

# Hardware

**COLLABORATORS**

	<i>TITLE :</i> Hardware		
<i>ACTION</i>	<i>NAME</i>	<i>DATE</i>	<i>SIGNATURE</i>
WRITTEN BY		March 28, 2025	

**REVISION HISTORY**

NUMBER	DATE	DESCRIPTION	NAME

# Contents

<b>1</b>	<b>Hardware</b>	<b>1</b>
1.1	Amiga® Hardware Reference Manual: Index	1
1.2	Numbers Index	1
1.3	68000 Index	1
1.4	680x0 Index	2
1.5	8520 Index	2
1.6	A Index	2
1.7	A1000 Index	3
1.8	A3000 Index	3
1.9	ADKCON Index	3
1.10	Agnus Index	3
1.11	Audio Index	3
1.12	B Index	4
1.13	Beam position Index	5
1.14	Bitplanes Index	5
1.15	Blitter Index	5
1.16	BLTCON0 Index	6
1.17	BLTCON1 Index	6
1.18	BPLCON0 Index	7
1.19	BPLCON2 Index	7
1.20	C Index	7
1.21	CIAAPRA Index	8
1.22	Clock Index	8
1.23	Collision Index	8
1.24	Color Index	8
1.25	Color registers Index	9
1.26	Color selection Index	9
1.27	Control register Index	9
1.28	Controller Port Index	9
1.29	Controllers Index	10

---

---

1.30	Copper Index . . . . .	10
1.31	Custom Chips Index . . . . .	11
1.32	D Index . . . . .	11
1.33	Data-fetch Index . . . . .	12
1.34	Disk Index . . . . .	12
1.35	Display window Index . . . . .	12
1.36	DMA Index . . . . .	13
1.37	DMACON Index . . . . .	13
1.38	Dual Playfield Index . . . . .	13
1.39	E,F,G,H Index . . . . .	13
1.40	Enhanced Chip Set Index . . . . .	14
1.41	Genlock Index . . . . .	14
1.42	Hardware Connection Index . . . . .	14
1.43	High resolution Index . . . . .	15
1.44	I,J,K Index . . . . .	15
1.45	Interlaced mode Index . . . . .	15
1.46	Interrupt Index . . . . .	16
1.47	Interrupt Control Register Index . . . . .	16
1.48	JOY0DAT/JOY1DAT Index . . . . .	16
1.49	Joystick Index . . . . .	16
1.50	Keyboard Index . . . . .	16
1.51	L,M,N,O Index . . . . .	17
1.52	Light Pen Index . . . . .	18
1.53	Line Drawing Index . . . . .	18
1.54	Memory allocation Index . . . . .	18
1.55	Modulo Index . . . . .	18
1.56	NTSC Index . . . . .	18
1.57	P Index . . . . .	19
1.58	PAL Index . . . . .	19
1.59	Parallel Port Index . . . . .	19
1.60	Playfields Index . . . . .	20
1.61	Ports Index . . . . .	20
1.62	POTGO / POTINP Index . . . . .	21
1.63	Priority Index . . . . .	21
1.64	R,S Index . . . . .	21
1.65	RAM Index . . . . .	22
1.66	Scrolling Index . . . . .	22
1.67	Serial Port Index . . . . .	22
1.68	Serial Shift Register Index . . . . .	23

---

---

1.69 Sprites Index . . . . .	23
1.70 T,U,V,W,Z Index . . . . .	24
1.71 Trackball Index . . . . .	24
1.72 VHPOSR Index . . . . .	24
1.73 Video Index . . . . .	25
1.74 VPOSR Index . . . . .	25
1.75 Zorro Expansion Bus Index . . . . .	25

---

# Chapter 1

## Hardware

### 1.1 Amiga® Hardware Reference Manual: Index

Misc.            Note: Numbers will refer to page numbers in  
A                the 'Amiga® Hardware Reference Manual'  
B                3rd edition, ISBN 0-201-56776-8  
C  
D  
E F G H  
I J K  
L M N O  
P  
R S  
T U V W Z

### 1.2 Numbers Index

\$00C00000, 5  
60 Pin Edge Connector, 321  
68000, -->  
68010, 1  
68020, 1 , 187  
68030, 1  
680x0, -->  
8361, 5  
8370, 5  
8371, 5  
8372A, 5  
8520, -->  
86 Pin Edge Connector, 322

### 1.3 68000 Index

68000, 2 , 187  
  normal cycle, 196  
  test-and-set instruction, 196

---

## 1.4 680x0 Index

680x0, 19 , 25 , 35 , 194 , 223  
  instead of Copper, 35  
  interrupting, 35 , 217  
  shared memory, 4  
  synchronizing with the video beam, 216

