SD Systems 51009 Computer

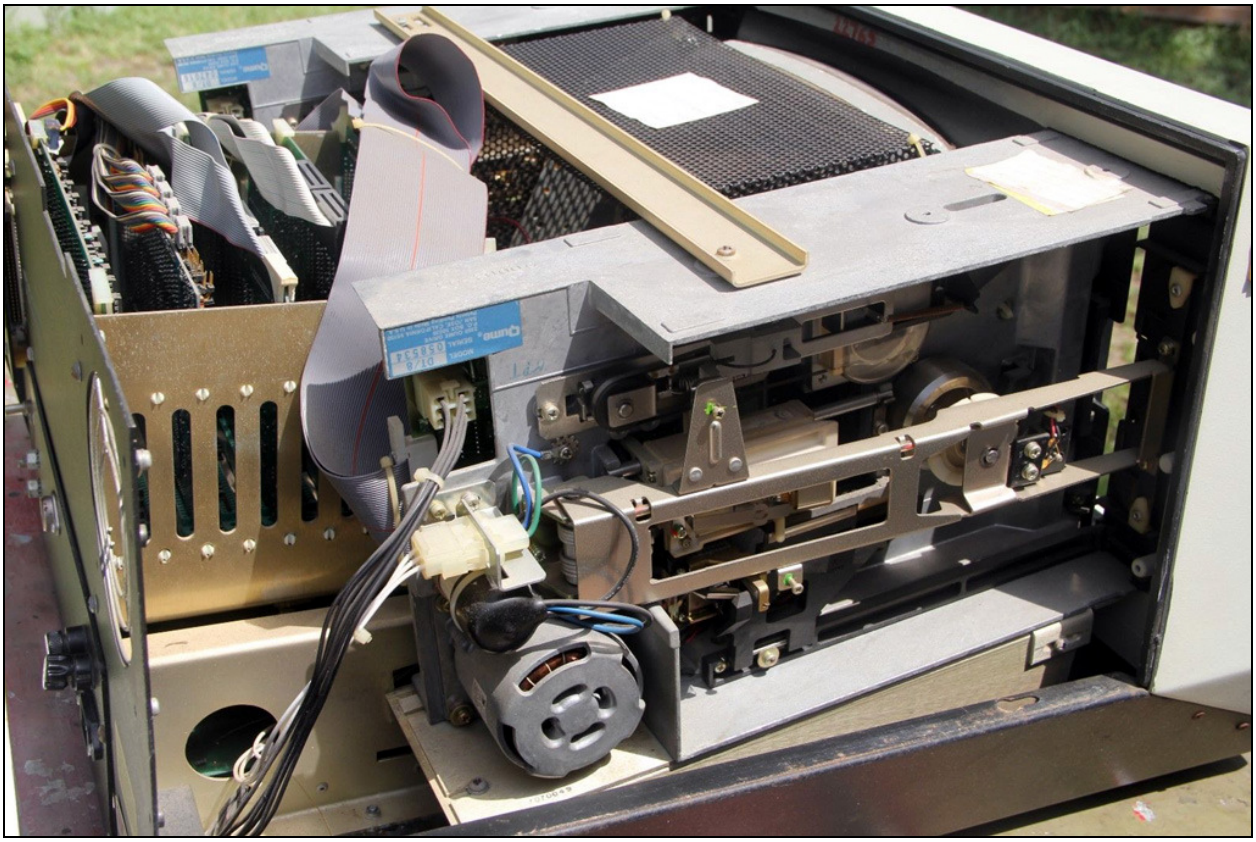
SD Systems was a popular S-100 board manufacturer in the late 1970's. They also sold a few computer systems, though the sale of computer systems appears to very limited. This paper details restoration of an SD Systems 51009 computer. This computer appears to be a custom product developed by SD Systems for TBS International, a shipping company. The computer is similar to the SDS-100 computer from SD Systems shown at the end of this paper.

The computer originally consisted of the following SD Systems boards: a Z80 CPU at 4Mhz, 64K static RAM, VersaFloppy II disk controller, VDB-8024 video interface board connected to a 12 inch monitor, and a multi-port serial interface board. Two 8 inch double-density floppy drives provided 1Mb of storage each. The computer is very large, very heavy, and built like a tank.

The system I purchased did not include the original SD Systems board set and both of the floppy drives (8 inch Qume DataTrak 842) had been removed. The seller removed and sold these items separately. Fortunately, I found some pictures the seller took before removing these items.

