

Use of the Disk II Interface Card Through Your Own Software

by John Uhley

This is the first of a series of three articles which will discuss several techniques used in accessing the Disk II Interface Card. The routines discussed in these articles will enable a programmer to access the Disk II without the use of Apple DOS or Apple RWTS. This article will introduce the programmer to one method of accessing the Disk II Interface card and develop several routines to position the disk drive's magnetic head across the surface of the diskette.

Each of the eight slots in back of the Apple computer is allocated 16 memory locations for I/O control. Some of these memory locations act as softswitches (software switches) and perform a predefined hardware task when addressed by a software routine. Other I/O memory locations are used as wormholes through which data can enter or exit the computer.

Most of the Apple's I/O is done on page \$C0 of memory. The following table illustrates the range of memory reserved for each slot's softswitches.

SLOT	LOCATIONS
0	\$C080 - \$C08F
1	\$C090 - \$C09F
2	\$C0A0 - \$C0AF
3	\$C0B0 - \$C0BF
4	\$C0C0 - \$C0CF
5	\$C0D0 - \$C0DF
6	\$C0E0 - \$C0EF
7	\$C0F0 - \$C0FF

One common method of accessing softswitches through software is to use the Apple's indexed addressing mode. By adding various values to the address of a slot zero softswitch it is possible to change the addressed slot by altering the index register alone. For example, if a program wanted to access the softswitches of the card in Slot 3 the following method could be used:

LDX #\$30 ; (select slot 3)

TURNON LDA \$C089,X ; turn on disk drive in slot 3
RTS ; and return

Using this technique the same routine can access any slot's softswitches by changing the value in the X-register:

LDX #\$60 ; (select slot 6)
JMP TURNON ; turn on disk drive in slot 6
; using the same routine

In the table below 'S' represents one of the 16 softswitches of the specified slot.

SLOT	SOFTSWITCH	X-REG	COMMAND
0	S	\$00	LDA \$C08S,X
1	S	\$10	LDA \$C08S,X
2	S	\$20	LDA \$C08S,X
3	S	\$30	LDA \$C08S,X
4	S	\$40	LDA \$C08S,X
5	S	\$50	LDA \$C08S,X
6	S	\$60	LDA \$C08S,X
7	S	\$70	LDA \$C08S,X

Depending on the actual card placed in a given slot the 16 softswitches will perform a different function. This article will only discuss the effect of these 16 softswitches on the Disk II Interface Card. The table below illustrates the functions of each of the softswitches.

MEMORY LOCATION	FUNCTION
\$C080 + SLOT	Phase 0 off (positioning)
\$C081 + SLOT	Phase 0 on (positioning)
\$C082 + SLOT	Phase 1 off (positioning)
\$C083 + SLOT	Phase 1 on (positioning)
\$C084 + SLOT	Phase 2 off (positioning)
\$C085 + SLOT	Phase 2 on (positioning)
\$C086 + SLOT	Phase 3 off (positioning)
\$C087 - SLOT	Phase 3 on (positioning)
\$C088 + SLOT	Power Down (drive off)
\$C089 - SLOT	Power Up (drive on)
\$C08A + SLOT	Select 1 (select drive 1)
\$C08B + SLOT	Select 2 (select drive 2)
\$C08C + SLOT	Readswitch (I/O wormhole)
\$C08D + SLOT	Writeswitch (I/O wormhole)
\$C08E + SLOT	Clearswitch (I/O wormhole)
\$C08F + SLOT	Shiftswitch (I/O wormhole)

(SLOT refers to the index value needed to access the softswitches of a given slot. As shown earlier, this value is equal to that slot number times 16.)

The following routines demonstrate some of the techniques used to activate or deactivate a disk drive. Each time a new disk

drive is activated it is necessary to wait for the drive's motor to reach operational speed. One suitable delay loop is illustrated by the "MWAIT" subroutine.

The first eight softswitches are used to position the disk drive's magnetic head above the physical tracks of a diskette. These softswitches are used to rotate a motor which moves the magnetic head back and forth along the surface of a diskette.

By rotating the motor in a clockwise direction the magnetic head is moved towards higher numbered tracks. Conversely, counterclockwise rotation forces the magnetic head towards

lower numbered tracks. Figures A and B illustrate the concepts discussed in these paragraphs using simplified models.

Figure C shows a magnetized needle surrounded by four electromagnetic poles. By magnetizing one of the four poles the needle is forced to 'point' towards that pole. By magnetizing and demagnetizing the poles in a given order the needle can be made to spin in a clockwise or counterclockwise direction (see figure D).

