MODEL ECM 4000

EDIT CODE MASTER

INSTRUCTION MANUAL

Revision 2

MANUAL CHANGE INFORMATION

DYNAQUIP

PRODUCT ECM 4000

CHANGE REFERENCE 4000-1

DATE September 23, 1983

CHANGE:	DESCRIPTION

Parts List Changes:

Dwg. # 4000-86D, 4000-36D

R63	3.3K ¼W5% changed to 3.32K ¼W1%
R37	1.8K ¼W5% changed to 4.7K ¼W5%
R33	27K ¼W5% changed to 82K ¼W5%

Dwg. # 4000-85B

R11	22K changed to 180K
C12	100pf changed to 1000pf

Dwg. # 4000-84D

R42,43	560 ohm ¼W5% changed to 681 ohm ¼W1%
R45	2.2K ¼W5% changed to 2K ¼W1%
R47	1K ¼W5% changed to 10K ¼W5%

Dwg. # 4000-84D, E

R7, R8	2.2M ohm ¼W5% changed to 560K ¼W5%

Manual Changes:

Appendix II: Serial I/O Connector Pin Assignments

Pin 2 & 3 should read 1200 BAUD

EVERTZ MICROSYSTEMS

MANUAL CHANGE INFORMATION

PRODUCT ECM 4000

CHANGE REFERENCE 4000-4

DATE November 20, 1984

CHANGE:	DESCRIPTION

The following sections of the manual are changed to read as below for units equipped with software version 2.0

2.5 REMOTE CONTROL AND SERIAL I/O

Four rear panel inputs on the remote control port can be delegated to any of 10 control functions (See Section 3.1.4). Remote control may also be accomplished by using one of the two serial ports. A remote control panel (Model RCU 400), connects to the remote control port and permits access to all the preset and control functions and provides a display of the reader or generator time or user bits. Alternately, an RS-232-C keyboard or computer connected to the serial I/O port may control and receive data from the ECM 4000. When the alpha-numeric user bit option is fitted, the RS-232-C serial I/O port is also used for entry of alpha-numeric data into the user bits.

2.5.1 RS-232-C Serial Port

The ECM 4000 provides an RS-232-C interface for remote control, and alpha-numeric user bit input and output. The ECM 4000 is configured to make the serial port appear as a Data Communication Equipment (DCE) device. In this configuration, the ECM 4000 expects an external Data Terminal Equipment (DTE) device to be connected to its serial port. See Sections 3.6 and 3.7 for a description of the alpha-numeric user bit and remote control functions. Section 2.7 outlines the pin assignments for the serial port. The following explanations of the serial port signals are given to aid the user in connecting the port properly.

The external computer (DTE) must be set to communicate at 1200 baud, with 7 bits, zero parity, and one stop bit.

A "communications protocol" is a convention whereby the ECM 4000 tells the DTE device, (computer or terminal) to stop transmitting characters while those already received by the ECM 4000 are being processed, and when to resume transmitting. A communications protocol is necessary when a computer sends data at a rate of more than approximately 30 characters per second. If no communications protocol is used by your computer, the ECM 4000 input buffer will overflow and data will be lost. XON/XOFF protocol, supported by the ECM 4000 is described more fully below.

2.5.2 XON/XOFF Protocol

Under this protocol, the ECM 4000 transmits an "XOFF" character (DC3 decimal ASCII 19) to the computer when the computer should stop transmitting characters, then transmits an "XON" character (DC1 decimal

ASCII 17) when transmission may resume. The serial port should be connected as shown below.

```
  Computer End                    ECM 4000 end

      2 (TXD) ------------------> 2 (RXD)   Data input to ECM 4000
      3 (RXD) <------------------ 3 (TXD)   Data Output from ECM 4000
      4 (RTS) ------------------> 4 (RTS)
      5 (CTS) <------------------ 5 (CTS)
      6 (DSR) ---|
     20 (DTR) ---|
      7 (GND) ------------------- 7 (GND)   Signal Ground
```

Note: 1. On some computers, pins 6 and 20 may have to be strapped together in the connector at the computer end of the cable, without running them to the other end.

2. The RXD and TXD connections may be reversed on some computers.

3. The connection of pins 4 and 5 is optional.

3.1.4 Remote Control Parameter

REM This key permits 4 rear panel inputs (located on the remote control connector) from momentary contact push buttons to be delegated to any of the following control functions of the ECM 4000 (ie. Generator VITC, VCG, USR.B; MOM & CONT Jam; Reader USR.B, VCG & FRZ; PAGE; PRESET SET). The first time REM is pressed, the display prompts to configure remote input 1 ("r1") with an identifier indicating which of the control functions remote input 1 is assigned to at this time. If a change is desired, press the new control function that you wish to assign remote input 1 to, and the new key identifier will appear in the prompt display. Press FORMAT SET to enter the new control function. The display then prompts to configure remote input number 2, and so on until all 4 have been configured. Pressing CLEAR exits from the remote input configuration routines.

3.2.2 Presetting the Generator Time or User Bits

Pressing the **SET** key in the PRESET key group initiates a data entry mode that allows presetting of either the time or user bits of the generator, whichever is currently displayed.

When setting the generator time, pressing PRESET SET the first time, displays the last time entered into the generator as a default. The displayed time may

be changed using the numeric keys to enter new values into the display starting at the left. After the required number of digits have been entered, press PRESET SET to complete the time entry mode. Unentered digits default to zero. Pressing CLEAR exits from the entry mode without presetting the time. Attempts to make illegal entries, ie 65 minutes will be ignored and the invalid digits will be blanked. Re-enter these digits and press PRESET SET to complete the data entry. After the entry mode has been terminated by either PRESET SET or CLEAR, the generator display will return to display the generator time.

When setting the generator user bits, pressing PRESET SET the first time, displays the current user bits as a default. The displayed user bits may be changed using the numeric keys to enter new values into the display starting at the left. After the required number of digits have been entered, press PRESET SET to complete the time entry mode. Unentered digits default to the previous values. Pressing CLEAR exits from the entry mode without presetting the user bits. After the entry mode has been terminated by either PRESET SET or CLEAR, the generator display will return to display the generator time.

3.6 RS-232-C REMOTE CONTROL INTERFACE

The remote control features of the ECM 4000 provide the user with the capability to fully control the Edit Code Master with a computer communicating directly to the internal microcontroller. In order to invoke a remote function from software, it is necessary to precede the specific function code with a lead-in code. The lead-in code, ASCII ESC (decimal 27) alerts the ECM 4000 that a special function follows. The lead-in code and the command following it will be interpreted with special meaning, invoking one of the remote control functions. If the code following the lead-in is not one of the valid remote control commands, that code will be ignored.

NOTE:

1. The command code must immediately follow the lead-in code without any intervening characters. (including NULL characters).

2. Some commands require a group of one or more data characters following the command code.

3. All command sequences must be terminated by a carriage return (decimal 13) character. The command will only be acted upon when the carriage return is received.

Once the command sequence has been received, and executed, an acknowledge ASCII ACK character (decimal 6) will be issued by the ECM 4000, signalling the computer that the command was received, and executed. If the command cannot be executed for some reason, ie. invalid command code, invalid data field, etc., the ECM 4000 will issue a negative acknowledge ASCII NAK character (decimal 15).

Appendix IV summarizes the remote commands described below; the ASCII code chart is shown in Appendix III.

3.6.1 Set Generator Time Source

On receipt of the SET TIME SRC command (ASCII space decimal 32) the ECM 4000 selects the source for the generator clock as defined by the SRC data character. The SRC data can take only the following values:

1 = Free run the Generator clock
2 = Continuous Jam to Reader time
3 = Momentary Jam to Reader time

3.6.2 Set User Bit Source

On receipt of the SET UB SRC command (ASCII ! decimal 33) the ECM 4000 selects the source for the generator user bits as defined by the SRC data character. The SRC data can take only the following values:

0 = Numeric entry from keyboard or using SET GEN UB command
1 = Transfer User Bits
2 = Transfer Reader Time
3 = Transfer Source ID

3.6.3 Set Generator Mode

On receipt of the SET GEN STAT command (ASCII " decimal 34) the ECM 4000 selects various operational modes for the generator as defined by the MODE data character. The mode command allows setting of the colour frame, drop frame (NTSC standard only) and parity operational modes. The MODE data character can take only the following values:

ASCII	DECIMAL VALUE	PARITY	COLOUR FRAME	DROP FRAME
@	64	OFF	OFF	OFF
A	65	OFF	OFF	ON
B	66	OFF	ON	OFF
C	67	OFF	ON	ON
P	80	ON	OFF	OFF
Q	81	ON	OFF	ON
R	82	ON	ON	OFF
S	83	ON	ON	ON

3.6.4 Set Generator Jam Sync Error Bypass

On receipt of the SET JAM ERR command (ASCII # decimal 35) the ECM 4000 presets the formatted continuous jam sync error bypass (See Section 3.2.3) to the number defined by the JAM ERR data character. The JAM ERR data can take values 1-9.

3.6.5 Set VITC Generator Lines

On receipt of the SET GEN LINE command (ASCII % decimal 37) the ECM 4000 presets the formatted VITC generator lines as defined by the following two data characters. The GEN LINE data characters can only take the following values:

VALUE	LINE # NTSC	PAL
0	10	6
1	11	7
2	12	8
3	13	9
4	14	10
5	15	11
6	16	12
7	17	13
8	18	14
9	19	15
A	20	16
B	invalid	17
C	invalid	18
D	invalid	19
E	invalid	20
F	invalid	21

3.6.6 Set Generator Time

On receipt of the SET GEN TIME command (ASCII (decimal 40) the ECM 4000 sets the generator time to the values defined by the following 8 data characters. The time format is 'HHMMSSFF'. Only valid times in the 24 hour format will be accepted.

3.6.7 Set Generator User Bits

On receipt of the SET GEN UB command (ASCII) decimal 41) the ECM 4000 sets the generator user bits to the values defined by the following 8 data characters. The first data character will be placed in binary group 8 (10 x hours position), etc. Only valid hexadecimal digits (0-9, A-F) will be accepted.

3.6.8 Generate Alpha-User Bits - Full page TEXT mode

This command is only operational if the alpha-numeric user bit option is fitted. On receipt of the GEN ALPHA TEXT command (ASCII , decimal 44) the ECM 4000 initializes the generator to place alpha-numeric text into the generator user bits in the full page mode. All characters received after the <CR> character will be interpreted as text data to be inserted into the user bits. See Section 3.7.1 for a full description of the alpha-numeric text generating mode.

3.6.9 Generate Alpha-User Bits - Two line CAPT mode

This command is only operational if the alpha-numeric user bit option is fitted. On receipt of the GEN ALPHA CAPT command (ASCII . decimal 45) the ECM 4000 initializes the generator to place alpha-numeric text into the generator user bits in the two line caption mode. All characters received after the <CR> character will be interpreted as text data to be inserted into the user bits. See Section 3.7.1 for a full description of the alpha-numeric text generating mode.

3.6.10 Read Generator Time Source

On receipt of the READ TIME SRC command (ASCII 0 decimal 48) the ECM 4000 sends back the selected source for the generator clock as defined below.

1 = Generator clock free running
2 = Continuous Jam to Reader time

3.6.11 Read User Bit Source

On receipt of the READ UB SRC command (ASCII 1 decimal 49) the ECM 4000 sends back the selected source for the generator user bits as defined below.

0 = Numeric entry
1 = Reader User Bits
2 = Reader Time

3.6.12 Read Generator Status

On receipt of the READ GEN STAT command (ASCII 2 decimal 50) the ECM 4000 sends back the status of the generator flag bits as defined below.