Original System Front View

Original System Rear View



Original System Internal View

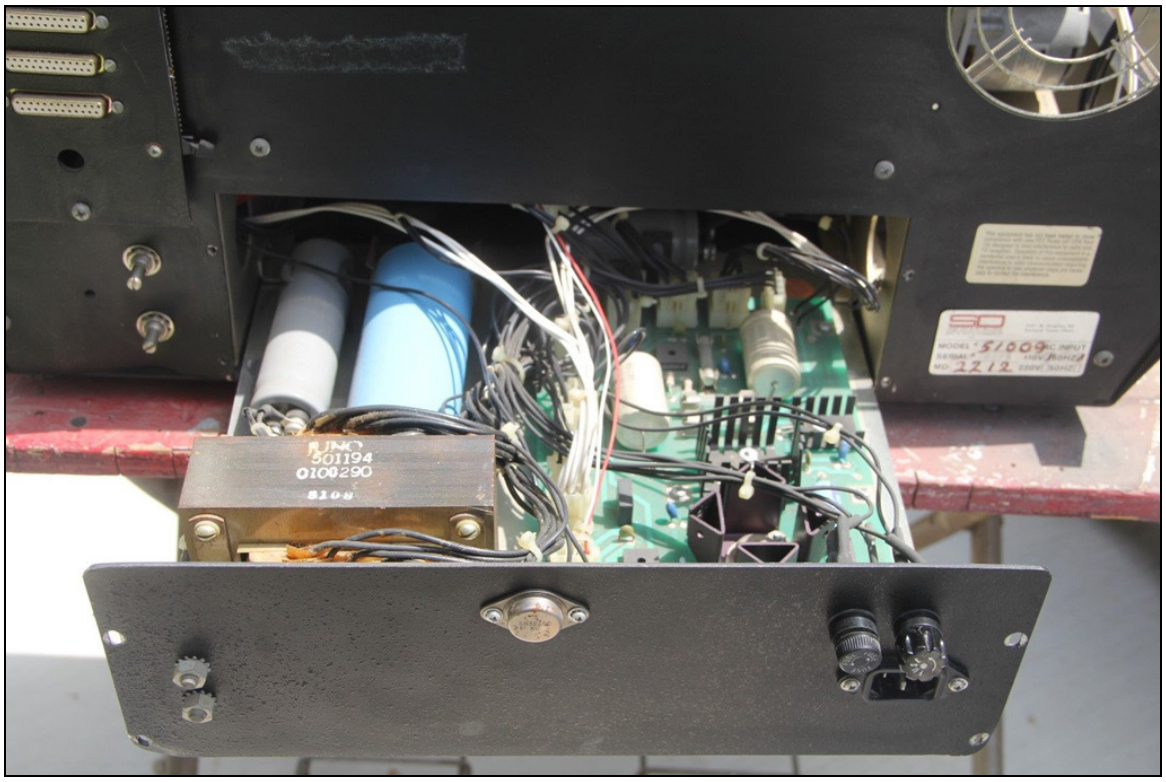
System as Purchased

I decided to purchase the gutted system because I had a pair of the same Qume 842 DataTrak floppy drives sitting on a shelf (already aligned and working), as well as a spare board set from Vector Graphic that very closely duplicated the functionality of the original SD Systems board set. Restoring this system allowed me to get these items off my shelf and into a working system.

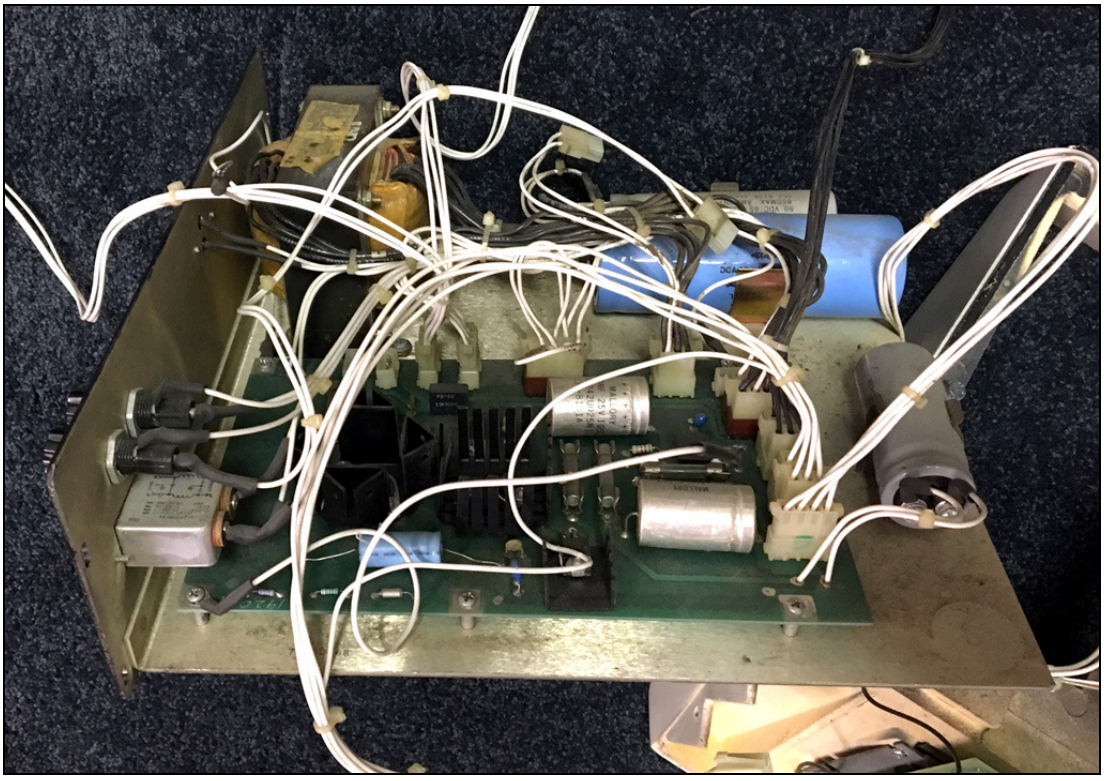
Shown below is the system as purchased in the trunk of my car. Notice the two floppy drives to each side of the 12 inch monitor are not present.