By replacing the needle with a motor and the poles with software controlled electromagnets (numbered 0,1,2, and 3) a model of the disk drive's positioning motor can be visualized (see figure E).

```

1 ****
2 *
3 * ROUTINE TO TURN ON DRIVE 1 *
4 *
5 ****
6 SLOT EQU $0001
7 WAIT EQU $0002
8 DISKON EQU $C089
9 DRIVEA EQU $C08A
10 ****
11 *
12 * SET SLOT EQUAL TO SLOT 6 *
13 *
14 ****
15 LDA #$60
16 STA SLOT
17 ****
18 *
19 * TURN ON THE DISK DRIVE AND *
20 * SELECT DRIVE A *
21 *
22 ****
23 LDX SLOT
24 LDA DISKON,X
25 LDA DRIVEA,X
26 ****
27 *
28 * WAIT FOR DRIVE TO POWER UP *
29 *
30 ****
31 MWAIT LDA #$EF
32 STA WAIT
33 LDA #$D8
34 STA WAIT+1
35 MWAITA LDY #$12
36 MWAITB DEY
37 BNE MWAITB
38 INC WAIT
39 BNE MWAITA
40 INC WAIT+1
41 BNE MWAITA
42 RTS
43 ****
44 *
45 * ROUTINE TO TURN ON DRIVE 2 *
46 *
47 ****
48 SLOT EQU $0001
49 WAIT EQU $0002
50 DISKON EQU $C089
51 DRIVEB EQU $C08B
52 ****
53 MWAIT LDA #$EF
54 STA WAIT
55 LDA #$D8
56 STA WAIT+1
57 MWAITA LDY #$12
58 MWAITB DEY
59 BNE MWAITB
60 INC WAIT
61 BNE MWAITA
62 INC WAIT+1
63 BNE MWAITA
64 RTS
65 ****
66 *
67 * ROUTINE TO TURN OFF A DISK *
68 *
69 ****
70 SLOT EQU $0001
71 DISKOFF EQU $C088
72 ****
73 MWAIT LDA #$EF
74 STA WAIT
75 LDA #$D8
76 STA WAIT+1
77 MWAITA LDY #$12
78 MWAITB DEY
79 BNE MWAITB
80 INC WAIT
81 BNE MWAITA
82 INC WAIT+1
83 BNE MWAITA
84 RTS
85 ****
86 *
87 * ROUTINE TO TURN OFF THE DISK DRIVE *
88 *
89 ****
90 SLOT EQU $0001
91 WAIT EQU $0002
92 DISKON EQU $C089
93 DRIVEB EQU $C08B
94 ****
95 MWAIT LDA #$EF
96 STA WAIT
97 LDA #$D8
98 STA WAIT+1
99 MWAITA LDY #$12
100 MWAITB DEY
101 BNE MWAITB
102 INC WAIT
103 BNE MWAITA
104 INC WAIT+1
105 BNE MWAITA
106 RTS
107 ****
108 *
109 * AND QUIT *
110 *
111 ****
112 MWAIT LDA #$EF
113 STA WAIT
114 LDA #$D8
115 STA WAIT+1
116 MWAITA LDY #$12
117 MWAITB DEY
118 BNE MWAITB
119 INC WAIT
120 BNE MWAITA
121 INC WAIT+1
122 BNE MWAITA
123 RTS
124 ****
125 *
126 * SET SLOT EQUAL TO SLOT 6 *
127 *
128 ****
129 MWAIT LDA #$EF
130 STA WAIT
131 LDA #$D8
132 STA WAIT+1
133 MWAITA LDY #$12
134 MWAITB DEY
135 BNE MWAITB
136 INC WAIT
137 BNE MWAITA
138 INC WAIT+1
139 BNE MWAITA
140 RTS
141 ****
142 *
143 * TURN OFF THE DISK DRIVE *
144 *
145 ****
146 MWAIT LDA #$EF
147 STA WAIT
148 LDA #$D8
149 STA WAIT+1
150 MWAITA LDY #$12
151 MWAITB DEY
152 BNE MWAITB
153 INC WAIT
154 BNE MWAITA
155 INC WAIT+1
156 BNE MWAITA
157 RTS
158 ****
159 *
160 * AND QUIT *
161 *
162 ****
163 MWAIT LDA #$EF
164 STA WAIT
165 LDA #$D8
166 STA WAIT+1
167 MWAITA LDY #$12
168 MWAITB DEY
169 BNE MWAITB
170 INC WAIT
171 BNE MWAITA
172 INC WAIT+1
173 BNE MWAITA
174 RTS
175 ****
176 *
177 * TURN OFF THE DISK DRIVE *
178 *
179 ****
180 MWAIT LDA #$EF
181 STA WAIT
182 LDA #$D8
183 STA WAIT+1
184 MWAITA LDY #$12
185 MWAITB DEY
186 BNE MWAITB
187 INC WAIT
188 BNE MWAITA
189 INC WAIT+1
190 BNE MWAITA
191 RTS
192 ****
193 *
194 * AND QUIT *
195 *
196 ****
197 MWAIT LDA #$EF
198 STA WAIT
199 LDA #$D8
200 STA WAIT+1
201 MWAITA LDY #$12
202 MWAITB DEY
203 BNE MWAITB
204 INC WAIT
205 BNE MWAITA
206 INC WAIT+1
207 BNE MWAITA
208 RTS
209 ****
210 *
211 * TURN OFF THE DISK DRIVE *
212 *
213 ****
214 MWAIT LDA #$EF
215 STA WAIT
216 LDA #$D8
217 STA WAIT+1
218 MWAITA LDY #$12
219 MWAITB DEY
220 BNE MWAITB
221 INC WAIT
222 BNE MWAITA
223 INC WAIT+1
224 BNE MWAITA
225 RTS
226 ****
227 *
228 * AND QUIT *
229 *
230 ****
231 MWAIT LDA #$EF
232 STA WAIT
233 LDA #$D8
234 STA WAIT+1
235 MWAITA LDY #$12
236 MWAITB DEY
237 BNE MWAITB
238 INC WAIT
239 BNE MWAITA
240 INC WAIT+1
241 BNE MWAITA
242 RTS
243 ****
244 *
245 * TURN OFF THE DISK DRIVE *
246 *
247 ****
248 MWAIT LDA #$EF
249 STA WAIT
250 LDA #$D8
251 STA WAIT+1
252 MWAITA LDY #$12
253 MWAITB DEY
254 BNE MWAITB
255 INC WAIT
256 BNE MWAITA
257 INC WAIT+1
258 BNE MWAITA
259 RTS
260 ****
261 *
262 * AND QUIT *
263 *
264 ****
265 MWAIT LDA #$EF
266 STA WAIT
267 LDA #$D8
268 STA WAIT+1
269 MWAITA LDY #$12
270 MWAITB DEY
271 BNE MWAITB
272 INC WAIT
273 BNE MWAITA
274 INC WAIT+1
275 BNE MWAITA
276 RTS
277 ****
278 *
279 * TURN OFF THE DISK DRIVE *
280 *
281 ****
282 MWAIT LDA #$EF
283 STA WAIT
