

BLUE RAM OPERATIONS

GENERAL: The BLUE RAM contains the following features:

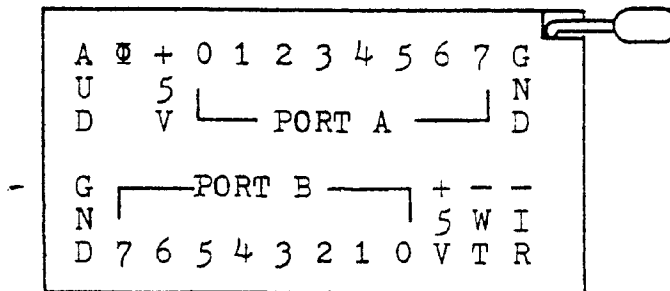
1. 4096 bytes of read-write random access memory (RAM) which can be write protected either manually or by program control. This memory is in addition to the 4K screen memory in the BALLY ARCADE.
2. 128 bytes of additional scratch pad memory which cannot be write protected.
3. A RANGE switch to allocate the add-on memory to either 6000H for normal use or 2000H for game cassette emulation. In this position, the RAM acts as if it were a cassette plugged into the front of the BALLY ARCADE and running a machine code game program.
4. Two 8-bit bi-directional I/O ports (PORT A and PORT B) where any bit or combination of bits in either port may be configured to be an input or output under control of the program. Bits may be reconfigured at will by output to several pseudo-ports within the BLUE RAM.
5. External power and ground (+5V and 0V) available for powering additional low-power applications.
6. Special connections to AUDIO-MIX, CLOCK, IOREQ, and WAIT for expanded sound and connection/sync to slower (future) devices such as floppy disks, etc.
7. All connections to the BLUE RAM are via a 24 pin Zero-insertion-force (ZIF) socket for easy access. This type of socket can accommodate 24 pin plugs, component leads, and bare wire ends directly without the risk of bending.

EXTENDED STRINGS: Of the many ways to use the BLUE RAM in conjunction with BASIC, probably the easiest is in the form of extended strings. As you are aware, BASIC would access up to 900 string entries (with no program) using the @(n) symbol. If you wrote a 1000 byte program then only 400 string entries were available. However, with the BLUE RAM 2112 string entries are always available, regardless of the size of your BASIC program. What's more, these string entries do not "move around" or otherwise change when you modify your BASIC program or load another program. These extended strings are accessed using the %(2n+24574) form where 2n is twice the number of the string entry desired. The first string entry, therefore, is at %(24576) and the second is at %(24578), the third at %(24580), etc. The MODE switch should either be in the RAM position or AUTO-"enabled". Executing a &(192) will enable RAM in the AUTO position. Try this short example:

```
10 FOR N=24576 TO 24600 STEP 2
20 %(N)=(N-24574)+2;NEXT N
30 FOR N=24576 TO 24600 STEP 2;PRINT N,%(N);NEXT N
```

You will note that each of the first 25 string entries was set to its own number (n) and the printout shows the relationship between the value placed in the %() statement and the string number.

INPUT/OUTPUT -- The BLUE RAM contains two 8-bit bi-directional I/O ports. The first 8 bits are referred to as port A while the second 8 are referred to as port B. Either port may be configured with any bit or combination of bits being in the input mode or the output mode. The following diagram shows the position of each bit of each port on the 24 pin ZIF socket:



<u>PIN</u>	<u>FUNCTION</u>
1	Ground return for port A
2	Bit 7 of port A
3	Bit 6 of port A
4	Bit 5 of port A
5	Bit 4 of port A
6	Bit 3 of port A
7	Bit 2 of port A
8	Bit 1 of port A
9	Bit 0 of port A
10	+5 volt source for port A
11	Z80 clock used for external synchronization
12	AUDIO-MIXER used to add or extract sound
13	Ground return for port B
14	Bit 7 of port B
15	Bit 6 of port B
16	Bit 5 of port B
17	Bit 4 of port B
18	Bit 3 of port B

- 19 Bit 2 of port B
- 20 Bit 1 of port B
- 21 Bit 0 of port B
- 22 +5 volts source for port B
- 23 WAIT used for external synchronization
- 24 IORQ responding to ports 80H through 0BFH

