

Sun Microsystems

**Sun-2/120 Video Board Diagnostic
Design Document**

Tom Kraus

March 8, 1985

Revision C

The Design Document for the Sun-2/120 Video Board Diagnostic is presented.

This document presents the high level design of the Sun-2/120 Video Board Diagnostic. It informs the reader as to *what* features of the Sun-2/120 Video Board will be tested by the Sun-2/120 Video Board Diagnostic. A description of *how* each feature will be tested by the Sun-2/120 Video Board Diagnostic is also given.

Members of any of the following four departments may find this document of interest for various reasons: (1) Design Engineering, (2) Manufacturing, (3) Field Service and (4) Diagnostics.

Using the Sun-2/120 Video Board Diagnostic, the Design Engineer(s) of the Sun-2/120 Video Board will be able to confirm the correctness of their design. Manufacturing and Field Service personnel will use the Sun-2/120 Video Board Diagnostic for testing and/or trouble shooting purposes. Member(s) of the Diagnostic department will review the design of the Sun-2/120 Video Board Diagnostic based on this document.

At a minimum, the reader is assumed to have some understanding of the function of the Sun-2/120 Video Board. An excellent preface to this document is "Theory of Operation Manual for the Sun-2/120 Video Board".

Revision A January 22, 1985 Initial release of this document.

Revision B February 18, 1985 Minor corrections were made. Several tests were clarified. Additional design details were added.

Revision C March 8, 1985 The final design modifications were incorporated.

CPU - Central Processing Unit

FRU - Field Replaceable Unit

SCC - Serial Communication Controller

The Sun-2/120 Video Board is the display subsystem for the Sun-2 products which use Multibus. It has a serial interface with the monitor, keyboard and mouse in addition to a parallel interface with the CPU board. As a part of the video board, a control register enables several advanced features such as copy mode and interrupts.

The Sun-2/120 Video Board Diagnostic has been designed to test the Sun-2/120 Video Board. The Sun-2/120 Video Board consists of the following three sections: (1) the control register, (2) serial communication controller and (3) video memory. All three sections of the Sun-2/120 Video Board will be tested by the Sun-2/120 Video Board Diagnostic.

Generally speaking, it is the objective of the Sun-2/120 Video Board Diagnostic to ensure that the Sun-2/120 Video Board works correctly. In this case, "works correctly" implies that the Sun-2/120 Video Board functions as stated in the "Theory of Operation Manual for the Sun-2/120 Video Board".

Again, the three functional sections of the Sun-2/120 Video Board are the control register, serial communication controller and video memory. The Sun-2/120 Video Board Diagnostic will test all three of these functional sections.

In particular, the *memorability* and *functionality* of the Sun-2/120 Video Board's control register will be tested. The *functionality* of the serial communication controller will be checked. Finally, the Sun-2/120 Video Board Diagnostic will test the *memorability* of video memory.

In the process of designing the Sun-2/120 Video Board Diagnostic, the following performance, functional, hardware and environmental requirements were assumed.

In terms of run time restraints, the Sun-2/120 Video Board Diagnostic should "quickly" test the Sun-2/120 Video Board. In other words, an experienced user should be able to test a Sun-2/120 Video Board in a matter of minutes.

It should be possible to interrupt the Sun-2/120 Video Board Diagnostic after the completion of any individual test and, in some cases, during individual tests. The Sun-2/120 Video Board Diagnostic should produce meaningful error messages. Adequate on-line help must also be available.

The minimum hardware configuration required is listed below.

1. A Sun-2/120 multibus hardware cage.
2. A Sun-2/120 power supply.
3. A Sun-2/120 CPU Board.
4. A Sun-2/120 Memory Board.
5. A Sun-2/120 Video Board.
6. A dumb terminal (TeleVideo, Wyse, etc.), attached to one of the CPU serial ports, will be required for board test (not system test).
7. A boot device (i.e. local disk, local tape or remote disk via ethernet).
8. A Sun-2/120 Video Monitor.
9. If an external loop back test is written, a loop back cable will be required.
 - A. For board test purposes, a card edge ribbon cable is required. This ribbon cable has not yet been constructed. Following the construction of the cable, if possible, a part number will be assigned to the cable by Document Control. That part number will be specified in the User's Document for the Sun-2/120 Video Board.
 - B. For system test purposes, a telephone-like cable is needed to connect the mouse and keyboard ports. This telephone-like cable has not yet been constructed. Following the construction of the cable, if possible, a part number will be assigned to the cable by Document Control. That part number will be specified in the User's Document for the Sun-2/120 Video Board.

The Sun-2/120 Video Board Diagnostic will be a stand alone diagnostic. It will NOT run on top of the UNIX operating system.

It is worth stating that the document which was used to determine what features of the Sun-2/120 Video Board need to be tested was the "Theory of Operation Manual for the Sun-2/120 Video Board". Therefore, any features that are not mentioned in that document will not be tested by the Sun-2/120 Video Board Diagnostic.

In addition, in order to maintain consistency between the Sun-2/120 Video Board Diagnostic and the other Sun-2/120 diagnostics, the Sun-2/120 Video Board Diagnostic's user interface will be similar to the other Sun-2/120 diagnostics. Although the existing user interface is not perfect, the advantage of keeping all of the Sun-2/120 diagnostic user interfaces similar would seem to outweigh the benefit gained by enhancing the user interface to the Sun-2/120 Video Board Diagnostic.

A functional description of the Sun-2/120 Video Board Diagnostic is given below. Initially, the general features of the Sun-2/120 Video Board Diagnostic are presented. Then, each module is discussed separately.

The Sun-2/120 Video Board Diagnostic will allow the user the flexibility of testing the three functional sections of the Sun-2/120 Video Board individually. In addition, an option will be provided to allow the user the ability to test all three functional sections of the Sun-2/120 Video Board in a continuous sequence.

The user interface of the Sun-2/120 Video Board Diagnostic will consist of a Main Menu with three submenus. A Help option on each menu will make more detailed user instructions available to the user. A Quit option will also be available on each menu. All submenus will provide the user with the ability to (1) return to the current submenu and (2) return to the Main Menu. Finally, it will be possible to initiate tests on other menus from the menu which is currently being displayed. Thus, the experienced user will not have to traverse the menu structure in order to execute tests available on other menus.

As stated previously, the Sun-2/120 Video Board consists of three functional sections. Those three functional sections are the control register, serial communication controller and the video memory. Before discussing these three functional sections, however, the Main Menu will be presented. Following that

discussion, the control register, serial communication controller and video memory will be covered, respectively.

The Main Menu, shown below, will have a total of eleven options. These options are discussed next.

1. If option "c" is selected, a submenu containing all of the control register tests will appear.
2. If option "s" is chosen, a submenu containing the tests specific to the serial communication controller will appear.
3. If option "v" is selected, a submenu containing all of the video memory tests will appear.
4. Selecting option "d" will initiate the default test sequence. It is being assumed that the default test should be a "quick and dirty" test. In other words, one of the primary factors in determining whether or not a test is included in the default test sequence is how long it takes to run. The default option will perform minimal testing the three functional sections. However, option "d" will *not* perform an exhaustive test of the Sun-2/120 Video Board.

At this point, it is not known how much time the individual tests will require. Therefore, it is not possible to state exactly which tests will be incorporated in the default test sequence. In order to get a rough idea of what tests will be included in the default test sequence, see the default option described in each of the following sections: "The Control Register", "The Serial Communication Controller" and "The Video Memory". The default test sequence will be clearly stated in the User's Document for the Sun-2/120 Video Board.

If the serial communication controller will be tested by the default test sequence and an external loop back test is written, the user will be required to install the appropriate loop back cable. In particular, in board test, the card edge loop back cable will have to be in place. On the other hand, in system test, the telephone-like loop back cable will be required. Assuming that Document Control will assign part numbers to these cables, the part numbers will be specified in the User's Document for the Sun-2/120 Video Board. Furthermore, detailed instructions for installing the cables will appear in the User's Document for the Sun-2/120 Video Board.

5. If option "a" is chosen from the Main Menu, all Sun-2/120 Video Board tests will be executed in sequence. Again, if an external loop back test is written for the serial communication controller, the appropriate loop back cable will have to be installed.
6. The sixth option, option "M", specifies whether or not messages are displayed on the screen. Entering "M 0" on the command line will turn off message mode (silent mode). On the other hand, the command "M 1" will turn the message mode on. By default, message mode will be on.
7. Option "K" specifies whether or not parity checking is performed. Entering "K 0" on the command line turns parity checking off while, "K 1" turns parity checking on. By default, parity checking will be on.
8. Option "l" (the letter ell) will give the user the opportunity to specify the number of times a user-specified sequence of tests is to be executed. For example, terminating a command line containing one or more user-specified tests with "l 5" would execute all of the tests on that command line five times.

The command line for the loop option will be:

```
"l [loop_count]"
```

The "loop_count" argument specifies (in *decimal*) the number of times the test(s) on the command line will be *executed*. The "loop_count" argument will be optional. Without it, the test(s) on the command line will be performed *once*. The range of legal *numerical* values for the "loop_count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the loop count argument, the given test sequence will run *forever*.

9. Option "e" will display an error log. More specifically, at a maximum, the first 100 errors messages of each type produced by the Sun-2/120 Video Board Diagnostic will be printed on the screen. The user will have the capability to suspend and restart the error log display as they see fit.
10. If option "h" is chosen, more detailed user instructions will appear.
11. Option "q" will terminate the Sun-2/120 Video Board Diagnostic.

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Sun-2/120 Video Board Diagnostic      REV 1 00/00/85      Main Menu

      c - Control Register Menu
      s - Serial Communication Controller Menu
      v - Video Memory Menu
      d - Default Test Sequence
      a - Execute All Tests
      M - Print Error Messages?
      K - Check Parity?
      l - Loop
      e - Error Log Display
      h - Help
      q - Quit