## 1.5 8520 Index

8520, 157 , 223 , 241 , 244 , 251 , 339  
  alarm, 344  
  handshaking, 341  
  input modes, 343  
  interval timers, 341  
    continuous, 342  
    force load, 342  
    one-shot, 342  
    PB on/off, 342  
    start/stop, 342  
    Toggle/pulse, 342  
  I/O ports, 341  
  read bit names, 343  
  register map, 340  
  signal assignments, 337  
  time-of-day clock, 344  
  write bit names, 343

## 1.6 A Index

A1000, -->  
A2000, 1 , 5 , 6 , 7 , 7 , 63 , 157 , 238 , 260  
A3000, -->  
A500, 1 , 5 , 7 , 63 , 157 , 238 , 260  
Address Registers, 10  
ADKCON, -->  
Agnus, -->  
Alarm, 344  
Aliasing, audio, 154  
AllocMem(), 52  
Amiga OS, 9  
Amplitude Modulation, 4  
Animated Objects, 6  
Animation, 176  
Apple II, 241  
Area Fill, 4 , 184  
ATTACH, 120  
Attachment - audio, 150 , sprites, 120  
Audio, -->  
Audio Channel, 19  
AUDx, 220  
AUDxEN, 144 , 222

---

AUDxLCH, 138 , 298  
AUDxLCL, 138  
AUDxLEN, 139  
AUDxPER, 143 , 298  
AUDxVOL, 139  
AUTOCONFIG, 7 , 223 , 431

## 1.7 A1000 Index

A1000, 1 , 5 , 7 , 63 , 64 , 238 , 260  
expansion port, 321

## 1.8 A3000 Index

A3000, 1 , 6 , 7 , 7 , 260  
expansion bus, 383

## 1.9 ADKCON Index

ADKCON, 241 , 250 , 256  
disk control bits, 249  
in audio, 149-150

## 1.10 Agnus Index

Agnus, 2 , 5 , 164-165 , 169  
ECS fat Agnus, 295  
fat agnus, 187

## 1.11 Audio Index

Audio, 4 , 9 , 20  
aliasing distortion, 154  
amplitude modulation, 4  
channels - attaching, 149 , 164 , choosing, 137  
data, 137  
data length registers, 139  
data location registers, 138 , 139  
data output rate, 140  
decibel values, 140 , 163  
DMA, 138 , 144 , 147 , 164  
equal-tempered scale, 158  
frequency modulation, 4  
in ECS, 310  
interrupts, 147 , 220

---

- joining tones, 147
- low-pass filter, 154
- modulation, 164
  - amplitude, 149
  - frequency, 149
- noise reduction, 154
- non-DMA output, 157
- period, 140
- period register, 143
- playing multiple tones, 149
- producing a steady tone, 145
- sampling period, 141
- sampling rate, 141 , 152 , 156 , 164
- state machine, 164
- stopping, 145
- system overhead, 153
- volume, 139 , 163
- volume registers, 139
- waveform transitions, 152

## 1.12 B Index

- Background color, 46
- Barrel Shifter, 179
- BBUSY, 222
- Beam comparator, 124
- Beam position, -->
- Beam position counter, 216
- BEAMCON0, 298 , 305
- Bitplanes, -->
- Blitter, -->
- Blitter Busy, 186
- Blitter registers - in line-drawing mode, 189
- Blitter shifting, 179
- BLTAXWM, 180
- BLTCON0, -->
- BLTCON0L, 298
- BLTCON1, -->
- BLTEN, 222
- BLTPRI, 222
- BLTSIZE, 169 , 171-173 , 186-187 , 191 , 308
- BLTSIZH, 298
- BLTSIZV, 298 , 308
- BLTXDAT, 170
- BLTXMOD, 172
- BLTXPTH, 170 , 298
- BLTXPTL, 170
- BPL1MOD, 62 , 64
- BPL2MOD, 62 , 64
- BPLCON0, -->
- BPLCON1 - setting scrolling delay, 85
- BPLCON2, -->
- BPLCON3, 298
- BPLCONx, 90 , 307
- BPLEN, 222

---

BPLxMOD, 84 , 91  
BPLxPT, 91  
BPLxPTH, 52 , 54 , 61 , 74  
BPLxPTL, 52 , 54 , 61 , 74  
BPUx, 48 , 87 , 90  
Bridgeboard, 7  
BZERO, 222

