

GAUNTLET

HARDWARE + OPERATING SYSTEM DESC.

COMPANY CONFIDENTIAL

DIST.

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GAUNTLET HARDWARE DESCRIPTION

CREATED: May 14, 1985
REVISED: Sept. 13, 1985
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I. Microprocessors:

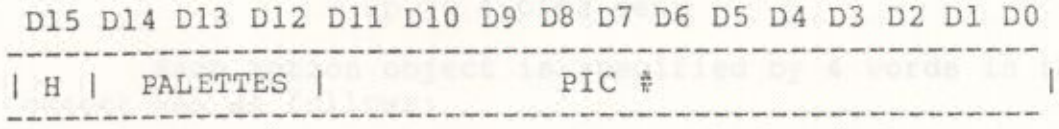
- A. 68010 running @ 7.16 MHz.
- B. Program ROM:
 - 176K words max. including 32K word of OS and 16k word of SLAPSTICK (see ROM map below.)
- C. Program RAM:
 - 4K word fixed, plus 2K word spare video RAM
- D. Interrupt:
 - Sound port (from 6502) - level 6
 - Vblank - level 4.
- E. 6502 runs at 1.78 mhz
 - IRQ from hardware. (Note. Not the YAMAHA)
 - NMI from the 68010.
- F. Input/output:
 - There are 4 bytes worth of inputs. This allows up to 4 switch joysticks and 16 buttons.
- G. EEPROM:

A 512 byte EEPROM is used as a nonvolatile memory for the 68010. You can read or write the EEPROM just as a RAM, however, after a write to the EEPROM, you should wait a minimum of 10 msec. before accessing (read or write) the EEPROM again (For more info. read the EEPROM data sheet & application notes.)

Before writing to the EEPROM, you should enable the write by writting (any data) to UNLOCK (@ 803150). You can not read the EEPROM after you UNLOCK until you have written something somewhere (any data, any location.)

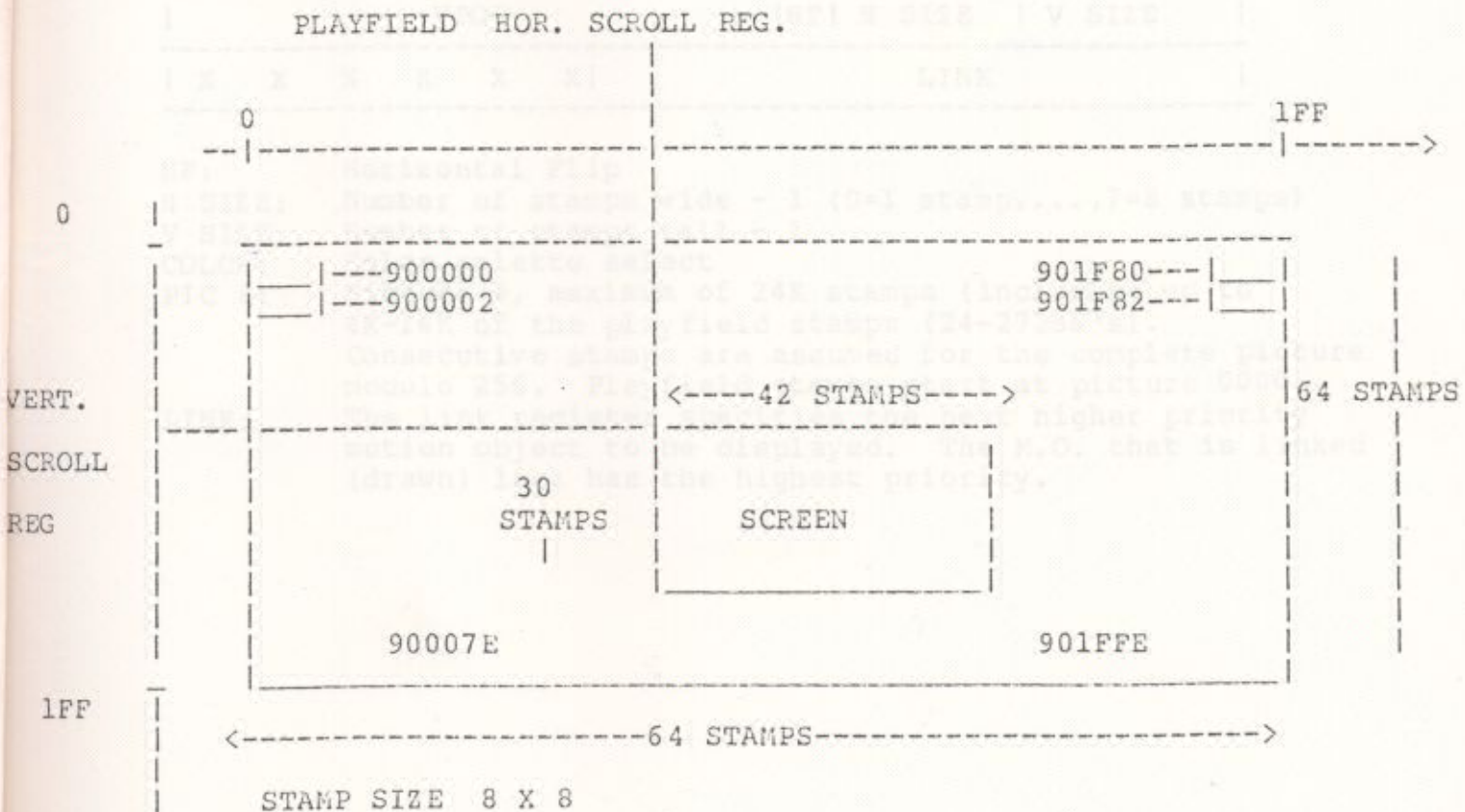
II. Graphics:

- A. Display: - 336 x 240 pixels - standard res. monitor.
- B. Playfield:
 - Size: 64 stamps x 64 stamps
 - Visible screen: 42 stamps x 30 stamps
 - Stamp size: 8 pixels x 8 pixels
 - Independent smooth scrolling horizontally & vertically (wrap-around).
 - Vertical scroll register does not need to be refreshed.
 - Max capacity: up to 4 banks.
 - Each bank = 12_bits = 4K stamps 4 bits deep.



H: Horizontal flip
 PALETTES: Palette select (3 bits)
 PIC: Picture number

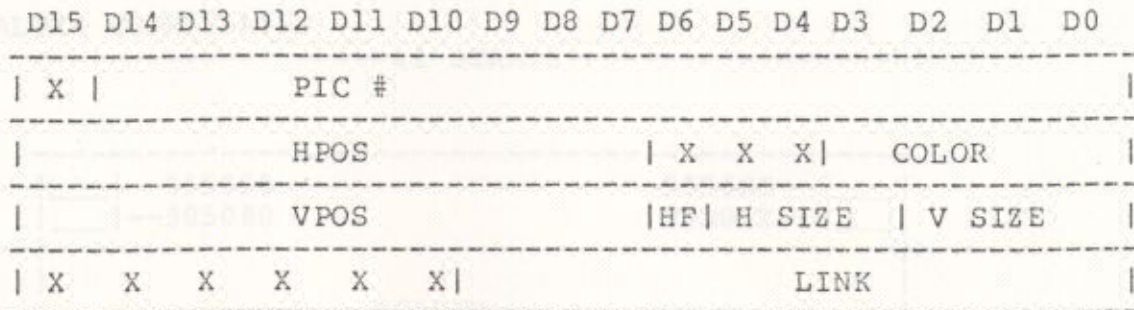
PLAYFIELD COORDINATES:



C. Motion Objects:

- 56 M.O.'s (1 stamp wide) visible on any scan line
- M.O. processing is pipelined to allow more than 56 stamps worth to be processed per line.
- "Linked" M.O.'s
- A new starting link pointer (SLIP) for every 8 scan lines of the playfield
- H and V positions relative to the playfield hence scrolling will automatically move objects with the playfield
- 1024 motion object descriptors
- stamps are 8 pixels wide x 8 pixels
- each object can specify up to 8 stamps tall and 8 stamps wide
- up to 4 bits deep