Command ==>
```

The control register holds a total of 16 bits. Generally speaking, the control register is used to enable/disable various functions, set the copy mode base address and monitor the vertical interrupt status. The processor is able to read the contents of the entire control register. It cannot, however, read the high or low byte of the control register on an individual basis. The processor is capable of writing to (1) the entire control register, (2) the high byte of the control register and (3) the low byte of the control register *with the following exceptions*. Bit 00 and bits 07-12 are not affected by the write operations. The control register is located at address 0x781800 (7870464). A diagram of the control register follows.

High Byte								Low Byte								
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
V I D E N	V C O P Y E N	V I N T E N	V V I N T	Configuration Jumpers				0	CMBASE 17 - 22							0
read or write	read or write	read or write	read only	read only				read only	read or write							read only

Two types of tests need to be performed on the control register. The memorability of the control register itself must be tested. In addition, the functionality of the control register will require testing.

When option "c" (Control Register Tests) is selected from the Main Menu, the Control Register Menu, shown below, will appear. The Control Register Menu will have a total of fifteen options. The first option on the menu will perform the memorability test of the control register. The memorability test, along with its options, will be discussed below in more detail in the section titled "Testing The Memorability Of The Control Register". The second option on the Control Register Menu will execute the "Copy Enable/Disable Test". This functionality test will be detailed later in the section titled "Testing The Functionality Of The Control Register". The next four options of the Control Register Menu (options 3-6) deal with the setting of *flags*. They are discussed below.

1. The third option, option "M", specifies whether or not messages are displayed on the screen. Entering "M 0" on the command line will turn off message mode (silent mode). On the other hand, the command "M 1" will turn the message mode on. By default, message mode will be on.
2. The fourth option, option "K", specifies whether or not parity checking is performed. Entering "K 0" on the command line turns parity checking off while, "K 1" turns parity checking on. By default, parity checking will be on.
3. The fifth option, option "W" (wait/stop on error), specifies whether or not the program is suspended upon the occurrence of a *memory* data error (not all types of errors). Entering "W 0" on the command line means that the program will not be suspended after the occurrence of a *memory* data error. If "W 1" was entered on the command line prior to the occurrence of a *memory* data error, the program will wait until the user presses any key. If the user presses "q" (a mnemonic for quit), the currently running memory test will be terminated. If any other key is pressed, the memory test will continue with the next address. By default, the wait-on-error flag will be off.
4. The sixth option, option "S" (scope loop on error), determines whether or not the program enters a scope loop upon the occurrence of a *memory* data error (not all types of errors). If the diagnostic enters a scope loop, it continues to write a value to the address in question and read back that value before comparing the expected and observed values (i.e the test performs write-read-compare cycles). Entering "S 0" on the command line means that the program will not enter a scope loop following the occurrence of a *memory* data error. If "S 1" is entered, the program will enter a scope loop following the occurrence of a *memory* data error. The user will be able to terminate a scope loop *on a particular address* by pressing "n" (a mnemonic for next address). They will also be able to terminate the scope loop and the currently running memory test by pressing "q" (a mnemonic for quit). By default, the scope-loop-on-error flag will be off.

It should be noted that the user will be able to turn both wait-on-error and scope-loop-on-error on simultaneously. Thus, it will be possible to suspend the diagnostic after each write-read-compare cycle within the scope loop. Again, the user will be able to terminate a scope loop *on a particular address* by pressing "n" (a mnemonic for next address). They will also be able to proceed from one write-read-compare cycle to the next by pressing any character *except 'q' and 'n'*. Finally, the scope loop, wait on error condition and the currently running memory test can be terminated by pressing "q" (a mnemonic for quit). By default, the scope-loop-on-error flag and the wait-on-error flag will be off.

Like option 2, options 7, 8 and 9 on the Control Register Menu test the functionality of the control register. Options 7-9 perform the "Screen (Display) Enable/Disable Test", the "Interrupt Enable/Disable Test" and the "Jumper Test", respectively. Again, these tests will be discussed in the section titled "Testing The Functionality Of The Control Register". The final six options on the Control Register Menu, options 10-15, are presented below.

1. Selecting option "d" will initiate the default control register test sequence. Again, given that it is not known how long any of the individual control register tests will take, it is not possible to specify exactly which tests will be performed by the default test. However, if intuition is at all reliable, all five of the control register tests should run quickly. Therefore, the plans at this point are to include all five of the control register tests in the default test sequence. Thus, in this case, the default control register test would exhaustively test the control register. The tests are listed next. A description of the first test is given in the section titled "Testing The Memorability Of The Control Register" while, the final four tests are detailed in the section titled "Testing The Functionality Of The Control Register".
 - A. Memory Test Of The Control Register.
 - B. Screen (Display) Enable/Disable Test.
 - C. Copy Enable/Disable Test.
 - D. Interrupt Enable/Disable Test.
 - E. Jumper Test.
2. Option "l" (the letter ell) will give the user the opportunity to specify the number of times a user-specified sequence of tests is to be executed. See discussion of the "loop" option under the section titled "The Main Menu" for more detail.
3. Option "e" will display an error log. More specifically, at a maximum, the first 100 error messages of each type produced by the Sun-2/120 Video Board Diagnostic will be printed on the screen. The user will have the capability to suspend and restart the error log display as they see fit. Notice that these error messages may not necessarily be related to the control register.
4. If option "h" is chosen, more detailed user instructions will appear.
5. Option "p" will return to the Main Menu.
6. Option "q" will terminate the Sun-2/120 Video Board Diagnostic.

Sun-2/120 Video Board Diagnostic REV 1 00/00/85 Control Register Menu

- m - Memory Test Of Control Register
- c - Copy Enable/Disable Test
- M - Print Error Messages?
- K - Check Parity?
- W - Wait (Stop) On Error?
- S - Scope Loop On Error?
- s - Screen (Display) Enable/Disable Test
- i - Interrupt Enable/Disable Test
- j - Jumper Test
- d - Default Control Register Test
- l - Loop
- e - Error Log Display
- h - Help
- p - Return To The Main Menu
- q - Quit

Command ==>

The goal of the memorability test is to ensure that whatever is written to the control register is actually stored there. However, it is not possible to test the memorability of the entire control register. In fact, the memorability of *only bits 01-06* of the control register will be tested. The following paragraph explains why.

To begin with, since bit 00 and bits 07-12 are not writable, the memorability of these bits cannot be tested. Secondly, since bit 15 of the control register turns the screen on and off, *the memorability of bit 15 will not be tested*. The "Screen (Display) Enable/Disable Test" will indirectly test the memorability of bit 15 of the control register. Thirdly, since bit 14 turns copy-mode on and off, *the memorability of bit 14 will not be tested*. The "Copy Enable/Disable Test" will indirectly test the memorability of bit 14 of the control register. Finally, since bit 13 of the control register generates video board interrupts, *the memorability of bit 13 will not be tested*. The "Interrupt Enable/Disable Test" will indirectly test the memorability of bits 12 and 13 of the control register.

The typical testing paradigm will consist of the following steps. First of all, a value will be written to the control register, bit 00 and bits 07-15 not included. In other words, only bits 01-06 will be written to.

Within certain constraints, the user will have the capability to specify which value(s) can be written to the control register. Secondly, the contents of the control register will be read back. Thirdly, since bit 00 and bits 07-15 will not be written to, a masking operation will be required. Fourthly, the value read back from the control register will be compared to the expected value. Finally, a message will be printed indicating the success or failure of the test.

The command line for the memorability test will be:

```
"m [beg_val [end_val]] [inc] [count]"
```

The "beg_val", "end_val", "inc" and "count" arguments will all be optional. Arguments "beg_val", "end_val" and "inc" must be specified in hexadecimal. Notice that, in order to use the "end_val" argument, the "beg_val" will also be required.

By default, the "beg_val" will be 0x00, while the "end_val" will be 0x7f. The range of values is constrained by the fact that only bits 01-06 are tested. The user will, however, be able to request that any value between 0x00 and 0x7f be assigned to the "beg_val" and the "end_val". The only constraint will be that the "beg_val" must be less than or equal to the "end_val".

By default, the value of the "inc" argument will be one (0x1). The "inc" argument will dictate the sequence of values which will be written to the control register. For example, given a "beg_val" of 0x00, an "end_val" of 0x06 and an "inc" value of 0x02, the following four values would be written to bits 01-06 the control register: 0x00, 0x01, 0x02 and 0x03.

The real power of having the "beg_val", "end_val" and "inc" arguments will become evident when all three arguments are used in combination. In particular, it will be possible to toggle (clear and set) any of the CMBASE (Copy Mode Base Address bits [bits 01-06]) bits of the control register without affecting the remaining bits of the control register. Furthermore, a group of bits may be manipulated independently of the rest of the control register. Specifying a "beg_val" of 0x00, an "end_val" of 0x7f and an "inc" of 0x01 will attempt to write all possible addresses to the CMBASE (Copy Mode Base Address bits [bits 01-06]) bits of the control register.

The "count" argument will specify the number of times which the memorability test is performed. This argument will be specified in *decimal*. By default, the memorability test will be performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test sequence will run *forever*.

Within reason, error checking will be performed on the command line arguments. Specifically, the following checks will be performed.

1. The value of the "beg_val" will be checked.
2. The value of the "end_val" will be checked.
3. The value of the "inc" will be checked.
4. The value of the "count" will be checked.
5. A check will be performed to prevent overflow from occurring.

In addition to testing the memorability of the control register, its functionality must also be tested. The four functionality tests which will be performed are listed below.

1. Screen (Display) Enable/Disable Test
2. Copy Enable/Disable Test
3. Interrupt Enable/Disable Test
4. Jumper Test

Each of these functionality tests is covered in a separate section below.

Option "s" on the Control Register Menu will initiate the Screen (Display) Enable/Disable Test. This test will aid the user in determining whether or the video display (screen) can be turned on and off. In particular, if bit 15 (VIDEN) of the control register is set (equal to 1), the video display should be on (white with black characters). If bit 15 (VIDEN) of the control register is clear (equal to 0), the video display should be off (black).

The Screen (Display) Enable/Disable Test will turn the video display off and then back on. Unfortunately, the user will be required to watch whether or not the video display flashes off and then back on. After the video display is turned back on, a question will appear on the screen asking the user whether or not the screen actually blinked off and then back on. However, to eliminate the need for user input, the question will NOT require an answer. It will simply remain on the screen for few seconds before the Sun-2/120 Video Board Diagnostic continues execution.

The command line for the Screen (Display) Enable/Disable Test will be:

"s [count]".

The "count" argument will specify the number of times which the Screen (Display) Enable/Disable Test is performed. This argument will be specified in *decimal*. By default, the Screen (Display) Enable/Disable Test will be performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test sequence will run *forever*.

Selecting option "c" on the Control Register Menu will execute the Copy Enable/Disable Test. This test will determine whether or not writing to a main memory shadow buffer also affects the video memory given the proper conditions. That is, whether or not the contents of the main memory shadow buffer are written to the video memory and, subsequently, are displayed on the screen given the proper conditions.

According to the "Theory of Operation Manual for the Sun-2/120 Video Board", the contents of the main memory shadow buffer will be written to the video memory and, subsequently, will be displayed on the screen if the following two conditions are met.

1. The address contained in bits 01-06 of the control register must match the address on bus lines 17-22.
2. Bit 14 of the control register must be set.

Independent of whether or not the address contained in bits 01-06 of the control register matches the address on bus lines 17-22, the copy operation will not be performed if bit 14 of the control register is clear. Also, no communication between the video board and the CPU takes place if the address contained in bus lines 17-22 does not match the address in bits 01-06 of the control register.

In particular, the following steps will be performed when the Copy Enable/Disable Test is executed.

1. Bit 14 of the control register (VCOPYEN) will be set.
2. The address of the first word in the main memory shadow buffer will be written to bits 01-06 of the control register (CMBASE bits: Copy Mode Base Address bits).
3. A value will be written to each word in the main memory shadow buffer. The contents of the main memory shadow buffer should consequently appear on the screen. The user will have the opportunity to specify a range of values which can be written to the main memory shadow buffer.
4. Bit 14 of the control register will be cleared.
5. The contents of the video memory and the main memory shadow buffer will be compared.
6. The success or failure of the comparison operation will be displayed on the screen.

The command line for the Copy Enable/Disable Test will be:

"c [beg_val [end_val]] [inc] [count]".

The "beg_val", "end_val", "inc" and "count" arguments will all be optional. Arguments "beg_val", "end_val" and "inc" must be specified in hexadecimal. Notice that, in order to use the "end_val" argument, the "beg_val" will also be required.

By default, the "beg_val" will be 0x0000, while the "end_val" will be 0xffff. The range of values is constrained by the fact that there are only 16 bits in a word. The user will, however, be able to request that any value between 0x0000 and 0xffff be assigned to the "beg_val" and the "end_val". The only constraint will be that *the "beg_val" must be less than or equal to the "end_val"*.

By default, the value of the "inc" argument will be one (0x1). The "inc" argument will dictate the sequence of values which will be written to the control register. For example, given a "beg_val" of 0x0000, an "end_val" of 0x0006 and an "inc" value of 0x0002, the following sequence will be repeated throughout the main memory shadow buffer: "0x0000 0x0002 0x0004 0x0006".

The "count" argument will specify the number of times which the Copy Enable/Disable Test is performed. This argument will be specified in *decimal*. By default, the test will be performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test sequence will run *forever*.

Within reason, error checking will be performed on the command line arguments. Specifically, the following checks will be performed.

1. The value of the "beg_val" will be checked.
2. The value of the "end_val" will be checked.
3. The value of the "inc" will be checked.
4. The value of the "count" will be checked.
5. A check will be performed to prevent overflow from occurring.

Choosing option "i" on the Control Register Menu will execute the Interrupt Enable/Disable Test. The Interrupt Enable/Disable Test will test the video board's ability to interrupt the CPU.

Specifically, the following steps will be performed when the Interrupt Enable/Disable Test is initiated. To begin with, bit 13 of the control register (VINTEN) will be set. This should, in turn, cause a jump to an interrupt handler on the next vertical interval. That is, following the conclusion of the current vertical interval, execution of the interrupt routine should begin. The duration of a vertical interval is approximately one-seventieth of a second. The interrupt routine will perform the following steps.

1. One of the consequences of setting bit 13 of the control register is that bit 12 of the control register (VVINT) should also get set on the next vertical interval. That is to say, following the conclusion of the current vertical interval, bit 12 of the control register should get set. Therefore, the interrupt handler will determine whether or not bit 12 of the control register was set. If it was not set, an error message to that affect will be displayed.
2. Next, the interrupt routine will clear bit 13 of the control register to disable the interrupt.
3. A check will be made to ensure that bit 13 of the control register was indeed cleared.
4. Again, because manipulation of bit 13 of the control register should be reflected in bit 12 of the control register on the next vertical interval, a check will be made to determine whether or not bit 12 of the control register was cleared. Given that bit 12 of the control register was not cleared, an appropriate error message will be displayed.
5. Finally, a global flag will be set to indicate that the interrupt routine was executed.

Since it is not reasonable to assume that the video board's ability to interrupt the CPU is functional, the Sun-2/120 Video Board Diagnostic will give up waiting for the execution of the interrupt routine after a specified amount of time (probably one second). This will eliminate an infinite loop in the case that the video boards interrupt facility is not working correctly. If the interrupt routine is not executed within the specified amount of time, an error message will be printed on the screen.

The command line for the Interrupt Enable/Disable Test will be:

"i [count]"

The "count" argument will specify the number of times which the Interrupt Enable/Disable Test is performed. This argument will be specified in *decimal*. By default, the test will be performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test sequence will run *forever*.

If option "j" on the Control Register Menu is selected, the (Configuration) Jumper Test will be initiated. Quite simply, the Jumper Test will display the contents of bits 08-11 of the control register. The contents of the Configuration Jumper Bits will be displayed in hexadecimal, decimal, octal and binary.

The command line for the (Configuration) Jumper Test will be:

"j [count]".

The "count" argument will specify the number of times which the (Configuration) Jumper Test is performed. This argument will be specified in *decimal*. By default, the test will be performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test sequence will run *forever*.

A Zilog 8530A serial communication controller (SCC) is used to communicate with the keyboard and the mouse. The serial communication controller consists of two channels (channels A and B). Each channel consists of two 16 bit words. One word is for commands while, the other word is for data.

The starting address for the serial communication controller is 0x780000. Four contiguous words on the video board are reserved for the serial communication controller. The addresses of those four words are 0x780000, 0x780002, 0x780004 and 0x780006. Words 0x780000 and 0x780002 correspond to Channel B of the serial communication controller. Channel B of the serial communication controller handles communication with the mouse. Words 0x780004 and 0x780006 correspond to Channel A of the serial communication controller. Channel A of the serial communication controller handles communication with the keyboard. This information is summarized in the following table.

ADDRESS:	FUNCTION:
0x780000	Channel B commands (mouse)
0x780002	Channel B data (mouse)
0x780004	Channel A commands (keyboard)
0x780006	Channel A data (keyboard)

The serial communication controller is a byte-oriented device. Data is transferred only on the high byte of the data words (data bits 08-15). During a read operation, the low byte contains the lower byte of the control register. The contents of the lower byte during a write operation is unimportant ("don't care"). This information is summarized in the figure below.

High Byte								Low Byte							
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
SCC read or write data								write = do not care read = lower byte of control register							

If option "s" (Serial Communication Controller Tests) is chosen from the Main Menu, the Serial Communication Controller Menu will appear. The Serial Communication Controller Menu will have a total of nine options. Prior to presenting the Serial Communication Controller Menu, each of the eight options is discussed below.

It should be noted that, if an external loop back test of the serial communication controller is written, the appropriate loop back cable will have to be installed. In particular, in board test, the card edge loop back cable will have to be in place. On the other hand, in system test, the telephone-like loop back cable will be required. Assuming that Document Control will assign part numbers to these cables, the part numbers will be specified in the User's Document for the Sun-2/120 Video Board. Furthermore, detailed instructions for installing the cables will appear in the User's Document for the Sun-2/120 Video Board.

1. Option "s" will execute the Serial Communication Controller Test. If an external loop back test is written, this option will test the interface to the serial communication controller by attempting to write data to one channel and read it back through the other channel. By default, all values between 0x00 and 0xff will be written to Channel A, read back through Channel B and compared before a message indicating the success or failure of the test is printed. Next, all values between 0x00 and 0xff will be written to Channel B, read back through Channel A and compared before a message indicating the success or failure of the test is printed. The range of values written to each channel is limited by the fact that the serial communication controller is a byte oriented device and that there are only 8 bits per byte. In short, all possible data values will be written to each channel and both data paths (Channel A ---> Channel B and Channel B ---> Channel A) will be tested.

On the other hand, if an internal loop back test is written, this option will test the interface to the serial communication controller by attempting to write data to one channel and read it back through the same channel. By default, all values between 0x00 and 0xff will be written to Channel A, read back through Channel A and compared before a message indicating the success or failure of the test is printed. Next, all values between 0x00 and 0xff will be written to Channel B, read back through Channel B and compared before a message indicating the success or failure of the test is printed. In short, all possible data values will be written to each channel.

The command line for the Serial Communication Controller Test will be:

```
"s [baud_rate] [count]"
```

The "baud_rate" and "count" arguments will both be optional. Again, by default, the Serial Communication Controller Test will write all possible data values to both channels. In addition, two default baud rates will be used. The default baud rates are 300 (slow) and 9600 (fast), respectively. The legal values for the "baud_rate" argument will be "300", "600", "1200", "2400", "4800", "9600", "19200", "38400", "76800", ".", and "*". The numeric baud rate values are self explanatory. The final two baud rate values ("." and "*") are in need of explanation. Entering the value "." for the baud rate will execute the Serial Communication Controller Test with the two default baud rates of 300 and 9600. Entering the value "*" for the baud rate will perform the Serial Communication Controller Test with all of the baud rates listed above.

The "count" argument will specify the number of times which the Serial Communication Controller Test will be performed. This argument will be specified in *decimal*. By default, the Serial Communication Controller Test will be performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test sequence will run *forever*.

2. Selecting option "d" will initiate the default serial communication controller test sequence. Again, based on intuition, the default test sequence will be as follows. All possible values (0x00 - 0xff) will be written to each channel at two baud rates. The first baud rate will be 300 (slow) while, the second baud rate will be 9600 (fast).

3. The third option, option "M", specifies whether or not messages are displayed on the screen. Entering "M 0" on the command line will turn off message mode (silent mode). On the other hand, the command "M 1" will turn the message mode on. By default, message mode will be on.
4. Option "K" specifies whether or not parity checking is performed. Entering "K 0" on the command line turns parity checking off while, "K 1" turns parity checking on. By default, parity checking will be on.
5. Option "l" (the letter ell) will give the user the opportunity to specify the number of times a user-specified sequence of tests is to be executed. See discussion of the "loop" option under the section titled "The Main Menu" for more detail.
6. Option "e" will display an error log. More specifically, at a maximum, the first 100 error messages of each type produced by the Sun-2/120 Video Board Diagnostic will be printed on the screen. Notice that these error messages may not necessarily be related to the serial communication controller.
7. If option "h" is chosen, more detailed user instructions will appear.
8. Option "p" will return to the Main Menu.
9. Option "q" will terminate the Sun-2/120 Video Board Diagnostic.

Sun-2/120 Video Board Diagnostic REV 1 00/00/85 Serial Com. Controller Menu

s - Serial Communication Controller Test
d - Default Serial Communication Controller Test
M - Print Error Messages?
K - Check Parity?
l - Loop
e - Error Log Display
h - Help
p - Return To The Main Menu
q - Quit

Command ==>

The memorability of the Sun-2/120 Video Board's video memory must be tested. Addresses 0x700000 (7340032) through 0x71FFFE (7471102) encompass the video memory. In terms of writing, the processor can write bytes or words. The Sun-2/120 Video Board Diagnostic's video memory tests will test the processor's ability to write bytes and words.

Given that option "v" (Video Memory Tests) is selected from the Main Menu, the Video Memory Menu will appear. The Video Memory Menu will have a total of sixteen options. The first five options on the menu will initiate a particular video memory test. Keep in mind that all five of these tests will execute the following four steps: (1) write to the video memory, (2) read back the contents of the video memory, (3) compare the values read back with the expected value and (4) display a message indicating the success or failure of the test. The major difference between the video memory tests is that each will write a different type of data to the video memory. Before presenting the Video Memory Menu itself, each option on the menu is discussed.

1. If option "a" is selected, the Address test will be invoked. The Address test will actually perform two tests of the video memory. In the first test, the low order bits of a given address will be written to the memory location corresponding to that address. In the second test, the ones complement of the low order bits of a given address will be written to the memory location corresponding to that address.
2. If option "c" is chosen, the Constant Pattern test will be performed. The Constant Pattern Test, by default, will write 0x5555 to each word in the video memory. The user will, however, have the option to override the default value of 0x5555 by specifying a different pattern.
3. Selecting option "r" will initiate the Random Pattern test. The Random Pattern test will write random numbers to the video memory based on a "seed" (a number used to generate the first random number). By default, the seed is the decimal integer seven (7). The user will have the opportunity to specify a seed.
4. If option "u" is selected, the Uniqueness test will be carried out. The Uniqueness test will write a series of unique numbers to the video memory. Given the *i*-th memory location in the video memory, the value that will be written to that location is i times constant. The default value of *constant* is one (1). The user will be able to specify a different *constant*, however.
5. Option "x" will invoke the Checker Pattern test. Like the Address test, the Checker Pattern test will actually perform multiple tests of the video memory. For the sake of notational convenience, let me introduce the following. Given a binary pattern xy , let \bar{y} be the ones complement of that binary pattern. For instance, if binary pattern xy is 0, the ones complement of that pattern (\bar{y}) is 1. Initially, the Checker Pattern test will write the alternating sequence of " $xy\bar{y}$ " throughout the video memory. In the second pass, the Checker Pattern test will write the alternating sequence of " $xy\bar{y}y\bar{y}$ " in the video memory. In the third pass, the Checker Pattern test will write the alternating sequence of " $xy\bar{y}y\bar{y}y\bar{y}$ " throughout the video memory. This process will continue until one half of the video memory is filled with xy 's and the other half is filled with \bar{y} 's.
6. Selecting option "d" will initiate the default video memory test. Once again, it is not possible to state exactly what video memory test(s) will be included in the default video memory test. It is quite probable that neither the Address Test nor the Checker test will be included in the default video memory test because they will probably require more run time than the other tests. Therefore, it is probable that the default video memory test will include one or more of the following tests.
 - A. The Constant Pattern Test.
 - B. The Random Pattern Test.
 - C. The Uniqueness Test.
7. Option "M" specifies whether or not messages are displayed on the screen. Entering "M 0" on the command line will turn off message mode (silent mode). On the other hand, the command "M 1" will turn the message mode on. By default, message mode will be on.
8. Option "B" specifies whether the memory tests will be executed in byte mode or word mode. That is, whether the processor will write, read and compare bytes or words. Entering "B 0" on the command line will turn byte mode on. On the other hand, the command "B 1" will turn word mode on. By default, word mode will be on (byte mode will be off).

9. The fourth option, option "K", specifies whether or not parity checking is performed. Entering "K 0" on the command line turns parity checking off while, "K 1" turns parity checking on. By default, parity checking will be on.
10. The fifth option, option "W" (wait/stop on error), specifies whether or not the program is suspended upon the occurrence of a *memory* data error (not all types of errors). Entering "W 0" on the command line means that the program will not be suspended after the occurrence of a *memory* data error. If "W 1" was entered on the command line prior to the occurrence of a *memory* data error, the program will wait until the user presses any key. If the user presses "q" (a mnemonic for quit), the currently running memory test will be terminated. If any other key is pressed, the memory test will continue with the next address. By default, the wait-on-error flag will be off.
11. The sixth option, option "S" (scope loop on error), determines whether or not the program enters a scope loop upon the occurrence of a *memory* data error (not all types of errors). If the diagnostic enters a scope loop, it continues to write a value to the address in question and read back that value before comparing the expected and observed values (i.e the test performs write-read-compare cycles). Entering "S 0" on the command line means that the program will not enter a scope loop following the occurrence of a *memory* data error. If "S 1" is entered, the program will enter a scope loop following the occurrence of a *memory* data error. The user will be able to terminate a scope loop *on a particular address* by pressing "n" (a mnemonic for next address). They will also be able to terminate the scope loop and the currently running memory test by pressing "q" (a mnemonic for quit). By default, the scope-loop-on-error flag will be off.

It should be noted that the user will be able to turn both wait-on-error and scope-loop-on-error on simultaneously. Thus, it will be possible to suspend the diagnostic after each write-read-compare cycle within the scope loop. Again, the user will be able to terminate a scope loop *on a particular address* by pressing "n" (a mnemonic for next address). They will also be able to proceed from one write-read-compare cycle to the next by pressing any character *except 'q' and 'n'*. Finally, the scope loop, wait on error condition and the currently running memory test can be terminated by pressing "q" (a mnemonic for quit). By default, the scope-loop-on-error flag and the wait-on-error flag will be off.

12. Option "l" (the letter ell) will give the user the opportunity to specify the number of times a user-specified sequence of tests is to be executed. See discussion of the "loop" option under the section titled "The Main Menu" for more detail.
13. Option "e" will display an error log. More specifically, at a maximum, the first 100 error messages of each type produced by the Sun-2/120 Video Board Diagnostic will be printed on the screen. Notice that these error messages may not necessarily be related to the video memory.
14. If option "h" is chosen, more detailed user instructions will appear.
15. Option "p" will return to the Main Menu.
16. Option "q" will terminate the Sun-2/120 Video Board Diagnostic.

Sun-2/120 Video Board Diagnostic REV 1 00/00/85 Video Memory Menu

- a - Address Test
- c - Constant Pattern Test
- r - Random Pattern Test
- u - Uniqueness Test
- x - Checker Pattern Test
- d - Default Video Memory Test
- M - Print Error Messages?
- B - Byte Or Word Mode?
- K - Check Parity?
- W - Wait (Stop) On Error?
- S - Scope Loop On Error?
- l - Loop
- e - Error Log Display
- h - Help
- p - Return To The Main Menu
- q - Quit

Command ==>

It should be noted that the run time for each video memory test will be displayed on the Video Memory Menu. Thus, the user will know which time consuming tests to avoid running if s/he is in a hurry.

Finally, all five of the video memory tests (Address, Constant Pattern, Random Pattern, Uniqueness and Checker Pattern) will have a "count" argument. The "count" argument will specify the number of times which a video memory test is performed. This argument will be specified in *decimal*. By default, each video memory test will be performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test sequence will run *forever*.

There are always ways to improve a software package.

1. Allowing the user the opportunity to specify a command line argument for the Default Test Sequence would save them a little time.
2. More detailed on-line help might be desirable. It may not be a good idea to assume that the user has a User's Document available. What if someone in field service happened to forget the User's Document?

In conclusion, this document presented the design specifications for the Sun-2/120 Video Board Diagnostic. Specifically, (1) *what* features of the Sun-2/120 Video Board will be tested and, (2) *how* they will be tested by the Sun-2/120 Video Board Diagnostic, were covered. The discussion was centered on the three functional sections of the Sun-2/120 Video Board: the control register, serial communication controller and video memory.

Theory of Operation Manual for the Sun-2/120 Video Board, Revision A, September 26, 1984.

Sun Microsystems

**Sun-2/120 Video Board Diagnostic
User's Document**

Tom Kraus

June 4, 1985

Revision A

The User's Document associated with the Sun-2/120 Video Board Diagnostic is presented.

It is the intention of this document to inform the reader how to use the Sun-2/120 Video Board Diagnostic. The command line syntax for each menu option (test) is presented and explained.

Members of any of the following five departments may find this document of interest for various reasons: (1) Design Engineering, (2) Manufacturing, (3) Field Service, (4) Diagnostics and (5) Documentation.

Using the Sun-2/120' Video Board Diagnostic, the Design Engineer(s) of the Sun-2/120' Video Board can confirm the correctness of their design. Manufacturing and Field Service personnel can use the Sun-2/120' Video Board Diagnostic for testing and/or trouble shooting purposes. Member(s) of the Diagnostic department can review the design of the Sun-2/120' Video Board Diagnostic based on this document. Finally, Documentation can use this document as a basis for developing the User's Guide which is shipped with the product itself.

At a minimum, the reader is assumed to have some understanding of the function of the Sun-2/120' Video Board. An excellent preface to this document is "Theory of Operation Manual for the Sun-2/120' Video Board". Another relevant document is titled "Sun-2/120 Video Board Diagnostic Design Document".

Revision A June 4, 1985 Initial release of this document.

CPU - Central Processing Unit

FRU - Field Replaceable Unit

ROM - Read Only Memory

SCC - Serial Communication Controller

SCSI - Small Computer System Interface

The Sun-2/120 Video Board is the display subsystem for the Sun-2 products which use Multibus. It has a serial interface with the monitor, keyboard and mouse in addition to a parallel interface with the CPU board. As a part of the video board, a control register enables several advanced features such as copy mode and interrupts.

The Sun-2/120 Video Board Diagnostic was designed to test the Sun-2/120 Video Board. The Sun-2/120 Video Board consists of the following three sections: (1) the control register, (2) serial communication controller and (3) video memory. All three sections of the Sun-2/120 Video Board can be tested by the Sun-2/120 Video Board Diagnostic.

Generally speaking, the objective of the Sun-2/120 Video Board Diagnostic to ensure that the Sun-2/120 Video Board works correctly. In this case, "works correctly" implies that the Sun-2/120 Video Board functions as stated in the "Theory of Operation Manual for the Sun-2/120 Video Board".

Again, the three functional sections of the Sun-2/120 Video Board are the control register, serial communication controller and video memory. The Sun-2/120 Video Board Diagnostic tests all three of these functional sections.

In particular, the *memorability* and *functionality* of the Sun-2/120 Video Board's control register are tested. The *functionality* of the serial communication controller is checked. Finally, the Sun-2/120 Video Board Diagnostic tests the *memorability* of video memory.

In order to run the Sun-2/120 Video Board Diagnostic, the following hardware, software and firmware requirements must be met.

The minimum hardware configuration required is listed below.

1. A Sun-2/120 multibus hardware cage.
2. A Sun-2/120 power supply.
3. A Sun-2/120 CPU Board.

4. A Sun-2/120 Memory Board.
5. A Sun-2/120 Video Board.
6. A dumb terminal (TeleVideo, Wyse, etc.), attached to one of the CPU serial ports, is required for board test (not system test).
7. A boot device (i.e. local disk, local tape or remote disk via ethernet).
8. A Sun-2/120 Video Monitor.

An executable version of the Sun-2/120 Video Board Diagnostic is to be used for testing and/or trouble shooting of the Sun-2/120 Video Board. The name of the relevant executable file is: "video120.diag".

The standard power-up diagnostic/monitor/boot ROM is needed. The power-up diagnostic performs a limited "crawl out" test. It is also used to load and begin execution of the Sun-2/120 Video Board Diagnostic.

The sections below describe how to load and operate the Sun-2/120 Video Board Diagnostic. Specifically, instructions for loading and beginning execution of the Sun-2/120 Video Board Diagnostic are covered in the section titled: "Loading And Starting". Operating instructions are discussed in the section titled: "The User Interface".

The following steps must be followed in the order listed below to run the Sun-2/120 Video Board Diagnostic.

1. Turn on the system.
2. After the system has been turned on, the power-up ROM diagnostics perform a "crawl out" test of the system before automatically booting UNIX. Since the Sun-2/120 Video Board Diagnostic is a stand alone diagnostic, UNIX should not be booted. The user should, therefore, terminate the process of booting UNIX. If the user is interacting with the Sun-2 console, this can be done by typing "L1-a". That is, hold down the "L1" key while pressing the "a" key. On the other hand, if the user is interacting with the Sun-2/120 Video Board Diagnostic via a dumb terminal, the booting of UNIX can be terminated by pressing the "break" key.
3. In order to reset the memory maps to their initial state, the following two keys should be typed prior to pressing the "return" key: "k1". Notice that the Sun-2/120 Video Board Diagnostic cannot be booted correctly if this reset step is skipped.
4. At this point the Sun-2/120 Video Board Diagnostic can be loaded and its execution started. The three ways to load the Sun-2/120 Video Board Diagnostic are listed below.
 - A. Assuming that the executable version of the Sun-2/120 Video Board Diagnostic, "video120.diag", resides on the machines *local disk* in directory "/pub/stand" or "/stand", the diagnostic can be loaded by typing the following command line before pressing the "return" key.

