distribution Amplifiers and two-conductor shielded audio cables, and patched through audio Switching Systems.

A potentially serious problem is Cross-Talk caused by the Time Code signal interfering with adjacent, low level audio signals. As with any high level signal, Time Code cables should not be placed too close to other audio routing lines.

Since Time Code is a symmetrical signal, it is immune to normal cable polarity problems, and is unaffected by inverted or "flipped" lines.

RECORDING TIME CODE

The digital Time Code signal, like an audio feed, is recorded on an audio or cue track of the videotape.

For 1" helical tape, record the Time Code in the 3rd audio or cue track.

For 2" quad tape, Time Code is recorded in the cue track (also called the Time Code track or auxiliary track).

For 3/4" helical videocassette, use the outside track or Audio 1. Some cassette machines feature a special Address or Time Code track with its own input. This frees Audio 1 for production work.

Most videotape machines have automatic gain or level controls for the audio inputs. These automatic controls should NOT be used for recording Time Code. To avoid distorting the Code signal, the audio gain should be set manually.

There are no current industry standards for Time Code recording levels, but field experience shows that the following levels will give the best results in most cases.

For 1", record the Time Code with a level between -5 and -10 VU.

2" quad requires the highest signal possible without causing problems such as Cross-Talk: + 3 to + 5 VU.

3/4" cassette machines always require a few tests to determine the best level, but it will generally fall between -5 and 0 VU.

Time Code should be recorded on Audio Tape on the furthest outside track available, saving the more responsive inside tracks for sound work. It is also a good idea to leave a blank track between the Time Code and the recorded sound to avoid Cross-Talk in multi-track audio production.

READING TIME CODE

There are two basic types of Time Code Readers: Playspeed-only and Variable Speed.

Variable speed readers are preferred since, especially in editing situations, it is necessary to read the Time Code across a wide range of tape speeds. Most modern readers can decode information from 1/50th to 100x playspeed. However, having a variable speed reader is no guarantee that the Code can be read at all speeds.

Time Code is recorded along the length of the videotape (in the "longitudinal mode"), therefore the tape must be moving over the playback heads at some minimum speed before there is sufficient level for the Time Code Reader to detect an error-free signal.

This is a problem at slower shuttle speeds and it is impossible to read SMPTE Time Code when viewing a still-frame. On a 1" helical VTR, Time Code is usually read accurately as slow as 1/20th playspeed. Most 3/4" videocassette machines only read accurately to 1/10th playspeed.

When using a Time Code Reader that can decode information at extremely high speeds, the major limitation is the bandwidth of the VTR's audio channel.

Shuttling at many times playspeed, the Time Code signal can go beyond the audio channel's ability to handle the information. The only solution to this problem is to modify the VTR audio (or cue track) playback amplifier to give it sufficient bandwidth to handle a wider speed range. For more information, see Chapter 7.

Another problem at extremely fast shuttle speeds is the "Air Layer Effect" in which the tape is moving so fast, a thin layer of air lifts the tape off the heads, causing the Time Code Reader to receive false information.

One more difficulty in reading Time Code is caused by the level at which the signal was originally recorded. Generally speaking, each videotape machine has its own "personality" in the manner in which it records and plays the Time Code signal.

A good rule of thumb is to experiment with each machine to determine the minimum record level necessary to assure accurate playback. Playback levels that are too high can cause Cross-Talk and levels that are too low may be impossible for the Time Code Reader to detect, especially when exchanging tapes between different VTR machines or different Readers.

Vertical Interval Time Code is being developed in an attempt to solve some of the above problems, and is discussed in Chapters 5, 9 and 10.

DISPLAYING TIME CODE

The most common display of Time Code information is on the front panel of the Time Code Reader, usually in the form of LEDs (Light Emitting Diodes) that show the Code as it advances frame by frame.

In most cases, however, it is necessary to see the Time Code numbers and the video pictures together. For this reason, most Time Code Readers have built-in Character Generators and Video Inserters, enabling the operator to superimpose the Time Code display over the video picture.

This can be done live without affecting the picture recorded on the original videotape, or it can be used to produce work copy videocassettes which have Time Code permanently burned-in to the picture area.

Both the size of the visible Time Code display and its placement in the TV picture are selectable by controls on the Reader. Visible Time Code is usually surrounded by a dark "box" to make it stand out from the video picture.

There are occasions when it is necessary to avoid displaying the burned-in Time Code in the video picture. For example, an edited 3/4″ cassette may be screened for content approval, and visible Time Code would obscure some portion of the picture area.

In this case, some Time Code Readers can position the Code display in the Vertical Interval, outside the TV picture's cut-off area. The edited video picture will be free of visible Time Code, and the burned-in display can be seen only by using a special Pulse Cross Monitor.

If Time Code is to be used for Computer Editing, it is necessary to supply the Code information to the computer. Most Time Code Readers are equipped with outputs to convert Time Code into BCD parallel data that the computer can read.

The types of display activities described above usually require that each VTR machine have its own Time Code Reader. Depending on the production load, an entire facility may or may not require more than one Time Code Generator.

A BRIEF CHECKLIST

✓ When adding Time Code to an existing system, it is important to check portions of the equipment (such as Time Code audio tracks) that may not have been used before.

Also, since the digital interface between Time Code equipment and editing systems is not standardized, there may be interconnection problems. Be certain your system is compatible with the Time Code equipment.

✓ A Video reference or Sync signal MUST be patched into the Time Code Generator, otherwise the recorded signal will be non-synchronous and useless for Computer Editing.

- One common problem inhibiting the recording and playback of Time Code is dirt, which may cause distortion and poor levels in the Time Code signal. Carefully clean the record, play and erase heads and the entire tape path prior to each use.

- Treat the Time Code as any other signal and make test recordings, especially to check for proper levels. As discussed earlier, every system will handle Time Code differently.

- Choose either Drop-Frame or Non-Drop Frame Code and stick with it. Attempts to mix these modes can cause difficulties in production and editing.

- In order for a computer to locate material on the videotape, the Time Code should be in ascending order on all reels and the same Code Address number should only appear once on a reel.

- There should be a minimum of 10 seconds of clean Time Code prior to any material included in an edited program. Otherwise, the computer will have insufficient room to pre-roll or back cue the tape to perform an edit.

- Material recorded near midnight may run into a problem. At midnight, the Time Code's clock advances not to 24 hours but to Zero hours. Recording this transition into a reel of videotape intended for editing will confuse the computer since the lower Code numbers will appear at the end of the tape.

  To avoid this, either start recording sufficiently in advance of Midnight to finish before the "Zero Hour" or wait until after Midnight to begin. A third option is to use the Time Code Generator's capacity to pre-set a Code Address independent of the clock.

  Additional problems and solutions can be found in Chapter 8.

VERTICAL INTERVAL TIME CODE 5

PROBLEMS WITH SMPTE TIME CODE

The most obvious problem with SMPTE Time Code has to do with reading the Code signal at extremely slow speeds.

There are high quality, variable speed Time Code Readers that can decode from slower than 1/50th to 100x normal playspeed, but because of limitations in the tape system, even they are ineffective at slower shuttle speeds and still-frame.

In addition, the Time Code signal takes up valuable space on the videotape, usually in an audio channel that could be put to better use for sound production work.

For these reasons, other methods of frame identification are being developed.

VERTICAL INTERVAL TIME CODE — VITC

The most promising alternative to SMPTE Time Code was introduced in 1978 and proposed as a standard in a slightly modified form in 1980.

Vertical Interval Time Code contains the same Address and User Information as SMPTE Code, but it is a different type of signal. VITC Code is recorded within the video signal itself, outside the visible picture area in a location called the Vertical Blanking Interval.

VITC has a number of advantages over SMPTE Code.

First, on 1″ or 3/4″ helical videotape, VITC can be read at the slowest frame-by-frame jogging speeds including still-frame. Because VITC is a part of the video information and is read by the rotating video heads, any time a video picture is visible, the Time Code is detectable.

This means VITC can replace burned-in SMPTE Code on work videocassettes. A Time Code Reader can superimpose the frame accurate VITC display when needed to develop the Edit List, but it will no longer be necessary to burn-in a permanent visible SMPTE Code display.

Second, VITC identifies video fields.
As discussed earlier, a SMPTE Code word is spaced evenly over an entire frame of video material. But, each video frame is really constructed of two individual fields, produced as the picture tube scans the odd lines (Field 1) and then the even lines (Field 2) in a video picture.

Since VITC is recorded in the video signal itself, this Time Code indexes both fields of a frame with an Address number that includes field identification.

Field identified Code means a sophisticated computer editing system using VITC can edit with field accuracy. In effect, VITC expands the number of edit points from 30 per second to 60 per second, since there are 60 fields that make up every 30 video frames.

When it is the only Time Code in use, VITC frees an audio channel for production, and completely eliminates the potential for Cross-Talk from the SMPTE Time Code signal.

VITC does have minor disadvantages. For example, some 3/4″ videocassette machines not capable of reproducing video at full shuttle speeds will still rely on SMPTE Time Code. 2″ quad machines will also continue to use SMPTE Code since quads cannot read still-frame or retain an image at speeds other than normal playback.

Although it does not take up space on the tape like SMPTE Code, VITC does occupy scan lines in the Vertical Interval that could be put to other uses.

Also, since VITC is a part of the video signal, it is difficult to add after the original material is recorded. In most cases, the video material must be dubbed down a generation to another tape while the VITC Code is added.

One solution to the question of which Time Code to use is: Both. Systems are being developed that could use whichever type of Time Code is detectable in each instance. When SMPTE Code and Vertical Interval Time Code are recorded on the original materials, these systems would combine the strengths of both.

For a more detailed look at VITC, see Chapters 9 and 10. The complete text of the SMPTE Proposed VITC Standard, is available in Appendix B.

THE TIME CODE TECHNICAL MANUAL

cipher digital, inc.

SMPTE CODE TECHNICAL GUIDELINES

6

CODE SIGNAL STRUCTURE

Time Code is a technology used in the TV industry to index recorded video material by providing a unique Address or identification number for each recorded video frame.

The Code is an electronic, digital signal encoded with low rate (2400 bits/sec) binary information. Because of the bit rate and structure of the signal (waveform), the Code can be processed as an audio-type signal and is normally recorded in an audio channel.

SMPTE Time Code is a continuous data stream divided into distinct Code words. Each Code word consists of 80 binary digits or bits that identify a single video frame.

The 80 bit Time Code word is synchronized to the start of each video frame and is timed to be distributed evenly over the period of one frame of video information.

Bi-Phase Encoding

The Time Code electronic signal is developed using a technique known as Manchester bi-phase modulation. Using this method, the beginning of each bit can be defined with either a positive or negative going voltage transition. This characteristic can be seen in the square wave shown in Figure 1, Page 16.

The bit period is equal to 1 video frame (time) divided by 80 bits/frame. A bit is defined as a binary Zero. To encode a binary One, an additional voltage transition is generated at the mid-point of a bit, i.e. in 1/2 of a bit period. See Figure 2.

Another way to describe this encoding technique is as a Frequency modulation process; the number of transitions per bit period is doubled to encode a binary One.

This encoding process provides a number of advantages:

• Because bits can be defined with positive or negative transitions, the resulting Code is immune to phase reversals. Cables can be routed with no regard for polarity.

• The Code is ''self-clocking''. At any bit rate, a binary One will continue to be recognized as a bit with a mid-point transition, therefore, synchronization can occur at every bit.

Since bit rate is determined by VTR play speed, this allows the Code to be read over a wide range of speeds.

• The Code information can be derived using ''zero crossing detection'' to identify transition rates. This demodulation method makes the Code relatively immune to amplitude variations.

• The Code can be read in either direction, so information can be decoded from recorded tape in forward or reverse.

Bit Rate
The bit rate can be described either in bits per second or by the corresponding square wave frequency.

When 80 bits are generated or resolved at playspeed in a continuous stream of binary Zeros, the bit rate is 2400 bits/sec, that is 80 bits/frame X 30 frames/sec. This is equivalent to a fundamental frequency of 1200 Hz.

Encoding the 80 bit structure with binary Ones does not change the bit rate, since the bits are recorded at a

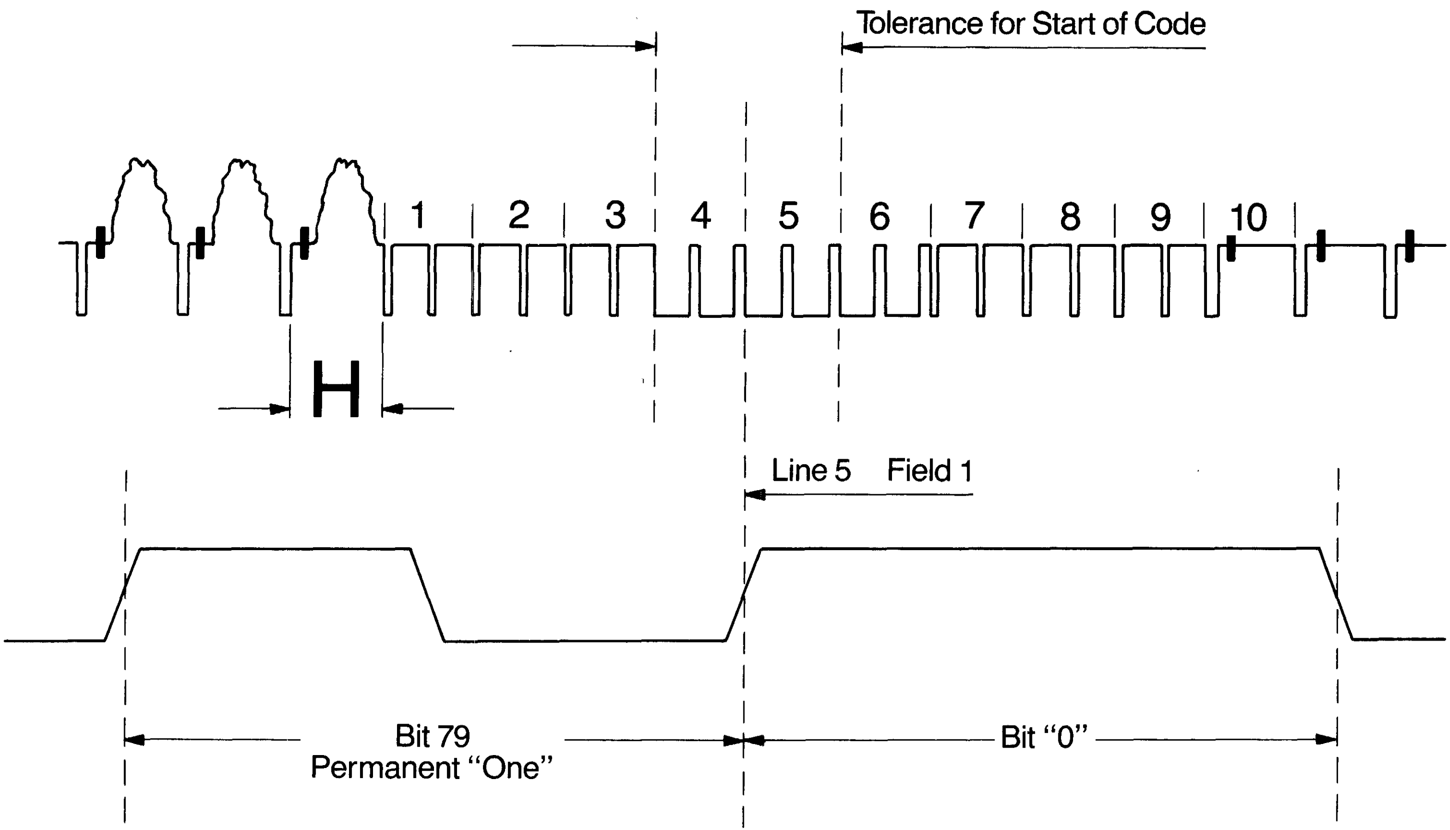


Figure 5 — SYNCHRONIZATION OF TIME CODE AND VIDEO SIGNAL

constant speed. However, the transitions double when binary Ones are encoded, equal to 2400 Hz at playspeed.

At the slowest practical tape speeds, such as 1/30th playspeed, binary Zeros will have a rate of 80 bits/sec. At high tape speeds, such as 60X playspeed, the binary Zero rate rises to 144,000 bits/sec (144 K bits/sec) or 72 kHz; binary Ones have a rate of 144 kHz.

Risetime Characteristics

Risetime is specified by SMPTE at 25 ± 5 microseconds. This is equivalent to a bandwidth of 15 kHz, which is within the range of audio frequencies. This means Time Code can be distributed and recorded as an audio signal. See the SMPTE recommended specification in Appendix A.

Synchronization

In order for the Code word to accurately define a single video frame, it is necessary to synchronize the 80 bit word to the video signal.

As defined in the specifications, the leading edge of bit "0" must begin at the start of line 5 of the video signal for field one. A tolerance of plus or minus one line is permitted. See Figure 5.

CODE INFORMATION

Bit Coding

SMPTE Time Code is encoded in a binary BCD format, with each Code word divided into 26 Time Address bits, 32 User Bits, 16 Sync Bits and 6 status flag bits.

The 6 status flags are located in the 4-bit BCD Time Address groups because the Time Address information runs on a 24 hour clock format. See Figure 6.

Because there are no hours above 23, no minutes and seconds above 59 and no frames above 29, the six bits numbered 10, 11, 27, 43, 58 and 59 are not needed to encode the Time Address data. Their use will be discussed later.

Time Address Data
26 bits represent 8 digits in a "time" format which can be set from 00:00:00:00 to 23:59:59:29.

This format allows the Time Address to double as a clock for timing functions. To use the Time Address as an accurate clock, the Code must be running in the Drop-Frame mode, see Page 53.

Time Address frame units increment by one frame count for each video frame.

User Data
There are 32 User Bits, divided into 8, 4-bit BCD hexadecimal groups.

When not encoding User data, the 4-bit User groups are automatically encoded as binary Zeros.

Sync Data
Sync information occupies the last 16 bits of the 80 bit Code word with a unique pattern of binary Zeros and Ones that cannot be duplicated by any combination of Address and User data.

Sync data defines the end of each Code word in the continuous bit stream, and determines the direction of the Code, forward or reverse.

The 16 Sync Bits are composed of 2 binary Zeros, 12 binary Ones, 1 binary Zero and 1 binary One. This configuration is readily identified on the oscilloscope as a burst of binary Ones.

Status Flag Data
Of the 6 status flag bits available, 4 are unused and are defined as permanent binary Zeros. They may be assigned as flags to indicate alternate modes of operation standardized in the future.

Two of the bits already have flag status. Bit 10 is encoded as a binary One to indicate Drop-Frame Time Code, and Bit 11 is a binary One when the Code is synced to the RS-170A 4-Field Sequence for Color Framing.

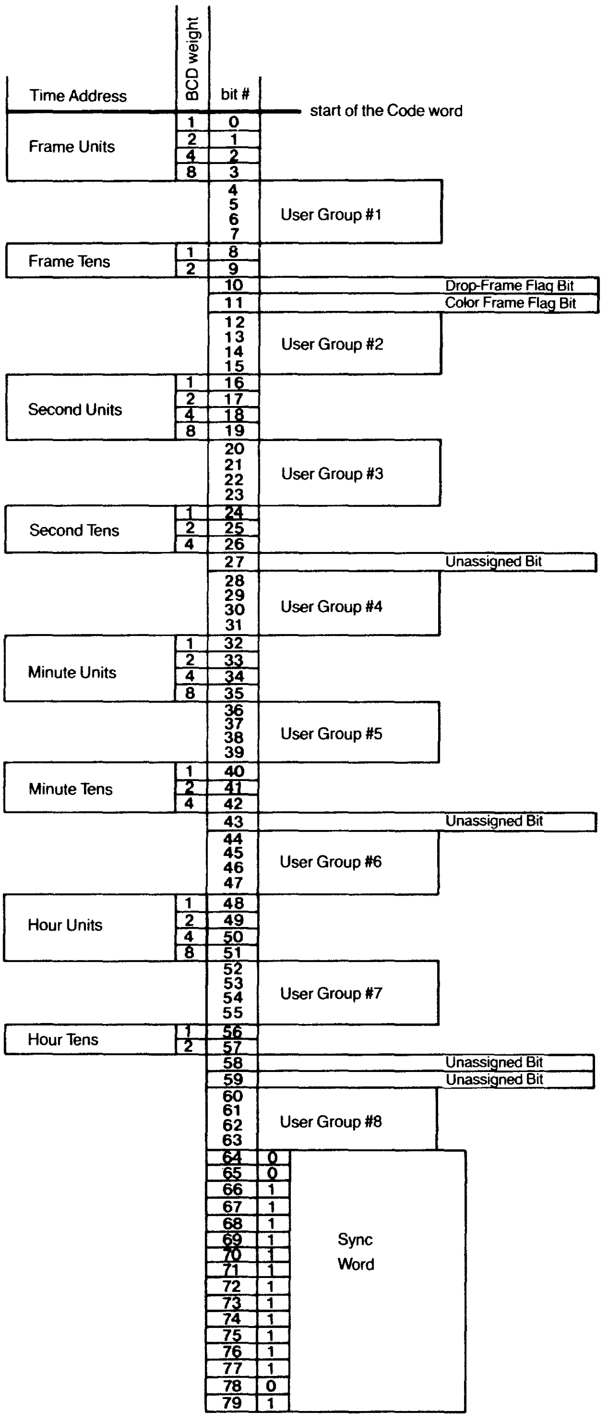


Figure 6 — TIME CODE DATA STRUCTURE

DROP-FRAME TIME CODE

Since Time Code runs at the video frame rate, an accumulated error builds between the Code Address count and the clock on the wall whenever the system is timed to a Color video signal.

Drop-Frame Code was developed to correct for the difference between a video signal running at 30 Fr/s and the Color video rate of 29.97 Fr/s.

The error can be determined by subtracting the two frame rates: 30 - 29.97 = .03 frames per second. This means that for every second that a Color video program is measured at 30 Fr/s, the program length will expand by .03 frames. Over an entire hour, the Color show will actually run 108 frames or 3.6 seconds too long.

Drop-Frame Time Code eliminates this error by omitting the first two frame counts (frames 00 and 01) in each new minute, except every tenth minute.

In effect, this "frame dropping" sets the Time Code Address count ahead once a minute and at the end of an hour, when the Time Code Address reads 1:00:00:00, it will agree with the clock. The Color program will be exactly one hour long.

Therefore, when using Non-Drop Frame Code, the Color program length must be adjusted to account for false measurements taken from the Time Code display.

For calculation purposes, Non-Drop Frame Code compared to Drop-Frame Code can be described as a ratio of their respective frame rates:

$$\frac{\text{Drop-Frame}}{\text{Non-Drop}} = \frac{29.97}{30} = .999 \text{ or } .1\%$$

This means that, when timing a Color TV program according to Non-Drop Frame Code, the program length must be shortened to eliminate the accumulated error:

$$\frac{X}{.999} = \text{Error for X period of time}$$

The above constant will provide a duration that must be subtracted from the program material to make the final program run the proper length. That is, Color programs measured by Non-Drop Code must be physically shortened or they will actually run longer than expected.

Residual Error in Drop-Frame Code

Long Term Error

Since the Color video signal does not run at exactly 29.97 Fr/s (29.97002617), Drop-Frame Code introduces an overcompensation of 2.2610 frames/day equal to an accumulating error of + 75.442 milliseconds over every 24 hours.

This is normally within the timing requirements of most broadcast and production facilities, but because the error accumulates, using the Time Code Generator as a master clock will cause discrepancies larger than 2 seconds/month unless a provision is made to re-set the Code Generator at regular intervals.

Short Term Error

Drop-Frame Code does not compensate fully for errors within a 10 minute period, due to the position of the dropped frames in relation to the accumulated error at a given point. See Figure 7.

As described earlier, the error between Time Code frame count and the clock builds at a constant rate, and no correction is made until the Code has counted for a full minute.

The error at the end of the First minute, before the frames are dropped, equals + 60 milliseconds — the maximum positive error that will be encountered in a given 10 minute period.

