VIC
Memory

VIC MEMORY EXPANSION

Features

1) The "Stack Vic Memory Expansion" is capable of expanding your 5k Vic computer to a 32k machine.

2) Provides space for a 2k EPROM eg Vic Kit.

3) The memory board can be bought in any size ie 3k,8k,8k + 3k, 16k, 16k + 3, 24k, 24k + 3.

4) From any configuration it is possible to move up to 24k + 3 giving a 32k Vic by simple plug in memory chips.

5) Memory expansion is by 2k Ram chips giving low cost ram extensio

6) Duplicate "Vic Expansion Port" for cartridges that would otherwise require an expansion unit to facilitate memory expansion.

7) Switchable 3k block in lst 8k.

MEMORY ORGANIZATION

VIC's 6502 microprocessor can access up to 32,000 independent user-RAM memory locations (with memory expansion). You can think of VIC's memory as a book with up to 125 "pages," with 256 memory locations on each page. For example, page $80 is the 256 memory locations beginning at location $8000 and ending at location $80FF. Since the 6502 uses two eight-bit bytes to form the address of any memory location, you can think of one of the bytes as the page number and the other as the location within the page.

The amount of active RAM may be 3.58k (addresses 4096 to 7679), 6.65k (addresses 1024 to 7679), or a total of 32k by adding 24k more RAM (addresses 8192 to 32767. Addresses 40960 to 49151 are allocated for the expansion of ROM. The first 1k-byte allocation (to 1024) is fixed; the larger the memory size, the more space is available in the user program area.

VIC has three types of memory: random access Memory (RAM), Read-Only Memory (ROM), and Input/Output locations (I/O). Figure 1 shows a typical VIC-20 memory, the different types, and the operations for which they are used.