284 LDA #$D8
285 STA WAIT+1
286 MWAITA LDY #$12
287 MWAITB DEY
288 BNE MWAITB
289 INC WAIT
290 BNE MWAITA
291 INC WAIT+1
292 BNE MWAITA
293 RTS
294 ****
295 *
296 * AND QUIT *
297 *
298 ****
299 MWAIT LDA #$EF
300 STA WAIT
301 LDA #$D8
302 STA WAIT+1
303 MWAITA LDY #$12
304 MWAITB DEY
305 BNE MWAITB
306 INC WAIT
307 BNE MWAITA
308 INC WAIT+1
309 BNE MWAITA
310 RTS
311 ****
312 *
313 * TURN OFF THE DISK DRIVE *
314 *
315 ****
316 MWAIT LDA #$EF
317 STA WAIT
318 LDA #$D8
319 STA WAIT+1
320 MWAITA LDY #$12
321 MWAITB DEY
322 BNE MWAITB
323 INC WAIT
324 BNE MWAITA
325 INC WAIT+1
326 BNE MWAITA
327 RTS
328 ****
329 *
330 * AND QUIT *
331 *
332 ****
333 MWAIT LDA #$EF
334 STA WAIT
335 LDA #$D8
336 STA WAIT+1
337 MWAITA LDY #$12
338 MWAITB DEY
339 BNE MWAITB
340 INC WAIT
341 BNE MWAITA
342 INC WAIT+1
343 BNE MWAITA
344 RTS
345 ****
346 *
347 * TURN OFF THE DISK DRIVE *
348 *
349 ****
350 MWAIT LDA #$EF
351 STA WAIT
352 LDA #$D8
353 STA WAIT+1
354 MWAITA LDY #$12
355 MWAITB DEY
356 BNE MWAITB
357 INC WAIT
358 BNE MWAITA
359 INC WAIT+1
360 BNE MWAITA
361 RTS
362 ****
363 *
364 * AND QUIT *
365 *
366 ****
367 MWAIT LDA #$EF
368 STA WAIT
369 LDA #$D8
370 STA WAIT+1
371 MWAITA LDY #$12
372 MWAITB DEY
373 BNE MWAITB
374 INC WAIT
375 BNE MWAITA
376 INC WAIT+1
377 BNE MWAITA
378 RTS
379 ****
380 *
381 * TURN OFF THE DISK DRIVE *
382 *
383 ****
384 MWAIT LDA #$EF
385 STA WAIT
386 LDA #$D8
387 STA WAIT+1
388 MWAITA LDY #$12
389 MWAITB DEY
390 BNE MWAITB
391 INC WAIT
392 BNE MWAITA
393 INC WAIT+1
394 BNE MWAITA
395 RTS
396 ****
397 *
398 * AND QUIT *
399 *
400 ****
401 MWAIT LDA #$EF
402 STA WAIT
403 LDA #$D8
404 STA WAIT+1
405 MWAITA LDY #$12
406 MWAITB DEY
407 BNE MWAITB
408 INC WAIT
409 BNE MWAITA
410 INC WAIT+1
411 BNE MWAITA
412 RTS
413 ****
414 *
415 * TURN OFF THE DISK DRIVE *
416 *
417 ****
418 MWAIT LDA #$EF
419 STA WAIT
420 LDA #$D8
421 STA WAIT+1
422 MWAITA LDY #$12
423 MWAITB DEY
424 BNE MWAITB
425 INC WAIT
426 BNE MWAITA
427 INC WAIT+1
428 BNE MWAITA
429 RTS
430 ****
431 *
432 * AND QUIT *
433 *
434 ****
435 MWAIT LDA #$EF
436 STA WAIT
437 LDA #$D8
438 STA WAIT+1
439 MWAITA LDY #$12
440 MWAITB DEY
441 BNE MWAITB
442 INC WAIT
443 BNE MWAITA
444 INC WAIT+1
445 BNE MWAITA
446 RTS
447 ****
448 *
449 * TURN OFF THE DISK DRIVE *
450 *
451 ****
452 MWAIT LDA #$EF
453 STA WAIT
454 LDA #$D8
455 STA WAIT+1
456 MWAITA LDY #$12
457 MWAITB DEY
458 BNE MWAITB
459 INC WAIT
460 BNE MWAITA
461 INC WAIT+1
462 BNE MWAITA
463 RTS
464 ****
465 *
466 * AND QUIT *
467 *
468 ****
469 MWAIT LDA #$EF
470 STA WAIT
471 LDA #$D8
472 STA WAIT+1
473 MWAITA LDY #$12
474 MWAITB DEY
475 BNE MWAITB
476 INC WAIT
477 BNE MWAITA
478 INC WAIT+1
479 BNE MWAITA
480 RTS
481 ****
482 *
483 * TURN OFF THE DISK DRIVE *
484 *
485 ****
486 MWAIT LDA #$EF
487 STA WAIT
488 LDA #$D8
489 STA WAIT+1
490 MWAITA LDY #$12
491 MWAITB DEY
492 BNE MWAITB
493 INC WAIT
494 BNE MWAITA
495 INC WAIT+1
496 BNE MWAITA
497 RTS
498 ****
499 *
500 * AND QUIT *
501 *
502 ****
503 MWAIT LDA #$EF
504 STA WAIT
505 LDA #$D8
506 STA WAIT+1
507 MWAITA LDY #$12
508 MWAITB DEY
509 BNE MWAITB
510 INC WAIT
511 BNE MWAITA
512 INC WAIT+1
513 BNE MWAITA
514 RTS
515 ****
516 *
517 * TURN OFF THE DISK DRIVE *
518 *
519 ****
520 MWAIT LDA #$EF
521 STA WAIT
522 LDA #$D8
523 STA WAIT+1
524 MWAITA LDY #$12
525 MWAITB DEY
526 BNE MWAITB
527 INC WAIT
528 BNE MWAITA
529 INC WAIT+1
530 BNE MWAITA
531 RTS
532 ****
533 *
534 * AND QUIT *
535 *
536 ****
537 MWAIT LDA #$EF
538 STA WAIT
539 LDA #$D8
540 STA WAIT+1
541 MWAITA LDY #$12
542 MWAITB DEY
543 BNE MWAITB
544 INC WAIT
545 BNE MWAITA
546 INC WAIT+1
547 BNE MWAITA
548 RTS
549 ****
550 *
551 * TURN OFF THE DISK DRIVE *
552 *
553 ****
554 MWAIT LDA #$EF
555 STA WAIT
556 LDA #$D8
557 STA WAIT+1
558 MWAITA LDY #$12
559 MWAITB DEY
560 BNE MWAITB
561 INC WAIT
562 BNE MWAITA
563 INC WAIT+1
564 BNE MWAITA
565 RTS
566 ****
567 *
568 * AND QUIT *
569 *
570 ****
571 MWAIT LDA #$EF
572 STA WAIT
573 LDA #$D8
574 STA WAIT+1
575 MWAITA LDY #$12
576 MWAITB DEY
577 BNE MWAITB
578 INC WAIT
579 BNE MWAITA
580 INC WAIT+1
581 BNE MWAITA
582 RTS
583 ****