System as Purchased

Following are some pictures of the system as I disassembled it. The power supply is accessible at the rear of the computer and slides out like a drawer. However, due to all the cables that connect to the power supply, additional disassembly is required to actually work on the power supply.



Power Supply Drawer



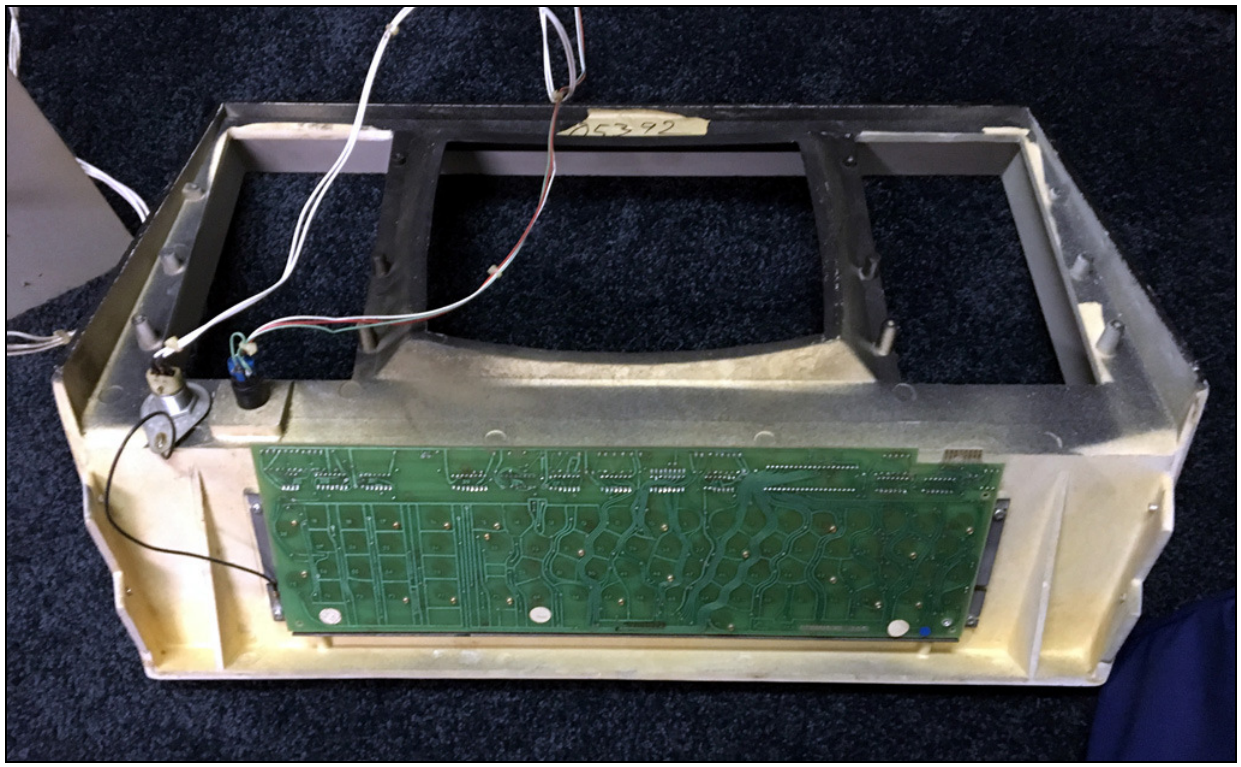
Power Supply Removed from Chassis

A ten slot card cage and motherboard mounts in the chassis above the power supply. It can be seen in a picture later in this document with boards installed. Power for the motherboard and a cable from the front panel reset button connect to the bottom of the motherboard using standard Molex connectors instead of the more typically used screw terminals.

