

Contents

Preface **x**

Acknowledgments **xiv**

1 Introduction **1**

Consumer Demand 1

Trends 3

Broadcast and Telecine Utilization 4

Large Studio Cameras 4

Small Studio–Outside Broadcast Types 5

Electronic News Gathering (ENG) 6

Electronic Field Production (EFP) 6

Utility Cameras 7

Telecine 8

Closed-Circuit Applications 8

Surveillance and Monitoring Cameras 8

Educational and Audio-Visual Systems 9

Scientific Applications 9

Image-Analysis Systems 9

Military Applications 10

Industrial Imaging Applications 10

Medical Imaging 11

Still Video 11

PART I CONSUMER CAMERAS AND CAMCORDERS

2	Optics, Autofocus, and White Balance	13
	The Zoom Lens	15
	Focusing	19
	Autofocus Systems	20
	<i>The Infrared Method</i>	20
	<i>The Piezo Autofocus System (TTL Method)</i>	25
	<i>The TCL Phase-Differential Detection Method</i>	26
	<i>The TCL Autofocus System</i>	28
	White Balance	33
	<i>Auto-White Balance in Zenith's Model 7100 Camcorder</i>	33
	Lens Iris Control	35
	<i>Automatic-Lens Iris Control</i>	36
	Viewfinders	38
	<i>Operation and Circuitry</i>	38
	Electronic Shutters	41
3	Solid-State Image Sensors	44
	Charge-Coupled Image Sensors (CCDs)	45
	MOS Imagers	46
	Silicon	49
	Scanning	49
	Interline-Transfer Operation of a CCD Image Sensor	50
	X-Y-Addressed MOS Imagers	56
4	Color Television and Color Filter Arrays	59
	Color Filter Arrays for Solid-State Image Sensors	60
	The Green-Striped R/B Line-Sequential System	63
	<i>Removal of False Color Signal</i>	63
	<i>Color Difference Signal Processing</i>	66
	<i>Luminance Signal Processing</i>	66
	Complementary Plus Green Color Array	68
	<i>First Field</i>	68
	<i>Second Field</i>	69
	Complementary "Delta" Plus White Array	73
	Complementary Plus Green Plus White Array	75
5	Camera Signal Processing with Color Primaries	76
	The Signal Processing System	78
	<i>The Process IC Stage</i>	78
	<i>The Matrix IC Stage</i>	79
	<i>The Encoder IC Stage</i>	80

Imager Circuit Operation	81
<i>Horizontal Shift-Register Drive Circuit</i>	82
<i>Vertical Shift-Register Drive Circuit</i>	82
Timing-Generator Circuit Operation	84
<i>The Timing Generator</i>	84
<i>Sync Signal Generator (SSG)</i>	85
<i>Defect Compensation</i>	87
Process Circuit Operation	87
<i>Process IC</i>	87
Matrix Circuit Operation	92
<i>Matrix IC</i>	92
Encoder Circuit Operation	95
<i>The Y Signal System</i>	98
<i>Color Difference Modulation and Burst-Signal Formation Circuits</i>	99
External Sync/Genlock	101
<i>External Sync Signal-Processor Circuit</i>	101
<i>V Reset Signal (Sync Separation)</i>	101
<i>f_H Control Signal (H.SYNC Separation and H.PHASE)</i>	103
<i>The f_{SC} Control Signal</i>	103
<i>Extraction of the Subcarrier Signal and SC.PHASE Control</i>	104

6 Camera Signal Processing with Complementary Color Arrays 105

Signal Processing with CCD Imager	105
<i>CCD Driver Section</i>	106
<i>Luminance Signal Processing</i>	108
<i>Chrominance Signal Processing</i>	110
Signal Processing with MOS Imagers	112
<i>Matrix Processing</i>	112
<i>Luminance Enhancer Operation</i>	114
<i>Luminance Aperture and Process Operation</i>	115
<i>Chroma Processing</i>	116
<i>NTSC Encoder Operation</i>	117
<i>Luminance Resampling</i>	119

7 Single-Sensor Tube Cameras 122

Photoconductive Image Sensors	123
Antimony Trisulfide Vidicons	124
Saticon	125
Newvicon	126
<i>Deflection Circuitry</i>	127
<i>High Voltage</i>	131
<i>Automatic Beam Optimizer</i>	133
<i>Dynamic Focus/Color Shading</i>	134
<i>Residual Image (Lag) Compensation</i>	135
<i>Power Supply</i>	136

