Restoration and Repair of a North Star Horizon Computer

The Horizon is a Z80 based computer made by North Star. Many were shipped with wood covers, however the one I picked up has a blue metal cover. The computer came with all North Star brand S-100 boards: Z80 CPU board (ZPB-A), DSDD floppy controller (MDS-A-D), 1 x 32K RAM (RAM-32-A) and 2 x 16K RAM (RAM-16-A). The motherboard includes two serial I/O ports and two parallel ports. Finally, two Tandon 100-2 floppy drives (DSDD, 360K) are mounted through the front panel.

Power Supply

The Horizon power supply is a simple, well built, linear power supply. Testing revealed no issue with capacity, ripple, etc. The transformer and wiring are all free of corrosion.

Z80 CPU Board

The Horizon did not ship with a ROM monitor. Instead, it is designed to boot directly from the floppy drive as soon as power is supplied. When getting an old system up and running, this means there is no way to isolate and test the CPU board, the RAM boards, the logic on the motherboard, or the floppy drives – short of most all of that already working properly. In addition, a working boot disk of CP/M, North Star DOS, etc., is required.

The North Star ZPB-A CPU board provided with the Horizon has an un-populated PROM option that allows installation of 2708 EPROM. The vacant PROM option can be seen in the center and bottom left corner of the CPU board shown below. Installation of the PROM option requires two regulators to generate +12v and -5v for the 2708, a couple of 74LS136's for address decoding, and the 2708 itself. I could install these parts, but I still needed to find/write a monitor for the Horizon.

I have a number of Vector Graphic systems and their "Extended Systems Monitor" is a great candidate for using on the Horizon. The monitor already uses the same 8251 UARTs and I/O addresses as used in the Horizon, so the port to the Horizon is very simple. The monitor offers memory examine, modification, breakpoints, an Intel hex file loader, memory test, memory search, and more. I modified the "B"oot command to jump to the North Star boot ROM at E800 instead of the Micropolis boot ROM at F800.

The only problem with using the VG monitor in the Horizon is that the VG monitor requires a 2716 or larger. After a quick look at the schematics for the ZPB-A CPU, it became clear that supporting a 2716 or 2732 on the CPU board was actually simpler than installing the standard 2708 PROM option since the two additional voltage regulators and filter caps are not required.

The following steps were performed to add a 2716/2732 EEPROM to the CPU board:

1) Cut the "PE" (PROM Enable) trace near top of board.
2) Install resistors and sockets for the PROM option. Do NOT install the power related parts for the PROM option (e.g., the two regulators and capacitors at the bottom left of the board).
3) Wire IC 5D-P4 to 4E-P19. This puts A10 on pin 19 of the EPROM socket (A10 on the 2716 and 2732).
4) Wire IC 4E-P24 to 4E-P21. This puts +5v on pin 21 of the EPROM socket (Vpp on 2716, A11 on 2732).
5) Wire PROM address header as required for the desired EPROM address. E000 requires 13, 12, and 11 to 6 or 7, and 10, 9 to 1 or 2.
6) Wire auto-jump header as required for EPROM entry. E000 requires 16, 15, 14 to 3 or 4, and 13-9 to 7 or 8.
7) Install IC's in sockets, lifting pin 6 of IC 5D out of the socket during insertion. This prevents A10 from affecting the PROM selection signal.

The CPU board with the 2716/2732 PROM option installed is shown below. Note that the regulator components at the bottom left are not installed. I installed R4 and the resistor pack RN3, however, it turns out they are not needed with a 2716 or 2732 EPROM. These pull-up resistors were required to ensure the input voltage for a data "1" exceeded the 2708's threshold of 2.4v. This input spec is not fully TTL compatible. The 2716 and 2732 have a voltage threshold of 2.0v for a data "1" which meets the TTL spec and the pull-up resistors are not required.

RAM Cards

Two 16K boards (RAM16-A3) and one 32K board (RAM32-A1) came with the Horizon. The boards are all configured for use with a Z80 processor, the Phantom option disabled, and no parity interrupts connected (one of the 16K boards and the 32K board has the parity option installed).

The 2nd 16K board has only the lower 8K enabled. This gives a total of 56K of RAM in the system (0000-DFFF). The monitor ROM (see previous section) is at E000-E7FF and the disk controller occupies E800-EFFF.

A 2.2uf tantalum was burnt out on the negative regulator on the 32K board. I replaced it with a 10uf tantalum. After this simple repair, all three boards passed extensive memory test cycles using the memory test function in the monitor ROM.

