

## **VIDEOTAPE RECORDING**

**Theory and Practice** 

JOSEPH F. ROBINSON



Focal Press · London

#### © 1978 FOCAL PRESS LIMITED

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the copyright owner.

### British Library Cataloguing in Publication Data

Robinson, Joseph Frederick, b.1942

Videotape recording. — 2nd ed. — (Library of image and sound technology).

1. Video tape recorders and recording

I. Title II. Series

621.389'32 TK6655.V5

ISBN (excl. U.S.A.) 0 240 51020 8 ISBN (U.S.A. only) 0 8038 7764 1

To ANDREA, JOHANNE and KIRSTI

> First Edition 1975 Second Impression 1975 Third Impression 1976 Second Edition 1978

# **Contents**

PR)	EFACE	13
INT	TRODUCTION	15
1	TAPE RECORDING PRINCIPLES  Hysteresis Sheared hysteresis Audio recording Erase process Record process Replay process Low frequency losses High frequency losses Other losses Head alignment losses Final response Distortion DC bias AC bias Equalisation	19 19 22 23 24 25 28 31 31 32 34 36 36 37 38
	Characteristics of recording tape References	41 44
2	BASIC REQUIREMENTS OF VIDEOTAPE RECORDING Elements of a videotape recorder Care of tape	45 45 48

	Tape checking Care of the tape deck Degaussing Tip projection Care of the electronics	49 49 51 51 51
3	THE BROADCAST QUADRUPLEX FORMAT Track width and spacing Overlap The purpose of longitudinal tracks Position of field sync Format data Deck layout Vacuum chambers References	55 56 58 58 61 61 63 63 65
4	CCTV FORMATS Two-headed wrap One-headed wraps Sync line-up Stop-motion The control track References	66 68 74 75 75 76
5	FM THEORY Basic FM theory Frequency modulation used in video recording Deviation frequency and modulation index Distortion in FM Signals Causes of moiré patterning Choosing centre frequency to combat patterning Pilot tone and chroma pilot Response requirements for the signal system Specification of pre-emphasis Conclusion References	77 77 80 83 84 87 89 91 92 93 94
6	SIGNAL SYSTEMS Record electronics Frequency modulators Automatic frequency control Record driver Optimisation	95 95 95 99 100 101

	Playback	102
	High input impedance amplifier	103
	Low input impedance channel amplifier	104
	Equalisers	104
	The cosine equaliser	105
	Switchers	107
	Blanking switchers (quadruplex)	108
	The stages of switching (quadruplex)	110
	Switch waveform generation (quadruplex)	110
	Generation of front porch switch	111
	Demodulation	112
	Methods of producing twice frequency pulses	113
	Switch suppression and feedback clamping	114
	Drop-out compensation	115
	Auto-equalisation	116
7	SERVO-MECHANISMS	119
	Velocity control methods	119
	Servo elements	120
	Phase comparators	121
	The forward backward counter	123
	Discriminators	124
	Motor control	126
	Ring counter	128
	Amplitude and pulse width control of an a.c. supply	129
	DC control	130
	Practical quadruplex servos	131
	Identification of frame pulse	138
	Head wheel servo	138
	Head wheel comparator	141
	Auto tracking (capstan)	142
	Practical helical servos	143
	Playback modes	144
	Instability	146
	References	146
8	GEOMETRICAL ERRORS	147
	Adjustments to quadruplex machines	147
	Azimuth (preset)	148
	Axial displacement (preset)	149
	Quadrature displacement (preset)	149
	Guide positional errors (adjustable)	150
	Velocity errors	153
	Guide radius	153
	Tape transport topology	154
	Temperature and humidity	156
		7

	Canalysian	150
	Conclusion Adjustments to helical machines	15
	Head position	15
	Tape path and interchange	158
	Compatibility coefficient	159
	Timing errors	162
	Environmental changes	162
	Tape tension	165
	Auto tension	167
	Conclusion	168
	References	168
9	TIME BASE ERROR CORRECTION	169
	Nature of timing errors	170
	Methods of monochrome correction	170
	Methods of applying delay	171
	Binary delay switching	174
	Determining the required delay	175
	Fourth power law	176
	The stable references	177
	The quantised gate	179
	Binary error detection	179
	Colour correction	181
	Sync feedback	183
	Error dumping	185
	Sync subcarrier lock	185
	Velocity error correction (quadruplex)	186
	Conclusion	193
	References	193
10	DIGITAL TIME BASE CORRECTION	194
	Analogue-digital conversion	194
	LF linearity	197
	Differential gain	197
	Differential phase	198
	Interpretation of results	198
	Methods of analogue to digital conversion	199
	A practical A-D convertor for video	201
	Digital to analogue conversion	202
	Time-base correction of digital signals	203
	Vernier correction	203
	Coarse correction	205 205
	The line shift register	203
	The RAM Sync feedback	207
	DITTO TOUTUGUE	200

	Velocity error correction Reduction of bit rate Delta modulation References	210 211 211 212
11	COLOUR CORRECTION IN CCTV  Tolerant systems Electronic stabilisation Pilot tone Burst locked oscillator Methods of stabilisation Bandwidth reduction Pilot chroma carrier Conclusion References	213 213 216 217 218 219 221 223 225 226
12	CASSETTES AND CARTRIDGES Broadcast cassettes The helical cassette Conclusion References	227 227 230 233 233
13	Physical editing Electronic editing Erase and RF turn-on Playback and record phase Editing color sequences Electronic editing, general Cue tone programming of edits Time code addressing Recording codes SMPTE address code Format of SMPTE code Functions of sync word Bit number 10 (the "drop frame flag") Bit number 11 (standard binary groups) Bits numbers 27, 43, 58, 59 Automatic editing References	234 234 236 238 246 247 248 250 250 253 254 258 259 260 261
14	MAGNETIC VIDEO DISCS AND SLOW MOTION TECHNIQUES Record and playback sequence Stop-motion	262 264 265