### 1.13 Beam position Index

Beam position  
  comparison enable bits, 24  
  detection of, 216  
  in Copper use, 31  
  registers, 216  
  vertical, 23 , 24

### 1.14 Bitplanes Index

Bitplanes  
  coloring, 55  
  DMA, 62  
  in dual-playfield mode, 68  
  setting the number of, 48  
  setting the pointers, 54

### 1.15 Blitter Index

Blitter, 4 , 6 , 9 , 19  
  address scanning, 173  
  addressing, 170  
  animation, 176  
  area fill, 4 , 184  
  area filling - exclusive, 184 , inclusive, 184  
  blit time, 193  
  blitter done flag, 186  
  blitter-finished disable bit (BFD), 35  
  blitter-nasty bit, 198  
  block transfers, 171 , 183  
  BLTSIZE, 187  
  bus sharing, 194  
  clock, 193  
  cookie-cut, 176 , 181 , 183  
  copying, 169 , 183  
  cycle time, 193  
  data fetch, 170  
  data overlap, 182  
  descending mode, 182-183  
  DisownBlitter(), 187  
  DMA enable, 181 , 184 , 187

---

- DMA priority, 194
- DMA time slots, 194
- equation-to-minterm conversion, 175
- example, 200
- FILL\_CARRYIN bit, 185
- height, 171
- immediate data, 170 , 182
- in ECS, 296
- interrupts, 187 , 220
- LF control byte, 174
- line drawing, 4
  - logic function, 191
  - octants, 190
  - registers, 189
- line drawing mode, 189
- line texture, 191
- linear data, 173
- logic equations, 175
- logic operations, 174
- masking, 181 , 183-184
- minterms, 175
- modulo, 172
- modulo registers, 172
- octants, 189
- OwnBlitter(), 187
- packed font, 180
- pipelined, 188
- pointer registers, 170
- sequence of bus cycles, 188
- shifting, 182 , 183
- size of blit, 171
- starting operation, 169
- text, 180
- truth-table, 174
- Venn Diagrams, 178
- WaitBlit(), 187
- width, 171
- with the Copper, 35
- zero detection, 187

## 1.16 BLTCON0 Index

- BLTCON0, 182
  - DMA enable, 170
  - in line drawing, 189 , 191
  - in logic operations, 174
  - in shift control, 179

## 1.17 BLTCON1 Index

- BLTCON1, 182 , 189 , 298
  - in area fill, 184

in blitter addressing, 182  
in line drawing, 189-191  
in shift control, 179

## 1.18 BPLCON0 Index

BPLCON0, 87 , 229 , 298 , 300  
  enabling color, 63  
  in dual-playfield mode, 72  
  in hold-and-modify mode, 87  
  in interlacing, 51  
  in resolution mode, 49  
  in the Enhanced Chip Set, 300  
  selecting bitplanes, 48  
  setting bits, 48  
  with light pen, 239

## 1.19 BPLCON2 Index

BPLCON2, 72 , 210 , 298  
  in dual-playfield priority, 71

## 1.20 C Index

Cache, 187 , 388  
CDANG, 26  
Chip Memory, 5-6 , 20 , 105 , 138 , 169 , 170 , 186 , 223 , 246 , 296  
CIA, 9 , 157 , 241 , 251 , 339  
CIAA - address map, 339  
CIAADDR, 241  
CIAAPRA, -->  
CIAB - address map, 340  
CIABPRB - disk, 244  
Clock, -->  
Clock Constant, 141 , 159  
Clock cycle, 4  
Clock Interval, 141  
CLXCON, 215  
CLXDAT, 214  
CNT, 251  
Collision, -->  
Collision Detection, 4  
Color, -->  
Color Clock, 60 , 194 , 255 , 304  
Color Palette, 3 , 19  
Color Registers, 3  
Color registers, -->  
Color selection, -->  
COLOR00, 46 , 55  
COLOR\_ON, 90

---

COLORx, 10 , 27 , 28 , 46 , 70-71 , 87  
Comparator, 124  
Composite Video, 7  
Control Register, -->  
Controller Port, -->  
Controllers, -->  
COP1LC, 25 , 30 , 32 , 32 , 35  
COP1LCH, 25 , 298  
COP1LCL, 25  
COP2LC, 25 , 26 , 32  
COP2LCH, 25 , 298  
COP2LCL, 25  
COPCON, 26 , 298  
COPEN, 30 , 35 , 222  
COPJMP1, 26  
COPJMP2, 26  
Copper, -->  
Coprocesor - 19 , see Copper  
Copying data, 169  
CP/M, 241  
CTRL-AMIGA-AMIGA, 253  
Custom Chips, -->