Each motion object is specified by 4 words in the motion object RAM as follows:



- HF: Horizontal Flip
- H SIZE: Number of stamps wide - 1 (0=1 stamp, ..., 7=8 stamps)
- V SIZE: Number of stamps tall - 1
- COLOR: Color palette select
- PIC #: Picture #, maximum of 24K stamps (including up to 4K-16K of the playfield stamps (24-27256's). Consecutive stamps are assumed for the complete picture modulo 256. Playfield stamps start at picture 0000.
- LINK: The link register specifies the next higher priority motion object to be displayed. The M.O. that is linked (drawn) last has the highest priority.

II. Alpha-Numerics:

- 2 bits deep per pixel, up to 32 color palettes.
- Stamp size: 8 pixels x 8 pixels
- Screen size: 42 stamps x 30 stamps

Every alpha stamp is specified by one word in the alpha numeric RAM as follows:

D15 D14 D13 D12 D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 D1 D0

 | BG | COLOR | SHAPE |

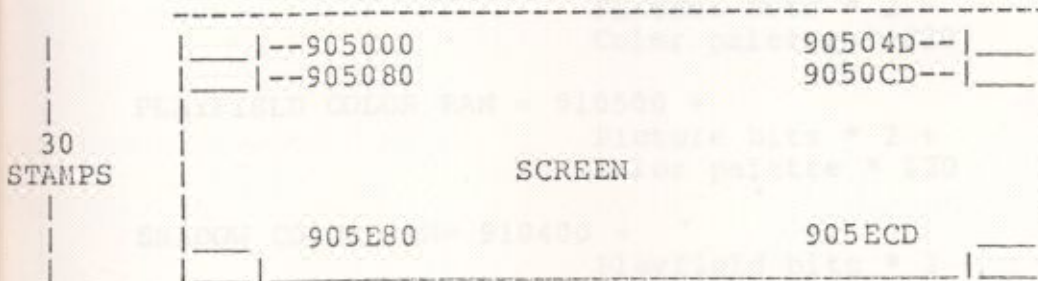
BG: The whole alpha stamp (including background) will have a higher priority than M.O.'s or PF.

COLOR: Color Palette.

SHAPE: Up to 1024 stamps (1-27128 or 1-27256).

ALPHA COORDINATES

<-----42 STAMPS----->



STAMP SIZE 8 X 8

IV. Priority:

- Alpha-numeric have the highest priority.
- If the "BG" bit in the alpha parameter is set, the background color or alpha will have priority over all other graphics.
- Motion object colors 2 thru \$F are next in priority.
- If motion object color 1 is specified then the shadow ram colors are used with the playfield color palettes and picture bits.
- Playfield has the lowest priority.

V. COLORAM:

The coloram gets graphics information from three sources:
ALPHA, PLAYFIELD, and MOTION OBJECT

$$\text{ALPHA COLORAM} = 910000 + \\ \text{Pictures bits} * 2 + \\ \text{C3-C0} * \$8 + \\ \text{C4} * \$100$$

where C4 to C0 are the color palette bits specified in the alpha RAM.

$$\text{MOTION OBJECT COLOR RAM} = 910200 + \\ \text{Picture bits} * 2 + \\ \text{Color palette} * \$20$$

$$\text{PLAYFIELD COLOR RAM} = 910500 + \\ \text{Picture bits} * 2 + \\ \text{Color palette} * \$20$$

$$\text{SHADOW COLOR RAM} = 910400 + \\ \text{Playfield bits} * 2 + \\ \text{Playfield color palette} * \$20$$

Coloram data interpretation:

<D15:D12> Intensity
<D11:D8 > Red
<D7 :D4 > Green
<D3 :D0 > Blue

In all cases, 0000=OFF
1111=highest intensity.