ASCII	DECIMAL VALUE	PARITY	BINARY GROUP 2	BINARY GROUP 1	COLOUR FRAME	DROP FRAME
@	64	OFF	OFF	OFF	OFF	OFF
A	65	OFF	OFF	OFF	OFF	ON
B	66	OFF	OFF	OFF	ON	OFF
C	67	OFF	OFF	OFF	ON	ON
D	68	OFF	OFF	ON	OFF	OFF
E	69	OFF	OFF	ON	OFF	ON
F	70	OFF	OFF	ON	ON	OFF
G	71	OFF	OFF	ON	ON	ON
H	72	OFF	ON	OFF	OFF	OFF
I	73	OFF	ON	OFF	OFF	ON
J	74	OFF	ON	OFF	ON	OFF
K	75	OFF	ON	OFF	ON	ON
L	76	OFF	ON	ON	OFF	OFF
M	77	OFF	ON	ON	OFF	ON
N	78	OFF	ON	ON	ON	OFF
O	79	OFF	ON	ON	ON	ON
P	80	ON	OFF	OFF	OFF	OFF
Q	81	ON	OFF	OFF	OFF	ON
R	82	ON	OFF	OFF	ON	OFF
S	83	ON	OFF	OFF	ON	ON
T	84	ON	OFF	ON	OFF	OFF
U	85	ON	OFF	ON	OFF	ON
V	86	ON	OFF	ON	ON	OFF
W	87	ON	OFF	ON	ON	ON
X	88	ON	ON	OFF	OFF	OFF
Y	89	ON	ON	OFF	OFF	ON
Z	90	ON	ON	OFF	ON	OFF
[	91	ON	ON	OFF	ON	ON
\	92	ON	ON	ON	OFF	OFF
]	93	ON	ON	ON	OFF	ON
^	94	ON	ON	ON	ON	OFF
_	95	ON	ON	ON	ON	ON

3.6.13 Read Generator Jam Sync Error Bypass

On receipt of the READ JAM ERR command (ASCII 3 decimal 51) the ECM 4000 sends back the formatted continuous jam sync error bypass (See Section 3.2.3)

3.6.14 Read VITC Generator Line Numbers

On receipt of the READ GEN LINE command (ASCII 5 decimal 53) the ECM 4000 sends back the formatted VITC generator lines as defined in Section 3.6.5.

3.6.15 Read Generator Time

On receipt of the READ GEN TIME command (ASCII 8 decimal 56) the ECM 4000 sends back the generator time in the format 'HHMMSSFF'.

3.6.16 Read Generator User Bits

On receipt of the READ GEN UB command (ASCII 9 decimal 57) the ECM 4000 sends back the generator user bits. The first character corresponds to the binary group 8 (10 x hours position), etc.

3.6.17 Set Reader Source

On receipt of the SET RDR SRC command (ASCII @ decimal 64) the ECM 4000 selects the source for the reader as defined by the SRC data character. The SRC data can take only the following values:

0 = LTC Reader
1 = VITC Reader
2 = Auto (display whichever is valid)

3.6.18 Read Reader Source

On receipt of the READ RDR SRC command (ASCII A decimal 65) the ECM 4000 sends back the selected reader source as defined in Section 3.6.17.

3.6.19 Read Reader Status

On receipt of the READ RDR STAT command (ASCII B decimal 66) the ECM 4000 sends back the status of the reader flag bits. (See table of values in Section 3.6.10) When reading data from the VITCode reader, the PARITY flag is OFF for field 1 and ON for field 2. ie, it is the same as the field mark bit in the VITCode. When reading data from the LTC reader, the PARITY flag follows the setting of the parity bit.

3.6.20 Read Reader Time

On receipt of the READ RDR TIME command (ASCII H decimal 72) the ECM 4000 sends back the reader time in the format 'HHMMSSFF'.

3.6.21 Read Reader User Bits

On receipt of the READ RDR UB command (ASCII I decimal 73) the ECM 4000 sends back the Reader user bits. The first character corresponds to the binary group 8 (10 x hours position), etc.

3.6.22 Read Alpha-numeric User Bits

This command is valid only if the alpha-numeric option is fitted. On receipt of the READ ALPHA UB command (ASCII L decimal 76) the ECM 4000 sends back the alpha-numeric user bits data stored on the two pages of VCG screen memory.

APPENDIX IV: SUMMARY OF REMOTE CONTROL COMMANDS

COMMAND	KEY STROKE	DECIMAL	COMMAND DATA FORMAT
Set Gen Source	<space>	32	1=Free Run, 2=Jam 3=Momentary Jam
Set UB Source	!	33	0=Numeric, 1=Rdr Time 2=Rdr UB, 3=Source ID
Set Gen Mode	"	34	1 char - see Fig &APP&-1
Set Jam Errors	#	35	1 char '1-9'
Set VITC Lines	%	37	2 char '0-9,A-F'
Set Gen Time	(	40	8 char 'HHMMSSFF'
Set Gen UB	)	41	8 char (bin group 8 first)

REMOTE COMMAND	KEY STROKE	DECIMAL	RESPONSE DATA FORMAT
Read Gen Source	0	48	1=Free Run, 2=Jam 3=Momentary Jam
Read UB Source	1	49	0=Numeric, 1=Rdr Time 2=Rdr UB, 3=Source ID
Read Gen Status	2	50	See Fig &APP&-2
Read Jam Error	3	51	1 char '1-9'
Read VITC Lines	5	53	2 char '0-9,A-F'
Read Gen Time	8	56	8 char 'HHMMSSFF'
Read Gen UB	9	57	8 char binary group 8 first
Set Rdr Source	@	64	0=LTC, 1=VITC, 2=Auto
Read Rdr Source	A	65	0=LTC, 1=VITC, 2=Auto
Read Rdr Status	B	66	See Fig &APP&-2
Read Rdr Time	H	72	8 char 'HHMMSSFF'
Read Rdr UB	I	73	8 char binary group 8 first

ASCII	DECIMAL VALUE	PARITY	COLOUR FRAME	DROP FRAME
@	64	OFF	OFF	OFF
A	65	OFF	OFF	ON
B	66	OFF	ON	OFF
C	67	OFF	ON	ON
P	80	ON	OFF	OFF
Q	81	ON	OFF	ON
R	82	ON	ON	OFF
S	83	ON	ON	ON

Figure IV-1 Set Generator Mode Commands

ASCII	DECIMAL VALUE	PARITY (FIELD)	BINARY GROUP 2	BINARY GROUP 1	COLOUR FRAME	DROP FRAME
@	64	OFF	OFF	OFF	OFF	OFF
A	65	OFF	OFF	OFF	OFF	ON
B	66	OFF	OFF	OFF	ON	OFF
C	67	OFF	OFF	OFF	ON	ON
D	68	OFF	OFF	ON	OFF	OFF
E	69	OFF	OFF	ON	OFF	ON
F	70	OFF	OFF	ON	ON	OFF
G	71	OFF	OFF	ON	ON	ON
H	72	OFF	ON	OFF	OFF	OFF
I	73	OFF	ON	OFF	OFF	ON
J	74	OFF	ON	OFF	ON	OFF
K	75	OFF	ON	OFF	ON	ON
L	76	OFF	ON	ON	OFF	OFF
M	77	OFF	ON	ON	OFF	ON
N	78	OFF	ON	ON	ON	OFF
O	79	OFF	ON	ON	ON	ON
P	80	ON	OFF	OFF	OFF	OFF
Q	81	ON	OFF	OFF	OFF	ON
R	82	ON	OFF	OFF	ON	OFF
S	83	ON	OFF	OFF	ON	ON
T	84	ON	OFF	ON	OFF	OFF
U	85	ON	OFF	ON	OFF	ON
V	86	ON	OFF	ON	ON	OFF
W	87	ON	OFF	ON	ON	ON
X	88	ON	ON	OFF	OFF	OFF
Y	89	ON	ON	OFF	OFF	ON
Z	90	ON	ON	OFF	ON	OFF
[	91	ON	ON	OFF	ON	ON
\	92	ON	ON	ON	OFF	OFF
]	93	ON	ON	ON	OFF	ON
^	94	ON	ON	ON	ON	OFF
_	95	ON	ON	ON	ON	ON

Figure IV-2 Read Status Responses

REV.	REVISION HISTORY	DATE
1	Original Issue	4/83
	Change Sheet 4000-1 added	9/83
	Change Sheet 4000-2 added	10/83
	Appendix IV changed	10/83
2	Complete Revision of text to correct technical and typographic errors. Includes Change Sheet 4000-2. Appendix IV changed to most recent messages.	12/83
	Status indicators changes	4/84

INDEX

1. INTRODUCTION

The ECM 4000 Edit Code Master is designed from the ground up to take full advantage of the multitude of application possibilities for VITCode (Vertical Interval Time Code). VITCode is a recently developed method of encoding timing and other information into the program video for video tape editing. However, its potential applications in the production and broadcast environment reach far beyond the editing suite.

For editing purposes, the most widely used time code is recorded on a separate audio track on the VTR. This method works well, but it has 2 major drawbacks: a separate track on the tape is required, and code can only be recovered at some minimum tape speed, usually 1/5 to 1/20 of playspeed. With the development of the broadcast quality helical scan VTR, a picture can be reproduced at very slow speeds, right down to still frame. VITCode, recorded in the video signal outside the active picture area, can be recovered at all times that the video is visible on the television screen, even when the tape is shuttled at high speeds or stopped. This gives the editor a powerful new tool.

But it doesn't stop there! In fact, there are many other exciting uses for VITCode. When the SMPTE/EBU time code was developed in the late 60's, provision was made for 32 user bits. Until now, these user bits have not been used to their full potential, but VITCode changes all this dramatically. By distributing, switching and recording VITCode along with program video, the possible applications are limitless. Here are some examples, all of which can be implemented with the ECM 4000:

* Synchronization of time clocks to frame accuracy in all stations of a network.

* Transmitting alpha-numeric data, such as program cues, etc. to network stations along with the program video.

* Issuing remote control commands to unmanned transmitter sites or loading computer data memories.

* In the video cassette copying industry, hundreds of recording machines can receive start, stop, record, etc. commands through the routing switcher along with the program video.

* Manual or automatic identification of each video source.

The ECM 4000 is a combination generator, and high speed reader for both VITCode and LTC (Longitudinal Time Code), and contains a high resolution character generator which can be delegated to either the reader or the generator. Thus, the generator will produce uninterrupted VITCode and LTC while the reader may be used to read VITCode or LTC from another tape without interfering with the generator function.

Using one of the most powerful microcontrollers available today, we have achieved new levels of functional flexibility and reliability. Particular attention has been paid to maintaining operating simplicity. In order to prevent the increased complexity from becoming an operational nightmare, we have included a FORMAT keypad which allows the unit to be quickly configured to

your specific operating environment. User friendly display prompts step you through the configuration modes. The preset parameters such as VITCode line numbers, LTC output level, VCG character position and size, etc., are stored in non-volatile memory. The day to day operation is thus greatly simplified, often reduced to a few remote push button functions.

Several jam sync modes allow regeneration of poor, frequently interrupted or discontinuous time code or conversion between VITCode and LTC. In the continuous jam sync mode, the generator is slaved to the reader. The generator may be momentarily synchronized to the reader using MOM JAM.

The model ECM 4000 follows the SMPTE(EBU)[1] specification for frame addressing. The unit may be configured to operate in the 2 field (4 field PAL) mode or the newer 4 field (8 field PAL) colour frame mode. See Appendix I for the SMPTE(EBU) standards regarding colour framing. Generation of LTC with the new bi-phase mark parity bit may also be selected.

In NTSC colour systems operation, with a frame rate of 29.97002618 Hz where the time of day is used for indexing, the generator may be operated in the drop frame mode. The reader D.F. indicator will light up if the reader data was recorded in this mode.

Both the generator and reader are capable of working with the unassigned user bits. Several modes of operation are possible. The generator may be preset to insert decimal values for each group in the generated code, and the reader will read decimal values for each binary group. In addition, the user may select the transfer of either reader time or reader user bits into the generator user bits, thus, allowing pre-edit frame addresses to be preserved when new continuous time code is laid down. This mode may also be useful for synchronizing audio and video tracks or recording film footage numbers in a film to tape transfer. A third user bit transfer function allows a presettable source identifier to be inserted into the user bits. This can be decoded by an economical VITCode reader/character generator (Model 4300) attached to your monitor.