## 1.21 CIAAPRA Index

CIAAPRA, 229 , 232 , 233 , 241 , 241  
disk, 244

## 1.22 Clock Index

Clock, 260  
8520, 344  
alarm, 344  
audio, 140 , 141 , 142 , 159 , 164  
blitter, 193 , 194  
color, 194 , 255  
keyboard, 251  
system, 2 , 193

## 1.23 Collision Index

Collision, 213  
control register, 215  
detection register, 214

## 1.24 Color Index

---

## Color

- attached sprites, 122
- background color, 46
- color indirection, 42
- color table, 46
- enabling, 63
- in dual-playfield mode, 70
- in hold-and-modify mode, 86
- in SuperHires mode, 301
- in the Enhanced Chip Set, 301
- sample register contents, 92
- sprites, 102

## 1.25 Color registers Index

### Color registers

- contents, 46
- loading, 47
- names of registers, 46
- sprites, 130

## 1.26 Color selection Index

### Color selection

- in high resolution mode, 94
- in hold-and-modify mode, 95
- in low resolution mode, 93

## 1.27 Control register Index

### Control Register, 348

- register A, 348
  - bitmap, 349
- register B, 349
  - bitmap, 350

## 1.28 Controller Port Index

### Controller Port

- connection chart, 228
  - joystick, 232
  - mouse, 229
  - output to, 240
  - registers, 229
  - trackball, 229
-

## 1.29 Controllers Index

### Controllers

- light pen, 238
- potentiometers, 236
- proportional - registers, 236
- special, 241
- types, 6

## 1.30 Copper Index

- Copper, 9 , 19 , 45 , 54 , 62 , 64 , 65 , 80 , 81 , 82 , 110 , 122 , 194 ,  
197 , 216 , 219
- affecting registers, 26
  - at reset, 30
  - bus cycles used, 20
  - comparison enable, 32
  - control register, 26
  - danger bit (CDANG), 26
  - DMA, 30 , 30
  - features, 19
  - horizontal beam position, 23
  - in interlaced mode, 34
  - in memory operations, 20
  - in vertical blanking interrupts, 219
  - instruction fetch, 25
  - instruction lists, 26 , 28
  - instructions
    - description, 20
    - ordering, 27
    - summary, 36
  - interrupt, 219
  - interrupting the 680x0, 35
  - jump, 25
  - jump strobe addresses, 26
  - location registers, 25 , 30 , 32
  - loops and branches, 32
  - memory cycles, 22
  - MOVE instruction, 21
  - MOVE to registers, 21
  - registers, 25
  - resolution, 23 , 24
  - SKIP instruction, 31 , 32
  - starting, 26 , 30
  - stopping, 30
  - strobe address, 26
  - vertical beam position, 24
  - WAIT instruction, 22 , 30 , 32
  - with sprites, 113
  - with the blitter, 26 , 35
-

## 1.31 Custom Chips Index

Custom Chips, 2 , 170 , 255  
  control registers, 19  
  register, 263  
  steal cycles, 4

## 1.32 D Index

Data-fetch, -->  
DBLPF, 87 , 90  
DDFSTOP, 60-61 , 80 , 82 , 91 , 99  
DDFSTRT, 60 , 80 , 82 , 91 , 99  
Decibel values, 163  
Denise, 2 , 297  
DENISEID, 298  
Descending Mode - blitter, 182  
DEST, 170  
Digital Joystick - connection, 329 , fire buttons, 329  
Disk, -->  
Disk Port, 320  
Display - size of, 57  
Display DMA, 20  
Display field, 40  
Display memory, 57  
Display modes, 41  
Display window, -->  
DIWHIGH, 298 , 306  
DIWSTOP, 59 , 78 , 91 , 99 , 219 , 306  
DIWSTRT, 58 , 59 , 76 , 91 , 99 , 219 , 306  
DMA, -->  
DMA Contention, 193  
DMA Priority, 194  
DMAB\_BLTDONE, 186  
DMACON, -->  
DMACONR, 222  
DMAEN, 144 , 222 , 247  
DMAF\_BLITHOG, 198  
DMAF\_BLTNZERO, 187  
DSK, 244  
DSKBLK, 220  
DSKBYTR, 241 , 248  
DSKCHANGE, 244  
DSKDIREC, 244  
DSKEN, 222  
DSKINDEX, 244  
DSKLEN, 241 , 246-247  
DSKMOTOR, 244  
DSKPROT, 244  
DSKPTH, 241 , 246 , 298  
DSKRDY, 244  
DSKSELx, 244  
DSKSIDE, 244  
DSKSTEP, 244