584 *
585 * TURN OFF THE DISK DRIVE *
586 *
587 ****
588 MWAIT LDA #$EF
589 STA WAIT
590 LDA #$D8
591 STA WAIT+1
592 MWAITA LDY #$12
593 MWAITB DEY
594 BNE MWAITB
595 INC WAIT
596 BNE MWAITA
597 INC WAIT+1
598 BNE MWAITA
599 RTS
600 ****
601 *
602 * AND QUIT *
603 *
604 ****
605 MWAIT LDA #$EF
606 STA WAIT
607 LDA #$D8
608 STA WAIT+1
609 MWAITA LDY #$12
610 MWAITB DEY
611 BNE MWAITB
612 INC WAIT
613 BNE MWAITA
614 INC WAIT+1
615 BNE MWAITA
616 RTS
617 ****
618 *
619 * TURN OFF THE DISK DRIVE *
620 *
621 ****
622 MWAIT LDA #$EF
623 STA WAIT
624 LDA #$D8
625 STA WAIT+1
626 MWAITA LDY #$12
627 MWAITB DEY
628 BNE MWAITB
629 INC WAIT
630 BNE MWAITA
631 INC WAIT+1
632 BNE MWAITA
633 RTS
634 ****
635 *
636 * AND QUIT *
637 *
638 ****
639 MWAIT LDA #$EF
640 STA WAIT
641 LDA #$D8
642 STA WAIT+1
643 MWAITA LDY #$12
644 MWAITB DEY
645 BNE MWAITB
646 INC WAIT
647 BNE MWAITA
648 INC WAIT+1
649 BNE MWAITA
650 RTS
651 ****
652 *
653 * TURN OFF THE DISK DRIVE *
654 *
655 ****
656 MWAIT LDA #$EF
657 STA WAIT
658 LDA #$D8
659 STA WAIT+1
660 MWAITA LDY #$12
661 MWAITB DEY
662 BNE MWAITB
663 INC WAIT
664 BNE MWAITA
665 INC WAIT+1
666 BNE MWAITA
667 RTS
668 ****
669 *
670 * AND QUIT *
671 *
672 ****
673 MWAIT LDA #$EF
674 STA WAIT
675 LDA #$D8
676 STA WAIT+1
677 MWAITA LDY #$12
678 MWAITB DEY
679 BNE MWAITB
680 INC WAIT
681 BNE MWAITA
682 INC WAIT+1
683 BNE MWAITA
684 RTS
685 ****
686 *
687 * TURN OFF THE DISK DRIVE *
688 *
689 ****
690 MWAIT LDA #$EF
691 STA WAIT
692 LDA #$D8
693 STA WAIT+1
694 MWAITA LDY #$12
695 MWAITB DEY
696 BNE MWAITB
697 INC WAIT
698 BNE MWAITA
699 INC WAIT+1
700 BNE MWAITA
701 RTS
702 ****
703 *
704 * AND QUIT *
705 *
706 ****
707 MWAIT LDA #$EF
708 STA WAIT
709 LDA #$D8
710 STA WAIT+1
711 MWAITA LDY #$12
712 MWAITB DEY
713 BNE MWAITB
714 INC WAIT
715 BNE MWAITA
716 INC WAIT+1
717 BNE MWAITA
718 RTS
719 ****
720 *
721 * TURN OFF THE DISK DRIVE *
722 *
723 ****
724 MWAIT LDA #$EF
725 STA WAIT
726 LDA #$D8
727 STA WAIT+1
728 MWAITA LDY #$12
729 MWAITB DEY
730 BNE MWAITB
731 INC WAIT
732 BNE MWAITA
733 INC WAIT+1
734 BNE MWAITA
735 RTS
736 ****
737 *
738 * AND QUIT *
739 *
740 ****
741 MWAIT LDA #$EF
742 STA WAIT
743 LDA #$D8
744 STA WAIT+1
745 MWAITA LDY #$12
746 MWAITB DEY
747 BNE MWAITB
748 INC WAIT
749 BNE MWAITA
750 INC WAIT+1
751 BNE MWAITA
752 RTS
753 ****
754 *
755 * TURN OFF THE DISK DRIVE *
756 *
757 ****
758 MWAIT LDA #$EF
759 STA WAIT
760 LDA #$D8
761 STA WAIT+1
762 MWAITA LDY #$12
763 MWAITB DEY
764 BNE MWAITB
765 INC WAIT
766 BNE MWAITA
767 INC WAIT+1
768 BNE MWAITA
769 RTS
770 ****
771 *
772 * AND QUIT *
773 *
774 ****
775 MWAIT LDA #$EF
776 STA WAIT
777 LDA #$D8
778 STA WAIT+1
779 MWAITA LDY #$12
780 MWAITB DEY
781 BNE MWAITB
782 INC WAIT
783 BNE MWAITA
784 INC WAIT+1
785 BNE MWAITA
786 RTS
787 ****
788 *
789 * TURN OFF THE DISK DRIVE *
790 *
791 ****
792 MWAIT LDA #$EF
793 STA WAIT
794 LDA #$D8
795 STA WAIT+1
796 MWAITA LDY #$12
797 MWAITB DEY
798 BNE MWAITB
799 INC WAIT
800 BNE MWAITA
801 INC WAIT+1
802 BNE MWAITA
803 RTS
804 ****
805 *
806 * AND QUIT *
807 *
808 ****
809 MWAIT LDA #$EF
810 STA WAIT
811 LDA #$D8
812 STA WAIT+1
813 MWAITA LDY #$12
814 MWAITB DEY
815 BNE MWAITB
816 INC WAIT
817 BNE MWAITA
818 INC WAIT+1
819 BNE MWAITA
820 RTS
821 ****
822 *
823 * TURN OFF THE DISK DRIVE *
824 *
825 ****
826 MWAIT LDA #$EF
827 STA WAIT
828 LDA #$D8
829 STA WAIT+1
830 MWAITA LDY #$12
831 MWAITB DEY
832 BNE MWAITB
833 INC WAIT
834 BNE MWAITA
835 INC WAIT+1
836 BNE MWAITA
837 RTS
838 ****
839 *
840 * AND QUIT *
841 *
842 ****
843 MWAIT LDA #$EF
844 STA WAIT
845 LDA #$D8
846 STA WAIT+1
847 MWAITA LDY #$12
848 MWAITB DEY
849 BNE MWAITB
850 INC WAIT
851 BNE MWAITA
852 INC WAIT+1
853 BNE MWAITA
854 RTS
855 ****
856 *
857 * TURN OFF THE DISK DRIVE *
858 *
859 ****
860 MWAIT LDA #$EF
861 STA WAIT
862 LDA #$D8
863 STA WAIT+1
864 MWAITA LDY #$12
865 MWAITB DEY
866 BNE MWAITB
867 INC WAIT
868 BNE MWAITA
869 INC WAIT+1
870 BNE MWAITA
871 RTS
872 ****
873 *
874 * AND QUIT *
875 *
876 ****
877 MWAIT LDA #$EF
878 STA WAIT
879 LDA #$D8
880 STA WAIT+1
881 MWAITA LDY #$12
882 MWAITB DEY