When the alpha-numeric user bit option is fitted, the ECM 4000 is able to insert strings of ASCII characters into the generator user bits from a keyboard or terminal. Several formats including full screen and caption modes are available. The reader will decode user bits recorded in this format as well as source ID user bits and display them on the built-in character generator.

The ECM 4000 is equipped with a high resolution character generator which provides white characters keyed into a black background. The character display may be delegated to either the generator or reader, using the respective video input as the source for the character inserter. Horizontal and vertical position and selection of 1 of 2 sizes are controllable from the front panel.

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[1]References to EBU standards appear in brackets following references to SMPTE standards throughout this manual.

Two levels of remote control are available. The standard unit provides 4 remote control inputs which can be delegated to any of the 9 control functions. When the serial remote control option is fitted, control of all the preset and control functions can be accomplished from an RS-232-C keyboard or computer or from an optional remote control. An optional remote control panel (Model RCU 400), also permits control of all the preset and control functions, and provides one display which is shared by the generator and reader.

2. INSTALLATION

2.1 MOUNTING

The standard unit is equipped with rack mounting angles and fits into a standard 19 inch by 3 1/2" (483mm x 89mm) rack space. The mounting angles may be removed if rack mounting is not desired.

2.2 POWER

Power requirements are 115 or 230 volts AC at 50 or 60 Hz, switch selectable at the rear panel. Before connecting the line power, be sure to select the proper line voltage. Also, check that the line fuse is rated for the correct value. Never replace with a fuse of greater value.

2.3 GENERATOR VIDEO IN/SYNC LOCK

For proper frame/address synchronization in video tape applications, the generator must be locked to a stable 1 volt p-p composte video or colour black source, applied to the generator input video connector. The internal sync separator has a high impedance input tapped off the loop through, therefore, the video signal must be properly terminated at some point in the line.

When colour frame synchronization is desired, the sync to subcarrier (Sc-H) phase relationship of the video source must conform to RS-170-A specification for NTSC models and PAL 8 field specification for PAL models. (See Appendix I for information regarding colour framing specifications.) Selection of the colour framed or non colour framed mode is accomplished from the front panel. (See Section 3.1) When the video source does not meet the colour frame specifications, the non colour frame mode must be selected to insure a proper generator lock condition.

2.4 VITCODE GENERATOR VIDEO IN/OUT

The ECM 4000 inserts VITCode on the same video input used to provide frame synchronization of the generator. (See Section 2.3) Program video plus VITCode is available on 2 separate outputs.

2.5 VITCODE READER VIDEO IN

The reader input video with VITCode recorded on it is connected to the VITCode reader input loop. The internal sync separator has a high impedance input tapped off the loop through, therefore, the video signal must be properly terminated at some point in the line.

2.6 LONGITUDINAL TIME CODE IN/OUT

The LTC generator code output is available on an XLR connector at the rear panel. Output level is presettable from the front panel in 4 steps from -12 dBm to +6 dBm. (See Section 3.1.1 Mode Key)

The LTC reader input connects to your head pre-amplifier output. When using an unbalanced input to the reader, the signal should be applied to pin 3 of the reader input connector. Normally, the unused input, (pin 2) should be connected to ground (pin 1).

2.7 CHARACTER GENERATOR

The program source for the character generator is selected from the front panel. When characters from the generator are being displayed, the generator video is used as a program source. When the characters from the reader are being displayed, the reader video input is used as a program source. When the reader video input is used as a source for off line time code burn-ins, the video should be vertically synchronized to the generator input video for proper operation. The internal sync separator has a high impedance input tapped off the loop through, therefore, the video signal must be properly terminated at some point in the line.

It is important to realize that a video source must be connected to the reader input loop if the reader VCG key is pressed, otherwise, the monitor screen will go blank. Using the character generator output as the input to the reader should be avoided as this will create a loop without any input when the reader VCG key is pressed.

2.8 REMOTE CONTROL AND SERIAL I/O

Four rear panel inputs on the remote control port can be delegated to any of the 9 control functions (See Section 3.1.4). When the serial remote control option is fitted, remote control may be accomplished by using one of the two serial ports. A remote control panel (Model RCU 400), connects to the remote control port and permits access to all the preset and control functions and provides a display of the reader or generator time or user bits. Alternately, an RS-232-C keyboard or computer connected to the serial I/O port may control

and receive data from the ECM 4000. (See Appendix II for pin assignments of the remote control and serial I/O ports.) When alpha-numeric user bit option is fitted, the RS-232-C serial I/O port is used for entry of alpha-numeric data into the user bits.

2.9 SAMPLE CONFIGURATIONS

Several sample installation setups are diagrammed below to aid the user in properly connecting the ECM 4000 into his system. Contact us for other applications