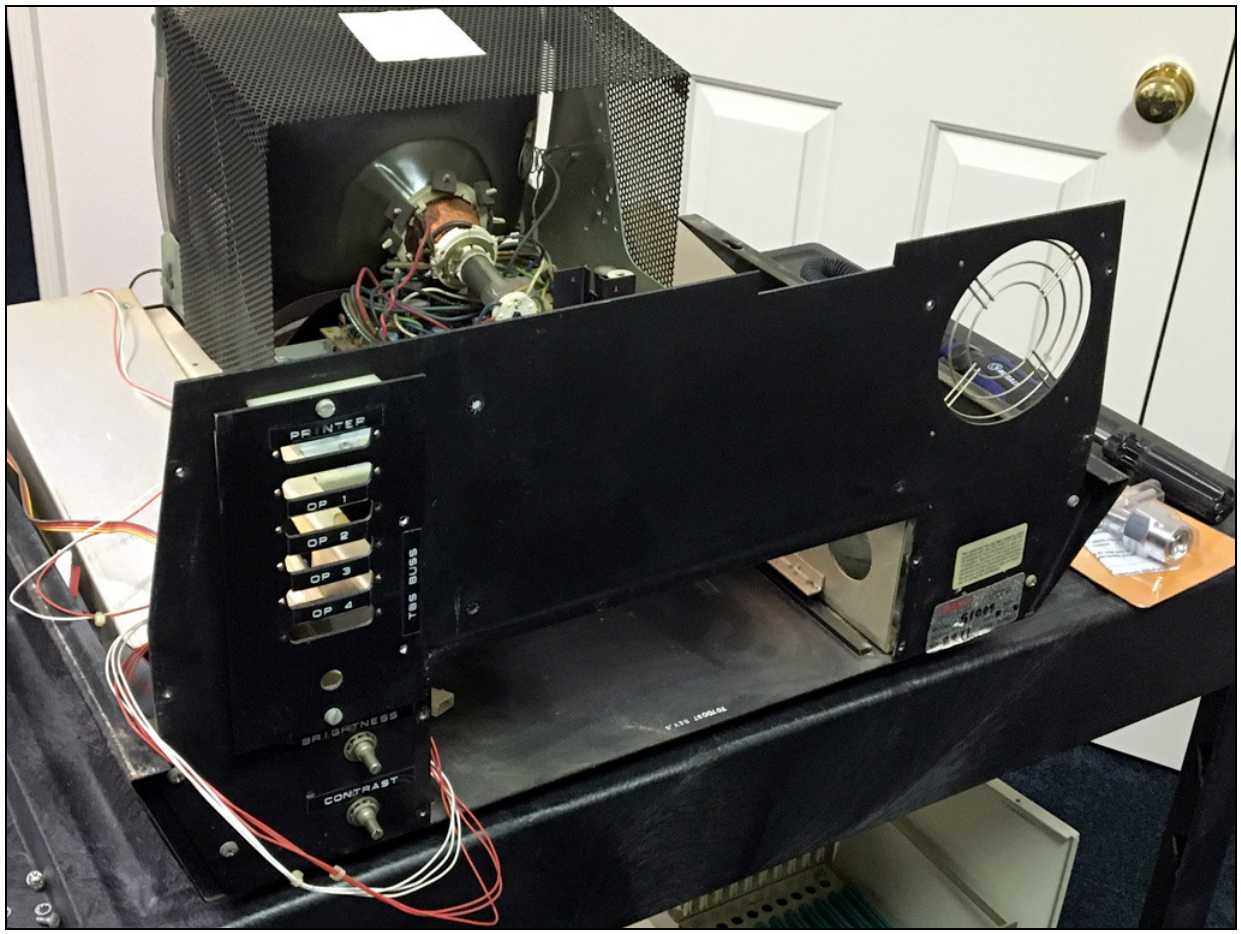
A fan mounted in the bottom of the cabinet blows air towards the back of the system (power supply and card cage area) by using a black plastic deflector. This can be seen in the following picture below the CRT.

The ribbon cable laying in the foreground is for the parallel keyboard. Obviously, the system was dusty and dirty and required some cleaning. The line down the middle of the CRT is just an artifact of reflections in the room.

A bottom view of the keyboard is shown in the following picture. It is a capacitive keyboard made by Keytronix. These keyboards use foam pads with metalized mylar on the bottom of each pad and are notorious for not working in their old age due to pad disintegration. This keyboard was no exception. Restoration of the keyboard is detailed in a following section.



Bottom View of Front Bezel and Keyboard



Rear View without Cover, Power Supply, Drives and Card Cage

Power Supply Restoration

The first restoration step was to get the power supply up and running. For the disk drives, two A/C cables provide 120vac for the drive motors and two DC cables provide +24v, +5v, and -5v for the logic board on the drives. The motherboard cable provides +8v, +16v, and -16v. A +12v cable provides power for the video monitor. A cable and connector from the power supply routes incoming A/C power through a keyswitch on the front bezel of the computer.

All power supply outputs were good except for the +24vdc line which was at zero volts. After testing, I determined the adjustable regulator used to generate the +24v supply was in fold-back protection due to an output short. I studied the board layout to determine which capacitors were across the +24vdc supply. A 25v rated tantalum capacitor had failed in a shorted condition. The regulator's foldback protection prevented the tantalum capacitor from visibly failing or burning. I have found that tantalum capacitors operated near their rated voltage fail very frequently in vintage equipment.

With the tantalum capacitor replaced, the +24vdc supply looked good. I then applied loads to all supplies and let things run for a while. The power supply performance looked good.

Motherboard and Board Set Restoration

The system as purchased did not include the original SD Systems board set or the original Qume 842 floppy drives. However, I had a working Vector Graphic board set with capabilities very similar to the SD Systems board set, along with a pair of the same Qume 842 floppy drives that I had previously restored and calibrated. In addition, I had a couple of versions of CP/M 2.2 ready to run on the VG board set and 8 inch drives.

Using the power supply and card cage removed from the computer, I got the system up and running using a separate keyboard and monitor that were known to work with the VG card set. I bypassed the original keyboard and monitor at this point because the keyboard and monitor interfaces for the Vector Graphic video board are different than for the SD Systems video board. Further, I knew the original keyboard and monitor that came with the system were most likely going to need some work before they would be functional.

I installed the following Vector Graphic board set:

- ZCB Z80 CPU board (includes monitor ROM and serial port)
- 64K Dynamic RAM board
- FlashWriter II 80x24 Video Interface board (includes parallel keyboard port)
- 8" Floppy Controller board

A picture of this system under test and running CP/M 2.2 on a single drive is shown on the following page.