883 BNE MWAITB
884 INC WAIT
885 BNE MWAITA
886 INC WAIT+1
887 BNE MWAITA
888 RTS
889 ****
890 *
891 * TURN OFF THE DISK DRIVE *
892 *
893 ****
894 MWAIT LDA #$EF
895 STA WAIT
896 LDA #$D8
897 STA WAIT+1
898 MWAITA LDY #$12
899 MWAITB DEY
900 BNE MWAITB
901 INC WAIT
902 BNE MWAITA
903 INC WAIT+1
904 BNE MWAITA
905 RTS
906 ****
907 *
908 * AND QUIT *
909 *
910 ****
911 MWAIT LDA #$EF
912 STA WAIT
913 LDA #$D8
914 STA WAIT+1
915 MWAITA LDY #$12
916 MWAITB DEY
917 BNE MWAITB
918 INC WAIT
919 BNE MWAITA
920 INC WAIT+1
921 BNE MWAITA
922 RTS
923 ****
924 *
925 * TURN OFF THE DISK DRIVE *
926 *
927 ****
928 MWAIT LDA #$EF
929 STA WAIT
930 LDA #$D8
931 STA WAIT+1
932 MWAITA LDY #$12
933 MWAITB DEY
934 BNE MWAITB
935 INC WAIT
936 BNE MWAITA
937 INC WAIT+1
938 BNE MWAITA
939 RTS
940 ****
941 *
942 * AND QUIT *
943 *
944 ****
945 MWAIT LDA #$EF
946 STA WAIT
947 LDA #$D8
948 STA WAIT+1
949 MWAITA LDY #$12
950 MWAITB DEY
951 BNE MWAITB
952 INC WAIT
953 BNE MWAITA
954 INC WAIT+1
955 BNE MWAITA
956 RTS
957 ****
958 *
959 * TURN OFF THE DISK DRIVE *
960 *
961 ****
962 MWAIT LDA #$EF
963 STA WAIT
964 LDA #$D8
965 STA WAIT+1
966 MWAITA LDY #$12
967 MWAITB DEY
968 BNE MWAITB
969 INC WAIT
970 BNE MWAITA
971 INC WAIT+1
972 BNE MWAITA
973 RTS
974 ****
975 *
976 * AND QUIT *
977 *
978 ****
979 MWAIT LDA #$EF
980 STA WAIT
981 LDA #$D8
982 STA WAIT+1
983 MWAITA LDY #$12
984 MWAITB DEY
985 BNE MWAITB
986 INC WAIT
987 BNE MWAITA
988 INC WAIT+1
989 BNE MWAITA
990 RTS
991 ****
992 *
993 * TURN OFF THE DISK DRIVE *
994 *
995 ****
996 MWAIT LDA #$EF
997 STA WAIT
998 LDA #$D8
999 STA WAIT+1
1000 MWAITA LDY #$12
1001 MWAITB DEY
1002 BNE MWAITB
1003 INC WAIT
1004 BNE MWAITA
1005 INC WAIT+1
1006 BNE MWAITA
1007 RTS
1008 ****
1009 *
1010 * AND QUIT *
1011 *
1012 ****
1013 MWAIT LDA #$EF
1014 STA WAIT
1015 LDA #$D8
1016 STA WAIT+1
1017 MWAITA LDY #$12
1018 MWAITB DEY
1019 BNE MWAITB
1020 INC WAIT
1021 BNE MWAITA
1022 INC WAIT+1
1023 BNE MWAITA
1024 RTS
1025 ****
1026 *
1027 * TURN OFF THE DISK DRIVE *
1028 *
1029 ****
1030 MWAIT LDA #$EF
1031 STA WAIT
1032 LDA #$D8
1033 STA WAIT+1
1034 MWAITA LDY #$12
1035 MWAITB DEY
1036 BNE MWAITB
1037 INC WAIT
1038 BNE MWAITA
1039 INC WAIT+1
1040 BNE MWAITA
1041 RTS
1042 ****
1043 *
1044 * AND QUIT *
1045 *
1046 ****
1047 MWAIT LDA #$EF
1048 STA WAIT
1049 LDA #$D8
1050 STA WAIT+1
1051 MWAITA LDY #$12
1052 MWAITB DEY
1053 BNE MWAITB
1054 INC WAIT
1055 BNE MWAITA
1056 INC WAIT+1
1057 BNE MWAITA
1058 RTS
1059 ****
1060 *
1061 * TURN OFF THE DISK DRIVE *
1062 *
1063 ****
1064 MWAIT LDA #$EF
1065 STA WAIT
1066 LDA #$D8
1067 STA WAIT+1
1068 MWAITA LDY #$12
1069 MWAITB DEY
1070 BNE MWAITB
1071 INC WAIT
1072 BNE MWAITA
1073 INC WAIT+1
1074 BNE MWAITA
1075 RTS
1076 ****
1077 *
1078 * AND QUIT *
1079 *
1080 ****
1081 MWAIT LDA #$EF
1082 STA WAIT
1083 LDA #$D8
1084 STA WAIT+1
1085 MWAITA LDY #$12
1086 MWAITB DEY
1087 BNE MWAITB
1088 INC WAIT
1089 BNE MWAITA
1090 INC WAIT+1
1091 BNE MWAITA
1092 RTS
1093 ****
1094 *
1095 * TURN OFF THE DISK DRIVE *
1096 *
1097 ****
1098 MWAIT LDA #$EF
1099 STA WAIT
1100 LDA #$D8
1101 STA WAIT+1
1102 MWAITA LDY #$12
1103 MWAITB DEY
1104 BNE MWAITB
1105 INC WAIT
1106 BNE MWAITA
1107 INC WAIT+1
1108 BNE MWAITA
1109 RTS
1110 ****
1111 *
1112 * AND QUIT *
1113 *
1114 ****
1115 MWAIT LDA #$EF
1116 STA WAIT
1117 LDA #$D8
1118 STA WAIT+1
1119 MWAITA LDY #$12
1120 MWAITB DEY
1121 BNE MWAITB
1122 INC WAIT
1123 BNE MWAITA
1124 INC WAIT+1
1125 BNE MWAITA
1126 RTS
1127 ****
1128 *
1129 * TURN OFF THE DISK DRIVE *
1130 *
1131 ****
1132 MWAIT LDA #$EF
1133 STA WAIT
1134 LDA #$D8
1135 STA WAIT+1
1136 MWAITA LDY #$12
1137 MWAITB DEY
1138 BNE MWAITB
1139 INC WAIT
1140 BNE MWAITA
1141 INC WAIT+1
1142 BNE MWAITA
1143 RTS
1144 ****
1145 *
1146 * AND QUIT *
1147 *
1148 ****
1149 MWAIT LDA #$EF
1150 STA WAIT
1151 LDA #$D8
1152 STA WAIT+1
1153 MWAITA LDY #$12
1154 MWAITB DEY
1155 BNE MWAITB
1156 INC WAIT
1157 BNE MWAITA
1158 INC WAIT+1
1159 BNE MWAITA
1160 RTS
1161 ****
1162 *
1163 * TURN OFF THE DISK DRIVE *
1164 *
1165 ****
1166 MWAIT LDA #$EF
1167 STA WAIT
1168 LDA #$D8
1169 STA WAIT+1