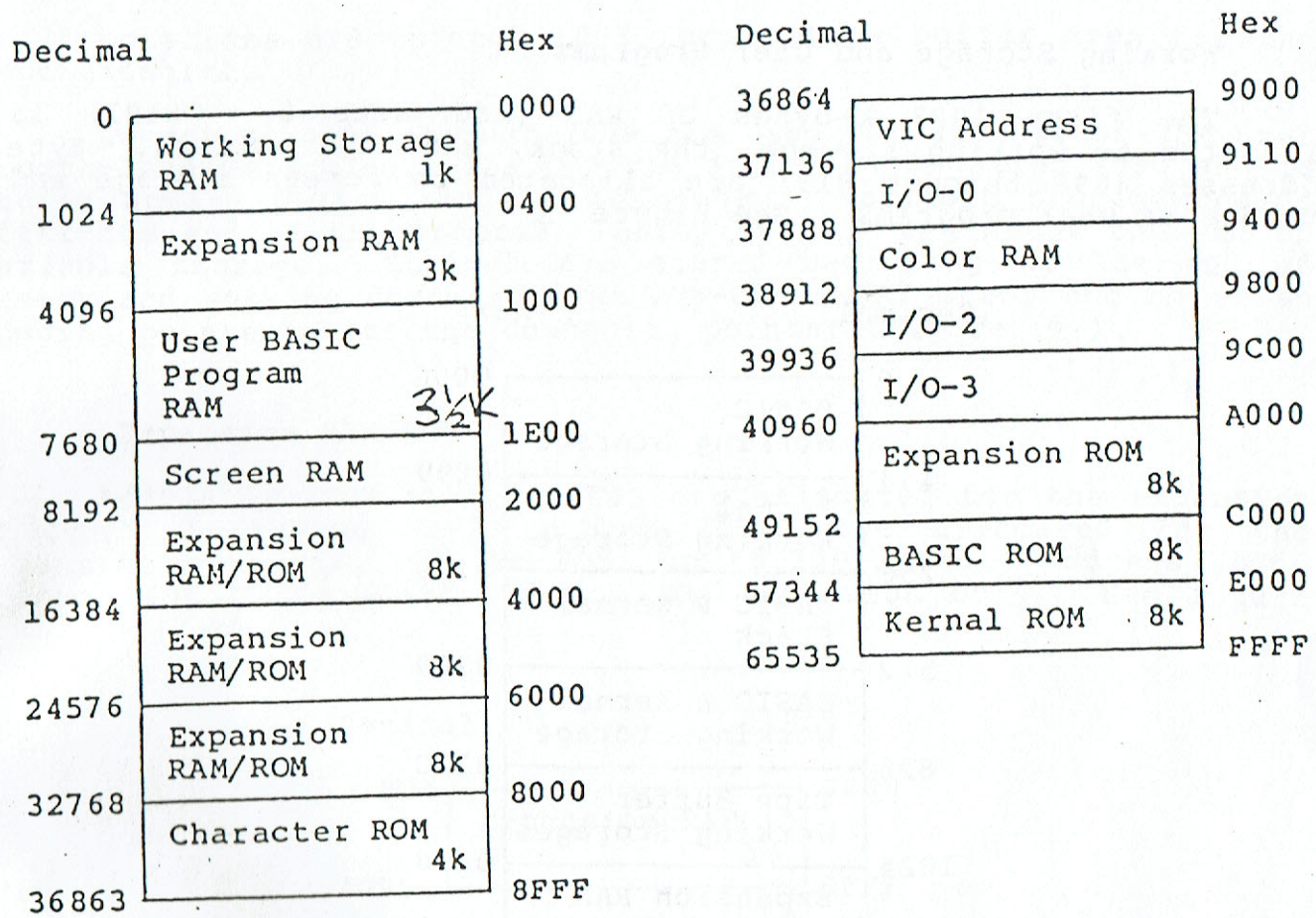

Figure 1 VIC-20 Memory Locations

Each portion of the memory is described in more detail in the following text.

Working Storage and User Programs

The first 1023 k-bytes of RAM (Addresses 0 - 8191) is allocated to working storage, the stack, and tape buffers. Byte addresses 4096 through 8191 are allocated to screen storage and storage of user programs. See Figure 2

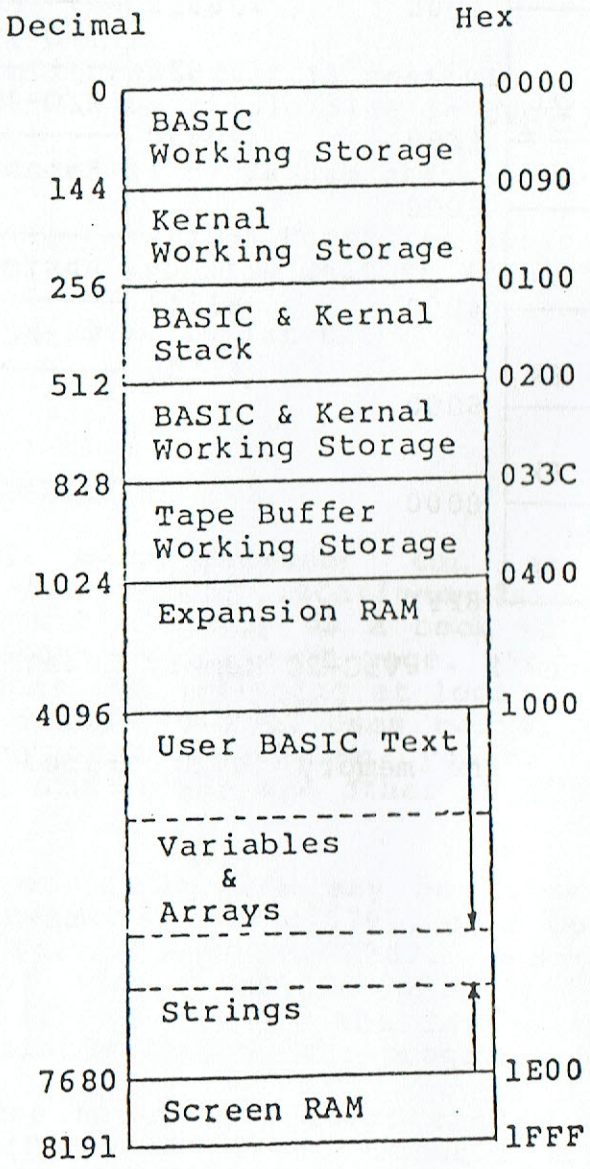

Figure 2 Working Storage and User Programs

Locations 256 through 511 are used for the stack area for BASIC, Kernal and the microprocessor. The stack begins at location 511 and proceeds downward. Storage is allocated dynamically as needed by BASIC and the hardware. An OUT-OF-MEMORY error occurs if the stack pointer reaches the end of available space in this area.

Locations 512 through 827 are used as additional BASIC and Kernal working-storage locations.

Locations 828 through 1023 form a tape buffer area for the tape cassette.

Locations 4096 through 7679 are used for storage of the user program and variables. The program begins at location 4096 and is stored upward toward the end of memory. Variable storage begins after the end of the program. Array storage begins at the end of variable storage. Strings are stored beginning at the end of memory and working downward. An OUT-OF-MEMORY error occurs if an upgoing pointer meets the downgoing pointer (Figure 2).