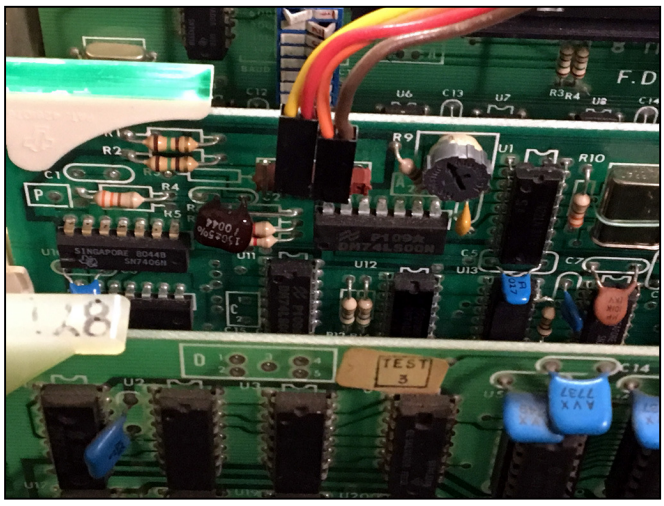
First Operation using Substitute Keyboard and Monitor

Video Monitor Restoration

Without connecting video signals from the FlashWriter video board, I was able to see that the monitor was functional and the CRT driver board was generating a raster scan. By looking at documentation for the SD Systems video board, I was able to determine the monitor was originally driven with separate video, horizontal sync, and vertical sync signals. With some jumper wires and experimentation, I was able to map FlashWriter video output pins to the video harness connected to the CRT driver board.

The CRT driver expects positive going video and sync signals. I cut off the original connector to the SD Systems video board and wired a pair of connectors wired as shown below for the VG FlashWriter II video board.

Signal	Video Harness Wire Color	FlashWriter Pin
Ground	Yellow	2
Video	Red	3
H-Sync	Orange	4
V-Sync	Brown	5



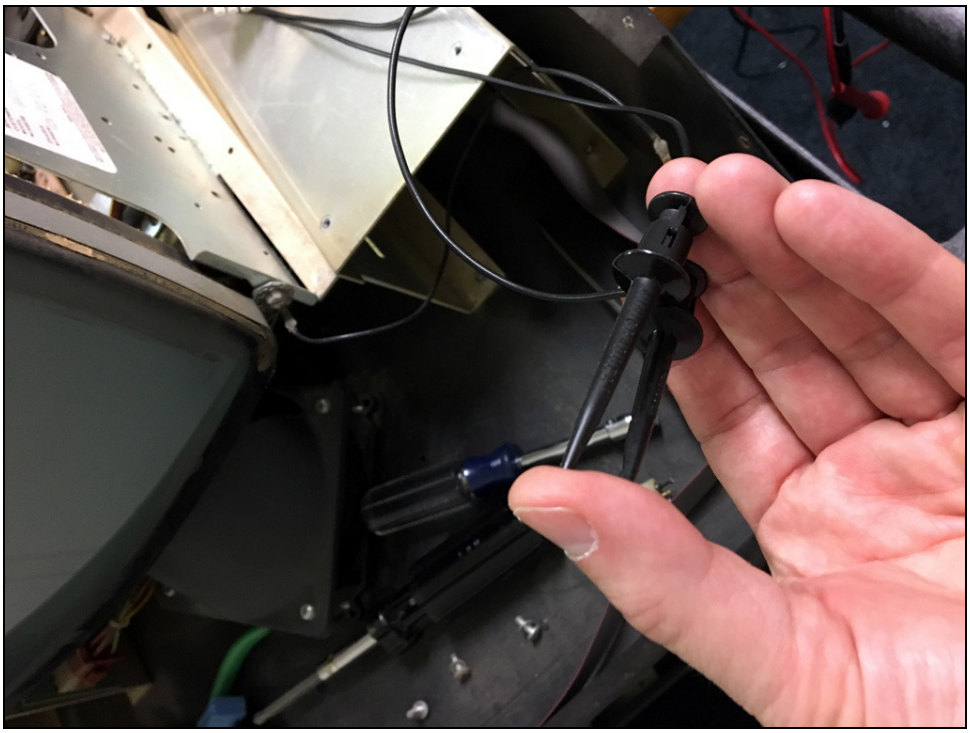
As can be seen in the following picture, there was still a video timing issue to be resolved. No matter how horizontal timing was adjusted on the FlashWriter or on the CRT driver board, The horizontal timing artifact shown in the picture remained.

Horizontal Video Timing Problem

A sticker on the side of the monitor frame showed the monitor is a Motorola MD3573-91. My first searches for schematics of the CRT driver board or a maintenance manual were unsuccessful. However, I was finally able to locate a manual with schematics for the video driver board.

Horizontal sync is generated by a 555 timer running in astable mode. I found the 555 was running too fast, causing a 2nd horizontal scan to start before horizontal sync was received from the FlashWriter video board. A 1000pf cap is used with the 555 to generate the horizontal timing. I suspected the capacitor was no longer 1000pf due to aging. I demonstrated this was the case by attaching clip leads across the 1000pf capacitor and using my finger as additional capacitance as shown in the following pictures.

Calculations based on the timing I measured showed an additional 300pf or so was required to restore the documented horizontal timing. Since removal of the monitor frame and CRT driver PCB was difficult, I tacked a 300pf capacitor in parallel with the original 1000pf capacitor to give horizontal timing that matched the waveforms shown in the monitor maintenance manual.