VI . NOTES:

1. Graphics pixel data is low true!!!
PBCONVERT in the PPS utilities will automatically do a 1's complement for you.
2. All motion object pictures using more than one "stamp" must be in the same page. The PB utilities have features that let you blank fill EPROM's.

| GAUNTLET 68010 MEMORY-MAP | ADDRESS | R/W | DATA |
|-------------------------------|---------------|-----|------------------------|
| Program ROM OS | 000000~00FFFF | R | D15~D0 |
| Program ROM SLAPSTICK | 038000~03FFFF | R | D15~D0 |
| Program ROM Main | 040000~07FFFF | R | D15~D0 |
| Spare RAM | 800000~801FFF | R/W | D15~D0 |
| EEPROM | 802001~802FFF | R/W | D7~D0 |
| Player 1 Input | 803001 | R | D0~D7 |
| Player 2 Input | 803003 | R | D0~D7 |
| Player 3 Input | 803005 | R | D0~D7 |
| Player 4 Input | 803007 | R | D0~D7 |
| : | | | D7 Joystick-up |
| : | | | D6 Joystick-down |
| : | | | D5 Joystick-left |
| : | | | D4 Joystick-right |
| Player inputs | : | | D3 Spare |
| : | | | D2 Spare |
| : | | | D1 Fire |
| : | | | D0 Magic/Start |
| BLANK | 803009 | R | D6 Active lo |
| Output-Buffer Full (@ 803170) | 803009 | R | D5 Active hi |
| Input-buffer Full (@ 80300F) | 803009 | R | D4 Active hi |
| Self-test | 803009 | R | D3 Active lo |
| Read Sound Processor (6502) | 80300F | R | D7~D0 |
| Watch Dog | 803100 | W | xx (128 msec. timeout) |
| LED-1 | 803121 | W | D0 Low ON |
| LED-2 | 803123 | W | D0 Low ON |
| LED-3 | 803125 | W | D0 Low ON |
| LED-4 | 803127 | W | D0 Low ON |
| Sound Processor Reset | 80312F | W | D0 Low Reset |
| Blank Acknowledge | 803140 | W | xx |
| Unlock EEPROM | 803150 | W | xx |
| Write Sound Processor (6502) | 803171 | W | D7~D0 |
| Playfield RAM | 900000~901FFF | R/W | D15~D0 |
| Motion Object Picture | 902000~9027FF | R/W | D15~D0 |
| Motion Object Horizontal Pos. | 902800~902FFF | R/W | D15~D0 |
| Motion Object Vertical Pos. | 903000~9037FF | R/W | D15~D0 |
| Motion Object Link | 903800~903FFF | R/W | D15~D0 |
| Spare RAM | 904000~904FFF | R/W | D15~D0 |
| Alpha-Numerics RAM | 905000~905FFF | R/W | D15~D0 |
| Playfield Vertical Scroll | 905F6E,F | R/W | D15~D7 |
| Playfield ROM bank select | 905F6F | R/W | D0,D1 |
| SLIP pointers | 905F80 | R/W | M.O. link pointers |
| Color RAM Alpha | 910000~9101FF | R/W | D15~D0 |
| Color RAM Motion Object | 910200~9103FF | R/W | D15~D0 |
| Color RAM Playfield Shadow | 910400~9104FF | R/W | D15~D0 |
| Color RAM Playfield | 910500~9105FF | R/W | D15~D0 |
| Color RAM (spare) | 910600~9107FF | R/W | D15~D0 |
| Playfield Horizontal Scroll | 930000,1 | W | D8~D0 (word mode only) |

Note: All addresses except 930000 can be accessed in byte or word mode.