Expansion RAM/ROM

Addresses 1024 through 4095 are allocated for the expansion of RAM. Addresses 8192 through 32767 are allocated for the expansion of either RAM or ROM, up to 32k-bytes. Address 40960 through 49151 are allocated for ROM expansion only. See figure 3 .

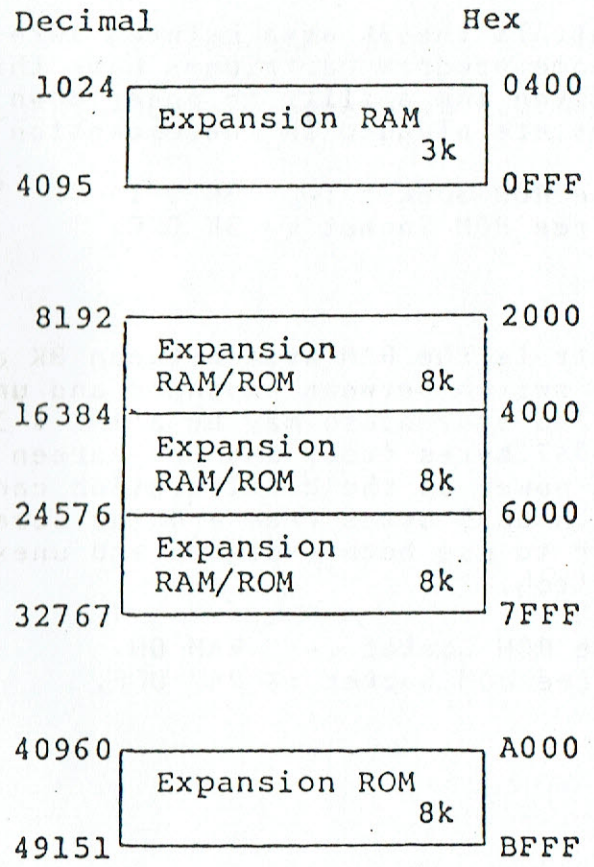

Figure 3 Expansion RAM/ROM

INSTALLATION.

The Storeboard is a single unit which can contain, all the basic RAM requirements of the VIC and most of its ROM capabilities. Before attempting to install the storeboard the user should ensure that the power is off. If the board, cartridge or clip is plugged or unplugged when power is on then damage will occur to the VIC and the peripheral.

The Storeboard plugs into the memory expansion port at the rear of the VIC, so that the VIC and the expansion unit sit at the same level. If the power is now turned on the VIC will initialize within 30 seconds. If it does not, power down, and check that the storeboard is installed correctly and is not sitting at an angle. Power up again. The VIC should now initialize. The number of bytes free displayed depends on the memory added. (See section "Bytes Free").

The Storeboard has 2 switches. The functions are outlined below.

SW 1.

This switch controls the 3K area between 1024 and 4096 on the storeboard. As some program cartridges have this RAM in them, the storeboard was given the ability to power down its own 3K when these cartridges are plugged in the expansion connector.

SW 1 towards the Free ROM Socket :- 3K ON.
SW 1 Away from the Free ROM Socket :- 3K OFF.

SW 2.

This switch controls the RAM area between 8K and 32K. Enabling the user to switch between expanded and unexpanded VIC configurations i.e. The storeboard may be a 16K + 3K giving an expanded VIC with 19967 bytes free, and the screen at 4096. By altering SW 2 before power up the configuration can be changed to an unexpanded VIC with 6655 bytes free and the screen at 7680. This enables the user to use both expanded and unexpanded software at the flick of a switch.

SW 2 towards the Free ROM Socket :- RAM ON.
SW 2 Away from the Free ROM Socket :- RAM OFF.

SOFTWARE.

When the VIC 20 is upgraded with extra memory, beyond RAM location $2000, the screen memory automatically moves down to $1000, and the associated colour nybbles move down to $9400.

For this reason it is recommended that programs written using PEEK and POKE statements (To the screen) reference a location via a base address (screen starting address) and an offset. For example

```
BA = 7680
POKE BA + 3,0
```

This will display a @ sign on line 0, column 3. When an expansion RAM is added with locations beyond $2000, simply change the statement from BA = 7680 to BA = 4096. All display characteristics will work as before.

	5K	8K	>8K
Start of Basic	4096	1024	4608
Screen Addr.	7680-8186	7680-8186	4096-4602
Colour Addr.	38400-38906	38400-38906	37888-38394

PROGRAM LOAD.