Using My Thumb to Increase Capacitance for 555 Timer

Good Video with My Thumb "Capacitor" Added

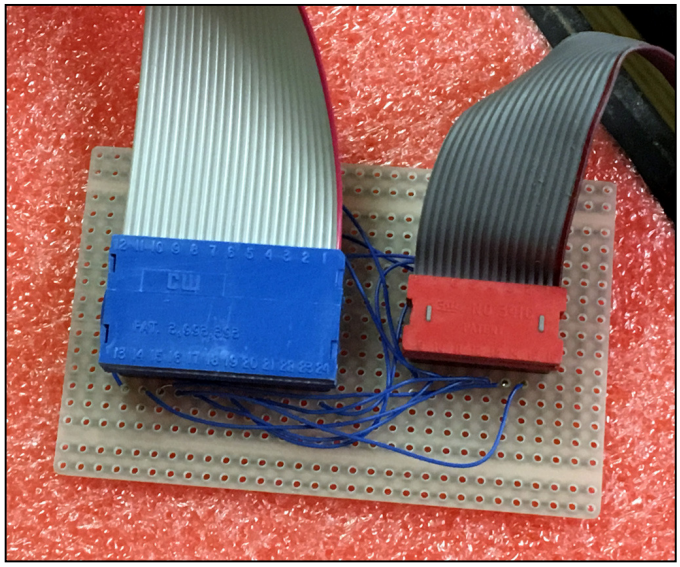
System Test Before Keyboard Repair (VG Keyboard Used Here)

Keyboard Restoration

The keyboard is a Keytronix Capacitive keyboard with a mylar faced foam pad under each key-switch. This same keyboard is used in the Sol-20 and Vector Graphic computers of the same time period. Almost invariably, decay of the foam pads renders these keyboards non-functional.

The keyboard provides a parallel interface through a ribbon cable to the original SD Systems video board. The connection to the video board is via a 16 pin DIP socket. The Vector Graphic FlashWriter II video board also provides a parallel keyboard interface, but through a 24 pin DIP socket with a substantially different pinout. I built a small adapter board to convert from the 16 pin SD Systems connector to the 24 pin FlashWriter connector which is wired as shown below:

Signal	VDB-8024 DIP-16	Flashwriter II DIP-24
+5v	1	24
D7	5	19
Strobe	6	12
Gnd	8	13
D0	9	7
D1	10	17
D2	11	8
D3	12	14
D4	13	20
D5	14	15
D6	15	16



When connecting the ribbon cable to the keyboard edge connector, match pin 1 and 15 as labeled on the ribbon cable connector to pin 1 and 15 as labeled on the keyboard card edge connector (ignore “pin 1” as indicated by the ribbon cable red wire).

After building the adapter board and connecting the cable, the keyboard did not work. Using a scope I determined the keyboard was receiving power, but not sending a data strobe for any keypress. This is the typical failure mode of these keypads for bad keyswitch pads. I removed the keyswitch array from the keyboard PCB and “typed” directly on the PCB artwork using my fingers. As with other Keytronix keyboards, this worked and demonstrated that bad foam pads were the problem.

Replacement foam pads for these keyboards are not easy to make. Some are occasionally available on eBay, but for as much as $2.55 per key. Sun Type 4 keyboards use a newer version of the same pad that does not seem to break down nearly as fast as in the older keyboards. As of 2017, Sun type 4 keyboards are still available on the Internet. A search under the part numbers, 320-1005 and 320-1018, yields results for the Sun Type 4 keyboard. This is not the official model number, but may be a Sun internal part number (the number is present on the product label, but it’s meaning is not identified). The 1018 number is a “French Canadian” keyboard. It seems to be the most readily available. These show up on numerous websites for $19.98. I think they’re all actually all coming from the same place. I have purchased three of these keyboards and they have all been received in brand-new like condition.

Shown to the right are some of the newer pads pulled from the Sun keyboard (these are in a plastic bag, hence the glare).

After replacing all pads, some keys still did not work. Multiple attempts at fixing the problem positions still did not fix every bad key. I then took fine grit sandpaper (600) and smoothed all PCB “capacitor” pads. Though I had not noticed or felt any sort build-up on these pads, the sanding fixed the remaining keyboard problems.

Front Panel Power Keyswitch

Power is applied to the system using a keyswitch on the front panel. The key was missing for the keyswitch, so I ordered a replacement keyswitch. The front bezel of the computer is made from a fiberglass-like material and the area surrounding the keyswitch is about 3/8” thick. The new keyswitch was not deep enough to expose its mounting threads on the inside of the front bezel. I removed a deeper keyswitch from a Vector Graphic MZ computer and installed the MZ keyswitch in the SD Systems computer. In turn, I installed the new keyswitch in the thinner front panel of the Vector Graphic MZ.