```
"b stand/video120.diag"
```

- B. If the Sun-2/120 Video Board Diagnostic resides on a *remote disk*, it can be loaded via ethernet. Assuming that the network file server has a partition reserved for the system being tested (i.e. the system under test is a client of the file server) and that "video120.diag" resides in the file server's directory "/pub/stand", the Sun-2/120 Video Board Diagnostic can be loaded by entering the following command line before pressing the "return" key.

```
"b ec(<file_server_host_net_number>)stand/video120.diag"
```

- C. Finally, the Sun-2/120 Video Board Diagnostic can be loaded from *local tape*. Assuming that the tape contains a bootable image of "video120.diag", the three command lines listed below can be used to load the Sun-2/120 Video Board Diagnostic. The user is

required to press the "return" key after entering one of the command lines.

- 1) If "video120.diag" resides on a SCSI tape, use the command line listed below.

"b st()"

- 2) If "video120.diag" resides on an archive tape, use the following command line.

"b ar()"

- 3) If "video120.diag" resides on a tape master, use the command line listed below.

"b mt()"

The four menus of the Sun-2/120 Video Board Diagnostic's user interface are presented below. Initially, the "main menu" is discussed in the section titled "The Main Menu". Secondly, the "control register menu" is presented in the section titled "The Control Register". Thirdly, the "serial communication controller menu" is explained in the section titled "The Serial Communication Controller". Finally, the "video memory menu" is discussed in the section titled "The Video Memory".

The Main Menu, shown below, has a total of eleven options. These options are discussed following the display of the "main menu". Keep in mind that typing the character corresponding to an option *selects* that option, while pressing the "return" key after the option was selected *invokes* the option.

Where it is appropriate, the time required to run a test is displayed on the menu. For example, the time required to run the default test sequence is 2 minutes and 4 seconds. This information is shown on the menu in the following shorthand form: "2 m 4 s". The "m" stands for minutes while, the "s" corresponds to seconds.

Sun-2/120 Video Board Diagnostic	REV 1.1 6/27/85	Main Menu
c - Control Register Menu		
s - Serial Communication Controller Menu		
v - Video Memory Menu		
d - Default Test Sequence		2 m 4 s
a - Execute All Tests		14 m 20 s
M - Print Error Messages?		
K - Check Parity?		
l - Loop		
e - Error Log Display		
h - Help		
q - Quit		
Command ==>		

- Option "c" on the "main menu" is a navigational command. If option "c" is selected, a sub-menu containing all of the control register tests appears. The "control register menu" is discussed later in the section titled "The Control Register". The command line syntax for option "c" is shown next.

"c"

Option "c" does not accept any arguments.

- Option "s" on the "main menu" is also a navigational command. If option "s" is chosen, a sub-menu containing the tests specific to the serial communication controller appears. The "serial communication controller menu" is presented below in the section titled "The Serial Communication Controller". The command line syntax for option "s" is shown next.

"s"

Like option "c", option "s" does not accept any arguments.

- Option "v" on the "main menu" is still another navigational command. If option "v" is selected, a submenu containing all of the video memory tests appears. The "video memory menu" is covered later in the section titled "The Video Memory". The command line syntax for option "v" is shown next.

"v"

Again, like options "c" and "s", option "v" does not accept any arguments.

4. Selecting option "d" on the "main menu" initiates the default test sequence. The default test is a "quick and dirty" test. It performs minimal testing of *all* parts of the three functional sections of the Sun-2/120 Video Board Diagnostic. Option "d" does *not*, however, perform an exhaustive test of the Sun-2/120 Video Board. Not all of the baud rates are used in testing the serial communication controller and only one video memory test is performed. The amount of time required to run the default test is approximately: 2 minutes and 4 seconds. Specifically, the tests listed below are performed by the default test option.
 - A. "Memory Test Of The Control Register" - Described in the section titled "The Control Register".
 - B. "Screen (Display) Enable/Disable Test" - Described in the section titled "The Control Register".
 - C. "Copy Enable/Disable Test" - Described in the section titled "The Control Register".
 - D. "Interrupt Enable/Disable Test" - Described in the section titled "The Control Register".
 - E. "Jumper Test" - Described in the section titled "The Control Register".
 - F. "Serial Communication Controller Test" at a "slow" baud rate (300) - Described in the section titled "The Serial Communication Controller".
 - G. "Serial Communication Controller Test" at a "fast" baud rate (9600) - Described in the section titled "The Serial Communication Controller".
 - H. "Constant Pattern Test" in byte mode (write and read bytes) - Described in the section titled "The Video Memory".
 - I. "Constant Pattern Test" in word mode (write and read words) - Described in the section titled "The Video Memory".

The command line syntax for option "d" is shown next.

"d"

Option "d" does not accept any arguments.

5. If option "a" on the "main menu" is chosen, all Sun-2/120 Video Board tests are executed in sequence. The amount of time required to run all tests is approximately: 14 minutes and 20 seconds. Specifically, the tests listed below are performed by the "a" option.
 - A. "Memory Test Of The Control Register" - Described in the section titled "The Control Register".
 - B. "Screen (Display) Enable/Disable Test" - Described in the section titled "The Control Register".
 - C. "Copy Enable/Disable Test" - Described in the section titled "The Control Register".
 - D. "Interrupt Enable/Disable Test" - Described in the section titled "The Control Register".
 - E. "Jumper Test" - Described in the section titled "The Control Register".
 - F. "Serial Communication Controller Test" at baud rate 300 - Described in the section titled "The Serial Communication Controller".
 - G. "Serial Communication Controller Test" at baud rate 600 - Described in the section titled "The Serial Communication Controller".
 - H. "Serial Communication Controller Test" at baud rate 1200 - Described in the section titled "The Serial Communication Controller".
 - I. "Serial Communication Controller Test" at baud rate 2400 - Described in the section titled "The Serial Communication Controller".
 - J. "Serial Communication Controller Test" at baud rate 4800 - Described in the section titled "The Serial Communication Controller".

- K. "Serial Communication Controller Test" at baud rate 9600 - Described in the section titled "The Serial Communication Controller".
- L. "Serial Communication Controller Test" at baud rate 19200 - Described in the section titled "The Serial Communication Controller".
- M. "Serial Communication Controller Test" at baud rate 38400 - Described in the section titled "The Serial Communication Controller".
- N. "Serial Communication Controller Test" at baud rate 76800 - Described in the section titled "The Serial Communication Controller".
- O. "Address Test" in word mode (write and read words) - Described in the section titled "The Video Memory".
- P. "Constant Pattern Test" in word mode (write and read words) - Described in the section titled "The Video Memory".
- Q. "Random Pattern Test" in word mode (write and read words) - Described in the section titled "The Video Memory".
- R. "Uniqueness Test" in word mode (write and read words) - Described in the section titled "The Video Memory".
- S. "Checker Pattern Test" in word mode (write and read words) - Described in the section titled "The Video Memory".
- T. "Address Test" in byte mode (write and read bytes) - Described in the section titled "The Video Memory".
- U. "Constant Pattern Test" in byte mode (write and read bytes) - Described in the section titled "The Video Memory".
- V. "Random Pattern Test" in byte mode (write and read bytes) - Described in the section titled "The Video Memory".
- W. "Uniqueness Test" in byte mode (write and read bytes) - Described in the section titled "The Video Memory".
- X. "Checker Pattern Test" in byte mode (write and read bytes) - Described in the section titled "The Video Memory".

The command line syntax for option "a" is shown next.

"a"

Option "a" does not accept any arguments.

6. Option "M" on the "main menu" specifies whether or not messages are displayed on the screen. The command line for setting the message-mode-flag is displayed next.

"M [0 | 1]"

The brackets ("[" "]") denote that the argument is *optional* (not required). The character "|" is a shorthand notation for the English word "or". These two conventions are used throughout the Sun-2/120 Video Board Diagnostic.

Option "M" accepts one argument which can have one of two possible values ("0" or "1"). If the user enters "M 0" on the command line, message mode is turned *off* (silent mode). On the other hand, if the user types "M 1" on the command line, message mode is turned *on* (verbose mode). It should be noted that, if the user simply enters "M" on the command line, message mode is turned on. By default, message mode is on.

7. Option "K" on the "main menu" specifies whether or not *parity checking* is performed. *Parity generation* is always on. The command line for setting the parity-checking-flag is displayed next.

"K [0 | 1]"

Option "K" accepts one argument which can have one of two possible values ("0" or "1"). If the user enters "K 0" on the command line, parity checking is *not performed*. On the other hand, if the user types "K 1" on the command line, parity checking *is executed*. It should be noted that, if the user simply enters "K" on the command line, parity checking is turned on. By default, parity checking is on.

8. Option "l" (the letter ell) on the "main menu" gives the user the opportunity to specify the number of times a user-specified sequence of tests is to be executed. For example, terminating a command line containing one or more user-specified tests with "l 5" executes all of the tests on that command line five times. The command line for the loop option is shown below.

"l [loop_count]"

Option "l" accepts one command line argument. The "loop_count" argument is optional. Without it, the test(s) on the command line are performed *once*. All command lines are executed once even if the "l" option does not appear at the end. Therefore, using the "l" option without an argument has *no affect*.

The "loop_count" argument specifies, in *decimal*, the number of times that the command line sequence is to be *executed*. The range of legal *numerical* values for the "loop_count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the "loop_count" argument, the given test sequence, theoretically, runs *forever*. With one exception, the asterisk (*) symbolizes "forever" throughout the Sun-2/120 Video Board Diagnostic. The only exception to this rule is explained in the section titled "The Serial Communication Controller".

At this point it is relevant to introduce a *special character* in the command line language. The ";" acts as a *separator* between commands. For instance, let's assume that our goal is to run the default option on the "main menu" five times. In order to accomplish this, we can make use of the loop option (option "l") as follows.

"d ; l 5"

The "d" specifies that the default test sequence is to be run. The ";" separates the "d" command from the "l" command. The "l 5" indicates that the command line is to be executed five times. In short, the ";" must be used to separate commands. It is *not* used to separate a command from its argument(s) and it is *not* used to separate one argument from another. Using the ";" in this manner causes a syntax error.

One more (unfortunate) rule of the command line language is worth mentioning here. Due to an implementation "error" in the Diagnostic stand-alone library, all commands, arguments and ";"s must be separated by, at least, one SPACE character. Thus, "d;l 5" is *not* a correct method of running the default test sequence five times. Instead, it causes a syntax error.

9. Option "e" on the "main menu" displays an error log. More specifically, at a maximum, the first 100 errors messages of each type recorded by the Sun-2/120 Video Board Diagnostic are printed on the screen. The command line syntax for option "e" is shown next.

"e"

Option "e" does not accept any arguments. The user does, however, have the ability to suspend and restart the error log display as they see fit. Pressing any key, except "q", suspends the error log display until the user presses another key. If the user presses "q" at any time, the error log display is terminated.

10. If option "h" on the "main menu" is chosen, more detailed user instructions appear on the screen. The command line syntax for option "h" is shown next.

"h"

Option "h" does not accept any arguments. The "help" screen associated with the "main menu" is shown next.