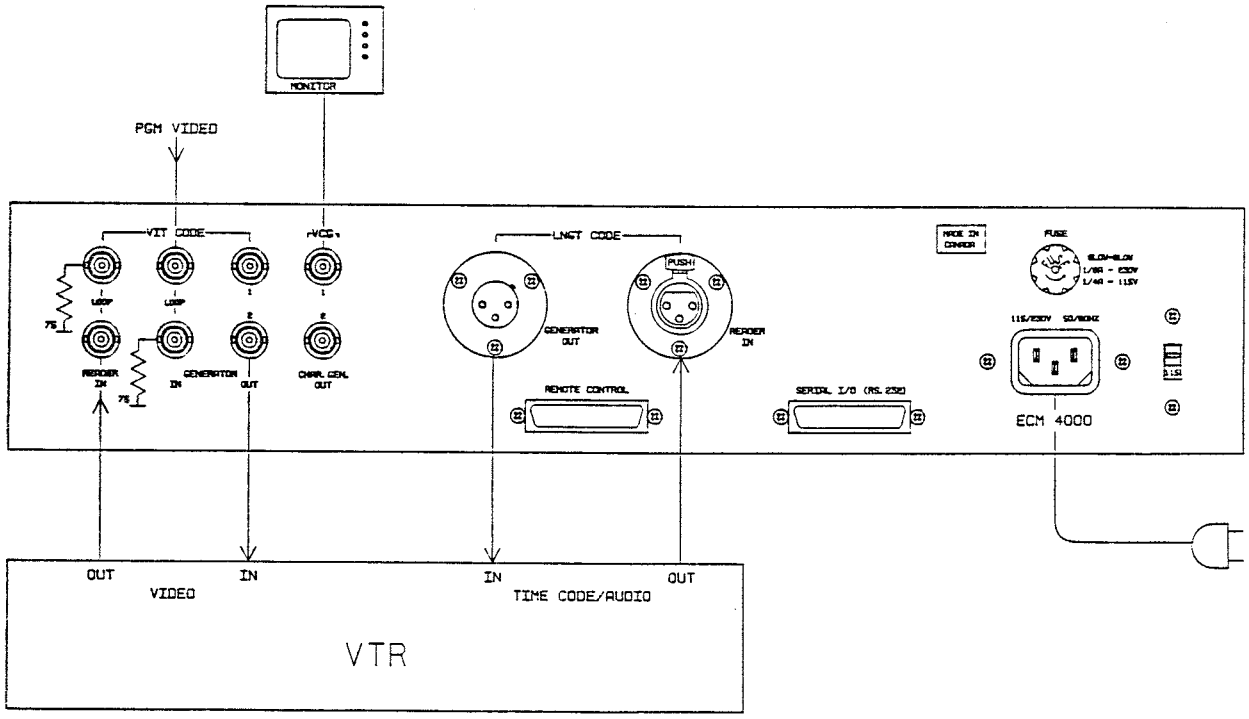


Figure 2-1 - Basic Generator/Reader Configuration

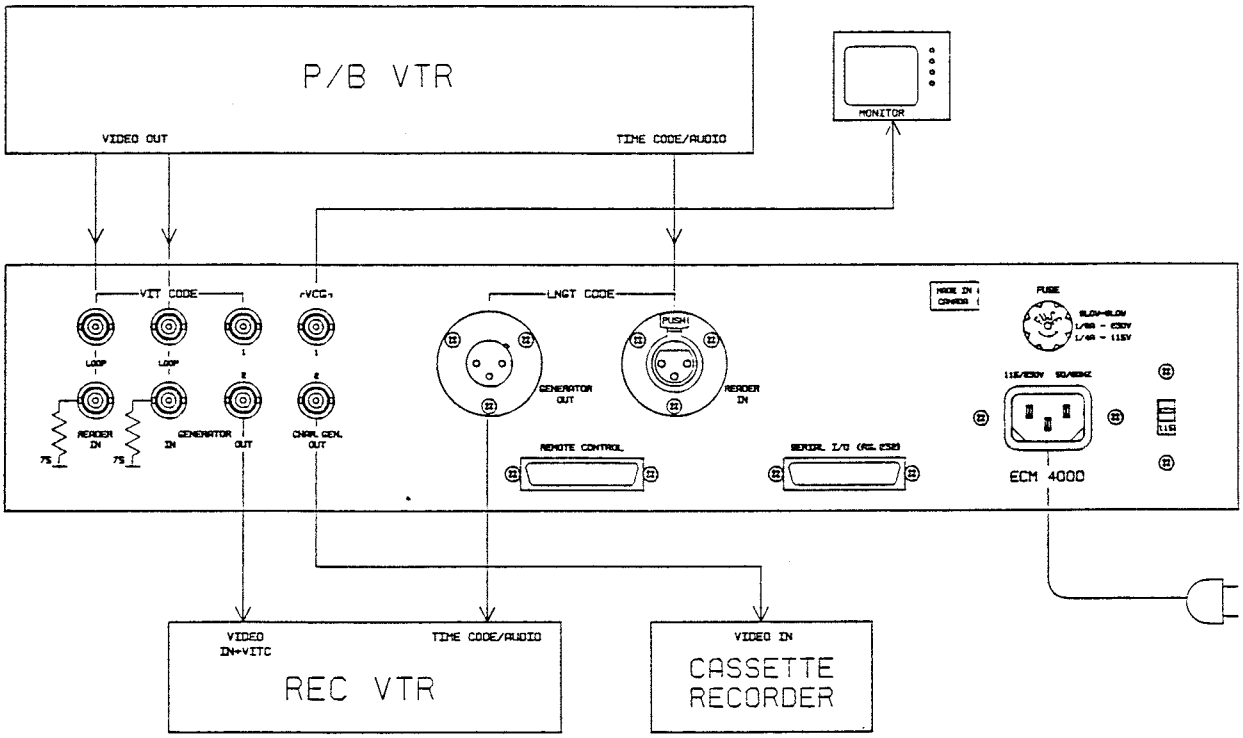


Figure 2-2 - Dubbing and Off-Line Character Burn In

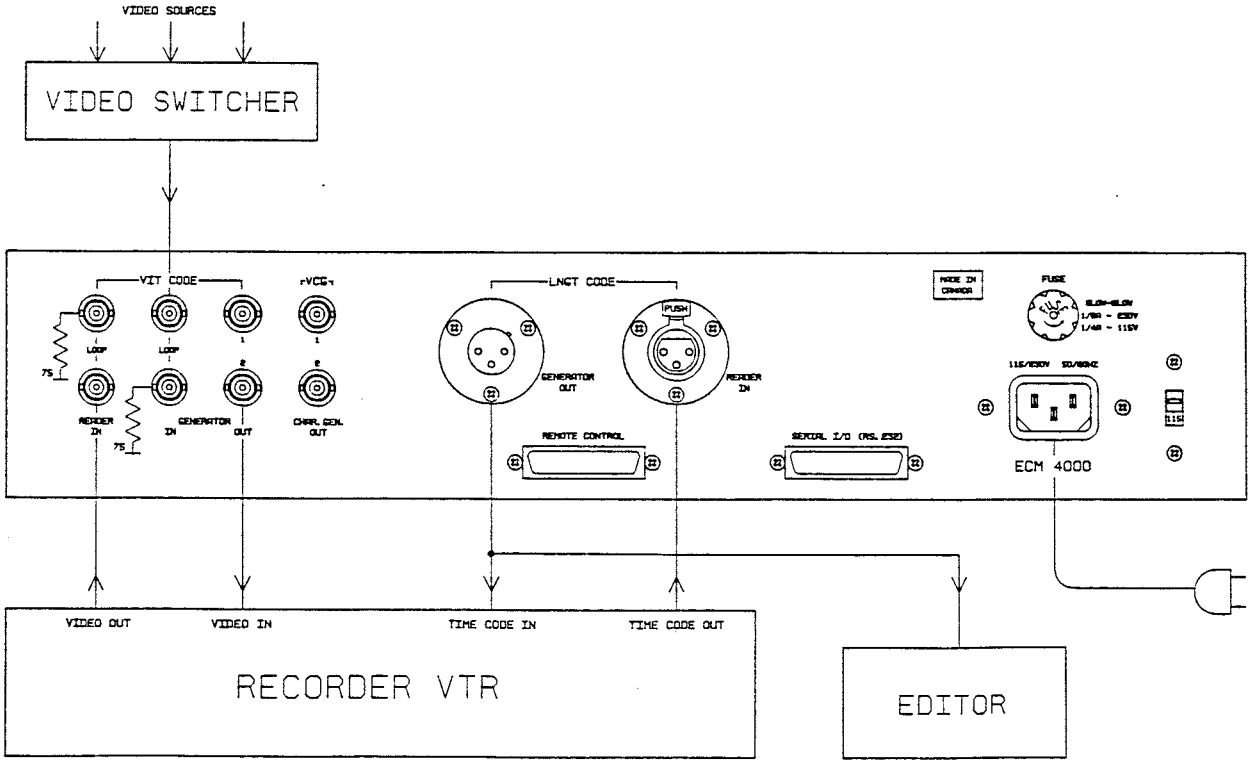


Figure 2-3 - Editing - Record Machine

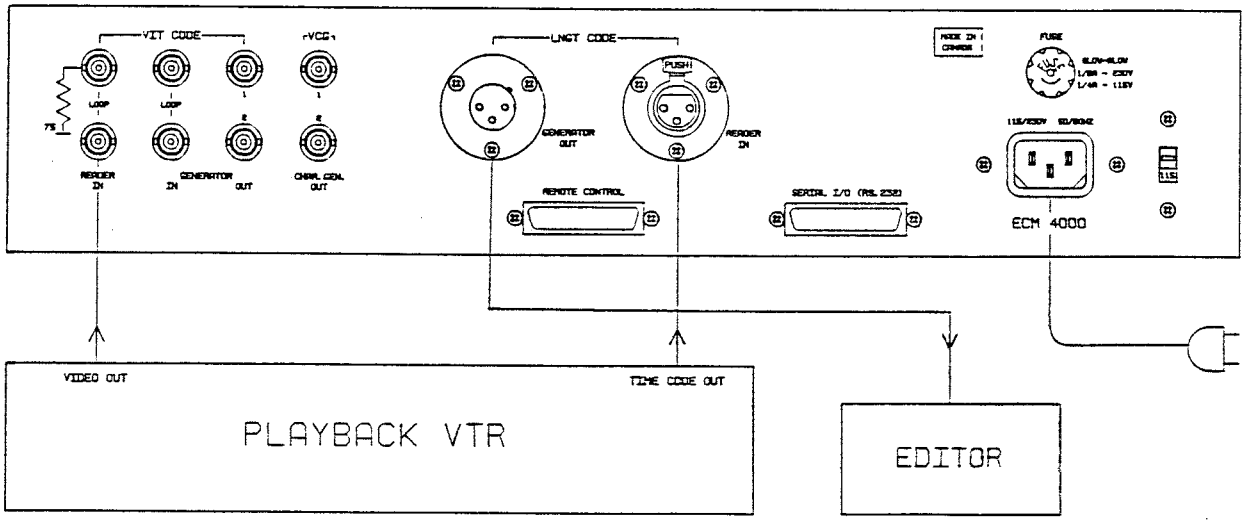


Figure 2-4 - Editing - Playback Machine Translation

3. OPERATION

Independent displays for the generator and the reader display time, user bits or formatting prompts. A PRESET key group allows entering time, user bits and other numeric data into the generator. A FORMAT key group permits many parameters and operating modes to be preset to adapt the unit to your particular operating methods. Twelve LED's provide operational status at a glance.

Since all functions are entirely under microprocessor control, certain modifications may have been supplied to meet your particular requirements, and may conflict with the descriptions below.

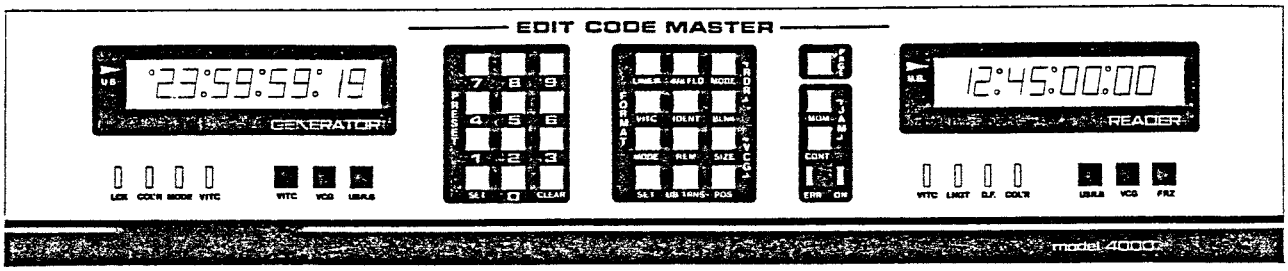


Figure 3-1 - Front Panel Layout

3.1 FORMAT FUNCTIONS

Pressing any one of the 11 blue keys in the FORMAT key group enters a configuration sequence for the selected parameter, and locks out all key entries unrelated to the formatting operation. **Therefore, the format mode must always be terminated using the FORMAT SET button or the CLEAR button before any of the other functions may be accessed again.**

Most of the FORMAT sequences consist of selecting one of several possible options for the parameter being formatted. This is accomplished by repeatedly depressing the parameter's formatting key. User friendly prompts, in the generator display, aid the operator in selecting the appropriate option. (Prompts are shown as eg. ("LINE 1") in the command descriptions below.) When the option that is currently configured is prompted, the display will flash on and off, thus, enabling the user to confirm the current mode of operation. When the desired option is prompted, press the FORMAT SET button. This changes the configuration to that currently prompted, and terminates the formatting sequence. If no changes are desired, press CLEAR to exit. If all the available options are exhausted before FORMAT SET is pressed, the formatting sequence is terminated automatically, and the generator display returns to displaying the generator time or user bits.

Some FORMAT parameters such as LINE # require the use of the PRESET numeric keys to enter an appropriate value. Values are entered by pressing the FORMAT SET key. Invalid values are blanked and reprompted. The REM parameter requires the use of the nine control function push buttons also.

Selected entries are stored in non-volatile memory but may be recalled and changed at any time. The FORMAT configuration is not affected by power interruptions.

3.1.1 Generator Parameters

LINE # Presets the 2 lines in the blanking interval for recording the VITCode. The first time it is pressed, the display prompt ("LINE 1") shows the first line currently selected for VITCode placement in the video. Use the PRESET numeric keys to make any change desired and press FORMAT SET. Pressing LINE # again, prompts for the second line ("LINE 2"), and changes may be made the same as for the first line. The operator will have to determine by experience the most suitable lines for recording the VITCode word according to the following criteria. When the same LINE # is chosen for both lines, VITCode is recorded only once in each field.

In order to protect the VITCode reading process against dropouts, the VITCode word is repeated on 2 non-adjacent available lines in the vertical interval of the video signal, but not earlier than line 10 (6 for PAL) or later than line 20 (21 for PAL). It must be kept in mind that for certain recordings, the use of some of these lines might interfere with other signals inserted in the field blanking interval. When an attempt is made to set the LINE # outside the permitted range, the error will be blanked and the entry is reprompted.

To avoid decoding errors, which may arise from the presence of skew, an adequate margin should be allowed between the video head switching points and the recorded VITCode word. Also note that one inch Type C VTR's with a sync head have a head switching point in the middle of the permitted lines. Type C VTR's without a sync head do not reproduce some of the permitted lines at all, therefore, these lines should not be used for recording VITC. See your VTR manual for further information.

4/8 FLD Selects the video standard being used for generator sync lock.

NTSC Units: Selects whether the generator will lock to an NTSC RS-170 source ("FIELd 2") or where available, the newer NTSC RS-170-A source ("FIELd 4").

PAL Units: Selects whether the generator will lock to a 4 field PAL source ("FIELd 4") or where available, the newer 8 field PAL source ("FIELd 8").

When generator sync/lock is achieved and the LCK indicator is on, the generator COL'R indicator will be on if the NTSC RS-170A (8 field PAL) source was selected. When in the continuous JAM SYNC mode, and the reader code was not recorded in the colour frame mode, the generator

COL'R indicator will be turned off and the generator will only maintain a frame lock (indicated by the LCK indicator). Upon exit of the continuous JAM SYNC mode, the formatted colour/non colour mode will be resumed.

VITC Configures the operation of the VITCode generator to either record or erase. In applications where the user desires to record VITCode on his video source, select ("COdE"). In applications where the user wishes to erase existing VITCode recorded on the specific line numbers selected above, select ("ErASE"). The operation of this key has no effect on the video if the VITCode generator is disabled. (See Section 3.2.1)

IDENT Is used to preset a source identifier to be transmitted in the user bits at any time. (See UB. TRNS below). At the destination, this source ID can be displayed with a reader/character generator. When the IDENT key is pressed, the current ID characters are displayed with each digit pair containing the decimal ASCII value of the ID characters. Use the PRESET numeric keys to enter decimal ASCII values for new source ID charcters. (See Appendix III for ASCII decimal values.)

Up to 4 displayable ASCII characters (decimal ASCII values 32 thru 90) may be entered to give complete flexibility to the user. ie. ASCII 65, 66, 67, 68 will be decoded as "ABCD". This format is only valid if the decoding reader is another ECM 4000.

Other readers such as our model 4300 and 4900, recognize a control character sequence to display common multi-character source and date identifiers and a source number. ie. VTR 22 requires only 3 ASCII characters as described below. Enter the character "Control-S" (decimal value 19) in the left most ("hours") digit pair. A two digit message number is placed in the second "minutes" digit pair (See Appendix IV for message numbers). A two digit source number from 01 to 99 is placed in the third "seconds" digit pair and the rightmost "frames" digit pair is set to zero.

When the desired source ID characters have been entered, press FORMAT SET to save them in the non-volatile memory.

Note: When the formatted source ID is transferred to the generator user bits (See UB.TRNS below), the decimal ASCII values entered are converted to their equivalent hexadecimal values and the most significant bit is set as a flag bit for the decoding reader. These converted values may be seen by selecting the generator user bit display (See Section 3.2.1) when source ID transfer is enabled (See UB.TRNS below)

example: Decimal values 65, 66, 67, 68 entered
will be viewed as C1, C2, C3, C4

MODE This is a multipurpose key which is used to configure several generator parameters. The first parameter to be set is longitudinal code output level ("OP db"). The output level may be set to +6, 0, -6, or -12 dBm into a 600 ohm load by repeatedly pressing the MODE key. When the desired output level is prompted, press FORMAT SET.

