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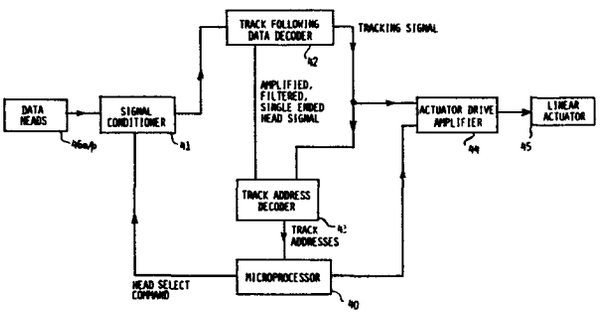
(54) Apparatus for controlling the movement of the data head in a moving-head data recording system.

(57) Two servoing functions, both operating from the data reading and recording transducer, are performed in a high performance movinghead disc drive. One servo rapidly moves the head from its current track to any other track utilizing absolute track identifying addresses recorded in the inter-sector gap between data sectors. Once located on a track, the other servo maintains head location precisely over the center of that track while data is being read or recorded employing track following information also recorded in the inter-sector gap. The resolution of transducer location is enhanced by secondary use of the track following information.



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In a typical prior art moving-head disc drive, the data reading and recording transducer, hereinafter referred to as the data head or head, is moved from one track to another under servo control to ensure that the data head will stop directly over the target track (e.g. US patent 35 34 344). Given practical acceleration limitations, the data head carrier or actuator is typically accelerated at the maximum level possible until half the total distance has been traveled, then decelerated until it is stopped over the target track. An open-loop head position system is impractical because electrical and mechanical perturbations will result in over-shoot and under-shoot of the target track.

The acceleration, velocity and position profiles of such a conventional system are shown in Figure 1. Combining the velocity and position curves, it is clear that the velocity at any instant in time is proportional to the square root of the distance yet to be traveled. Such proportionality is the principle of many conventional track locating servos such as the one shown in Figure 2. Such servos typically include one register for containing the target track information and another for containing current track location, the latter being updated as the head moves. Update information is obtained by counting track crossings from a glass encoder or dedicated, continuous servo surface. The informational difference between these two registers represents the distance yet to be traveled and is converted to an analog voltage which is proportional to the distance to the target track. The desired velocity of the carrier is obtained by taking the square root of the analog voltage which is then compared to the actual velocity to derive a current proportional to the difference between the two velocities for driving the motor.

For the conventional track locating system diagrammed in Figure 2, the position transducer is a pulse generator which produces a pulse to increment or decrement the up/down counter (or current

track register) whenever a track center is crossed. Track centers are obtained by detecting lines on a glass encoder attached to the structure for moving the head, or by detecting specially written tracks on a dedicated surface of the disc pack which is read by a separate servo head. However, such systems require a dedicated servo surface or position transducers other than the data head itself. Moreover, such systems define the relative position of the servo head to servo track, not of the data head to data track. Other prior art systems use encoders on the head carriage. In addition to expense, however, encoder systems define the relative position of the casting to head carriage, not of the data head to data track.

The system shown in U.S. Patent 3 924 268 is typical of more recent prior art moving head disc track locating systems. It describes a system, having track following information recorded in the inter-sector gap between data sectors and read by the data head, which is dependent on sensing the velocity of the transducer carriages while moving to another track. In this case there is a primary and a low-mass secondary carriage for supporting and translating the data head. The position of transducer carriages is determined with respect to a reference plane by servo circuitry which includes a register for storing a commanded track position, a counter which is incremented or decremented relative to the reference plane as the transducer moves across data tracks and a comparator for comparing the contents of the counter and register. The low-mass secondary carriage to which the head is actually coupled, is used for fast response movement to follow, for example, the radial runout of the track, such movement typically being limited to a single track width.

Conventional track following systems, such as the one shown in Figure 3, employ rate and position feedback in a continuous null-seeking analog servo system. The rate information is obtained from a velocity transducer, and the position information from one of several possible transducers.

Position transducers may consist of an optical or magnetic encoder attached to the same moving structure as the head, or a separate head which reads magnetic transitions on the surface of the disc pack dedicated to servo information (servo surface). A continuous, linear voltage-versus-distance signal (with zero volts at track center) is derived from the encoder or separate head output.

In most prior art track following systems, the object is to center a data head over a data track based on reference information derived from servo data written on another servo surface. Thus, these systems depend on the stability, fidelity and integrity of the mechanical linkages between the reference- and data tracks for assuring that the data head are over data track centers. Such mechanical linkages are inadequate at best owing to misalignments, uncompensated temperature coefficients and spindle runout.

A track locating servo constructed according to the present invention servos on the position profile of Figure 1 rather than on the velocity profile. Hence, the need for an expensive velocity transducer is eliminated. Data relating to the current track, the target, and maximum actuator acceleration and deceleration levels, is provided to a microprocessor which mathematically generates a characteristic curve of position-versus-time.

The desired position is compared to the actual position. The error signal representing the difference between the actual and desired position is processed by digital signal processing circuitry which determines the linear actuator motor current, since no direct velocity feedback is used.

No encoder or dedicated servo head and surface is required in the present invention since position information for track locating is provided by the data head reading track identifying addresses recorded on the data surface. Track identification data, in the form of coded track addresses, are pre-recorded on the surfaces of the disc in the gap between the sectors of data on each

track (inter-sector gap hereafter). The track addresses are sampled and stored and are updated as each inter-sector gap is read by the data head.

For track following, again no remote reference exists since magnetic transitions detected by the data head, to produce a tracking signal, also have been written on the data surface. These transitions are written in the inter-sector gaps but separate from track addresses. The tracking signal is updated by reading the magnetic transitions at each inter-sector gap. Again, the velocity transducer has been eliminated and, for this mode, replaced by analog lead networks to compensate the servo loop. In addition, the resolution of data head position is enhanced by adding data, derived from the tracking signal produced by the track following servo, for determining which side of and the distance from a track's center the data head is located to the coded track address data produced by the track locating servo.

The microprocessor used in the present invention is located in the disc controller, and otherwise would be idle while the drive is in track locating mode. Since the present invention has no dedicated servo surface, data storage capacity is maximized. The present system also has no velocity transducers or decoders, thus reducing manufacturing cost.

Figure 1 shows the acceleration, velocity and position profiles for conventional disc drive head positioning systems.

Figure 2 is a block diagram of a typical track locating servo used in a conventional disc drive head positioning system.

Figure 3 is a block diagram of a typical track following servo used in a conventional disc drive head positioning system.

Figure 4 is an overall block diagram of a moving-head disc drive head positioning system constructed according to the preferred embodiment of the present invention.

Figure 5 is a block diagram of the signal conditioner used in the head positioning system of Figure 4.

Figure 6 is a block diagram of the track following data decoder used in the head positioning system of Figure 4.

Figure 7 is a diagram of the track following and track address data as recorded in the inter-sector gap of a disc used in the head positioning system of Figure 4.

Figure 8 is a block diagram of the track address decoder used in the head positioning system of Figure 4.

Figure 9 is a block diagram of the actuator drive amplifier used in the head positioning system of Figure 4

Figure 10 is a diagram of the tracking signal showing the points thereon corresponding to track centers, and showing points thereon at which the recorded track addresses change code.

Figure 11 is a diagram of the tracking signal of Figure 10 showing points thereon at which the extended precision information changes.

Figures 12A-12C are flow charts of the algorithms used by the microprocessor of the positioning system of Figure 4 to compute the position profile according to the present invention.

Figure 13A is a characteristic curve of position-versus-time showing settling time over target track in the positioning system of Figure 4 uncorrected for steady-state track locating error.

Figure 13B is a characteristic curve of position-versus-time showing settling time over target track in the positioning system of Figure 4 corrected for steady-state track locating error.

Referring to Figures 4 and 5, the disc drive servos of the present invention comprise microprocessor 40, signal conditioner 41, track following data decoder 42, track address decoder 43, actuator drive amplifier 44, and data heads 46a and 46b carried by linear actuator 45. Magnetic transitions, recorded in the inter-sector gap as shown, for example at 71, in Figure 7, are detected by data head 46a and 46b as the inter-sector gap passes beneath them. The differential signals produced by the data heads are amplified by preamps 411a and 411b and one of the signals, as selected by head selector switch

412 in response to a head select command from microprocessor 50, is transmitted to track following data decoder 42 via buffer 413 and filter 414.

In Figure 6, track following data decoder 42 comprises voltage-controlled-gain amplifier 421 for receiving the differential head signal from signal conditioner 41, signal converter 422 for converting input signal from a differential signal to a single-ended signal, that single-ended signal hereinafter referred to as the head signal, and pulse detector 423 for initiating time base 424 in cooperation with GAP command from microprocessor 40. The GAP command is timed to activate time base 424 circuitry to process the head signal at and during the time the inter-sector gap passes beneath the data head. Synchronization (sync) pulse detector 423 detects a first sync pulse derived from magnetic transition 74 on the head signal. Peak detectors 425 and 426, the input to which being controlled by time base 424 via switches S_1 and S_2, respectively, transmits the head signal to summing and difference networks 427 and 429 in response to control signals from time base 424. Summing network 427 in turn controls the gain of amplifier 421 via AGC (automatic gain control) 428 and difference network 429 transmits a signal, hereinafter referred to as the tracking signal, to track address decoder 43 and actuator drive amplifier 44.

Referring now to Figures 7 and 8, coded track identifying data are recorded in the form of magnetic transitions (or lack thereof) at regularly spaced intervals, designated W_1 - W_n and referred to hereafter as address intervals 73 in the inter-sector gap. Window time base 433 generates "bit windows" synchronously timed with disc rotation speed to correspond to detection of address intervals 73 by one of the data heads, 46a or 46b, in response to a second sync pulse derived from magnetic transition 72. Transition 72, also recorded in the inter-sector gap, is located just ahead in sequence,

of the coded track identifying data. Window time base 433 automatically terminates bit window generation at the end of bit window W_n.

The presence of a magnetic transition recorded in an address interval W_1 - W_n causes a pulse to be transmitted on the head signal. That pulse is interpreted by multiplexer 434 at a "one" in the corresponding bit window generated by window time base 433. The absence of a magnetic transition in an address interval is conversely interpreted as a "zero". The cumulative result of bit window data is a coded track address.

If the data head is moving to another track and crosses more than one track as the inter-sector gap passes beneath it, the data head will sense all "ones" common to all track addresses sensed. The decoded track address, however, can be resolved to $\pm$ 1/2 track maximum simply by using the address coding scheme described later in this specification and by suitably limiting the length of the track address code. Thus, track addresses should be limited in length so that the head travels over parts of no more than two such addresses at maximum translation velocity of the head and rotation speed of the disc.

According to Figure 8, track address decoder 43 comprises pulse detector 431, flip flop 432, multiplexer 434, window time base 433 and analog-to digital (A/D) converter 435. Pulse detector 431 actuates window time base 433 upon detection of the second sync pulse representing magnetic transition 72. Flip flop 432 is set by pulses representing magnetic transitions in intervals W_1 - W_n. Flip flop 432 is reset by window time base 433 at the end of each data window. If no pulse appears in a data window, flip flop 432 remains reset. Thus, the output of flip flop 432 is coded address data, hereinafter referred to as the track address, uniquely identifying each track, and derived from the head signal for the time period during which the intersector gap passes beneath the data head. Flip

flop 434 ignores the third sync pulse and pulse detector 431 is insensitive to interval pulses.

Multiplexer 434 combines the track address data from flip flop 432 with two additional bits of data from A/D converter 435 in accordance with the timing of bit windows received from window time base 433 to produce an extended precision track address as explained later in this specification with respect to Table I. A/D converter 435 produces the additional data from the tracking signal as also described in connection with Table I later in this specification.

Among the features of the present invention is the method used to determine data head location while it is moving to another track. Track addresses are written in the inter-sector gap as shown in Figure 7 at 70 for tracks Ø - 7, together with track following magnetic transitions shown at 71 which are used by the track following servo described elsewhere in this specification. As the inter-sector gap passes beneath the data head, it detects at least one track address for processing into position information by microprocessor 40. Since a track address is available only at inter-sector gaps, track following data decoder 42 produces tracking signal 100 as shown in Figure 10, which is similar to a position signal produced by "sampling" the output signal of a servo head detecting transitions on a dedicated servo disc surface.

In Figure 10 V in the tracking signal resulting from the data head being at position X at the time an inter-sector gap passes under the head. N is the approximate distance over which unit distance code address "N" in read by the data head. V_{MAX} is the maximum tracking signal amplitude produced when the data head is exactly between two data tracks.

Referring also to Figure 7, each magnetic transition at 71 is centered between tracks such that slightly less than one-half of

two serially disposed transitions for each track is on a track. The other half of the two transitions are disposed approximately equally to each side of each track. Thus, if the data head is exactly at center track, the tracking signal amplitude is zero; if the data head is off track center, the tracking signal amplitude increases toward $\pm V_{MAX}$ as the center of a magnetic transition is approached. At $\pm V_{MAX}$, the data head is exactly between tracks.

At high head velocities and track densities, as many as 10 tracks may be crossed between "samples" taken at each gap in the present invention. A track address according to the present invention, therefore, is written in absolute form and formatted to minimize decoding errors if the data head is instantaneously positioned between tracks when the inter-sector gap passes beneath it.

Decoding errors are limited to $\pm$ 1/2 track in the present invention by writing the track addresses in a unit distance code. Track locating resolution is improved to at least $\pm$ 1/8 track by addition of two bits of track locating data generated from processing of track following data as explained later in this specification. Track addresses in the preferred embodiment of the present invention are written in a unit distance code known as the Gray code. The Gray code is described in detail in U.S. Patent 2 632 058 which is incorporated by reference as if set forth fully herein. In a unit distance code, consecutive binary numbers differ by only one bit of digital data. Therefore, the addresses of neighboring tracks differ by only one data bit. Hence, if the head is between two adjacent tracks and reads a part of the address of both, the ambiguity is limited to $\pm$ 1/2 track.

In the unit distance code addressing scheme of the present invention, the address of the track over which the data head is located is read as the inter-sector gap passes under the head. Again, this address could be as much as 1/2 track in error, simply because the same address is produced even if the head is up to 1/2 track to either

side of the track center. However, in this invention, the resolution of data head position is improved by using the tracking signal produced by track following data decoder 42 to determine which side of and the distance from track center the data head is located. The tracking signal is processed by A/D converter 435 to provide bits A and B which are added to the track address produced by the track locating servo. A single, unit distance code having greater precision is thus produced.

Referring to Figure 11, the A/D converter 435 outputs two bits according to the following criteria:
Bit A is high if the track following position signal is negative.
Bit A is low if the track following position signal is positive.
Bit B is high if the magnitude of the track following position signal (V) is less than 1/2 V_{MAX}.
Bit B is low if the magnitude of the track following position signal (V) is greater than 1/2 V_{MAX}.

Table I summarizes the resulting sequence of increased precision bits of track locating data code as the radial position of the data head is increased. It should be noted that the points at $\pm V_{MAX}$ on the waveform represent the midpoint between tracks, but also the points at which the track address code changes.

Increasing X	A	B	Final Bits of Track Address Unit Distance Code
Track Ø Center	1	1	00
	1	0	00
	1	0	01
	1	1	01
Track 1 Center	0	1	01
	0	0	01
	0	0	11
	0	1	11
Track 2 Center	1	1	11
	1	0	11
	1	0	10
	1	1	10
Track 3 Center	0	1	10
	0	0	10

Table I X

The sequence is itself a unit distance code. Thus, the precision of the track locating servo system has been increased to at least $\pm$ 1/8 track.

Referring now to Figure 9, actuator drive amplifier 44 comprises odd/even track inverter 441, servo compensation network 442, digital-to-analog (D/A) converter 443, mode selector 444 and output amplifier 445. Linear actuator 45 is driven by output amplifier 445 which is powered by the tracking signal or a track locating power signal as determined by mode selector 444 in response to appropriate command from microprocessor 40. Compensated error signals, representing the difference between actual head position and the computed position profile for a given target track, are derived by microprocessor 40 in the form of digital control words in accordance with the algorithm shown in Figures 12A - 12C, utilizing track addresses detected by the data head as it moves in the track

locating mode. Digital-to-analog (D/A) converter 443 then converts the control words into track locating power signals for driving actuator 45. The computed position profile then converges on the target track.

Referring also to Figure 11, track Ø center is identified at A on the signal waveform. Similarly, track 1 center is identified at B, track 2 center is at C, and so on. While each track center is at zero, the slope of the signal is of opposite polarity for adjacent tracks, such as tracks Ø and 1, and the slope is the same for every other track, such as tracks Ø and 2. Thus, if the head were slightly off-center to the left on track Ø, the polarity of the signal required to move it back to center track might be, for example, positive, but negative for the same error on track 1. Therefore, odd/even track inverter 441 arbitrarily inverts the tracking signal for every other track so that the head moves in the same direction relative to track center for every track in response to the tracking signal.

Servo compensation network 442 comprises lead and lag networks well known to those skilled in system technology to provide loop stability, noise reduction and resistance to steady-state forces on the actuator. These, as well as other specific circuits which perform the functions described in Figures 4-6, 8 and 9 are well known to those skilled in the art. Since such circuits form no part of the present invention, they are not detailed in this specification.

The track following and track locating servos of the present invention rely on a sampled servo signal rather than a continuous servo signal. For that reason the band-width and the servo loop gain are less than the bandwidth and the servo loop gain of a conventional track locating system. Thus, the track locating servo o the present invention inherently includes a steady-state error of several tracks, where conventional

systems have steady-state errors of only a fraction of a track. To compensate for this large error and reduce settling time of the actuator at the target track, microprocessor 40 actually computes a positive profile for several tracks short of the target track. The profile generated then "jumps" when the true target is finally approached as shown in Figure 13B. The steady-state error is controlled, primarily by compensation network 442.

This method of reducing settling time requires that short track locating seeks be considered as special cases -i.e., seeks shorter than the steady-state error. Thus,for short seeks in the present invention, the position profile is essentially set equal to the target tracks for the entire duration of the seek.

Single track seeks must be as fast as possible to facilitate repaid transfer of large segments of data. Therefore, a one track seek is performed entirely "open loop" whereby the arm is accelerated, then decelerated, for the required amounts of time to step over one track. The track following servo is then initiated immediately.

A complete listing of the routines and subroutines of instructions, including all constants, employed by the head positioning system of the present invention is given below.