Floppy Disk Controller

The Horizon computer came with the North Star DSDD floppy disk controller (MDS-A-D). This is a hard sectored controller using ten sector disks. I had already tested the FDC in a Sol-20 computer using known-good drives and the FDC is fully functional.
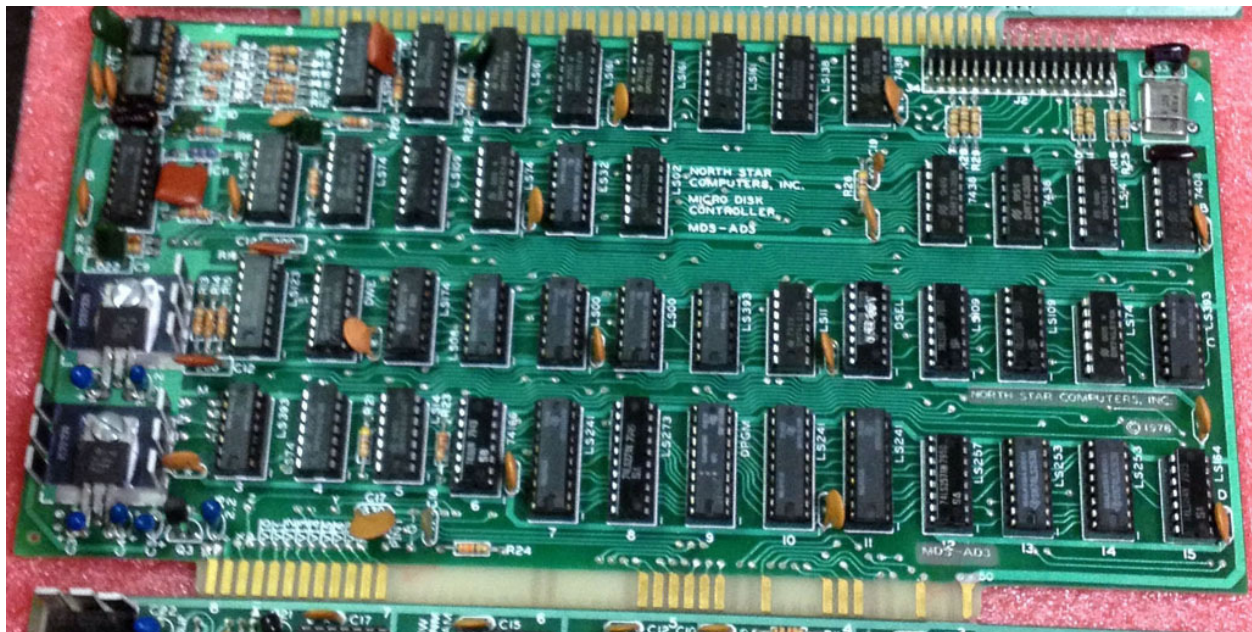
Motherboard

The motherboard in the Horizon includes hardware for two serial ports and two parallel ports. The serial ports use the 8251 UART. Headers allow configuration of DB-25 pin assignment and baud rate for each of the two serial ports. Both ports were configured as DCE with the console port at 9600 baud and the 2nd port at 300 baud. I modified the baud rate header to run the 2nd port at 9600 baud instead of 300 baud. The following picture shows the I/O hardware that is part of the motherboard in the Horizon computer.
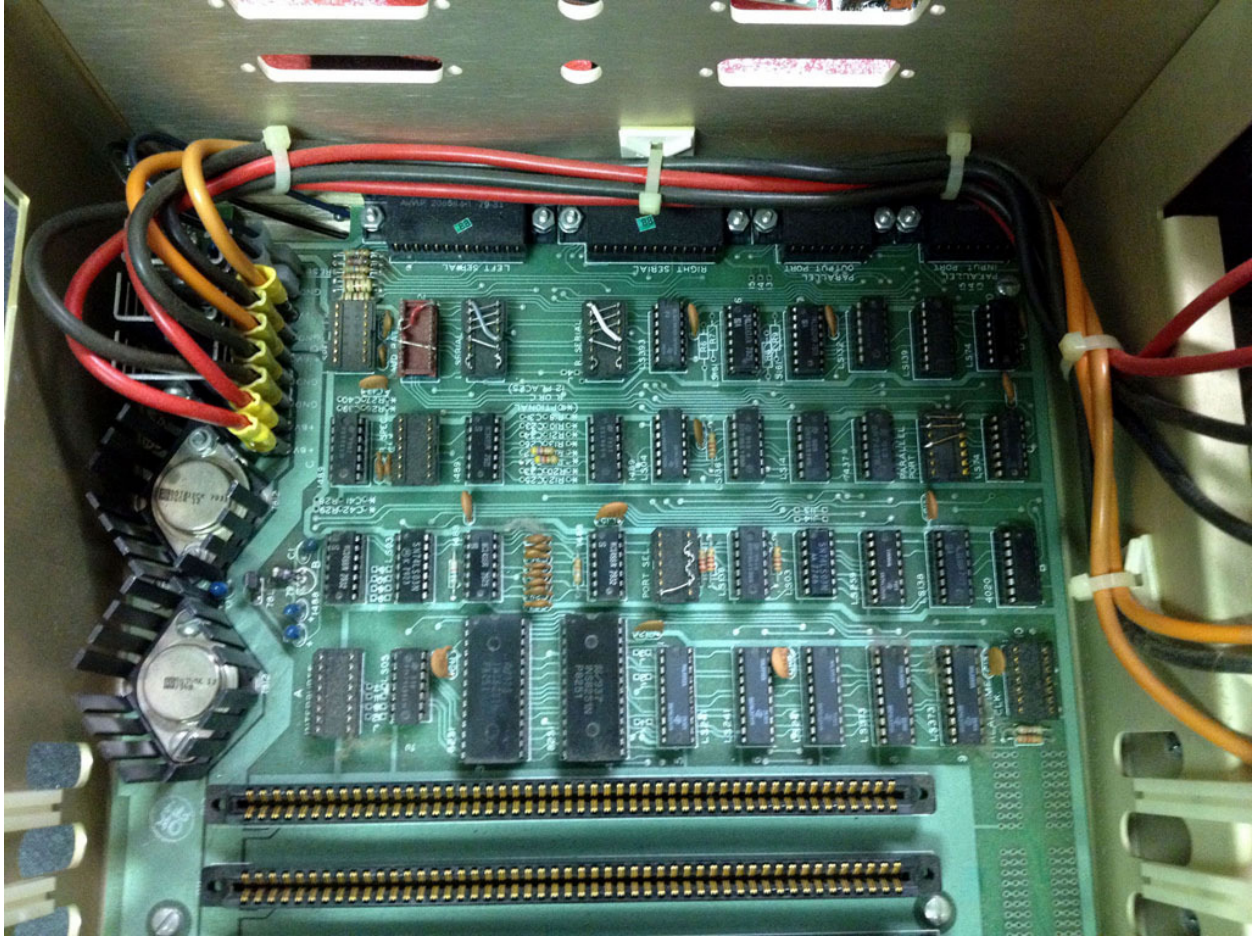
Floppy Drives