In NTSC units, the next mode to be selected is the drop frame mode. When ("dFr") is selected, the generator operates in the drop frame mode to provide accurate time of day when locked to NTSC colour sync with a frame rate if 29.97002618 Hz. This mode drops the first 2 frame counts (0, 1) at the start of each minute except minute 0, 10, 20, 30, 40 and 50. This compensates for an approximate timing error of 4 seconds per hour. A special drop frame flag bit is set in the generated code to signal this operating mode. When ("NO dFr") is selected, the generator includes all frame counts. The drop frame mode is indicated by the D.F. indicator.

Note: When in the continuous jam sync mode, the drop frame status of the reader overrides the formatted drop frame mode.

The next parameter to be preset is the use of the bi-phase mark parity bit in the LTC code. The purpose of the phase correction parity bit is to compensate for phase reversals in the LTC bi-phase mark modulation that could occur when code inserts are performed. Use of the bi-phase mark parity bit is optional as some readers may not recognize its presence. When ("PAR") is selected, the bi-phase mark parity bit will be put in a state where every 80 bit word will contain an even number of logic zeros, in order that the magnetization transient between bit cell 79 of one word and bit cell zero of the next shall always be in the same direction. The parity bit will be always set to zero if ("NO PAr") is selected.

The next parameter to be configured is the number of jam sync by-pass errors ("JS Err"). This is the number of consecutive read errors allowed in the continuous jam sync mode before the generator recognizes discontinuities in the reader time. Use the PRESET numeric keys to enter any number of jam sync errors from 1 to 9, and press FORMAT SET to enter. The user will have to determine the best value for his application but a nominal value of 5 is suggested. (See Section 3.2.3)

UB. TRNS Selects 1 of 3 user bit transfer modes. Successive depressions of the key prompt for no user bit transfer to the generator ("no-tr"), ie. user bits may be preset from the PRESET numeric keys (See Section 3.2.2), transfer of reader user bits to the generator user bits ("rU-tr"),transfer of reader time to generator user bits ("rt-tr"), or transfer of the preset source identifier into the generator user bits ("Id-tr"). (See IDENT above) Press FORMAT SET to configure the user bit transfer mode you desire, or CLEAR to exit.

3.1.2 Reader Parameters

MODE Sets the reader source being displayed to either LTC ("LONG"), or VITCode ("VITC") or ("AUtO") which displays the last valid code from either source. Press FORMAT SET to configure the unit for the desired mode of operation or CLEAR to exit.

In NTSC units, the next mode to be selected is the drop frame mode. When ("dFr") is selected, the generator operates in the drop frame mode to provide accurate time of day when locked to NTSC colour sync with a frame rate if 29.97002618 Hz. This mode drops the first 2 frame counts (0, 1) at the start of each minute except minute 0, 10, 20, 30, 40 and 50. This compensates for an approximate timing error of 4 seconds per hour. A special drop frame flag bit is set in the generated code to signal this operating mode. When ("NO dFr") is selected, the generator includes all frame counts. ~~In NTSC units~~, the drop frame mode is indicated by the "MODE" indicator.

Note: When in the continuous jam sync mode, the drop frame status of the reader overrides the formatted drop frame mode.

The next parameter to be preset is the use of the bi-phase mark parity bit in the LTC code. The purpose of the phase correction parity bit is to compensate for phase reversals in the LTC bi-phase mark modulation that could occur when code inserts are performed. Use of the bi-phase mark parity bit is optional as some readers may not recognize its presence. When ("PAR") is selected, the bi-phase mark parity bit will be put in a state where every 80 bit word will contain an even number of logic zeros, in order that the magnetization transient between bit cell 79 of one word and bit cell zero of the next shall always be in the same direction. The parity bit will be always set to zero if ("NO PAr") is selected. ~~On PAL units, the "PAR" mode is indicated by the "MODE" indicator.~~

The next parameter to be configured is the number of jam sync by-pass errors ("JS Err"). This is the number of consecutive read errors allowed in the continuous jam sync mode before the generator recognizes discontinuities in the reader time. Use the PRESET numeric keys to enter any number of jam sync errors from 1 to 9, and press FORMAT SET to enter. The user will have to determine the best value for his application but a nominal value of 5 is suggested. (See Section 3.2.3)

UB. TRNS Selects 1 of 3 user bit transfer modes. Successive depressions of the key prompt for no user bit transfer to the generator ("no-tr"), ie. user bits may be preset from the PRESET numeric keys (See Section 3.2.2), transfer of reader user bits to the generator user bits ("rU-tr"),transfer of reader time to generator user bits ("rt-tr"), or transfer of the preset source identifier into the generator user bits ("Id-tr"). (See IDENT above) Press FORMAT SET to configure the user bit transfer mode you desire, or CLEAR to exit.

3.1.2 Reader Parameters

MODE Sets the reader source being displayed to either LTC ("LONG"), or VITCode ("VITC") or ("AUtO") which displays the last valid code from either source. Press FORMAT SET to configure the unit for the desired mode of operation or CLEAR to exit.

When ("AUtO") is selected, the reader will continue reading from whatever source was previously selected. When it encounters invalid code, the reader will display the other source, if valid code exists on that source. Otherwise, it will continue displaying the last valid code read until valid code resumes on one of the sources. If the reader switches sources, it will not switch back, even if valid code resumes on the previous source, until it encounters invalid code on the presently selected source. This permits continuous time code reading where speeds exceed the reading capabilities of one of the readers (in excess of 40 times play speed for VITCode or less than about 1/10 play speed for LTC), as long as both LTC and VITCode have been recorded on the tape. If only one code has been recorded on the tape, then that particular code source should be selected for the best operation of the reader. When ("AUtO") is used both codes should be identical or unpredictable results may occur.

BLNK Selects frames blanking of the reader and generator displays. The first time it is pressed it prompts for no blanking ("--- ---"). The next time it is pressed it prompts for reader frames blanking ("--- rdr"). The next time it prompts for generator frames blanking ("GEN ---"). The last prompt is to blank both frames displays ("GEN rdr"). Press FORMAT SET to configure the desired mode of operation, or CLEAR to exit.

3.1.3 Character Generator Parameters

SIZE Selects 1 of 2 character sizes when the character generator is turned on (See Section 3.4). The size will be visible in your picture monitor. Successive depressions of this key toggle between 1 of 2 sizes. Press FORMAT SET or CLEAR to exit.

POS Selects the raster position of the characters. The first time it is pressed, the characters will move through the various raster positions on the screen. Press POS again to stop the characters in the desired raster position. Press FORMAT SET or CLEAR to exit.

3.1.4 Remote Control Parameter

REM This key permits 4 rear panel inputs (located on the remote control connector) from momentary contact push buttons to be delegated to any of the nine control functions of the ECM 4000 (ie. Generator VITC, VCG, USR.B; MOM & CONT Jam; Reader USR.B, VCG & FRZ; PAGE). The first time REM is pressed, the display prompts to configure remote input 1 ("r1") with an identifier indicating which of the control functions remote input 1 is assigned to at this time. If a change is desired, press the new control function that you wish to assign remote input 1 to, and the new key identifier will appear in the prompt display. Press FORMAT SET to enter the new control function. The display then prompts to configure remote input number 2, and so on until all 4 have been configured. Pressing CLEAR exits from the remote input configuration routines.

3.2 GENERATOR CONTROL FUNCTIONS

3.2.1 Primary Control

Two of the keys located directly beneath the generator display provide primary control of the LTC and VITCode generators.

VITC Alternately enables or disables the VITCode generator, according to the formatted function (See Section 3.1.1 VITC Key above). A status indicator "VITC" indicates when the VITCode generator is active. When the VITCode generator is inactive, the program video passes through unaltered.

USR.B Alternately displays the generator time or user bits. A status LED in the upper left corner of the generator display indicates when user bits are being displayed. Also, the colons of the generator display are blanked when user bits are displayed. If the generator VCG is enabled (See Section 3.4) the user bits are also keyed into the video.

3.2.2 Presetting the Generator Time or User Bits

Twelve keys in the PRESET key group are used to enter time or user bit data into the generator.

SET When pressed the first time, it initiates a data entry mode that allows presetting of either the time or user bits of the generator, whichever is currently displayed. Depressing any numeric key now will enter the value into the display starting at the left. Unentered digits default to zero if entering the time, or to the previous value if entering user bits. After the required number of digits have been entered, press PRESET SET to complete the data entry mode. Pressing CLEAR exits from the data entry mode without presetting the time or user bits. Attempts to make illegal entries, ie 65 minutes will be ignored and the invalid digits will be blanked. Re-enter these digits and press PRESET SET to complete the data entry. After the entry mode has been terminated by either PRESET SET or CLEAR, the generator display will return to display the generator time.

3.2.3 Jam Sync Controls

MOM Momentarily jams reader data into the generator.

CONT Continuously jams reader data into the generator. The generator and reader times are compared with each other during each frame, automatically compensating for the frame decoding offset. If for any reason they are not equal, the jam is bypassed, the next frame address is substituted by the generator and the ERR LED is turned on. The number of consecutive frames containing jam sync errors that are to be bypassed may be configured using the FORMAT keypad (See Section 3.1.1 MODE key). If this number of jam sync errors is exceeded, the last valid reader time will be jammed into the generator again. In the absence of valid reader code, the generator will be preset to the last

valid reader time and will not increment until valid reader code resumes, or the jam sync mode is cancelled by pressing the CLEAR button.

In NTSC units when the continuous jam sync mode is entered, the generator is set to the drop frame mode that the reader data is recorded in. When the continuous jam sync mode is exited, the generator formatted drop frame mode is restored.

The continuous jam sync mode should be used when dubbing longitudinal time code from one tape to another, because the quality of the time code signal deteriorates with each generation. Translation from VITCode to LTC or from LTC to VITCode may be accomplished by using continuous jam and setting the jam sync by-pass errors to 1.

Since tapes cannot be prestriped with VITCode, the code must be recorded at the same time as the video. This makes jam sync code regeneration on the electronically edited master tape mandatory. In practice, the first program segment recorded on the edited master tape includes VITCode originating from a VITCode generator or from the source tape that is supplying the program segment. When in continuous jam, the last recorded frames of VITCode from the previous edit interval are jammed into the generator clock during the pre-roll to the edit point. This process is repeated at the start of every subsequent edit interval through the entire recorded program on the master tape. The result is that continuous VITCode is laid down in an ascending count from start to finish. It is important that any video tape editing system utilizing VITCode as the sole indexing method include jam syncing in the time code feed to the record VTR.

3.3 READER CONTROL FUNCTIONS

Two keys beneath the reader display provide control over the reader functions.

USR.B Alternately dislays the reader time or user bits. A status LED in the upper left corner of the reader display indicates when user bits are being displayed. Also, the colons of the reader display are blanked when user bits are displayed. If the reader VCG is enabled (See Section 3.4) the user bits are also keyed into the video.

FRZ Freezes the reader display. Alternate action of this key restores the normal display mode.

3.4 CHARACTER GENERATOR CONTROLS

Two keys labelled VCG, located beneath each of the generator and reader displays, control display of the generator and reader information respectively in the character generator. When the generator VCG button is pressed, the

generator video input is routed to the character generator. The data displayed in the VCG is the same as the data shown in the generator display. Pressing the generator VCG key again turns off the generator characters.

Pressing the reader VCG key routes the reader input video to the character generator and displays reader information in the character generator. The data displayed is the same as that shown in the reader display. Simple 4 character source ID user bit data will be shown as alpha-numeric characters. Pressing the reader VCG key again turns off the reader characters. Alpha-numeric user bit data will be shown as alpha-numeric characters when the alpha-numeric user bit option is fitted.

The character size and position are controlled from the FORMAT keypad. (See Section 3.1.3)

3.4.1 Drop Frame Indication (NTSC Units Only)

When displaying generator time, the colons will be replaced by periods if the generator is operating in drop frame mode. When displaying reader time, the colons will be replaced by periods if the data being read was recorded in SMPTE drop frame format.