1170 MWAITA LDY #$12
1171 MWAITB DEY
1172 BNE MWAITB
1173 INC WAIT
1174 BNE MWAITA
1175 INC WAIT+1
1176 BNE MWAITA
1177 RTS
1178 ****
1179 *
1180 * AND QUIT *
1181 *
1182 ****
1183 MWAIT LDA #$EF
1184 STA WAIT
1185 LDA #$D8
1186 STA WAIT+1
1187 MWAITA LDY #$12
1188 MWAITB DEY
1189 BNE MWAITB
1190 INC WAIT
1191 BNE MWAITA
1192 INC WAIT+1
1193 BNE MWAITA
1194 RTS
1195 ****
1196 *
1197 * TURN OFF THE DISK DRIVE *
1198 *
1199 ****
1200 MWAIT LDA #$EF
1201 STA WAIT
1202 LDA #$D8
1203 STA WAIT+1
1204 MWAITA LDY #$12
1205 MWAITB DEY
1206 BNE MWAITB
1207 INC WAIT
1208 BNE MWAITA
1209 INC WAIT+1
1210 BNE MWAITA
1211 RTS
1212 ****
1213 *
1214 * AND QUIT *
1215 *
1216 ****
1217 MWAIT LDA #$EF
1218 STA WAIT
1219 LDA #$D8
1220 STA WAIT+1
1221 MWAITA LDY #$12
1222 MWAITB DEY
1223 BNE MWAITB
1224 INC WAIT
1225 BNE MWAITA
1226 INC WAIT+1
1227 BNE MWAITA
1228 RTS
1229 ****
1230 *
1231 * TURN OFF THE DISK DRIVE *
1232 *
1233 ****
1234 MWAIT LDA #$EF
1235 STA WAIT
1236 LDA #$D8
1237 STA WAIT+1
1238 MWAITA LDY #$12
1239 MWAITB DEY
1240 BNE MWAITB
1241 INC WAIT
1242 BNE MWAITA
1243 INC WAIT+1
1244 BNE MWAITA
1245 RTS
1246 ****
1247 *
1248 * AND QUIT *
1249 *
1250 ****
1251 MWAIT LDA #$EF
1252 STA WAIT
1253 LDA #$D8
1254 STA WAIT+1
1255 MWAITA LDY #$12
1256 MWAITB DEY
1257 BNE MWAITB
1258 INC WAIT
1259 BNE MWAITA
1260 INC WAIT+1
1261 BNE MWAITA
1262 RTS
1263 ****
1264 *
1265 * TURN OFF THE DISK DRIVE *
1266 *
1267 ****
1268 MWAIT LDA #$EF
1269 STA WAIT
1270 LDA #$D8
1271 STA WAIT+1
1272 MWAITA LDY #$12
1273 MWAITB DEY
1274 BNE MWAITB
1275 INC WAIT
1276 BNE MWAITA
1277 INC WAIT+1
1278 BNE MWAITA
1279 RTS
1280 ****
1281 *
1282 * AND QUIT *
1283 *
1284 ****
1285 MWAIT LDA #$EF
1286 STA WAIT
1287 LDA #$D8
1288 STA WAIT+1
1289 MWAITA LDY #$12
1290 MWAITB DEY
1291 BNE MWAITB
1292 INC WAIT
1293 BNE MWAITA
1294 INC WAIT+1
1295 BNE MWAITA
1296 RTS
1297 ****
1298 *
1299 * TURN OFF THE DISK DRIVE *
1300 *
1301 ****
1302 MWAIT LDA #$EF
1303 STA WAIT
1304 LDA #$D8
1305 STA WAIT+1
1306 MWAITA LDY #$12
1307 MWAITB DEY
1308 BNE MWAITB
1309 INC WAIT
1310 BNE MWAITA
1311 INC WAIT+1
1312 BNE MWAITA
1313 RTS
1314 ****
1315 *
1316 * AND QUIT *
1317 *
1318 ****
1319 MWAIT LDA #$EF
1320 STA WAIT
1321 LDA #$D8
1322 STA WAIT+1
1323 MWAITA LDY #$12
1324 MWAITB DEY
1325 BNE MWAITB
1326 INC WAIT
1327 BNE MWAITA
1328 INC WAIT+1
1329 BNE MWAITA
1330 RTS
1331 ****
1332 *
1333 * TURN OFF THE DISK DRIVE *
1334 *
1335 ****
1336 MWAIT LDA #$EF
1337 STA WAIT
1338 LDA #$D8
1339 STA WAIT+1
1340 MWAITA LDY #$12
1341 MWAITB DEY
1342 BNE MWAITB
1343 INC WAIT
1344 BNE MWAITA
1345 INC WAIT+1
1346 BNE MWAITA
1347 RTS
1348 ****
1349 *
1350 * AND QUIT *
1351 *
1352 ****
1353 MWAIT LDA #$EF
1354 STA WAIT
1355 LDA #$D8
1356 STA WAIT+1
1357 MWAITA LDY #$12
1358 MWAITB DEY
1359 BNE MWAITB
1360 INC WAIT
1361 BNE MWAITA
1362 INC WAIT+1
1363 BNE MWAITA
1364 RTS
1365 ****
1366 *
1367 * TURN OFF THE DISK DRIVE *
1368 *
1369 ****
1370 MWAIT LDA #$EF
1371 STA WAIT
1372 LDA #$D8
1373 STA WAIT+1
1374 MWAITA LDY #$12
1375 MWAITB DEY
1376 BNE MWAITB
1377 INC WAIT
1378 BNE MWAITA
1379 INC WAIT+1
1380 BNE MWAITA
1381 RTS
1382 ****
1383 *
1384 * AND QUIT *
1385 *
1386 ****
1387 MWAIT LDA #$EF
1388 STA WAIT
1389 LDA #$D8
1390 STA WAIT+1
1391 MWAITA LDY #$12
1392 MWAITB DEY
1393 BNE MWAITB
1394 INC WAIT
1395 BNE MWAITA
1396 INC WAIT+1
1397 BNE MWAITA
1398 RTS
1399 ****
1400 *
1401 * TURN OFF THE DISK DRIVE *
1402 *
1403 ****
1404 MWAIT LDA #$EF
1405 STA WAIT
1406 LDA #$D8
1407 STA WAIT+1
1408 MWAITA LDY #$12
1409 MWAITB DEY
1410 BNE MWAITB
1411 INC WAIT
1412 BNE MWAITA
1413 INC WAIT+1
1414 BNE MWAITA
1415 RTS
1416 ****
1417 *
1418 * AND QUIT *
1419 *
1420 ****
1421 MWAIT LDA #$EF
1422 STA WAIT
1423 LDA #$D8
1424 STA WAIT+1
1425 MWAITA LDY #$12
1426 MWAITB DEY
1427 BNE MWAITB
1428 INC WAIT
1429 BNE MWAITA
1430 INC WAIT+1
1431 BNE MWAITA
1432 RTS
1433 ****
1434 *
1435 * TURN OFF THE DISK DRIVE *
1436 *
1437 ****
1438 MWAIT LDA #$EF
1439 STA WAIT
1440 LDA #$D8
1441 STA WAIT+1
1442 MWAITA LDY #$12
1443 MWAITB DEY
1444 BNE MWAITB
1445 INC WAIT
1446 BNE MWAITA
1447 INC WAIT+1
1448 BNE
```