```

Sun-2/120 Video Board Diagnostic      REV 1.1 6/27/85      Main Menu

c - Control Register Menu              c
s - Serial Communication Controller Menu  s
v - Video Memory Menu                  v
d - Default Test Sequence              2 m 4 s  d
a - Execute All Tests                  14 m 20 s  a
M - Print Error Messages?              M [0 | 1]
K - Check Parity?                      K [0 | 1]
l - Loop                                l [loop_count]
e - Error Log Display                  e
h - Help                                h
q - Quit                                q

Command ==>

```

11. Finally, option "q" on the "main menu" terminates the Sun-2/120 Video Board Diagnostic. The command line syntax for option "q" is shown next.

"q"

Option "q" does not accept any arguments.

The control register associated with the Sun-2/120 Video Board holds a total of 16 bits. Generally speaking, the control register is used to enable/disable various functions, set the copy mode base address and monitor the vertical interrupt status. The processor is able to read the contents of the entire control register. It cannot, however, read the high or low byte of the control register on an individual basis. The processor is capable of writing to (1) the entire control register, (2) the high byte of the control register and (3) the low byte of the control register *with the following exceptions*. Bit 00 and bits 07-12 are not affected by the write operations. The control register is located at address 0x781800 (7870464). A diagram of the control register follows.

High Byte								Low Byte							
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
V I D E N	V C O P Y E N	V I N T E N	V V I N T	Configuration Jumpers				0	CMBASE 17 - 22						0
read or write	read or write	read or write	read only	read only				read only	read or write						read only

Two types of tests need to be performed on the control register. The memorability of the control register itself must be tested. In addition, the functionality of the control register requires testing.

The Control Register Menu, shown below, has a total of fifteen options. These options are discussed following the display of the "control register menu". Again, be aware that typing the character corresponding to an option *selects* that option, while pressing the "return" key after the option was selected *invokes* the option.

Where it is appropriate, the time required to run a test is displayed on the menu. For example, the time required to run the default test sequence is 52 seconds. This information is shown on the menu in the following shorthand form: "52 s". The "s" stands for seconds.

Sun-2/120 Video Board Diagnostic	REV 1.1 6/27/85	Control Register Menu
m - Memory Test Of Control Register		8 s
c - Copy Enable/Disable Test		17 s
M - Print Error Messages?		
K - Check Parity?		
W - Wait (Stop) On Error?		
S - Scope Loop On Error?		
s - Screen (Display) Enable/Disable Test		12 s
i - Interrupt Enable/Disable Test		5 s
j - Jumper Test		9 s
d - Default Control Register Test		52 s
l - Loop		
e - Error Log Display		
h - Help		
p - Return To The Main Menu		
q - Quit		
Command ==>		

1. The first option on the "control register menu", option "m" performs the memorability test of the control register. The goal of the memorability test is to ensure that whatever is written to the control register is actually stored there. However, it is not possible to test the memorability of the entire control register. In fact, the memorability of *only bits 01-06* of the control register are tested. The following paragraph explains why.

To begin with, since bit 00 and bits 07-12 are not writable, the memorability of these bits cannot be tested. Secondly, since bit 15 of the control register turns the screen on and off, *the memorability of bit 15 is not tested*. The "Screen (Display) Enable/Disable Test", discussed later, indirectly tests the memorability of bit 15 of the control register. Thirdly, since bit 14 turns copy-mode on and off, *the memorability of bit 14 is not tested*. The "Copy Enable/Disable Test", discussed later, indirectly tests the memorability of bit 14 of the control register. Finally, since bit 13 of the control register generates video board interrupts, *the memorability of bit 13 is not tested*. The "Interrupt Enable/Disable Test", discussed later, indirectly tests the memorability of bits 12 and 13 of the control register.

The typical testing paradigm consists of the following steps. First of all, a value is written to the control register, bit 00 and bits 07-15 not included. In other words, only bits 01-06 are written to. Within certain constraints, the user has the ability to specify which value(s) are written to the control register. Secondly, the contents of the control register are read back. Thirdly, since bit 00 and bits 07-15 are not written to, a masking operation is required. Fourthly, the value read back from the control register is compared to the expected value. Finally, a message is printed indicating the success or failure of the test.

The command line syntax for the memorability test is:

```
"m [beg_val [end_val]] [inc] [count]"
```

Option "m" accepts as many as four arguments. The "beg_val" (beginning hexadecimal value), "end_val" (ending hexadecimal value), "inc" (hexadecimal increment) and "count" (pass count) arguments are all optional. Arguments "beg_val", "end_val" and "inc" must be specified in hexadecimal while, argument "count" must be specified in decimal. Notice that, in order to use the "end_val" argument, the "beg_val" is also be required. That explains why the string "[end_val]" is contained in the brackets surrounding "beg_val".

By default, the value of argument "beg_val" is 0x00, while the value of argument "end_val" is 0x7f. The range of values is constrained by the fact that only bits 01-06 are tested. The user is, however, able to request that any value between 0x00 and 0x7f be assigned to the "beg_val" and the "end_val" arguments. The only constraint is that *the value of argument "beg_val" must be less than or equal to the value of argument "end_val"*.

By default, the value of the "inc" argument is one (0x1). The "inc" argument dictates the sequence of values which are written to the control register. For example, given a "beg_val" of 0x00, an "end_val" of 0x06 and an "inc" value of 0x02, the following four values would be written to bits 01-06 the control register: 0x00, 0x01, 0x02 and 0x03.

The real power of having the "beg_val", "end_val" and "inc" arguments becomes evident when all three arguments are used in combination. In particular, it is possible to toggle (clear and set) any of the CMBASE (Copy Mode Base Address bits [bits 01-06]) bits of the control register without affecting the remaining bits of the control register. Furthermore, a group of bits may be manipulated independently of the rest of the control register. Specifying a "beg_val" of 0x00, an "end_val" of 0x7f and an "inc" of 0x01 attempts to write all possible addresses to the CMBASE (Copy Mode Base Address bits [bits 01-06]) bits of the control register.

The optional "count" argument specifies the number of times which the memorability test is performed. This argument is specified in *decimal*. By default, the memorability test is performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test runs *forever*.

At first glance, it may seem to be redundant to have a "count" argument for the memorability test in addition to an "l" (loop) option, discussed later, on the "control register menu". However, there is a distinction. The "count" argument indicates the number of times that the memorability test is run. The "l" option indicates the number of times that the entire command line is executed. For example, the "l 10" option indicates that the following command line is to be executed ten times.

```
"m 0x1 0xf 0x3 9 ; i ; j ; l 10"
```

For each of the ten invocations of the above command line, the memorability test is to be run nine times (with a "beg_val" of 0x1, an "end_val" of 0xf and an "inc" of 0x3) while, the

interrupt test (discussed later) and the jumper test (discussed later) are to be run once. Thus, the memorability test would be run a total of ninety (90) times, rather than ten.

Another convention of the command line language should be made clear at this point. Let's say that we would like to run the memorability test seven times with the default values for the "beg_val", "end_val" and "inc" arguments. Simply entering "m 7" would *not* be sufficient. Such a command would run the memorability test once with the initial value of "beg_val" equal to seven (7). In order to accomplish our goal, the following command line should be entered.

```
"m . . . 7"
```

The "." (period) is another special character within the command line language. It causes the default value of an argument to be assigned to that argument. In a sense, the "." acts as a place holder. It informs the command line interpreter that the "7" is to be assigned to the "count" argument rather than to one of the other arguments. You can think of the "." as meaning DEFAULT.

Within reason, error checking is performed on the command line arguments. Specifically, the following checks are performed.

- A. The value of the "beg_val" is checked.
 - B. The value of the "end_val" is checked.
 - C. The value of the "inc" is checked.
 - D. The value of the "count" is checked.
 - E. A check is performed to prevent overflow from occurring.
2. The second option on the Control Register Menu, option "c", executes the "Copy Enable/Disable Test". This test determines whether or not writing to a main memory shadow buffer also affects the video memory given the proper conditions. That is, whether or not the contents of the main memory shadow buffer are written to the video memory and, subsequently, are displayed on the screen given the proper conditions.

According to the "Theory of Operation Manual for the Sun-2/120 Video Board", the contents of the main memory shadow buffer are written to the video memory and, subsequently, are displayed on the screen if the following two conditions are met.

- A. The address contained in bits 01-06 of the control register must match the address on bus lines 17-22.
- B. Bit 14 of the control register must be set.

Independent of whether or not the address contained in bits 01-06 of the control register matches the address on bus lines 17-22, the copy operation is not performed if bit 14 of the control register is clear. Also, no communication between the video board and the CPU takes place if the address contained in bus lines 17-22 does not match the address in bits 01-06 of the control register.

In particular, the following steps are performed when the Copy Enable/Disable Test is executed.

- A. Bit 14 of the control register (VCOPYEN) is set.
- B. The address of the first word in the main memory shadow buffer is written to bits 01-06 of the control register (CMBASE bits: Copy Mode Base Address bits).
- C. A value is written to each word in the main memory shadow buffer. The contents of the main memory shadow buffer should consequently appear on the screen. The user has the opportunity to specify the range of values which are written to the main memory

shadow buffer.

- D. Bit 14 of the control register is cleared.
- E. The contents of the video memory and the main memory shadow buffer are compared.
- F. The success or failure of the comparison operation is displayed on the screen.

The command line syntax for the Copy Enable/Disable Test is:

```
"c [beg_val [end_val]] [inc] [count]"
```

Option "c" accepts as many as four arguments. The "beg_val" (beginning hexadecimal value), "end_val" (ending hexadecimal value), "inc" (hexadecimal increment) and "count" (pass count) arguments are all optional. Arguments "beg_val", "end_val" and "inc" must be specified in hexadecimal while, argument "count" must be specified in decimal. Notice that, in order to use the "end_val" argument, the "beg_val" is also required. That explains why the string "[end_val]" is contained in the brackets surrounding "beg_val".

By default, the value of the "beg_val" argument is 0x0000, while the value of the "end_val" argument is 0xffff. The range of values is constrained by the fact that there are only 16 bits in a word. The user can, however, request that any value between 0x0000 and 0xffff be assigned to the "beg_val" and the "end_val" arguments. The only constraint is that *the "beg_val" must be less than or equal to the "end_val"*.

By default, the value of the "inc" argument is one (0x1). The "inc" argument dictates the sequence of values which are written to the control register. For example, given a "beg_val" of 0x0000, an "end_val" of 0x0006 and an "inc" value of 0x0002, the following sequence would be repeated throughout the main memory shadow buffer: "0x0000 0x0002 0x0004 0x0006".

The optional "count" argument specifies the number of times which the Copy Enable/Disable Test is performed. This argument is specified in *decimal*. By default, the test is performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test runs *forever*.

Although it may seem to be redundant to have a "count" argument for the Copy Enable/Disable Test in addition to an "l" (loop) option, discussed later, on the "control register menu". There is a useful distinction, however. The "count" argument indicates the number of times that the Copy Enable/Disable Test is run. The "l" option indicates the number of times that the entire command line is executed. For example, the "l 10" option indicates that the following command line is to be executed ten times.

```
"c 0x1 0xff 0x4 8 ; m . . . 3 ; l 10"
```

For each of the ten invocations of the above command line, the Copy Enable/Disable Test is to be run eight times (with a "beg_val" of 0x1, an "end_val" of 0xff and an "inc" of 0x4) while, the memorability test (discussed earlier) would be run three times. Thus, Copy Enable/Disable Test would be run a total of eighty (80) times, rather than ten.

For the sake of an example, let's say that our goal is to run the Copy Enable/Disable Test twice with the default values for arguments "beg_val", "end_val" and "inc". Entering "c 2" would *not* be sufficient. Such a command would run the Copy Enable/Disable Test once with the initial value of argument "beg_val" equal to two (2). In order to accomplish our goal, the following command line should be entered.

```
"c . . . 2"
```

The "." (period) is special character within the command line language. Its affect is to assign

the default value of an argument to that argument. Therefore, the "." acts as a sort of place holder. It informs the command line interpreter that the "2" is to be assigned to the "count" argument rather than to one of the other arguments. The "." means DEFAULT.

Within reason, error checking is performed on the command line arguments. Specifically, the following checks are performed.

- A. The value of the "beg_val" is checked.
- B. The value of the "end_val" is checked.
- C. The value of the "inc" is checked.
- D. The value of the "count" is checked.
- E. A check is performed to prevent overflow from occurring.

3. The third option on the "control register menu", option "M", specifies whether or not messages are displayed on the screen. The command line for setting the message-mode-flag is displayed next.

"M [1 | 0]"

Option "M" accepts one argument which can have one of two possible values ("0" or "1"). If the user enters "M 0" on the command line, message mode is turned *off* (silent mode). On the other hand, if the user types "M 1" on the command line, message mode is turned *on* (verbose mode). It should be noted that, if the user simply enters "M" on the command line, message mode is turned on. By default, message mode is on.

4. The fourth option on the Control Register Menu, option "K", specifies whether or not *parity checking* is performed. *Parity generation* is always on. The command line for setting the parity-checking-flag is displayed next.

"K [0 | 1]"

Option "K" accepts one argument which can have one of two possible values ("0" or "1"). If the user enters "K 0" on the command line, parity checking is *not performed*. On the other hand, if the user types "K 1" on the command line, parity checking *is executed*. It should be noted that, if the user simply enters "K" on the command line, parity checking is turned on. By default, parity checking is on.

5. The fifth option on the Control Register Menu, option "W" (wait/stop on error), specifies whether or not the program is temporarily suspended upon the occurrence of a *memory* data error (not all types of errors). The command line for setting the wait-on-error-flag is displayed next.

"W [0 | 1]"

Option "W" accepts one argument which can have one of two possible values ("0" or "1"). Entering "W 0" on the command line means that the program is not suspended after the occurrence of a *memory* data error. If "W 1" was entered on the command line prior to the occurrence of a *memory* data error, the program waits until the user presses any key before continuing. It should be noted that, if the user simply enters "W" on the command line, the wait-on-error-flag is turned off. By default, the wait-on-error-flag is off.

Given that the program is waiting for the user to press any key and the user presses "q" (a mnemonic for quit), the currently running test is terminated. If, on the other hand, the user presses any other key, the memory test continues with the next address. By default, the wait-on-error flag is off.

4. The sixth option on the "control register menu", option "S" (scope loop on error), determines whether or not the program enters a scope loop upon the occurrence of a *memory* data error (not all types of errors). If the diagnostic enters a scope loop, it continues to write a value to

the address in question and read back that value before comparing the expected and observed values (i.e the test performs write-read-compare cycles). The command line for setting the scope-loop-on-error-flag is displayed next.

"S [0 | 1]"

Option "S" accepts one argument which can have one of two possible values ("0" or "1"). Entering "S 0" on the command line means that the program does not enter a scope loop following the occurrence of a *memory* data error. If "S 1" is entered, the program does enter a scope loop following the occurrence of a *memory* data error. It should be noted that, if the user simply enters "S" on the command line, the scope-loop-on-error-flag is turned off. By default, the scope-loop-on-error flag is off.

The user is able to terminate a scope loop *on a particular address* by pressing "n" (a mnemonic for next address). They can also terminate the scope loop and the currently running memory test by pressing "q" (a mnemonic for quit).

It should be noted that the user can turn both the wait-on-error-flag and the scope-loop-on-error-flag on simultaneously. Thus, it is possible to suspend the diagnostic after each write-read-compare cycle within the scope loop. Again, the user is able to terminate a scope loop *on a particular address* by pressing "n" (a mnemonic for next address). They are also able to proceed from one write-read-compare cycle to the next by pressing any character *except 'q' and 'n'*. Finally, the scope-loop, wait-on-error condition and the currently running memory test can be terminated by pressing "q" (a mnemonic for quit). By default, the scope-loop-on-error flag and the wait-on-error flag are off.

7. Option "s" on the Control Register Menu initiates the Screen (Display) Enable/Disable Test. This test aids the user in determining whether or the video display (screen) can be turned on and off. In particular, if bit 15 (VIDEN) of the control register is set (equal to 1), the video display should be on (white with black characters). If bit 15 (VIDEN) of the control register is clear (equal to 0), the video display should be off (black).

The Screen (Display) Enable/Disable Test turns the video display off and then back on. Unfortunately, the user is required to watch whether or not the video display flashes off and then back on. After the video display is turned back on, a statement appears on the screen informing the user that the screen should have just blinked off and then back on. However, to eliminate the requirement of user input, the statement does NOT require a response. It simply remains on the screen for few seconds before the Sun-2/120 Video Board Diagnostic continues execution.

The command line syntax for the Screen (Display) Enable/Disable Test is:

"s [count]".

Option "s" accepts one argument. The optional "count" argument specifies the number of times which the Screen (Display) Enable/Disable Test is performed. This argument is specified in *decimal*. By default, the test is performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test runs *forever*. Error checking is performed on the value entered for the "count" argument.

8. Choosing option "i" on the Control Register Menu executes the Interrupt Enable/Disable Test. The Interrupt Enable/Disable Test tests the video board's ability to interrupt the CPU.

Specifically, the following steps are performed when the Interrupt Enable/Disable Test is initiated. To begin with, bit 13 of the control register (VINTEN) is set. This should, in turn, cause a jump to an interrupt handler on the next vertical interval. That is, following the conclusion of the current vertical interval, execution of the interrupt routine should begin. The

duration of a vertical interval is approximately one-seventieth of a second. The interrupt routine performs the following steps.

- A. One of the consequences of setting bit 13 of the control register is that bit 12 of the control register (VVINT) should also get set on the next vertical interval. That is to say, following the conclusion of the current vertical interval, bit 12 of the control register should get set. Therefore, the interrupt handler determines whether or not bit 12 of the control register is set. If it is not set, an error message to that affect is displayed.
- B. Next, the interrupt routine clears bit 13 of the control register to disable the interrupt.
- C. A check is made to ensure that bit 13 of the control register is indeed cleared.
- D. Again, because manipulation of bit 13 of the control register should be reflected in bit 12 of the control register on the next vertical interval, a check is made to determine whether or not bit 12 of the control register is clear. Given that bit 12 of the control register is not clear, an appropriate error message is displayed.
- E. Finally, a global flag is set to indicate that the interrupt routine was executed.

Since it is not reasonable to assume that the video board's ability to interrupt the CPU is functional, the Sun-2/120 Video Board Diagnostic gives up waiting for the execution of the interrupt routine after a approximately one second. This eliminates an infinite loop in the case that the video board's interrupt facility is not working correctly. If the interrupt routine is not executed within the specified amount of time, an error message is printed on the screen.

The command line syntax for the Interrupt Enable/Disable Test is:

"i [count]" .

Option "i" accepts one argument. The optional "count" argument specifies the number of times which the Interrupt Enable/Disable Test is performed. This argument is specified in *decimal*. By default, the test is performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test runs *forever*. Error checking is performed on the value entered for the "count" argument.

9. If option "j" on the Control Register Menu is selected, the (Configuration) Jumper Test is initiated. Quite simply, the Jumper Test displays the contents of bits 08-11 of the control register. The contents of the Configuration Jumper Bits are displayed in hexadecimal, decimal, octal and binary.

The command line for the (Configuration) Jumper Test is:

"j [count]" .

Option "j" accepts one argument. The optional "count" argument specifies the number of times which the Jumper Test is performed. This argument is specified in *decimal*. By default, the test is performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test runs *forever*. Error checking is performed on the value entered for the "count" argument.

10. Selecting option "d" initiates the default control register test. Since the five control register tests run quickly, all five of them are include in the default control register test sequence. Therefore, in this case, the default control register test exhaustively tests the control register. The amount of time required to run the default control register test is approximately: 52 seconds. The five tests are listed next.
 - A. Memory Test Of The Control Register.
 - B. Screen (Display) Enable/Disable Test.

- C. Copy Enable/Disable Test.
- D. Interrupt Enable/Disable Test.
- E. Jumper Test.

The command line syntax for option "d" is shown next.

"d"

Option "d" does not accept any arguments.

11. Option "l" (the letter ell) on the "control register menu" gives the user the opportunity to specify the number of times a user-specified sequence of tests is to be executed. Terminating a command line containing one or more user-specified tests with "l 11", for example, executes all of the tests on that command line eleven times. The command line for the loop option is shown below.

"l [loop_count]"

Option "l" accepts one command line argument. The "loop_count" argument is optional. Without it, the test(s) on the command line are performed *once*. All command lines are executed once even if the "l" option does not appear at the end. Therefore, using the "l" option without an argument has *no affect*.

The "loop_count" argument specifies, in *decimal*, the number of times that the command line sequence is to be *executed*. The range of legal *numerical* values for the "loop_count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the "loop_count" argument, the given test sequence, theoretically, runs *forever*. With one exception, the asterisk (*) symbolizes "forever" throughout the Sun-2/120 Video Board Diagnostic. The only exception to this rule is explained in the section titled "The Serial Communication Controller".

The ";" is a *special character* in the command line language. It acts as a *separator* between commands. If our goal is to run the default option on the "control register menu" five times, the loop option is useful. Rather than entering the "d" command five times (d ; d ; d ; d ; d), the following command can be used.

"d ; l 5"

The "d" specifies that the default test sequence is to be run. The ";" separates the "d" command from the "l" command. The "l 5" indicates that the command line is to be executed five times. In short, the ";" must be used to separate commands. It is *not* used to separate a command from its argument(s) and it is *not* used to separate one argument from another. Using the ";" in this manner causes a syntax error.

Another (unfortunate) rule of the command line language is relevant here. Due to an implementation "error" in the Diagnostic stand-alone library, all commands, arguments and ";"s must be separated by, at least, one SPACE character. Thus, "d;l 5" is *not* a correct method of running the default test sequence five times. Instead, it causes a syntax error.

12. Option "e" on the "control register menu" displays an error log. Specifically, at a maximum, the first 100 error messages of each type produced by the Sun-2/120 Video Board Diagnostic are printed on the screen. Notice that these error messages may not necessarily be related to the control register. The command line syntax for option "e" is shown next.

"e"

Option "e" does not accept any arguments. The user does, however, have the ability to suspend and restart the error log display as they see fit. Pressing any key, except "q", suspends the error log display until the user presses another key. If the user presses "q" at any time, the

error log display is terminated.

13. If option "h" on the "control register menu" is chosen, more detailed user instructions appear on the screen. The command line syntax for option "h" is shown next.

"h"

Option "h" does not accept any arguments. The "help" screen associated with the "control register menu" is shown next.