3.4.2 Field Identification

When reading VITCode, the field number sequence will be displayed to the right of the reader time frames display. When the data being read was recorded in the non colour frame mode, ie. the COL'R indicator is off, the field number sequence will be 1, 2, 1, etc. (1, 2, 3, 4, 1, etc. for PAL). When the reader data was recorded in the colour frame mode, ie. the COL'R indicator is on, the field number sequence will be 1, 2, 3, 4, 1, etc. (1, 2, 3, 4, 5, 6, 7, 8, 1, etc. for PAL)

3.5 STATUS INDICATORS

There are 12 status indicators which show operational status at a glance.

3.5.1 Generator Status Indicators

U.B. Located beside the generator display indicates user bits being displayed.

LCK Indicates that the generator is properly locked to a composite video or colour black signal.

COL'R Indicates that the unit is operating in the colour frame mode and is properly locked to an NTSC RS-170A (8 field PAL) video source.

NTSC_Units: The 4 field NTSC sequence is being properly decoded. Frames containing field 1 of the sequence are being assigned an even frame number.

PAL_Units: The 8 field PAL sequence is being properly decoded. The EBU specified relationship between the frame address and the television field is being used in assignment of the generator frame numbers.

When the generator is operated in the continuous jam sync mode, and the reader data was not recorded in the colour frame format, the colour LED will not be illuminated. The generator frame numbers will be slaved to the reader frames.

D.F. Indicates that the generator is operating in the EIA drop frame format. (See Section 3.1.1 MODE)

VITC Indicates that the VITCode generator is enabled. When this indicator is on, the VITCode generator will be either recording VITCode, or erasing VITCode, depending upon the FORMAT modes selected. (See Section 3.1.1 VITC) When the VITCode indicator is off, the VITCode generator is disabled, and the generator input video is passed unchanged to the VITCode generator output.

3.5.2 Jam Sync Indicators

ERR Indicates a variety of problems in the jam sync mode. When it is flashing on an irregular basis, the reader could be receiving bad code, there may be a discontinuity in the code, or the code was recorded in a different standard than the generator is locked to. If it is flashing on a regular basis, it indicates that the reader code was colour framed with the frame numbers synchronized to the wrong field of the colour field sequence.

ON Indicates that the generator is operating in the continuous jam sync mode.

3.5.3 Reader Status Indicators

U.B. Located beside the reader display indicates user bits are being displayed.

VITC Indicates that the reader data being displayed is coming from the VITCode reader.

LTC Indicates that the reader data being displayed is coming from the LTC reader.

Selection of the source of reader data is controlled by the reader MODE key (See Section 3.1.2).

NTSC_Units: The 4 field NTSC sequence is being properly decoded. Frames containing field 1 of the sequence are being assigned an even frame number.

PAL_Units: The 8 field PAL sequence is being properly decoded. The EBU specified relationship between the frame address and the television field is being used in assignment of the generator frame numbers.

In Rev 2-4/84 When the generator is operated in the continuous jam sync mode, and the reader data was not recorded in the colour frame format, the colour LED will not be illuminated. The generator frame numbers will be slaved to the reader frames.

Add D.F. MODE OUT

Indicates that the generator is operating in the EIA drop frame format (See Section 3.1.1 MODE)

PAL_Units: Indicates that the generator is operating with use of the bi-phase mark parity bit selected. (See Section 3.1.1 MODE).

NTSC_Units: Indicates that the generator is operating in the EIA drop frame format. (See Section 3.1.1 MODE)

VITC Indicates that the VITCode generator is enabled. When this indicator is on, the VITCode generator will be either recording VITCode, or erasing VITCode, depending upon the FORMAT modes selected. (See Section 3.1.1 VITC) When the VITCode indicator is off, the VITCode generator is disabled, and the generator input video is passed unchanged to the VITCode generator output.

3.5.2 Jam Sync Indicators

ERR Indicates a variety of problems in the jam sync mode. When it is flashing on an irregular basis, the reader could be receiving bad code, there may be a discontinuity in the code, or the code was recorded in a different standard than the generator is locked to. If it is flashing on a regular basis, it indicates that the reader code was colour framed with the frame numbers synchronized to the wrong field of the colour field sequence.

ON Indicates that the generator is operating in the continuous jam sync mode.

3.5.3 Reader Status Indicators

U.B. Located beside the reader display indicates user bits are being displayed.

VITC Indicates that the reader data being displayed is coming from the VITCode reader.

~~LNGT~~ LTC Indicates that the reader data being displayed is coming from the LTC reader.

Selection of the source of reader data is controlled by the reader MODE key (See Section 3.1.2).

D.F. Indicates that the data being read was recorded in the SMPTE drop frame format.

COL'R Indicates that the data being read was recorded in the colour frame mode, ie. the correct relationship between frame address and colour burst phase was adhered to.

3.6 ALPHA-NUMERIC USER BIT CONTROLS

Alpha-numeric user bit information may be generated and read when the alpha-numeric user bit option is fitted.

3.6.1 Generating

When generating code with alpha-numeric user bits, connect an RS-232-C keyboard or terminal to the serial I/O port on the rear panel. (See Appendix II for description of serial I/O port pin assignments and I/O format.) The user bit transfer modes should be turned off. (See Section 3.1.1 UB. TRNS)

The following control keys are used to issue commands to the model ECM 4000, to enter alpha-numeric text into the screen buffer. Up to 4 pages of 14 (16 for EBU) lines of 32 characters each are available in the screen buffer. (A CTL-"key") is generated by simultaneously depressng the control key on the keyboard and striking that character.)

CTL-A Initializes the screen for entering characters in the full screen mode. The cursor is located at the top left corner of the first page.

CTL-C Initializes the screen for entering characters in the caption mode. The screen is configured for 2 rows of 32 characters each located at the bottom of the screen. The cursor is located at the left edge of the top row of characters on the first page. Up to 4 separate caption messages may be entered.

When initialized to either of the above entry modes, upper case displayable characters, ie. any ASCII character with decimal codes from 32 through 90 inclusive may be entered and will appear on the screen. (See Appendix III)

The cursor will advance once for each character entered. When the cursor reaches the bottom of the page, it will automatically advance to the next page.

The following control keys will help in editing the entered characters. The cursor will flash on and off when placed over a non-space character.

BACK SPACE (CTL-H) Will move the cursor to the left one position and erase the last character entered.

CTL-S Will move the cursor to the left one position without erasing that character.

CTL-D Will move the cursor to the right one position.

CTL-E Will move the cursor up one line. When the cursor reaches the top of the page it will roll over to the previous page.

CTL-X Will move the cursor down one line. When it reaches the bottom of the screen it will roll over to the next page.

CTL-W Views the previous page of text.

CTL-Z Views the next page of text.

CTL-I Inserts a space at the cursor location.

CTL-O Deletes the character at the cursor location.

RETURN (CTL-M) Stores a special "invisible" control character at the cursor location and moves the cursor to the beginning of the next line. If the cursor was previously on the bottom line of the screen, the cursor will go to the top line of the next page.

CTL-P Transmits a special control character which commands the edit code reader to turn off the alpha-numeric mode and to clear its screen.

When the required data is entered, or the entry buffer is full, place the cursor at the end of the text that you wish transmitted.

CTL-B Terminates the entry mode and enters the transmission mode. The characters from the screen are inserted into the edit code being generated according to the SMPTE/EBU specified format. A special alpha-numeric flag bit is set to indicate alpha-numeric data is present in the user bits. Four characters per frame are inserted into the code. The transmitted characters are replaced by blanks on the screen as they are transmitted. When the buffer is empty, the screen is cleared and the alpha-numeric mode is turned off. Characters placed to the right of the special carriage return character are ignored.

ESC (CTL-[) Terminates the entry mode, clears the screen and turns off the alpha-numeric mode without transmitting any characters.

3.6.2 Reading

When reading code with alpha numeric user bits, the reader character generator is used to display up to 4 pages of 14 (16 for EBU) lines of 32 characters each as they are received. (Reader VCG must be turned on to enable alpha-numeric user bit display - See Section 3.4) At least the first 2 frames of user bits received with the alpha flag bit set must contain either a CTL-A or CTL-C characters which are used to configure the screen for full screen mode or caption mode respectively. Successive characters are displayed as they are received.

Pressing the **PAGE** key views the next page of alpha-numeric data that was read and stored in the screen buffer. Pressing the **PAGE** button 4 times will return to the original page.

Receiving special control characters (issued by the CTL-P command above) turns off the alpha mode and restores the screen to its normal operation. Turning the reader character generator off using the reader VCG key on the front panel also terminates the alpha mode of the reader, and clears the screen.

4. TECHNICAL DESCRIPTION

The model ECM 4000 is a modular design consisting of a motherboard, six plug-in modules, and a display/keypad. The functions of each module are divided as follows:

4000-1 Display and keyboard
4000-2 Microcomputer and LTC generator
4000-3 VITCode generator
4000-4 VITCode and LTC readers
4000-5 Character generator logic
4000-6 VITCode and VCG keyers

4.1 DISPLAY AND KEYBOARD MODULE 4000-1

Two 8 digit displays and 10 status LED's are multiplexed; that is segment information for each digit is presented in coincidence with a digit enable pulse to the appropriate digit. The 33 keys are aranged in a 4 x 10 matrix. Data from 4 keys is latched into U5 at the time of the digit enable pulse, thus scanning the total array.

4.2 PROCESSOR MODULE 4000-2

At the heart of the ECM 4000 is an 8751 single chip microcomputer (MCU). Port 2 and the Bus port are used as a 16 bit address/data bus for communicating with various devices located throughout the unit. Address decoding is accomplished on the module where the device is located.

4.2.1 LTC Bit Rate Generator

An on board ocsillator, part of U13, is crystal controlled and provides the main processor clock and is divided down to the LTC bit rate. The oscillator frequency is calibrated to 7.76823 MHz (7.776 MHz PAL) by the use of VC1. Connection of a frequency counter at U13 pin 16 may cause the MCU to lose program control, however, this will not affect the frequency measurement.

4.2.2 Reset Threshold Adjustment

U2a and associated components senses the loss of pre-regulated voltage due to a mains brownout or power failure condition. For proper operation, VR1 should be adjusted so that the RESET pin of the MCU (pin 9) is high when the mains voltage is below 95 volts (190 volts for 230 VAC operation).

4.3 VITCode GENERATOR MODULE 4000-3

4.3.1 Colour Frame Detector

Recalibration of the colour frame detector is accomplished by adjusting VR2. The generator input loop must be connected to an RS-170-A (8 field PAL) video source and properly terminated. The unit must also be set up to operate in the colour frame mode as described in the Section 3.1.1 (4/8 FLD) of this manual. There are two methods of checking the calibration.

Procedure A:

You may use procedure A if you have a colour field #1 identification pulse output from your sync generator.

1. Display the colour field #1 identification pulse from your sync generator on channel A of your scope. Set up the time base to show two pulses.

2. Display the CFP output of the model ECM 4000 (U26 pin 4) on channel B of your scope. CFP is also available on pin 21 of the 25 pin remote control connector or on pin 5 of the module Bus connector. CFP is an active high pulse of 5 μSec duration.

3. Adjust VR2 slowly until CFP coincides with your sync generator field #1 identification pulse. Adjust VR2 clockwise until CFP disappears or moves halfway between the two pulses on channel A. Mark this position of VR2 with a pencil. Adjust VR2 counterclockwise until CFP reappears coincident with your sync generator field #1 pulse and continue adjusting VR2 until CFP disappears again. Mark the position of VR2 with a pencil.

4. Position VR2 halfway between the two marks. The LCK and COL'R indicators of the generator should be on.

Procedure B:

You may use procedure B if you have another model ECM 4000 that you can use as a calibration standard.