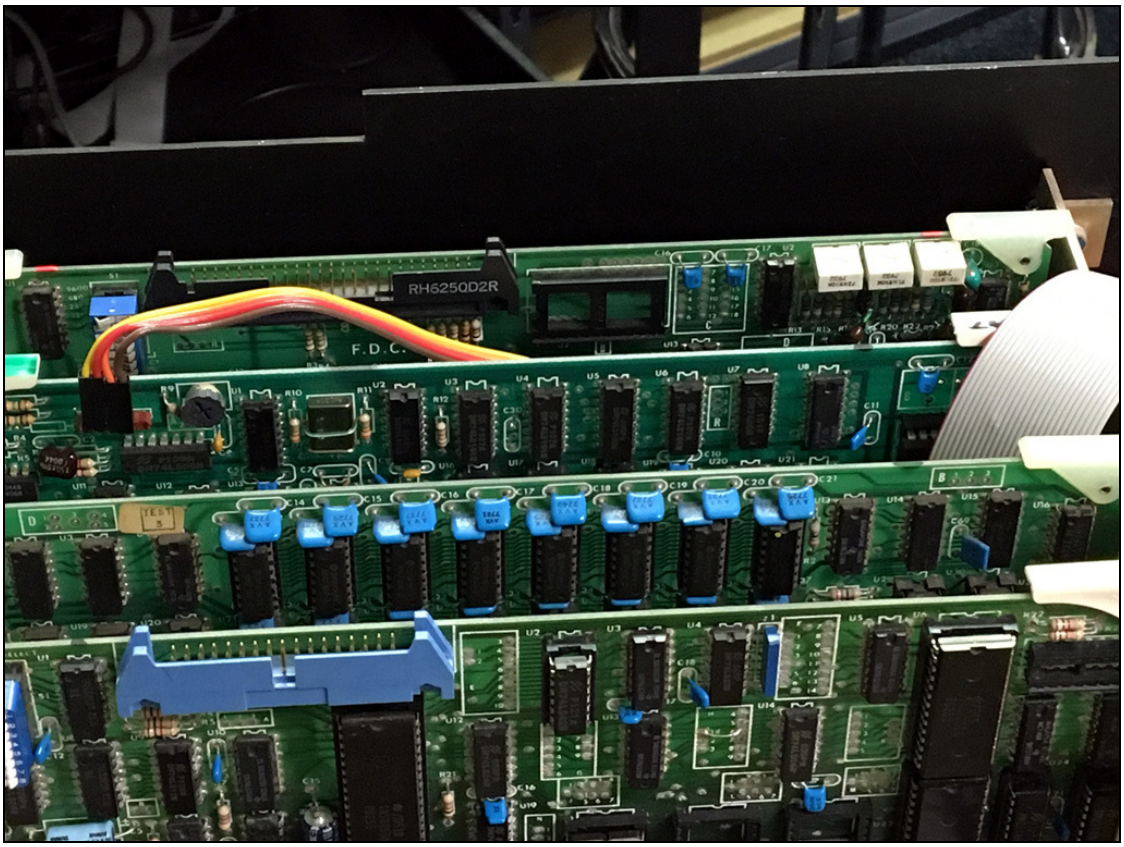
Final Assembly and Test

The Vector Graphic board set assumes a terminated motherboard, and therefore, the ZCB CPU board has no pull-ups on the data input lines. This can affect operation in situations where an input of 0FFh is assumed when nothing responds on the bus. For example, a program searching for which I/O ports are in use, generation of the default "RST7" (0FFh) instruction during an interrupt acknowledge cycle, etc. To prevent these problems, I installed a GodBout active bus terminator.

A custom "T" style disk drive cable had to be made since the floppy disk controller is physically located between the two disk drive – one on the left and one on the right.

In the end, I updated the Vector Graphic board set to a 6mhz set of boards instead of the 4mhz set I started with. The 6mhz version of their boards was one of the last updates Vector Graphic did before finally going out of business in the early 1980's.

Following are pictures of the system during and after final assembly.


RH6250D2R
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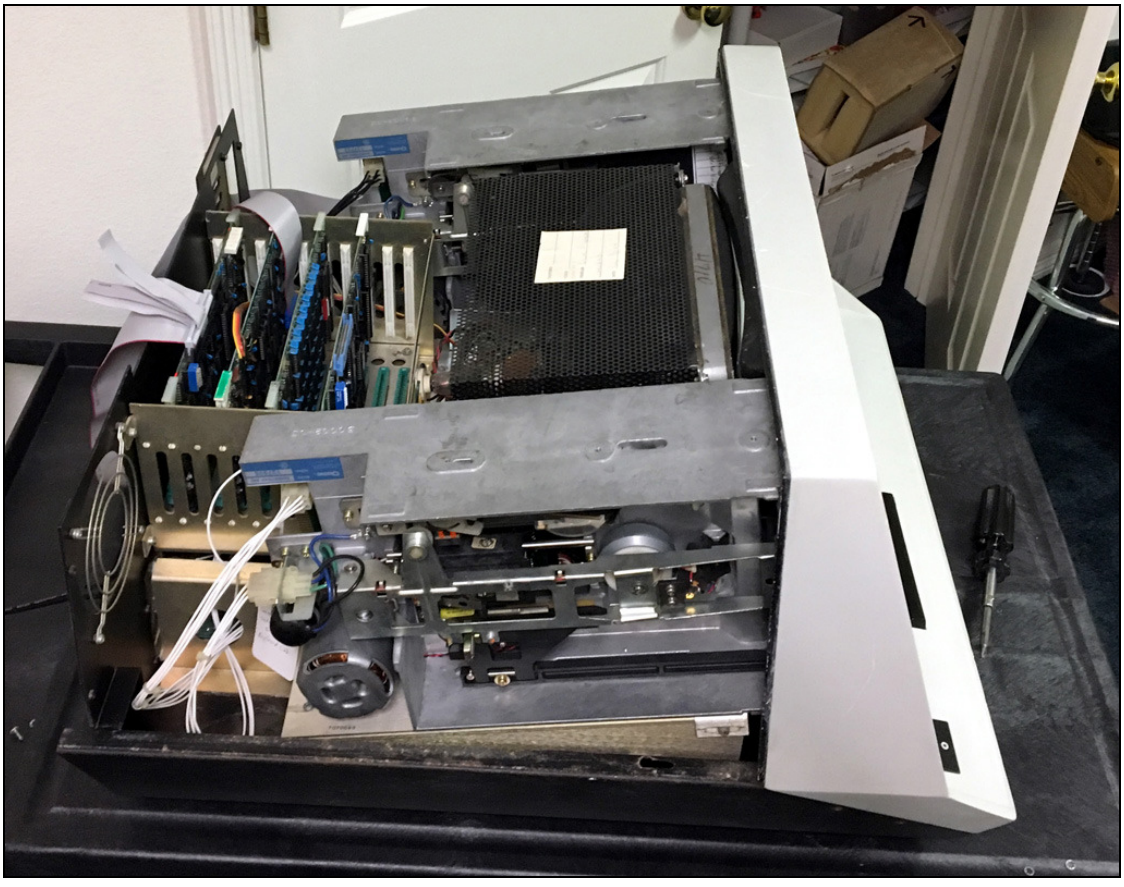