Access to the I/O ports is via the &(n) symbol where n is taken from the following table:

write	read	
&(n)=	=&(n)	FUNCTION
162	-	Configures port A bits to be input bits or output bits according to the value sent to &(162). Each bit is an input bit unless it is programmed as an output bit by setting its corresponding bit value into &(162). 1=bit 0; 2=bit 1; 4=bit 2; 8=bit 3; 16=bit 4; 32=bit 5; 64=bit 6; 128=bit 7; 40=bits 3 and 5; etc. as outputs. Any position not set will become an input even if it was set to an output by the previous value.
163	-	Configures port B bits to be input bits or output bits according to the value sent to &(163) as in port 162 above.
160	160	Accesses port A for data transfers to and from the BLUE RAM. Input bits set high during a read result in corresponding values from the read. Output bits set high during a write result in high logic states at those bit positions on the ZIF socket. Those not set result in low logic states at those bit positions.
161	161	Accesses port B for data transfers to and from the BLUE RAM as in port 160 above.
128	128	Accesses bit 0 of port a individually. If bit 0 is an input bit and is being held high during a read, a value of 128 will be returned; otherwise the value is 0. Any value sent will set the output for this bit low if it is an output bit.

write	read	
&(n)=	=&(n)	FUNCTION
129 thru 135	129 thru 135	Same as &(128) except bit 1 through 7 of port A respectively.
136 thru 143	136 thru 143	Same as &(128) except bit 0 through 7 of port B respectively.
144	144	Same as &(128) except that any value written to &(144) will set the output for this bit high.
145 thru 151	145 thru 151	Same as &(144) except bit 1 through 7 of port A respectively.
152 thru 159	152 thru 159	Same as &(144) except bit 0 through 7 of port B respectively.
64	64	Any access to this port sets the mode to ROM when the MODE switch is in the AUTO position.
192	192	Any access to this port sets the mode to RAM when the MODE switch is in the AUTO position.

NOTE: Output pins will only supply 2 ma. of current. Do not expect them to drive heavy loads. Use small relays or other amplifiers where more power is required.

WARNING WARNING WARNING WARNING WARNING WARNING WARNING WARNING
 Do not connect A.C. appliances directly to the BLUE RAM I/O ports. NEVER CONNECT A.C. FROM THE WALL (120V) DIRECTLY TO ANY PART OF YOUR BALLY ARCADE OR THE BLUE RAM ADD-ON OR SEVERE DAMAGE AND SHOCK HAZARD WILL RESULT!!!
 Relays or optical isolators with at least 1500V isolation should be used for controlling 120V A.C. devices.

Open the ZIF socket (handle in the up position) and insert the remaining 4.7K ohm resistor between pins 10 and 9 of the socket and close it (handle on the down position). Try this simple program:

-- 10	&(162)=0;&(163)=0	Set ports A & B to all inputs.
20	A=&(160);B=&(161)	Reads both ports
30	IF A#OPRINT "A",A	Prints port A if #0
40	IF B#OPRINT "B",B	Prints port B if #0
50	GOTO 20	Recycle to try again

As long as the resistor is there, you should receive a

A 1

printout. Now move the resistor end from pin 9 among pins 8 through 2 and over to 14 through 21 and watch the printout change as the program continually monitors the connection of the resistor to the various input pins. Switches and other sensors may be similarly connected to the I/O pins in order to hook up to some real applications. Watch the ARCADIAN for further sample applications and tutorials.

MACHINE LANGUAGE PROGRAMMING: This is far too complex and wide ranging a subject to adequately treat here. There are many books written on the subject and we expect to run tutorials in serial form in the ARCADIAN concerning how to use machine code routines in conjunction with BASIC programs and the built-in routines of the BALLY ARCADE itself. Similarly, additional data will be distributed relating to the "extra" pins on the ZIF socket for external synchronization to devices such as floppy disks, etc.

SWITCH SETTINGS: There are two switches located on the BLUE RAM for control of the memory range and memory protection:

RANGE: has two positions. The 6K-RAM position is the normal position for this switch. This position is used for all memory uses except cassette emulation. It allocates memory to 6000H (or 24576 decimal). The 2K-CASS. position allocates memory such that it displaces the cassette plugged into the cassette slot in the front of the BALLY ARCADE. The only use of this position is in emulating a game cassette by running a machine code program similar those in the game cassettes. Future issues of the ARCADIAN will explore this capability further. Also, see the COPY A GAME CARTRIDGE feature of the BLUE RAM UTILITY program.

MODE: has three positions. The AUTO position is the normal position for this switch. In this position, the setting can effectively be switched internally between RAM and ROM by the special I/O ports &(64) and &(192). (See the table under INPUT/OUTPUT). The center position of the MODE switch is the RAM mode which forces the first 4096 bytes of memory into the read/write mode (no memory protection).

The ROM position forces the first 4096 bytes of BLUE RAM memory into the read-only mode where its contents cannot be altered as long as power is applied to the BLUE RAM. This position is helpful whenever it is important to preserve the contents of memory, say prior to writing it to tape. Remember, however, that in this position, memory cannot be changed even if you want to change it. Strings cannot be altered, at least not the first 2096 entries. The switch must be moved to the RAM position or the AUTO position with write enabled (&(192)=0).