Tabel of Contents

```
2                  ************************** LSEEK04 ******************3/9/77.1050****  00002000
3                  *                                                                    *  00003000
4                  *                        LOGICAL SEEK ROUTINE                        *  00004000
5                  *                                                                    *  00005000
6                  *     THIS ROUTINE PERFORMS AN INTERFACE BETWEEN THE SEEK COMMAND     *  00006000
7                  *  PROCESSOR AND THE PHYSICAL SEEK ROUTINE.  IT ACCEPTS A LOGICAL    *  00007000
8                  *  TARGET TRACK ADDRESS, PERFORMS BOUNDS CHECKING, SETS UP THE NEW   *  00008000
9                  *  ICW VALUE, COMPUTES THE PHYSICAL TARGET ADDRESS, AND INVOKES THE  *  00009000
10                 *  PHYSICAL SEEK ROUTINE.  IT THEN SETS UP THE TERMINATION STATUS    *  00010000
11                 *  AND RETURNS.                                                      *  00011000
12                 *                                                                    *  00012000
13                 *  AT ENTRY:  TARG CONTAINS THE TARGET TRACK NUMBER (LOGICAL)        *  00013000
14                 *             CTRK HAS THE CURRENT TRACK # (PHYSICAL*4) IF ON TRACK  *  00014000
15                 *             THSEC CONTAINS THE TARGET HEAD/SECTOR ADDRESS          *  00015000
16                 *  AT EXIT:   FINE SERVO CONTROL IS RESTORED                         *  00016000
17                 *             REGISTER 2 CONTAINS SEEK TERMINATION STATUS            *  00017000
18                 *                 0 FOR SUCCESSFUL COMPLETION                        *  00018000
19                 *                 1 FOR BOUNDS VIOLATION (CYLINDER OR HEAD/SECTOR)   *  00019000
20                 *                 -1 FOR UNSUCCESSFUL SEEK ATTEMPT (SEEK FAILURE)    *  00020000
21                 *             REGISTER 1 CONTAINS RESULT STATUS OF REGISTER 2        *  00021000
22                 *             ALL OTHER REGISTERS ARE VOLATILE                       *  00022000
23                 *             CICW IS UNCHANGED FOR A BOUNDS VIOLATION, OTHERWISE IT *  00023000
24                 *                  HAS THE FINE SERVO ICW VALUE AT THE TARGET TRACK. *  00024000
25                 *             CTRK IS UNCHANGED FOR A BOUNDS VIOLATION, OTHERWISE IT *  00025000
26                 *                  HAS THE VALUE OF THE PHYSICAL TARGET TRACK * 4.   *  00026000
27                 *                                                                    *  00027000
28                 *                                                                    *  00028000
29                 ************************************************************************  00029000

31    F800    ORG   IS    :F800                                                          00031000
```

```
33                  ********************************************************************** 00033000
34                  *                                                                    * 00034000
35                  *     THE FOLLOWING VALUES ARE VARIABLES STORED IN THE RAM.          * 00035000
36                  *     THE FIRST VARIABLE (TARG) IS THE VALUE OF THE LOGICAL TARGET   * 00036000
37                  *  TRACK NUMBER.  THIS VARIABLE IS SET UP BY THE SEEK COMMAND        * 00037000
38                  *  INTERPRETER BEFORE THIS ROUTINE IS CALLED (SEE ABOVE).  THE       * 00038000
39                  *  SEEK ROUTINE DOES NOT CHANGE THIS VALUE.                          * 00039000
40                  *     THE SECOND VARIABLE (FCNT) IS A TIMEOUT INDEX THAT IS          * 00040000
41                  *  DECREMENTED EVERY SAMPLE TIME AND GOES TO ZERO IF THE SEEK        * 00041000
42                  *  DOES NOT COMPLETE WITHIN 200 MILLISECONDS (320 SAMPLE TIMES).     * 00042000
43                  *  IF DECREMENTED TO ZERO, THE SEEK ABORTS AND RETURNS AN ERROR      * 00043000
44                  *  STATUS.                                                           * 00044000
45                  *     THE THIRD VARIABLE (CTRK) CONTAINS THE PHYSICAL ADDRESS OF THE * 00045000
46                  *  CURRENT TRACK (TIMES 4).  THIS VALUE IS ASSUMED TO HAVE BEEN SET  * 00046000
47                  *  BY THE PREVIOUS SEEK AND IS SET BY THIS ROUTINE FOR THE FOLLOWING * 00047000
48                  *  SEEK.  IF THE OFF TRACK FLAG IS SET THEN ALL BETS ARE OFF AND THE * 00048000
49                  *  CURRENT TRACK VALUE WILL BE OBTAINED BY TRACK SAMPLING.           * 00049000
50                  *     THE FOURTH VARIABLE (CICW) IS THE CURRENT VALUE OF THE ICW AND * 00050000
51                  *  IS UPDATED BY THIS ROUTINE TO REFLECT THE VALUE AT THE TARGET.    * 00051000
52                  *     THE FIFTH VARIABLE (THSEC) IS THE HEAD AND SECTOR ADDRESS OF   * 00052000
53                  *  THE SEEK TARGET.  THE HIGH BYTE SPECIFIES THE HEAD (SURFACE) AND  * 00053000
54                  *  THE LOW BYTE SPECIFIES THE SECTOR.                                * 00054000
55                  *                                                                    * 00055000
56                  ********************************************************************** 00056000

58        0069      TARG  IS    $0069          * TARGET TRACK                             00058000
59        006B      FCNT  IS    $006A          * SEEK TIMEOUT COUNT                       00059000
60        0066      CTRK  IS    $0066          * CURRENT TRACK # SAVE LOCATION            00060000
61        0064      CICW  IS    $0064          * CURRENT ICW VALUE                        00061000
62        0060      THSEC IS    $0060          * TARGET HEAD/SECTOR VALUE                 00062000
```

```
64                  ********************************************************************  00064000
65                  *                                                                  *  00065000
66                  *     THE FOLLOWING VALUES ARE CONSTANTS USED BY THE SEEK ROUTINE.  *  00066000
67                  *     OFSET IS THE TRACK OFFSET BETWEEN PHYSICAL TRACK NUMBERS AND  *  00067000
68                  *  LOGICAL TRACK NUMBERS.  TMOUT IS THE MAXIMUM NUMBER OF SAMPLE    *  00068000
69                  *  TIMES ALLOWED FOR ANY SINGLE SEEK.  MAXTR IS THE MAXIMUM LOGICAL  *  00069000
70                  *  TARGET TRACK VALUE.  QUAD IS THE NUMBER OF TRACKS IN A QUADRANT.  *  00070000
71                  *  MXSEC IS THE MAXIMUM SECTOR ADDRESS.                             *  00071000
72                  *                                                                  *  00072000
73                  ********************************************************************  00073000

75       000F       OFSET IS    15     * PHYSICAL TRACK OFFSET IS 15 TRACKS              00075000
76       0140       TMOUT IS    320    * SEEKS TIME OUT IN 320 SAMPLE TIMES (200 MSEC)   00076000
77       02EC       MAXTR IS    748    * THE MAXIMUM LOGICAL TRACK NUMBER IS 748         00077000
78       00BB       QUAD  IS    187    * QUADRANTS ARE 187 TRACKS WIDE                   00078000
79       001F       MXSEC IS    31     * THE MAXIMUM SECTOR ADDRESS IS 31                00079000
```

LOGICAL SEEK ROUTINE   CURRENT TRACK DETERMINATION

```
                          PORG  ORG+!100                                                    00081000
                          DORG  *                                                           00082000

                  ******************************************************************        00084000
                  *                                                                *        00085000
                  *    THE FOLLOWING CODE INITIALIZES THE SEEK TIMEOUT INDEX (FCNT)  *      00086000
                  *  AND DETERMINES THE CURRENT TRACK.  THE FIRST INSTRUCTION TESTS  *      00087000
                  *  THE NOT READY FLAG AND THE FOLLOWING INSTRUCTION CALLS THE DRIVE *     00088000
                  *  RECOVERY ROUTINE IF THE NOT READY FLAG IS SET.  THIS ROUTINE WILL *    00089000
                  *  BRING THE ARM TO THE OUTSIDE CRASH STOP AND CLEAR THE NOT READY" *     00090000
                  *  FLAG (THE ROUTINE DOES NOT WAIT FOR THE DRIVE TO BECOME READY).  *     00091000
                  *  THE FOLLOWING TWO INSTRUCTIONS SET FCNT TO THE SEEK TIMEOUT VALUE *    00092000
                  *  (TMOUT).  THIS VALUE DETERMINES WHEN THE SEEK WILL TIMEOUT AND IS *    00093000
                  *  RETAINED IN R3 FOR SUBSEQUENT USE.  THE NEXT INSTRUCTION LOADS R6 *    00094000
                  *  WITH THE VALUE OF CTRK.  THE FOLLOWING TWO INSTRUCTIONS TEST THE *     00095000
                  *  OFF TRACK FLAG AND BRANCH TO LS02 IF ITS CLEAR WHICH INDICATES  *      00096000
                  *  THAT CTRK (AND THUS R6) SHOULD CONTAIN THE CORRECT CURRENT TRACK *     00097000
                  *  VALUE (PHYSICAL*4).                                             *      00098000
                  *    IF THE OFF TRACK FLAG IS SET THEN THE CURRENT TRACK VALUE IS  *      00099000
                  *  OBTAINED BY READING A TRACK SAMPLE WHICH IS PERFORMED BY THE NEXT *    00100000
                  *  INSTRUCTION.  THE FOLLOWING TWO INSTRUCTIONS SET R6 TO THIS VALUE *    00101000
                  *  ROUNDED TO THE NEAREST TRACK+1/2.  THE CODE THEN DROPS TO THE   *      00102000
                  *  FOLLOWING BLOCK OF CODE WHICH PERFORMS A REDUNDANT CALL TO THE  *      00103000
                  *  TRACK SAMPLING ROUTINE TO CHECK FOR A POSSIBLE SAMPLING ERROR.  *      00104000
                  *                                                                *        00105000
                  ******************************************************************        00106000

F900  2ADC  8  LSEEK BTST  R2 = XR4(13)       * TEST NOT READY FLAG                         00108000
F901  9543  9        CALL  RECOV IF <>        * CALL RECOVERY ROUTINE IF NOT READY          00109000
F902  B803  6        LLIT  R3 = TMOUT         * R3 := TIMEOUT COUNT                         00110000
F903  0140
F904  D003 12        STOR  FCNT = R3          * INITIALIZE TIMEOUT COUNT                    00111000
F905  0068
F906  C006 12        LOAD  R6 = CTRK          * R6 := PHYSICAL CURRENT TRACK VALUE          00112000
F907  0066
F908  2FEC  8        BTST  R7 = XR4(14)       * TEST OFF TRACK FLAG                         00113000
F909  6217  6        GOTO  LS02  IF =         * BRANCH IF ON TRACK                          00114000
F90A  9F5F  9  LS01  CALL  IGAP,I             * READ TRACK ADDRESS                          00115000
F90B  1EE2  7        BSET  R6 = R2(14)        * ROUND TO TRACK + 1/2                        00116000
F90C  0EF6  7        BCLR  R6(15)                                                           00117000
```

```
119                  ************************************************************************  00119000
120                  *                                                                      *  00120000
121                  *     AT ENTRY INTO THE FOLLOWING CODE R6 CONTAINS A CURRENT TRACK     *  00121000
122                  *  VALUE THAT HAS BEEN OBTAINED FROM A TRACK SAMPLING.  THIS CODE      *  00122000
123                  *  CHECKS THE TRACK VALUE FOR A POSSIBLE SAMPLING ERROR.  THE FIRST    *  00123000
124                  *  INSTRUCTION PERFORMS A REDUNDANT TRACK SAMPLING.  THE FOLLOWING     *  00124000
125                  *  INSTRUCTION SETS R2 WITH DIFFERENCE BETWEEN THIS SAMPLE AND R6.     *  00125000
126                  *  THE FOLLOWING TWO INSTRUCTIONS YIELD THE ABSOLUTE VALUE OF THIS     *  00126000
127                  *  DIFFERENCE.  THE NEXT TWO INSTRUCTIONS TEST THIS VALUE AND BRANCH   *  00127000
128                  *  TO LS02 IF IT IS LESS THAN FOUR (1 TRACK).  OTHERWISE THE NEXT      *  00128000
129                  *  TWO INSTRUCTIONS TEST THE TIMEOUT INDEX AND BRANCH BACK TO LS01     *  00129000
130                  *  IF ITS GREATER THAN TWO.  IF THE TIMEOUT INDEX IS TWO OR LESS, A    *  00130000
131                  *  TIMEOUT ERROR IS ASSUMED AND THE FOLLOWING TWO INSTRUCTIONS SET     *  00131000
132                  *  R2 TO ZERO (INDICATING A SEEK FAILURE) AND BRANCH TO LS04.          *  00132000
133                  *                                                                      *  00133000
134                  ************************************************************************  00134000

136  F90D  9F5F  9       CALL  IGAP,I          * TEST WITH REDUNDANT TRACK SAMPLING          00136000
137  F90E  7A26  7             R2 = R6-R2                                                    00137000
138  F90F  8311  6       GOTO  *+2   IF >=                                                   00138000
139  F910  8332  6             R2 = -R2                                                      00139000
140  F911  6A04  6             R2 = R2-4                                                     00140000
141  F912  8617  6       GOTO  LS02  IF <=     * BRANCH IF <= 1 TRACK DIFFERENCE             00141000
142  F913  6602  6             R3 = R3-2       * TEST TIMEOUT                                00142000
143  F914  810A  6       GOTO  LS01  IF >       * LOOP IF TIME OK                            00143000
144  F915  E200  6             R2 = 0          * R2 INDICATES SEEK FAILURE                   00144000
145  F916  873C  6       GOTO  LS04            * BRANCH TO ERROR CODE                        00145000
```

```
                    ********************************************************************************  00147000
                    *                                                                              *  00148000
                    *     THE FOLLOWING CODE TESTS FOR A TRACK BOUNDS VIOLATIONS ON THE            *  00149000
                    *  TARGET TRACK TRACK AND COMPUTES THE QUADRANT BITS FOR THE ICW.               *  00150000
                    *  THE FIRST INSTRUCTION SETS R2 TO TWO WHICH INDICATES A BOUNDS               *  00151000
                    *  VIOLATION.  THE FOLLOWING SIX INSTRUCTIONS SET R7 TO THE LOGICAL            *  00152000
                    *  TARGET TRACK VALUE AND BRANCH TO LS05 IF IT IS LESS THAN ZERO OR            *  00153000
                    *  GREATER THAN MAXTR (MAXIMUM TRACK VALUE).  THESE SIX INSTRUCTIONS           *  00154000
                    *  DROP THROUGH WITH R4 CONTAINING THE NEGATIVE VALUE TARGET-MAXTR.            *  00155000
                    *  THE NEXT INSTRUCTION LOADS R3 WITH THE ICW VALUE FOR NOP, RUN,              *  00156000
                    *  AND FINE SERVO.  THE NEXT FOUR INSTRUCTIONS SIT IN A LOOP THAT              *  00157000
                    *  INCREMENTS R4 BY THE QUADRANT WIDTH (SEE DESCRIPTION OF QUAD)               *  00158000
                    *  UNTIL IT REACHES ZERO, EACH TIME INCREMENTING THE QUADRANT FIELD             *  00159000
                    *  (BITS 12&13) OF THE ICW MASK (R3).  THE CODE EXITS TO LS03 WITH             *  00160000
                    *  R3 CONTAINING THE PROPER QUADRANT BITS FOR THE TARGET TRACK.                *  00161000
                    *                                                                              *  00162000
                    ********************************************************************************  00163000

F917  E202  6  LS02       R2 = 2              * R2 INDICATES BOUNDS VIOLATION                        00165000
F918  C007 12       LOAD  R7 = TARG           * R7 := LOGICAL TARGET TRACK VALUE                     00166000
F919  0069
F91A  6700  6             R7 = R7+0           * TEST LOGICAL TRACK VALUE                             00167000
F91B  843E  6       GOTO  LS05  IF <          * EXIT IF NEGATIVE                                     00168000
F91C  8804  6       LLIT  R4 = MAXTR          * R4 := MAXIMUM TRACK VALUE                            00169000
F91D  02EC
F91E  7C27  7             R4 = R7-R4          * R4 := TARGET - MAXIMUM                               00170000
F91F  813E  6       GOTO  LS05  IF >          * EXIT IF TARGET > MAXIMUM                             00171000
F920  8803  6       LLIT  R3 = !AF9E          * R3 := ICW MASK (FINE SERVO)                          00172000
F921  AF9E
F922  6488  6             R4 = R4+QUAD        * TEST TARGET QUADRANT                                 00173000
F923  8326  6       GOTO  LS03  IF >=         * BRANCH IF QUADRANT BITS RIGHT                        00174000
F924  8804  6             R3 = R3-4           * DECREMENT QUADRANT FIELD                             00175000
F925  8722  6       GOTO  *-3                 * LOOP UNTIL QUADRANT BITS OK                          00176000
```

```
178                     ************************************************************************  00178000
179                     *                                                                      *  00179000
180                     *      AT *1                                                           *  00180000
181                     *  R0 := LSEEK RETURN ADDRESS                                          *  00181000
182                     *  R2 := 2 (BOUNDS VIOLATION INDICATOR)                                *  00182000
183                     *  R3 := ICW MASK                                                      *  00183000
184                     *  R4 := SCRATCH                                                       *  00184000
185                     *  R5 := SCRATCH                                                       *  00185000
186                     *  R6 := CURRENT TRACK VALUE (PHYSICAL*4)                              *  00186000
187                     *  R7 := TARGET TRACK VALUE (LOGICAL)                                  *  00187000
188                     *                                                                      *  00188000
189                     ************************************************************************  00189000

191                     ************************************************************************  00191000
192                     *                                                                      *  00192000
193                     *     THE FOLLOWING CODE COMPUTES THE PHYSICAL TARGET TRACK VALUE      *  00193000
194                     *  AND SETS UP THE EVEN/ODD BIT OF THE ICW MASK (R3).  THE FIRST       *  00194000
195                     *  INSTRUCTION ADDS THE LOGICAL TRACK OFFSET TO R7 LEAVING IT WITH     *  00195000
196                     *  THE PHYSICAL TRAGET TRACK NUMBER.  THE NEXT INSTRUCTION SHIFTS      *  00196000
197                     *  THIS VALUE LEFT ONE PLACE (MULTIPLIES BY 2).  THE FOLLOWING TWO     *  00197000
198                     *  INSTRUCTIONS EXTRACT THE LSB OF THE INTEGER PART OF R7 (BIT 14)     *  00198000
199                     *  AND USE IT TO SET THE EVEN/ODD BIT OF THE ICW MASK (R3(14)).        *  00199000
200                     *  (1 FOR EVEN, 0 FOR ODD).  THE NEXT INSTRUCTION AGAIN SHIFTS R7 TO   *  00200000
201                     *  THE LEFT ONE PLACE LEAVING IT WITH FOUR TIMES THE PHYSICAL TARGET    *  00201000
202                     *  TRACK NUMBER.                                                       *  00202000
203                     *                                                                      *  00203000
204                     ************************************************************************  00204000

206  F926  670F  6  LS03      R7 = R7+OFFSET     * R7 := PHYSICAL TRACK # OF TARGET          00206000
207  F927  0737  6           LSL   R7,F         * R7 := 2*TARGET TRACK                      00207000
208  F928  2CE7  7           BTST  R4 = R7(14)  * R4(14) := TARGET LSB                      00208000
209  F929  3324  7           R3 = R3 XOR R4     * SET EVEN/ODD BIT IN ICW MASK              00209000
210  F92A  0707  6           LSL   R7           * R7 := TARGET*4                            00210000
```

```
212                  ************************************************************  00212000
213                  *                                                          *  00213000
214                  *     THE FOLLOWING CODE PERFORMS A BOUNDS CHECK OF THE HEAD/SECTOR  *  00214000
215                  *  ADDRESS AND SETS UP THE SURFACE BIT OF THE ICW MASK (R3).  THE  *  00215000
216                  *  FIRST INSTRUCTION LOADS R4 WITH THE TARGET HEAD/SECTOR ADDRESS.  *  00216000
217                  *  THE FOLLOWING THREE INSTRUCTIONS TEST THE HEAD ADDRESS BIT AND  *  00217000
218                  *  SET THE SURFACE BIT IN THE ICW MASK (R3(10)) IF SURFACE 1 IS THE  *  00218000
219                  *  ADDRESSED SURFACE, OTHERWISE LEAVING THE BIT CLEAR.  *  00219000
220                  *     THE FOLLOWING INSTRUCTION CLEARS THE SURFACE BIT FROM R4 WHICH  *  00220000
221                  *  SHOULD RESULT IN R4 CONTAINING JUST THE SECTOR ADDRESS.  THE NEXT  *  00221000
222                  *  THREE INSTRUCTIONS WILL BRANCH TO LS05 IF THESE REMAINING BITS  *  00222000
223                  *  ARE NEGATIVE OR GREATER THAN MXSEC WHICH WOULD INDICATE A BOUNDS  *  00223000
224                  *  VIOLATION.  *  00224000
225                  *                                                          *  00225000
226                  ************************************************************  00226000

228  F92B C004 12        LOAD  R4 = THSEC       * R4 := TARGET HEAD/SECTOR VALUE      00228000
     F92C 0060
229  F92D 2D74  7        BTST  R5 = R4(7)       * TEST SURFACE BIT                    00229000
230  F92E 8230  6        GOTO  *+2   IF =       * SKIP IF SURFACE 0                   00230000
231  F92F 1BA3  7        BSET  R3(10)           * SET ICW MASK TO SURFACE 1           00231000
232  F930 0C74  7        BCLR  R4(7)            * CLEAR SURFACE BIT                   00232000
233  F931 843E  6        GOTO  LS05  IF <       * EXIT IF HEAD/SECTOR BOUNDS ERROR    00233000
234  F932 0C1F  6              R4 = R4-MXSEC    * TEST HEAD/SECTOR VALUE              00234000
235  F933 813E  6        GOTO  LS05  IF >       * EXIT IF HEAD/SECTOR BOUNDS ERROR    00235000
```

```
237                ********************************************************************** 00237000
238                *                                                                    * 00238000
239                *      AT *:                                                         * 00239000
240                *  R0 := LSEEK RETURN ADDRESS                                        * 00240000
241                *  R2 := SCRATCH                                                     * 00241000
242                *  R3 := FINE SERVO ICW VALUE FOR TARGET                             * 00242000
243                *  R4 := SCRATCH                                                     * 00243000
244                *  R5 := SCRATCH                                                     * 00244000
245                *  R6 := CURRENT TRACK VALUE (PHYSICAL*4)                            * 00245000
246                *  R7 := TARGET TRACK VALUE (PHYSICAL*4)                             * 00246000
247                *                                                                    * 00247000
248                ********************************************************************** 00248000


250                ********************************************************************** 00250000
251                *                                                                    * 00251000
252                *     THE FOLLOWING CODE SETS UP AND INVOKES PSEEK (PHYSICAL SEEK    * 00252000
253                *  ROUTINE).  THE FIRST INSTRUCTION SETS R2 TO THE SEEK ICW VALUE.   * 00253000
254                *  THE FOLLOWING INSTRUCTION STORES THE TARGET'S ICW VALUE INTO CICW * 00254000
255                *  (CURRENT ICW LOCATION).  THE NEXT INSTRUCTION STORES THE PHYSICAL * 00255000
256                *  TARGET TRACK VALUE (R7) INTO CTRK (CURRENT TRACK LOCATION).  THE  * 00256000
257                *  FOLLOWING INSTRUCTION INVOKES THE PHYSICAL SEEK ROUTINE (PSEEK).  * 00257000
258                *     FOLLOWING THE RETURN FROM THE PHYSICAL SEEK ROUTINE, THE NEXT  * 00258000
259                *  INSTRUCTION TESTS THE COMPLETION STATUS.  THE NEXT INSTRUCTION    * 00259000
260                *  WILL BRANCH TO LSOS FOR A SUCCESSFUL SEEK COMPLETION; OTHERWISE,  * 00260000
261                *  THE FOLLOWING INSTRUCTION WILL TEST THE NOT READY FLAG, AND THE   * 00261000
262                *  NEXT INSTRUCTION WILL CALL THE DRIVE RECOVERY ROUTINE IF THE FLAG * 00262000
263                *  INDICATES THAT THE DRIVE IS READY.  THIS WILL LEAVE THE ARM AT    * 00263000
264                *  THE OUTSIDE CRASH STOP.  NOTE THAT IF THE DRIVE IS NOT READY, THE * 00264000
265                *  RECOVERY ROUTINE IS NOT CALLED AND THE ARM IS LEFT LATCHED UP.    * 00265000
266                *                                                                    * 00266000
267                ********************************************************************** 00267000
```

```
269    F934  3A93  7          BCPL  R2 = R3(9)          * R2 := SEEK ICW VALUE                          00269000
270    F935  0003  12         STOR  CICW = R3           * CICW := FINE SERVO ICW FOR TARGET             00270000
       F936  0064
271    F937  0007  12         STOR  CTRK = R7           * CTRK := PHYSICAL TARGET TRACK VALUE*4         00271000
       F938  0066
272    F939  9F52  9          CALL  ISEEK+1             * CALL SEEK ROUTINE                             00272000
273    F93A  6200  6                R2 = R2+0           * TEST COMPLETION STATUS                        00273000
274    F93B  813E  6          GOTO  LS05  IF >          * BRANCH IF SEEK SUCCESSFUL                     00274000
275    F93C  2DDC  8   LS04   BTST  R5 = XR4(13)        * TEST NOT READY FLAG                           00275000
276    F93D  9243  9          CALL  RECOV IF =          * CALL DRIVE RECOVERY IF DRIVE READY            00276000
```

```
278                     *****************************************************************  00278000
279                     *                                                               *  00279000
280                     *     AT LS05, R2 CONTAINS A 2 IF A BOUNDS VIOLATION WAS DETECTED IN *  00280000
281                     *  THE ABOVE CODE, R2 CONTAINS A 1 FOR A SUCCESSFUL SEEK COMPLETION, *  00281000
282                     *  AND R2 CONTAINS A 0 IF A SEEK FAILURE OCCURED.  THE INSTRUCTION  *  00282000
283                     *  THEN DECREMENTS R2 THUS SETTING R2 AND R1 TO THE APPROPRIATE EXIT *  00283000
284                     *  VALUES.  THE NEXT INSTRUCTION RETURNS TO THE CALLING PROGRAM.    *  00284000
285                     *                                                               *  00285000
286                     *****************************************************************  00286000

288   F93E  6A01  6   LS05        R2 = R2-1          * SET TERMINATION STATUS              00288000
289   F93F  8100 10         RTRN                     * RETURN                              00289000

291                     *****************************************************************  00291000
292                     *                                                               *  00292000
293                     *     THE FOLLOWING ROUTINE PERFORMS A DELAY BY DECREMENTING THE *  00293000
294                     *  DELAY INDEX (R2) UNTIL IT REACHES ZERO.  THE DELAY OBTAINED IS *  00294000
295                     *  4.5125+2.85*(R2) MICROSECONDS FOR (R2)>0.  THE DELAY IS ABOUT  *  00295000
296                     *  .187 SECONDS FOR (R2)=0.                                     *  00296000
297                     *                                                               *  00297000
298                     *****************************************************************  00298000

300   F940  6A01  6   DELAY       R2 = R2-1          * DECREMENT DELAY INDEX               00300000
301   F941  8540  6         GOTO  *-1   IF <>        * LOOP UNTIL INDEX=0                  00301000
302   F942  8100 10         RTRN                     * RETURN                              00302000
```

```
304                  ************************************************************************  00304000
305                  *                                                                      *  00305000
306                  *     THE FOLLOWING ROUTINE IS CALLED IN ORDER TO BRING THE ARM OUT    *  00306000
307                  *  OF THE LANDING ZONE AND CLEAR THE NOT READY FLAG.  THE FIRST TWO     *  00307000
308                  *  INSTRUCTIONS SET R3 TO AN ICW VALUE WITH THE RUN BIT DISSASSERTED    *  00308000
309                  *  AND R2 TO THE SAME ICW VALUE WITH THE RUN BIT ASSERTED.  USING       *  00309000
310                  *  THESE TWO VALUES, THE NEXT INSTRUCTION DISSASSERTS THE RUN SIGNAL    *  00310000
311                  *  AND THE FOLLOWING INSTRUCTION IMMEDIATELY REASSERTS RUN.  THIS       *  00311000
312                  *  HAS THE EFFECT OF RELEASING THE ARM FROM THE LATCH.  THE NEXT        *  00312000
313                  *  INSTRUCTION SETS THE SCW TO APPLY A SLIGHT OUTWARD FORCE TO THE      *  00313000
314                  *  ARM IN ORDER TO MOVE IT TO THE OUTSIDE CRASHSTOP.  THE FOLLOWING     *  00314000
315                  *  INSTRUCTION CLEARS THE NOT READY FLAG AND THE NEXT INSTRUCTION       *  00315000
316                  *  SETS THE CURRENT ICW MEMORY VALUE TO THE VALUE IN R2.  THE NEXT      *  00316000
317                  *  FIVE INSTRUCTIONS LOOP FOR ABOUT 1.5 SECONDS TO ALLOW THE ARM TO     *  00317000
318                  *  REACH THE OUTSIDE CRASHSTOP FOLLOWING WHICH THE ROUTINE RETURNS.     *  00318000
319                  *  THE ROUTINE EXITS WITH R2=R3=0 WHICH IS USED BY SOME CALLS.          *  00319000
320                  *                                                                      *  00320000
321                  ************************************************************************  00321000

323  F943  8803  6  RECOV LLIT  R3 = !HFD2        * R3 := ICW VALUE (RUN DISSASSERTED)      00323000
     F944  BFD2
324  F945  5823  8           XR0 = R3             * DISSASSERT THE RUN SIGNAL               00324000
325  F946  3A33  7       BCPL  R2 = R3(3)         * R2 := ICW VALUE (RUN ASSERTED)          00325000
326  F947  5822  8           XR0 = R2             * REASSERT RUN (RELEASE LATCH)            00326000
327  F948  E921  7           XR1 = !21            * SET SCW TO APPLY OUTWARD FORCE          00327000
328  F949  EA05  7           XR2 = 5              * CLEAR NOT READY FLAG                    00328000
329  F94A  D002 12       STOR  CICW = R2          * SET CURRENT ICW LOCATION                00329000
     F94B  0064
330  F94C  E200  6           R2 = 0               * CLEAR R2 (DELAY INDEX)                  00330000
331  F94D  E308  6           R3 = 8               * SET R3 := 8 (LOOP INDEX)                00331000
332  F94E  9740  9       CALL  DELAY              * DELAY (APPROX. 0.187 SECONDS)           00332000
333  F94F  6801  6           R3 = R3-1            * DECREMENT LOOP INDEX                    00333000
334  F950  614E  6       GOTO  *-2    IF >        * LOOP ON DELAY (END WITH R2=R3=0)        00334000
335  F951  6100 10       RTRN                     * RETURN                                  00335000
```

```
337                    ********************************************************************** 00337000
338                    *                                                                    * 00338000
339                    *     THE FOLLOWING CODE PROVIDES THE LINKS TO THE EXTERNAL ROUTINES * 00339000
340                    *  REFERENCED IN THIS PROGRAM.  ISEK IS A LOINK TO THE PHYSICAL      * 00340000
341                    *  SEEK ROUTINE.  IGAP IS A LINK TO SGAP (TRACK SAMPLING ROUTINE).   * 00341000
342                    *  THE IGAP LINK IS ONLY REFERENCED BY THIS CODE SINCE EVEN THOUGH    * 00342000
343                    *  IT RESIDES ON THIS MEMORY PAGE, IT IS ACTUALLY DEFINED IN THE      * 00343000
344                    *  PHYSICAL SEEK PROGRAM.                                            * 00344000
345                    *                                                                    * 00345000
346                    ********************************************************************** 00346000

348  F952  F800       ISEEK DATA  PSEEK              * LINK TO PHYSICAL SEEK ROUTINE        00348000
349        F95F       IGAP  IS    ORG+!15F           * LINK TO SGAP                         00349000
350        F800       PSEEK IS    ORG                * ADDRESS OF PHYSICAL SEEK ROUTINE     00350000

352                    ********************************************************************** 00352000
353                    *                                                                    * 00353000
354                    *                    END OF LOGICAL SEEK ROUTINE                     * 00354000
355                    *                                                                    * 00355000
356                    ********************************************************************** 00356000

358                         END                                                               00358000
```