1. Connect the generator output of the unit you wish to calibrate (TEST unit) to the reader input of the unit already calibrated (STD unit). Connect the same video signal to the GEN loop input of each unit. Make sure the signal is only terminated once if you are looping through one unit to the other. The LCK and COL'R indicators of the STD unit should be on.
2. Put the STD unit in the continuous jam sync mode. Adjust VR2 in the TEST unit until the LCK and COL'R indicators come on and the ERR indicator on the STD unit is off. Adjust VR2 in the TEST unit clockwise until the ERR indicator in the STD unit flashes. Mark the position of VR2 with a pencil. Adjust VR2 counter-clockwise until the ERR indicator goes off and then starts flashing again. Mark this position of VR2 with a pencil.

3. Position VR2 half way between the two marks. The LCK and COL'R indicators of the TEST unit should be on and the ERR indicator on the STD unit should be off.

4.3.2 VITCode Bit Rate Generator

The VITCode bit rate is generated by a crystal controlled oscillator consisting of U1a and associated components. The oscillator output (U3 pin 2) is 8 times the VITCode bit rate (14.31818 MHz for NTSC, 14.5 MHz for PAL) and is adjusted using VC1.

4.3.3 VITCode Position

VITCode positioning with respect to horizontal sync on the selected VITCode lines is adjusted by VR1. Connect the generator output to one of the channels on your oscilloscope. Trigger the scope on the field drive signal from your sync generator using the external trigger input and adjust the scope to view one of the selected VITCode lines using the variable delay trigger facility of your scope. Adjust VR1 so that the leading edge of the first "1" bit is 10.5 µSec (11.0 µSec Pal) after the leading edge of horizontal sync. Take care that the keyed in "0" bit level (black level) which extends 6 bit periods after the last bit of the CRC does not extend beyond the leading edge of horizontal sync for the next video line.

4.4 READER MODULE 4000-4

The LTC clock and data separator circuitry decodes clock pulses from the longitudinal code and data is shifted into shift registers U10, U12, and U15. The VITCode sync and data separator recovers VITCode data from the incoming video and data is shifted into shift registers U18 and U22. Both the VITCode and LTC readers signal the MCU when they have received one frame of data, and the respective data is transferred to the MCU via a common shift register U20.

4.5 VCG LOGIC MODULE 4000-5

The MCU writes characters into specified locations of the 2048 bytes of RAM corresponding to the position of the characters on the screen. RAM locations scanned during each television field address corresponding sections of the character PROM U27 and character data is shifted out from U28 and keyed into the video on the Keyer module.

4.5.1 Character Size and Positioning Adjustments

Horizontal size of the small and large size characters is adjusted by VR1 and VR2 respectively. The starting position of the characters at the left of the screen is preset but may be altered by varying the value of R5.

4.6 VIDEO KEYER MODULE 4000-6

There are two keyers on this module, one for the character generator, and one for the VITCode generator. The VITCode keyer is located on the right side and the VCG keyer is on the left.

4.6.1 VITCode Keyer Setup

Connect colour bars from your sync generator to the generator input loop and to channel A of your scope and terminate it. Turn on the VITCode generator as described in section 3.2.1 of this manual. Connect the generator output to channel B of your scope and properly terminate it. Trigger the scope on the field drive signal from your SPG using the external trigger input and adjust the scope to view one of the selected VITCode lines using the variable delay trigger facility of your scope. Adjust the **BLACK BALANCE** trimpot (VR5) so that the logic "0" level of the VITCode is coincident with the black level of the incoming video. Adjust the **KEY BALANCE** trimpot (VR3) to minimize any key spikes that may occur at either end of the inserted VITCode line.

Adjust the scope so that the vertical gain of both channels is the same, and position the traces so that the input and output traces are overlayed. Adjust the **GAIN** (VR4) so that the amplitude of the generator output matches the input. Adjust the **DC LEVEL** trimpot (VR6) so that the DC level of the generator output is at 0 VDC. Adjust the Frequency Response trimmer (VC2) so that the burst amplitude of the generator output matches that of the input.

4.6.2 VCG Keyer Setup

Connect colour bars from your sync generator to the generator input loop and to channel A of your scope, and terminate it. Connect the VCG output to channel B of your scope and terminate it. Select the generator VCG as described in Section 3.4 of this manual. Adjust the **GAIN** trimpot (VR1) so that the output amplitude matches the input. Adjust the **CHAR LEVEL** trimpot (VR2) so that the inserted characters are slightly above peak white luminance level. Disconnect the colour bars from the generator input and connect to the reader input loop, with the scope and the termination connected to the reader input loop. Select the reader VCG as described in Section 3.4 of this manual. Confirm that the output amplitude matches the input.

APPENDIX I:

COLOUR FRAMING AND THE SMPTE/EBU CODE

DISCUSSION:

Operation of an editing system using SMPTE or EBU standard editing codes require a number of special parameters in the way the code is recorded, the operation and setup of the VTR's, and the way the editor is used. These parameters are listed below:

1. Synchronizng the time code to the video signal, as concerning field one/field two synchronization.

2. Synchronizing the time code to the video signal, as concerning 4-field (8-field PAL) colour framing.

3. The stability of the station sync generator to meet EIA RS-170A (EBU PAL 8-field) specifications.

4. The setup of the VTR itself for proper 4-field (8-field PAL) colour identification and synchronization.

When all of the above parameters are met for use with direct, high band type VTR's, editing synchronization can be achieved.

1. Longitudinal SMPTE/EBU time code (LTC) is a digital reference code that is recorded along the length of an audio or cue track of a video tape. Each video frame is given a unique identifying number, which is formatted to include hours, minutes, seconds, and frames as well as other information.

   Vertical Interval Time Code (VITCode) is a digital reference signal recorded in the field blanking interval of the video signal. It identifies the video fields in addition to information in the LTC.

   Each frame is composed of two sequential fields of video called field 1 and field 2. Each of these two fields is uniquely identified and should always be sequential. SMPTE/EBU specifications call for LTC time code to start during the vertical serrations at the start of field one. The generator, therefore, must be connected to a stable synchronizing video or sync source, or the generated code will "free run" and will produce ambiguous identification of the video frames. Because VITCode is recorded on the program video, it always provides accurate field identification.

   In editing, if the recorded time code is not synchronized to the VTR video an "ABORT" may occur at the edit point. (The VTR's will be synchronized as pertaining to vertical sync, but the time codes would not.)

2. The NTSC television standard used a chroma subcarrier frequency of 3579545 Hz. of which 227.5 complete cycles fit into one horizontal line. With 525 horizontal lines in one frame, this produces

227.5sc cycles/hor line x 525 hor lines/frame
= 119,437.5 subcarrier cycles per frame.

After one frame, there is an additional .5 subcarrier left over. In this manner, it takes 2 frames (4 fields) to return to a nonfractional subcarrier cycle count.

The PAL television standard uses a chroma subcarrier frequency of 4433618.75 Hz of which 283.7516 cycles fit into one horizontal line. With 625 horizontal lines in one frame, this produces

283.7516 cycles/hor line x 625 hor lines/frame
= 177,344.75 subcarrier cycles per frame.

Therefore, it takes 4 frames (8 fields) to return to a non-fractional subcarrier cycle count.

Before the development of time-base correction techniques, a part cycle displacement at the beginning of each field did not cause any problems. With time-base correcting, a sudden shift of a part cycle (as at an edit point for example) will cause a shift of the entire picture horizontally to match up the subcarrier cycles into proper sequence.

To eliminate such problems, most high band, direct-recording VTR's detect and synchronize the playback video with the incoming video so that the subcarrier cycles are matched. When this is done, a video edit will produce a proper sequence of the subcarrier. As discussed above, it requires 2 (4 PAL) frames of video before the proper sequence occurs. If two edit points (one for record VTR, one for source) are selected that do not maintain the proper colour sequence, the editing computer will attempt to synchronize the two VTR's to match an improper colour sequence. If the record VTR contains its own colour framing correction circuit, a conflict occurs: the record VTR will attempt to synchronize for proper colour sequence, and the edit controller will attempt to synchronize for proper selected edit point.

If the specific fields of the colour sequence are defined when the time code is recorded on all tapes used in an edit session, then edit points may be easily chosen which will observe the correct colour field sequence. It is imperative that such colour framed time code be used when editing with colour framing VTR's. A colour flag bit is set in the code to indicate colour frame address assignments.

The SMPTE specification regarding colour frame addresses states:

> "If colour field identification in the code is required, then the even units of frame numbers shall identify frame A and the odd units of frame numbers shall identify frame B as defined in EIA standard RS-170-A."

The EBU specification regarding colour frame addresses and the associated eight fields of the PAL video signal states:

> "When the time code is displayed in decimal numbers, S and P designating the number of seconds and pictures respectively, then:
>
> a) S+P is odd for fields 1 and 2 and fields 5 and 6
> S+P is even for fields 3 and 4 and fields 7 and 8
>
> b) The remainder after dividing S+P by 4 is:
>
> 0 for fields 7 and 8
> 1 for fields 1 and 2
> 2 for fields 3 and 4
> 3 for fields 5 and 6."

3. Since the subcarrier to horizontal sync (Sc-H) relationship has become an important part of today's technology in video tape recording, new standards have been adopted which outline the 4 (8 PAL) colour fields and set up tighter specifications in subcarrier to horizontal sync (Sc-H) drift.

For NTSC colour systems, colour field 1 is that field with positive going subcarrier zero-crossings most nearly coincident with the half-amplitude point of the leading edges of even numbered horizontal sync pulses. The tolerance in this coincidence is +/- 40° of reference subcarrier. (See Figure I-2)

For PAL colour systems, the Sc-H phase is defined as the phase of the Eu component of the colour burst extrapolated to the half amplitude point of the leading edge of the synchronizing pulse of line 1 of field #1. Colour field 1 of the 8 field sequence is defined as that field where the preferred Sc-H phase is 0°. For maximum protection against picture disturbances at edit points, the EBU recommends Sc-H values 0 +/- 20° for colour field 1. (See Figure I-1)

4. On many of the 1" VTR's presently in use, the colour frame identification is switched on or off when the tape is first recorded. A special colour frame pulse is recorded on the control track to identify a special colour field (15 Hz NTSC, 6.25 Hz PAL). When the full colour frame mode is used, all of the above parameters must be met, in order for a proper edit sequence of the colour fields. It should be understood that although the VTR itself is capable of synchronizing to full colour field synchronization, the sync source must be capable of meeting the new Sc-H specifications. (A portable camera used in a remote location may not meet this spec.)