```

Sun-2/120 Video Board Diagnostic  REV 1.1 6/27/85  Control Register Menu

m - Memory Test Of Control Register      8 s  c [beg_val [end_val]] [inc] [count]
c - Copy Enable/Disable Test             17 s c [beg_val [end_val]] [inc] [count]
M - Print Error Messages?                M [0 | 1]
K - Check Parity?                        K [0 | 1]
W - Wait (Stop) On Error?                W [0 | 1]
S - Scope Loop On Error?                 S [0 | 1]
s - Screen (Display) Enable/Disable Test 12 s s [count]
i - Interrupt Enable/Disable Test        5 s  i [count]
j - Jumper Test                          9 s  j [count]
d - Default Control Register Test        52 s d
l - Loop                                  l [loop_count]
e - Error Log Display                     e
h - Help                                  h
p - Return To The Main Menu               p
q - Quit                                  q

Command ==>
    
```

14. If option "p" on the Control Register Menu is executed, the Main Menu appears on the screen. In other words, option "p" returns to the Main Menu. This option allows the user the ability get back to the "main menu" in the case that they want to go to another submenu (i.e. The Video Memory Menu or The Serial Communication Controller Menu). The command line syntax for option "p" is shown next.

"p"

Option "p" does not accept any arguments.

15. Finally, option "q" on the "control register menu" terminates the Sun-2/120 Video Board Diagnostic. The command line syntax for option "q" is shown next.

"q"

Option "q" does not accept any arguments.

A Zilog 8530A serial communication controller (SCC) is used to communicate with the keyboard and the mouse. The serial communication controller consists of two channels (channels A and B). Each channel consists of two 16 bit words. One word is for commands while, the other word is for data.

The starting address for the serial communication controller is 0x780000. Four contiguous words on the video board are reserved for the serial communication controller. The addresses of those four words are 0x780000, 0x780002, 0x780004 and 0x780006. Words 0x780000 and 0x780002 correspond to Channel B of the serial communication controller. Channel B of the serial communication controller handles communication with the mouse. Words 0x780004 and 0x780006 correspond to Channel A of the serial communication controller. Channel A of the serial communication controller handles communication with the keyboard. This information is summarized in the following table.

ADDRESS:	FUNCTION:
0x780000	Channel B commands (mouse)
0x780002	Channel B data (mouse)
0x780004	Channel A commands (keyboard)
0x780006	Channel A data (keyboard)

The serial communication controller is a byte-oriented device. Data is transferred only on the high byte of the data words (data bits 08-15). During a read operation, the low byte contains the lower byte of the control register. The contents of the lower byte during a write operation is unimportant ("don't care"). This information is summarized in the figure below.

High Byte								Low Byte							
15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
SCC read or write data								write = do not care read = lower byte of control register							

The Serial Communication Controller Menu, displayed below, has a total of nine options. These options are discussed following the display of the "serial communication controller menu". Recall that typing the character corresponding to an option *selects* that option, while pressing the "return" key after the option was selected *invokes* the option.

Where it is appropriate, the time required to run a test is displayed on the menu. For example, the time required to run the default test sequence is 37 seconds. This information is shown on the menu in the

following shorthand form: "37 s". The "m" stands for minutes while, the "s" corresponds to seconds.

Sun-2/120 Video Board Diagnostic REV 1.1 6/27/85 Serial Com. Controller Menu

- s - Serial Communication Controller Test
- d - Default Serial Communication Controller Test 37 s
- M - Print Error Messages?
- K - Check Parity?
- l - Loop
- e - Error Log Display
- h - Help
- p - Return To The Main Menu
- q - Quit

Command ==>

1. The first option on the Serial Communication Controller Menu, option "s", executes the internal loopback "Serial Communication Controller Test". This option tests the interface to the serial communication controller by attempting to write data to one channel and read it back through that same channel. By default, all values between 0x00 and 0xff inclusive are written to Channel A, read back through Channel A and compared before a message indicating the success or failure of the test is printed. Next, all values between 0x00 and 0xff inclusive are written to Channel B, read back through Channel B and compared before a message indicating the success or failure of the test is printed. The range of values written to each channel is limited by the fact that the serial communication controller is a byte oriented device and that there are only 8 bits per byte. In short, both channels are tested with all possible data values.

The command line syntax for the "Serial Communication Controller Test" is:

"s [baudrate] [count]".

Option "s" accepts a maximum of two arguments. The "baudrate" and "count" arguments are both optional.

Again, by default, the "Serial Communication Controller Test" writes all possible data values to both channels. In addition, *if the user does not specify a baud rate on the command line*, baud rate 300 is used. The legal values for the "baudrate" argument are "300", "600", "1200", "2400", "4800", "9600", "19200", "38400", "76800", "." and "*".

The numeric baud rate values listed above are self explanatory. The final two baud rate values

("." and "*") are in need of explanation. Entering the value "." for the baud rate will execute the "Serial Communication Controller Test" with the two default baud rates of 300 and 9600. Entering the value "*" for the baud rate will perform the "Serial Communication Controller Test" with all of the baud rates listed above. Therefore, in this case, the asterisk (*) takes on the new meaning of *all* rather than *forever*.

The optional "count" argument specifies the number of times which the "Serial Communication Controller Test" is performed. This argument is specified in *decimal*. By default, the "Serial Communication Controller Test" is performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test runs *forever*. The discussion under the "m" option of the section titled "The Control Register" explains the purpose of having both the "count" argument and the loop option (option "l") presented below.

2. Selecting option "d" on the "serial communication controller menu" initiates the default serial communication controller test sequence. The default test sequence is as follows. All possible values (0x00 - 0xff) are written to Channel A and read back through Channel A before all possible values (0x00 - 0xff) are written to Channel B and read back through Channel B. These values are written to both channels at two baud rates. The first baud rate is 300 (slow) while, the second baud rate is 9600 (fast).

The command line syntax for option "d" is shown next.

```
"d"
```

Option "d" does not accept any arguments.

3. The third option on the "serial communication controller menu", option "M", specifies whether or not messages are displayed on the screen. The command line for setting the message-mode-flag is displayed next.

```
"M [1 | 0]"
```

Option "M" accepts one argument which can have one of two possible values ("0" or "1"). If the user enters "M 0" on the command line, message mode is turned *off* (silent mode). On the other hand, if the user types "M 1" on the command line, message mode is turned *on* (verbose mode). It should be noted that, if the user simply enters "M" on the command line, message mode is turned on. By default, message mode is on.

4. The fourth option on the "serial communication controller menu", option "K", specifies whether or not *parity checking* is performed. *Parity generation* is always on. The command line for setting the parity-checking-flag is displayed next.

```
"K [0 | 1]"
```

Option "K" accepts one argument which can have one of two possible values ("0" or "1"). If the user enters "K 0" on the command line, parity checking is *not performed*. On the other hand, if the user types "K 1" on the command line, parity checking *is executed*. It should be noted that, if the user simply enters "K" on the command line, parity checking is turned on. By default, parity checking is on.

5. Option "l" (the letter ell) on the "serial communication controller menu" gives the user the opportunity to specify the number of times a user-specified sequence of tests is to be executed. For example, terminating a command line containing one or more user-specified tests with "l 5" executes all of the tests on that command line five times. The command line for the loop option is shown below.

```
"l [loop_count]"
```

Option "l" accepts one command line argument. The "loop_count" argument is optional. Without it, the test(s) on the command line are performed *once*. All command lines are

executed once even if the "l" option does not appear at the end. Therefore, using the "l" option without an argument has *no affect*.

The "loop_count" argument specifies, in *decimal*, the number of times that the command line sequence is to be *executed*. The range of legal *numerical* values for the "loop_count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the "loop_count" argument, the given test sequence, theoretically, runs *forever*. The discussion under the "l" option of the section titled "The Main Menu" provides additional details relevant to the usage of the loop option.

6. Option "e" on the "serial communication controller menu" displays an error log. More specifically, at a maximum, the first 100 errors messages of each type recorded by the Sun-2/120 Video Board Diagnostic are printed on the screen. Notice that these errors may not be related to the serial communication controller. The command line syntax for option "e" is shown next.

"e"

Option "e" does not accept any arguments. The user does, however, have the ability to suspend and restart the error log display as they see fit. Pressing any key, except "q", suspends the error log display until the user presses another key. If the user presses "q" at any time, the error log display is terminated.

7. If option "h" on the "serial communication controller menu" is chosen, more detailed user instructions appear on the screen. The command line syntax for option "h" is shown next.

"h"

Option "h" does not accept any arguments. The "help" screen associated with the "serial communication controller menu" is shown next.

```

Sun-2/120 Video Board Diagnostic REV 1.1 6/27/85 Serial Com. Controller Menu

s - Serial Communication Controller Test          s [baudrate] [count]
d - Default Serial Communication Controller Test  37 s d
M - Print Error Messages?                        M [0 | 1]
K - Check Parity?                                K [0 | 1]
l - Loop                                          l [loop_count]
e - Error Log Display                            e
h - Help                                         h
p - Return To The Main Menu                     e
q - Quit                                         q