CROSS REFERENCE TABLE

CICW	100	LIT [61]	329	270			
CTRK	102	LIT [60]	271	112			
FCNT	104	LIT [59]	111				
IGAP	-1097	LIT [349]	136	115			
ISEEK	F952	ROM [348]	272				
LS01	F90A	ROM [115]	143				
LS02	F917	ROM [165]	141	114			
LS03	F926	ROM [206]	174				
LS04	F93C	ROM [275]	145				
LS05	F93E	ROM [288]	274	235	233	171	168
LSEEK	F900	ROM [108]					
MAXTH	748	LIT [77]	169				
MXSEC	31	LIT [79]	234				
OFSET	15	LIT [75]	206				
ORG	-2048	LIT [31]	350	349	81		
PSEEK	-2048	LIT [350]	346				
QUAD	187	LIT [78]	173				
RECOV	F943	ROM [323]	276	109			
SDLAY	F940	ROM [300]	332				
TARG	105	LIT [58]	166				
THSEC	96	LIT [62]	228				
TMOUT	320	LIT [76]	110				

NUMBER OF PASS 2 ERRORS=0
NUMBER OF PASS 2 WARNINGS=0

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```
2                ********** SEEK1A **********3/9/77.1000****  00002000
3                *                                           *  00003000
4                *                SEEK ROUTINE               *  00004000
5                *                                           *  00005000
6                *    THIS ROUTINE EXECUTES THE FIRMWARE OPERATIONS NECESSARY *  00006000
7                *  TO PERFORM A SEEK OPERATION FROM THE CURRENT TRACK TO THE *  00007000
8                *  TARGET TRACK.                            *  00008000
9                *                                           *  00009000
10               *  AT ENTRY:  CTRK CONTAINS TARGET TRACK VALUE (PHYSICAL*4)  *  00010000
11               *             CICW CONTAINS TARGET ICW VALUE (FOR FINE SERVO) *  00011000
12               *             FCNT CONTAINS TIMEOUT INDEX (REMAINING SAMPLE TIMES) *  00012000
13               *             R2 CONTAINS SEEK ICW VALUE    *  00013000
14               *             R3 CONTAINS FINE SERVO ICW VALUE (SAME AS CICW) *  00014000
15               *             R6 CONTAINS CURRENT TRACK VALUE (PHYSICAL*4) *  00015000
16               *             R7 CONTAINS TARGET TRACK VALUE (PHYSICAL*4) *  00016000
17               *  AT EXIT:   R2 = 1 FOR SUCCESSFUL SEEK COMPLETION *  00017000
18               *             R2 = 0 FOR SEEK FAILURE (TIMEOUT) *  00018000
19               *             ALL OTHER REGISTERS ARE VOLATILE *  00019000
20               *                                           *  00020000
21               *                  ***** NOTE *****         *  00021000
22               *    IF THE SEEK ROUTINE IS UNABLE TO COMPLETE THE SEEK (IF IT *  00022000
23               *  EXCEEDS A GROSS TIMEOUT), IT WILL ATTEMPT TO LATCH UP THE HEAD *  00023000
24               *  IN THE LANDING ZONE AND RETURN AN ERROR STATUS (REGISTER 2 = 0). *  00024000
25               *                                           *  00025000
26               *********************************************  00026000

28        F800   ORG   IS   *F800                               00028000
```

```
30                ********************************************************************** 00030000
31                *                                                                    * 00031000
32                *     THE FOLLOWING VALUES ARE VARIABLES STORED IN THE RAM.          * 00032000
33                *     THE FIRST VALUE (M) IS THE MODEL POSITION WHICH IS COMPUTED    * 00033000
34                *  IN THE SERVO LOOP TO DETERMINE SERVO ERROR.  (EIGHTHS OF A TRACK) * 00034000
35                *     THE NEXT TWO VALUES (ETA2 AND ETASQ) ARE FUNCTIONS OF THE      * 00035000
36                *  ESTIMATED TIME TO ARRIVAL AT THE TARGET TRACK (ETA).  THESE TWO   * 00036000
37                *  VALUES ARE INITIALIZED IN THE SINIT ROUTINE AND USED TO COMPUTE   * 00037000
38                *  THE MODEL POSITION (M).  ETA2 IS EQUAL TO ETA TIMES 2 AND ETASQ  * 00038000
39                *  IS EQUAL TO ETA SQUARED.  (TIME IS IN SAMPLE TIMES WHICH EQUAL   * 00039000
40                *  THE TIME BETWEEN SUCCESSIVE SAMPLES, 625 MICROSECONDS)           * 00040000
41                *     THE FOURTH VARIABLE (FCNT) IS A TIMEOUT INDEX THAT IS         * 00041000
42                *  DECREMENTED EVERY SAMPLE TIME AND GOES TO ZERO IF THE SEEK       * 00042000
43                *  DOES NOT COMPLETE WITHIN 200 MILLISECONDS (320 SAMPLE TIMES).    * 00043000
44                *  IF DECREMENTED TO ZERO, THE SEEK ABORTS AND RETURNS AN ERROR     * 00044000
45                *  STATUS (SEE NOTE ABOVE).                                         * 00045000
46                *     THE FIFTH VARIABLE (PTARG) IS THE ADJUSTED TARGET VALUE.  THIS * 00046000
47                *  IS A COMPUTED VALUE THE MODEL MUST CONVERGE TO IN ORDER TO HAVE   * 00047000
48                *  THE ACTUAL HEAD POSITION COME INTO THE ACTUAL TARGET TRACK.  (SEE * 00048000
49                *  THE EXPLANATION GIVEN IN SINIT).                                 * 00049000
50                *     THE SIXTH VARIABLE (CTRK) IS THE PHYSICAL TARGET TRACK VALUE  * 00050000
51                *  AND IS SET PRIOR TO ENTRY INTO THIS ROUTINE.  THE SEEK ROUTINE   * 00051000
52                *  DOES NOT CHANGE THIS VALUE.                                      * 00052000
53                *     THE SEVENTH VARIABLE (CICW) IS THE CURRENT ICW VALUE.  IT IS  * 00053000
54                *  SET UP BY THE CALLING PROGRAM, AND DURING THE SEEK IT CONTAINS   * 00054000
55                *  THE VALUE OF THE ICW FOR FINE SERVOING AT THE TARGET TRACK.      * 00055000
56                "                                                                    * 00056000
```

```
                *     THE FINAL VARIABLE (SSLIM) IS THE SEEK SERVO LIMITS CODE
57              *  WORD.  IF ANY OF THE LOWER 15 BITS OF THE WORD IS A ONE THEN,     *  00057000
58              *  DURING THE SERVO PORTION OF THE SEEK, THE CURRENT COMMAND IS      *  00058000
59              *  ALLOWED TO VARY OVER THE ENTIRE RANGE (-1 AMP TO +1 AMP); THIS    *  00059000
60              *  IS ALLOWED ONLY WHEN THE SEEK MODEL HAS REACHED THE TARGET        *  00060000
61              *  TRACK.  PRIOR TO THIS, THE CURRENT IS ALLOWED TO VARY OVER        *  00061000
62              *  ONLY HALF OF THE ENTIRE RANGE.  IF BIT(0)=0 AND BITS(1-15)=0      *  00062000
63              *  (SSLIM=0) THEN THE CURRENT IS ALLOWED TO VARY WITHIN THE RANGE    *  00063000
64              *  -1 AMP TO 0 AMPS.  IF BIT(0)=1 AND BITS(1-15)=0 (SSLIM=¦8000)     *  00064000
65              *  THEN THE CURRENT IS ALLOWED TO VARY WITHIN THE RANGE 0 AMPS TO     *  00065000
66              *  +1 AMP.  THIS VALUE IS KEPT IN R0 RATHER THAN A MEMORY LOCATION,  *  00066000
67              *  BUT ITS USE IS COMPLICATED ENOUGH TO REQUIRE SOME EXPANATION AT   *  00067000
68              *  THIS POINT.                                                       *  00068000
69              *                                                                    *  00069000
70              ********************************************************************  00070000