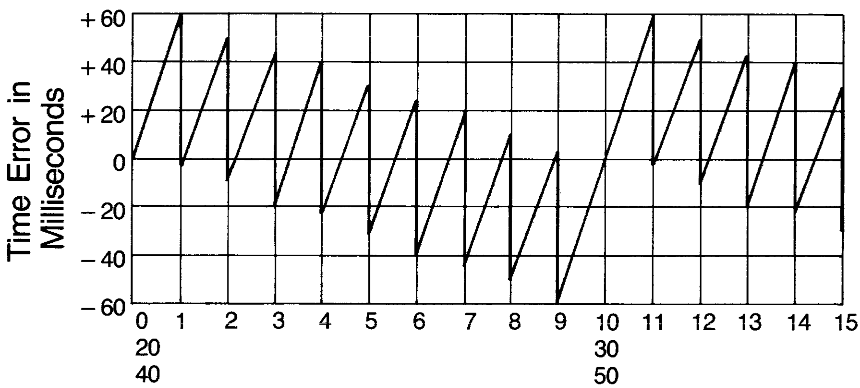
But, a + 60 millisecond error does not quite equal the two frames that will be dropped, and the Code begins to overcompensate slightly each minute as frames are dropped.

By the beginning of the Ninth minute, the error is − 60 milliseconds, which is compensated for by not dropping the first two frames in the Tenth minute.

The error then returns to the long term error of + 75.442 milliseconds/24 hours, which is equal to a residual error of .524 milliseconds in 10 minutes.

SMPTE Time Code running in the Drop-Frame mode has a flag in its signal by encoding Bit 10 as a binary One.

Figure 7 — SHORT TERM ERROR IN DROP-FRAME MODE



COLOR FRAME TIME CODE

In order to avoid the "H" shift problem in editing full bandwidth, Color video material, Time Code may be synced to the Color video signal in a way that allows video frames to be identified by their Time Code Address numbers, rather than using the more difficult process of identifying the frames from the video signal itself.

This identification method defines color frames according to the RS-170A 4-field Color Frame sequence.

The relation of Code Address numbers to the A or B characteristics of Color video frames is specified by SMPTE: an even Code Address identifies an A video frame and an odd Code Address identifies a B video frame.

In the RS-170A 4-field sequence, an even Code Address represents the video frame beginning at line 5 of field one. An odd Code Address represents the video frame beginning on line 5 of field three.

Without Color Framed Time Code, an even Code Address could represent either field one or field three.

If an RS-170A SCH (Subcarrier to Horizontal Sync) phased signal is not available, or if SCH phasing is varying and cannot be guaranteed, identification of Color Frames must be made from a 15 Hz field ID pulse fed to the Time Code Generator from the same source as the reference sync.

Time Code synchronized to Color video frames according to the RS-170A standard is identified by a Binary One encoded in Flag Bit 11.

EBU CODE COMPARED TO SMPTE CODE

Code Structure
EBU Code has the same 80 bits per frame in its Code word, but it runs at the European frame rate of 25 Fr/s.

Since both Monochrome and Color video signals run at exactly the 25 Fr/s rate, there is no need for Drop-Frame Time Code. Therefore, EBU Code has an unassigned Zero in Bit 10 of its Code word.

Bit 11 is the same in EBU Code, defining a Color Framing mode. In this case, the mode defined is the PAL 8-field Color Frame sequence.

Of the other SMPTE Code Unassigned Bits, EBU has chosen bits 27 and 43 as flags to indicate how the User Bit groups (called Binary Groups by the EBU) are encoded:

	Bit 27	Bit 43
Binary Groups unused or covered by an in-house format	0	0
ASCII characters	1	0
Unassigned	0	1
Unassigned	1	1

Equipment Compatibility
Time Code Generators must adjust to 25 Fr/s to handle EBU Code and must be equipped to sync the PAL 8-field Color Frame sequence if necessary.

(The 8-field sequence is not applicable to SECAM, which uses a 4-field Color Framing sequence similar to the RS-170A sequence for SMPTE Code.)

Time Code Readers must accept the 25 Fr/s rate.

The complete EBU Code specifications can be requested from the EBU Technical Center, Avenue Albert Lancaster 32, B-1180 Brussels, Belgium.

SMPTE CODE IN PRACTICE 7

TIME CODE GENERATORS

A Time Code Generator produces the Time Code signal and synchronizes the Code to a video source. See Figure 4, Page 33.

Inputs

• The Generator must have a Sync input from a stable sync reference source or the Code generated will be non-synchronous, meaning it may produce ambiguous identification of video frames. This may make the recorded Time Code useless for indexing frames and especially for computer editing.

In a house system, where all equipment is "Gen-Locked" to a house Sync Generator, supply a separate feed to the Time Code Generator.

For a system with no house sync, Code Generators are designed to determine sync from the composite video signal that is to be recorded. The video signal is fed from the source (VTR, ATR, Camera), looped through the Time Code Generator and fed into the recording VTR. This will lock the Generator Code output to the video signal.

• If Color Framed Time Code is necessary, timed to the RS-170A standard, a Color Field ID pulse must be supplied to the Generator. This is normally a 15Hz signal from an RS-170A sync source such as the house Sync Generator.

Outputs

• Time Code is output as a +4 to +8 dBm balanced signal using standard 3 pin audio connectors.

• Normal source impedance from a Time Code Generator is 50 to 600 ohms.

Modes of Operation — all are User Selectable

• Frame Rates: True 30 Fr/s for Monochrome video, 29.97 Fr/s for Color video, 25 Fr/s for EBU TV systems and 24 Fr/s for Film production.

• Drop-Frame Time Code and Non-Drop Frame Code are selectable by an internal or external switch.

• Color Framed Code is selected either by a switch, or automatically when the RS-170A field ID pulse is patched to the Generator's field ID input.

• Risetime: 25 microseconds for SMPTE Code, or 50 microseconds for EBU Code

Sync Sources

• External composite video or sync for TV applications.

• Internal crystal sync for Audio applications.

• External Tach pulse for Film production.

• Power Line is used only as a last resort. It is unstable and supplies the wrong frequency for video use.

Operation

• Preset switches may select any start time within the 24 hour clock format. These switches are located on the Time Code Generator's front panel.

• If User Bits encoding is available, this data can also be set by front panel switches.

• The Code start switch is available on the front panel or may be wired for remote start.

Distribution
Time Code distribution uses methods identical to audio signal distribution — 2 conductor shielded audio cable, audio distribution amplifiers and house audio switching systems.

Cross-Talk
• Time Code is a high level signal and can interfere with microphone lines if they are cabled together.

For minimum Cross-Talk, Time Code should be distributed as a balanced signal at "0" dBm or less.

• Cross-Talk can also interfere with adjacent audio tracks. Assign the outside track to Time Code and use the inside tracks for sound work.

Recording Time Code
Record the Code in an Audio or Cue track or the Auxiliary Time Code Track if the VTR has one. Do NOT use Auto gain controls — adjust Time Code signal gain manually.

(Auxiliary Time Code tracks on 3/4" videocassette machines do not have level controls. Check manufacturer's literature for more information.)

Tape Format	Where to Record Code	Best Levels
1"	3rd audio or cue track	– 5 to – 10 VU
3/4"	Outside Track-Audio 1 or the Time Code Track	– 5 to "0" VU
2"	Cue track, also called Auxiliary or Time Code Track	+ 3 to + 5 VU
ATR	Edge Track	– 5 to – 10 VU

TIME CODE READERS

Time Code Readers decode the information recorded on tape. Some Readers display Time Code data on their Front Panels. To offer a visual display of the Code superimposed over the video picture, the Reader must have a built-in Character Inserter.

There are two types of Readers, playspeed only and variable speed. Variable speed Readers are preferred since they decode information over a wide range of tape shuttle speeds.

Inputs

• The Time Code signal should be fed from the VTR on a standard 2 conductor shielded cable and 3 pin audio connector.

• Typical Readers have high impedance inputs and will accept levels from 200 mv to 10 v p-p.

• For character insertion, supply the video input for the material that will be Addressed by the Code display.

Outputs

• There is usually a visual display of the Code on front panel LEDs, but an output must be patched for display of the Code on a Monitor.

• A Parallel Data output is supplied for interfacing with Editing Systems and remote display devices.

• Most Readers have Restored Code Output: the output signal is the same as the Code input signal, but it has been reshaped with correct risetime values and a fixed voltage output. This type of output does not correct for Bit or timing errors.

• Regenerated Code Output is the same as the input Code, but it is corrected for bit errors and timing errors as well as reshaping risetime and level.

Frame Rate Selection
Is accomplished normally with internal switches, the same as a Time Code Generator. In order for the Code frame count to increment properly, the Reader must be set to detect the same mode and frame rate as the Code fed to the Reader input.

How the Reader Decodes
Since Time Code is encoded using a frequency modulated process, the distortion of amplitude during playback does not affect the Reader as long as the Code signal is above the minimum required level of the Reader's input. Therefore, since the Time Code is recorded as a square wave, and the Code plays back in a highly distorted waveform, this distortion in amplitude does not interfere with the decoding process.

(Waveform distortion during dubbing of Time Code is discussed under Jam Sync on Page 69.)

During decoding, determination of Bit periods is derived using Zero crossing detection, or a slight modification of this process to account for Baseline shifting at low speeds.

Code is typically demodulated by timing individual bit periods and making comparisons to locate or identify the 50% bit periods indicating an encoded binary One.

One limitation of this Demodulation method is false readings caused by bit to bit variations during rapid tape acceleration and deceleration. Most Readers are designed to accept bit to bit "Jitter error" of this sort up to 25%.

Error Bypass
To isolate the Reader's output from false information caused by momentary disturbances in the Code signal, such as tape dropout or noise, Error Bypass may be supplied as a special feature.

With Error Bypass, the Reader compares the decoded Time Code value with an expected value the Reader derives from the preceding frame's Address number. If the incoming Code value is not the same as the Reader expected, it will display the expected value rather than the actual decoded value.

This process continues for a preset number of frames as an "error limit", after which the Reader will output the decoded value even if it doesn't match the expected value.

For example, a 2 frame error limit means a disturbance of the Code signal up to 2 frames is not visible in the Time Code display. Beyond 2 frames, the error becomes visible.

The problem with Error Bypass is that valid changes in Code values — for example, a break in the middle of a reel of tape during which the Code changed from 1 to 2 hours — will de delayed during decoding for the duration of the error limit.

Plus-One-Frame

Plus-One-Frame is an important feature on a Time Code Reader since it assures that the Code Address being displayed corresponds to the current video frame.

Not all Readers feature Plus-One-Frame, but it is required for accurate Code display, because of the structure of the Code word.

The Reader decodes information continuously, but it will not update the Code display until the end of the 16 bit sync data at the end of the Code word.

That means all the video information for a frame is already transmitted before the Reader can display the Address number it is reading.

Therefore, there is natural delay between reading the Code word and displaying the Address data.

To compensate for the delay, the Reader must automatically add one frame count to the Address it is reading in order for the Code display to match the video frame being scanned.

Difficulties Reading Code

Code Reading difficulties are mainly a function of tape speed, once the Code input is above the minimum required level for the Reader.

Most variable speed Readers are designed to decode bi-phase signals from 1/50th to 100x playspeed. Their ability to read from tape is reduced by physical limitations in the record/playback process.

Still-Frame and Slow Tape Speeds

SMPTE Code is a longitudinal signal requiring a minimum tape speed over the playback head to detect the Code.

SMPTE Code cannot be read at Zero tape speed (still-frame) as encountered on 1" and 3/4" helical VTRs.

At very slow speeds, typically less than 1/10th playspeed on 3/4" VCRs and 1/20th playspeed on 1" VTRs, the reproduced waveform exhibits extreme amplitude distortions that can cause extraneous transitions. These "false" transitions are detected as valid by the Reader's decoding circuitry, and the Reader will output false data.

The solution to these problems is an alternate type of Time Code. See chapters 9 and 10 for information on VITC — Vertical Interval Time Code.

High Shuttle Speeds

Limitations with high tape speeds relate primarily to the high frequency characteristics of the system. A normal 2400 bit/sec signal when shuttled at 50X playspeed rises to a bit rate of 120 K bits/sec for binary Zeros, 240 K bit/sec for binary Ones, equal to audio frequencies from 60 kHz to 120 kHz.

These bit rates/frequencies are well above the frequency response of normal audio equipment.

When Time Code is recorded on a sound track, the audio channel playback amplifier's upper limit must be modified to accomodate the highest shuttle speeds/frequencies expected. For example, if 10X playspeed is expected, the signal will reach a maximum of 24 kHz.

Modern 1" VTRs with 3rd audio channels designed for Time Code use need no modification. These VTRs have high frequency amplifiers built-in especially to decode high speed signals.

High frequency characteristics must be kept in mind when distributing playback Time Code signals. Problems inherent in the transmission of high frequency signals normally mean there must be a dedicated Reader for each VTR and ATR to decrease the distance the Code signal must travel before being decoded.

DISPLAYING TIME CODE

Front Panel LED Display

Usually a display on the Reader's front panel will give the full Hours:Minutes:Seconds:Frames format.

Most Readers have front panel indicators for Drop-Frame and Color Frame modes. There are also Hold or Freeze controls to manually stop the display from counting for identification purposes.

Video Monitor Display

This is the preferred method of displaying Code data, superimposed over the video material it represents. This is normally accomplished with a Character Inserter built into the Reader.

Video from the playback VTR is fed through the Reader which Keys the Code Address number over the program video. Front panel switches select the size and placement of the Code display within the raster, and some Readers can also move the visual display out of the TV cut-off area into the Vertical Blanking Interval.

There is usually a black background mask around the Code display for improved readability.

This display can be inserted live, or permanently burned-in over the picture, for example, on a dubbed work videocassette intended for Off-Line editing.

JAM SYNC OR RESTRIPING TIME CODE

Jam Sync is a special feature in a Time Code Generator that can: reconstruct defective sections of Code; produce new Code to match the old Code Address numbers during a dub; initialize multiple Generators to the same starting Address.

The Jam Sync Process

Jam Sync slaves the Generator's output to an external source of SMPTE Code. For this reason, a Jam Sync Generator incorporates a built-in Reader that accepts a Code signal at playspeed from a recorded source of Code such as a tape in playback or another Generator.

The internal Reader detects the incoming Address and User data and loads that data into the Generating circuitry. The Code output will then have the same, identical information as the Code input, but the Code signal will be regenerated and free of distortions.

One-Time Jam Sync

After the Reader is activated by a front panel control, the Reader takes the next valid incoming Code word and initializes the Address count beginning at that point. The Generator output is now on its own, operating with normal sync in a normal sequence. Any deteriorations or discontinuities are ignored and the Generator outputs uninterrupted Time Code Address numbers.

Continuous Jam Sync
This type of Jam Sync is necessary in those cases in which the Original Address numbers are still needed.

Once the Reader is activated, the Generator updates the Address count each frame, filling in all unrecorded areas with ascending Time Code, but retaining the discontinuities.

If non-synchronous Code is supplied, the output will be properly synced, but not necessarily count in a consecutive sequence. The Generator will automatically round the Address numbers down to the nearest whole frame, and may introduce repeated Addresses or omit Address numbers.

Restriping Time Code
Patching:
• Time Code output from the VTR goes to the Jam Sync input on the Generator.
• Code output on the Generator goes to the Code input on the VTR.
• Video or sync output goes to Time Code Generator from the VTR.

This creates a loop from the VTR, through the Generator and back to the VTR.

With the VTR in playback and Jam Sync activated, the Reader detects a minimum amount of valid Code signal (normally 2 frames) and initializes the Time Code Generator with the incoming information.

At this point, the Operator selects an audio-only recording on the Time Code track of the VTR. The Generator will then feed clean, identical Code which will be re-recorded on each video frame, replacing the deteriorated Time Code.

(This process is not possible on 3/4" VCRs with a dedicated Time Code Address track, since this track will only record the Code at the time of video recording.)

Other Uses for Jam Sync

In addition to replacing bad sections of Code, it is recommended that Jam Sync be used when dubbing encoded tapes to insure a clean Time Code signal on all copies. This is necessary because each successive generation introduces severe distortions into the Code signal, reducing readability.

Jam Sync can also be used to initialize multiple Time Code Generators with the same starting Address number. This is important when using multiple Generators for wide coverage events involving many separate recorders.

USER DATA

The 32 User Bits per Code word are currently broken into 4-bit BCD groups to represent an 8 digit hexadecimal number.

Time Code Generators enter this data in the Code by front panel preset switches or a 32 bit parallel data input. Once loaded, a particular User word is continuously encoded in every frame of video until manually re-set.

This system limits the User data to static ID functions such as location, date, reel and VTR number, shot or take ID, personnel data etc.

Other information includes:

- Encoding Film data in the User Bits. See Page 29.
- For some editing situations in which reels of source material have many Code breaks, the original Code Address numbers can be recorded in the User Bits while recording a new, continuous Code Address sequence in the Address bits. To use this method efficiently, it is necessary to have a Reader that displays both Time Address and User data on its front panel.
- Work is currently under way to give an expanded data capacity to the User Bits by multiplexing. This would go beyond the limits of the static 8 digit hexadecimal ID tags to spread out the User data over any number of video frames until all the required information is recorded.

Further development of User data specifications over the next few years will make it possible to use multiplexing techniques to encode such full data capacities as ASCII data and permit the encoding of complete text information, captions, instructional material etc., in the User Bits.

Because there is no way to anticipate what User data may be present, it is not possible to use Error Bypass techniques in Reading User data.

PROBLEM SOLVING

8

This chapter is broken into problems found at different times during production and follows this format:
Symptom
- Possible Problem
  — Solution

READING PROBLEMS

Code not Reading at Slow Speeds or Displaying Invalid Data

- Recorded level too low
  — Jam Sync new Code at higher level

- Reader threshold too high
  — Recalibrate Reader to increase gain

- Bit rate too slow to decode
  — Increase shuttle speed. Readers cannot decode below minimum tape speed.
  (See Chapters 9 and 10 for information on VITC Code that can be read at slow speeds and still-frame.)

- Record/Play process has introduced distortions
  — Increase shuttle speed since most distortions are aggravated during slow speed playback

- Tape Jitter — Tape is oscillating in tape path
  — Solutions require modification of VTR servo systems

Will not Read Code at Playspeed

- Equipment failure — Reader failure
  — Confirm presence of Code, replace Reader

- Level recorded too low on Tape
  — Jam Sync new Code at higher level

Decoder Reads correctly in one direction only

- Tape tension within VTR is not constant
  — Adjust tension in tape transports

Will not Read at high shuttle speeds

- Tape lifters activated
  — Modify tape transport to disengage tape lifters

- Audio or Cue channel Amplifier has insufficient bandwidth to handle increased Code frequency
  — Electronic modification of amplifier to provide wider frequency response

- Tape lifting off head — the Air Layer or Air Bearing Effect
  — Install pressure pads (especially on 2" quad VTRs) This is not recommended due to problems of excessive head wear.

Code Address displaced One frame from video

- Reader does not have Plus-One-Frame function
  — Replace Reader

RECORDING/PLAYBACK PROBLEMS

Tape won't play on other VTRs, OK on Recording VTR

- Misaligned Time Code track
  — Align cue track head

Cross-Talk

- Code recorded at too High level
  — Jam Sync new Code at lower level

(If Cross-Talk is recorded into program sound, reduce by dubbing down a generation through a notch filter or other filtering technique. Since Time Code Signal is a wide bandwidth of frequencies, this will not be very successful.)

- Mispositioned Audio head
  — Realign heads to standard

JAM SYNC PROBLEMS

Output of Jam Sync offset from Input

- Input is non-synchronous (Non-sync Code will be brought to the nearest frame causing an error of ± One frame.)
  — Record synchronous Code on source material

- Code is being forced to house Color Frame mode in Time Code Generator
  — Temporarily disable Color Framing

- Incoming Code has a large discontinuity not reflected by a Momentary Jam Sync Generator
  — Re-Jam Generator after each Code change
  — Use a Continuous Jam Generator

EDITING PROBLEMS

Reader shows valid Code but not accepted by Edit control

- Code is Non-synchronous or not synced to correct video field
  — Jam Sync with synchronous Code
  — On 1″ VTRs, disable automatic scan tracking

Certain spots on tapes not accepted, rest of tape OK

- Code is non-synchronous
  — Jam sync with synchronous Code

- Missing or repeated frame numbers were introduced in Continuous Jam Sync
  — Re-record using Momentary Jam Sync

- Tape and Edit Control not set for same mode — Drop-Frame Code or Non-Drop Frame Code
  — Choose an edit point on the tape away from the Drop-Frame point
  — Switch modes on Edit Control panel
  — Jam Sync enough material to get into Edit, at least enough for the duration of the pre-roll

Tape Cues in the wrong direction

- Non-ascending Time Code recorded
  — Manually cue tape

- Recording continues past Midnight (00:00:00:00)
  — Manually cue past Zero hour

VITC CODE TECHNICAL GUIDELINES

9

BACKGROUND

During the standardization meetings for Time Code, proposals were made to create a Video Time Code, rather than one that used an audio track.

Unfortunately, the then universally used 2" Quad VTR reproduced video only at playspeed, making the Video Code inaccessible at other tape speeds. The proposed Code, a Vertical Interval Time Code, was set aside for the more appropriate longitudinal Code.

As videotape technology progressed, slow motion and still-frame capabilities were developed, emphasizing the problems found in longitudinal SMPTE Time Code.

SMPTE Code is difficult to read at slow tape speeds, and impossible to read in still-frame. Also, SMPTE Code is a frame indexing Code, lacking field identification, and is recorded in an audio track that could be put to other production uses.

The current Vertical Interval Time Code, or VITC, was developed to eliminate these problems, however, VITC has its own set of restrictions.

CODE SIGNAL STRUCTURE

VITC Code data is recorded on horizontal lines in the Vertical Interval of the field scan, and must be compatible with standard video processing equipment. It must transmit its data quickly, using a limited portion of the video signal.

Although its waveform will probably be reproduced accurately, VITC decoding must be immune to videotape dropouts as long as one horizontal line.

Unlike SMPTE Code, VITC Code will be reproduced in the "forward" direction, even during reverse tape motion.

Encoding Technique

Given these criteria, bi-phase encoding is not needed for VITC; a binary One is represented by an 80 IRE signal level, a binary Zero by a "0" to 10 IRE signal level.

The Code "clock rate", varying only slightly during one Code frame, is derived from the video line rate.

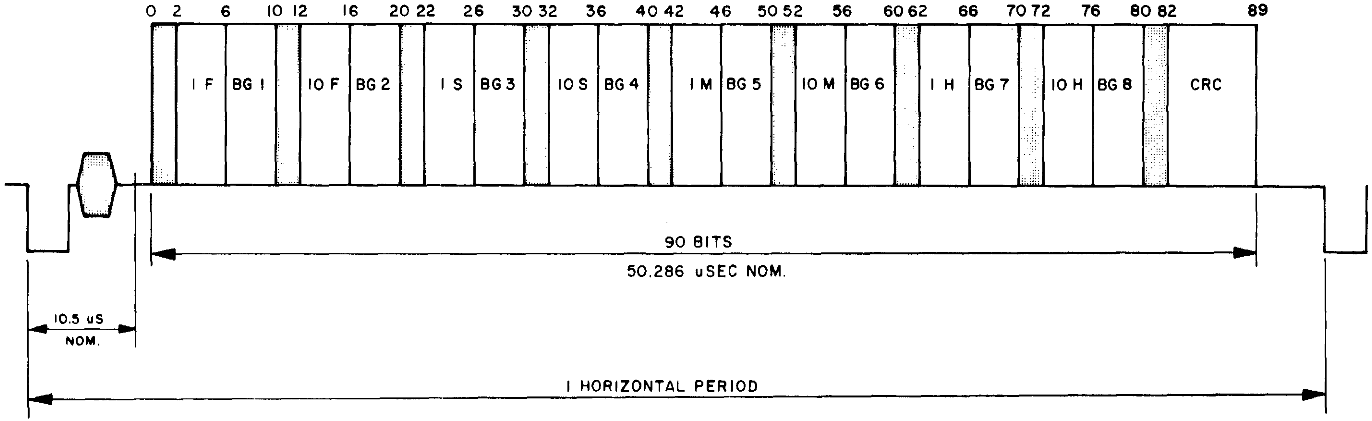
Code Format

As shown in Figure 8, the VITC signal is formatted somewhat differently than SMPTE Code.