---

DSKSYN, 220  
DSKSYNC, 241 , 247 , 250  
DSKTRACK0, 244  
Dual Playfield, -->

### 1.33 Data-fetch Index

Data-fetch  
  high resolution, 62  
  in basic playfield, 60  
  in horizontal scrolling, 82  
  start - normal, 60  
  stop - normal, 60

### 1.34 Disk Index

Disk, 20  
  controller, 6 , 241  
  DMA, 246  
  DMA pointer registers, 246  
  drives, 6  
  external  
    identification, 335  
    interface, 334  
    limitations, 335  
    pins, 334  
  external connector, 367  
    device ID, 370  
    pins, 367  
    signals, 368  
  floppy, 4  
  input stream synchronization register (DSKSYNC), 250  
  internal - pins, 336 ,power, 336  
  interrupts, 220 , 250  
  MFM Encoding, 250  
  read data register, 248  
  write, 246

### 1.35 Display window Index

Display window  
  positioning, 57  
  size - maximum, 79 , 306 ,normal, 58  
  starting position - horizontal, 58 , 77 , 306 ,vertical, 58 , 77 , 306  
  stopping position - horizontal, 59 , 78 , 306 ,vertical, 59 , 79 , 306

---

## 1.36 DMA Index

DMA, 4 , 207  
  audio, 137 , 138 , 141 , 144 , 145 , 147 , 148 , 153 , 157 , 164-165 ,  
    194 , 220  
  bitplanes, 62  
  blitter, 50 , 170-173 , 174 , 176 , 179-181 , 183-184 , 187 , 189 ,  
    191 , 193 , 194 , 196-198  
  control, 222  
  control register, 218 , 222  
  copper, 19-20 , 30  
  disk, 4 , 194 , 220 , 241 , 246 , 247 , 250  
  display, 20 , 194 , 300  
  playfield, 62  
  sprites, 4 , 27 , 97 , 102 , 108 , 109 , 110 , 115 , 116-117 , 118 ,  
    120-121 , 123 , 126 , 127 , 128 , 194

## 1.37 DMACON Index

DMACON, 222 , 247  
  blitter done, 186  
  DMAF\_BLITHOG bit, 198  
  in audio, 144  
  in playfields, 62  
  stopping the Copper, 30  
  zero detection, 187

## 1.38 Dual Playfield Index

Dual Playfield, 44  
  bitplane assignment, 68  
  description, 67  
  enabling, 72  
  high resolution colors, 71  
  in high resolution mode, 71  
  low resolution colors, 70  
  priority, 71  
  scrolling, 71

## 1.39 E,F,G,H Index

ECS - sprites, 302 , 303  
ECS Registers, 298  
Enhanced Chip Set, -->  
Examples, 9  
Expansion Boards, 7  
Expansion Bus, 383  
Expansion Connector, 7 , 385  
External interrupts, 219

---

FAST, 249  
Fast Memory, 5  
Fat Agnus, 5 , 187  
Field time, 40  
Floppy Disk, 4 , 241 , See DISK  
Frame Buffer, 6  
Frequency Modulation, 4  
  
Game Controller Port, 327  
GAUD, 89  
GCR, 250  
Genlock, -->  
HAM, 86  
  
Hardware Connection, -->  
HBSTOP, 298  
HBSTRT, 298  
HCENTER, 298  
High resolution, -->  
HIRES, 87  
Hold-And-Modify, 3 , 86  
HOMOD, 87 , 90  
Horizontal blanking interval, 23 , 304  
HSSTOP, 298  
HSSTRT, 298  
HSTART, 59 , 91 , 107 , 107 , 113  
HSTOP, 59 , 78 , 91  
HTOTAL, 298 , 304

## 1.40 Enhanced Chip Set Index

Enhanced Chip Set, 295  
  blitter, 296  
  ECS Registers, 298  
  memory, 296

## 1.41 Genlock Index

Genlock, 2 , 49 , 51 , 89 , 159 , 260  
  effect on background color, 46  
  in ECS, 296  
  in playfield register, 89

## 1.42 Hardware Connection Index

Hardware Connection, 353  
  address inputs, 354  
  chip select, 353  
  clock input, 353

---

data bus I/O, 354  
interrupt request, 354  
read/write input, 353  
reset input, 354

### 1.43 High resolution Index

High resolution  
color selection, 49 , 94  
memory requirements, 52  
SuperHires, 300  
with dual playfields, 71  
with ECS, 296