72      006C    M       IS    ¦006C          * MODEL POSITION                          00072000
73      0068    ETA2    IS    ¦0068          * ESTIMATED TIME TO ARRIVAL TIMES 2       00073000
74      006A    ETASQ   IS    ¦006A          * ESTIMATED TIME TO ARRIVAL SQUARED       00074000
75      0068    FCNT    IS    ¦0068          * SEEK TIMEOUT COUNT                      00075000
76      0067    PTARG   IS    ¦0067          * ADJUSTED TARGET VALUE                   00076000
77      0066    CTRK    IS    ¦0066          * TARGET TRACK (PHYSICAL*4)               00077000
78      0064    CICW    IS    ¦0064          * TARGET FINE SERVO ICW VALUE             00078000
79      0002    SSLIM   IS    R0             * MINIMUM/MAXIMUM SCW SERVO VALUES        00079000
```

```
81                ********************************************************************  00081000
82                *                                                                  *  00082000
83                *     THE FOLLOWING VALUES ARE CONSTANTS USED BY THE SEEK ROUTINE.  *  00083000
84                *  THE FIRST FOUR CONSTANTS ARE VALUES USED TO SET UP THE SCW.      *  00084000
85                *     MAXV IS EQUAL TO THE MAXIMUM VELOCITY THAT THE ARM CAN REACH  *  00085000
86                *  DURING A SEEK.  THE VALUE IS GIVEN IN QUARTER TRACKS.  SCWMX IS  *  00086000
87                *  THE MAXIMUM VALUE THAT THE SCW CAN BE SET TO (MAGNITUDE ONLY).   *  00087000
88                *  FVAL IS THE ICW VALUE THAT IS SET FOR A SEEK FAILURE.            *  00088000
89                *     TCNT1 AND TERR1 ARE TWO TERMINATION PARAMETERS THAT DETERMINE *  00089000
90                *  WHEN THE SEEK TURNS CONTROL OVER TO FINE SERVO.  THIS OCCURS     *  00090000
91                *  WHEN THE HODEL HAS ARRIVED ON TARGET AND THE SEEK SERVO HAS HELD  *  00091000
92                *  THE HEAD ON TRACK WITH A MAXIMUM ERROR OF TERR1 FOR TCNT1 SAMPLE  *  00092000
93                *  TIMES.  LIKEWISE, TCNT2 AND TERR2 ARE TWO TERMINATION PARAMETERS  *  00093000
94                *  THAT DETERMINE WHEN THE SEEK ROUTINE EXITS.  THIS OCCURS WHEN THE *  00094000
95                *  FINE SERVO HAS HELD THE HEAD ON TRACK WITH A MAXIMUM ERROR OF     *  00095000
96                *  TERR2 DURING WHICH TIME TCNT2 SEQUENTIAL SAMPLES ARE READ WITHOUT *  00096000
97                *  AN OFF TRACK CONDITION OCCURING.                                 *  00097000
98                *     DLY1 AND DLY2 ARE TWO DELAY INDEXES THAT COME INTO PLAY DURING *  00098000
99                *  A ONE TRACK SEEK.  FOR A ONE TRACK SEEK, THE HEAD IS ACCELERATED  *  00099000
100               *  TOWARDS THE TARGET TRACK FOR A TIME DETERMINED BY DLY1 AND IS     *  00100000
101               *  THEN DEACCELERATED FOR A TIME DETERMINED BY DLY2 AFTER WHICH THE  *  00101000
102               *  CODE DROPS INTO THE SERVO LOOP.                                  *  00102000
103               *                                                                  *  00103000
104               ********************************************************************  00104000
```

```
106          001F     SCW31  IS    31      * ACCELERATE UP VALUE FOR INWARD SEEKS                    00106000
107          003F     SCW63  IS    63      * ACCELERATE UP VALUE FOR OUTWARD SEEKS                   00107000
108          0000     SCW0   IS    0       * NO ACCELERATION VALUE                                   00108000
109          0010     SCW16  IS    16      * HALF ACCELERATION VALUE TOWARDS LANDING ZONE            00109000

111          003C     MAXV   IS    60      * MAXIMUM VELOCITY EQUALS 15 TRACKS/SAMPLE TIME           00111000
112          AFFE     FVAL   IS    !AFFE   * SEEK FAILURE ICW VALUE                                  00112000
113          001F     SCWMX  IS    31      * SCW MAXIMUM MAGNITUDE := 31  (5 BITS)                   00113000
114          0003     TCNT1  IS    3       * SERVO TERMINATION COUNT := 3                            00114000
115          0002     TERR1  IS    2       * SERVO TERMINATION ERROR := 2 EIGHTHS OF A TRACK         00115000
116          0008     TCNT2  IS    8       * FINE SERVO TERMINATION COUNT := 8                       00116000
117          0004     TERR2  IS    4       * FINE SERVO TERM. ERROR := 4 EIGHTHS OF A TRACK          00117000
118          0198     DLY1   IS    !0198   * TRACK-TO-TRACK DELAY INDEX 1 := 408 (1.16 MSEC)        00118000
119          022C     DLY2   IS    !022C   * TRACK-TO-TRACK DELAY INDEX 2 := 556 (1.58 MSEC)        00119000
```

```
SEEK ROUTINE     INITIAL SETUP

121                      PORG  ORG                                                    00121000
122                      DORG  *                                                      00122000

124                ********************************************************************  00124000
125                *                                                                  *  00125000
126                *     THE SEEK ROUTINE BEGINS BY PUSHING THE RETURN ADDRESS ONTO   *  00126000
127                *  THE STACK.  THIS FREES R0 FOR COMPUTATIONAL USE.  THE FOLLOWING *  00127000
128                *  TWO INSTRUCTIONS PLACE THE TERMINATION COUNT IN THE STACK.  THE *  00128000
129                *  TERMINATION COUNT IS AN INDEX VALUE THAT DECREMENTS TO ZERO WHILE*  00129000
130                *  THE SERVO HOLDS THE HEAD ON TARGET.  UPON REACHING ZERO, FINE   *  00130000
131                *  SERVO IS INVOKED AND THE TERMINATION COUNT IS SET TO A NEGATIVE *  00131000
132                *  VALUE FROM WHERE IT IS INCREMENTED TO ZERO UPON WHICH THE SEEK  *  00132000
133                *  EXITS.                                                          *  00133000
134                *     THE NEXT TWO INSTRUCTIONS INITIALIZE THE SSLIM VALUE (R0) AND*  00134000
135                *  THE SCW ACCELERATE UP VALUE (R4) FOR AN OUTWARD SEEK.           *  00135000
136                *     TRACKS ARE NUMBERED BEGINNING WITH 0 AT THE OUTSIDE EDGE AND *  00136000
137                *  INCREASING TO JUST ABOUT 800 AT THE INSIDE EDGE; THEREFORE, FOR *  00137000
138                *  INWARD SEEKS, THE CURRENT TRACK IS LESS THAT THE TARGET TRACK,  *  00138000
139                *  AND FOR OUTWARD SEEKS THE CURRENT TRACK IS GREATER THAN THE     *  00139000
140                *  TARGET TRACK.  THE FOLLOWING CODE SAVES THE TARGET TRACK NUMBER *  00140000
141                *  IN R3.  R7 THEN GETS THE OUTWARD SEEK DISTANCE (CURRENT TRACK - *  00141000
142                *  TARGET TRACK).  THIS VALUE IS ZERO FOR A SEEK SELF (TO CURRENT  *  00142000
143                *  TRACK).  IT IS NEGATIVE IF THE SEEK IS INWARD AND POSITIVE IF THE*  00143000
144                *  SEEK IS OUTWARD.  FOR AN OUTWARD SEEK, A BRANCH TO SK02 OCCURS. *  00144000
145                *  A BRANCH TO SK01 OCCURS FOR AN INWARD SEEK, AND FOR A SEEK SELF *  00145000
146                *  CONTROL DROPS THROUGH TO THE FOLLOWING INSTRUCTIONS WHICH SET THE*  00146000
147                *  ICW TO THE APPROPRIATE VALUE, WAIT TWO SAMPLE TIMES TO ALLOW THE*  00147000
148                *  ELECTRONICS TO SETTLE OUT, AND BRANCH TO SK07.                  *  00148000
149                *                                                                  *  00149000
150                ********************************************************************  00150000
```

```
152   F800  8000  8  SEEK  PUSH  R0                * SAVE RETURN ADDRESS                    00152000
153   F801  E303  6        R3 = TCNT1             * TERMINATION COUNT != 3                 00153000
154   F802  8003  8        PUSH  R3               * SAVE TERMINATION COUNT                 00154000
155   F803  8800  6        LLIT  R0 = !8000       * R0 (SSLIM) != !8000                    00155000
      F804  8000
156   F805  E43F  6        R4 = SCW63             * SCW ACCELERATE UP VALUE (OUTWARD)      00156000
157   F806  5327  7        R3 = R7                * R3 != TARGET TRACK                     00157000
158   F807  7F26  7        R7 = R6-R7             * R7 != CURRENT TRK - TARGET TRK         00158000
159   F808  8112  8        GOTO  SK02  IF >       * BRANCH IF SEEK OUTWARD                 00159000
160   F809  840F  6        GOTO  SK01  IF <       * BRANCH IF SEEK INWARD                  00160000
161   F80A  3892  7        HCPL  R3 = R2(9)       * R3 != FINE SERVO ICW VALUE FOR TARGET  00161000
162   F80B  5823  8        XR0 = R3               * SET ICW (FINE SERVO)                   00162000
163   F80C  970D  9        CALL  SGAP             * WAIT FOR SECTOR GAP                    00163000
164   F80D  970D  9        CALL  SGAP             * WAIT FOR SECTOR GAP                    00164000
165   F80E  87A1  6        GOTO  SK07             * BRANCH (SEEK SELF)                     00165000
```

```
                        ********************************************************************** 00167000
                        *                                                                    * 00168000
                        *     AFTER DETERMINING THE SEEK DIRECTION, SOME SET UP IS REQUIRED  * 00169000
                        *  BEFORE THE SEEK BEGINS.  FIRST OF ALL SSLIM MUST BE SET (SEE      * 00170000
                        *  DESCRIPTION OF SSLIM).  THE SEEK STARTS BY SUPPLYING FULL CURRENT * 00171000
                        *  ACCELERATING THE ARM TOWARDS THE TARGET TRACK UNTIL REACHING A     * 00172000
                        *  SWITCHPOINT WHERE THE CURRENT IS REVERSED AND SUPPLYS A VARIABLE  * 00173000
                        *  AMOUNT OF BRAKING FORCE TO THE ARM FOLLOWING A MATHEMATICALLY     * 00174000
                        *  COMPUTED APPROACH TO THE TARGET TRACK.  POSITIVE CURRENT SUPPLYS   * 00175000
                        *  INWARD ACCELERATION; THEREFORE, DURING THE BRAKING PORTION OF AN  * 00176000
                        *  OUTWARD SEEK SSLIM SHOULD BE !8000 TO ALLOW THE CURRENT TO VARY   * 00177000
                        *  FROM 0 TO +1 AMP.  LIKEWISE, IN THE BRAKING PORTION OF AN INWARD  * 00178000
                        *  SEEK, SSLIM SHOULD BE 0 LIMITING THE CURRENT FROM 0 TO -1 AMP.    * 00179000
                        *     THE SCW REGISTER CONTROLS THE CURRENT.  IT IS A SIGN/MAGNITUDE * 00180000
                        *  VALUE WITH A 5 BIT MAGNITUDE ALLOWING THE CURRENT TO BE SET TO A  * 00181000
                        *  1/32 AMP RESOLUTION.  THE CURRENT IS NEGATIVE FOR A SIGN (BIT 10) * 00182000
                        *  OF 1 AND IS POSITIVE FOR A SIGN OF 0.  THE MAXIMUM SERVO VALUE IS * 00183000
                        *  THE VALUE OF THE SCW THAT SUPPLYS FULL BRAKING CURRENT TO THE ARM * 00184000
                        *  DURING THE SERVO PORTION OF THE SEEK.  THIS VALUE IS PLACED IN    * 00185000
                        *  THE SCW AT THE SWITCHPOINT IMMEDIATLY FOLLOWING THE ACCELERATE UP * 00186000
                        *  PHASE OF THE SEEK.  SINCE THE ACCELERATE UP SCW VALUE PROVIDES    * 00187000
                        *  FULL CURRENT ACCELERATING, THE MAXIMUM SERVO VALUE IS THIS VALUE  * 00188000
                        *  WITH THE SIGN BIT (BIT 10) COMPLEMENTED.                          * 00189000
                        *     TO START THE SEEK AT FULL CURRENT REQUIRES THE SCW BE SET TO   * 00190000
                        *  63 (31+SIGN) FOR AN OUTWARD SEEK AND 31 FOR AN INWARD SEEK.       * 00191000
                        *     THE FOLLOWING CODE IS ENTERED AT SK01 FOR AN INWARD SEEK.  THE * 00192000
                        *  CODE SETS UP THE SEEK DISTANCE (R7), THE SSLIM VALUE (R0), AND    * 00193000
                        *  THE ACCELERATE UP SCW VALUE (R4).  AT SK02, THESE REGISTERS HAVE  * 00194000
                        *  THE APPROPRIATE VALUES REGARDLESS OF SEEK DIRECTION.  THE MAXIMUM * 00195000
                        *  SERVO VALUE (R5) IS THEN COMPUTED FROM R4 (ACCELERATE UP VALUE).  * 00196000
                        *                                                                    * 00197000
                        ********************************************************************** 00198000

F80F  6337  6  SK01          R7 = -R7          * R7 := SEEK DISTANCE                        00200000
F810  C000  0                R0 = 0            * R0 (SSLIM) := 0                            00201000
F811  E41F  6                R4 = SCW31        * ACCELERATE UP VALUE = 31                   00202000
F812  3DA4  7  SK02  BCPL    R5 = R4(10)       * R5 := MAXIMUM SERVO VALUE                  00203000
```

```
SEEK ROUTINE     INITIAL SETUP

205                 ********************************************************************************  00205000
206                 *                                                                              *  00206000
207                 *     AT FOLLOWING CODE:                              STACK:                   *  00207000
208                 *  R0 := SSLIM VALUE                                                           *  00208000
209                 *  R2 := SEEK ICW VALUE                          TERMINATION COUNT             *  00209000
210                 *  R3 := TARGET TRACK                            SEEK RETURN ADDRESS           *  00210000
211                 *  R4 := ACCELERATE UP SCW VALUE                                               *  00211000
212                 *  R5 := MAXIMUM SERVO VALUE                                                   *  00212000
213                 *  R6 := CURRENT TRACK                                                         *  00213000
214                 *  R7 := POSITIVE SEEK DISTANCE                                                *  00214000
215                 *                                                                              *  00215000
216                 ********************************************************************************  00216000

218                 ********************************************************************************  00218000
219                 *                                                                              *  00219000
220                 *    THE FOLLOWING INSTRUCTIONS SAVE THE MAXIMUM SERVO VALUE (R5) ON           *  00220000
221                 *  THE STACK FOR SUBSEQUENT USE, PLACES THE ACCELERATE UP VALUE (R4)           *  00221000
222                 *  IN THE SCW (XR1), AND THEN SETS THE ICW (XR0) WITH SEEK ICW VALUE           *  00222000
223                 *  (R2).  THIS TAKES THE DISC OUT OF THE FINE SERVO MODE AND STARTS            *  00223000
224                 *  THE ARM ACCELERATING TOWARDS THE TARGET TRACK.                              *  00224000
225                 *     THE CODE THEN TESTS THE POSITIVE SEEK DISTANCE (R7) AND IF THE           *  00225000
226                 *  DISTANCE IS ONE TRACK (4 QUARTERS OF A TRACK), BRANCHES TO SK06.            *  00226000
227                 *                                                                              *  00227000
228                 ********************************************************************************  00228000

230  F813  B005  8          PUSH  R5              * SAVE MAXIMUM SERVO VALUE                        00230000
231  F814  5924  8                XR1 = R4        * SCW := R4                                       00231000
232  F815  9FFA  9          CALL  SCWST,I         * ANALYSIS PATCH                                  00232000
233  F816  5822  8                XR0 = R2        * SET SEEK ICW (START MOTION)                     00233000
234  F817  9FF8  9          CALL  SKSET,I         * ANALYSIS PATCH                                  00234000
235  F818  A704  6          CMP   R7,4            * TEST DISTANCE                                   00235000
236  F819  8298  6          GOTO  SK06  IF =      * BRANCH IF ONE TRACK SEEK                        00236000
```

```
23A  ********************************************************************** 00238000
239  *                                                                    * 00239000
240  *       AT SINIT:                                    STACK:          * 00240000
241  *  R0 := SSLIM VALUE                                                 * 00241000
242  *  R2 := SCRATCH                              MAXIMUM SERVO VALUE    * 00242000
243  *  R3 := TARGET TRACK ADDRESS                 TERMINATION COUNT      * 00243000
244  *  R4 := SCRATCH                              SEEK RETURN ADDRESS    * 00244000
245  *  R5 := SCRATCH                                                     * 00245000
246  *  R6 := CURRENT TRACK ADDRESS                                       * 00246000
247  *  R7 := POSITIVE SEEK DISTANCE                                      * 00247000
248  *                                                                    * 00248000
249  ********************************************************************** 00249000

251  ********************************************************************** 00251000
252  *                                                                    * 00252000
253  *     THE PURPOSE OF THE SINIT IS TO INITIALIZE THE MODEL PARAMETERS * 00253000
254  *  AND THE SWITCHPOINT VALUE.  AT THE END OF THIS CODE, THE MODEL    * 00254000
255  *  POSITION IS CONTAINED IN MEMORY LOCATION M, THE ETA SQUARED VALUE * 00255000
256  *  IS CONTAINED IN ETASQ, ETA TIMES 2 IS IN ETA2, THE SWITCHPOINT    * 00256000
257  *  VALUE IS IN R5, AND THE ADJUSTED MODEL TARGET IS IN PTARG.  ALL   * 00257000
258  *  REGISTERS ARE VOLATILE (EXCEPT FOR R0 AND R5).                    * 00258000
259  *     THE SEEK SERVO ALGORITHM DEVELOPES A STEADY STATE SERVO ERROR  * 00259000
260  *  OF ABOUT 3.75 TRACKS.  THIS MEANS THAT THE ACTUAL ARM WILL TEND   * 00260000
261  *  TO LEAD THE MODEL BY ABOUT 3.75 TRACKS AND THUS WHEN THE MODEL    * 00261000
262  *  REACHES THE TARGET TRACK, THE ACTUAL ARM WILL HAVE OVERSHOT BY     * 00262000
263  *  3.75 TRACKS.  THE SEEK ROUTINE COMPENSATES FOR THIS BY HAVING     * 00263000
264  *  THE MODEL CONVERGE 3.75 TRACKS SHORT OF THE ACTUAL TARGET TRACK,  * 00264000
265  *  AND THEN JUMPING THE MODEL POSITION TO THE TARGET TRACK AFTER THE * 00265000
266  *  MODEL ETA HAS REACHED 0.  THIS SCHEME HAS THE DISADVANTAGE THAT   * 00266000
267  *  FOR SHORT SEEKS THE MODEL NEVER REACHES ITS STEADY STATE SERVO    * 00267000
268  *  ERROR.  TO REMEDY THIS PROBLEM, THE SEEK ROUTINE REDUCES THE SEEK * 00268000
269  *  DISTANCE BY ONLY ONE TRACK (INSTEAD OF 3.75) IF THE ACTUAL SEEK   * 00269000
270  *  DISTANCE IS LESS THAN 6 TRACKS (EXCEPT 0 OR 1 TRACK SEEKS WHICH   * 00270000
271  *  ARE DEALT WITH SEPARATELY).
```