The SMPTE Code sync word has been replaced by pairs of sync bits, spaced through the VITC Code to aid in maintaining clock synchronization.

A Cyclic Redundancy Check number, a type of checksum, gives an immediate indication of a decoding error. With about a 99.6% certainty, a VITC frame followed by its correct CRC sum has not lost data to dropouts.

As a safeguard, in case a dropout has produced errors, the entire VITC Code word is repeated on another non-adjacent line, to allow a second chance for good decoding.



0-1	Synchronizing bits	0 Fixed one 1 Fixed zero
2-5	Units of Frames	
6-9	First Binary Group	(BG 1)
10-11	Synchronizing bits	10 Fixed one 11 Fixed zero
12-13	Tens of Frames	
14	Drop Frame Flag	
15	Color Frame Flag	
16-19	Second Binary Group	(BG 2)
20-21	Synchronizing bits	20 Fixed one 21 Fixed zero
22-25	Units of Seconds	
26-29	Third Binary Group	(BG 3)

30-31	Synchronizing bits	30 Fixed one 31 Fixed zero
32-34	Tens of Seconds	
35	Field Mark	
36-39	Fourth Binary Group	(BG 4)
40-41	Synchronizing bits	40 Fixed one 41 Fixed zero
42-45	Units of Minutes	
46-49	Fifth Binary Group	(BG 5)
50-51	Synchronizing bits	50 Fixed one 51 Fixed zero
52-54	Tens of minutes	
55	Unassigned bit	(Zero until Spcfd.)
56-59	Sixth Binary Group	(BG 6)

60-61	Synchronizing bits	60 Fixed one 61 Fixed zero
62-65	Units of Hours	
66-69	Seventh Binary Group	(BG 7)
70-71	Synchronizing bits	70 Fixed one 71 Fixed zero
72-73	Tens of Hours	
74-75	Unassigned bits	(Zero until Spcfd.)
76-79	Eighth Binary Group	(BG 8)
80-81	Synchronizing bits	80 Fixed one 81 Fixed zero
82-89	CRC Code (Cyclic Redundancy Check Code)	

Figure 8 — VITC CODE WORD DATA STRUCTURE
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This redundancy — the placement of VITC Code on 2 non-adjacent lines — is required by the proposed VITC Code specification. See Appendix B.

The data carried by VITC is much the same as that of SMPTE Code. Drop-Frame and Color Frame modes, Address data, and User Bits are unchanged from the SMPTE Code data. Since this information is transmitted in both video fields, one of the Unassigned Bits in SMPTE Code is redefined as a Field Identification bit to allow for independent addressing of each field in VITC.

Since the VITC data is part of the video signal, there is no ambiguity in image identification. At all times, the frame being seen corresponds to the number just decoded. Therefore, there is no potential for non-synchronous Code in VITC.

The 90 bits of one line of VITC data are transmitted using a bit rate of 1.79 MHz. As this is one-half of the color subcarrier frequency, the VITC signal can be processed by digital Timebase Correctors as well as analog distribution equipment without distortion.

Code Placement
The user of VITC generating equipment must specify which two non-adjacent lines in the vertical interval are to be used by the Code. The first line that may be used is line ten; the last usable line is line 20. The VITC data will be inserted on the same line in both fields.

The full text of the proposed VITC specification is available in Appendix B.

VITC CODE IN PRACTICE 10

VITC equipment looks almost identical to SMPTE Code equipment. All of the usual functions and most of the operational controls are the same; most of the rear panel signals are similar.

VITC equipment includes Code Generators, Readers and Character Inserters, or some combination of these functions. But, there might also be routing switchers, inserter/keyers, and stripper/inserters in some VITC systems.

ROUTING VITC CODE

In a small system, signal routing is straightforward. The Generator inserts Time Code data into two selected horizontal lines of a video signal using an internal keyer. This VITC coded video can then be distributed as needed before being recorded. See Figure 9.

Coming out of a playback VTR the demodulated video signal is fed to a Reader to decode and display the VITC data. If the Reader requires stable video, it must be connected to a Time Base Corrector. The output of the TBC must be adjusted to pass the needed Vertical Interval lines.

If the Reader produces a character output, it can be viewed directly on a monitor, or recorded on videocassette for Off-Line use.

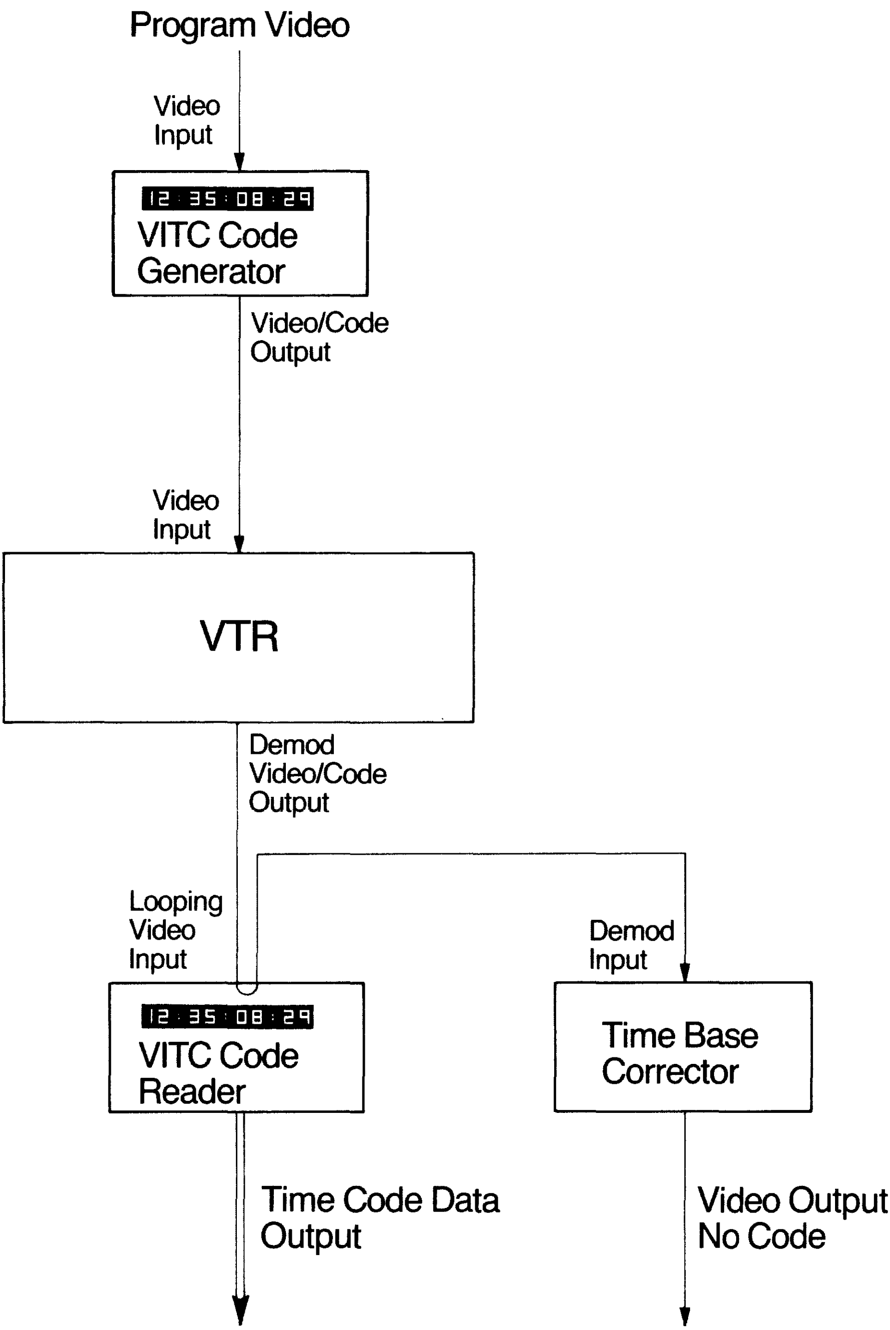


Figure 9 — VITC SYSTEM DIAGRAM

ROUTING IN EDITING SYSTEMS

VITC use is more complicated in an editing system. Since you would wipe out any existing VITC on the record VTR each time you make a video edit, the Record machine's Time Code must be reinserted as VITC in its video input. This requires a type of Jam Sync VITC Generator to reproduce the correct data from either the preceding VITC or from a SMPTE Code signal. See Figure 10.

If the VITC Code of the playback VTR is retained in the video, passing through the TBCs and Video Switcher, it can also be recorded on the Record VTR, assuming that non-interfering pairs of Code lines were chosen. This provides a kind of automatic logging of the source and Address of any video edit recorded.

If this logging of video sources is desired but the Switcher and other equipment do not pass Vertical Interval signals, the stripped playback VITC must either be routed around the switcher to a separate re-inserter, or another Generator must be used to reproduce the data on the record video.

DISTRIBUTING VITC

As in current SMPTE Code master Generator systems, it is possible to generate a master VITC signal and then distribute it to many insertion points. The VITC signal is handled in the same fashion as a camera signal, taking into account cable and amplifier delays to produce a properly timed signal at each video inserter.

Considering the relative costs of timed cabling, the inserter or keyer, and the other Generator electronics, dedicated Generator/Inserters are more cost-effective in most cases than a central Generator with distributed Inserters. Dedicated equipment is also more flexible in operation.

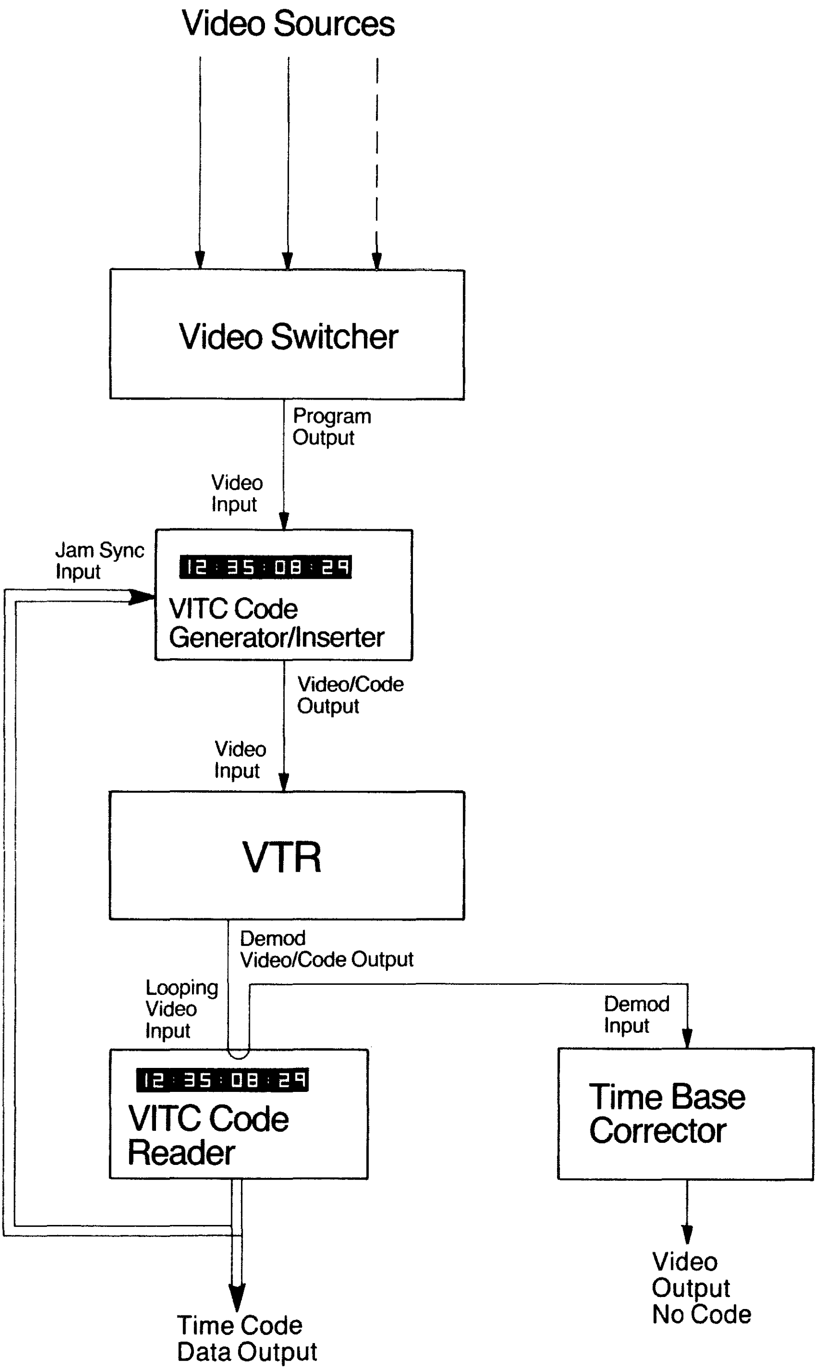


Figure 10 — VITC EDITING SYSTEM

When synchronized timing is necessary, Jam Sync operation to a common SMPTE or VITC feed may be used. Any Generator may be used as the master, or all may be used independently.

RECORDING VITC

As part of the video signal, VITC must be added to a video feed prior to recording. In practice, this means that every Studio output, ENG camera, Network feed, or VTR playback that might be edited using VITC must have the Code added prior to recording because it can't be added later.

For facilities that regularly stripe a tape with SMPTE code during recording or any time thereafter, this is a significant change in procedure.

For some operations, already having material on videotape without VITC, this might mean dubbing pre-recorded footage to gain the advantages of VITC when this material is used in editing. Of course, standard SMPTE Code can still be used if VITC has not been recorded, sacrificing the Reading advantages of VITC at slow speeds.

VITC AND 1″ TYPE C VTRs

Although the introduction of VITC was encouraged by the widespread use of Type C VTRs, these machines may provide a difficult environment for VITC use under some conditions.

The Type C specifications allow for optional use of a Sync Head, an auxiliary video record/play head. When used, the Sync Head "fills in" the Vertical Interval dropout caused by the small gap in the tape wrap around the head drum. When the Sync Head is not used, a ten line dropout of the video signal is produced, from line 5 to line 15.

Including the problems of tape interchange between VTRs, tracking error, and worst-case "growth" of the dropout with tape motion, the reproduction of lines 3 through 15 cannot be assured without use of a Sync Head.

What this means in practice is that recording VITC on a Type C VTR without a Sync Head limits the choice of VITC insertion to lines 16 through 20.

Also, when recording on a Sync Head equipped VTR, VITC should not be inserted in lines 10 through 15 if Post Production might occur in a "rented" facility not equipped with Sync Head VTRs.

There is one potential benefit resulting from this confusing situation. As noted earlier, VITC usually cannot be restriped into previously recorded material. But, some of the newer Sync Head equipped VTRs have the capability to record a Video insert on the Sync Head only. This allows a video insert edit to be recorded on lines 5 through 16 alone.

As the switching point between Sync Head reproduction and Video head reproduction can "move" in the range of line 12-16, a VITC insert edit on these lines using only the Sync Head might lead to a "hide and seek" situation; the code might appear and disappear as its line is reproduced from one head or the other.

Considering the worst-case situation, only lines ten through 12 seem suitable for adding VITC after video recording.

Before deciding to use this method it is prudent to consider the state of mind required to intentionally press the "Video Insert Edit" button on a reel of irreplaceable original material.

To sum up these suggestions for line usage with 1" Type C Helical VTRs:

LINE #	USAGE
10	save for emergency re-insertion
11	spare
12	save for emergency re-insertion
13-15	not read without Sync Head usable with Sync Head record and playback machines
16	original material VITC
17	edit material VITC
18	original material VITC
19	reserved for VIR video signal
20	edit material VITC

If additional pairs of lines are required, they can be added by working "upward" to lower line numbers, limited by VTR reproduction.

A Note on 3/4" VCRs

These restrictions are much looser in a Cassette operation. All lines in the Vertical Interval are recorded and, except for a "sync fill-in" pulse occasionally found near the vertical sync pulse, all lines are reproduced well.

So, the selection of lines to assign to VITC can be almost arbitrary when recording only on cassettes. Of course, the list above can still be used for compatability with any one-inch material that might be used.

READING VITC CODE

Now that the VITC signals have been recorded on selected lines, how do you choose which Code is to be read? Most Readers have a selection for the lines they will "look at." As long as the lines where the Code was recorded are known, this selection works well.

However, when Reading VITC from a TBC output, the video might "lift" or misframe by one or two lines if the TBC error window is exceeded by the VTR timebase error. This moves the Code out of the selected lines, producing an intermittent read error.

To solve these problems, various "auto" systems have been developed as alternatives to fixed line selection. Some Readers start looking at the video signal after V Sync and stop when they find data with a good CRC. With several active Codes, this method always finds the Code on the lowest line unless it is obliterated by a dropout. It will then find the next good line, which may not be from the same Code.

When using this type of Reader, always record VITC Code on non-adjacent lines, but arrange the line assignments so that the pairs are not "interleaved."

Another method of automatic line selection reads all Vertical Interval lines, comparing any Codes found to the selected "right" one before display. This method can track a Code that has shifted a line or two, as long as the Code is relatively continuous.

Another line identification problem can arise when the demodulated video output of a Type C machine without Sync Head is fed to a Reader. The Vertical Interval dropout can lead to ambiguous line identification especially at high shuttle speeds. Since the location and size of the line dropout varies, accurate line number determination is difficult.

VITC AND BROADCAST VIDEO

It is unlikely that a VITC signal might be accidentally "aired". The number of TBCs, Processing Amplifiers, and VIR/VITS inserters that the average Broadcast signal passes through would seem to insure that the Vertical Interval would be scrubbed clean. Occasionally the VIR signal has trouble making it to the transmitter, all effort notwithstanding.

One ready solution to this concern might be to set all TBCs to strip VITC and use Readers that can operate directly from the VTR demodulator outputs.

CAN VITC REPLACE SMPTE CODE?

For those wishing to replace longitudinal Code entirely, an important issue is how fast can VITC be read? The usual answer is, "It depends."

First, the VTR or VCR must be able to produce video at shuttle speeds. For the fastest current machines, this may mean 60-80 times playspeed for a 1" machine and up to 30-40 times playspeed for a cassette unit.

Second, the "doppler shift", or frequency change of the reproduced video signal, must be within the detection range of the VITC Reader. This range is a tradeoff between circuit complexity, stability, and cost, and varies from about 5% to over a 50% acceptance range; about the same as a 2x playspeed to 60x playspeed shift.

(This frequency shift is more severe in one shuttle direction than the other, due to the effect of the head drum rotation.)

Readers using Timebase-Corrected video leave most of the frequency-correction to the TBC, making the TBC correction range the "weak link."

Finally, the Reader has to decode a line of Code without being disturbed by a "hash mark", produced as the video head jumps to the next track. The chance of reading a VITC line without error gets progressively worse above 30-40 times playspeed, so shuttle speed Readers must rely on good error detection and Error Bypass systems to compensate for deteriorating reading conditions.

For guaranteed shuttle speed reading, systems combining VITC and SMPTE Code will continue to be popular. The tradeoff between reliance on the "New Code," with its new problems and the "Old Standard," with its use of an audio channel will not be settled quickly.

It is anticipated that, as VTR and VITC Code technologies improve, the long term outlook is for VITC Frame Identification alone.

SMPTE CODE AUDIO APPLICATIONS 11

BACKGROUND

The use of SMPTE Time Code in audio production involves synchronizing multiple ATR and VTR machines, allowing them to function as a single machine with multiple audio channels. The machines are linked together using the electronic SMPTE Time Code signal.

The first SMPTE Code synchronizers were modifications of AC line "resolvers." They controlled playback speed but, other than an "Early/Late" indicator, didn't attempt to produce synchronized playback.

Next came interfaces between audiotape machines and video editing systems. In these, the audio machine, generally a four track, was treated like just another VTR; shuttled, cued, and even commanded to edit by the central computer. Compared to the audio work possible using only VTRs, this was quite an improvement.

The trouble was, when the system shuttled audio at full speed, it required the tape lifters to be disabled so that it could read Time Code. Head wear, tape wear, and accidentally blown speakers were the result.

Moreover, these systems occasionally responded to a bad SMPTE read with a speed hit as the controller expected its "VTRs" to have control tracks to regulate speed during Time Code dropouts.

In the last few years, synchronizers designed especially for audio use have come onto the market. Although capable of Video/Audio synchronizing, they are also useful for synchronizing multiple audio transports. In many cases, new methods have been used to eliminate many of the initial shortcomings of synchronizing and offer unique new features.

INTERFACING TO A SYNCHRONIZER

A basic synchronizer interfaces two transports. One transport is designated as "Master" and the second transport is designated as "Slave." The synchronizer controls the position and speed of the "Slave" transport to lock to the "Master" transport using the SMPTE Time Code as its reference.

Interface signals to a synchronizer can be divided into two categories: Commands and Tallies. Commands are signals generated by the synchronizer to control the transport. The Tallies are the responses from the transport to the synchronizer.

Typical commands generated by the synchronizer are Play, Stop, Rewind, Fast Forward, Record In, and Record Out. Most synchronizers have other outputs available depending on individual characteristics of the transports. Not all transports have the capability to feedback all the Tally information to the synchronizer. In these situations it is necessary to manufacture the information required by the synchronizer. This is normally achieved through the interface cable. Other signals needed by the synchronizer for proper control are transport direction and transport speed. The transport direction signal must indicate the actual direction of the transport's motion.

The transport speed signals are tach pulses, control track pulses, etc. and are used to indicate the transport's speed. One of these is necessary for the synchronizer to determine the position of, and maintain control of, the transport during a Fast Forward or Rewind when Time Code is not being read by the synchronizer because the tape lifters have pulled the tape away from the playback head on the transport. To properly control the "Slave" transport the synchronize must override the capstan servo. This signal can be either a frequency or a variable voltage, depending on the transport. The transport's play speed must vary in response to this signal within the appropriate range. Ideally, the variation should be between 1/2 and 2 times play speed. Synchronization takes longer if the transport is not capable of this play speed range.

LOCKING MODES

Most synchronizers have available two types of locking modes, either one of which can be employed when play speed is being controlled to achieve lock. The lock modes are Frame and Phase Lock.

Frame Lock locks "Master" and "Slave" using all information contained within the reference Time Codes: hours, minutes, seconds, and frames. This mode provides a lock so tight that any speed variations in the "Master" reference are passed to the "Slave."

Phase Lock (which is also referred to as Sync Lock) precisely and strictly synchronizes the "Slave" to the phase information arriving from the "Master." The synchronizer ignores Master Time Code values in Phase Mode and uses the 16 bit sync word as its reference in the Time Code as described in Chapter 2. This provides an effective"software filter" to prevent sudden speed variations, such as wow and flutter, from being passed to the "Slave."

SYNCHRONIZER FEATURES

One refinement of the basic synchronization method uses a more sophisticated interface to the transports. This allows use of the timers or other control signals for initial cuing with "lifters on."

Another enhancement automatically switches from play mode back to cue mode, allowing the slave transport to "chase" the master whenever it is rewound and resync to it when it is again put into play.

Other synchronization methods include multi-machine "editing" systems. Here, the emphasis is on flexible control of the interaction between machines.

Offsets can be set between machines, allowing a tape to be "slipped" out of sync by a controlled amount. Often, offset of less than one frame is allowed. This feature is essential for critical work.

These systems also take control over transport record/edit functions, allowing tight "In" and "Out" record points to be repeated accurately, with resolutions as fine as 1/100th of a frame in some units.