8	Color Encoding and Processing in Single-Tube Cameras	143
	Single-Carrier Encoding	144
	<i>Trinicon</i>	144
	<i>Tri-Electrode Vidicon</i>	146
	Two-Carrier Encoding	147
	Color Stripe Encoding—Single Carrier	147
	Color Filter and Circuitry of a Newvicon Consumer Camera	148
	<i>Input Circuitry</i>	150
	<i>Luminance Processing</i>	151
	<i>Automatic Gain Control</i>	152
	<i>Horizontal Aperture Correction</i>	154
	<i>Chrominance Processing Circuitry</i>	155
	<i>Red/Blue Separation</i>	156
	<i>R-Y/B-Y Matrix</i>	159
	<i>Color Balance</i>	159
	<i>Chroma Modulator</i>	161
	$\frac{1}{2}$ H Chroma Beat Prevention Circuit	163
	<i>NTSC Output Stage</i>	164
	<i>Color Correction Circuitry</i>	165
9	Consumer Camcorder Recording Formats	169
	Betamovie	170
	VHS Video Movie	174
	<i>Head and Tape Transport System</i>	174
	<i>Loading Mechanism</i>	175
	<i>Drum Servo System</i>	177
	Enhancements	177
	<i>VHS HQ</i>	179
	<i>VHS Hi-Fi</i>	180
	<i>Super Beta (Also Called Hi-Band Beta)</i>	182
	<i>ED Beta (Extended Definition Beta)</i>	183
	The S-VHS System	184
	<i>Luminance Signal Bandwidth and Deviation</i>	184
	<i>Dark-Clip and White-Clip Level</i>	186
	<i>S-VHS Recording</i>	186
	<i>S-VHS Playback</i>	187
	<i>S-VHS Videocassette Tape</i>	189
	The 8-mm Format	189
	<i>Relation Between Tape and Head</i>	190
	<i>Flying Erase Head</i>	191
	<i>Automatic Track Finder</i>	192
	<i>Special Modes</i>	193
	<i>Audio Processing</i>	194
	Videotape for Consumer Camcorders	195

PART II BROADCAST CAMERAS AND CAMCORDERS

10 Multi-Sensor Color Cameras 197

A Two-Sensor Solid-State Camera	198
Three-Sensor Color Cameras	199
<i>Signal Processing</i>	200
Camera Tubes	202
<i>The Plumbicon</i>	203
<i>The Saticon</i>	204
<i>The 2/3-inch Tube Format</i>	204
<i>Resolution</i>	205
<i>Registration</i>	205
<i>Lag and Shading</i>	206
<i>Noise</i>	206
Solid-State Image Sensors	206
<i>Vertical Smear Solutions</i>	208
<i>Electronic Shutters</i>	211
<i>Colorimetry</i>	212
<i>Noise in CCD Imagers</i>	212
<i>Resolution</i>	213
A Studio Solid-State Broadcast Camera	214

11 ENG/EFP Camcorders 216

Evolution from Film to Tape	216
The Video Camera and the Portable Videotape Player	217
The First ENG Camcorders	219
<i>RCA's Hawkeye</i>	219
<i>Sony's BVW-1</i>	220
Today's ENG/EFP Camcorders	220
<i>Tube-Type Sensor Designs</i>	221
<i>Solid-State Sensor Designs</i>	223
Features of Solid-State ENG/EFP Camcorders	224
<i>Frame Transfer CCDs</i>	224
<i>Interline Frame Transfer and the Electronic Shutter</i>	224
<i>Dual-Green System</i>	228
<i>Registration Accuracy and Stability of CCDs</i>	231

12 Broadcast Camcorder Recording Formats 232

Composite Recording	233
<i>The Direct Method</i>	233
<i>The Color-Under Method</i>	233
<i>Separate Track Y/C Recording</i>	233

Component Recording	233
<i>Line-Sequential Multiplex</i>	233
<i>Frequency-Division Multiplex</i>	234
<i>Compressed Time Division Multiplex</i>	235
Chromatrack	235
Betacam	238
Betacam SP	244
The M and MII Formats	247
<i>Cassette, Tape, and Heads</i>	248
<i>Frequency Allocation and Drum Diameter</i>	249
<i>Video-Signal Recording and Reproducing Process</i>	250
<i>Time-Axis Compression and Expansion Process</i>	251
<i>Vertical-Interval Subcarrier</i>	252
Videotapes for Broadcasting Use	253
Future Trends	254

PART III CLOSED-CIRCUIT AND NON-TV APPLICATIONS

13 Surveillance and Monitoring 257

Tube-Type Imagers	258
<i>The Chalnicon</i>	258
<i>Infrared Vidicon</i>	259
<i>X-ray Vidicon</i>	259
<i>Image Dissector</i>	259
<i>Silicon-Diode-Array Vidicon</i>	264
<i>The Silicon Intensifier Target Tube</i>	266
Cameras Using Silicon-Diode-Array Tubes	267
<i>Automatic Light Range</i>	267
<i>Automatic Protection Systems</i>	269
Solid-State Infrared Sensors	270

14 Image Analysis 272

The Image Analysis System	272
Image Sensors	274
Serial and Parallel Processing	275
<i>Single Instruction Multiple Data Processing</i>	276
<i>Multiple Instruction Multiple Data (MIMD) Processing</i>	277
<i>Parallel-Processing Topologies</i>	277
<i>Parallel-Processing Applications</i>	278
Optical Processing in Machine Vision	278

15 Still Video 281

Sony's Mavica and Mavigraph 282

Improving Resolution 284

Record and Playback 286

Printer Alternatives 287

Complete Systems 288

Still Video Transceiver 288

Consumer Still Video 290

16 Adjustments and Service Procedures 291

Adjustment Test Equipment and Tools 291

Preparation 292

Adjustment Steps 294

Fault Isolation 297

Service Procedures 298

Matrix Processing of CMR300 298

Luminance Enhancer of CMR300 298

Luma Aperture and Process of CMR300 298

Chroma Processing of CMR300 299

NTSC Encoder of CMR300 299

Luminance Resampling Circuit of CPR350 299

Infrared Autofocus System of Magnavox Movie Maker 300

Electronic Viewfinder of Magnavox Movie Maker 301

Glossary 302

Abbreviations 308

References 312

Index 317