```
                *                                                               *  00271000
272             *     IN ORDER TO ACCOMPLISH THIS DISTANCE OFFSETTING, THE ROUTINE   *  00272000
273             *  USES THE THREE CONSTANTS DOFF1, DOFF2, & DOFF3 (DEFINED BELOW).   *  00273000
274             *  THE ROUTINE SUBTRACTS 6 (DOFF1) FROM THE SEEK DISTANCE AND IF     *  00274000
275             *  THIS IS NEGATIVE THEN IT ADDS 2.75 (DOFF2) TO THE DISTANCE; NEXT, *  00275000
276             *  2.25 (DOFF3) IS ADDED TO THE SEEK DISTANCE REGARDLESS OF LENGTH.  *  00276000
277             *  THEREFORE, FOR 2,3,4, OR 5 TRACK SEEKS THE SEEK DISTANCE OFFSET   *  00277000
278             *  IS DOFF2+DOFF3-DOFF1 = -1 TRACK.  FOR SEEKS OF 6 TRACKS OR LONGER *  00278000
279             *  THE SEEK DISTANCE OFFSET IS DOFF3-DOFF1 = -3.75 TRACKS.  NOTE     *  00279000
280             *  THAT ALL VALUES ARE COMPUTED IN QUARTER TRACKS.                   *  00280000
281             *                                                                   *  00281000
282             *******************************************************************  00282000

284     0018    DOFF1 IS    24    * DISTANCE OFFSET 1 IS 6.00 TRACKS                  00284000
285     0006    DOFF2 IS    11    * DISTANCE OFFSET 2 IS 2.75 TRACKS                  00285000
286     0009    DOFF3 IS     9    * DISTANCE OFFSET 3 IS 2.25 TRACKS                  00286000
```

```
288                ********************************************************************** 00288000
289                *                                                                    * 00289000
290                *     THE FOLLOWING CODE PERFORMS THE SEEK DISTANCE OFFSETTING (SEE   * 00290000
291                *  THE ABOVE DESCRIPTION) AND STORES THE ADJUSTED RESULT IN PTARG.    * 00291000
292                *  THE FIRST INSTRUCTION SUBTRACTS DOFF1 OFF THE SEEK DISTANCE (R7).  * 00292000
293                *  IF THE SEEK DISTANCE IS GREATER THAN OR EQUAL DOFF1 THEN THE NEXT  * 00293000
294                *  INSTRUCTION BRANCHES; OTHERWISE, THE THIRD INSTRUCTION ADDS DOFF2  * 00294000
295                *  TO THE PARTIALLY ADJUSTED SEEK DISTANCE (R7).  REGARDLESS OF THE   * 00295000
296                *  SEEK DISTANCE, THE NEXT INSTRUCTION ADDS DOFF3 LEAVING R7 WITH     * 00296000
297                *  THE FULLY ADJUSTED SEEK DISTANCE FOR USE IN THE ETA CALCULATIONS   * 00297000
298                *  BELOW.  PTARG IS THE ADJUSTED MODEL TARGET.  FOR OUTWARD SEEKS,    * 00298000
299                *  PTARG EQUALS THE CURRENT TRACK LOCATION MINUS THE DISTANCE WHICH   * 00299000
300                *  EQUALS R6-R7.  FOR INWARD SEEKS, PTARG EQUALS MINUS THE CURRENT    * 00300000
301                *  TRACK LOCATION MINUS THE DISTANCE WHICH EQUALS -R6-R7.  NOTE THAT  * 00301000
302                *  PTARG IS NEGATIVE FOR INWARD SEEKS.  THESE TWO EQUATIONS DIFFER    * 00302000
303                *  ONLY IN THE SIGN OF R6; THEREFORE, THE NEXT THREE INSTRUCTIONS     * 00303000
304                *  TEST THE SEEK DIRECTION AND NEGATE R6 IF THE SEEK IS OUTWARD.      * 00304000
305                *  THUS THE EQUATION FOR PTARG REDUCES TO -(R6+R7) REGARDLESS OF THE  * 00305000
306                *  DIRECTION.  THE NEXT THREE INSTRUCTIONS PERFORM THIS OPERATION     * 00306000
307                *  LEAVING THE RESULT IN R3.  THIS VALUE IS IN QUARTER TRACK UNITS    * 00307000
308                *  THEREFORE, THE NEXT INSTRUCTION SHIFTS R3 LEFT 1 PLACE TO YIELD    * 00308000
309                *  PTARG IN EIGHTHS OF A TRACK.  THE FOLLOWING INSTRUCTION STORES     * 00309000
310                *  THIS VALUE IN PTARG.                                               * 00310000
311                *                                                                    * 00311000
312                ********************************************************************** 00312000
```

```
314    F81A  6F18  6  SINIT        R7 = R7-DOFF1      * R7 := SEEK DISTANCE - DOFF1          00314000
315    F81B  8110  6          GOTO  *+2  IF >          * BRANCH IF > 0                        00315000
316    F81C  6708  6                R7 = R7+DOFF2      * ADJUST SEEK DISTANCE (ADD DOFF2)     00316000
317    F81D  6709  6                R7 = R7+DOFF3      * R7 := FULLY ADJUSTED SEEK DISTANCE   00317000
318    F81E  2623  7          CMP   R3,R6              * TEST DIRECTION OF SEEK               00318000
319    F81F  8121  6          GOTO  *+2   IF >         * SKIP ON INWARD SEEK                  00319000
320    F820  8336  6                R6 = -R6           * R6 := - CURRENT TRACK (OUTWARD SEEK) 00320000
321    F821  5327  7                R3 = R7            * R3 := ADJUSTED SEEK DISTANCE         00321000
322    F822  7326  7                R3 = R3+R6         * R3 := - ADJUSTED TARGET              00322000
323    F823  8333  6                R3 = -R3           * R3 := ADJUSTED TARGET (*4)           00323000
324    F824  8703  6          LSL   R3                 * R3 := ADJUSTED TARGET (*8)           00324000
325    F825  D003 12          STOR  PTRNG = R3         * STORE ADJUSTED TARGET VALUE          00325000
       F826  0067
```

```
327          ********************************************************************  00327000
328          *                                                                  *  00328000
329          *     THE MODEL COMPUTATIONS ARE BASED ON A TIME VALUE WHICH IS THE  *  00329000
330          *  ESTIMATED TIME TO ARRIVAL AT THE TARGET TRACK.  THIS VALUE IS    *  00330000
331          *  COMPUTED FROM THE EQUATION T=SQRT(2*X/A) WHERE X IS THE DISTANCE  *  00331000
332          *  TRAVELED BY THE MODEL AND A IS THE MODEL ACCELERATION.  THE ETA   *  00332000
333          *  IS THEN ROUNDED TO THE NEAREST WHOLE NUMBER SO THAT THE MODEL     *  00333000
334          *  WILL CONVERGE EXACTLY TO THE (ADJUSTED) TARGET TRACK.  FROM THIS  *  00334000
335          *  ROUNDED VALUE THE MODEL PARAMETERS ETAC AND ETASQ ARE COMPUTED.   *  00335000
336          *     IN THE EQUATION T=SQRT(2*X/A), X IS EQUAL TO THE DISTANCE FROM *  00336000
337          *  THE SWITCHPOINT TO THE ADJUSTED TARGET WHICH EQUALS D*20/37 WHERE *  00337000
338          *  D IS THE ADJUSTED DISTANCE WHICH IS CONTAINED IN R7.  THUS THE    *  00338000
339          *  EQUATION REDUCES TO T=SQRT(R7)*SQRT(2*(4/7)/A).  THE FOLLOWING    *  00339000
340          *  CODE COMPUTES SQRT(R7).  THE ADJUSTED TARGET (R3) IN INVOLATILE.  *  00340000
341          *     THE FIRST TWO INSTRUCTIONS CLEAR R2 AND R5.  R2 WILL CONTAIN   *  00341000
342          *  THE OPERAND MINUS THE ROOT SQUARED (ERROR INDICATION) AND R5 WILL *  00342000
343          *  CONTAIN THE ROOT.  THE NEXT INSTRUCTION SETS R6 TO 9 WHICH IS THE *  00343000
344          *  ITERATION INDEX (THE PROGRAM WILL LOOP 9 TIMES).  THE NEXT FOUR   *  00344000
345          *  INSTRUCTIONS SHIFT (R2,R7) LEFT TWO PLACES.  THIS MULTIPLIES THE  *  00345000
346          *  OPERAND BY FOUR BRINGING IN TWO NEW BITS.  THE NEXT INSTRUCTION   *  00346000
347          *  SHIFTS THE ROOT (R5) LEFT ONE PLACE.  THE EFFECT OF THESE LAST 5  *  00347000
348          *  INSTRUCTIONS IS THAT THE OPERAND HAS BEEN MULTIPLIED BY 4 AND THE *  00348000
349          *  ROOT BY 2.  THE NEXT 3 INSTRUCTIONS SET R4 TO 2*ROOT+1 WHICH IS   *  00349000
350          *  THE DIFFERENCE BETWEEN ROOT**2 AND (ROOT+1)**2.  THE FOLLOWING    *  00350000
351          *  INSTRUCTION TESTS THIS VALUE.  IF IT IS LESS THAN OR EQUAL TO THE *  00351000
352          *  OPERAND MINUS THE ROOT**2 THEN THE NEXT INSTRUCTION BRANCHES;     *  00352000
353          *  OTHERWISE THE NEXT 3 INSTRUCTIONS INCREMENT THE ROOT (R5) AND     *  00353000
354          *  UPDATE R2 BY SUBTRACTING R4.  THE NEXT INSTRUCTION DECREMENTS THE *  00354000
355          *  INDEX (R6) AND THE NEXT INSTRUCTION LOOPS BACK TO SINTI IF NOT 0;  *  00355000
356          *  OTHERWISE, THE ROUTINE DROPS THROUGH WITH R5 HAVING THE SQUARE    *  00356000
357          *  ROOT OF THE SEEK DISTANCE IN 1/4 TRACK UNITS.                     *  00357000
358          *                                                                  *  00358000
359          ********************************************************************  00359000
```

```
361   F827  E200  6                 R2 = 0          * R2 IS OPERAND - SQUARE                00361000
362   F828  E500  6                 R5 = 0          * R5 IS ROOT                            00362000
363   F829  E609  6                 R6 = 9          * R6 IS INDEX                           00363000
364   F82A  B707  6  SINT1  LSL      R7              * SHIFT (R2+R7) LEFT TWO BITS           00364000
365   F82B  B722  6         RRL      R2,C            *   THIS BRINGS TWO NEW BITS            00365000
366   F82C  B707  6         LSL      R7              *   INTO R2                             00366000
367   F82D  B722  6         RRL      R2,C                                                    00367000
368   F82E  B705  6         LSL      R5              * SHIFT ROOT LEFT ONE BIT               00368000
369   F82F  E401  6                  R4 = 1          * R4 = ROOT+ROOT+1                      00369000
370   F830  7425  7                  R4 = R4+R5                                              00370000
371   F831  7425  7                  R4 = R4+R5                                              00371000
372   F832  2224  7         CMP      R4,R2           * IF 2*ROOT+1 > OPERAND-ROOT**2         00372000
373   F833  B137  6         GOTO     SINT2 IF >      * THEN GOTO SINT2                       00373000
374   F834  6501  6                  R5 = R5+1       * ELSE   ROOT = ROOT+1                  00374000
375   F835  7A24  7                  R2 = R4-R2      *  AND   R2 = OPERAND-ROOT**2           00375000
376   F836  B332  6                  R2 = -R2                                                00376000
377   F837  6E01  6  SINT2           R6 = R6-1       * DECREMENT INDEX                       00377000
378   F838  B12A  6         GOTO     SINT1 IF >      * LOOP TILL DONE                        00378000
```

```
                ************************************************************************  00380000
                *                                                                      *  00381000
                *     AT ENTRY INTO THE FOLLOWING CODE, R3 HAS THE ADJUSTED TARGET     *  00382000
                *  VALUE AND R5 CONTAINS THE SQRT(D) WHERE D IS THE ADJUSTED SEEK      *  00383000
                *  DISTANCE.  SINCE THE ETA IS EQUAL TO SQRT(D)*SQRT(2*(4/7)/A),       *  00384000
                *  R5 MUST BE MULTIPLIED BY SQRT(2*(4/7)/A) WHICH IS A CONSTANT        *  00385000
                *  EQUAL TO APPROXIMATELY 2.515625.  THE FOLLOWING CODE THEREFORE      *  00386000
                *  MULTIPLIES THE SQRT(D) BY 2.515625.                                 *  00387000
                *     THE MULTIPLICATION IS DONE BY THE FIRST EIGHT INSTRUCTIONS.      *  00388000
                *  THE SINT4 ROUTINE PERFORMS A SHIFT AND ADD OPERATION, THE SHIFT     *  00389000
                *  ONLY IS DONE EXPLICITLY.  SINCE THE SQRT(D) CONTAINED IN R5 WAS     *  00390000
                *  EXPRESSED IN QUARTER TRACK UNITS AND SINCE THE ROUTINE PERFORMS     *  00391000
                *  SIX SHIFTS IN ADDITION TO THE MULTIPLY BY 2.X SHIFT, THE RESULT     *  00392000
                *  LEFT IN R6 AFTER THE EIGHTH INSTRUCTION HAS THE INTEGER PART IN     *  00393000
                *  THE HIGH BYTE.  THE NEXT INSTRUCTION ROUNDS THE VALUE BY ADDING     *  00394000
                *  1/2 AND THE FOLLOWING INSTRUCTION TRUNCATES THE RESULTING VALUE     *  00395000
                *  BY MOVING DOWN THE HIGH BYTE.  THIS CODE EXITS WITH THE INTEGER     *  00396000
                *  VALUE OF THE ETA CONTAINED IN R6.                                   *  00397000
                *                                                                      *  00398000
                ************************************************************************  00399000

F839  5625  7           R6 = R5          * R6 := R5*2.515625 := ETA                      00401000
F83A  B705  6     LSL   R5                                                               00402000
F83B  B705  6     LSL   R5                                                               00403000
F83C  B705  6     LSL   R5                                                               00404000
F83D  B705  6     LSL   R5                                                               00405000
F83E  9706  9     CALL  SINT4                                                            00406000
F83F  B705  6     LSL   R5                                                               00407000
F840  9706  9     CALL  SINT4                                                            00408000
F841  6680  6           R6 = R6+!80      * ROUND OFF                                     00409000
F842  5696  7           R6 = R6(80)      * MOVE DOWN INTEGER PART                        00410000
```

```
412                ********************************************************************** 00412000
413                *                                                                    * 00413000
414                *     AT ENTRY INTO THE FOLLOWING CODE, R6 CONTAINS THE ETA AND R3   * 00414000
415                *  CONTAINS THE ADJUSTED TARGET VALUE.  USING THESE VALUES THIS CODE  * 00415000
416                *  COMPUTES THE SWITCHPOINT AND THE INITIAL VALUES FOR THE MODEL     * 00416000
417                *  PARAMTERS ETASQ, ETA2, AND M.                                     * 00417000
418                *     THE ETA SQUARED PARAMETER (ETASQ) IS COMPUTED BY SQUARING THE  * 00418000
419                *  ETA (R6).  THE FIRST 3 INSTRUCTIONS SET UP THE LOOP INDEX (R2),   * 00419000
420                *  THE PRODUCT (R4) AND THE MULTIPLIER (R5).  THE NEXT INSTRUCTION   * 00420000
421                *  DOUBLES THE PRODUCT (R4) (INITIALLY ZERO).  THE FOLLOWING TWO     * 00421000
422                *  SHIFT UP A NEW MULTIPLIER BIT AND SKIP IF THE BIT IS ZERO.  THE   * 00422000
423                *  NEXT INSTRUCTION WILL ADD THE ETA VALUE (R6) TO THE PRODUCT (R4)  * 00423000
424                *  IF THE MULTIPLIER BIT WAS A ONE.  THE FOLLOWING TWO INSTRUCTIONS  * 00424000
425                *  DECREMENT THE INDEX VALUE (R2) AND LOOP BACK TO SINT3 UNTIL THE   * 00425000
426                *  INDEX GOES TO ZERO.  THE FOLLOWING INSTRUCTION STORES THE SQUARED * 00426000
427                *  VALUE IN ETASQ.                                                   * 00427000
428                *     THE NEXT TWO INSTRUCTIONS COMPUTE THE ETA TIMES 2 VALUE (ETA2) * 00428000
429                *  BY SHIFTING ETA (R6) LEFT ONE PLACE AND THEN STORING THE VALUE IN * 00429000
430                *  ETA2.                                                             * 00430000
431                *     AT THIS POINT R3 CONTAINS THE ADJUSTED TARGET VALUE AND R4 HAS * 00431000
432                *  THE ETASQ VALUE.  THE NEXT INSTRUCTION CALLS THE MCOMP ROUTINE    * 00432000
433                *  WHICH COMPUTES THE MODEL LOCATION PARAMETER FROM THESE VALUES AND * 00433000
434                *  STORES IT IN M (IN EIGHTHS OF TRACKS).  THE CODE EXITS WITH THIS  * 00434000
435                *  INITIAL MODEL VALUE IN R5.                                        * 00435000
436                *     THE SWITCHPOINT IS THE SAME AS THE INITIAL MODEL VALUE EXCEPT  * 00436000
437                *  IT IS EXPRESSED IN QUARTER TRACKS.  THE NEXT INSTRUCTION SHIFTS   * 00437000
438                *  INITIAL MODEL VALUE (R5) RIGHT ONE PLACE AND THE MODEL INITIALIZE * 00438000
439                *  ROUTINE THEN RETURNS WITH THE SWITCHPOINT IN R5 (QUARTER TRACKS).  * 00439000
440                *                                                                    * 00440000
441                ********************************************************************** 00441000
```

```
443   F843  E207  6            R2 = 7              * R2 = LOOP INDEX                        00443000
444   F844  E400  6            R4 = 0              * CLEAR R4                               00444000
445   F845  5516  7            R5 = R6(HB1)        * R5 := MULTIPLIER (HIGH BYTE)           00445000
446   F846  B704  6  SINT3 LSL  R4                  * R4 *= R4*2                             00446000
447   F847  B705  6        LSL  R5                  * SHIFT UP NEXT MULTIPLIER BIT           00447000
448   F848  634A  6        GOTO *+2   .IF >=        * SKIP IF BIT = 0                        00448000
449   F849  7426  7            R4 = R4+R6          * ADD MULTIPLICAND (R6)                  00449000
450   F84A  6A01  6            R2 = R2-1           * DECREMENT INDEX                        00450000
451   F84B  6146  6        GOTO SINT3 IF >         * LOOP TILL DONE                         00451000
452   F84C  D004 12        STOR ETASQ = R4          * STORE ETA SQUARED VALUE               00452000
      F84D  006A
453   F84E  B706  6        LSL  R6                  * R6 := ETA TIMES 2                     00453000
454   F84F  D006 12        STOR ETA2 = R6           * STORE ETA TIMES 2 VALUE               00454000
      F850  006B
455   F851  9FD9  9        CALL ICOMP,I             * COMPUTE MODEL LOCATION                00455000
456   F852  B545  6        LSR  R5                  * R5 := SWITCHPOINT (QUARTER TRACKS)    00456000
```