To isolate themselves from speed changes during Time Code dropouts, synchronizers may "freewheel," passing over Code loss at a constant speed. The free-running speed may be calculated using separate short term and long term measurements. This technique allows a large end-of-reel slowdown to be corrected without requiring the use of audibly large short term speed corrections to maintain sync.

PROBLEMS WITH SYNCHRONIZERS

The audio reproduction of the slave transports can be affected by wow and flutter produced by the master. The synchronizer will attempt to follow these variations, causing all transports to exhibit degraded performance. If the playback tapes play well without the synchronizer, but poorly with it, this might be the cause. Attempt to synchronize using a known stable reference, such as a SMPTE Code Generator, as the master. If all is well, suspect the master transport or its Time Code.

To enable multitrack transports to be successfully synchronized with video cassette or other low-stability masters, some synchronizers offer an "external reference" mode. This mode derives the short term slave speed corrections from a stable reference signal, using the master Time Code input only for long term error calculations. This produces a "flutter-filter" effect, reducing the effect of bad master Code on the slave transports.

Theoretically, any Time Code frame standard could be used for audio applications. If interfacing to video is a possibility, the use of the video rate is necessary. This is 29.97 Fr/s in North America and 25 Fr/s in Europe.

A few synchronizers allow use of "mixed codes," that is 30 Fr/s with 29.97 Fr/s. Without fully understanding this situation, problems can arise and confuse the audio engineer. Most synchronizers take the Time Code values and turn them into binary numbers. This manipulation makes synchronization easier to process, however the actual Time Code numbers being displayed will not match due to the dropping of frames. See Figure 11. This "offset" will accumulate depending on the location of the Time Code. For example, Time Code recorded at 1:00:00 will have less of an offset than Time Code recorded at 23:00:00. This is due to the dropping of two frames every minute. Using mixed Codes is not recommended because of this confusion. If mixed Codes are used, special care must be taken when the EDL (edit decision list) is compiled.

00:00:59:29	00:01:00:00	00:01:00:01	00:01:00:02

NON-DROP FRAME TIME CODE

00:00:59:29	00:01:00:02	00:01:00:03	00:01:00:04

DROP FRAME TIME CODE

Figure 11

Getting the Best Results

For best results with audio synchronizers, care should be taken to insure that clean, stable Time Code is recorded on work material and that Time Code reproduction is equally clean. The zero crossings or edges of the SMPTE Code square waves are especially critical for reduction of flutter.

Wide bandwidth reproduction cards are available for most ATRs from their manufacturers. Although originally intended to reproduce Code during shuttle, they also can produce improved zero crossing response at play speeds. Although biasing a track especially for good Time Code recording is best, the occasional user might find the setup time hard to justify.

Time Code Generators intended for audio use should have very little bit-to-bit jitter. As they will rarely have Video sources to use as speed references, they should be able to run on internal reference. Here, units with crystal references are more stable than A.C. line referenced units, especially for applications where eventual synchronizing with video sources may occur.

Cross-Talk

Time Code is generally provided as a +4dBm to +8dBm balanced signal. It will Cross-Talk to microphone lines it is cabled with, as will any signal of this average level. Although it is possible to reduce cabling Cross-Talk by switching to a slower risetime on the Code Generator, this may degrade system flutter performance.

Time Code has also been known to Cross-Talk to adjacent tracks on ATRs. Common practice is to assign the highest-numbered track to SMPTE Code, and either leave the adjacent track free, or use it for a drum track or other low-frequency recording.

SPLITTING STEREO PAIRS AND HEAD OFFSET

Although synchronizer performance is improving, it is still risky to split stereo pairs across two tapes. Generally, the same work should be set up with all stereo pairs of the same generation on the same physical tape, bouncing generations onto the alternate tape.

Finally, remember that the Time Code channel is subject to the same record/play head offset as the other tracks. Just as Mixdown tracks "move up" relative to their original tracks, they "move up" relative to the time code track.

Using a synchronizer, the mixdown will also "move up" relative to any interlocked material, for example, its corresponding video. So, to return to proper sync, a corresponding offset must be introduced. At 15 IPS and the standard 2.5 inch head-to-head spacing, the offset of a 29.97 Fr/s code is 5 frames.

AUDIO EDITING 12

ELECTRONIC AUDIO EDITING

For many decades the art of tape editing has been accomplished by using a simple and inexpensive razor blade. Although the age of state-of-the-art electronic audio editing is upon us, razor blade cutting and splicing are still widely used.

Editing a tape manually entails making a work copy so that the master is never cut, mounting the reel on the transport, and positioning the tape to a specific location with the aid of the tape counter—a simple device which holds no accuracy between transports. It is difficult to determine the right tape count location. "Rocking the Reels" and careful listening found the edit point. A grease pencil marked the spot. With a second check, the edit point was verified. Releasing the tape and carefully pressing it into the splicing block made the tape ready for the razor blade. After the cut, tape was either removed or replaced with new dialogue or program and a splicing tab was added to finish the edit. After listening to the tape, it was often discovered that the transistion in the edit was audible and therefore not acceptable. A repeat of the entire procedure was then necessary.

For those who use electronic audio editing, the razor blade is obsolete. In electronic editing systems such as the Softouch Edit Controller, many facets of manual editing have been automated to save time, money and improve the overall quality of the final product.

With the help of SMPTE Time Code, a tape striped with Time Code can be easily positioned to the edit point by entering the specific Time Code number into the controller and then telling that particular transport to "GOTO" or "AUTOLOCATE" to that location. At this time the program material can be reviewed by the editing personnel to determine what steps should be taken next.

If a small portion of dialogue needs to be replaced, it can take up precious studio time to manually edit the tape.

With the use of an edit controller, the precise edit point can be located and pre-programmed to "Rehearse" or "Loop," allowing the engineer to "Trim" or adjust the selected edit point or "Record-in" point before actually doing the "Hot" record. At the beginning of each Loop, the engineer has the option of enabling the transport for the "Hot" record. This way the edit can be made correctly the first time.

There are some other aspects of setting-up an edit session to consider.

Two multitracks might be used for the program material while part of vocal track on one transport may need some clean-up. The synchronizer does its job by keeping the two transports "Locked-up" (See Chapter 11).

The engineer, using the edit controller, can now program in "Pre-roll" time, the time it may take the transports to "Lock-up" or synchronize; "Mark-in" time, the time the vocalist may use to determine pitch and timing; "Record-in" time, the time actual dialogue or program material will be replaced on tape; "Record-out" time, the time the actual replacement of dialogue or program will end; "Mark-out" time, the time for a smooth transition for the edit; or "Post-roll" time, the time it takes for clean Loop ending. All these parameters define a "Loop" or "Cue List." The edit controller should have the ability to save multiple Loops or Cue Lists for future recall. When many of these Loops are saved, they are called an Edit Decision List (EDL).

Throughout the editing process, the controller uses the SMPTE Time Code as a reference to determine all the Loop parameters, any offsets in Time Code between the master and slave(s), and specific transport position requirements.

Flexibility through programmable keys is a major advantage in post-production.

During the edit session, an engineer may repeatedly use the same keystrokes for set-up or autolocation of the transports. Programmable keys, such as the softkeys on the Softouch Edit Controller, lessen the set-up time in many situations. These special keys can easily replace multiple keystrokes with just one. For instance, if the engineer intends to use the same ten digit Time Code number five times for an edit session, up to fifty keys would have to be pressed. Entering that Time Code number into a Softkey would require the engineer to press only one key to access that specific number.

An edit controller with the flexibility of Autolocation, multiple Loops, Record-on-the-Fly, multiple transport control, programmable edit sessions, and user defined programmable keys can help make the engineer forget about the days of razor blades.

ENHANCED FEATURES 13

CORRECTING TIME CODE

Restoring defective Time Code has always been an area of concern. The manner in which the Code became defective, although important, will not be addressed here since new ways are invented daily. Correcting defective Code falls into three major categories: Retimed, Reshaped, and Regenerated.

Retimed Code is Time Code correction in which the bit time, or bit clock, is adjusted to compensate for drift (short term error), or jitter to ensure that the encoding technique and accuracy are preserved. Time Code readers are transition sensing and dependent. In order to assure compatibility from manufacturer to manufacturer, a specification has been adopted detailing the recording techniques and specifications. The latest version of the specification is ANSI/SMPTE 12M-1986. All details of the signal are specified and it is important to be familiar with them. Cipher Digital Time Code products sample the incoming analog signal, convert it to digital, adjust the sample rate if required, and reconvert the signal back to analog to ensure the signal quality is the best possible represention of the input.

Reshaped Code is Time Code correction which adjusts the rise and fall times of the signal. This is necessary since analog recording techniques are employed to record a basically digital signal. As described above, the digital to analog conversion limits the slew rates of the outputs to

25 micro seconds for SMPTE and 50 micro seconds for E.B.U. Time Codes. The rise and fall times are specifed in section 3.3.1 of ANSI/SMPTE 12M-1986.

Regenerated Code is Time Code correction which replaces the Time Code and shifts it to the correct starting point. Bit zero of the 80 bit Code stream must start at horizontal line 5, plus or minus 1 H line, of vertical field one. The frame being identified has two fields, and field one must start the Code word to prevent an editing error which will cause a picture jump.

Several products in the Cipher Digital family of readers and generators will restore Time Code. Any units in the 700 series of readers (700A, 735L, 735V, 735CD, 710A, and 750), will reshape and retime the incoming Time Code at the reader out connector. This is a standard feature and not an option. The CDI-710A has a standard "Regen" feature built into the reader that will fully regenerate the Time Code as described below. Both the generators in the Cipher Digital family are full function "Jam Code" generators, meaning they have the ability to jam the incoming Time Code data to the output. Both have this feature either in momentary or continuous modes. A momentary jam is a one time jam to the generator to preset its starting point. The Code will continue to increment from that preset point. A continuous jam reads every frame and inserts that data into the generator on a frame by frame basis. The Regen restoration of the CDI-710A is much the same as the continuous jam described above.

REGENERATED TIME CODE FEATURE

The "Regen" feature of the CDI 710A Time Code Reader is a very powerful aid in correcting the shift of the Time Code in relation to the video. This shift, or error, is often created by the use of time base correctors on the video and normal processing of the audio. Head position and VTR model are also factors.

In normal operation of the 710A, input Time Code is retimed and reshaped prior to being output. This will correct bit jitter, rise and fall time distortion, and level distortion of the outgoing Code. The retiming is accomplished by dynamic ranging of the clock and making small adjustments to it. The reshaping and level restoration is accomplished in the analog output driver section.

The "Regen" feature will re-establish the relationship to video, by sampling the incoming video signal and extrapolating from it, field one VSYNC, HSYNC, and other control signals. The incoming VSYNC is timed to establish rate, NTSC or PAL, and monitor the stability of it. Regen mode will not inject Code if the external sync is not stable, but will pass retimed and reshaped incoming Time Code. When external sync is stable a counter will be loaded providing the timing reference for the digital phase locked loop which controls the internal bit timing. Regenerated Time Code will be generated internally and timed to external video, it will not inject the Code until F1VSYNC, HSYNC line 5 and bit zero of Code are coincident. The unit does not modify color framing to a field reference signal, therefore gross input Code errors may result in a field shift. Defective Time Code frames will be error bypassed as long as the sync bytes are intact. Code drop-outs will be corrected with the use of the control track update feature. This will restore long term Code drop-outs. The "Regen" feature will allow small external sync errors. Once they become excessive the unit will discontinue regeneration at the next F1VSYNC. The unit will return to "Regen," if still enabled and when sync is once again stable.

GENERAL PURPOSE INTERFACE (GPI)

General purpose interfacing to Time Code is frame accurate switching at a predetermined Time Code point. Coincidence detection and event control are terms used for this detection. Several products are marketed for this activity, some of which are stand alone units or additions to other products. Cipher Digital includes it as a standard part of the unit and not an option. Three products in the Cipher Digital family have event contol built into them: the CDI-735CD Reader, the CDI-750 Reader Generator, and the CDI-4800 Synchronizer. The use of these outputs are limited in use only by the imagination. Any operation that can be controlled by a switch closure can be frame accurately controlled by these outputs.

The CDI-735CD is a full function reader with LED front panel display and an eight channel coincidence detector. The event point for any of the eight channels may be loaded from the front panel or the remote serial port. The outputs may be open collector, optional opto-isolator, or optional form "C" relays. When the incoming Time Code matches the preset channel point, the output will fire for one second then return to the off state. This matching is done at play speed and in the forward direction only. The values for the presets are stored in non-volatile memory and may be enabled or disabled serially or from the front panel. This product has been used in low end editing applications and timed multi-media displays, just to name a few. It provides a very cost effective interface for frame accurate Time Code.

The CDI-750 is a full function reader and generator with numerous LED displays, full video insertion capabilities, and a fully programable sixteen channel event controller. The advantage of this event controller over the CDI-735CD is that it is fully programmable. The source Time Code can be from the reader input or the generator output on an individual channel basis. Each output can be programmed to turn on, turn off, toggle state, and pulse. When pulse mode is selected, the programmed pulse width may be expressed in frame counts or a Time Code mark out point. Events may be programmed or acted upon immediately. They may be loaded on the fly from the reader or the generator and trimmed up or down by frame increments. The event table can be displayed on the keyed video output. The programming of the event controller can be accomplished from the Cipher Digital "Softouch" Controller or any serial device using this protocol.

The CDI-4800 synchronizer has a four channel event controller. The event outputs may be toggled immediately or programmed to pulse with a 250 MS duration. Programming is accomplished from the "Softouch" Audio Editing System Controller.

All of the event controllers described above provide a very powerful and cost effective means of adding Time Code synchronous external control to the small or large system.

MULTI-KEYING

One of the specialized Cipher Digital products is the CDI-700 Reader/Multi Keyer, a product developed for the "isolated" camera market. The unit will key Time Code data onto four separate but synchronous video sources for burned prints. In normal application, the camera feeds video to a one inch VTR for mastering. The output is then fed through the CDI-700A, and the burned-in video dub is simultaneously recorded on a three quarter inch VCR. The copy that is produced is used for making the edit decision list for master mixing and post-production. This operation saves many hours of burning window dubbed tapes after the fact and speeds the entire process. The unit occupies one rack space for all four keyers, which reduces the use of precious rack space, lowers power consumption, and cuts cost significantly.

ANSI/SMPTE 12M-1986
Revision and Redesignation of
ANSI V98.12M-1981

American National Standard for television– time and control code– video and audio tape for 525-line/60-field systems

Approved January 29, 1986 Sponsor: Society of Motion Picture and Television Engineers

1. Scope

1.1 The first part of this standard specifies a format and modulation method for a digital code to be recorded on a longitudinal track of video and audio magnetic tape recorders. The code is to be used for timing and control purposes.

1.2 The second part specifies the digital format to be inserted into the television signal vertical interval to be used for timing and control purposes in video magnetic tape recorders. This part also specifies the location of the code within the television baseband signal and its relationship to other components of the television signal and to the longitudinal track code described in the first part of this standard.

2. Referenced Standards

This standard is intended for use in conjunction with the following standards:

EIA Industrial Electronics Tentative Standard No. 1, Color Television Studio Picture Line Amplifier Output Drawing

International Standard ISO 646-1983, Information Processing — ISO 7-Bit Coded Character Set for Information Interchange

International Standard ISO 2022-1982, Information Processing — ISO 7-Bit and 8-Bit Coded Character Sets — Code Extension Techniques

3. Longitudinal Track Application

3.1 Modulation Method. The modulation method shall be such that a transition occurs at the beginning of every bit period. "One" is represented by a second transition one half a bit period from the start of the bit. "Zero" is represented when there is no transition within the bit period. (See Fig. 1.)

3.2 Code Format

3.2.1 Frame Make-up. Each television frame shall be identified by a unique and complete address. A frame consists of two television fields or 525 horizontal lines. The frames shall be numbered successively 0 through 29, except as noted in 5.2.2 (Drop Frame). If color frame identification in the code is required, the even units of frame numbers shall identify Frame A and odd units of frame numbers shall identify Frame B, as defined by EIA Tentative Standard No. 1.

3.2.2 Frame Address. Each address shall consist of 80 bits numbered 0 through 79.

3.2.2.1 Boundaries of Address. The address shall start at the clock edge before the first address bit (bit 0). The bits shall be evenly spaced throughout the address period, and shall occupy fully the address period which is one frame. Consequently, the bit rate shall be 80 times the frame rate in frames per second. (See 3.2.1 for definition of a television frame.)

American National Standards Institute, 1430 Broadway, New York, N.Y. 10018 ANSI7½C386/6

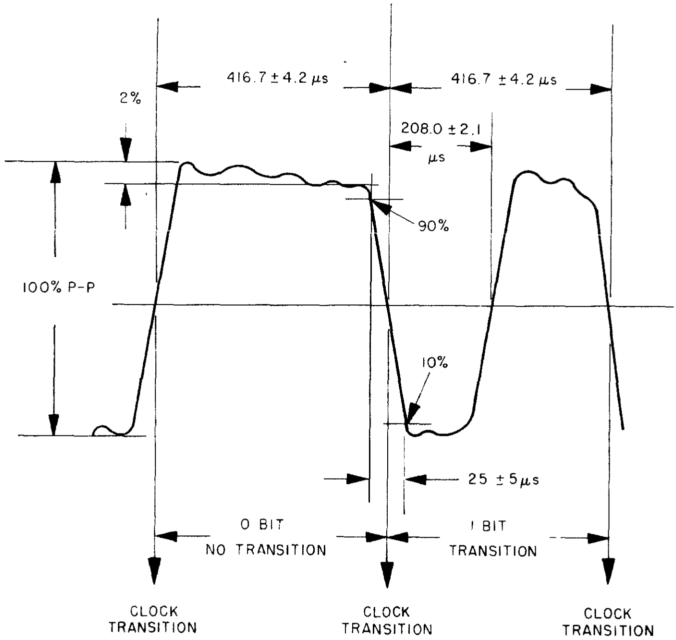


Fig. 1
Longitudinal Recorder Waveform

3.2.2.2 Start of Address. The start of the address shall occur at the beginning of line 5 in fields I and III, as defined in EIA Tentative Standard No. 1. The tolerance shall be ±1 line.

3.3 Longitudinal Recorder Input Waveform Characteristics (See Fig. 1.)

3.3.1 Rise Time. The rise and fall times of the clock and "one" transitions of the code pulse train shall be 25 ± 5 microseconds, measured between the 10 and 90 percent amplitude points on the waveform.

3.3.2 Amplitude Distortion. Amplitude distortion, such as overshoot, undershoot, and tilt, shall be limited to 2 percent of the peak-to-peak amplitude of the code waveform.

3.3.3 Time of Transitions. The time between clock transitions shall not vary more than 1 percent of the average clock period measured over at least one frame. The "one" transition shall occur halfway between two clock transitions within 0.5 percent of one clock period. Measurements of these timings shall be made at half-amplitude points on the waveform.

3.4 Use of Binary Groups. The binary groups are intended for storage of data by the users, and the 32 bits within the 8 groups may be assigned in any manner without restriction if the character set used for the data insertion is not specified and the binary group flag bits 43 and 59 are both zero.

If an 8-bit character set is used, the binary group flag bits 43 and 59 shall be set according to the following truth table:

	Bit 43	Bit 59
Character set not specified	0	0
Eight-bit character set	1	0
Unassigned	0	1
Unassigned	1	1

Unassigned states of the truth table cannot be used and their assignment is reserved to the SMPTE.

3.4.1 If an 8-bit character set conforming to ISO 646-1983 and ISO 2022-1982 is signalled by the binary group flag bits 43 and 59, the characters should be inserted in accordance with Fig. 2. Information carried by the user-bits is not specified.

3.5 Assigned and Unassigned Address Bits. Six bits are reserved within the address groups, 4 for identifying operational modes, 1 for bi-phase correction, and 1 unassigned bit reserved for future assignment and defined as zero until further specified by the SMPTE.

Bit 10 — Drop Frame Flag. If certain numbers are being dropped to resolve the difference between real time and color time, as defined in 5.2.2, a "1" shall be recorded.

Bit 11 — Color Frame Flag. If color frame identification has been intentionally applied, as defined in 3.2.1, a "1" shall be recorded.

Bit 27 — "Bi-phase Mark" Phase Correction. This bit shall be put in a state so that every 80-bit word will contain an even number of logical zeros. This requirement results in the following truth table for Bit 27:

Number of Logical Zeros in Bits 0 to 63 (27 exclusive):	Bit 27
Odd	1
Even	0

Bits 43 and 59 — Binary Group Flag Bits. These two bits shall be set in accordance with the truth table as specified in 3.4.

Bit 58 — Unassigned Address. "0" until assigned by the SMPTE.

The bits shall be assigned as shown in Fig. 3 and described below:

0-3	Units of frames	
4-7	First binary group	
8-9	Tens of frames	
10	Drop frame flag (see 3.5)	
11	Color frame flag (see 3.5)	
12-15	Second binary group	
16-19	Units of seconds	
20-23	Third binary group	
24-26	Tens of seconds	
27	Bi-phase mark phase correction bit (see 3.5)	
28-31	Fourth binary group	
32-35	Units of minutes	
36-39	Fifth binary group	
40-42	Tens of minutes	
43	Binary group flag bit (see 3.4)	
44-47	Sixth binary group	
48-51	Units of hours	
52-55	Seventh binary group	
56-57	Tens of hours	
58	Unassigned address bit (0 until assigned by the SMPTE)	
59	Binary group flag bit (see 3.4)	
60-63	Eighth binary group	
64-79	Synchronizing word	
	64-65	Fixed zero
	66-77	Fixed one
	78	Fixed zero
	79	Fixed one

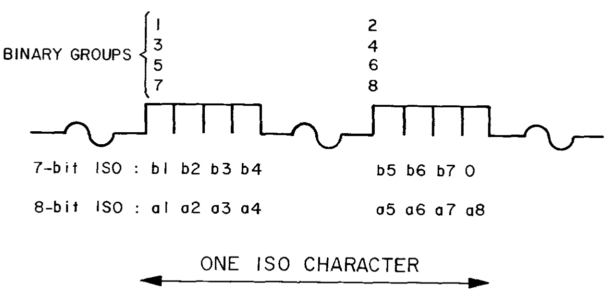


Fig. 2
Use of Binary Groups to Describe ISO Characters Coded with 7 or 8 Bits

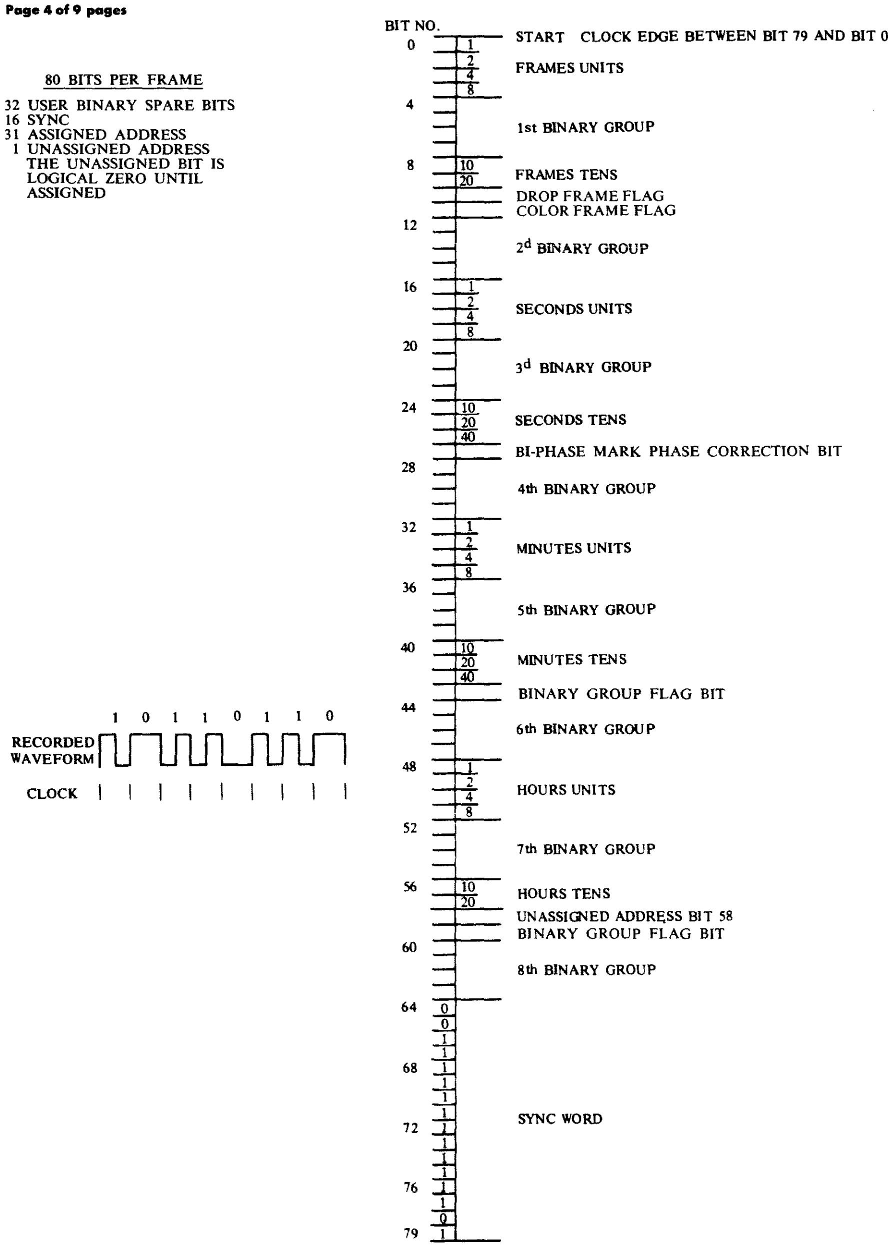


Fig. 3
Longitudinal Bit Assignment

4. Vertical Interval Application

4.1 Modulation Method. The modulation method shall be such that each state of the signal corresponds to a binary state and a transition occurs only when there is a change in the data contained in adjacent bit cells from a "1" to "0" or "0" to "1." No transitions shall occur when adjacent bits contain the same data. Synchronization bit pairs shall be inserted as required in 4.2.3 (modified NRZ).