The Horizon computer came with two 5.25" Tandon 100-2 DSDD drives. With typical Horizon software (North Star DOS and CP/M), these drives are used double sided, 35 tracks per side, 10 sectors per track, 512 bytes per sector. This provides 358,400 bytes of storage.

I cleaned out the drives, cleaned the heads, then lightly lubed the stepper and hub motor shafts as well as the hub pulley shaft. I then performed radial and index alignment of the drives using a disk utility running on an Altair computer. The main drive (drive 1) has bad bearings on the stepper shaft and makes a good deal of noise as it steps. However, the motor is still able to reliably overcome the additional friction of the bad bearing(s) and step reliably.

The second drive (drive 2) has quieter stepper bearings, but I ran into a couple of problems that could not be easily fixed. I could obtain radial alignment only if the disk utility thought the drive was on track 17 instead of the actual alignment track (track 16). There is not enough radial adjustment to move a full track, so this indicates a track zero switch position issue.

However, no matter what is done with track zero adjustment, the drive remains off by +1 track or -3 tracks – nothing in between. This is a four phase stepper with track zero is asserted only on phase zero. This explains why only every fourth track can qualify as track zero. Apparently there is some slight mechanical displacement/bend that cannot be corrected along the radial axis. Fur-

ther, two of the screws that must be tightened after performing radial alignment are stripped and the track 0 adjustment mechanism is damaged. This makes me think the previous owner had already been down this same path.

I have a "parts" Tandon 100-2 drive on the shelf, so I decided to use pieces from the Horizon drive 2 to restore my parts drive to working condition. This required moving the door latch, flywheel, belt, motor control board, and nylon PCB spacers from Horizon drive 2 to the parts drive.

The flywheel on the parts drive is a cheap, sintered metal flywheel full of circumferential and radial cracks. However, it is a slightly larger diameter than the Horizon drive's flywheel, so I had to use the belt from the Horizon drive as well. Motor speed adjustment on the parts drive could not account for the difference in flywheel size, so I had to move the motor control board from the Horizon drive to the parts drive.

After cleaning and lubing this "new" drive, I attempted to perform radial and index alignment, but I wasn't getting any index/sector pulses out of the drive. After ten minutes of probing with a scope, I discovered I wasn't getting sector pulses because the disk wasn't spinning! The flywheel spun, but the clamp hub force was too light to make the actual floppy spin. I removed three thin washers under the c-clip that held the clamp bearing in place and this adjustment sufficiently increased the clamp force to engage the floppy. I was then able to perform radial and index alignment of the drive. Its stepper bearings are quiet compared to the Horizon drive 1.

Software

I created versions of PC2Flop and Flop2PC for the Horizon computer to write floppies from disk images and to archive floppies to a disk image. The simple linear format disk images used by these utilities are the same as used with Dave Dunfield's NST utility and .NSI images.

I created a few CP/M 2.2 and North Star DOS 5.x images. These images, the PC2Flop and Flop2PC images, along with other useful software and documents are available at http://deramp.com in the downloads->north_star->horizon section.

Final Notes

On the following page are pictures of the restored Horizon configuration with all original boards and hardware functioning. The second picture shows the Virtual Sector Generator (VSG) board in-line between the FDC and the drives so that soft-sectored media can used in addition to 10-sector media since the latter has become so hard to find. See http://deramp.com/vsg.htm for more information about the VSG.