```
458 ********************************************************************** 00458000
459 *                                                                    * 00459000
460 *     THE FOLLOWING CODE LOOPS ON ITSELF UNTIL THE ACTUATOR REACHES  * 00460000
461 *  THE SWITCHPOINT.  AT ENTRY INTO THE CODE, R5 CONTAINS THE VALUE   * 00461000
462 *  OF THE SWITCHPOINT (QUARTER TRACKS), R4 CONTAINS THE ACCELERATION * 00462000
463 *  SERVO VALUE, AND R0 CONTAINS THE SSLIM VALUE (THE SSLIM VALUE AT  * 00463000
464 *  THIS POINT IS EITHER 0 FOR INWARD SEEKS OR #8000 FOR AN OUTWARD   * 00464000
465 *  SEEK).  DURING THIS PHASE A SINGLE ERRONEOUS TRACK SAMPLE IS NOT  * 00465000
466 *  ALLOWED TO PREMATURELY INDICATE SWITCHPOINT ARRIVAL.  THIS IS     * 00466000
467 *  ACHIEVED BY TESTING THE DISTANCE BETWEEN THE TRACK SAMPLE WHICH   * 00467000
468 *  APPEARS TO HAVE REACHED THE SWITCHPOINT AND THE PREVIOUS SAMPLE.  * 00468000
469 *  IF THIS DISTANCE IS GREATER THAN THE MAXIMUM VELOCITY (MAXV) THEN * 00469000
470 *  THE SAMPLE IS IGNORED AND THE CODE EXECUTES ANOTHER SAMPLE READ.  * 00470000
471 *     THE FIRST INSTRUCTION POPS THE STACK TO GET THE MAXIMUM SERVO  * 00471000
472 *  VALUE (R4).  THE NEXT INSTRUCTION PROVIDES A SECTOR TIME DELAY IN * 00472000
473 *  ORDER TO SYNC THE ROUTINE TO THE GAP AND ALLOW THE ELECTRONICS    * 00473000
474 *  TIME TO SETTLE OUT.                                               * 00474000
475 *     THE NEXT INSTRUCTION READS A TRACK SAMPLE INTO R2.  THIS SETS  * 00475000
476 *  UP THE LOOP.  THE NEXT INSTRUCTION TRANSFERS THE PREVIOUS TRACK   * 00476000
477 *  SAMPLE TO R3 AND THE FOLLOWING INSTRUCTION READS A NEW TRACK      * 00477000
478 *  SAMPLE INTO R2.  THE NEXT TWO INSTRUCTIONS SET R6 WITH THE VALUE  * 00478000
479 *  OF THE SWITCHPOINT - THE CURRENT TRACK SAMPLE.  THE SIGN OF THIS  * 00479000
480 *  VALUE INDICATES TO WHICH SIDE OF THE SWITCHPOINT THE TRACK SAMPLE * 00480000
481 *  LIES.  THE NEXT INSTRUCTION EXCLUSIVE ORS R6 WITH THE SSLIM VALUE * 00481000
482 *  WHICH HAS THE EFFECT OF COMPLEMENTING THE SIGN BIT IF AND ONLY IF * 00482000
483 *  THE SEEK IS OUTWARD.  THUS THE SIGN OF R6 NOW INDICATES WHETHER   * 00483000
484 *  OR NOT SWITHCPOINT HAS BEEN PASSED.  THE NEXT INSTRUCTION LOOPS   * 00484000
485 *  BACK TO SK03 IF THE R6 IS POSITIVE INDICATING THE SWITCHPOINT HAS * 00485000
486 *  NOT YET BEEN REACHED.                                             * 00486000
```

```
487                     *     THE NEXT THREE INSTRUCTIONS SET R3 WITH THE DISTANCE BETWEEN   *  00487000
488                     *  THE LAST TWO TRACK SAMPLES (ABSOLUTE VALUE).  THIS VALUE IS THEN  *  00488000
489                     *  COMPARED TO THE MAXIMUM VELOCITY BY THE NEXT INSTRUCTION, AND THE *  00489000
490                     *  FOLLOWING INSTRUCTION LOOPS BACK TO SK03 IF THE DISTANCE IS TOO   *  00490000
491                     *  LARGE (INDICATING A TRACK SAMPLING ERROR).                        *  00491000
492                     *     WHEN THE SWITCHPOINT HAS BEEN REACHED, THE SERVO ERROR (R6) IS *  00492000
493                     *  SET TO ZERO AND THE CODE THEN BRANCHES INTO THE SERVO LOOP AT THE *  00493000
494                     *  POINT WHERE THE SCW VALUE IS SET (FROM R4).                       *  00494000
495                     *                                                                    *  00495000
496                     ************************************************************************  00496000

498  F853  8904  9          POP   R4                 * R4 := MAXIMUM SERVO VALUE                00498000
499  F854  97DD  9          CALL  SGAP               * WAIT ONE SECTOR TIME DELAY               00499000
500  F855  97DD  9          CALL  SGAP               * R2 := TRACK SAMPLE (QUARTER TRACKS)      00500000
501  F856  5322  7  SK03           R3 = R2           * R3 := OLD TRACK SAMPLE                   00501000
502  F857  97DD  9          CALL  SGAP               * R2 := NEW TRACK SAMPLE                   00502000
503  F858  5622  7                 R6 = R2           * R6 := NEW TRACK SAMPLE                   00503000
504  F859  7E25  7                 R6 = R5-R6        * R6 := DISTANCE FROM SWITCHPOINT          00504000
505  F85A  3620  7                 R6 = R6 XOR R0    * TEST DIRECTION FROM SWITCHPOINT          00505000
506  F85B  8156  6          GOTO  SK03  IF >         * LOOP IF NOT PAST SWITCHPOINT             00506000
507  F85C  7B22  7                 R3 = R2-R3        * R3 := NEW SAMPLE - OLD SAMPLE            00507000
508  F85D  835F  6          GOTO  *+2   IF >=        * SKIP IF POSITIVE                         00508000
509  F85E  6333  6                 R3 = -R3          * R3 := ABS(NEW SAMPLE - OLD SAMPLE)       00509000
510  F85F  A33C  6          CMP   R3,MAXV            * TEST DISTANCE BETWEEN SAMPLES            00510000
511  F860  8156  6          GOTO  SK03  IF >         * LOOP IF TRACK SAMPLE READ ERROR          00511000

512  F861  7A25  7                 R2 = R5-R2        * ANALYSIS PATCH                           00512000
513  F862  8732  6          LSL   R2,F               * ANALYSIS PATCH                           00513000
514  F863  9FFC  9          CALL  ERSET,I            * ANALYSIS PATCH                           00514000
515  F864  E600  6                 R6 = 0            * SET INITIAL ERROR TO ZERO                00515000
516  F865  8784  6          GOTO  SK05               * BRANCH INTO SERVO LOOP                   00516000
```

```
518                ************************************************************************  00518000
519                *                                                                      *  00519000
520                *       AT SK04:                                    STACK:             *  00520000
521                *  R0 := SSLIM VALUE                                                   *  00521000
522                *  R2 := SCRATCH                              TERMINATION COUNT        *  00522000
523                *  R3 := SCRATCH                              SEEK RETURN ADDRESS      *  00523000
524                *  R4 := SCRATCH                                                       *  00524000
525                *  R5 := SCRATCH                                                       *  00525000
526                *  R6 := SERVO ERROR * COMPENSATION GAIN (HIGH WORD)                   *  00526000
527                *  R7 := SCRATCH                                                       *  00527000
528                *                                                                      *  00528000
529                ************************************************************************  00529000


531                ************************************************************************  00531000
532                *                                                                      *  00532000
533                *     THE FOLLOWING CODE IS THE START OF THE SERVO LOOP.  THE SERVO    *  00533000
534                *  LOOP COMPUTES NEW VALUES FOR THE SCW BASED ON THE SERVO ERRORS      *  00534000
535                *  AND UPDATES THE SERVO MODEL.  AT EACH ITERATION THROUGH THE LOOP,   *  00535000
536                *  THE SCW IS SET EQUAL TO (K*E1)-(Z*K*E0) WHERE K IS THE GAIN OF      *  00536000
537                *  THE COMPENSATION, Z IS THE COMPENSATION'S ZERO LOCATION, E0 IS       *  00537000
538                *  THE PREVIOUS SERVO ERROR, AND E1 IS THE CURRENT SERVO ERROR.        *  00538000
539                *     AT THE START OF THE SERVO LOOP R6 CONTAINS THE K*E1 TERM FROM    *  00539000
540                *  THE PREVIOUS SERVO LOOP ITERATION.  THIS VALUE IS EQUAL TO K*E0     *  00540000
541                *  FOR THE PRESENT SERVO LOOP ITERATION AND CAN BE CONVERTED TO THE    *  00541000
542                *  SECOND TERM OF THE SERVO EQUATION BY NEGATING AND MULTIPLYING BY     *  00542000
543                *  Z (GIVES -Z*K*E0).                                                  *  00543000
544                *     THE FIRST INSTRUCTION NEGATE R6 LEAVING IT WITH -K*E0.  THE      *  00544000
545                *  NEXT INSTRUCTION SAVES THE SIGN BIT FOR USE IN THE MULTIPLY.  THE   *  00545000
546                *  NEXT INSTRUCTION CLEARS R4 WHICH IS TO RECEIVE THE RESULT OF THE    *  00546000
547                *  MULTIPLY BY Z.                                                      *  00547000
```

```
548                 *     SINCE Z IS EQUAL TO 7/8, R4 MUST BE SET EQUAL TO -(7/8)*K*E0.  *  00548000
549                 *  THIS IS ACCOMPLISHED BY THREE CALLS TO ZMULT.  ZMULT DIVIDES R6   *  00549000
550                 *  BY TWO AND ADDS THE RESULT TO R4.  PRIOR TO THE CALLS TO ZMULT,   *  00550000
551                 *  R4=0 AND R6=-K*E0.  AFTER THE FIRST CALL TO ZMULT, R4=R6=-K*E0/2. *  00551000
552                 *  AFTER THE SECOND ZMULT CALL, R4=-(3/4)*K*E0 AND R6=-(1/4)*K*E0.   *  00552000
553                 *  AFTER THE THIRD CALL TO ZMULT, R4=-(7/8)*K*E0 WHICH IS THE SECOND *  00553000
554                 *  TERM OF THE SERVO EQUATION.  (R6,R7)=-(1/8)*K*E0.                  *  00554000
555                 *                                                                     *  00555000
556                 ***********************************************************************  00556000

55H  F866  H336  6  SK04        R6 = -R6          * R6 := -K*E0                            00558000
559  F867  2B06  7       BTSI   R3 = R6(0)        * R3 := SIGN BIT                         00559000
560  F868  E400  6              R4 = 0            * R4 := 0                                00560000
561  F869  9702  9       CALL   ZMULT             * R4 := R6*7/8 := -Z*K*E0                00561000
562  F86A  9702  9       CALL   ZMULT                                                      00562000
563  F86B  2AF6  7       BTST   R2 = R6(15)       * R2 := LSB OF R6                        00563000
564  F86C  9702  9       CALL   ZMULT                                                      00564000
565  F86D  7422  7              R4 = R4+R2        * ROUND OFF R4                           00565000
```

```
                ********************************************************************** 00567000
                *                                                                    * 00568000
                *    HAVING COMPUTED THE SECOND TERM OF THE SERVO EQUATION IN THE    * 00569000
                *  ABOVE CODE, THERE REMAINS THE FIRST TERM (K*E1) TO BE COMPUTED.   * 00570000
                *  THE FIRST STEP TO ACCOMPLISH THIS IS TO COMPUTE THE SERVO ERROR   * 00571000
                *  WHICH IS THE MODEL POSTION MINUS THE ACTUAL POSITION.  THE ACTUAL * 00572000
                *  POSITION IS READ FROM A TRACK SAMPLING WHICH YIELDS TWO BINARY    * 00573000
                *  PLACES; HOWEVER, THE FOUR STATES REPRESENTED BY THESE TWO BITS    * 00574000
                *  (00,01,10,11) CORRESPOND TO 1/8, 3/8, 5/8, AND 7/8 RESPECTIVELY.  * 00575000
                *  THE ERROR IS THEREFORE COMPUTED TO THREE BINARY PLACES (EIGHTHS).  * 00576000
                *     TO COMPUTE THE ERROR, THE MODEL POSITION IS FIRST LOADED FROM  * 00577000
                *  ITS MEMORY LOCATION (M).  (M IS IN EIGHTHS OF TRACKS)             * 00578000
                *     THE NEXT INSTRUCTION CALLS THE SGAP ROUTINE WHICH WAITS FOR A  * 00579000
                *  SECTOR GAP AND THEN READS THE TRACK ADDRESS SAMPLE.  THIS VALUE   * 00580000
                *  IS RETURNED IN R2 WITH A 2 BIT FRACTION.  THE NEXT INSTRUCTION    * 00581000
                *  SHIFTS THE VALUE LEFT ONE PLACE, SHIFTING A 1 INTO THE LSB, THUS  * 00582000
                *  LEAVING R2 WITH THE ACTUAL POSITION AND A FRACTIONAL PART OF 1/8, * 00583000
                *  3/8, 5/8 OR 7/8.  THE NEXT INSTRUCTION SETS R2 TO THE SERVO ERROR * 00584000
                *  (MODEL POSITION - ACTUAL POSITION) TO AN EIGHTH OF A TRACK.       * 00585000
                *     THE NEXT THREE INSTRUCTIONS SET R6 TO K*E1 WHERE K=32 AND E1   * 00586000
                *  IS IN R2 (IN EIGHTHS).  SINCE R2 IS IN EIGHTHS R6 SHOULD BE SET   * 00587000
                *  EQUAL TO K*(R2)/8 = (R2)*K/8 = (R2)*4.  THIS IS PERFORMED BY THE  * 00588000
                *  TWO SHIFTS.                                                       * 00589000
                *     THE FOLLOWING INSTRUCTION ADDS R6 (K*E1) TO R4 (-2*K*E0) WHICH * 00590000
                *  LEAVES R4 WITH (K*E1)-(2*K*E0) WHICH IS THE SERVO EQUATION.  THE  * 00591000
                *  NEXT THREE INSTRUCTIONS RESULT IN R5 BEING SET TO THE SIGN OF THE * 00592000
                *  RESULT AND R4 IS SET TO THE MAGNITUDE OF THE RESULT.              * 00593000
                *                                                                    * 00594000
                ********************************************************************** 00595000
```

```
597   F86E  C003 12     LOAD  R3 = M            * R3 := MODEL POSITION * 8          00597000
      F86F  006C
598   F870  97DD  9      CALL  SWAP              * R2 := ACTUAL POSITION * 4         00598000
599   F871  B732  6      LSL   R2,F              * R2 := ACTUAL POSITION * 8         00599000
600   F872  7A23  7            R2 = R3-R2        * R2 := ERROR * 8                   00600000
601   F873  9FFC  9      CALL  ERSET,I           * ANALYSIS PATCH                    00601000
602   F874  5622  7            R6 = R2           * R6 := K*E1                        00602000
603   F875  B706  6      LSL   R6                                                    00603000
604   F876  B706  6      LSL   R6                                                    00604000
605   F877  7426  7            R4 = R4+R6        * R4 := (K*E1)-(Z*K*E0)             00605000
606   F878  2D04  7      BTSI  R5 = R4(0)        * R5 := SIGN BIT OF R4 (SCW)        00606000
607   F879  B27B  6      GOTO  *+2  IF =         * SKIP IF R4 POSITIVE               00607000
608   F87A  B334  6            R4 = -R4          * R4 := ABSOLUTE VALUE (R4)         00608000
```

```
610                ********************************************************************** 00610000
611                *                                                                    * 00611000
612                *       AT FOLLOWING CODE:                        STACK:             * 00612000
613                *  R0 := SSLIM VALUE                                                 * 00613000
614                *  R2 := SERVO ERROR VALUE (EIGHTHS)          TERMINATION COUNT      * 00614000
615                *  R3 := SCRATCH                              SEEK RETURN ADDRESS    * 00615000
616                *  R4 := NEW SCW VALUE (MAGNITUDE)                                   * 00616000
617                *  R5 := SIGN OF NEW SCW VALUE (MSB)                                 * 00617000
618                *  R6 := K*(SERVO ERROR)                                             * 00618000
619                *  R7 := SCRATCH                                                     * 00619000
620                *                                                                    * 00620000
621                ********************************************************************** 00621000

623                ********************************************************************** 00623000
624                *                                                                    * 00624000
625                *     THE FOLLOWING CODE BOUNDS CHECKS THE NEW SCW VALUE, ADJUSTS    * 00625000
626                *  THE VALUE IF NECESSARY, AND OUTPUTS IT TO THE SCW REGISTER (XR1).  * 00626000
627                *  DEPENDING ON THE CONTENTS OF SSLIM (R0), THE SCW (XR1) BOUNDS ARE  * 00627000
628                *  EITHER -SCWMX TO 0, 0 TO SCWMX, OR -SCWMX TO SCWMX.  REGARDLESS,   * 00628000
629                *  THE SCW CANNOT EXCEED SCWMX.  THE FIRST INSTRUCTION COMPARES THE   * 00629000
630                *  MAGNITUDE OF THE SCW (R4) WITH SCWMX.  THE NEXT TWO INSTRUCTIONS   * 00630000
631                *  WILL SET THE SCW MAGNITUDE TO SCWMX (LARGEST VALUE IN BOUNDS) IF   * 00631000
632                *  IT EXCEEDS THIS BOUND.  THE NEXT INSTRUCTION TESTS THE SIGN OF     * 00632000
633                *  THE SCW VALUE (R5).  THE FOLLOWING TWO INSTRUCTIONS SET THE SCW    * 00633000
634                *  SIGN BIT IN R4 (BIT 10) IF THE SCW SHOULD BE NEGATIVE.             * 00634000
```

```
635                    *     THE RESULT OF THE FOLLOWING XOR INSTRUCTION HAS ITS LOW ORDER  *  00635000
636                    *  15 BITS EQUAL TO THE 15 LOW ORDER BITS OF SSLIM (R0).  THESE BITS *  00636000
637                    *  ARE ALL ZERO IF THE SCW RANGE IS SIGNED (EITHER -SCWMX TO ZERO OR *  00637000
638                    *  ZERO TO SCWMX).  IF THE RANGE IS UNSIGNED (-SCWMX TO SCWMX) THEN  *  00638000
639                    *  AT LEAST ONE OF THESE BITS WILL BE A ONE.  THE SIGN BIT OF THE    *  00639000
640                    *  EXCLUSIVE OR RESULT IS THE EXCLUSIVE OR OF THE SIGN OF THE SCW    *  00640000
641                    *  VALUE (R5) AND THE SIGN OF SSLIM (R0).  IF THE RANGE IS SIGNED    *  00641000
642                    *  THEN THIS BIT IS A ZERO ONLY IF THE SCW VALUE HAS THE WRONG SIGN. *  00642000
643                    *  THEREFORE, THE 16 BIT RESULT WILL BE ZERO ONLY IF THE SCW VALUE   *  00643000
644                    *  SET THE SCW VALUE TO ZERO IF IT HAS AN INAPPROPRIATE SIGN BIT.    *  00644000
645                    *     AT THIS POINT THE SCW VALUE (R4) HAS BEEN PROPERLY BOUNDED AND *  00645000
646                    *  THE NEXT INSTRUCTION OUTPUTS IT TO THE SCW.  THIS INSTRUCTION IS  *  00646000
647                    *  ALSO THE POINT AT WHICH THE SERVO LOOP IS ENTERED FROM THE        *  00647000
648                    *  ACCELERATE UP PHASE AFTER THE SWITCHPOINT HAS BEEN REACHED.       *  00648000
649                    *                                                                    *  00649000
650                    ************************************************************************  00650000