NTSC chroma correction	266
Half line delay logic	267
Video disc signal path	270
PAL chroma correction	270
Slow and fast motion	272
Conclusion	273
References	274
APPENDIX	275
GLOSSARY	319
INDEX	324

## **Videotape Recording**



#### LIBRARY OF IMAGE AND SOUND TECHNOLOGY

ACOUSTICS OF STUDIOS AND AUDITORIA
v. s. mankovsky

BASIC MOTION PICTURE TECHNOLOGY L. BERNARD HAPPÉ

WIDE-SCREEN CINEMA AND STEREOPHONIC SOUND

MICHAEL Z. WYSOTSKY

COLOR FILM FOR COLOR TELEVISION RODGER J. ROSS

FILM LIBRARY TECHNIQUES
HELEN P. HARRISON

VIDEOTAPE RECORDING JOSEPH F. ROBINSON

This book is sold subject to the Standard Conditions of Sale of Net Books and may not be re-sold in the UK below the net price.

## **VIDEOTAPE RECORDING**

**Theory and Practice** 

JOSEPH F. ROBINSON



#### © 1978 FOCAL PRESS LIMITED

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the copyright owner.

### British Library Cataloguing in Publication Data

Robinson, Joseph Frederick, b.1942

Videotape recording. — 2nd ed. — (Library of image and sound technology).

1. Video tape recorders and recording

I. Title II. Series

621.389'32 TK 6655.V5

ISBN (excl. U.S.A.) 0 240 51020 8 ISBN (U.S.A. only) 0 8038 7764 1

To ANDREA, JOHANNE and KIRSTI

First Edition 1975 Second Impression 1975 Third Impression 1976 Second Edition 1978

# **Contents**

PRI	EFACE	13
INI	TRODUCTION	15
1	TAPE RECORDING PRINCIPLES  Hysteresis Sheared hysteresis Audio recording Erase process Record process Replay process Low frequency losses High frequency losses Other losses Head alignment losses Final response Distortion DC bias AC bias Equalisation Characteristics of recording tape References	19 19 22 23 24 25 28 31 31 32 34 36 36 37 38 39
2	BASIC REQUIREMENTS OF VIDEOTAPE RECORDING Elements of a videotape recorder Care of tape	45 45 48

	Tape checking Care of the tape deck Degaussing Tip projection Care of the electronics	49 49 51 51
3	THE BROADCAST QUADRUPLEX FORMAT Track width and spacing Overlap The purpose of longitudinal tracks Position of field sync Format data Deck layout Vacuum chambers References	55 56 58 58 61 61 63 63
4	CCTV FORMATS Two-headed wrap One-headed wraps Sync line-up Stop-motion The control track References	66 68 74 75 75
5	FM THEORY Basic FM theory Frequency modulation used in video recording Deviation frequency and modulation index Distortion in FM Signals Causes of moiré patterning Choosing centre frequency to combat patterning Pilot tone and chroma pilot Response requirements for the signal system Specification of pre-emphasis Conclusion References	77 77 80 83 84 87 89 91 92 93 94
6	SIGNAL SYSTEMS Record electronics Frequency modulators Automatic frequency control Record driver Optimisation	95 95 95 99 100

Low input Equalisers The cosing Switchers Blanking s The stages Switch wa Generatio Demodula Methods of Switch sup	switchers (quadruplex) s of switching (quadruplex) veform generation (quadruplex) n of front porch switch ation of producing twice frequency pulses oppression and feedback clamping compensation	102 103 104 105 107 108 110 111 112 113 114
Velocity of Servo elen Phase com The forward Discrimina Motor con Ring count Amplitude DC control Practical of Identificat Head when Auto track	nparators and backward counter ators ators atter e and pulse width control of an a.c. supply bl quadruplex servos ion of frame pulse el servo el comparator king (capstan) nelical servos modes	119 119 120 121 123 124 126 128 129 130 131 138 138 141 142 143 144 146 146
Adjustmer Azimuth ( Axial dispi Quadratur Guide pos Velocity er Guide radi Tape trans	lacement (preset) re displacement (preset) itional errors (adjustable) rrors	147 147 148 149 149 150 153 153 154

	Tape tension Conclusion Adjustments to helical machines Head position Tape path and interchange Compatibility coefficient Timing errors Environmental changes Tape tension Auto tension Conclusion References	156 156 157 157 158 159 162 162 165 167 168
9	TIME BASE ERROR CORRECTION  Nature of timing errors Methods of monochrome correction Methods of applying delay Binary delay switching Determining the required delay Fourth power law The stable references The quantised gate Binary error detection Colour correction Sync feedback Error dumping Sync subcarrier lock Velocity error correction (quadruplex) Conclusion References	169 170 170 171 174 175 176 177 179 181 183 185 185 186 193 193
10	DIGITAL TIME BASE CORRECTION Analogue—digital conversion LF linearity Differential gain Differential phase Interpretation of results Methods of analogue to digital conversion A practical A—D convertor for video Digital to analogue conversion Time—base correction of digital signals Vernier correction Coarse correction The line shift register The RAM Sync feedback	194 194 197 197 198 198 199 201 202 203 203 205 205 207