4.2 Format

4.2.1 Make-up. The frames shall be numbered successively 0 through 29, except as noted in 5.2.2 (Drop Frame), with field identification as specified in 4.4.

The address recorded in each field shall relate directly to the field/frame identification as set forth in EIA Tentative Standard No. 1, and shall be related to the longitudinal code as shown in Fig. 4.

Bit Rate. The bit rate, F_c, at which the address is generated shall be as follows:

$$F_c = F_h \times \frac{455}{4} \pm 200\,\text{Hz}$$

where F_h is the horizontal line rate.

Recorder Input Waveform Characteristics. The baseband video signal after address insertion shall be specified as shown in Fig. 5.

4.2.2 Address. Each address shall consist of 90 bits numbered 0 through 89.

4.2.2.1 Boundaries of Address. The address shall start at the leading edge of the first synchronizing bit (bit 0). The bits shall be evenly spaced throughout the address period, and shall occupy fully the address period which is 50.286 μsec nominal in duration.

4.2.2.2 Timing of the Start of Address. The half-amplitude point of bit 0 shall occur not earlier than 10.0 μsec following the half-amplitude point of the leading edge of the line synchronizing pulse. The half-amplitude point of the trailing edge of bit 89 logical 1 shall occur not later than 2.1 μsec before the half-amplitude point of the leading edge of the following line synchronizing pulse. (See Fig. 6.)

4.2.2.3 Location of the Address Code Signal in the Vertical Interval. The address code signal, generated at the bit rate F_c, shall be inserted on two non-adjacent lines of the vertical interval in both fields. Insertion of the address code shall not be earlier than line 10 or later than line 20, as defined in EIA Tentative Standard No. 1. The address code shall be on the same lines in all fields for a given recording.

User bits shall be the same in both fields of a frame to avoid confusion when transferring from the vertical interval to the longitudinal code.

4.2.3 The bits shall be assigned as shown in Fig. 6.

4.3 Use of Binary Groups The binary groups are intended for storage of data by the users, and the 32 bits within the 8 groups may be assigned in any manner without restriction if the character set used for the data insertion is not specified and the binary group flag bits 55 and 75 are both zero.

If an 8-bit character set is used, the binary group flag bits 55 and 75 shall be set according to the following truth table:

	Bit 55	Bit 75
Character set not specified	0	0
Eight-bit character set	1	0
Unassigned	0	1
Unassigned	1	1

Unassigned states of the truth table cannot be used and their assignment is reserved to the SMPTE.

4.3.1 If an 8-bit character set conforming to ISO 646-1983 and ISO 2022-1982 is signalled by the binary group flag bits 55 and 75, the characters should be inserted in accordance with Fig. 2. Information carried by the user-bits is not subject to any regulation.

4.4 Assigned and Unassigned Address Bits. Six bits are reserved within the address groups, 5 for identifying operational modes and 1 unassigned bit reserved for future assignment and defined as zero until further specified by the SMPTE.

Bit 14 — Drop Frame Flag. If certain numbers are being dropped to resolve the difference between real time and color time, as defined in 5.2.2, a "1" shall be recorded.

Page 6 of 9 pages

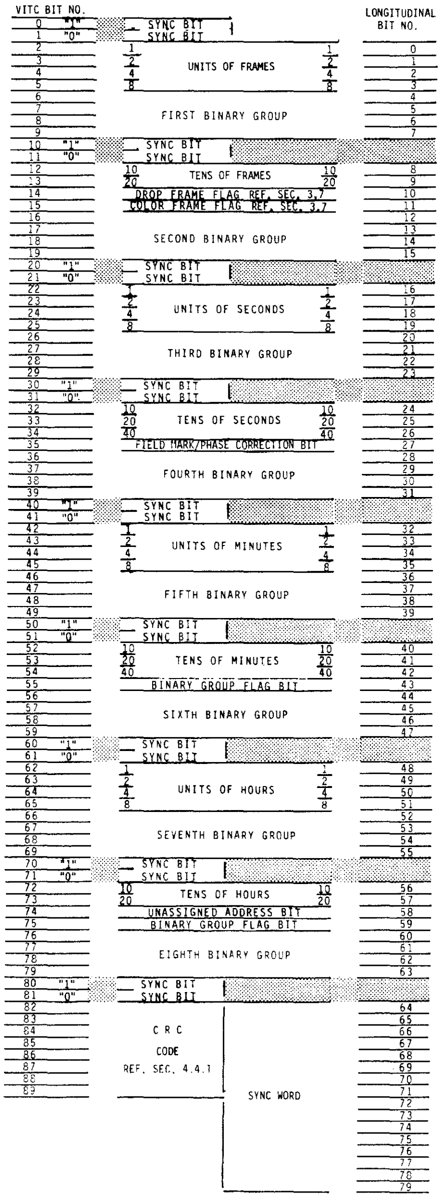


Fig. 4
Relationship of Vertical Interval Code to Longitudinal Code

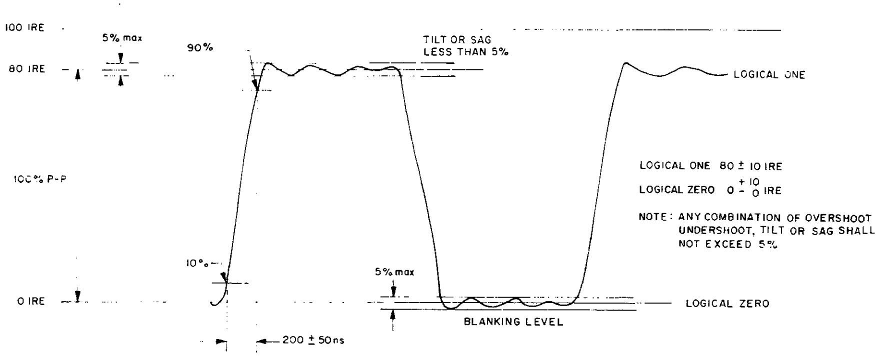


Fig. 5
Vertical Interval Recorder Waveform

Bit 15 — Color Frame Flag. If color frame identification has been applied intentionally, a "1" shall be recorded. Color frame identification of the code is defined as the even units of frame numbers identifying frame A and the odd units of frame numbers identifying frame B. Frames A and B correspond to color frames A and B as defined by EIA Tentative Standard No. 1.

Bit 35 — Field Mark. Field identification shall be recorded as follows: A "0" shall represent the field in which the first pre-equalizing pulse follows the preceding horizontal sync pulse by a whole line. This corresponds to monochrome field I and color field I or III. A "1" shall represent the field in which the first pre-equalizing pulse follows the preceding horizontal sync pulse by a half line. This corresponds to monochrome field II and color field II or IV. Color fields I and III and II and IV are defined in EIA Tentative Standard No. 1.

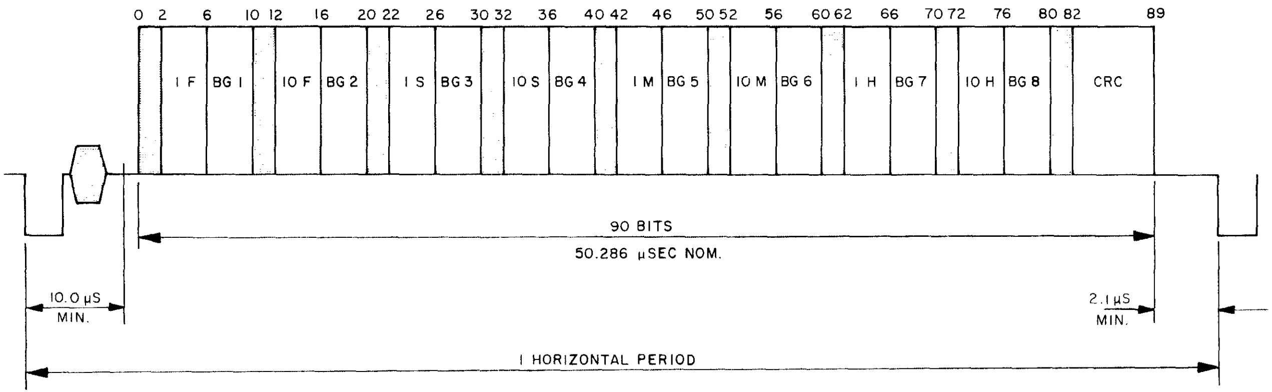
Bits 55 and 75 — Binary Group Flag Bits. These two bits shall be set in accordance with the truth table specified in 4.3.

Bit 74 — Unassigned Address. "0" until assigned by SMPTE.

4.4.1 Cyclic Redundance Check Code. Eight bits, 82 to 89, are set aside at the end of the code to provide for error detection by checking for cyclic redundance. The generating polynomial of the cyclic redunance check, G(X), will be applied to all bits from 0 to 81 inclusive and shall be as follows:

$$G(X) = X^8 + 1$$

The received data divided by the generating polynomial shall result in a remainder of "all zeros" when no error exists in the received data.



0-1	Synchronizing bits	0 Fixed one 1 Fixed zero
2-5	Units of Frames	
6-9	First Binary Group	(BG 1)
10-11	Synchronizing bits	10 Fixed one 11 Fixed zero
12-13	Tens of Frames	
14	Drop Frame Flag	
15	Color Frame Flag	
16-19	Second Binary Group	(BG 2)
20-21	Synchronizing bits	20 Fixed one 21 Fixed zero
22-25	Units of Seconds	
26-29	Third Binary Group	(BG 3)
30-31	Synchronizing bits	30 Fixed one 31 Fixed zero
32-34	Tens of Seconds	
35	Field Mark	
36-39	Fourth Binary Group	(BG 4)
40-41	Synchronizing bits	40 Fixed one 41 Fixed zero
42-45	Units of Minutes	
46-49	Fifth Binary Group	(BG 5)
50-51	Synchronizing bits	50 Fixed one 51 Fixed zero
52-54	Tens of minutes	
55	Binary Group Flag	
56-59	Sixth Binary Group	(BG 6)
60-61	Synchronizing bits	60 Fixed one 61 Fixed zero
62-65	Units of Hours	
66-69	Seventh Binary Group	(BG 7)
70-71	Synchronizing bits	70 Fixed one 71 Fixed zero
72-73	Tens of Hours	
74	Unassigned bit	(Zero until specified)
75	Binary Group Flag	
76-79	Eighth Binary Group	(BG 8)
80-81	Synchronizing bits	80 Fixed one 81 Fixed zero
82-89	CRC Code (Cyclic Redundance Check Code. See 4.4.1)	

Fig. 6
Address Bit Assignment

5. Time Discrepancies

5.1 Definitions of Real Time and Color Time

5.1.1 One-second real time is defined as the time elapsed during the scanning of 60 fields (or any multiple thereof) in an ideal television system at a vertical field rate of exactly 60 fields per second.

5.1.2 One-second color time is defined as the time elapsed during the scanning of 60 fields (or any multiple thereof) in a color television system at a vertical field rate of approximately 59.94 fields per second.

5.2 Because the vertical field rate of a color signal is approximately 59.94 fields per second, straightforward counting at 30 frames per second (60 fields per second) will yield an error of + 108 frames (+ 216 fields), approximately equivalent to + 3.6 seconds timing error, in one hour of running time. For correction of this time discrepancy, two methods of operation are allowed:

5.2.1 Nondrop Frame — Uncompensated Mode. During a continuous recording, no numbers shall be omitted from the chain of addresses. Each address shall be increased by 1 frame over the frame number immediately preceding it. When this mode is used, the drop-frame flag of each address shall be a "0" as specified in 3.5 and 4.4.

5.2.2 Drop Frame — Compensated Mode. To resolve the color time error, the first two frame numbers (0, 1) at the start of each minute, except minutes 0, 10, 20, 30, 40, and 50, shall be omitted from the count. When this mode is used, the drop-frame flag of each address shall be a "1" as specified in 3.5 and 4.4.

6. Structure of the Address Bits

6.1 The basic structure of the address is based upon the Binary Coded Decimal (BCD) system. Because the count in some cases does not rise to 9, conservation of bits is achieved because 4 bits are not needed as in an ordinary BCD code. (The 24-hour clock system is used; 2:00 p.m. is 1400 hours.)

6.2 Longitudinal Track and Vertical Interval Applications. Assignment of bits and binary coded decimal arrangements for both applications are shown in the following table:

Longitudinal Track and Vertical Interval Structure

Structural Member	Assignments of Bits		Binary Coded Decimal (BCD)		
	Longitudinal	VIT	No. of Bits	Arrangement	Count
Units Frames	0-3	2-5	4	1 2 4 8	0-9
Tens Frames	8-9	12-13	2	1 2	0-2
Units Seconds	16-19	22-25	4	1 2 4 8	0-9
Tens Seconds	24-26	32-34	3	1 2 4	0-5
Units Minutes	32-35	42-45	4	1 2 4 8	0-9
Tens Minutes	40-42	52-54	3	1 2 4	0-5
Units Hours	48-51	62-65	4	1 2 4 8	0-9
Tens Hours	56-57	72-73	2	1 2	0-2

APPENDIX B

Proposed SMPTE Recommended Practice RP 108

Vertical Interval Time and Control Code for Video Tape for 525 Line/60 Field Television Systems

1. SCOPE

This practice specifies the digital format to be inserted into the television signal vertical interval to be used for timing and control purposes in video magnetic tape recorders. The practice also specifies the location of the code within the television baseband signal, its relationship to other components of the television signal, and to American National Standard Time and Control Code for Video and Audio Tape for 525-Line/60-Field Television Systems, ANSI V 98.12 M — 1981.

2. MODULATION METHOD

2.1 The modulation method shall be such that each state of the signal corresponds to a binary state and a transition occurs only when there is a change in the data contained in adjacent bit cells from a "1" to "0" or "0" to "1". No transitions shall occur when adjacent bits contain the same data. Synchronization bit pairs shall be inserted as required in Sec. 3.3 (modified NRZ).

2.2 Bit Rate. The bit rate, F_c, at which the address is generated shall be as follows:

$$F_c = F_h \times \frac{455}{4} \pm 200 \text{ Hz}$$

where F_h is the horizontal line rate.

2.3 Recorder Input Waveform Characteristics. The baseband video signal after address insertion shall be specified as shown in Fig. 1.

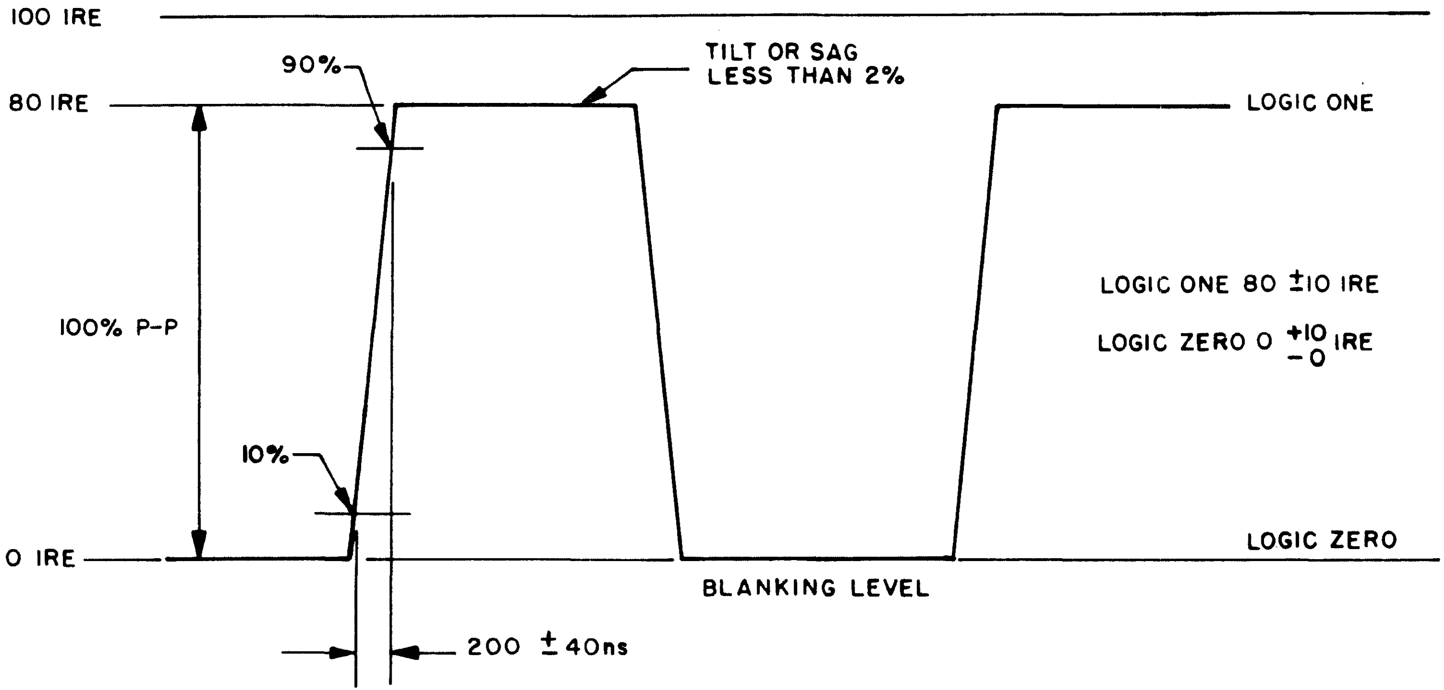


Fig. 1
Recorder Input Waveform

3. CODE FORMAT

3.1 Each television frame shall be identified by a unique and complete address. A frame consists of two television fields or 525 horizontal television lines.

3.1.1 The frames shall be numbered successively 0 through 29 with field identification as specified in Sec. 3.7.3.

3.1.2 The address recorded in each field shall relate directly to the field/frame identification as set forth in EIA Industrial Electronics Tentative Standard No. 1, Color Television Studio Picture Line Amplifier Output Drawing, and shall correspond to the address recorded as defined in ANSI V98.12M-1981 and shown in Fig. 2.

3.2 Each address shall consist of 90 bits numbered 0 through 89.

3.3 The bits shall be assigned as shown in Fig. 3.

3.4 Boundaries of Address. The address shall start at the leading edge of the first synchronizing bit (Bit 0). The bits shall be evenly spaced throughout the address period, and shall occupy fully the address period which is 50.286 µsec nominal in duration.

3.5 Timing of the Start of Address. The start of the address shall occur no earlier than 10.0 µsec from the 50-percent point of the leading edge of horizontal sync and no later than 11.0 µsec from this edge (nominal 10.5 µsec). The start of address is defined as the leading edge of Bit 0. (See Fig. 3.)

3.6 Use of Binary Groups. The binary groups are intended for storage of supplementary data by the users. The 32 bits within the eight groups may be assigned in any manner with the restriction that the binary groups within a frame must contain the same data on both fields.

3.7 Assigned and Unassigned Address Bits. Six bits are reserved within the address groups, three for identifying operational modes and three unassigned but reserved for future assignment and defined as zeros until further specified by the SMPTE.

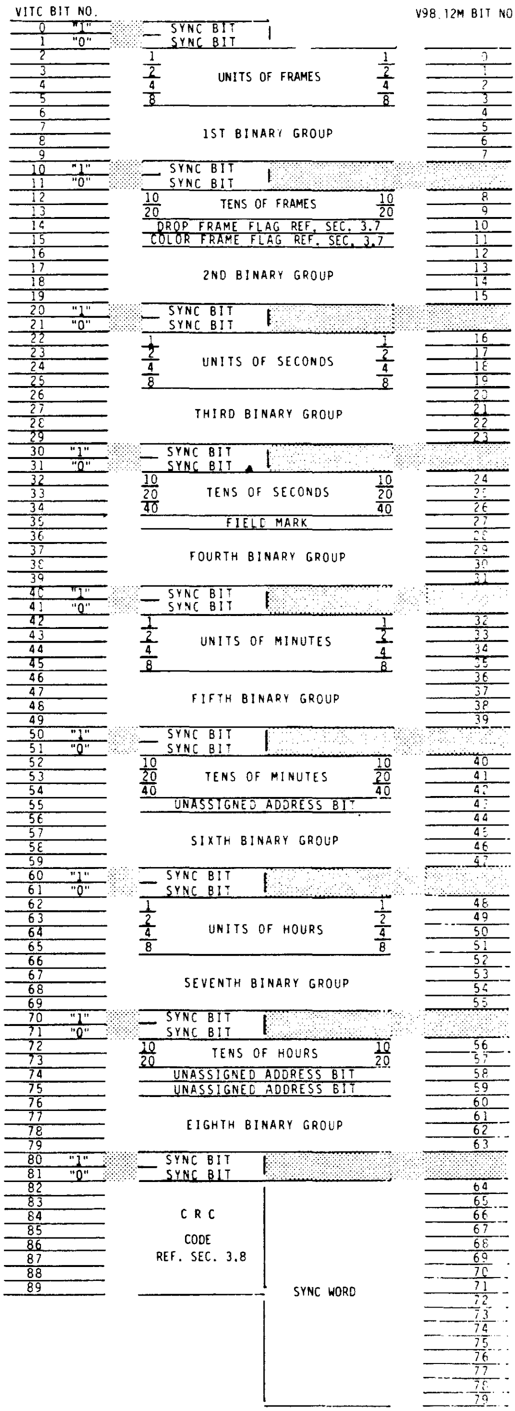


Fig. 2
Relationship of Vertical Interval Code to Video and Audio Code

3.7.1 Bit No. 14, Drop Frame Flag. If certain numbers are being dropped to resolve the difference between real time and color time as defined in Sec. 4.2.2, a "1" shall be recorded.

3.7.2 Bit No. 15, Color Frame Flag. If color frame identification has been applied intentionally, a "1" shall be recorded. Color frame identification of the code is defined as the even units of frame numbers identifying Frame A and the odd units of frame numbers identifying Frame B. Frames A and B correspond to Color Frames A and B as defined by EIA Tentative Standard No. 1.