### 1.44 I,J,K Index

IBM PC, 6 , 7 , 241  
Include Files, 10 , 22 , 373  
INTEN, 218  
INTENA, 217  
INTENAR, 217  
Interlaced mode, -->  
Interleaved Memory, 4  
Internal Slots, 7  
Interrupt, -->  
Interrupt Control Register, -->  
Interrupts - during vertical blanking, 219  
INTF\_BLIT, 187  
INTREQ, 35 , 218  
INTREQR, 218  
  
Joy stick port, 323  
JOY0DAT/JOY1DAT, -->  
Joystick, -->  
JOYxDAT, 229  
  
Keyboard, -->  
Keyboard Port, 319

### 1.45 Interlaced mode Index

Interlaced mode  
Copper in, 34  
memory requirements, 52  
modulo, 62  
setting interlaced mode, 49

---

## 1.46 Interrupt Index

Interrupt, 26 , 35 , 35 , 207 , 217  
8520, 251  
audio, 147 , 148 , 153 , 157 , 164-165 , 220  
beam synchronized, 3  
blitter, 35 , 171 , 187 , 220  
control registers, 217  
copper, 25 , 32 , 216 , 219  
disk, 220 , 245 , 250  
external, 219  
graphics, 33  
interrupt enable bit, 218  
interrupt lines, 217  
maskable, 217  
nonmaskable, 217  
parallel, 259  
priorities, 221  
registers, 218  
serial, 255 , 256 , 258  
serial port, 220  
setting and clearing bits, 218  
vertical blanking, 219

## 1.47 Interrupt Control Register Index

Interrupt Control Register, 346  
read, 347  
write, 347

## 1.48 JOY0DAT/JOY1DAT Index

JOY0DAT/JOY1DAT  
with joystick, 232  
with mouse/trackball, 230

## 1.49 Joystick Index

Joystick  
connections, 228  
port, 323  
reading, 232

## 1.50 Keyboard Index

---

Keyboard, 251 , 357  
  Caps lock, 359  
  communications, 357  
  errors, 359  
  ghosting, 253  
  hard reset, 361  
  keycodes, 358  
    transmission, 358  
  matrix, 362  
  out-of-sync, 359  
  power up, 360  
  raw keycodes, 251  
  reading, 251  
  reset warning, 361  
  self test, 360  
  signals, 6 , 357  
  special codes, 364  
  timing diagram, 358

## 1.51 L,M,N,O Index

LACE, 51  
LED - caps-lock, 253  
Light Pen, -->  
Line Drawing, -->  
Low resolution - color selection, 93  
LPEN, 89  
  
Manual mode - in sprites, 123  
Memory - adding, 7 ,blitter access to, 169  
Memory allocation, -->  
Memory Allocation - playfields, 76  
Memory allocation - sprite data, 105  
Memory Cycle Time, 194  
Memory map, 388  
MFM Encoding, 241 , 250  
MFMPREC, 249  
MIDI, 318  
Minterms, 175  
Modulation - amplitude, 149 ,frequency, 149  
Modulo, -->  
Monitors - 260 , See Video  
Mouse - connections, 228 ,reading, 229  
Mouse Port, 328  
MOVE, 19 , 20 , 21  
MSBSYNC, 249-250  
MS-DOS, 6 , 7 , 241  
Multiprocessor, 223  
Multitasking, 9  
  
Noise - audio, 154  
NTSC, -->  
  
Octants, 189

---

OVERRUN, 256  
Overscan, 3 , 57 , 99

## 1.52 Light Pen Index

Light Pen, 333  
connections, 228  
pins, 333  
reading, 238  
registers, 238

## 1.53 Line Drawing Index

Line Drawing, 4 , 189  
length, 191  
logic function, 191  
octants, 189  
registers, 191

## 1.54 Memory allocation Index

Memory allocation  
audio, 137  
formula for playfields, 76  
playfields, 52

## 1.55 Modulo Index

Modulo  
blitter, 172  
in basic playfield, 60-62  
in horizontal scrolling, 82  
in interlaced mode, 62  
in larger playfield, 73

## 1.56 NTSC Index

NTSC, 62 , 100 , 100  
audio, 140 , 141 , 158-159  
blitter, 193  
clock, 2  
playfield, 49 , 52 , 57 , 58  
serial baud rate, 255  
sprites, 100 , 100  
vertical blank, 219  
video, 3 , 24 , 27 , 34 , 40-41 , 45 , 304