| 6502 MEM-MAP | ADDRESS | R/W | DATA | |
|-------------------------|-----------|-----|-------|----------------|
| Program RAM | 0000~0FFF | R/W | D7~D0 | |
| Write 68000 Port | 1000 | W | D7~D0 | Output buffer |
| Read 68000 Port | 1010 | R | D7~D0 | Input buffer |
| Audio mix | 1020 | W | D7~D5 | Speech mix |
| | 1020 | W | D4,D3 | Effects mix |
| | 1020 | W | D2~D0 | Music mix |
| Coin 1 (left) | 1020 | R | D3 | |
| Coin 2 | 1020 | R | D2 | |
| Coin 3 | 1020 | R | D1 | |
| Coin 4 (right) | 1020 | R | D0 | |
| Data available (@ 1010) | 1030 | R | D7 | Hi active |
| Outbuf full (@ 1000) | 1030 | R | D6 | Hi active |
| Speech ready | 1030 | R | D5 | Low active |
| Self Test | 1030 | R | D4 | Low active |
| Music reset | 1030 | W | D7 | Low Reset |
| Speech Write | 1031 | W | D7 | Low Active |
| Speech reset | 1032 | W | D7 | Low Active |
| Speech Squeak | 1033 | W | D7 | Low=650KHz clk |
| Coin Counter Right | 1034 | W | D7 | Hi active |
| Coin Counter Left | 1035 | W | D7 | Hi active |
| Effects | 1800~180F | R/W | D7~D0 | |
| Music | 1810~1811 | R/W | D7~D0 | |
| Speech | 1820 | W | D7~D0 | |
| Interrupt acknowledge | 1830 | R/W | xx | |
| Program ROM | 4000~FFFF | R | D7~D0 | 48k bytes. |

Notes: NO 6502 watchdog (see 68010)

NO NMI mask for the NMI coming from the 68010. NMI is automatically acknowledged when the 6502 reads the input data buffer at location 1010


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2.5V      : 2.5 volt audio amplifier reference
+5AUD     : 5 volt audio amplifier reference
10.3V    : Power-on-reset control voltage
+12V     : +12 volts regulated
+15V     : +15 volts unregulated
-15V     : -15 volts unregulated
-5V      : -5 volts regulated
1H ~ 256H : screen horizontal address counter chain
1V ~ 128V : screen vertical address counter chain
/4H      : inverted 4H signal
4HD3, /4HD3 : 4H signal delayed 3 clock cycles
/4HDD    : 4H signal delayed 2 clock cycles
/4HDL    : 4H signal delayed one clock cycle
68KBUF   : 68010 output buffer full (to 6502)
AL^A23   : 68010 address bus unbuffered
/ACS     : 'A' line buffer RAMs chip select
ALC3, ALC4 : alphanumeric pallet data bits 3 & 4
/ALHI, /ALLO : alphamumerics RAM chip selects
APIX0, APIX1 : alphamumerics pixel data
/AS      : 68010 address strobe
AUDIO-L, AUDIO-R : left & right audio outputs (5v pk-pk)
E02     : 6502 buffered phase 2
BAS     : buffered address strobe (see /AS)
/BCS    : 'B' line buffer RAMs chip select
BLU0 ~ BLU3 : blue color RAM data
BLUE    : blue analog video output
BOUT0 ~ BOUT3 : blue latched digital video output
BR//W   : 68010 read/write control, buffered
/BUFCLR  : swap 'A' & 'B' line buffers, clear LB counter chain
BW//R   : 68010 read/write inverted, buffered
CA5, CA7 : color RAM address bits 5 & 7
CCTR1, CCTR2 : coin counter outputs 1 & 2
/CLRA   : clear line buffer 'A' address counters
/CLRB   : clear line buffer 'B' address counters
/COIN   : coin input buffer chip select
COIN1-L, COIN2, COIN3, COIN4-R : 4 coin switch inputs
/COMPSYNC : negative composite sync output
CRA0 ~ CRA9 : Color RAM address
/CRAM, CRAM : 68010 address decode for color RAM
/CRAMWR  : Color RAM write enable
D0 ~ D15 : 68010 data bus, unbuffered
DOWN-1 ~ DOWN-4 : joystick down switch inputs, player 1-4
EEPROM   : electrically erasable PROM chip select
/END     : current motion object finished
FCLOCK   : system clock inverted phase
FIRE-1 ~ FIRE-4 : fire switch inputs, player 1-4
/FLBA   : line buffer 'A' fill control
/FLBB   : line buffer 'B' fill control
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GCS0 ~ GCS5      : graphics ROMs chip select
/GLD             : graphics load (to SLAGS chips)
GND             : system ground
GOUT0 ~ GOUT3   : green latched digital video output
GP0 ~ GP14      : graphics picture address
GP1V, GP2V, GP4V : graphics picture stamp sub-address
GPEN           : graphics picture enable
GREEN          : green analog video output
GRH/L         : graphics ROM hi/lo select (A14 on a 27256)
GRN0 ~ GRN3    : green color RAM data
H03           : alphanumeric load (to shift registers)
HFLP          : graphics stamp horizontal flip
/HORZ         : latch motion object horizontal data and pallet data
HORZDL, /HORZDL : HORZ delayed one clock cycle
HPOS0 ~ HPOS8  : motion object horizontal position data
/HSCRLD       : latch playfield horizontal scroll data
HSIZ0 ~ HSIZ2  : motion object horizontal size
HSYNC, /HSYNC  : horizontal sync output
/INPUT        : 68010 miscellaneous inputs buffer select
INT0 ~ INT3    : intensity color RAM data
IOUT0 ~ IOUT3  : intensity latched digital video output
/LATCH        : 68010 miscellaneous latched outputs chip select
LAUD          : summed left channel audio
LBA0 ~ LBA8    : line buffer 'A' address bus
LBB0 ~ LBB8    : line buffer 'B' address bus
LBCKF        : line buffer clock inverted phase
LBCKR        : line buffer clock
LBDA0 ~ LBDA7  : line buffer 'A' data bus
LBDB0 ~ LBDB7  : line buffer 'B' data bus
/LDA          : load line buffer 'A' address counters
/LDAB        : load line buffer 'A' or 'B' address counters
/LDB         : load line buffer 'B' address counters
/LDS         : 68010 lower data strobe
LED1 ~ LED4    : LED outputs, player 1-4
LEFT-1 ~ LEFT-4 : joystick left switch inputs, player 1-4
/LINK        : latch motion object link data
/LMPD       : stop motion object processing for line buffer changeover
LNK0 ~ LNK9   : motion object link data
MA1 ~ MA14    : 68010 address bus buffered
MATCH        : motion object H & V data matches current
              : playfield position
MATCHDL      : previous MATCH state
MBUS         : 68010 'M' data bus buffers enable
MCO, MC1     : motion object parameter control select
/MCEN       : motion object parameter control enable
MCKF        : master clock, inverted phase
MCKR        : master clock
MD0 ~ MD15   : 68010 'M' data bus
NFLP        : motion object horizontal flip parameter
/MIX        : latch audio mix data
MO//PF      : 'motion-object' or 'playfield' picture select
/MOHI, /MOLO : motion object RAM chip selects