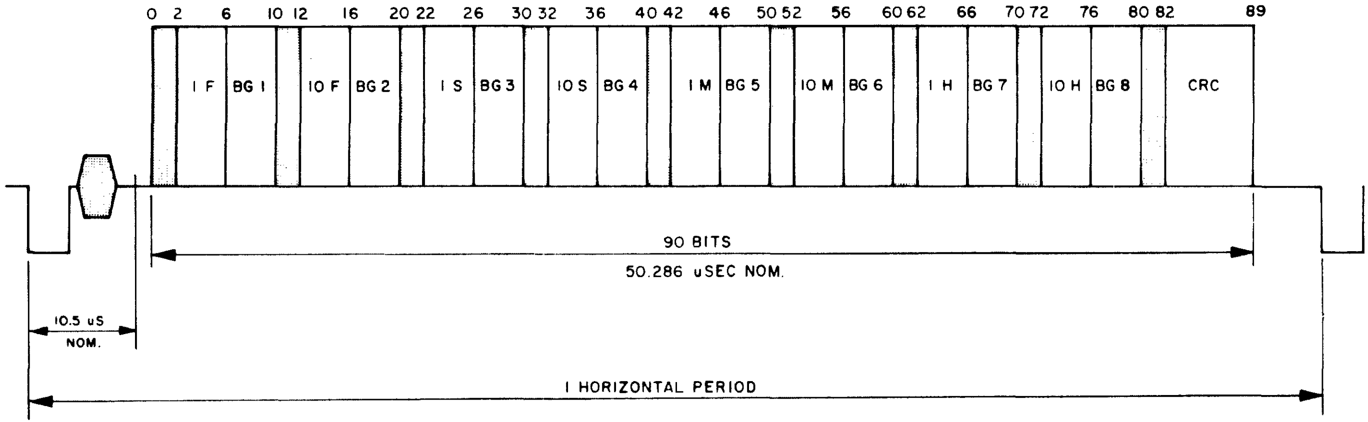
3.7.3 Bit No. 35, Field Mark. Field identification shall be recorded as follows: A "0" shall represent the field in which the first pre-equalizing pulse follows the preceding horizontal sync pulse by a whole line. This corresponds to Monochrome Field 1 and Color Field 1 or 3. A "1" shall represent the field in which the first pre-equalizing pulse follows the preceding horizontal sync pulse by a half line. This corresponds to Monochrome Field 2 and Color Fields 2 or 4. Color Fields 1 and 3 and 2 and 4 are defined in EIA Tentative Standard No. 1.

3.8 Cyclic Redundance Check Code. Eight bits, 82 through 89, set aside at the end of the code interval are cyclic redundance check codes for error detection. The generating polynomial of the cyclic redundancy check G (X) is as follows:

$$G(X) = X^8 + 1$$

4. TIME DISCREPANCIES

4.1 Definitions of Real Time and Color Time. Real time is defined as the time elapsed during the scanning of 60 fields (or any multiple thereof) in an ideal television system at a vertical field rate of exactly 60 fields per second. Color time is defined as the time elapsed during the scanning of 60 fields (or any multiple thereof) in a color television system at a vertical rate of approximately 59.94 fields per second.



0-1	Synchronizing bits	0 Fixed one 1 Fixed zero
2-5	Units of Frames	
6-9	First Binary Group	(BG 1)
10-11	Synchronizing bits	10 Fixed one 11 Fixed zero
12-13	Tens of Frames	
14	Drop Frame Flag	
15	Color Frame Flag	
16-19	Second Binary Group	(BG 2)
20-21	Synchronizing bits	20 Fixed one 21 Fixed zero
22-25	Units of Seconds	
26-29	Third Binary Group	(BG 3)
30-31	Synchronizing bits	30 Fixed one 31 Fixed zero
32-34	Tens of Seconds	
35	Field Mark	
36-39	Fourth Binary Group	(BG 4)
40-41	Synchronizing bits	40 Fixed one 41 Fixed zero
42-45	Units of Minutes	
46-49	Fifth Binary Group	(BG 5)
50-51	Synchronizing bits	50 Fixed one 51 Fixed zero
52-54	Tens of minutes	
55	Unassigned bit	(Zero until Spcfd.)
56-59	Sixth Binary Group	(BG 6)
60-61	Synchronizing bits	60 Fixed one 61 Fixed zero
62-65	Units of Hours	
66-69	Seventh Binary Group	(BG 7)
70-71	Synchronizing bits	70 Fixed one 71 Fixed zero
72-73	Tens of Hours	
74-75	Unassigned bits	(Zero until Spcfd.)
76-79	Eighth Binary Group	(BG 8)
80-81	Synchronizing bits	80 Fixed one 81 Fixed zero
82-89	CRC Code (Cyclic Redundancy Check Code)	

Fig. 3
Address Bit Assignment

4.2 Because vertical field rate of color signal is approximately 59.94 fields per second, straightforward counting at 30 frames per second (60 fields per second) will yield an error of + 108 frames (+ 216 fields) equivalent to + 3.6 seconds timing error in one hour of running time. For correction of this time discrepancy, two methods of operation are allowed:

4.2.1 Uncompensated Mode. During a continuous recording, no numbers shall be omitted from the chain of addresses. Each address shall be increased by 1 frame (2 fields) over the frame number immediately preceding it. When this mode is used, Bit 14 of each address shall be a "0" as specified in Sec. 3.7.1.

4.2.2 Compensated Mode. To resolve the color time error, the first two frame numbers (0, 1) at the start of each minute, except minutes 0, 10, 20, 30, 40, and 50, shall be omitted from the count. When this mode is used, Bit 14 of each address shall be a "1" as specified in Sec. 3.7.1.

5. STRUCTURE OF THE ADDRESS BITS

5.1 The basic structure of the address is based upon the Binary Coded Decimal (BCD) System. Because the count in some cases does not rise to 9, conservation of bits is achieved because 4 bits are not needed as in ordinary BCD code. (The 24-hour clock system is used: 2:00 p.m. is 1400 hours.)

5.1.1 Units Frames. Bits 2-5—4-bit BCD arranged 1, 2, 4, 8. Count 0-9.

5.1.2 Tens Frames. Bits 12-13—2-bit BCD arranged 1, 2. Count 0-2.

5.1.3 Units Seconds. Bits 22-25—4-bit BCD arranged 1, 2, 4, 8. Count 0-9.

5.1.4 Tens Seconds. Bits 32-34—3-bit BCD arranged 1, 2, 4. Count 0-5.

5.1.5 Units Minutes. Bits 42-45—4-bit BCD arranged 1, 2, 4, 8. Count 0-9.

5.1.6 Tens Minutes. Bits 52-54—3-bit BCD arranged 1, 2, 4. Count 0-5.

5.1.7 Units Hours. Bits 62-65—4-bit BCD arranged 1, 2, 4, 8. Count 0-9.

5.1.8 Tens Hours. Bits 72-73—2-bit BCD arranged 1, 2. Count 0-2.

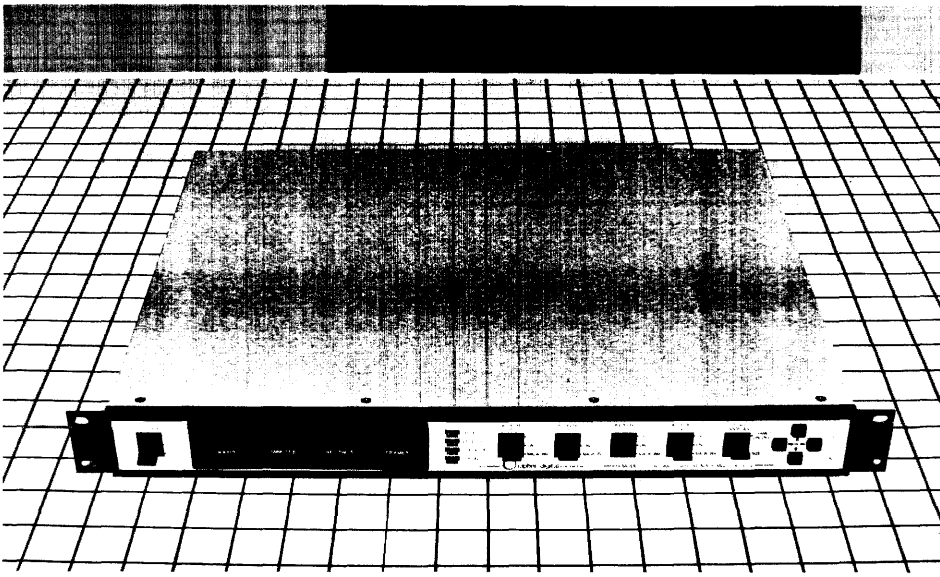
6. LOCATION OF THE ADDRESS CODE IN THE VERTICAL INTERVAL

The address code signal, generated at the bit rate F_c, shall be inserted on two nonadjacent lines in both fields of the vertical interval. Insertion of the addess code shall not be earlier than line 10 or later than line 20 and shall be on the same line number of all fields, as defined in EIA Tentative Standard No. 1.

INDEX

NOTES

NOTES



Time Code Reader with Quad Video Character Inserter

CDI-700A

User Friendly and Priced Right

The CDI-700A brings ease of operation and affordability to video production and post-production editing. This microprocessor-based time code reader features front panel controls, clearly labeled keys that independently control all four of the equipment's video character inserter channels, and front panel displays of time code and status indicators, including color-frame and drop-frame.

An important advantage of the 700A is its ability to generate burned-in work prints for production with multiple synchronous video sources, thereby minimizing error by precisely identifying every video frame.

cipher digital, inc.

CDI-700A

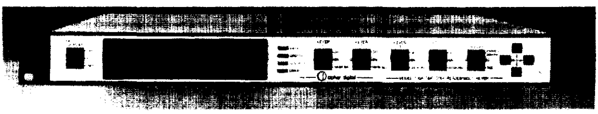
Time Code Reader with Quad Video Character Inserter

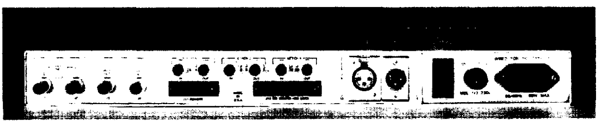
FEATURES

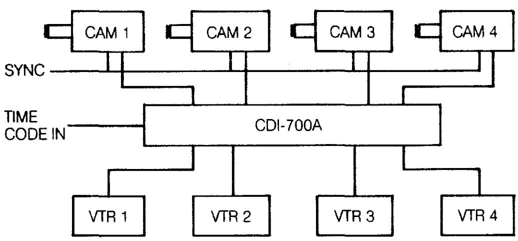
- Decodes 30-frame SMPTE or 25-frame EBU code formats
- Keys time data onto four different video sources
- Error bypass eliminates faulty readings by replacing defective code with sequentially correct code
- Character data fully positionable over entire raster
- Independent character display delete, background mask and inverse video for each keyer
- Four character sizes

OPTIONS

- Serial RS232 / RS422 Data Outputs







SPECIFICATIONS

VIDEO INPUT

Format: NTSC-PAL-SECAM composite video

Amplitude: .5 to 2.0v p-p

Impedance: Channel 1—Non-terminated, bridging, looping BNC Channels 2, 2, 4—Non-terminated, 75 ohm, BNC

VIDEO OUTPUTS

Format: Same as input plus character display

Level: 1.0v p-p

Impedance: 75 ohm, unbalanced, BNC connector

INPUT CODE

Format: 30-frame SMPTE, 25-frame EBU or 24-frame film code, drop-frame or non-drop-frame mode

Amplitude: 20mv to 10v p-p

Band width: 1/30th to 80x VTR play speed

Impedance: 10k ohm balanced

RESHAPED OUTPUT CODE

Format: Same as input code

Amplitude: +4 dbm into 60 ohm balanced load

Rise time: Selectable 25 USEC (SMPTE) or 50 USEC (EBU)

POWER

115V or 230V

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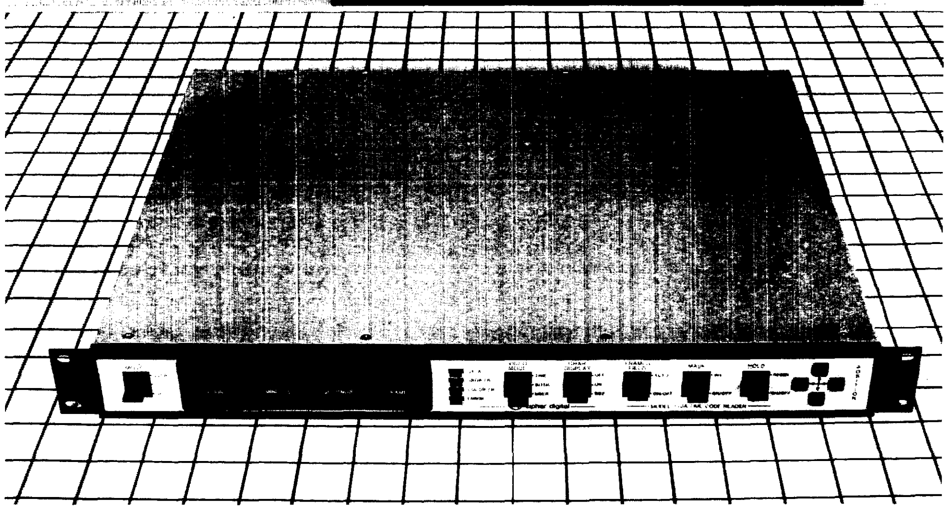
(301) 695-0200 TELEX: 272065CDINC

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE



Time Code Reader with Fully Regenerated Time Code Output

CDI-710A

Corrects or Eliminates Timing Errors

Designed around a high-speed microprocessor, the CDI-710A offers all the latest time code reader features demanded in today's sophisticated video production environment.

In addition to error-free, frame-accurate decoding and front-panel display of time and user data, the 710A provides an integral video character inserter. But its most exceptional function is a completely regenerated time code output that corrects incoming code for phase shift, short- and long-term timing errors and, when used with the error bypass feature, will actually eliminate defective code.

The "Regen" capability is particularly important where code fed to a computer editor has been displaced in relation to the video signal, causing edit aborts. It also corrects phase shifts due to head alignment, tracking errors, TBC processing and non-synchronous free-running code. Supplied with control-track pulses, it will even continue to output error-free time code with our incoming data.

The "Regen" output is ideal for dubbing code from VTR to VTR and as a direct source of stable code for driving telecine type transports in video to film applications.

cipher digital, inc.

CDI-710A

Time Code Reader with Fully Regenerated Time Code Output

FEATURES

- Decodes 30-frame SMPTE, 25-frame EBU and 24-frame film formats
- Reads time and user date simultaneously
- Wide speed decoding—1/30th to 80X play speed
- Completely regenerated time code output
  - —Retimed and resynced
  - —Corrects or eliminates timing errors
  - —Error-free time code output without incoming data
- Multi-function video character inserter
  - —Displays combined code information superimposed over program video
  - —Individual or simultaneous display of time and user data
  - —Full raster positioning with "soft control"
  - —Multi-size characters
  - —Selectable background mask
  - —Inverse keyer video
  - —Manual or automatic "frames" display
  - —Selectable field identification
- Error bypass eliminates faulty readings by replacing defective code with sequentially correct code

OPTIONS

- Parallel BCD data output
- Film burst code

SPECIFICATIONS

CODE INPUT

Amplitude: 10mv to 10v p-p

Bandwidth: 80 bps to 170k bps

Impedance: 10k ohm balanced on 3 pin XLR connector

RESTORED CODE OUTPUT

Format: Same as input, reshaped/retimed

Amplitude: +4dbm into 600 ohm 3 pin XLR connector

Risetime: Selectable 25usec./50usec.

VIDEO INPUT

Format: NTSC, PAL, SECAM composite video

Level: 0.5v to 2.0v p-p

Impedance: Non-terminated, bridging, BNC connector

VIDEO OUTPUTS (2)

Format: Same as input with Time/User characters

Level: 1.0v p-p

Impedance: 75 ohm unbalanced, BNC connector

VIDEO CONTROLS

Size 1, 2, 3, & 4
H&V position
Time, User, or Time & User
Display delete
Frames delete
Freeze display
Mask delete
Inverse keyer

PANEL DISPLAY CONTROLS

8-Char, 7-segment display
Clearly identified status indicators
4 key type switches for video position

PADDLE SWITCHES

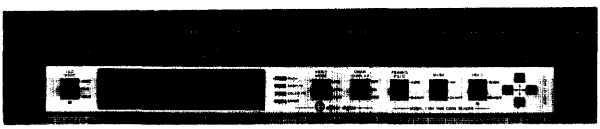
LED mode
Video mode
Char display
Frames/field
Mask
Hold

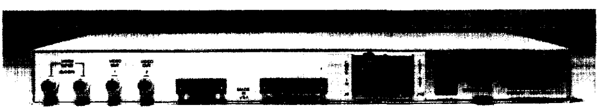
POWER

115 or 230v, 50/60hz

DIMENSIONS

19"W, 14"D, 1¾"H
Track mounting ears





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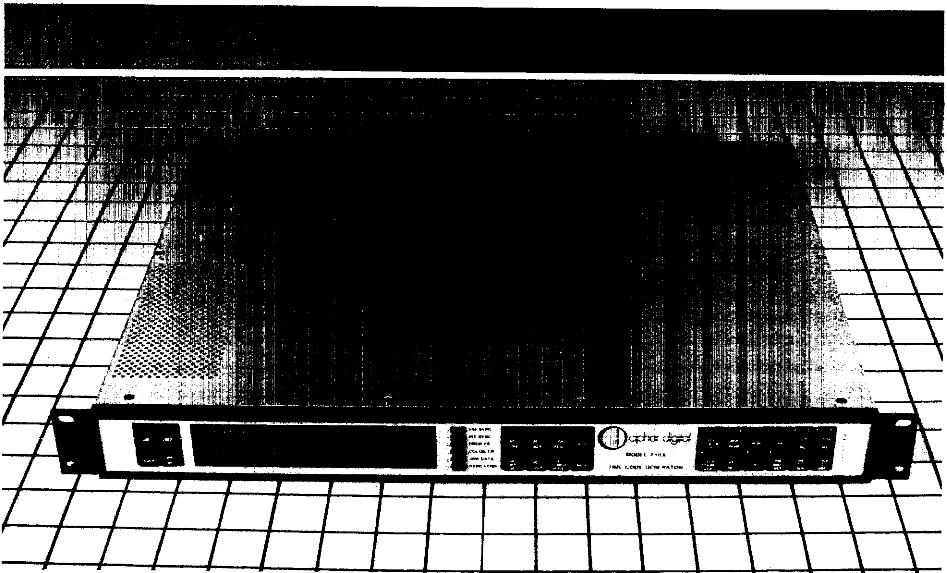


Micro-processor-Based Time Code Generator

CDI-716A

Features Multi-Function Jam-Sync

The CDI-716A is a cost-effective answer to the time code generator needs of contemporary video, audio and post-production studios.

This microprocessor-based generator handles both SMPTE and EBU current and proposed longitudinal time code formats for data, user data, status and flag bits. It also makes precise high band color video editing possible by accepting an external field I.D. pulse that follows the NTSC 4-field and PAL 4- or 8-field encoding standards.

An important plus is the CDI-716A's unique multi-function Jam-Sync (including Jam-Sync coding with an end-user selectable offset) which permits correction of errors produced by head offset or mistracking.

cipher digital, inc

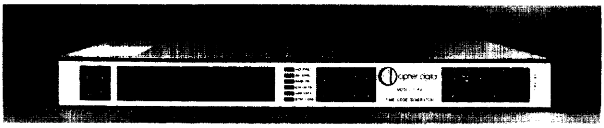
cipher digital, inc

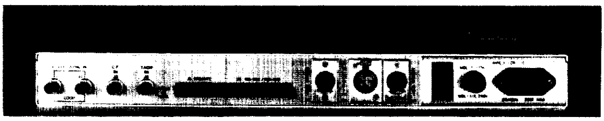
CDI-716A

Microprocessor-Based Time Code Generator

FEATURES

- Microprocessor-based for future upgrades
- Operational parameters and preset easily loaded via front panel
- Generates SMPTE, EBU or Film Code formats
- All frame rates
- Multi-function Jam-Sync
- Jam-Sync coding with user selectable offsets
- Generates 4-field NTSC RS-170A or 8-field PAL color code
- Internal time of day clock
- Selectable SMPTE "Phase Bit"
- Programmable operation modes from front panel
- Non-volatile memory on user presets and setups





SPECIFICATIONS

VIDEO INPUT
Loop Thru: .5V to 2V, 75 ohm not terminating
Black burst composite sync

Color Field ID: Field Ref pulse
Line 3 to line 20 field 1

TACHOMETER INPUT
Frame Rate: X1 thru X256 per frame

CODE OUTPUT
SMPTE/EBU or Film Standards: .5 to 2v p-p, factory set 1v p-p

JAM CODE INPUT
SMPTE/EBU or Film Standards: 300 mv to 10 v p-p

RATE OUTPUT
2x Frame Rate Tone: .5V to 2v p-p
Factory set 1v p-p

POWER
115V/230V
50/60 Hz

DIMENSIONS
19"W, 14"D, 1¾"H
Rack mounting ears

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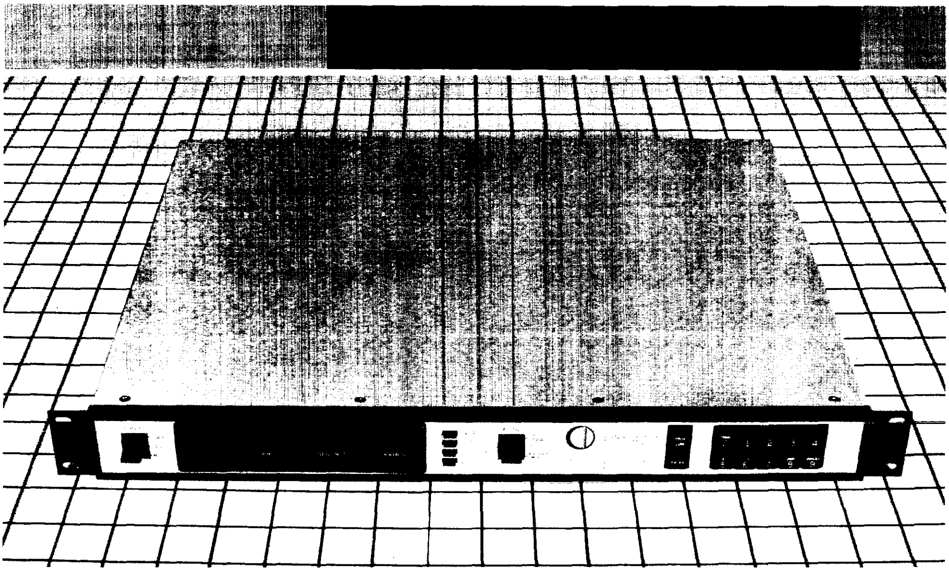
SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE



Time Code Reader with 8-Channel Coincidence Detector

CDI-735CD

Advanced Code Reading *Plus* Peripheral Equipment Control

The 735CD is a new generation time code product especially popular for post-production editing and time-of-day machine automation in a broadcast environment.

In addition to advanced code reading capabilities, it has the capability to control peripheral equipment on receipt of a time code number coincident with a pre-programmed value, thereby providing frame-accurate event control of up to 8 individual channels.

cipher digital, inc.