Command ==>

```

8. If option "p" on the Serial Communication Controller Menu is executed, the Main Menu appears on the screen. In other words, option "p" returns to the Main Menu. This option allows the user the ability get back to the "main menu" in the case that they want to go to another submenu (i.e. The Video Memory Menu or The Control Register Menu). The command line syntax for option "p" is shown next.

"p"

Option "p" does not accept any arguments.

9. Finally, option "q" on the "serial communication controller menu" terminates the Sun-2/120 Video Board Diagnostic. The command line syntax for option "q" is shown next.

"q"

Option "q" does not accept any arguments.

Addresses 0x700000 (7340032) through 0x71FFFE (7471102) encompass the video memory. In terms of writing, the processor can write bytes or words. The Sun-2/120 Video Board Diagnostic's video memory tests tests the processor's ability to write bytes and words.

The Video Memory Menu, presented next, has a total of sixteen options. The first five options on the menu initiate a particular video memory test. Keep in mind that all five of these tests execute the following four steps: (1) write to the video memory, (2) read back the contents of the video memory, (3) compare the values read back with the expected value and (4) display a message indicating the success or failure of the test. The major difference between the video memory tests is that each writes a different type of data to the video memory. Recall that typing the character corresponding to an option *selects* that option, while pressing the "return" key after the option was selected *invokes* the option.

Where it is appropriate, the time required to run a test is displayed on the menu. For example, the time

required to run the "Checker Pattern Test" in *byte* mode is 5 minutes and 58 seconds while, the time needed to complete the "Checker Pattern Test" in *word* mode is 2 minutes and 52 seconds. This information is shown on the menu in the following shorthand form: "b: 5 m 58 s, w: 2 m 52 s". The "b" stands for byte mode while, the "w" corresponds to word mode. As on other menus, "m" implies minutes while, "s" is a mnemonic for seconds.

Sun-2/120 Video Board Diagnostic	REV 1.1 6/27/85	Video Memory Menu
a - Address Test	b: 51 s,	w: 28 s
c - Constant Pattern Test	b: 26 s,	w: 15 s
r - Random Pattern Test	b: 37 s,	w: 21 s
u - Uniqueness Test	b: 42 s,	w: 23 s
x - Checker Pattern Test	b: 5 m 58 s,	w: 2 m 52 s
d - Default Video Memory Test	42 s	
M - Print Error Messages?		
B - Byte Or Word Mode?		
K - Check Parity?		
W - Wait (Stop) On Error?		
S - Scope Loop On Error?		
l - Loop		
e - Error Log Display		
h - Help		
p - Return To The Main Menu		
q - Quit		
Command ==>		

1. If option "a" on the "video memory menu" is selected, the "Address Test" is invoked. The "Address Test" actually performs two tests of the video memory. In the first test, the low order bits of a given address are written to the memory location corresponding to that address. In the second test, the ones complement of the low order bits of a given address are written to the memory location corresponding to that address.

The command line syntax for the "Address Test" is:

"a [count]".

Option "a" accepts a maximum of one argument. The optional "count" argument specifies the number of times which the "Address Test" is performed. This argument is specified in *decimal*. By default, the "Address Test" is performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test runs *forever*. The discussion under the "m" option of the section titled "The Control Register" explains the purpose of having both the "count" argument and the loop option (option "l") presented later. Error checking is performed on the value entered for the "count" argument.

2. If option "c" on the "video memory menu" is chosen, the "Constant Pattern Test" is performed. The "Constant Pattern Test" writes a constant pattern throughout video memory. The command line syntax for the "Constant Pattern Test" is:

"c [pattern] [count]".

Option "c" accepts a maximum of two arguments. The "pattern" argument indicates which *hexadecimal* value is to be written throughout video memory. If *byte* mode is on, the "Constant Pattern Test", by default, writes 0x55 to each byte in the video memory. On the other hand, if *word* mode is on, the "Constant Pattern Test", by default, writes 0x5555 to each word in the video memory. The distinction between byte and word mode is covered below under option "B". Assuming that byte mode has been enabled, the legal range of values for the "pattern" argument is 0x00 through 0xff. The legal range of values for the "pattern" argument when word mode is active is 0x0000 through 0xffff. Error checking is performed on the value entered for the "pattern" argument.

The optional "count" argument specifies the number of times which the "Constant Pattern Test" is performed. This argument is specified in *decimal*. By default, the "Constant Pattern Test" is performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test runs *forever*. The discussion under the "m" option of the section titled "The Control Register" explains the purpose of having both the "count" argument and the loop option (option "l") presented later. Error checking is performed on the value entered for the "count" argument.

3. Selecting option "r" on the "video memory menu" initiates the "Random Pattern Test". The "Random Pattern Test" writes random numbers to the video memory based on a "seed" (a number used to generate the first random number). The command line syntax for the "Random Pattern Test" is:

"r [seed] [count]".

Option "r" accepts a maximum of two arguments. The "seed" argument is the *decimal* value that determines the sequence of random numbers which are written to video memory. By default, the seed is the decimal integer seven (7). The user can specify any decimal value between 0 and 2147483647 for the seed.

The optional "count" argument specifies the number of times which the "Random Pattern Test" is performed. This argument is specified in *decimal*. By default, the "Random Pattern Test" is performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test runs *forever*. The discussion under the "m" option of the section titled "The Control Register" explains the purpose of having both the "count" argument and the loop option (option "l") presented later. Error checking is performed on the value entered for the "count" argument.

4. If option "u" on the "video memory menu" is selected, the "Uniqueness Test" is carried out. The "Uniqueness Test" writes a series of unique numbers to the video memory. Given the *i*-th memory location in the video memory, the value that is written to that location is \$i times constant\$. The command line syntax for the "Uniqueness Test" is:

"u [constant] [count]"

Option "u" accepts a maximum of two arguments. The "constant" argument is used in determining the values that get written to the video memory. The default value of the "constant" argument is one (1). The user is able to specify a different "constant", however. Assuming that *byte* mode has been enabled, the legal range of *decimal* values for the "constant" argument is 0 through 255. The legal range of values for the "constant" argument when *word* mode is active is 0 through 65535. The distinction between byte and word mode is covered below under option "B". Error checking is performed on the value entered for the "constant" argument.

The optional "count" argument specifies the number of times which the "Uniqueness Test" is performed. This argument is specified in *decimal*. By default, the "Uniqueness Test" is performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test runs *forever*. The discussion under the "m" option of the section titled "The Control Register" explains the purpose of having both the "count" argument and the loop option (option "l") presented later. Error checking is performed on the value entered for the "count" argument.

5. Option "x" on the "video memory menu" invokes the "Checker Pattern Test". Like the "Address Test", the "Checker Pattern Test" actually perform multiples tests of the video memory. For the sake of notational convenience, let's introduce the following. Given a binary pattern \$y\$, let \$y bar\$ be the ones complement of that binary pattern. For instance, if binary pattern \$y\$ is 0, the ones complement of that pattern (\$y bar\$) is 1. Initially, the "Checker Pattern Test" writes the alternating sequence of "\$y\$ \$y bar\$" throughout the video memory. In the second pass, the "Checker Pattern Test" writes the alternating sequence of "\$y\$ \$y\$ \$y bar\$ \$y bar\$" in the video memory. In the third pass, the "Checker Pattern Test" writes the alternating sequence of "\$y\$ \$y\$ \$y\$ \$y bar\$ \$y bar\$ \$y bar\$" throughout the video memory. This process continues until one half of the video memory is filled with \$y\$'s and the other half is filled with \$y bar\$'s.

The command line syntax for the "Checker Pattern Test" is:

"x [pattern] [count]"

Option "x" accepts a maximum of two arguments. The "pattern" argument is used in determining the values that are written to the video memory. If *byte* mode is on, the default *hexadecimal* value of the "pattern" argument is 0xa0. On the other hand, if *word* mode is on, the default *hexadecimal* value of the "pattern" argument is 0xa0a0. The distinction between byte and word mode is covered below under option "B". The user is able to specify a different "pattern", however. Assuming that byte mode has been enabled, the legal range of *hexadecimal* values for the "constant" argument is 0x00 through 0xff. The legal range of values for the "pattern" argument when word mode is active is 0x0000 through 0xffff. Error checking is performed on the value entered for the "pattern" argument.

The optional "count" argument specifies the number of times which the "Checker Pattern Test" is performed. This argument is specified in *decimal*. By default, the "Checker Pattern Test" is performed once. The range of legal *numerical* values for the "count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the count argument, the given test runs *forever*. The discussion under the "m" option of the section titled "The Control Register" explains the purpose of having both the "count" argument and the loop option

(option "l") presented later. Error checking is performed on the value entered for the "count" argument.

6. Selecting option "d" on the "video memory menu" initiates the default video memory test. The default video memory test executes the following two tests.
 - A. The "Constant Pattern Test" in byte mode with pattern 0xa0.
 - B. The "Constant Pattern Test" in word mode with pattern 0xa0a0.

The command line syntax for option "d" is shown next.

"d"

Option "d" does not accept any arguments.

7. The seventh option on the "video memory menu", option "M", specifies whether or not messages are displayed on the screen. The command line for setting the message-mode-flag is displayed next.

"M [1 | 0]"

Option "M" accepts one argument which can have one of two possible values ("0" or "1"). If the user enters "M 0" on the command line, message mode is turned *off* (silent mode). On the other hand, if the user types "M 1" on the command line, message mode is turned *on* (verbose mode). It should be noted that, if the user simply enters "M" on the command line, message mode is turned on. By default, message mode is on.

8. The eighth option on the Video Memory Menu, option "B", specifies whether the memory tests will be executed in byte mode or word mode. That is, whether the processor writes, reads and compares bytes or words. The command line for setting the byte-or-word-mode-flag is displayed next.

"B [0 | 1]"

Option "B" accepts one argument which can have one of two possible values ("0" or "1"). If the user enters "B 0" on the command line, byte mode is turned on. On the other hand, if the user types "B 1" on the command line, word mode is turned on. It should be noted that, if the user simply enters "B" on the command line, word mode is turned on. By default, word mode is active.

9. The ninth option on the "video memory menu", option "K", specifies whether or not *parity checking* is performed. *Parity generation* is always on. The command line for setting the parity-checking-flag is displayed next.

"K [0 | 1]"

Option "K" accepts one argument which can have one of two possible values ("0" or "1"). If the user enters "K 0" on the command line, parity checking is *not performed*. On the other hand, if the user types "K 1" on the command line, parity checking is *executed*. It should be noted that, if the user simply enters "K" on the command line, parity checking is turned on. By default, parity checking is on.

10. The tenth option on the Video Memory Menu, option "W" (wait/stop on error), specifies whether or not the program is temporarily suspended upon the occurrence of a *memory* data error (not all types of errors). The command line for setting the wait-on-error--flag is displayed next.

"W [0 | 1]"

Option "W" accepts one argument which can have one of two possible values ("0" or "1"). Entering "W 0" on the command line means that the program is not suspended after the occurrence of a *memory* data error. If "W 1" was entered on the command line prior to the occurrence of a *memory* data error, the program waits until the user presses any key before

continuing. It should be noted that, if the user simply enters "W" on the command line, the wait-on-error-flag is turned off. By default, the wait-on-error-flag is off.

Given that the program is waiting for the user to press any key and the user presses "q" (a mnemonic for quit), the currently running test is terminated. If, on the other hand, the user presses any other key, the memory test continues with the next address. By default, the wait-on-error flag is off.

11. The eleventh option on the "video memory menu", option "S" (scope loop on error), determines whether or not the program enters a scope loop upon the occurrence of a *memory* data error (not all types of errors). If the diagnostic enters a scope loop, it continues to write a value to the address in question and read back that value before comparing the expected and observed values (i.e the test performs write-read-compare cycles). The command line for setting the scope-loop-on-error-flag is displayed next.

"S [0 | 1]"

Option "S" accepts one argument which can have one of two possible values ("0" or "1"). Entering "S 0" on the command line means that the program does not enter a scope loop following the occurrence of a *memory* data error. If "S 1" is entered, the program does enter a scope loop following the occurrence of a *memory* data error. It should be noted that, if the user simply enters "S" on the command line, the scope-loop-on-error-flag is turned off. By default, the scope-loop-on-error flag is off.

The user is able to terminate a scope loop *on a particular address* by pressing "n" (a mnemonic for next address). They can also terminate the scope loop and the currently running memory test by pressing "q" (a mnemonic for quit).

It should be noted that the user can turn both the wait-on-error-flag and the scope-loop-on-error-flag on simultaneously. Thus, it is possible to suspend the diagnostic after each write-read-compare cycle within the scope loop. Again, the user is able to terminate a scope loop *on a particular address* by pressing "n" (a mnemonic for next address). They are also able to proceed from one write-read-compare cycle to the next by pressing any character *except 'q' and 'n'*. Finally, the scope-loop, wait-on-error condition and the currently running memory test can be terminated by pressing "q" (a mnemonic for quit). By default, the scope-loop-on-error flag and the wait-on-error flag are off.

12. Option "l" (the letter ell) on the "video memory menu" gives the user the opportunity to specify the number of times a user-specified sequence of tests is to be executed. For example, terminating a command line containing one or more user-specified tests with "l 5" executes all of the tests on that command line five times. The command line for the loop option is shown below.

"l [loop_count]"

Option "l" accepts one command line argument. The "loop_count" argument is optional. Without it, the test(s) on the command line are performed *once*. All command lines are executed once even if the "l" option does not appear at the end. Therefore, using the "l" option without an argument has *no affect*.

The "loop_count" argument specifies, in *decimal*, the number of times that the command line sequence is to be *executed*. The range of legal *numerical* values for the "loop_count" argument is 1 to 2147483647 (0x7fffffff). However, if an asterisk (*) is entered as the "loop_count" argument, the given test sequence, theoretically, runs *forever*. The discussion under the "l" option of the section titled "The Main Menu" provides additional details relevant to the usage of the loop option.

13. Option "e" on the "video memory menu" displays an error log. More specifically, at a maximum, the first 100 errors messages of each type recorded by the Sun-2/120 Video Board

Diagnostic are printed on the screen. The command line syntax for option "e" is shown next.

"e"

Option "e" does not accept any arguments. The user does, however, have the ability to suspend and restart the error log display as they see fit. Pressing any key, except "q", suspends the error log display until the user presses another key. If the user presses "q" at any time, the error log display is terminated.

14. If option "h" on the "video memory menu" is chosen, more detailed user instructions appear on the screen. The command line syntax for option "h" is shown next.

"h"

Option "h" does not accept any arguments. The "help" screen associated with the "serial communication controller menu" is shown next.

Sun-2/120 Video Board Diagnostic	REV 1.1 6/27/85	Video Memory Menu
a - Address Test	b: 51 s, w: 28 s	a [count]
c - Constant Pattern Test	b: 26 s, w: 15 s	c [pattern] [count]
r - Random Pattern Test	b: 37 s, w: 21 s	r [seed] [count]
u - Uniqueness Test	b: 42 s, w: 23 s	u [constant] [count]
x - Checker Pattern Test	b: 5 m 58 s, w: 2 m 52 s	x [pattern] [count]
d - Default Video Memory Test	42 s	d
M - Print Error Messages?		M [0 1]
B - Byte Or Word Mode?		B [0 1]
K - Check Parity?		K [0 1]
W - Wait (Stop) On Error?		W [0 1]
S - Scope Loop On Error?		S [0 1]
l - Loop		l [loop_count]
e - Error Log Display		e
h - Help		h
p - Return To The Main Menu		p
q - Quit		q
Command ==>		

15. If option "p" on the Video Memory Menu is executed, the Main Menu appears on the screen. In other words, option "p" returns to the Main Menu. This option allows the user the ability get back to the "main menu" in the case that they want to go to another submenu (i.e. The Serial Communication Controller Menu or The Control Register Menu). The command line syntax for option "p" is shown next.

"p"

Option "p" does not accept any arguments.

16. Finally, option "q" on the "video memory menu" terminates the Sun-2/120 Video Board Diagnostic. The command line syntax for option "q" is shown next.

"q"

Option "q" does not accept any arguments.

In conclusion, this document explained how the user loads and operates the Sun-2/120 Video Board Diagnostic. The command line syntax for each and every menu option was presented.

Theory of Operation Manual for the Sun-2/120 Video Board, Revision A, September 26, 1984.

The Sun-2/120' Video Board Diagnostic Design Document, Revision C, May 20, 1984