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MOSR0 ~ MOSR3 : M.O. pixel data, before the line buffers
MOSR4 ~ MOSR7 : M.O. pixel pallet data, before the line buffers
MPIC0 ~ MPIC7 : the lower 8 bits of M.O. picture address
MPX0 ~ MPX7 : M.O. pixel data, after the line buffers
MREFL : motion object stamp horizontal flip state
MUSIC : music chip select
/NEWMO : start a new motion object
NXL, /NXL : next line
(/NXL*) : NXL one clock cycle early
NXLDL : NXL delayed one clock cycle
/PFLD ~ /PF256LD : latched playfield horizontal scroll data
PF1V ~ PF256V : playfield vertical address counter chain
PF8H ~ PF256H : playfield horizontal address counter chain
PFBANK0, PFBANK1 : playfield picture bank select
/PFHI, /PFLO : playfield RAM chip selects
/PFHST : playfield scroll control
PFSR0 ~ PFSR3 : playfield pixel data, before PFHS
PFSR4 ~ PFSR6 : playfield pixel pallet data, before PFHS
PFX0 ~ PFX6 : playfield pixel data after PFHS
PICST0 ~ PICST7 : motion object picture start address
/PICT : latch motion object picture data
PICTDL : PICT delayed one clock cycle
PKAUD : effects chip audio
/PL1 ~ /PL4 : player inputs chip selects, players 1-4
PM0 ~ PM2 : effects audio mix control bits
POKEY : effects chip select
PR1 ~ PR6 : pullup resistors
R//W : 68010 read/write control, unbuffered
RAM0, RAM1 : 68010 working RAM chip selects
RAUD : summed right channel audio
RCLOCK : system clock
RD0 ~ RD15 : 68010 ROM data bus
/RD68K : 6502 read 68010 output buffer
RED : red analog video output
RED0 ~ RED3 : red color RAM data
RIGHT-1 ~ RIGHT-4 : joystick right switch inputs, player 1-4
ROM : 68010 ROM data bus enable
/ROM0 ~ /ROM4 : 68010 program ROM chip selects
ROMH/L : 68010 program ROM hi/lo select (A14 on a 27256)
ROUT0 ~ ROUT3 : red latched digital video output
SA0 ~ SA15 : 6502 address bus unbuffered
SBA0 ~ SBA13 : 6502 buffered address bus
SBD0 ~ SBD7 : 6502 buffered data bus
SBR//W : 6502 buffered read/write control
SBW//R : 6502 buffered read/write control inverted
SD0 ~ SD7 : 6502 data bus unbuffered
/SELFTST : self-test switch input test pad
SID : serial in data
/SIORD : 6502 miscellaneous inputs read control
/SIOWR : 6502 outputs latch control
/SIRQACK : 6502 interrupt acknowledge
SLAPSTK : slapstick chip select
SM0 ~ SM2 : speech audio mix control bits