With all the aforementioned variables met, proper colour field editing and edit control synchronization can be achieved with minimal problems. It can be concluded that time code edit synchronization can be achieved by:

1. Proper recording of time code and video synchronized to a sync generator using new Sc-H tolerances.

2. Using a time code generator capable of synchronizing to the 4-field (8-field PAL) colour sequence.

3. Proper set up of all VTR's and TBC's for correct colour sequencing.

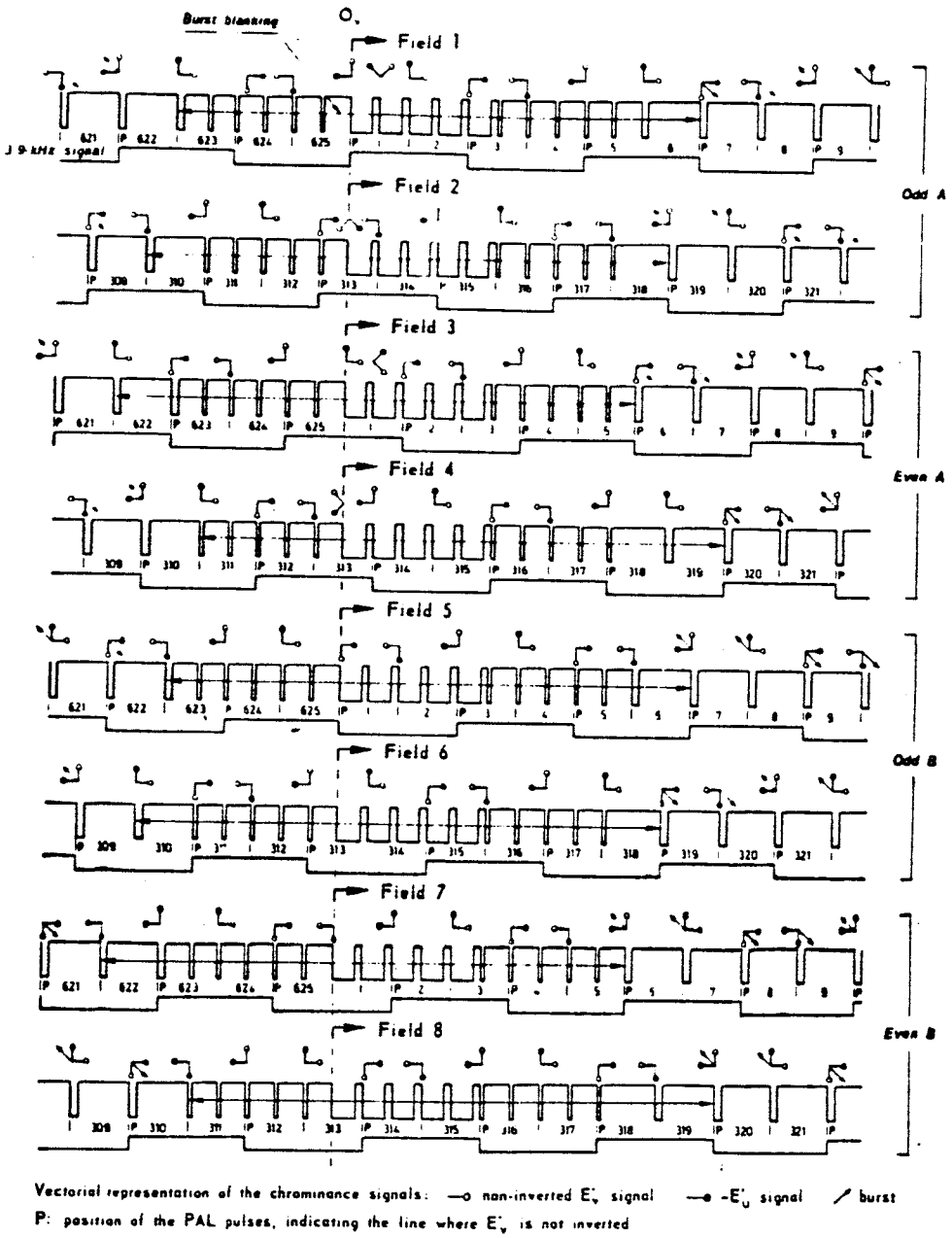


Figure I-1 - The Eight-Field Sequence of the PAL System

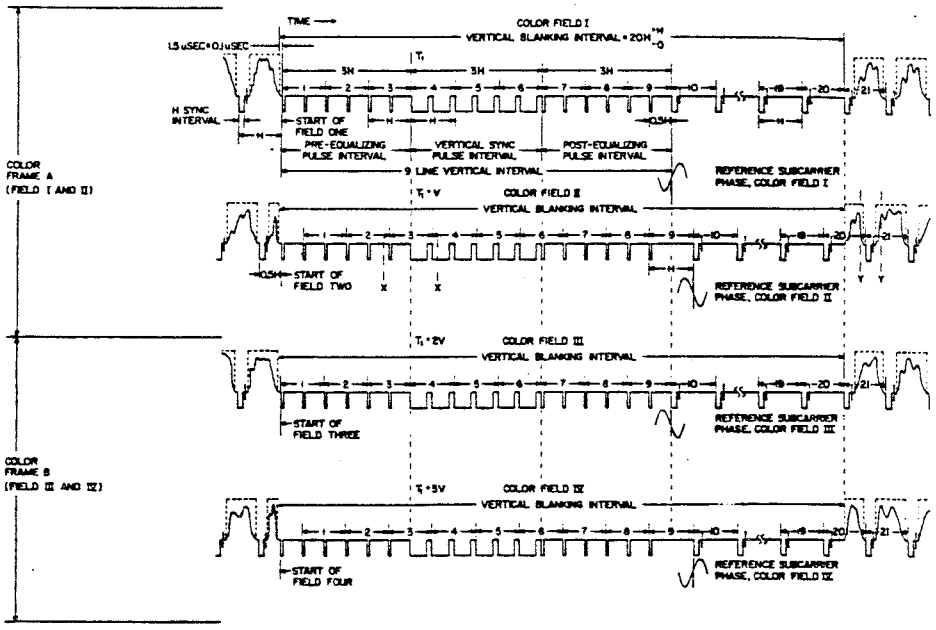


Figure I-2 - RS-170-A Synchronizing Waveforms

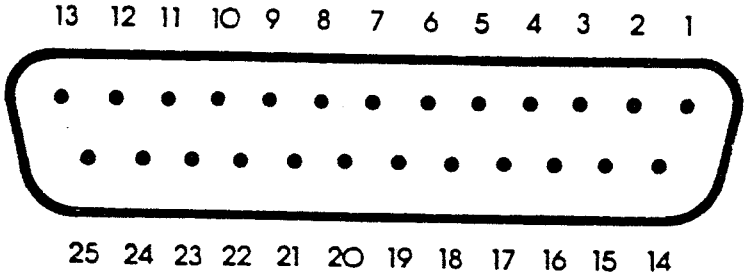
APPENDIX II:

REMOTE CONTROL PORT PIN ASSIGNMENTS

Note: To avoid conflict, connect only the pins required for your application.

Pins 9 to 12 refer to the standard remote control interface.

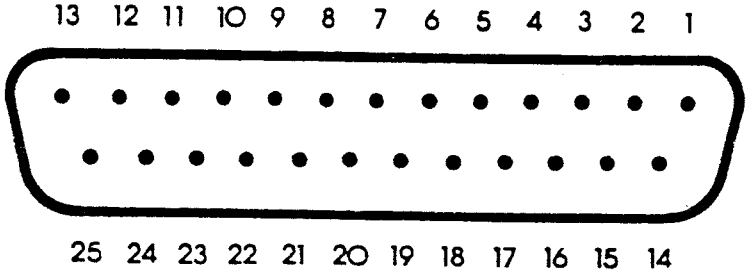
Pins 3 thru 8, and 14 thru 20 refer to the optional remote control unit RCU 400.



Pin	Name	Description
1	--	Not Used
2	--	" "
3	RX	5V Balanced Input
4	RX	
5	TX	5V Balanced Output
6	TX	
7	RTS	5V Handshake Lines
8	CTS	
9	REM 4	Remote Control Input #4
10	REM 3	" " " #3
11	REM 2	" " " #2
12	REM 1	" " " #1
13	GND	Remote Control Ground
14	+8V	
15	+8V	300 mA MAX DC
16	+8V	supply to optional
17	+8V	Remote Control Panel
18	GND	
19	GND	
20	GND	
21	CFP	Field #1 Identification Pulse
22	GND	VITCode Keyer Control
23	VITCode EN	
24	GND	VITCode Keyer Information
25	VITCode	

SERIAL I/O PORT PIN ASSIGNMENTS

Note: To avoid conflict, connect only the pins required for your application.



Pin	Name	Description
1	--	Not Used
2	RD	Received Data 8 bits, 1 stop bit
3	TD	Transmitted Data 1200 BAUD, no parity
4	RTS	Must be high for data to be transmitted
5	CTS	High when data is being transmitted
6	DSR	Acknowledges remote device is operational
7	GND	Signal Ground
8	--	Not Used
9	--	" "
10	--	" "
11	--	" "
12	--	" "
13	--	" "
14	--	" "
15	--	" "
16	--	" "
17	--	" "
18	--	" "
19	--	" "
20	DTR	High when DSR high
21	--	Not Used
22	--	" "
23	--	" "
24	--	" "
25	GND	

APPENDIX III:

ASCII CODE LIST

CHAR	DEC	HEX	CHAR	DEC	HEX	CHAR	DEC	HEX
CTL-@(NUL)	0	00	SPACE	32	20	@	64	40
CTL-A(SOH)	1	01	!	33	21	A	65	41
CTL-B(STX)	2	02	"	34	22	B	66	42
CTL-C(ETX)	3	03	#	35	23	C	67	43
CTL-D(EOT)	4	04	$	36	24	D	68	44
CTL-E(ENQ)	5	05	%	37	25	E	69	45
CTL-F(ACK)	6	06	&	38	26	F	70	47
CTL-G(BEL)	7	07	'	39	27	G	71	47
CTL-H(BS)	8	08	(	40	28	H	72	48
CTL-I(HT)	9	09	)	41	29	I	73	49
CTL-J(LF)	10	0A	*	42	2A	J	74	4A
CTL-K(VT)	11	0B	+	43	2B	K	75	4B
CTL-L(FF)	12	0C	,	44	2C	L	76	4C
CTL-M(CR)	13	0D	-	45	2D	M	77	4D
CTL-N(SO)	14	0E	.	46	2E	N	78	4E
CTL-O(SI)	15	0F	/	47	2F	O	79	4F
CTL-P(DLE)	16	10	0	48	30	P	80	50
CTL-Q(DC1)	17	11	1	49	31	Q	81	51
CTL-R(DC2)	18	12	2	50	32	R	82	52
CTL-S(DC3)	19	13	3	51	33	S	83	53
CTL-T(DC4)	20	14	4	52	34	T	84	54
CTL-U(NAK)	21	15	5	53	35	U	85	55
CTL-V(SYN)	22	16	6	54	36	V	86	56
CTL-W(ETB)	23	17	7	55	37	W	87	57
CTL-X(CAN)	24	18	8	56	38	X	88	58
CTL-Y(EM)	25	19	9	57	39	Y	89	59
CTL-Z(SUB)	26	1A	:	58	3A	Z	90	5A
CTL-[(ESC)	27	1B	;	59	3B	[	91	5B
CTL-\(FS)	28	1C	<	60	3C	\	92	5C
CTL-](GS)	29	1D	=	61	3D	]	93	5D
CTL-^(RS)	30	1E	>	62	3E	^	94	5E
CTL-_(US)	31	1F	?	63	3F	_	95	5F

APPENDIX IV:

SOURCE IDENTIFICATION MESSAGES

DISPLAYED MESSAGE	MSG #	DISPLAYED MESSAGE	MSG #	DISPLAYED MESSAGE	MSG #
	00	PRES	34	SPARE	67
JAN	01	REM	35	SPARE	68
FEB	02	SAT	36	SPARE	69
MAR	03	SLID	37	SPARE	70
APR	04	STL	38	SPARE	71
MAY	05	STUD	39	SPARE	72
JUN	06	TC	40	SPARE	73
JUL	07	TEST	41	SPARE	74
AUG	08	TV	42	SPARE	75
SEP	09	VCR	43	SPARE	76
OCT	10	VITC	44	SPARE	77
NOV	11	VT	45	SPARE	78
DEC	12	VTR	46	SPARE	79
AIR	13	SPARE	47	SPARE	80
AUX	14	SPARE	48	SPARE	81
BARS	15	SPARE	49	SPARE	82
BAY	16	SPARE	50	SPARE	83
BLK	17	SPARE	51	SPARE	84
BVU	18	SPARE	52	SPARE	85
CAM	19	SPARE	53	SPARE	86
CAP	20	SPARE	54	SPARE	87
CGEN	21	SPARE	55	SPARE	88
CLK	22	SPARE	56	SPARE	89
CRT	23	SPARE	57	SPARE	90
DUB	24	SPARE	58	SPARE	91
ECM	25	SPARE	59	SPARE	92
EDIT	26	SPARE	60	SPARE	93
ENG	27	SPARE	61	SPARE	94
FILM	28	SPARE	62	SPARE	95
LINE	29	SPARE	63	SPARE	96
MCR	30	SPARE	64	SPARE	97
MON	31	SPARE	65	SPARE	98
NET	32	SPARE	66	SPARE	99
OB	33				

Figure IV-1 - Message Select Codes