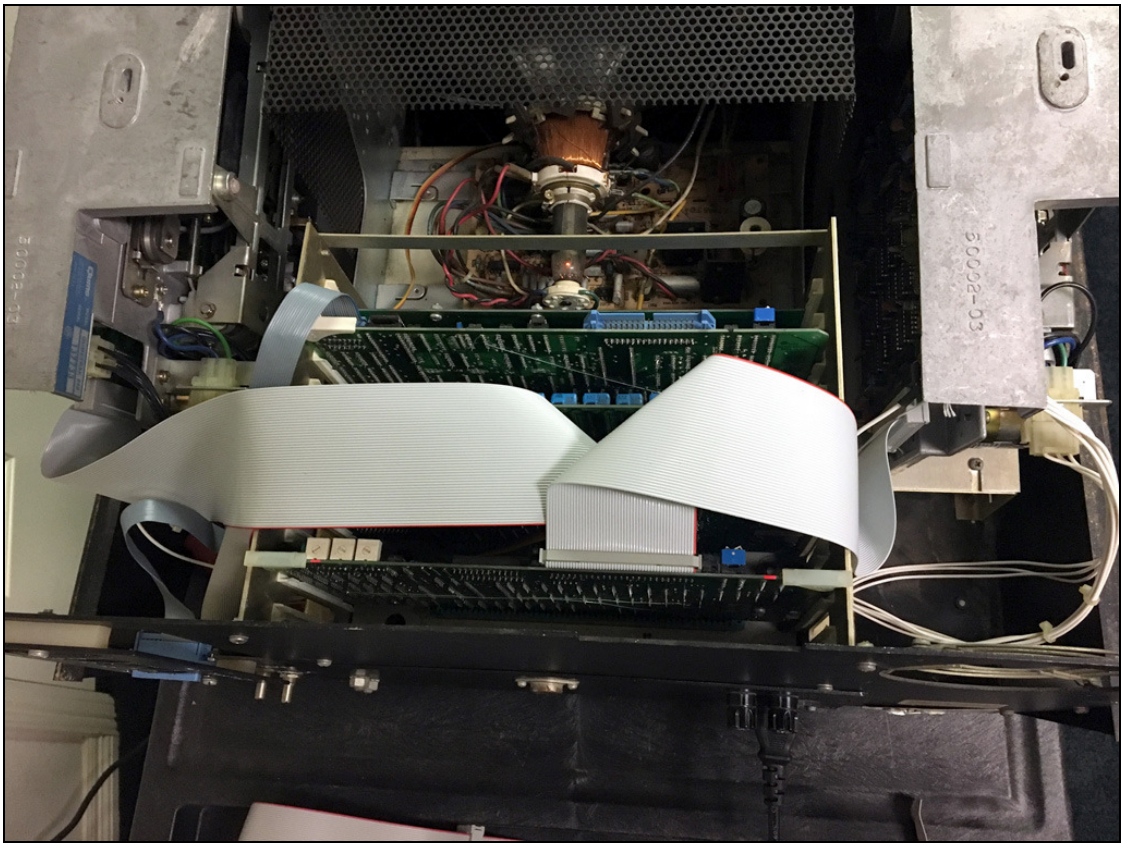

SDS-100 Computer

The custom SDS-51009 computer discussed in this paper is very similar to the SDS-100 computer made for retail sale by SD Systems. Here is an ad for the SDS-100 computer:

SDS-100 THE ULTIMATE SMALL BUSINESS COMPUTER

The SDS-100 is pure computing power. . . designed strictly for small business and professional applications. The proven SD Systems computer boards give you reliability, unequaled flexibility and performance through standard software programs. The system is packaged in a totally shielded single case, housing two full-size dual-sided floppy disk drives, a full sized 12" video monitor, the keyboard and the SDS-100 computer power.

For the more technical features: ● 32K Random Access Memory (Expandable to 64K on board) ● 1,025,024 Bytes of on line disk storage ● IBM 3740 Compatible 12-inch Video monitor reading 80 characters by 24 lines ● Numeric accounting and statistical keyboard ● Full cursor control keys ● Parallel and Serial (RS-232) input and output ports ● C/PM Operating System (by Digital Research of Pacific Grove, California).

The SDS-100 is available through your local SD Dealer. The price of the SDS-100 is $5,795.00 FOB Dallas, Texas. For information concerning the location of your nearest dealer call toll free, 800-527-3460 or 800-527-2304.

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