CDI-735CD

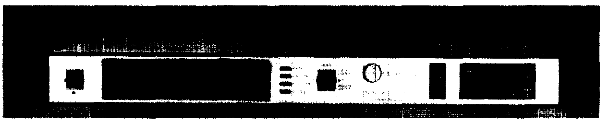
Time Code Reader with 8-Channel Coincidence Detector

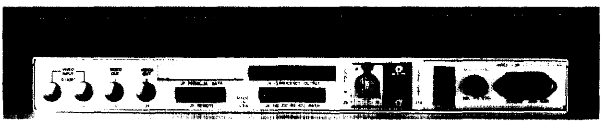
FEATURES

- Error Bypass eliminates faulty readings by replacing defective code with sequentially correct code
- Decodes all frame rate formats
- 8-digit LED display of time or user data
- Built-in coincidence detector with 8 controlled outputs
- 3 modes for programming coincident times—
  - — Front panel numeric keypad for event times input
  - — Stores capture value on-the-fly from incoming code
  - — Optional remote programming via RS-232/422 serial data port
- All setup parameters and event values stored in nonvolatile memory

OPTIONS

- Opto Isolator
- "Form C" Relay
- Parallel BCD Output





SPECIFICATIONS

CODE INPUT

Amplitude: 10mv to 10v p-p

Bandwidth: 1/30 to 80x play speed

Impedance: 10k ohm balanced, 3 pin XLR connector

RESTORED CODE OUTPUT

Format: Same as input, reshaped

Amplitude: +4dbm into 600 ohm 3 pin XLR connector

Risetime: Selectable 25usec./50usec.

COINCIDENCE DETECTOR

Coincidence times programmable via front panel controls or optional serial data (RS-422) input

OUTPUTS

Eight controlled outputs with 1 sec. TTL pulse (Form C relays optional)

POWER

115v or 230v, 50/60hz

DIMENSIONS

19"W, 14"D, 1¾"H
Back mounting ears

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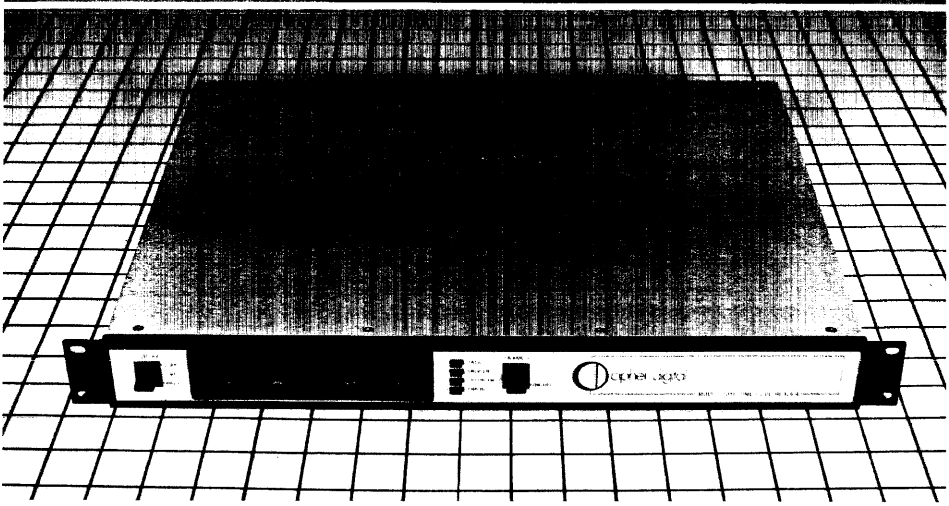
(301) 695-0200 TELEX: 272065CDINC

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE



Time Code Reader with Front Panel LED Display

CDI-735L

Affordable and Compact

Compact design makes the CDI-735L ideal for rapid, off-line "news bay" type editing. In addition, it features a frame-accurate front end for computer-related applications by utilizing optional parallel or serial RS-232/422 data ports and a highly legible LED readout for time and user data display. Future feature enhancements come easy thanks to this cost-effective system's high speed microprocessor control.

cipher digital, inc.

CDI-735L

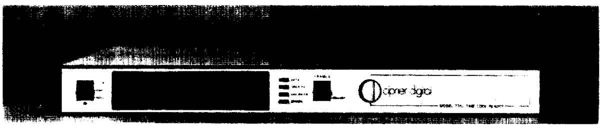
Time Code Reader with Front Panel LED Display

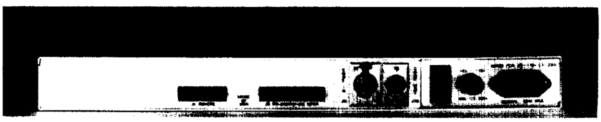
FEATURES

- Decodes 30-frame SMPTE and 25-frame EBU code formats
- Eight-digit front panel display selectable for time or user data
- Error bypass eliminates faulty readings by replacing defective code with sequentially correct code
- Frames-delete function for uncluttered viewing
- Hold feature for capture of edit points
- Wide range decoding and high sensitivity front end
- LED time or user data readout
- Single rack unit

OPTIONS

- Serial RS 232/422 data output
- Parallel BCD data output





SPECIFICATIONS

CODE INPUT

Amplitude: 10mv to 10v p-p

Bandwidth: 1/30 to 80x play speed

Impedance: 10 k ohm, balanced, 3 pin XLR connector

RESHAPED CODE OUTPUT

Format: Same as input, reshaped

Amplitude: +4dbm in 600 ohm, 3 pin XLR connector

Risetime: Selectable 25usec/50usec

CONTROLS

Time/User select
Display Freeze
Frames delete

INDICATORS

Drop Frame
Color Frame
Data Present
Error

POWER

115V or 230V

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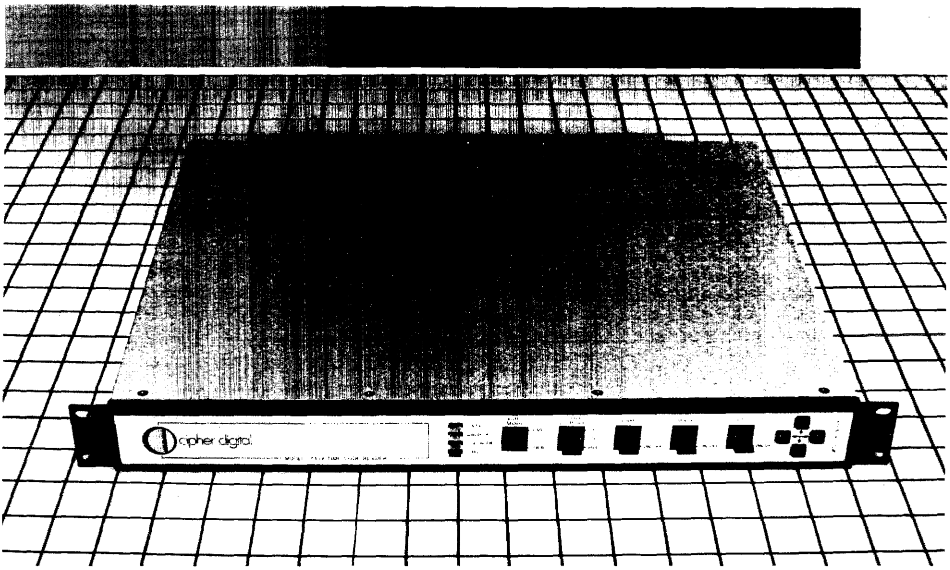


Time Code Reader with Video Character Inserter

CDI-735V

Designed for Affordable Video Production

The CDI-735V offers cost-effective time code reader capabilities without sacrificing the features most demanded by today's sophisticated video production studio.

Designed around a high speed microprocessor, it allows error-free, frame-accurate decoding of time and user data. Plus it has a multi-function integral video character inserter that supplies a monitor display of combined code information superimposed over program video.

The CDI-735V is ideal for generating "burned in" workprints.

cipher digital, inc.

CDI-735V

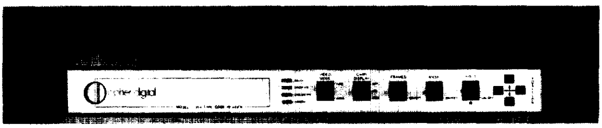
Time Code Reader with Video Character Inserter

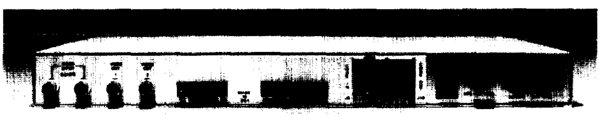
FEATURES

- Decodes 30-frame SMPTE, 25-frame EBU and 24-frame film formats
- Frame-accurate, wide-speed decoding from 1/30th to 80x play speed
- Multi-function video character inserter
  - Switchable to display time or user data
  - Full-raster positioning via "soft control"
  - Multi-size characters
  - Remote keyer control
- Unique error bypass eliminates faulty readings by replacing defective code with sequentially correct code
- Front panel frames and mask control
- Reshaped code output to feed edit computer
- Front panel and video display of drop frame and color frame modes
- All set-up parameters stored in nonvolatile memory
- High sensitivity front end

OPTIONS

- Parallel BCD or serial RS 232/RS-422 data outputs





SPECIFICATIONS

CODE INPUT

Amplitude: 10mv to 10v p-p

Bandwidth: 1/30 to 80x play speed

Impedance: 10k ohm balanced, 3 pin XLR connector

RESHAPED CODE OUTPUT

Format: Same as input, reshaped

Amplitude: +4dbm into 600 ohm, 3 pin XLR connector

Risetime: Selectable 25usec/50usec

VIDEO INPUT

Format: NTSC, PAL, SECAM composite video

Level: 0.5 to 2.0v p-p

Impedance: Non-terminated, bridging, BNC connector

VIDEO OUTPUTS

Format: Same as input with Time or User characters

Level: 1.0v p-p

Impedance: 75 ohm unbalanced, BNC connector

VIDEO CONTROLS

Char size
H&V position
Time or User
Display delete
Frames delete
Freeze display
Mask delete

POWER

115V or 230V, 50/60hz

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SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

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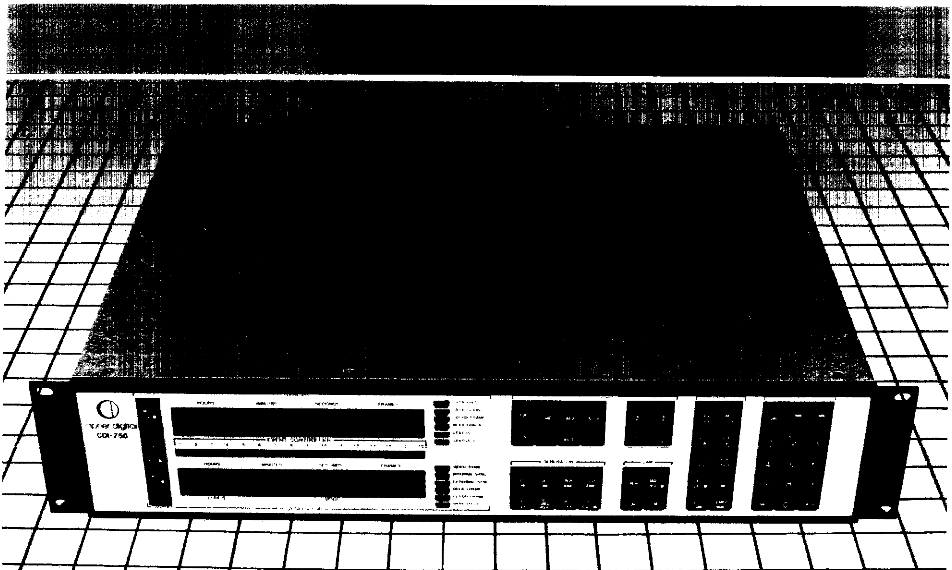

Time Code System CDI-750

Reader, Generator, Character Inserter and Event Controller All In One System

The CDI-750 is the only time code system you'll ever need. This intelligent microprocessor-based instrument has the versatility to fill a wide range of time code requirements in a variety of applications.

In addition to simultaneously generating and reading time code, the 750 offers a unique programmable jam sync mode, built-in time of day clock, RS-232 computer interface and 16-event controller. The reader and generator can be individually tailored to immediate needs, while the system's state-of-the-art software controls make it readily adaptable to future enhancement.

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CDI-750

Time Code System

FEATURES

- Extended sync source selection
- Reads longitudinal time code from 1/30th to 80 times play speed
- Built-in time-of-day clock
- Microprocessor based, software controlled
- Programmable Jam Sync mode operation
- Instant selection of 24, 25, 30, or Dropframe Time Code
- Two 8 Digit LED displays showing reader and generator time code, plus numerous status indicators on the front panel
- Clustered Key Switches for "operator friendly" selection of numerous functions
- Memory Retention of set up on power loss
- Fully positionable video inserter

Longitudinal Time Code Reader

- Decodes and displays entire time code, including time data, user date, status bits and drop-frame indicators
- Large LED displays
- Reads from 1/30 to 80 times play speed
- Reads poorly written or deteriorated time code, then reshapes and retimes it with properly shaped edges, redefined rise times and amplitude—*without* altering frame rate

Longitudinal Time Code Generator

- Meets both SMPTE and EBU longitudinal time code specifications, including time date, user data, status bits and drop frame or color frame indicators
- Generator status easily monitored from front panel
- Accepts color field I.D. pulse required for color video editing
- Recognizes four-field NTSC and eight-field PAL encoding standards
- Time base selectable between external video sync or internal crystal reference
- Instantaneous choice of 30-frame, drop-frame, 24- and 25-frame formats
- Generates a two-times frame rate sine wave output for resolver applications
- Generates "burst" and "continuous" time code formats

Character Inserter

- Full-featured video keyer with two separate outputs and four character sizes
- Size, position and window style quickly defined and controlled via easy-to-use front panel operations

Event Controller

- 16 programmable, time-code operable general purpose interfaces control studio or special effects equipment with frame-accurate timing
- Configured with opto-isolators or optional Form C relays for adaptability to any voltage and equipment requirements
- Four easily programmed output modes: switch to on, switch to off, toggle output on pulse output

Intelligent System

- One of the new generation of microprocessor-driven broadcast quality equipment
- Intelligent firmware programmed for ease of use
- Communicates with or controlled by a computer via its RS-232/422 computer interface
- Fully compatible with the SOFTOUCH™ Audio Editing System

Jam Sync Mode

- Will use incoming time code as a generator start point in momentary jam
- Will regenerate incoming code on a frame by frame basis in continuous jam. Will stop or selectively continue incrementing with incoming code loss
- User selection of jam mode/source
- Frame accurate immediate or programmed jam points

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SPECIFICATIONS

CODE INPUT
Amplitude: 10mv to 10v p-p

Bandwidth: 80 bps to 192k bps

Impedance: 10k ohm balanced on 3 pin XLR connector

RESTORED CODE OUTPUT
Format: Same as input, reshaped, retimed

Amplitude: +4dbm into 600 ohm 3 pin XLR connector

Risetime: Selectable 25usec./50usec. (internal selection)

Applitude: Preset 1V p-p, ADJ .5 to 2V p-p

VIDEO INPUT
Format: NTSC, PAL, SECAM composite video

Level: 0.5v to 2.0v p-p

Impedance: Non-terminated, bridging, BNC connector

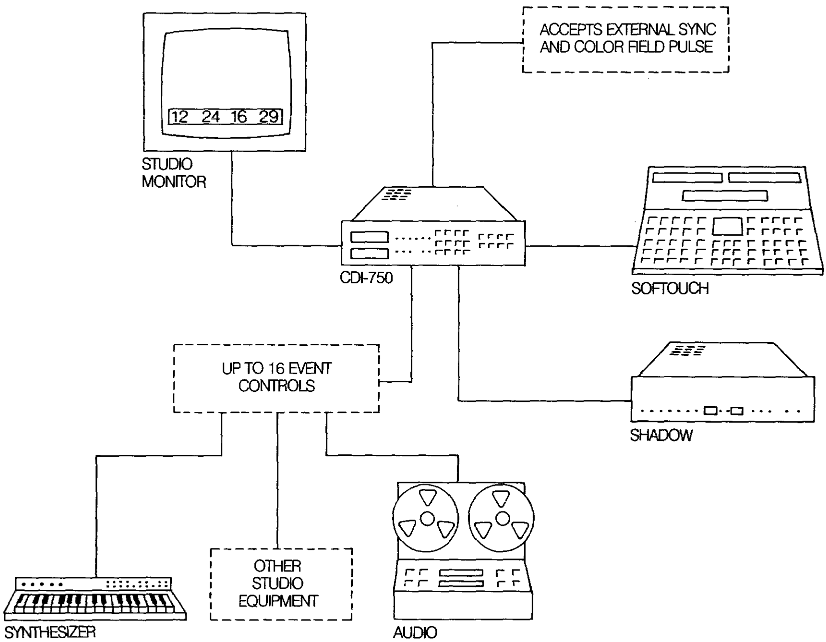
CODE OUTPUT
XLR connector
SMPTE/EBU standards
Factory set 10PK to PK
Adjustable .5 to 2V

RATE OUTPUT
2x XLR connector
Frame rate (format c)
SMPTE/EBU standards
Factory set 1V p-p
adjustable .5 to 2V p-p

VIDEO OUTPUTS (2)
Format: Same as input with Time/User characters from reader, generator or both

Level: 1.0v p-p (adjustable)

Impedance: 75 ohm unbalanced, BNC connectors
Keyer black & white
Level internally adjustable



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VIDEO CONTROLS
Size 1, 2, 3 & 4
H&V position
Time, User, or Time & User
Display delete
Frames delete
Freeze display
Mask delete
Inverse keyer video

PANEL DISPLAY CONTROLS
Dual 8-char 7-segment displays
Full status LED indicators
All key type switches

TACH INPUT
TTL Tach
TTL Direction
Non-standard Tach-BNC
Rate user scalable from 1V to 256X per frame

GEN SYNC INPUT
BNC loop, no terminating, video, black burst, composite sync

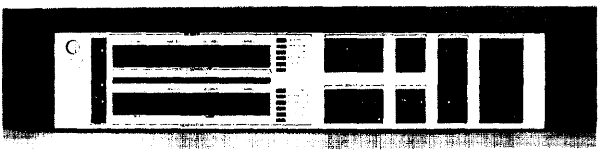
FIELD REF
Field ref pulse line 3 to line 20, line 1
BNC

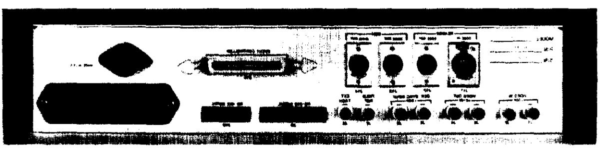
EVENT CONTROLLER
16 Opto coupled outputs (form "c" relay optional)
50 pin telco style connector

GENERATOR SYNC SOURCES
Reader video input
Generator sync input
TTL external Tach / direction
Non-standard level external Tach
"A" / "B" quadrature encoder (TTL)
Time code sync word
Internal XTAL

DIMENSIONS
19"W, 14"D, 3½"H, rack mounting ears

POWER
100 / 120 / 220 / 240 V
Field selectable





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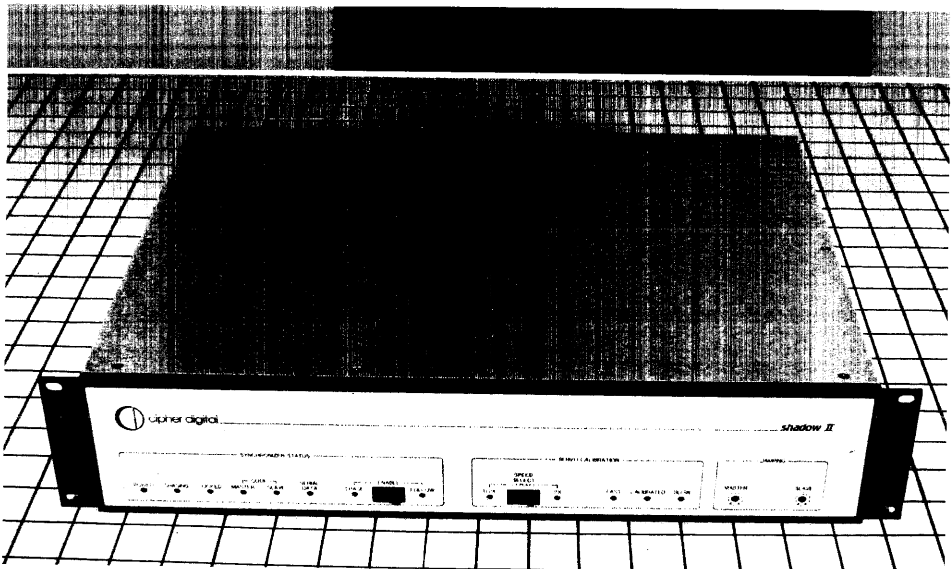

Synchronizer Controller SHADOW II™

Computer Compatible for Maximum Flexibility

The all new Shadow II is the latest synchronizer/controller from Cipher Digital. Based on the same adaptive loop techniques used in the first Shadow, it offers the same full functionality, advanced capabilities and long-term dependability thousands of post-production professionals have come to expect from Shadow product line—*plus more*.

The Shadow II performs with even greater reliability and versatility than its predecessor. Redesigned features include selectable RS-232/422 computer compatibility, an improved time code reader, new mute command path, additional memory locations and variable park tolerances. Universal transport adaptability makes the Shadow II capable of controlling virtually any audio, video or film transport on the market.

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SHADOW II™

Synchronizer Controller

UNIVERSAL TRANSPORT COMPATIBILITY

The Shadow II synchronizer is a fully intelligent multi-functional instrument providing complete synchronization and control of multiple audio, video and film transports in any combination.

Its powerful internal microprocessor enables the Shadow II to dynamically learn the control characteristics of any Using SMPTE / EBU standard time code as the reference, optionally augmented by an external sync signal, the Shadow II continually adjusts a transport's capstan speed to keep it accurately synchronized to another transport within 1 / 100th of a frame (1 / 3000th of a second). When multiple Shadow IIs are connected in a series, numerous transports can be interlocked to a Master transport.

- Typically interlocks in a two to four seconds in Play
- Exclusive chase mode maintains strict interlock even when the master machine is in fastforward or rewind
- Wide Band reader assures time code readability from 1 / 50 to 80-times normal Play speed.
- At higher wind speeds, the Shadow II utilizes available tach pulses to maintain synchronization until head contact is made again.
- Interchangeably locks to code, video sync and 50 / 60Hz tone.
- A unique software "filter" can eliminate wow and flutter transfer for the smoothest, most stable lock possible in any application.

Use a Softouch or Shadowpad controller with Shadow II, for additional power of transport control. Along with standard transport motion and autolocation commands, this power includes offsets up to 24-hours, selection of the speed and type of transport interlock, subframe-accurate record and mute commands, time code and offset memory.

Applications

The Shadow II synchronizer is currently satisfying professionals in synchronization and control of:

- Multiple ATRs for audio post-production;
- Multiple ATRs and VTRs for audio for video post-production;
- Sprocketed film transports for audio for film post-production;
- Film projectors and ATRs for corporate and institutional presentations requiring high fidelity sound.
- Multi-track ATRs with a video editor.

Computer Power

The Shadow II is specifically designed for direct computer interface. Its incorporation of RS-232C / RS-422 interface control makes it compatible with video / audio editing systems, mixdown consoles and virtually any computer device, including personal computers.

Under computer control, the Shadow II Provides the ultimate in production flexibility, allowing control over an unlimited number of transports for execution of complex edits.

SPECIFICATIONS

SYNCHRONIZATION TOLERANCES

Accuracy: ± 50 microseconds

Resolution: ± 0.5 microseconds

Transport Speed: 1 / 50-80x Play speed

Normal Lock Rate: ½ Play speed or 2x Play speed

Slow Lock Rate: 18 subframes / sec. to 15 frames / sec., selectable

Typical Lock-Up Time from Stop: 2-5 sec.

INPUTS

MASTER AND SLAVE

Time Code: 24 / 25 / 30 frames / sec. and Drop Frame

Auxiliary: 50 / 60 Hz

Command Indication (tallies): Active low / variable threshold

Direction Sense: Floating logic input

Tach Frequency Range:
Play: Greater than 4Hz
Maximum wind speed: Less than 2.5 kHz

OUTPUTS

MASTER AND SLAVE

Commands: Opto-isolated open collector

SLAVE ONLY

Capstan Speed Override:
Voltage Output (1x): 12V max. swing within ± 12V range

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SHADOW II

OUTPUTS

SLAVE ONLY

Voltage Output (2x): 30V, 15V max. swing within ± 30V range (user supply required)

Frequency Output: 45 hz-40 kHz floating TTL compatible

SPECIAL INPUTS

Video Reference Input: Nominal impedance- 1 megohm or 75 ohm, switch selectable

Video Reference Types: composite sync, vertical drive, black burst, color bars, composite video

INTERFACES

RS-232C; CDI SOFTOUCH editor/controller, SHADOWPAD controller

MECHANICAL

Dimensions: 3½"H x 17"W x 17"D, rack-mountable

Weight: 16 lbs. (Ship weight: 24 lbs.)