652    F87B  A41F  6          CMP   R4,SCWMX          * TEST MAGNITUDE OF R4 (SCW)              00652000
653    F87C  867E  6          GOTO  *+2  IF <=        *    SKIP IF LESS THAN OR EQUAL SCWMX     00653000
654    F87D  E41F  6                R4 = SCWMX        *    ELSE SET TO SCWMX                    00654000
655    F87E  6500  6                R5 = R5+0         * TEST SIGN OF SCW (R5)                   00655000
656    F87F  8281  6          GOTO  *+2  IF =         *    SKIP IF POSITIVE                     00656000
657    F880  1CA4  7          BSET  R4(10)            *    ELSE SET SIGN OF R4 (SCW)            00657000
658    F881  3520  7                R5 = R5 XOR R0    * TEST SERVO LIMITS                       00658000
659    F882  8584  6          GOTO  *+2  IF <>        * SKIP IF IN BOUNDS                       00659000
660    F883  E400  6                R4 = 0            * SET R4 = 0  (SCW)                       00660000
661    F884  5924  8  SK05          XR1 = R4          * SCW := R4                               00661000
662    F885  9FFA  9          CALL  SCWST,I           * ANALYSIS PATCH                          00662000
```

```
                ********************************************************************** 00664000
                *                                                                    * 00665000
                *     THE FOLLOWING CODE UPDATES THE MODEL PARAMETERS! AT ENTRY INTO * 00666000
                *  THIS CODE, THE MODEL PARAMETERS ETA2, ETASQ, AND M CONTAIN THE    * 00667000
                *  APPROPRIATE VALUES FOR THE SERVO PASS JUST COMPLETED.  AT EXIT    * 00668000
                *  FROM THIS CODE THESE VALUES MUST BE SET APPROPRIATELY FOR THE     * 00669000
                *  NEXT PASS THROUGH THE SERVO LOOP.  (ETA = ETA-1)                  * 00670000
                *     THE FIRST INSTRUCTION LOADS THE ETA TIMES 2 PARAMETER (ETA2)   * 00671000
                *  INTO R4.  THE NEXT TWO INSTRUCTIONS WILL CAUSE A BRANCH TO SK09   * 00672000
                *  IF ETA2 IS ZERO WHICH INDICATES THAT THE MODEL HAS COMPLETED THE  * 00673000
                *  APPROACH AND IS NOW AT TARGET.                                    * 00674000
                *     SINCE (X-1)*2 = X-2 THE NEXT INSTRUCTION UPDATES THE ETA2      * 00675000
                *  PARAMETER BY SUBTRACTING 2 FROM IT.  IF THIS CAUSES THE VALUE TO  * 00676000
                *  GO TO ZERO THEN THE MODEL HAS ARRIVED AT TARGET AND THE FOLLOWING * 00677000
                *  INSTRUCTION DOES A BRANCH TO SK08 WHERE THE MODEL IS PROPERLY     * 00678000
                *  TERMINATED.  OTHERWISE THE NEXT INSTRUCTION STORES THE NEW ETA2.  * 00679000
                *     THE NEXT INSTRUCTION LOADS THE ETA SQUARED VALUE (ETASQ) INTO  * 00680000
                *  R5.  SINCE (X-1)**2 = X**2 - 2*X + 1 = X**2 - 2*(X-1) - 1, THE    * 00681000
                *  ETASQ VALUE IS UPDATED BY THE NEXT TWO VALUES WHICH SUBTRACT THE  * 00682000
                *  UPDATED ETA2 VALUE (=2*(X-1)) AND SUBTRACTING 1.  THE FOLLOWING   * 00683000
                *  INSTRUCTION STORES THE UPDATED ETASQ.                             * 00684000
                *     THE NEXT INSTRUCTION SETS UP A CALL TO MCOMP BY LOADING THE    * 00685000
                *  PTARG VALUE INTO R3.  THE NEXT INSTRUCTION CALLS MCOMP WHERE THE  * 00686000
                *  NEW MODEL POSITION IS COMPUTED AND STORED IN M.  (SEE DESCRIPTION  * 00687000
                *  OF MCOMP).  THE LAST INSTRUCTION BRANCHES BACK TO THE START OF    * 00688000
                *  THE SERVO LOOP.                                                   * 00689000
                *                                                                    * 00690000
                ********************************************************************** 00691000
```

```
693   F8B6  C004 12       LOAD  R4 = ETA2          * R4 := ETA TIMES 2                00693000
      F8B7  006B
694   F8B8  6400  6              R4 = R4+0         * TEST ETA                         00694000
695   F8B9  82AE  6        GOTO  SK09  IF =        * BRANCH IF ETA = 0                00695000
696   F8BA  6C02  6              R4 = R4-2         * UPDATE ETA TIMES 2               00696000
697   F8BB  86A5  6        GOTO  SK0A  IF <=       * BRANCH IF NEW ETA = 0            00697000
698   F8BC  D004 12       STOR  ETA2 = R4          * STORE UPDATED ETA TIMES 2        00698000
      F8BD  006B
699   F8BE  C005 12       LOAD  R5 = ETASQ         * R5 := ETA SQUARED                00699000
      F8BF  006A
700   F8C0  7C25  7              R4 = R5-R4        * UPDATE ETA SQUARED               00700000
701   F8C1  6C01  6              R4 = R4-1         * R4 := NEW ETA SQUARED            00701000
702   F8C2  D004 12       STOR  ETASQ = R4         * STORE UPDATED ETA SQUARED        00702000
      F8C3  006A
703   F8C4  C003 12       LOAD  R3 = PTARG         * R3 := ADJUSTED TARGET VALUE      00703000
      F8C5  0067
704   F8C6  9FD9  9       CALL  ICOMP,I            * COMPUTE MODEL POSITION VALUE     00704000
705   F8C7  8766  6       GOTO  SK0A               * BRANCH TO START OF SERVO LOOP    00705000
```

SEEK ROUTINE ONE TRACK SEEK (SPECIAL CASE)

```
707  ************************************************************************  00707000
708  *                                                                      *  00708000
709  *       AT SK06:                                    STACK:             *  00709000
710  *  R0 := SSLIM VALUE                                                   *  00710000
711  *  R2 := SEEK ICW VALUE                        MAXIMUM SERVO VALUE     *  00711000
712  *  R3 := TARGET TRACK                          TERMINATION COUNT       *  00712000
713  *  R4 := ACCELERATE UP SCW VALUE               SEEK RETURN ADDRESS     *  00713000
714  *  R5 := MAXIMUM SERVO VALUE                                           *  00714000
715  *  R6 := CURRENT TRACK                                                 *  00715000
716  *  R7 := POSITIVE SEEK DISTANCE                                        *  00716000
717  *                                                                      *  00717000
718  ************************************************************************  00718000


720  ************************************************************************  00720000
721  *                                                                      *  00721000
722  *     THE FOLLOWING CODE PERFORMS A ONE TRACK SEEK.  IT IS ENTERED     *  00722000
723  *  RIGHT AFTER THE ICW HAS BEEN SET AND SEEK MOTION STARTED.  THE      *  00723000
724  *  FIRST TWO INSTRUCTIONS SET UP THE DELAY INDEX AND CALL THE DELAY    *  00724000
725  *  ROUTINE, THUS INVOKING A DELAY WHILE THE ARM ACCELERATES TO ABOUT    *  00725000
726  *  THE MIDPOINT OF THE SEEK.  THE FOLLOWING TWO INSTRUCTIONS GET THE   *  00726000
727  *  MAXIMUM SERVO VALUE FROM THE STACK (R2) AND OUTPUT IT TO THE SCW    *  00727000
728  *  REGISTER.  THIS REVERSES THE CURRENT IN THE ACTUATOR AND BEGINS      *  00728000
729  *  DEACCELERATING THE ARM.  THE NEXT TWO INSTRUCTIONS SET UP THE       *  00729000
730  *  DELAY INDEX (R2) AND AGAIN CALL THE DELAY ROUTINE WHICH RESULTS     *  00730000
731  *  IN A DELAY WHILE THE ARM DEACCELERATES TO ZERO APPROXIMATELY ON     *  00731000
732  *  TARGET.  THE FOLLOWING BLOCK OF CODE IS ENTERED EITHER FROM THE     *  00732000
733  *  TRACK-TO-TRACK SEEK CODE OR FOR THE START OF A SEEK SELF.  IN       *  00733000
734  *  EITHER OF THESE CASES THE CODE EXITS DIRECTLY INTO FINE SERVOING.   *  00734000
735  *  THIS IS ACCOMPLISHED BY SETTING THE TERMINATION COUNT TO ONE AS     *  00735000
736  *  IS DONE BY THE FOLLOWING THREE INSTRUCTIONS.  THE FOLLOWING         *  00736000
737  *  INSTRUCTION CLEARS R2 THUS INITIALIZING THE SERVO ERROR TO ZERO.    *  00737000
738  *                                                                      *  00738000
739  ************************************************************************  00739000
```

```
741   F898 8802 6  SK06  LLIT  R2 = DLY1        * R2 := DELAY INDEX                    00741000
      F899 0198
742   F89A 97DA 9        CALL  SDLAY            * CALL DFLAY ROUTINE                   00742000
743   F89B 8902 9        POP   R2               * R2 := MAXIMUM SERVO VALUE            00743000
744   F89C 5922 8              XR1 = R2         * SCW := R2                            00744000
745   F89D 8802 6        LLIT  R2 = DLY2        * R2 := DELAY INDEX                    00745000
      F89E 022C
746   F89F 97DA 9        CALL  SDLAY            * CALL DFLAY ROUTINE                   00746000
747   F8A0 9FFA 9        CALL  SCWST,I          * ANALYSIS PATCH                       00747000
748   F8A1 8902 9  SK07  POP   R2               * R2 := TERMINATION COUNT              00748000
749   F8A2 E201 6              R2 = 1           * SET TERMINATION COUNT := 1           00749000
750   F8A3 8002 8        PUSH  R2               * SAVE TERMINATION COUNT               00750000
751   F8A4 E200 6              R2 = 0           * CLEAR R2 (SERVO ERROR)               00751000
```

```
753                  ************************************************************************  00753000
754                  *                                                                      *  00754000
755                  *       AT SK08:                                          STACK:       *  00755000
756                  *  R0 := SCRATCH                                                       *  00756000
757                  *  R2 := CURRENT SERVO ERROR                      TERMINATION COUNT    *  00757000
758                  *  R3 := SCRATCH                                  SEEK RETURN ADDRESS  *  00758000
759                  *  R4 := SCRATCH                                                       *  00759000
760                  *  R5 := SCRATCH                                                       *  00760000
761                  *  R6 := SCRATCH                                                       *  00761000
762                  *  R7 := SCRATCH                                                       *  00762000
763                  *                                                                      *  00763000
764                  *                                                                      *  00764000
765                  ************************************************************************  00765000

767                  ************************************************************************  00767000
768                  *                                                                      *  00768000
769                  *     THE FOLLOWING CODE IS EXECUTED ONLY ONCE DURING A SEEK.  IT IS   *  00769000
770                  *  ENTERED EITHER AT THE START OF A SEEK SELF (0 TRACK SEEK), JUST      *  00770000
771                  *  AFTER THE OPEN LOOP PORTION OF A ONE TRACK SEEK, OR WHEN THE        *  00771000
772                  *  ESTIMATED TIME TO ARRIVAL REACHES ZERO DURING ANY OTHER SEEK.       *  00772000
773                  *     THE FIRST THREE INSTRUCTIONS SET THE MODEL POSITION PARAMETER    *  00773000
774                  *  (M) TO THE ACTUAL TARGET TRACK.  THE NEXT INSTRUCTION SETS THE      *  00774000
775                  *  SSLIM VALUE (R0) SUCH THAT THE SERVO RANGE EXTENDS FROM -SCWMX TO   *  00775000
776                  *  SCWMX (FULL RANGE).  THE NEXT INSTRUCTION CLEARS THE SERVO ERROR    *  00776000
777                  *  TERM (R6).  THE FOLLOWING INSTRUCTION SETS THE ESTIMATED TIME TO    *  00777000
778                  *  ARRIVAL TO ZERO (ETA2) TO INDICATE ARRIVAL AT TARGET.               *  00778000
779                  *                                                                      *  00779000
780                  ************************************************************************  00780000

782  F8A5  C005 12   SK08  LOAD  R5 = CTHK        * R5 := TARGET TRACK (PHYSICAL*4)          00782000
     F8A6  0066
783  F8A7  B705  6         LSL   R5               * R5 := TARGET TRACK * 8                   00783000
784  F8A8  D005 12         STOR  M = R5           * SET MODEL TO TARGET TRACKS (EIGHTHS)     00784000
     F8A9  006C
785  F8AA  0001  6         R0 = R0+1              * SET SSLIM: MIN = -31; MAX = 31           00785000
786  F8AB  E600  6         R6 = 0                 * CLEAR SERVO ERROR TERM                   00786000
787  F8AC  D006 12         STOR  ETA2 = R6        * CLEAR ETA2                               00787000
     F8AD  006B
```

```
789 ********************************************************************** 00789000
790 *                                                                    * 00790000
791 *       AT SK09:                                      STACK:         * 00791000
792 *  R0 := SSLIM VALUE (FULL RANGE)                                    * 00792000
793 *  R2 := CURRENT SERVO ERROR                    TERMINATION COUNT    * 00793000
794 *  R3 := SCRATCH                                SEEK RETURN ADDRESS  * 00794000
795 *  R4 := SCRATCH                                                     * 00795000
796 *  R5 := SCRATCH                                                     * 00796000
797 *  R6 := K*SERVO ERROR                                               * 00797000
798 *  R7 := SCRATCH                                                     * 00798000
799 *                                                                    * 00799000
800 ********************************************************************** 00800000

802 ********************************************************************** 00802000
803 *                                                                    * 00803000
804 *     THE FOLLOWING CODE IS ENTERED FROM THE MODEL UPDATE CODE IF     * 00804000
805 *  THE MODEL VELOCITY HAS REACHED ZERO.  THIS CODE CHECKS THE SERVO   * 00805000
806 *  ERROR AND DETERMINES AT WHAT POINT TO SWITCH TO FINE SERVO AND AT  * 00806000
807 *  WHAT POINT TO EXIT THE SEEK ROUTINE.  THE TERMINATION IS DONE IN   * 00807000
808 *  TWO PHASES.  THE FIRST PHASE IS UNDER CONTROL OF THE TCNT1 AND     * 00808000
809 *  TERR1 PARAMETERS.  DURING THIS PHASE THE TERMINATION COUNT (WHICH  * 00809000
810 *  WAS INITIALIZED TO TCNT1) IS DECREMENTED EACH PASS IF THE SERVO    * 00810000
811 *  ERROR IS LESS THAN OR EQUAL TERR1.  IF THE ERROR EXCEEDS TERR1     * 00811000
812 *  THEN THE TERMINATION COUNT IS REINITIALIZED TO TCNT1 AND THE       * 00812000
813 *  TERMINATION SEQUENCE STARTS OVER.  WHEN THE TERMINATION COUNT IS   * 00813000
814 *  DECREMENTED TO ZERO, FINE SERVO IS INVOKED, THE TERMINATION COUNT  * 00814000
815 *  IS SET TO -TCNT2, AND THE TERMINATION SEQUENCE PROGRESSES TO THE   * 00815000
816 *  SECOND PHASE.  THIS PHASE IS UNDER CONTROL OF THE TCNT2 AND TERR2  * 00816000
817 *  PARAMETERS.  AT THE START OF THIS PHASE THE TERMINATION COUNT IS   * 00817000
818 *  EQUAL TO -TCNT2.  THEREAFTER THE TERMINATION COUNT IS INCREMENTED  * 00818000
819 *  EACH PASS IF THE SERVO ERROR IS LESS THAN OR EQUAL TERR2.  IF THE  * 00819000
820 *  ERROR EXCEEDS TERR2 THEN SEEK SERVO IS REINVOKED, THE TERMINATION  * 00820000
821 *  COUNT IS REINITIALIZED TO TCNT1, AND THE TERMINATION SEQUENCE      * 00821000
822 *  STARTS OVER FROM THE BEGINNING.  WHEN THE TERMINATION COUNT IS     * 00822000
823 *  INCREMENTED TO ZERO (IN THE SECOND PHASE) THE SEEK ROUTINE EXITS.  * 00823000
```

```
824                    *     THE FOLLOWING CODE BEGINS BY COPYING THE ERROR VALUE INTO R5.  *  00824000
825                    *  IF THE ERROR IS NEGATIVE, THE FOLLOWING TWO INSTRUCTIONS NEGATE   *  00825000
826                    *  R5, LEAVING IT WITH THE POSITIVE ERROR VALUE.  THE FOLLOWING TWO  *  00826000
827                    *  TWO INSTRUCTIONS POP AND TEST THE TERMINATION VALUE.  THE NEXT    *  00827000
828                    *  INSTRUCTION BRANCHES TO SK10 IF THE TERMINATION COUNT IS NEGATIVE *  00828000
829                    *  (SECOND PHASE OF TERMINATION SEQUENCE); OTHERWISE, THE CODE DROPS  *  00829000
830                    *  THROUGH TO THE NEXT BLOCK (FIRST PHASE OF TERMINATION SEQUENCE).  *  00830000
831                    *                                                                    *  00831000
832                    ************************************************************************  00832000

834    F8AE  5522  7  SK09        R5 = R2              * R5 := ERROR * 8                        00834000
835    F8AF  8361  6        GOTO  *+2   IF >=         * SKIP IF POSITIVE                       00835000
836    F8B0  8335  6              R5 = -R5             * R5 := ABS(ERROR*8)                     00836000
837    F8B1  8902  9        POP   R2                   * R2 := TERMINATION COUNT                00837000
838    F8B2  6200  6              R2 = R2+0            * TEST TERMINATION COUNT                 00838000
839    F8B3  848E  6        GOTO  SK10  IF <           * BRANCH IF NEGATIVE                     00839000
```