---

## 1.57 P Index

Packed Font, 180  
Paddle Controller - connections, 228 ,reading, 234  
PAL, -->  
Parallel, 9  
Parallel Port, -->  
Paula, 2 , 6 , 255  
Peripherals, 6 , 7  
Pipeline, 188  
Pixels - definition, 40 ,in sprites, 101 , 101  
Playfield, 4 , 6 , 9  
Playfields, -->  
Playfield-sprite priority, 209  
Port Signal Assignments, 350  
Ports, -->  
POT0DAT, 236 , 298  
POT1DAT, 236 , 298  
POTGO, 229  
POTGO / POTINP, -->  
POTGOR, 229  
POTINP - name changed to POTGOR, 240  
POTxDAT, 229  
Power up operation, 223  
PRECOMPx, 249  
Priority, -->  
Productivity mode, 3  
Proportional Controller, 331 - pins, 332  
Proportional Controllers - reading, 234  
Proportional Joystick - connections, 228 ,reading, 234

## 1.58 PAL Index

PAL, 3 , 62  
    audio, 140 , 141 , 158-159  
    beam position, 216  
    blitter, 193  
    clock, 2  
    playfield, 49 , 52 , 57 , 58  
    serial baud rate, 255  
    sprites, 100  
    vertical blank, 219  
    video, 3 , 24 , 34 , 40-41 , 45 , 304

## 1.59 Parallel Port Index

Parallel Port, 227 , 259 , 319  
    pin assignment, 324  
    specification, 324  
    timing - input, 325 ,output, 325

## 1.60 Playfields Index

### Playfields

- allocating memory, 52 , 61
- bitplane pointers, 54
- collision, 213
- color of pixels, 42-44
- color register contents, 92
- color table, 46
- coloring the bitplanes, 45 , 55
- colors in a single playfield, 45
- defining a scrolled playfield, 85
- defining display window, 57
- defining dual playfields, 72
- defining the basic playfield, 63
- display window size - maximum, 79 , normal, 58
- displaying, 62
- dual-playfield mode, 67
- enabling DMA, 62
- fetching data, 60-61 , 80
- forming, 44
- high resolution, 41
  - color selection, 94
  - example, 66
- hold-and-modify, 95
- hold-and-modify mode, 86
- interlaced, 41
- interlaced example, 66
- low resolution, 41
  - colors, 93
- memory required, 52 , 76
- modulo registers, 62
- multiple-playfield display, 89
- non-interlaced, 42
- normal, 42
- pointer registers, 54 , 61 , 74
- priority, 210
- register summary, 89
- scrolling - horizontal, 82 , vertical, 81
- selecting bitplanes, 48
- setting resolution mode, 49
- specifying modulo, 60-62 , 73
- specifying the data fetch, 76
- with external video source, 89
- with genlock, 89
- with larger display memory, 73

## 1.61 Ports Index

### Ports

- controller, 227
- disk, 241
- parallel, 259
- serial, 255

---

video, 260

## 1.62 POTGO / POTINP Index

POTGO / POTINP

as digital I/O, 240

as proportional inputs, 234

## 1.63 Priority Index

Priority

dual playfields, 71

playfield-sprite, 209

priority control register, 210

sprites, 207

## 1.64 R,S Index

RAM, -->

RAMEX, 321

Reboot, 223-224

Refresh, 20

Reset, 223

Resolution - setting, 49

RF Modulator, 260

RF Monitor, 320

RGB - analog, 260 ,digital, 260

RGB Video, 7 , 49 , 63 , 64

ROM, 1 , 6 , 223 , 253

RS-232, 6 , 255

RS-232 and MIDI, 318

Sampling - period, 141 ,rate, 152

Scrolling, -->

SCSI Disk Port, 321

SCSI internal disk - pins, 336

SERDAT, 258 , 259

SERDATR, 256

Serial, 9

Serial Port, -->

Serial Shift Register, -->

SERPER, 255

SET/CLR, 35 , 144 , 145 , 218 , 222 , 249 , 257

Shifting - blitter, 182

SKIP, 20

Slow Memory, 5

Sound generation, 134

SPREN, 222

Sprite, 3 , 9 , 19-20

Sprite Colors, 27

Sprite DMA, 27  
Sprites, -->  
SPRCTL, 107 , 123 , 124 , 126 , 128-129 , 298 , 303  
SPRDATA, 123 , 126 , 129  
SPRDATB, 123 , 126 , 129  
SPRPOS, 107 , 123 , 124 , 126 , 127-128 , 129 , 303  
SPRPT, 114  
SPRPTH, 110 , 126 , 127  
SPRPTL, 110 , 126 , 127  
SRCA, 170  
SRCB, 170  
SRCD, 170  
Stereo, 4  
STRLONG, 298  
System Clock, 2  
System Control Hardware, 9