When loading machine code programs on VIC use:

```
LOAD "NAME",1,1
```

NOT

```
LOAD "NAME",1
```

BYTES FREE.

When adding memory to the VIC Microcomputer the user would expect to see more bytes free as more memory is added. On the VIC this is not the case. The bytes free is a count of the ram locations set aside for basic to use, and the VIC varies this allocation depending on the available RAM free. As RAM is added up to the first 8K boundry (3K Memory Expansion) the VIC gives all the free ram space to basic hence bytes free equals 6655. When RAM is added above the 8K boundry the VIC only allocates some of the memory to basic and saves the 3K area for machine code programs hence a VIC with 3K memory expansion plus 8K gives only 11½K and not 14½K as expected. If the user does not want to use the 3K area then the two chips in 3R12 and 3R3 can be moved to the lowest CR sockets and they will now add 4K of RAM to basic ie 3K (moved) plus 8K VIC gives 14½K bytes free.

A table is given below for expected bytes free.

RAM SIZE ADDED	BYTES FREE
3K	6655
8K	11775
8K + 3K	11775
16K	19967
16K + 3K	19967
24K	28159
24K + 3K	28159

To mix cartridges and RAM or ROM on the storeboard see cartridge slection table.

VIC MEMORY CARTRIDE SELECTION TABLE.

	MEMORY LOCATION DECIMAL	MEMORY TYPE	MEMORY LOCATION HEXADECIMAL	CARTRIDGE TYPE
1.	1024 4096	RAM (3K)	0400 0FFF	3K MEMORY EXPANSION 3R12 and 3R3 SOCKETS STOREBOARD SOME GAMES.
2.	8192 16384	RAM (or rom) (8K)	2000 4000	8K RAM CARTRIDGE (STANDARD) 1st ½ of 16K CARTRIDGE (STANDARD) CR2/CR4/CR6/CR8 STOREBOARD.
3.	16385 24576	RAM (or rom) (8K)	4000 6000	8K RAM CARTRIDGE (MODIFIED) 2nd ½ of 16K CARTRIDGE (STANDARD) CR10/CR12/CR14/CR16 STOREBOARD.
4.	24576 32767	RAM (or rom) (8K)	6000 7FFF	8K RAM CARTRIDGE (MODIFIED) CR18/CR20/CR22/CR24/ STOREBOARD MACHINE CODE / MONITOR CARTRIDGE PROGRAMMERS AID
5.	40960 49151	ROM 8K	A000 BFFF	ALL GAMES CARTRIDGES SUPER EXPANDER (A000 B000) VICKIT SERIES ROMS (B000 BFFF) ROM SOCKET STOREBOARD. "
6.	37136 37888	I/O	9110 9400	IEEE CARTRIDGE (WHEN AVAILABLE) OUTPUT BOARDS (CUSTOM DESIGN) INPUT BOARDS (CUSTOM DESIGN)

ADDING EXTRA MEMORY.

1. Remove the four rivets in each corner. To do this the centre pin of each rivet should be pushed up from the bottom with a small screw driver without allowing the centre pin to fall free. Now remove the whole rivet by pushing from the bottom. Remove the base plate.

Now remove the centre two rivets as above and remove lid.

Inside are rows of sockets CR2 to CR24 and 3R12, 3R3. The new ram chips should be plugged into these sockets with the indent on the chip furthest away from SW1 (writing on chip same orientation as writing below socket).

3R12, 3R3 are the lower 3K of block 1.
1024 to 4096 decimal.

CR2 to CR8 are the second 8K 8192 to 16384.
CR2 being the lowest and CR8 the highest.

CR10 to CR16 are the third 8K addressed as 16384 to 24579.
CR10 being the lowest, CR16 the highest.

CR18 to CR24 are the fourth 8K addressed as 24579 to 32768.
CR18 being the lowest, CR24 the highest.

To map extra ram into basic (program user ram) the chips must be added to fill the lowest memory addresses first.

NOTE.

Take care not to damage the legs of the Ram chips when inserting. To remove ram chips use a chip remover or lever out from both ends with a small screw driver, carefully.

EPROM SLOT

The socket on the right of the expansion board is designed to take a 2K or 4K EPROM (eg a "VICKIT").

Eproms should be plugged in with the notch towards the VIC. This should be carried out with the VIC switched off.

The socket sits between decimal addresses 45056 and 49152.

Any EPROM is therefore initialised by:

SYS 45056

If a VICKIT is plugged in the VIC will reply:

(C) TSP81