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SNDBUF      : 6502 output buffer full (to 68010)
/SNDINT     : 68010 interrupt from 6502
/SNDIRQ     : 6502 4 millisecond interrupt
/SNDNMI     : 6502 non maskable interrupt
/SNDRD      : 68010 read buffer from 6502
/SNDRES     : 6502 master reset (controlled by 68010)
/SNDWR      : 68010 write to output buffer (to 6502)
SOD         : serial output data
/SPHRDY     : speech chip ready
/SPHRES     : speech chip reset
/SPHWR      : speech chip write
SQUEAK      : speech chip operating frequency control
/SRD        : 6502 read phase
START-1 ~ START-4 : start switch inputs, player 1-4
STEST       : self-test switch input
/SWR        : 6502 write phase
/SYSRES     : system reset (power up)
/UDS        : 68010 upper data strobe
/UNLOCK     : EEPROM write enable control
UP-1 ~ UP-4 : joystick up switch inputs, player 1-4
VAS0, VAS1  : video RAM address control
(VASC*), (VAS1*) : VAS0&1 before being latched
VBD0 ~ VBD15 : video RAM buffered data bus
/VBKACK     : vertical blank interrupt acknowledge
/VBKINT     : vertical blank interrupt
/VBLANK     : vertical blank
VBUS        : 68010 'V' bus enable (for video RAM)
VCC         : system VCC (5 volts regulated)
VCPU        : 68010 to video RAM synchronisation control
/VERT       : latch M.O. vertical data and size data
VERTDL, /VERTDL : VERT delayed one clock cycle
/VIDBLANK   : video blank (horizontal and vertical blank mixed)
/VHATCH     : motion object vertical parameter matches
              current playfield vertical position
VOICE       : speech chip select
VPOS0 ~ VPOS8 : motion object vertical position data
VRA0 ~ VRA11 : video RAM address bus
/VRAM       : 68010 address decode for video RAM
/VRAMRD     : 68010 read from video RAM
/VRAMWE     : 68010 write to video RAM
VRD0 ~ VRD15 : video RAM data bus, unbuffered
VRDTACK     : video RAM to 68010 data acknowledge
VSIZE0 ~ VSIZE2 : motion object vertical size parameter
VSYNC, /VSYNC : vertical sync
/WDOG       : watchdog control
/WH         : 68010 write hi byte
/WL         : 68010 write lo byte
/WR68K      : 6502 write to output buffer (to 68010)
/YAMRES     : music chip reset
YM0 ~ YM2   : music audio mix control bits
ZREF        : intensity reference for video output.

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