## 1.65 RAM Index

RAM, 21 , 47  
  address space, 2  
  at startup, 223  
  chip, 6 , 20 , 138  
  disk, 246  
  expansion, 2 , 7  
  keyboard, 253

## 1.66 Scrolling Index

Scrolling  
  data fetch, 82  
  delay, 85  
  horizontal, 82  
  in dual-playfield mode, 71  
  in high resolution mode, 82  
  modulo, 82  
  vertical, 81

## 1.67 Serial Port Index

Serial Port, 255  
  characteristics, 327  
  pin assignment, 326  
  specification, 326  
  timing, 327

---

## 1.68 Serial Shift Register Index

Serial Shift Register, 345  
    bidirectional feature, 346  
    input mode, 345  
    output mode, 345

## 1.69 Sprites Index

Sprites  
    address pointers, 110  
    arming and disarming, 123  
    attached  
        color registers, 131  
        colors, 122  
        control word, 120  
        copper list, 122  
        data words, 121 , 123  
    clipped, 100  
    collision, 113 , 213  
    color, 102 , 302  
    color registers used, 102-103  
    comparator, 124 , 126  
    control registers, 124 , 126 , 127  
    control words, 107 , 107  
    data registers, 126 , 129  
    data structure, 104  
    data words, 107  
    designing, 104  
    displaying - example, 111 , steps in, 109  
    DMA, 110 , 114  
    end-of-data words, 108  
    Enhanced Chip Set, 302 , 303  
    forming, 98  
    manual mode, 123  
    memory requirements, 105  
    moving, 113  
    overlapped, 118  
    parallel-to-serial converters, 124  
    pixels in sprites, 101 , 101  
    pointer registers, 127  
        initializing, 110  
        resetting, 110  
    position registers, 124 , 126  
    priorities, 207  
    priority, 115 , 118 , 210  
    reuse, 114 , 116  
    screen position - horizontal, 98 , 107 , vertical, 100  
    shape, 101  
    size, 101  
    vertical position, 107 , 107  
    with copper, 113

---

## 1.70 T,U,V,W,Z Index

TAS, 196 , 223  
Trackball, -->  
Trackdisk, 9  
TSRE, 259

UART, 255  
UARTBRK, 257

VBSTOP, 298  
VBSTRT, 298  
VCR, 46  
Vertical Blanking, 30 , 30 , 32 , 304  
VGA, 304  
VHOSR, -->  
VHOSW - with beam counter, 216  
Video, -->  
Video Beam Position, 26  
Video Input, 46  
Video Port, 319  
Volume, 139  
VOSR, -->  
VOSW - with beam counter, 216  
VSSTOP, 298  
VSSTRT, 298  
VSTART, 59 , 91 , 107 , 107 , 108 , 113  
VSTOP, 59 , 78 , 91 , 107 , 108 , 113  
VTOTAL, 298 , 304

WAIT, 19 , 20  
Waveform, 4  
Waveforms - audio, 134  
WORDSYNC, 249 , 250

Zero Detection, 187  
Zorro Expansion Bus, -->

## 1.71 Trackball Index

Trackball, 328  
  connections, 228  
  reading, 229

## 1.72 VHOSR Index

VHOSR, 229  
  with beam counter, 216  
  with light pen, 238

---

## 1.73 Video Index

### Video

- analog RGB, 260
- beam position, 3 , 23
- camera input, 7
- composite, 260
- digital RGB, 260
- external sources, 89
- interrupt, 3
- laser disk input, 7
- monitors, 7
- monochrome, 260
- output, 260
- priority, 4
- RF modulator, 260
- RGB, 49 , 63 , 64
- synchronization, 3
- VCR input, 7
- video slot, 260

## 1.74 VPOSR Index

- VPOSR, 229 , 298 , 299
  - in playfields, 66
  - with beam counter, 216
  - with light pen, 238-239

## 1.75 Zorro Expansion Bus Index

- Zorro Expansion Bus, 383
  - A2000, 384 , 387 , 387 , 387 , 391
  - A3000, 384 , 387 , 387 , 387
  - autoconfiguration, 431
  - mechanical specifications, 427
  - memory mapping, 388
  - multiple transfer timing, 420
  - quick interrupt timing, 422
  - read timing, 416
  - write timing, 418
  - Zorro II signals, 391 , 437-439
  - Zorro III signals, 409 , 437-439