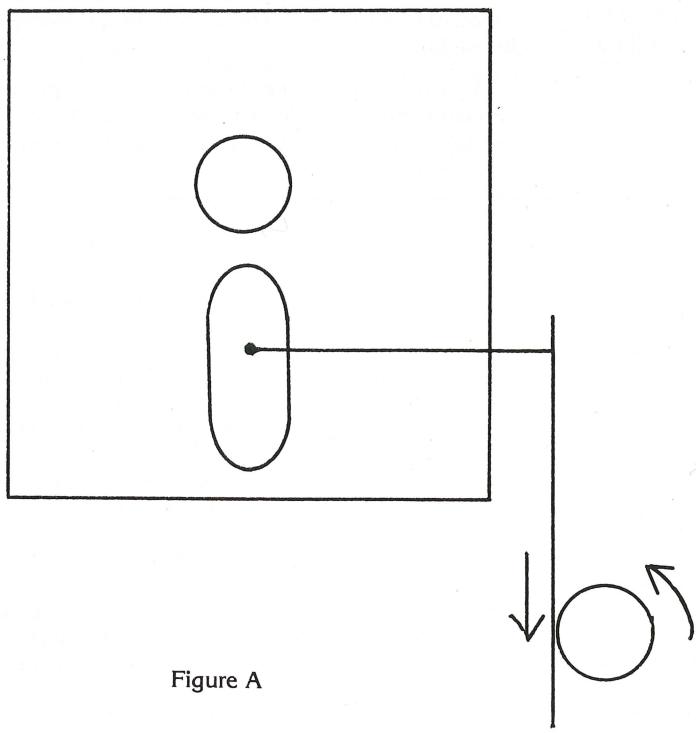


Figure A

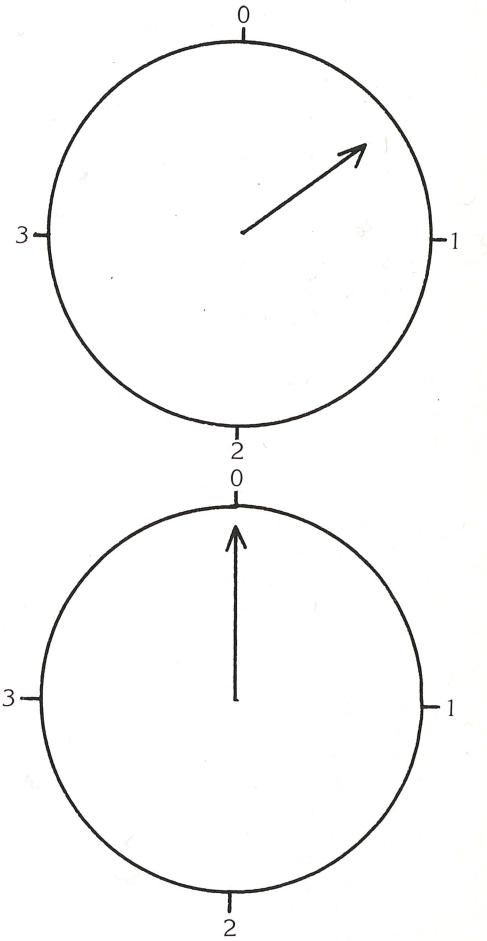


Figure C

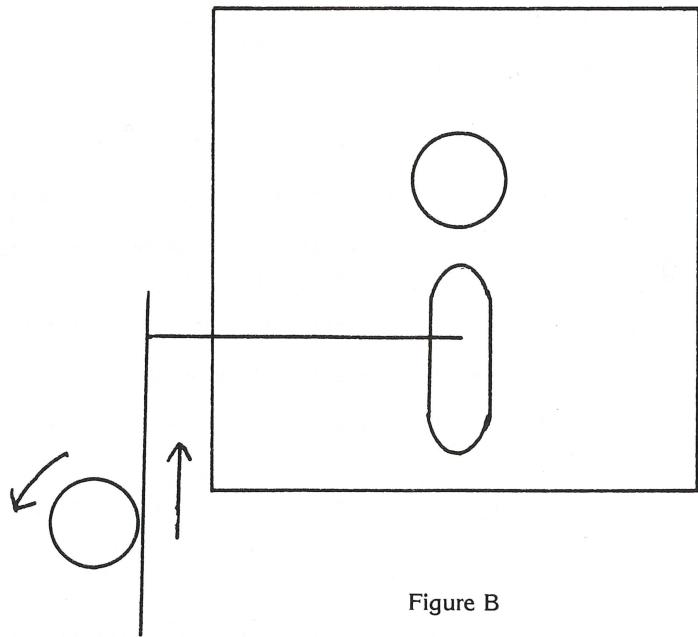


Figure B

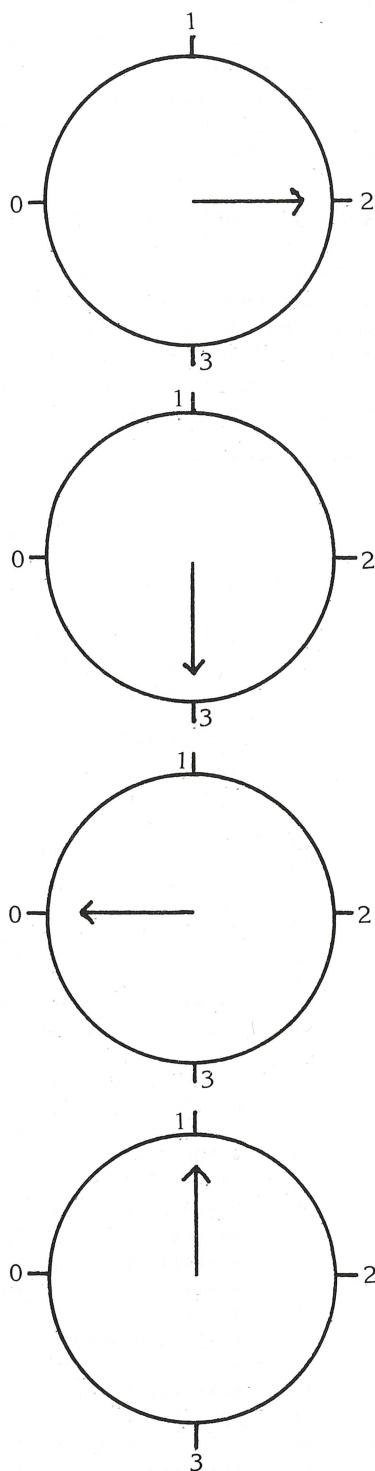


Figure D

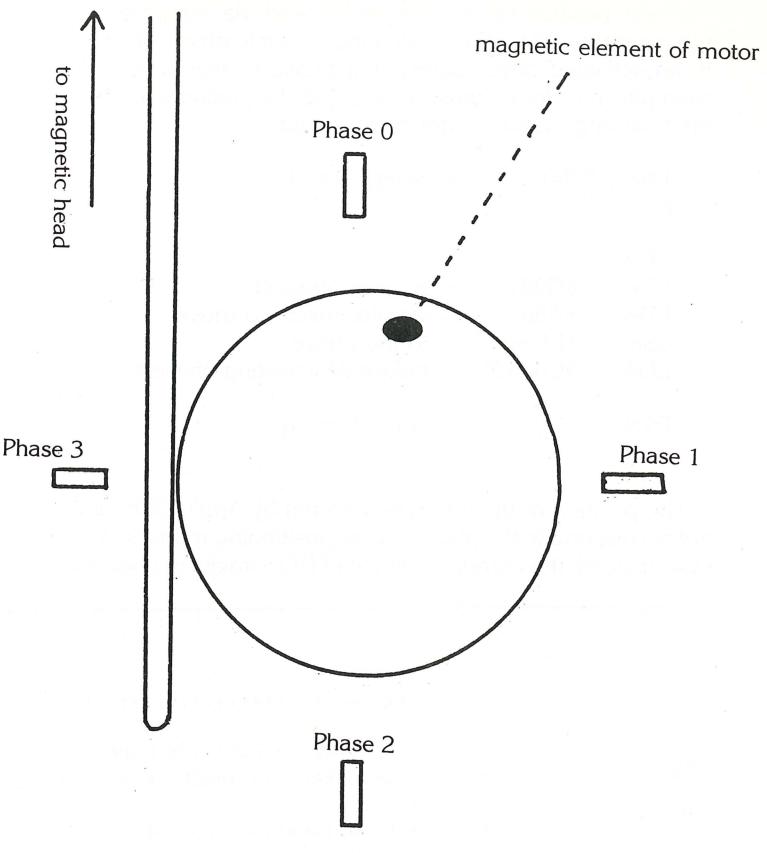


Figure E

Each of the eight softswitches used in positioning the magnetic head actually activates or deactivates a specific phase of the positioning motor. By addressing these softswitches in a specific order the motor can be rotated and the magnetic head positioned back and forth along the surface of a diskette.

The following table illustrates the function of each of the eight 'positioning' softswitches. Note that SLOT refers to the index value needed to access the softswitches of a given slot.

MEMORY LOCATION	PHASE	FUNCTION
\$C080 + SLOT	0	Turn phase 0 off
\$C081 + SLOT	0	Turn phase 0 on
\$C082 + SLOT	1	Turn phase 1 off
\$C083 + SLOT	1	Turn phase 1 on
\$C084 + SLOT	2	Turn phase 2 off
\$C085 + SLOT	2	Turn phase 2 on
\$C086 + SLOT	3	Turn phase 3 off
\$C087 + SLOT	3	Turn phase 3 on

When positioning the magnetic head via software, it is necessary to wait for the positioning motor to physically move to an activated phase before that phase is deactivated. For example, in order to 'pulse' phase 0 of the positioning motor the following routine might be executed.

```
LSX    #$60      ; (select slot 6)
:
LDA
LDA    $C081,X   ; turn on phase 0
LDA    #$56       ; wait for motor to move
JSR    $FCA8     ; to the phase
LDA    $C080,X   ; before deactivating phase 0
:
RTS              ; and returning
```

The position of the tracks recognized by Apple DOS does not correspond to the phases of the positioning motor in a 1:1 ratio. Instead, the correspondence of DOS tracks to phases is

in the ratio of 1:2. All even numbered tracks are positioned "under" phase 0 and all odd numbered tracks are positioned "under" phase 2. When positioned on phases 1 or 3 the disk drive's magnetic head is positioned over a half-track (much like a car driving in two lanes). Half-tracks are not used by Apple DOS although some protected software makes use of them.

The phase to which a DOS track corresponds can be calculated by multiplying the DOS track number by two (using the ASL opcode). This value represents the number of phases that must be pulsed from phase 0 (of track zero) in order to reach the specified DOS track.