ELECTRICAL

Voltage: 115/230, switch selectable

Frequency: 50/60 Hz

Power: 40 Watts (typical)

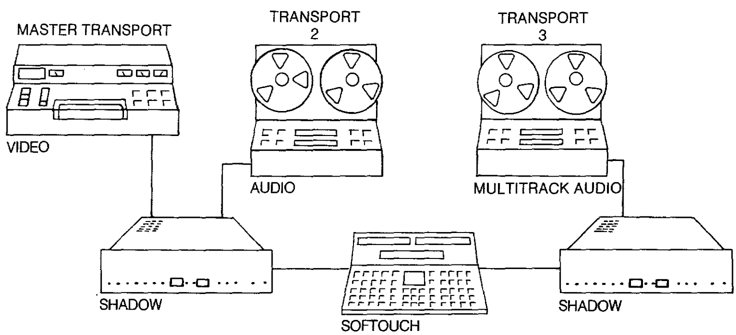
STANDARD ACCESSORIES

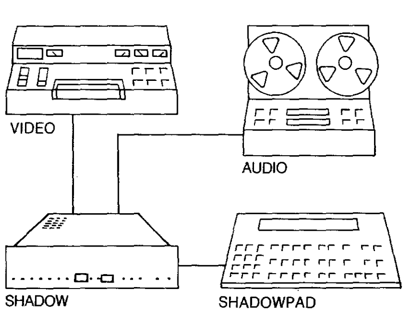
Power cord
Instruction Manual

SHADOWPAD

Dimensions: 2½"H x 16"W x 8" D

Weight: 4 lbs.





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SOFTOUCH™

The SOFTOUCH system represents a technological breakthrough in audio editing. It provides a highly cost-effective, "building-block" approach to a wide range of editing applications, including preparation of program material for simulcast and stereo television, videodiscs, and post-production editing of pure audio, audio for video, and audio for film.

SOFTOUCH is a single-system solution to time-code applications plus the synchronization and control of multiple ATRs, VTRs and film transports. More importantly, SOFTOUCH automates the post-production activities of sound effects assembly, sweetening, dialogue replacement and Foley.

SOFTOUCH is the original and still unsurpassed audio editor. Unlike some editors, it interfaces with a wide variety of studio equipment, regardless of manufacturer. Plus it costs less than many multi-track audio transports. That's why hundreds of the world's most prestigious studios and corporations have chosen SOFTOUCH.

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SOFTOUCH™

The Audio Editing System

MODULAR, FRIENDLY, FUNCTIONAL

The complete SOFTOUCH system consists of three intelligent, distributed modules: the SOFTOUCH editor/controller, SHADOW II synchronizer(s), and the CDI-750 time code system. These modules are networked together via RS-232C, the standard communications protocol. Transports and other studio equipment, such as consoles and special effects cart machines, are connected via straightforward interfaces.

This single system directly controls and synchronizes any combination of up to four multi-track audio, video, or sprocketed film transports while supporting additional transports in a "chase-lock" synchronization model.

The SOFTOUCH system is designed to provide unique functionality and "friendly" user/machine interaction.

- All transport control and editing functions are accomplished from the compact SOFTOUCH keyboard.
- The status of any edit or control operation is determined at a glance.
- Master and Slave time code to eight digits appear on two large LED displays. Additional LEDs indicate transport status, system modes and record status information simultaneously for four transports.
- A Command Display prompts the user with messages throughout the editing process.

The SOFTOUCH keyboard provides for full multi-transport control and monitoring during the editing process. At the same time, it permits independent control or independent autolocation of any transport at any time without regard to other tasks the system might be performing. This means you can set up for the next take while the first is being automatically edited. The keyboard also allows separate "record assigns" for each transport in the system with either "hot" or preprogrammed control over the record window during loops.

POWERFUL SOFTKEYS™ AND LOOP MEMORY

The SOFTOUCH system's exceptional power comes from its ability to streamline the audio editing process. Its range of memory functions speeds up editing sessions and helps eliminate costly errors.

Sixteen SOFTKEYS™ permit repetitive or intricate pre- and post- production editing routines to be executed at the touch of a single key. Any command or routine that can be executed manually on the SOFTOUCH keyboard can be done automatically with SOFTKEYS. Set up each SOFTKEY to perform a single task, string together multiple tasks or multiple SOFTKEYS, even perform calculations and carry messages and prompts for the operator. Plus, the SOFTKEY sequences can be modified, erased or replaced at any time.

Loop Memory provides the flexibility to define, modify and save all pre- and post-roll data, beep-tone setting, trim, mark in/out and record in/out data for up to 100 loops at one time. Choose to cycle through any individual loop, or execute complex assembles with a minimum of keystrokes. Additional "scratch-pad" memory (to store edit points) is yet another feature of SOFTOUCH's intelligence.

A virtually maintenance-free internal battery preserves the programmed keys when the unit is shut off.

NUMEROUS SPECIAL FEATURES

SOFTOUCH incorporates numerous special features and capabilities that make it the sole solution to a wide range of editing applications.

- It simplifies and controls time-code applications. **Facilities** generating or reading both SMPTE and EBU standard longitudinal or VITC code in choice of 24, 25, or 30 drop-frame format.
- Regenerating code or jam syncing code eliminates drop-outs or "patch work" code easily and quickly.
- Allows optional triggering of events with frame-accuracy, so special effects cart machines and other studio equipment can be easily brought into the editing process.
- Supplies a time-adjustable beep tone for cueing talent.
- Permits "hot" or preprogrammed record "punch in" for frame-accurate "on the word" edits and overdubs.
- The preview function is a valuable tool, enabling review of edit decisions without recording.

CONFIGURATION FLEXIBILITY

The SOFTOUCH System allows you to select only those modules which are needed today, but as requirements demand you can leverage the original purchase and expand to a fully configured audio editing suite. Start with a CDI-750 time-code generator or two-transport SHADOW synchronizer and expand to SOFTOUCH at a later date.

For ultimate economy, SOFTOUCH can also be purchased as a complete system. The fully-configurated SOFTOUCH system, including the SOFTOUCH Editor/Controller, SHADOW II synchronizer(s), CDI-750 time code system, the RS-232C/422 interface, multiple transport interfaces and all necessary cabling, can be purchased at a packaged-system price less than that of many multi-track transports.

DESIGNED FOR THE FUTURE

The SOFTOUCH System features the latest microprocessor technology incorporated into a design that is consistent with the future of audio editing.

As newer, more powerful microprocessors and memory modules become available, SOFTOUCH will support them. Standard personal computer operating systems techniques are also employed to allow for intergration of a wide variety of future studio-related products. The SOFTOUCH System's architecture ensures that system functionality can expand at a pace consistent with the latest technical advances in sound recording, engineering, producing and editing.

SPECIFICATIONS

SOFTOUCH

INTERFACES

Five Communication Ports

ELECTRICAL

Voltage: 115VAC/230 VAC, switch selectable

Frequency: 50/60 Hz

Power: 40 watts (typical)

MECHANICAL

DIMENSIONS

Power Supply Unit: 3½"H x 17"W x 13"D, Rack-mountable

Keyboard Unit: 4⅜"H x 16¼"W x 10¾"D maximum

WEIGHT

Power Supply Unit: 13½ lbs.

Keyboard Unit: 6½ lbs.

Total Ship Weight: 30 lbs.

STANDARD ACCESSORIES

Keyboard Cable
Power Cord
Instruction Manual

SHADOW II

SYNCHRONIZATION TOLERANCES

Accuracy: ± 50 microseconds

Resolution: ± 0.5 microseconds

Code Reading Speed: 1/50-80x Play Speed

Normal Lock Rate: ½ Play Speed or 2x Play Speed

Slow Lock Rate: 18 subframes/sec. to 15 frames/sec. selectable

Typical Lock-Up Time from Stop: 2-5 sec.

INPUTS

MASTER AND SLAVE

Time Code: 24/25/30 frames/sec. and Drop Frame

Auxiliary: 50/60 Hz

Command Indication (tallies): Active low/variable threshold

Direction Sense: Floating logic input

Tach Frequency Range: Play: Greater than 4 Hz

Maximum wind speed: Less than 2.5 kHz

OUTPUTS

MASTER AND SLAVE

Commands: Opto-isolated open collector

SLAVE ONLY

Capstand Speed Override:

Voltage Output (1x): 12V max. swing within ± 12V range

Voltage Output (2x): 30V, 15V max. swing within ± 30V range (user supply req.)

Frequency Output: 45 hz-40 kHz floating TTL compatible

SPECIAL INPUTS

Video Reference Input: Nominal impedance-1 megohm or 75 ohm, switch selectable

Video Reference Types: composite sync, vertical drive, black burst, color bars, composite video

INTERFACES

RS-232C; SOFTOUCH editor/controller, SHADOWPAD controller

MECHANICAL

DIMENSIONS

3½"H x 17"W x 17"D, rack-mountable

Weight: 16 lbs. (Ship weight: 24 lbs.)

ELECTRICAL

Voltage: 115/230, switch selectable

Frequency: 50/60 Hz

Power: 40 watts (typical)

STANDARD ACCESSORIES

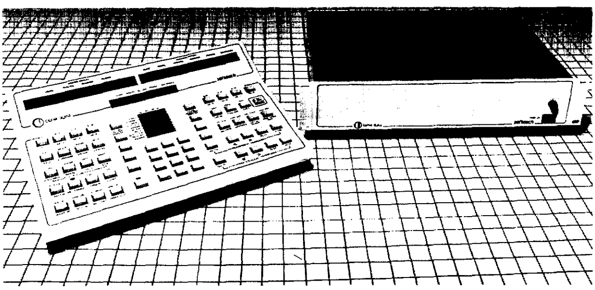
Power Cord
Instruction Manual

CDI-750 LTC Generator

OUTPUT

Types: SMPTE/EBU standard 24, 25, 30 and drop frame rates

Output Level: Adjustable up to + 8 dBm, single-ended (transformer output optional)



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INPUT

External Input Types: Composite video sync (switch selectable termination, EIA tentative standard RS170A Nov. 1977), color field identification pulse, external frame lock, external bit clock, generator direction.

INTERFACES

RS-232/422 Serial I/O

MISCELLANEOUS OUTPUTS

60/59.94 Hz frame rate

LTC Reader

INPUT

Input Level: -25 to +15 dBm, hysteresis adjustable from -25 to -11 dBm, input impedance 50 kHz electronically balanced.

Speed Range: 1/50 to 80x Play speed, forward and reverse

OUTPUT

Regenerated Output: Adjustable level up to + 8 dBm wideband or transformer output optional

Miscellaneous Reader Outputs: Reader direction, Reader clock, Reader ones, data loss, Reader frame pulse

Character Inserter

INPUT

75 ohm terminated video input

OUTPUT

75 ohm/video output, NTSC/PAL compatible (SECAM optional)

CHARACTER FORMAT

9 x 7 dot matrix alphanumeric characters; size, position, and window are user-variable

Event Controller

OUTPUT

Optically-isolated open collector outputs, active low (Relay optional)

MECHANICAL

Dimensions: 3½"H x 17"W x 18½D rack-mountable

Weight: 13 lbs. maximum (Ship Weight: 17 lbs.)

ELECTRICAL

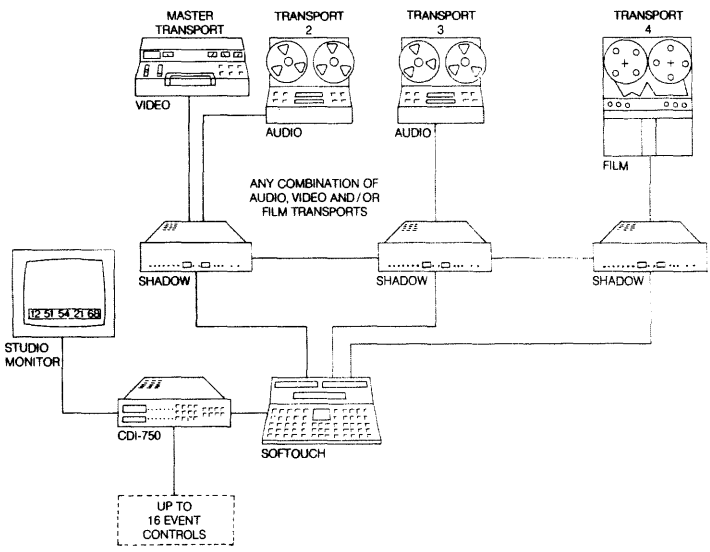
Voltage: 115/230 switch selectable

Frequency: 50/60 Hz

Power: 40 watts (typical)

STANDARD ACCESSORIES

Power Cord
Instruction Manual



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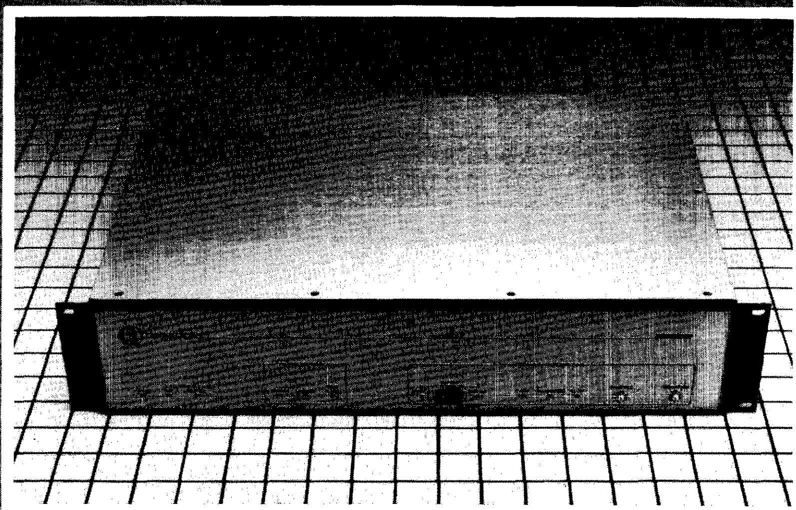

Phantom Emulator CDI-4810

Interfaces Video Editing Systems [illegible]

The PHANTOM Emulator [illegible] editing system via the RS-422 [illegible] information to the audio [illegible] control U-Matic-type VCRs to video [illegible] 1" VTRs.

Designed around a high speed [illegible] also provides control of up to [illegible] 4835 Shadow [illegible] to provide [illegible] as well as external control of the [illegible]

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CDI-4810

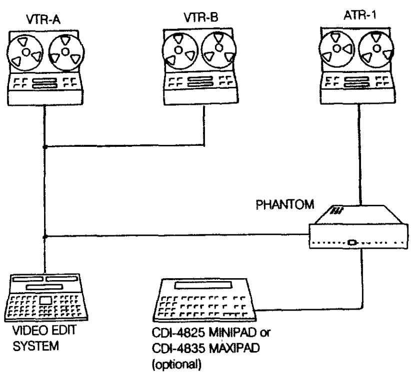
Phantom Emulator

FEATURES

- RS-422 In
- Parallel Out
- Compatable with AMPEX, SONY and other protocols (Selectable from an externally accessable dip switch)
- Event Controller (x4 Events)
- Interface with SHADOWPAD MiNi & SHADOWPAD MAXI

SPECIFICATIONS

Mechanical:
Dimensions—3½"H x 17"W x 13D, Rack Mountable
Weight—16 lbs. (ship weight: 22 lbs.)
Electrical:
Voltage—115/230, switch selectable
Frequency—50/60 Hz
Power—40 watts (typical)
Standard Accessories:
Power Cord
Instruction Manual



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Specifications: Subject to change without notice.

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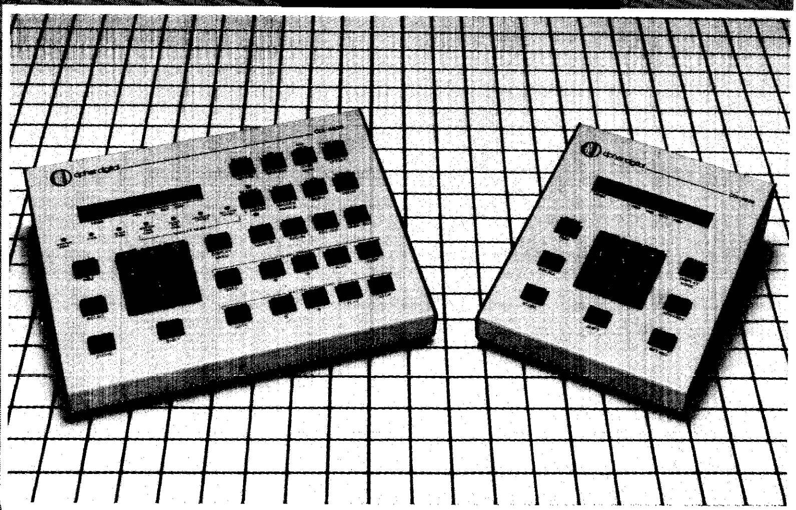

Shadowpad-Maxi CDI-4835

Team it with the Shadow II Transport Synchronizer

The 4835 MAXIPAD offers a new look and a new electronics package that improves communications between operator and Shadow II Transport.

The 4835 SHADOWPAD-MAXI gives the operator complete control of the Shadow II's information display. Plus the full function keypad displays status and operation of the Shadow II and transports connected to it.

Independent transport control, speed, type of interlock and modification of slave offset parameters are just a few of it's extended features.

Shadowpad-Mini CDI-4825

Enter offset Register Information to the Shadow II Transport Synchronizer.

The SHADOWPAD-MINI allows you to enter offset register information and recall and modify system register information. Plus it enhances the power of the Shadow II Transport and can be used with both the 4700 and 4800 Shadows.

Primarily developed to control offset between transports, the MINIPADS keyboard display provides status information of the Shadow II and transports connected to it. The Minipad keyboard allows such features as trim, recall, retard, store, advance, message, and display modes.

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CDI-4835

Shadowpad-Maxi

FEATURES

- RS-232 Communications
- Independent Transport Control
- Highly Legend Display
- Control of System Registers
- Full Function Keypad
- Offset Control
- ....and more

SPECIFICATIONS

Mechanical: 11"W, 8½"D, 2¾"H
Weight: 2 lbs. (shipping weight 3 lbs.)
Electrical: +8VDC from the SHADOW II
Standard Accessories:
20' Interconnect cable
Instruction Manual

CDI-4825

Shadowpad-Mini

FEATURES

- RS-232 Communications
- Highly Legend Display
- Control of System Registers
- Offset Control
- ....and more

SPECIFICATIONS

Mechanical:
Dimensions—6½"W, 8½"D, 2¾"H
Weight—2 lbs. (shipping weight: 3 lbs.)
Electrical: +8VDC from SHADOW II
Standard Accessories:
20' Interconnect Cable
Instruction Manual

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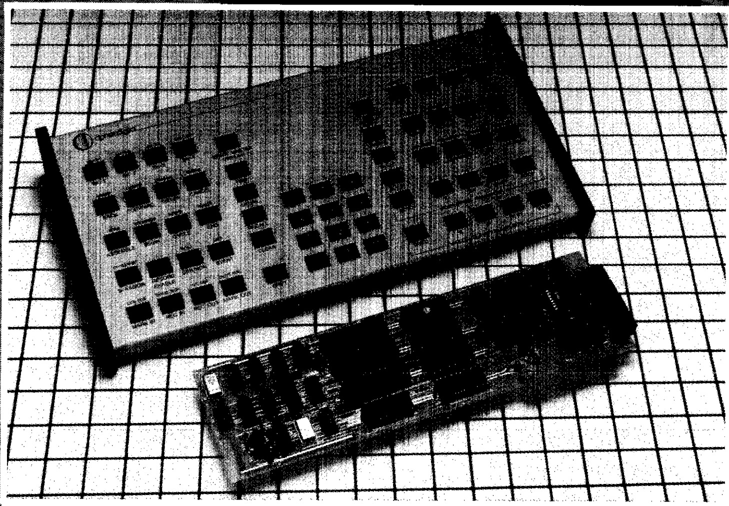
Specifications: Subject to change without notice.



The Audio Editing Controller

SOFTOUCH-PC

Enhance the power of your PC-Type computer.

Representing the latest in Audio Editing technology the SOFTOUCH-PC gives you control of two keyboards. Use one for edit decision lists, annotating etc., and the other for actual use during an edit session.

As soon as you "boot up" your computer you'll see the SOFTOUCH-PC's enhancements. The screen shows status of the complete system, machine status, time code, as well as, loop and SOFTKEYS display.

SOFTOUCH-PC's edit keyboard has the look and feel of the original SOFTOUCH. An important bonus: No hunting for special color or marked keys.

SOFTOUCH-PC

The Audio Editing Controller

POWERFUL SOFTKEYS™ AND LOOP MEMORY

The SOFTOUCH-PC's exceptional power comes from its ability to streamline the audio editing process. Its range of memory functions speeds up editing sessions and helps eliminate costly errors.

Sixteen SOFTKEYS™ permit repetitive or intricate pre- and post-production editing routines to be executed at the touch of a single key. Any command or routine that can be executed manually on the SOFTOUCH keyboard can be done automatically with SOFTKEYS. Set up each SOFTKEY to perform a single task, string together multiple tasks or multiple SOFTKEYS, even perform calculations and carry messages and prompts for the operator. Plus, the SOFTKEY sequences can be modified, erased or replaced at any time.

Loop Memory provides the flexibility to define, modify and save all pre- and post-roll data, beep-tone setting, trim, mark in/out and record in/out data for up to 100 loops at one time. Choose to cycle through any individual loop, or execute complex assembles with a minimum of keystrokes. Additional "scratch-pad" memory (to store edit points) is yet another feature of SOFTOUCH's intelligence.

A virtually maintenance-free internal battery preserves the programmed keys when the unit is shut off.

NUMEROUS SPECIAL FEATURES

SOFTOUCH incorporates numerous special features and capabilities that make it the sole solution to a wide range of editing applications.

- It simplifies and controls time-code applications. **Facilities** generating or reading both SMPTE and EBU standard longitudinal or VITC code in choice of 24, 25, or 30 drop-frame format.
- Regenerating code or jam syncing code eliminates drop-outs or "patch work" code easily and quickly.
- Allows optional triggering of events with frame-accuracy, so special effects cart machines and other studio equipment can be easily brought into the editing process.
- Supplies a time-adjustable beep tone for cueing talent.
- Permits "hot" or preprogrammed record "punch in" for frame-accurate "on the word" edits and overdubs.
- The preview function is a valuable tool, enabling review of edit decisions without recording.

DESIGNED FOR THE FUTURE

The SOFTOUCH-PC features the latest microprocessor technology incorporated into a design that is consistent with the future of audio editing.

As newer, more powerful microprocessors and memory modules become available, SOFTOUCH will support them. Standard personal computer operating systems techniques are also employed to allow for intergration of a wide variety of future studio-related products. The SOFTOUCH-PC's architecture ensures that system functionality can expand at a pace consistent with the latest technical advances in sound recording, engineering, producing and editing.

SPECIFICATIONS

Interfaces:
Four Communications Ports
3 SHADOW II (4700 or 4800)
1 CDI-750 or CYPHER

Electrical:
All Electrical Supplied from Host P.C.

Mechanical:
Dimensions—
Keyboard 16.5 x 8.25 x 2.5
P.C. Board 4" x 13"

Weight:
Keyboard 3 lbs.
P.C. Board 13 oz.

Standard Accessories:
Keyboard Cable
Instruction Manual
Software

cipher digital, inc.
5734 Industry Lane • Frederick, MD 21701
(301) 695-0200 TELEX: 272065CDINC

Specifications: Subject to change without notice.