Virtual Sector Generator (VSG)
Issues with Drive Startup and Drive Selection

The sector counter on a hard-sector disk controller is in an unknown state when a different drive is selected, or if the same drive is selected but the motor must be started. In these cases, disk I/O must be delayed until the sector counter re-syncs with the media in response to a valid index pulse.

North Star Controllers

With North Star controllers, index sync occurs when a sector pulse is received from the drive and the intra-sector timer is still less than 16.4ms (a sector is 20ms). Since the sector timer on the controller continues to generate fake sector pulses every 32.8ms in the absence of sector pulses from the drive, there is roughly a 50% chance that the first sector pulse received from the drive will generate index sync on the controller. This first index sync is most likely not a valid sync and software must not assume the disk is ready for I/O at this point.

With the North Star double-density controller, an index flag is available in the status register to indicate index sync has just occurred. Software polls this flag during drive selection to determine when the controller and drive have index sync. However, the very first index flag, as described above, must not be used as a ready status. For example, the CP/M BIOS for the DD controller waits for two sector pulses to occur after drive selection to be sure it has skipped this possible errant index flag before it begins polling for the index flag. The SD controller does not have the index flag in a status register, so instead, software waits for 13 sectors to pass to ensure a valid index pulse has been received.

Drive selection is handled in typical drivers for the North Star controllers as follows:

North Star SD Controller

- Motor spin up counts 50 sectors
- New drive select counts 13 sectors (ensures index has occurred)

North Star DD Controller

- Motor spin up counts 23 or 48 sectors (23 if DD drive – assumes quicker motor startup)
- Selection of a new drive counts 2 sectors, then waits for index flag within 12 more sectors. The 2 sector count ensures an erroneous index flag, which can easily occur with the first sector pulse from the drive, is ignored.

Virtual Sector Generator (VSG) Implications:

- When operating with the SD controller, the VSG must be in sync with the disk *and* the controller by the time the 14th sector pulse occurs (software counts 13 pulses, then I/O can begin on the next pulse). The controller generates sector pulses inter-

nally every 32.8ms even if pulses are not being received from the drive, so the VSG cannot stall the controller and software by not sending pulses.

In order to maximize the amount of time allowed for sector sync, the VSG doesn't generate sector pulses during the first revolution until it is time for the sector 8 pulse. This results in the controller using internal 32.8ms pulses instead of 20ms pulses until the VSG sends the sector 8 pulse. The worst case sequence of drive selection, first index pulse from the drive, and pseudo-sector alignment results in the controller outputting the sector 8 pulse about 9.5ms into the 12th pseudo-sector. In this case, the sector 8 pulse is treated as an index pulse by the controller, the sector 9 pulse is treated as the 13th sector pulse, and the VSG, drive, and controller are then all in sync for the next sector (zero).

- When operating with the DD controller, software waits for two sector pulses to pass, then looks for any subsequent sector pulse in which the index flag is set, then I/O can begin on the next sector pulse received. The VSG, drive, and controller must all be in sync by this time. The same algorithm described above for the SD controller satistfies the sync requirements of the DD controller. See the timing diagram at the end of this document for details.

Micropolis and Vector Graphic HD/FD (Tandon) Controller

Note: References to the Micropolis controller in this section apply to both the Micropolis controller and the Vector Graphic HD/FD (Tandon) controller.

For the Micropolis controller, index sync occurs when a sector pulse is received from the drive and the intra-sector timer is sill less than about 10ms (a sector is 12.5ms). The first two consecutive pulses received from the drive spaced less than 10ms apart generate index sync. Unlike the North Star controller, the Micropolis controller does not internally generate fake sector pulses in the absence of pulses from the drive.

Index sync normally occurs in response to detecting the sector 15 pulse followed by the index pulse. However, sync could also occur (during initial drive selection) from the index pulse followed by the sector 0 pulse. In the latter case, the sector numbers are wrong for the entire first revolution. This problem is avoided in software by delaying 250ms after drive selection before hunting for a sector number. This timing ensures the disk has completed more than a full revolution. Unlike the North Star drivers, this is a software only timing loop – sector holes are not counted as the timing mechanism.

The Micropolis controller originally left the drive motors running all the time like typical 8" configurations. The head loaded when the drive was selected, and the drive deselected and the head unloaded after 4 seconds of inactivity. For this reason, none of the Micropolis software (e.g., MZOS, MDOS, VG CP/M, Lifeboat CP/M) has provision for handling a motor spin-up period.

A motor mod became "standard" on the Micropolis controller and upgraded a version 0 board to version 1. This mod made the Micropolis controller work like most 5.25" con-

trollers: The motor turns on when a drive is selected and the motor turns off after 4s of inactivity.

No software changes were made to support the motor modification, so software begins disk I/O just 250ms after the motor is started. This is substantially sooner than the 1 second startup spec'd by Micropolis for the drive itself (1015 Mod-II). To ensure index sync is properly registered, the drive must be 65% up to speed within just 50ms. Since disk I/O is attempted at 250ms, the drive must be 100% up to speed within 250ms.

Worst case scenario is a write request without pre-read of track/sector ID for which no track stepping is required and the desired sector number is immediately available. This particular write will occur very close to 250ms after the motor starts. Since the motor is not fully stabilized at this point, the write may be marginal. Even if the write verifies on read, jitter in the write timing makes this sector subject to subsequent read failure.

Virtual Sector Generator (VSG) Implications:

- The VSG generates a fake sector 15 pulse and index pulse (6.25ms between) after it has determined this is not a hard sector disk but before the 250ms software timer expires. This will force the controller's sector register to zero.
- After sending the index sync sequence, no subsequent pulses are sent to the controller until the sector 0 pulse on the revolution for which the VSG and drive are in sync. After the 250ms timeout, host software is in a loop waiting for the next sector pulse. By not sending pulses until ready, the VSG can stall the software.

Altair Minidisk Controller

With the Altair Minidisk controller, the index counter is reset to zero when a sector pulse is received from the drive and the intra-sector timer is still less than 9.6ms (a sector is 12.5ms). In addition, an "index verify" step is then enforced before the controller asserts the "Head Status" bit and allows the sector register that software reads to indicate the start of each sector ("Sector True"). The index verify step requires an index reset (sector pulse to index pulse less than 9.6ms), immediately followed by another sector pulse (i.e., sector 0) within 9.6ms.

Software does not see the "Sector True" flag asserted in the sector register until index verify has completed on the controller. The Sector True flag is also qualified by a one-second timeout each time a drive is selected after being deselected (e.g., switching drives, deliberate de-select, or motor timeout).

Virtual Sector Generator (VSG) Implications:

- If the same 16 sector algorithm as used for Micropolis is used with an Altair controller, the Altair controller will reset the sector counter with the fake index sync pulses, but index verify will then fail since a sector zero pulse does not immediately follow.

- When the VSG begins generating valid pulses starting with sector 0, the Altair won't assert index verify until that rotation completes and sector 15, index, sector 0 pulses are received. At this point, index verify is true, but in reality, the controller is most likely still waiting on the one second motor-start timeout to expire before it lets "sector true" assert in the sector register.

Heathkit Hard Sector Controller

The Heathkit hard sector disk controller does not maintain a sector counter at all. Instead, software determines the sector that is passing under the head by actually reading the track/sector ID bytes from the disk. This, of course, requires that a format routine initially wrote this information.

Virtual Sector Generator (VSG) Implications:

- Since the Heathkit controller is mostly software driven, sector counter and the related timing issues aren't a problem.