The following routine can be used to position the disk drive's magnetic head over any physical track of a diskette. All DOS track numbers must be multiplied by two to account for the unused phases (half-tracks). Access to half tracks can be accomplished by setting the least significant bit of the multiplied track number to 1. If you don't know the current track number you must recalibrate the magnetic head to track zero using the "RECAL" routine provided.

```

1 ****  

2 *  

3 * ROUTINE TO POSITION FROM *  

4 * ANY TRACK TO TRACK ZERO *  

5 *  

6 * RECALIBRATION ROUTINE *  

7 *  

8 *****  

9 CURTRK EQU $0004  

10 DESTRK EQU $0005  

11 POSITION EQU $0800  

12 *****  

13 *  

14 * SET UP "CURTRK" & "DESTRK" *  

15 * FOR THE RECALIBRATION *  

16 *  

17 *****  

2000: A9 80 18 RECAL LDA #\$80  

2002: B5 04 19 STA CURTRK  

2004: A9 00 20 LDA #\$00  

2006: B5 05 21 STA DESTRK  

2008: 4C 00 08 33 JMP POSITION

--- END ASSEMBLY ---

TOTAL ERRORS: 00

11 BYTES OF OBJECT CODE
WERE GENERATED THIS ASSEMBLY.

```

```

1 *****  

2 *  

3 * ROUTINE TO PORTTTON FROM  

4 * "CURTRK" TO "DESTRK"  

5 *  

6 *  

7 * REMEMBER!!! CURTRK AND  

8 * DESTRK REFER  

9 * TO PHASES...  

10 * ACTUAL DOS  

11 * TRACKS MUST  

12 * BE MULTIPLIED  

13 * BY TWO BEFORE  

14 * USE IN THIS  

15 * ROUTINE  

16 *  

17 *****  

18 SLOT EQU $0001  

19 WAIT EQU $0002  

20 CURTRK EQU $0004  

21 DESTRK EQU $0005  

22 PHSOFF EQU $0080  

23 PHSON EQU $C081  

24 DTISKON EQU $C089  

25 DISKOFF EQU $C088  

26 DRIVEA EQU $C08A  

27 MONWAIT EQU $FCA8  

28 *****  

29 *  

30 * SET SLOT EQUAL TO SLOT 6  

31 *  

32 *****  

33 POSITION LDA #$60  

34 STA SLOT  

35 *****  

36 *  

37 * TURN ON DRIVE A AND WAIT  

38 *  

39 *****

```

```

7004: A6 01 40      LDX   SLOT          103 *****
7006: BD 89 C0 41      LDA   DISKON,X    104 *
7009: BD 8A C0 42      LDA   DRIVEA,X    105 * TURN OFF PHASE (ALWAYS) & *
700C: A9 EF 43      LDA   #$EF        106 * LOOP BACK TO CHECK ON NEW *
700E: 85 02 44      STA   WAIT         107 * CURTRK-DESTRK RELATIONSHIP *
7010: A9 D8 45      LDA   #$D8        108 *
7012: 85 03 46      STA   WAIT+1     109 *****
7014: A0 12 47      MWAITA LDY   #$12        2042: B9 80 C0 110      LDA   PHSOFF,Y
7016: 88 48      MWAITB DEY           2043: 40 21 70 111      JMP   MAINLOOP
7017: D0 F0 49      BNE   MWAITB      112 *****
7019: E6 02 50      INC   WAIT         113 *
701B: D0 F2 51      BNE   MWAITA      114 * ALL DONE... QUIT
701D: E6 03 52      INC   WAIT+1     115 *
701F: D0 F3 53      BNE   MWAITA      116 *****
54 *****
55 *
56 * CHECK & BRANCH ON CURTRK-*
57 * DESTRK RELATIONSHIP *
58 *
59 *****
7021: A5 04 60      MAINLOOP LDA   CURTRK
7023: C5 05 61      CMP   DESTRK
7025: F0 21 62      BEQ   ALLDONE
7027: 90 07 63      BCC   MOVEUP
7029: B0 00 64      BCS   MOVEDOWN
65 *****
66 *
67 * MOVE DOWN TO LAST PHASE *
68 *
69 *****
702B: C6 04 70      MOVEDOWN DEC   CURTRK
702D: 4C 32 70 71      JMP   DOWORK
72 *****
73 *
74 * MOVE UP TO NEXT PHASE *
75 *
76 *****
7030: E6 04 77      MOVEUP INC   CURTRK
78 *****
79 *
80 * COMPUTE PHASE NUMBER *
81 * FROM THE "NEW" CURTRK *
82 *
83 *****
7032: A5 04 84      DOWORK LDA   CURTRK
7034: 29 03 85      AND   #$03 ;0-3 PHS
7036: 0A 86      ASL   ;$0-$7
87 *****
88 *
89 * GET INDEXING FOR CUR SLOT# *
90 *
91 *****
7037: 05 01 92      ORA   SLOT
7039: A8 93      TAY
94 *****
95 *
96 * TURN ON PHASE TO MOVE & *
97 * WAIT FOR PHYSICAL ACTION *
98 *
99 *****
703A: B9 81 C0 100     LDA   PHSOFF,Y
703D: A9 56 101      LDA   #$56
703F: 20 AB FC 102     JSR   MONWAIT

```

--- END ASSEMBLY ---

TOTAL ERRORS: 00

78 BYTES OF OBJECT CODE
WERE GENERATED THIS ASSEMBLY.

YOU'LL HAVE MORE FUN WHEN YOU PLAY BY THE BOOK

THE SURVIVAL KIT FOR APPLE COMPUTER GAMES is the **only** book that gives you the play-by-play on two dozen of the most exciting home computer games. Covering games in four categories—Adventure, Arcade, Fantasy, and Strategy—the book's not too sophisticated for beginners, yet packed with plenty of challenges for avowed computer game freaks. For each game you'll find detailed, fun-to-read descriptions, winning strategies, tips from experts, and a quality rating. All the games run on an Apple and hardware specs tell you at a glance what other machines can be used (many games run on the Atari 400 or 800, the TRS-80, and the IBM PC).



Registered trademarks: Apple—Apple Computer, Inc. ■ Atari—Atari, Inc. ■ TRS-80—Tandy Corporation/Radio Shack ■ IBM—International Business Machines Inc.

WADSWORTH ELECTRONIC PUBLISHING COMPANY

Stater Office Building • 20 Park Plaza • Boston, Massachusetts 02116

TOLL FREE

1-800-322-2208

ALL ORDERS MUST BE PREPAID AND SHOULD BE SENT TO: WADSWORTH ELECTRONIC PUBLISHING CO., Stater Office Building, 20 Park Plaza, Boston, MA 02116. **Postage and handling will be paid by the publisher.**

YES, I want to have more fun playing home computer games! Please send me:

copies of THE SURVIVAL KIT FOR APPLE COMPUTER GAMES @ \$9.95

MA residents please add sales tax \$
AO TOTAL \$

Enclosed is my check. Please charge my VISA MasterCard
Card # Exp Date
Name
Address
City State Zip
Signature for Credit Card
For credit card orders you can also call **TOLL FREE 1-800-322-2208**

THE SURVIVAL KIT FOR APPLE COMPUTER GAMES is also available at your local computer dealer. If not, have them contact Wadsworth Electronic Publishing Company.