```
                    ********************************************************************************  00841000
                    *                                                                              *  00842000
                    *     AT ENTRY INTO THE FOLLOWING CODE, R2 CONTAINS THE TERMINATION            *  00843000
                    *  COUNT (>0), AND R5 CONTAINS THE SERVO ERROR (>0).  SEEK SERVO IS            *  00844000
                    *  IN EFFECT AND THE TERMINATION SEQUENCE IS IN ITS FIRST PHASE.               *  00845000
                    *     THE FOLLOWING CODE BEGINS BY COMPARING THE SERVO ERROR WITH              *  00846000
                    *  TERR1.  IF THE SERVO ERROR IS GREATER THAN TERR1, THE FOLLOWING            *  00847000
                    *  INSTRUCTION WILL BRANCH TO SK13 WHERE THE TERMINATION COUNT WILL           *  00848000
                    *  BE RESET TO TCNT1; OTHERWISE, THE TERMINATION COUNT (R2) WILL BE           *  00849000
                    *  DECREMENTED BY THE FOLLOWING INSTRUCTION.  IF THE COUNT HAS NOT            *  00850000
                    *  YET REACHED ZERO, THE NEXT INSTRUCTION WILL BRANCH TO SK14 WHERE           *  00851000
                    *  THE TERMINATION COUNT WILL BE PUT BACK ON THE STACK AND CONTROL            *  00852000
                    *  PASSED BACK TO THE SERVO LOOP.                                             *  00853000
                    *     IF THE TERMINATION COUNT HAS REACHED ZERO THEN THE FIRST PHASE          *  00854000
                    *  OF THE TERMINATION SEQUENCE IS ENDED.  THE NEXT INSTRUCTION GETS           *  00855000
                    *  THE FINE SERVO ICW VALUE FROM CICW WHICH WAS SET UP PRIOR TO               *  00856000
                    *  ENTERING THIS ROUTINE.  THE NEXT INSTRUCTION OUTPUTS THIS VALUE            *  00857000
                    *  TO THE ICW THUS INVOKING FINE SERVO.  THE FOLLOWING INSTRUCTION            *  00858000
                    *  SETS THE TERMINATION COUNT (R2), WHICH IS CURRENTLY ZERO, TO THE           *  00859000
                    *  NEGATIVE VALUE OF TCNT2 BY SUBTRACTING (0-TCNT2=-TCNT2).  THE              *  00860000
                    *  NEXT INSTRUCTION BRANCHES TO SK14 FOLLOWING WHICH THE TERMINATION          *  00861000
                    *  COUNT IS PUSHED ONTO THE STACK AND CONTROL GIVEN BACK TO THE               *  00862000
                    *  SERVO LOOP.                                                                *  00863000
                    *                                                                              *  00864000
                    ********************************************************************************  00865000

F8B4  A502  6       CMP   R5,TERR1          * TEST ERROR*A                                          00867000
F8B5  81CF  6       GOTO  SK13  IF >        * BRANCH IF > TERR1                                     00868000
F8B6  6A01  6             R2 = R2-1         * DECREMENT TERMINATION COUNT                           00869000
F8B7  8100  6       GOTO  SK14  IF >         * BRANCH IF > 0                                         00870000
F8B8  C005 12       LOAD  R5 = CICW         * R5 := FINE SERVO ICW                                  00871000
F8B9  0064
F8BA  5825  8             XR0 = R5          * SET ICW (WITH FINE SERVO)                             00872000
F8BB  9FF9  9       CALL  SKCLR,I           * ANALYSIS PATCH                                        00873000
F8BC  6A08  6             R2 = R2-TCNT2     * SET FINE SERVO TERM COUNT                             00874000
F8BD  8700  6       GOTO  SK14              * BRANCH                                                00875000
```

```
877 ********************************************************************** 00877000
878 *                                                                    * 00878000
879 *       AT SK10:                                      STACK:         * 00879000
880 *  R0 := SSLIM VALUE (FULL RANGE)                                    * 00880000
881 *  R2 := TERMINATION COUNT                       SEEK RETURN ADDRESS  * 00881000
882 *  R3 := SCRATCH                                                     * 00882000
883 *  R4 := SCRATCH                                                     * 00883000
884 *  R5 := POSITIVE SERVO ERROR (EIGHTHS)                              * 00884000
885 *  R6 := K*SERVO ERROR                                               * 00885000
886 *  R7 := SCRATCH                                                     * 00886000
887 *                                                                    * 00887000
888 ********************************************************************** 00888000

890 ********************************************************************** 00890000
891 *                                                                    * 00891000
892 *     AT ENTRY INTO THE FOLLOWING CODE, THE TERMINATION COUNT (R2)   * 00892000
893 *  IS NEGATIVE AND FINE SERVO IS IN EFFECT (THE TERMINATION SEQUENCE * 00893000
894 *  IS IN ITS SECOND PHASE).  THE FIRST INSTRUCTION TESTS THE SERVO   * 00894000
895 *  ERROR (R5) AGAINST TERR2.  IF THE ERROR IS GREATER THAN TERR2,    * 00895000
896 *  THE NEXT INSTRUCTION BRANCHES TO SK12 WHERE THE 1ST PHASE OF THE  * 00896000
897 *  SEEK TERMINATION IS REINVOKED; ELSE, THE NEXT INSTRUCTION TESTS   * 00897000
898 *  THE OFF TRACK FLAG.  IF THE FLAG IS SET THE NEXT INSTRUCTION WILL * 00898000
899 *  DROP TO THE NEXT THREE INSTRUCTIONS WHERE THE OFF TRACK COUNT IS  * 00899000
900 *  RESET AND THE OFF TRACK FLAG IS CLEARED FOLLOWED BY A BRANCH TO   * 00900000
901 *  SK14.  IF THE FLAG IS CLEAR THEN THE CODE BRANCHES TO SK11 WHERE  * 00901000
902 *  THE OFF TRACK COUNT IS UPDATED AND TESTED.  IF LESS THAN ZERO,    * 00902000
903 *  THE SEEK IS NOT DONE AND THE CODE BRANCHES TO SK14 WHERE THE OFF  * 00903000
904 *  TRACK COUNT (R2) IS PUSHED BACK ON THE STACK AND THE SERVO LOOP   * 00904000
905 *  IS REEXECUTED.  IF THE COUNT HAS REACHED ZERO, THEN THE SEEK HAS  * 00905000
906 *  SUCCESSFULLY COMPLETED, SO THE CODE SETS R2 TO 1 FOR SUCCESSFUL   * 00906000
907 *  COMPLETION STATUS AND BRANCHES TO THE EXIT CODE.                  * 00907000
908 *                                                                    * 00908000
909 ********************************************************************** 00909000
```

```
911   F8BE  A504  6  SK10  CMP   R5,TERR2          * TEST ERROR#A                00911000
912   F8BF  81CA  6        GOTO  SK12  IF >        * BRANCH IF > TERR2           00912000
913   F8C0  2CEC  8        BTST  R4 = XR4(14)      * TEST OFF TRACK FLAG         00913000
914   F8C1  82C6  6        GOTO  SK11  IF =        * BRANCH IF ON TRACK          00914000
915   F8C2  E200  6              R2 = 0            * CLEAR R2*(TERMINATION COUNT) 00915000
916   F8C3  6A08  6              R2 = R2-TCNT2     * R2 = -TERMINATION COUNT     00916000
917   F8C4  EA06  7              XR2 = 6           * CLEAR OFF TRACK FLAG        00917000
918   F8C5  87D0  6        GOTO  SK14              * BRANCH                      00918000
919   F8C6  6201  6  SK11        R2 = R2+1         * INCREMENT TERMINATION COUNT 00919000
920   F8C7  84D0  6        GOTO  SK14  IF <        * BRANCH IF NOT DONE          00920000
921   F8C8  E201  6              R2 = 1            * SET STATUS FOR SUCCESSFUL SEEK 00921000
922   F8C9  87F6  6        GOTO  EXIT              * BRANCH TO EXIT CODE         00922000
```

```
924  ************************************************************************  00924000
925  *                                                                      *  00925000
926  *       AT SK12, SK13, OR SK14:                          STACK:        *  00926000
927  *  R0 := SSLIN VALUE (FULL RANGE)                                     *  00927000
928  *  R2 := TERMINATION COUNT                        SEEK RETURN ADDRESS  *  00928000
929  *  R3 := SCRATCH                                                       *  00929000
930  *  R4 := SCRATCH                                                       *  00930000
931  *  R5 := SCRATCH                                                       *  00931000
932  *  R6 := N*SERVO ERROR                                                 *  00932000
933  *  R7 := SCRATCH                                                       *  00933000
934  *                                                                      *  00934000
935  ************************************************************************  00935000


937  ************************************************************************  00937000
938  *                                                                      *  00938000
939  *     AT SK12, FINE SERVO IS IN EFFECT AND THE TERMINATION SEQUENCE    *  00939000
940  *  IS IN ITS SECOND PHASE, BUT THE SERVO ERROR HAS EXCEEDED TERR2.     *  00940000
941  *  THEREFORE, THE CODE MUST REINITIALIZE THE TERMINATION SEQUENCE.     *  00941000
942  *  THE FIRST STEP IN DOING THIS IS TO REINVOKE THE SEEK SERVO.  THE    *  00942000
943  *  FIRST INSTRUCTION GETS THE FINE SERVO ICW VALUE FROM CICW.  THE     *  00943000
944  *  FOLLOWING TWO INSTRUCTIONS SET THE SEEK BIT IN THE ICW VALUE (R5)   *  00944000
945  *  AND OUTPUT THIS VALUE TO THE ICW THUS INVOKING SEEK SERVO.          *  00945000
946  *     AT SK13, SEEK SERVO IS IN EFFECT (EITHER JUST SET IN THE PRIOR   *  00946000
947  *  INSTRUCTIONS OR FROM THE FIRST PHASE OF THE TERMINATION SEQUENCE)   *  00947000
948  *  BUT THE SERVO ERROR HAS EXCEEDED THE ERROR BOUND (TERR1 OR TERR2)   *  00948000
949  *  AND THEREFORE, THE TERMINATION COUNT (R2) MUST BE RESET TO TCNT1.   *  00949000
950  *  THIS IS DONE BY THE INSTRUCTION AT SK13.                            *  00950000
951  *     AT SK14, THE APPROPRIATE SERVO VALUE IS IN THE ICW AND THE       *  00951000
952  *  APPROPRIATE TERMINATION COUNT IS IN R2.  THESE TWO INSTRUCTIONS     *  00952000
953  *  PUT THE TERMINATION COUNT (R2) BACK ONTO THE STACK AND BRANCH TO    *  00953000
954  *  SK04 THUS REEXECUTING THE SERVO LOOP.                               *  00954000
955  *                                                                      *  00955000
956  ************************************************************************  00956000
```

```
95A  FBCA C005 12  SK12  LOAD  R5 = CICW      * R5 = FINE SERVO ICW          00958000
     FBCB 0064
     FBCC 3095  7        BCPL  R5(9)          * SET SEEK BIT OF ICW MASK     00959000
959  FBCD 5825  8              AND = R5       * SET ICW (WITH SEEK)          00960000
960  FBCE 9FF8  9        CALL  SKSET,1        * ANALYSIS PATCH               00961000
961
963  FBCF E203  6  SK13        R2 = TCNT1     * RESET TERMINATION COUNT      00963000
965  FBD0 0002  6  SK14  PUSH  R2             * SAVE TERMINATION COUNT       00965000
966  FBD1 8766  6        GOTO  SK04           * LOOP                         00966000
```

```
968                 ********************************************************************** 00968000
969                 *                                                                    * 00969000
970                 *       AT ZMULT:                                      STACK:        * 00970000
971                 *  R0 := ZMULT RETURN ADDRESS                                        * 00971000
972                 *  R2 := SCRATCH                                  SSLIM VALUE        * 00972000
973                 *  R3 := SIGN BIT OF R6                           TERMINATION COUNT  * 00973000
974                 *  R4 := Z*K*E0                                   SEEK RETURN ADDRESS * 00974000
975                 *  R5 := SCRATCH                                                     * 00975000
976                 *  R6 := SERVO ERROR * K (K*E0)                                      * 00976000
977                 *  R7 := SCRATCH                                                     * 00977000
978                 *                                                                    * 00978000
979                 *** NOTE ***    K := COMPENSATION GAIN                              * 00979000
980                 *                                                                    * 00980000
981                 ********************************************************************** 00981000

983                 ********************************************************************** 00983000
984                 *                                                                    * 00984000
985                 *     THE ZMULT ROUTINE IS USED IN THE SERVO LOOP TO MULTIPLY BY Z   * 00985000
986                 *  (Z = 7/8).  TO PERFORM THIS OPERATION ZMULT IS CALLED 3 TIMES.     * 00986000
987                 *  THE PURPOSE OF ZMULT IS TO DIVIDE R6 BY TWO AND ADD THIS TO R4.   * 00987000
988                 *  THUS IN CALLING ZMULT 3 TIMES WITH R6 BEING DIVIDED BY TWO EACH   * 00988000
989                 *  TIME, R4 IS SET AS FOLLOWS: R4 = R4 + R6/2 + R6/4 + R6/8.  THUS,  * 00989000
990                 *  SINCE R4 IS INITIALLY ZERO, R4 IS SET TO R6*7/8.                  * 00990000
991                 *     THE FIRST INSTRUCTION SHIFTS R6 RIGHT ONE PLACE, BUT THIS      * 00991000
992                 *  CLEARS THE MSB OF R6; THEREFORE, THE NEXT INSTRUCTION ADDS THE    * 00992000
993                 *  SIGN BIT (R3) TO R6 THUS PROPAGATING THE SIGN.  THE FOLLOWING     * 00993000
994                 *  INSTRUCTION ADDS R6 TO R4 AND THE LAST INSTRUCTION RETURNS TO THE * 00994000
995                 *  SERVO LOOP.                                                       * 00995000
996                 *                                                                    * 00996000
997                 ********************************************************************** 00997000

999  F8D2  8546  6  ZMULT LSR   R6              * R6 := R6/2                           00999000
1000 F8D3  7623  7             R3 = R6+R3                                            01000000
1001 F8D4  7426  7             R4 = R4+R6      * R4 := PARTIAL SUM                    01001000
1002 F8D5  8100 10       RTRN                  * RETURN                               01002000
```

SEEK ROUTINE SPECIAL MULTIPLICATION ROUTINE (7)

```
1004                ********************************************************************** 01004000
1005                *                                                                    * 01005000
1006                *     THE SINT4 ROUTINE IS USED IN THE SINIT ROUTINE TO PERFORM A    * 01006000
1007                *  SHIFT AND ADD OPERATION (SHIFT R5 AND ADD TO R6).                  * 01007000
1008                *     ICOMP IS AN INDIRECT LINK TO THE MCOMP ROUTINE WHICH COMPUTES  * 01008000
1009                *  THE MODEL VALUE M.                                                * 01009000
1010                *                                                                    * 01010000
1011                ********************************************************************** 01011000

1013  F8D6  6705  6 SINT4 LSL   R5              * R5 := R5*2                            01013000
1014  F8D7  7625  7         ADD   R6,R5         * ADD TO PRODUCT (R6)                   01014000
1015  F8D8  6100 10         RTRN                * RETURN                                01015000


1017  F8D9  F960    ICOMP DATA  MCOMP           * LINK TO MCOMP ROUTINE                 01017000
```

```
1019                ************************************************************************  01019000
1020                *                                                                      *  01020000
1021                *                          SHORT DELAY ROUTINE                         *  01021000
1022                *     THE SHORT DELAY ROUTINE IS USED BY THE SEEK ROUTINE AT THOSE     *  01022000
1023                *  THOSE PLACES WHERE THE PROGRAM MUST PAUSE FOR A FIXED PERIOD OF     *  01023000
1024                *  TIME.  THIS OCCURS IN THE ONE TRACK OPEN LOOP SEEK CODE, IN THE     *  01024000
1025                *  TRACK ADDRESS SAMPLING CODE, AND IN THE SEEK FAILURE CODE.          *  01025000
1026                *     THE OPEN LOOP CODE IN THE TRACK-TO-TRACK SEEK ACCELERATES UP     *  01026000
1027                *  FOR A FIXED TIME PERIOD, AND THEN DEACCELERATTES FOR A FIXED TIME   *  01027000
1028                *  PERIOD.  THESE TWO DELAYS USE THIS ROUTINE.                         *  01028000
1029                *     THE TRACK ADDRESS SAMPLING CODE MUST PAUSE BRIEFLY AFTER THE     *  01029000
1030                *  EOG (END OF GAP) FLAG HAS OCCURED IN ORDER TO INSURE THAT THE       *  01030000
1031                *  TRACK ADDRESS HAS BEEN LOADED INTO THE SPIAF (XR3).  THIS DELAY     *  01031000
1032                *  ALSO USES THIS ROUTINE.                                             *  01032000
1033                *     THE SEEK FAILURE CODE RETRACTS THE ARM INTO THE LANDING ZONE     *  01033000
1034                *  FOLLOWING A SEEK FAILURE (INABILITY TO LATCH UP ON TRACK).  IT       *  01034000
1035                *  ACCOMPLISHES THIS BY SUPPLYING HALF ACCELERATION TOWARDS THE        *  01035000
1036                *  LANDING ZONE LONG ENOUGH TO INSURE THAT THE ARM IS THERE.  THIS      *  01036000
1037                *  DELAY USES THIS ROUTINE AS WELL.                                    *  01037000
1038                *     AT ENTRY INTO THIS ROUTINE, R2 CONTAINS THE DELAY INDEX.  THE    *  01038000
1039                *  DELAY IS PERFORMED BY LOOPING ON THE FIRST TWO INSTRUCTIONS UNTIL    *  01039000
1040                *  THE INDEX HAS BEEN DECREMENTED TO ZERO AT WHICH POINT THE CODE       *  01040000
1041                *  FALLS THROUGH TO THE THIRD INSTRUCTION WHICH RETURNS.  IF THE        *  01041000
1042                *  INDEX IS EQUAL TO ZERO AT ENTRY, THE LOOP IS PERFORMED 64K TIMES.    *  01042000
1043                *     THE LOOP EXECUTES IN 12 MACHINE CYCLES.  THE OVERHEAD INVOLVED    *  01043000
1044                *  IN CALLING THE ROUTINE AND RETURNING IS 19 MACHINE CYCLES.  THUS     *  01044000
1045                *  FOR AN INDEX GREATER THAN ZERO THE DELAY IS 19+12*(INDEX) MACHINE    *  01045000
1046                *  CYCLES.  A MACHINE CYCLE IS FIXED AT 237.5 NANOSECONDS BY A         *  01046000
1047                *  CRYSTAL OSCILLATOR; THERFORE, FOR A DELAY INDEX GREATER THAN 0,     *  01047000
1048                *  THE DELAY OF THIS ROUTINE IS 4.5125 + 2.85*(INDEX) MICROSECONDS.     *  01048000
1049                *                                                                      *  01049000
1050                ************************************************************************  01050000

1052  F8DA  6A01  6  SDLAY      R2 = R2 - 1        * DECREMENT DELAY INDEX                    01052000
1053  F8DB  85DA  6        GOTO SDLAY IF <>        * LOOP UNTIL ZERO                          01053000
1054  F8DC  6100 10        RTRN                    * RETURN                                   01054000
```

```
1056                ********************************************************************** 01056000
1057                *                                                                    * 01057000
1058                *                          SGAP ROUTINE                              * 01058000
1059                *    THE SGAP ROUTINE SERVES THE TRIPLE PURPOSE OF (1) WAITING FOR   * 01059000
1060                *  FOR A SECTOR GAP TO OCCUR, THUS KEEPING TIME DEPENDENT PROCESSES  * 01060000
1061                *  SUCH AS THE SERVO LOOP IN STEP; (2) READING THE TRACK ADDRESS OUT * 01061000
1062                *  OF THE SPIBF FOLLOWING EOG (END OF GAP); AND (3) MONITORING THE   * 01062000
1063                *  NUMBER OF SAMPLE TIMES SINCE THE SEEK BEGAN AND ABORTING THE SEEK * 01063000
1064                *  AFTER A SPECIFIED GROSS TIMEOUT.  THIS ROUTINE DOES NOT ALTER THE * 01064000
1065                *  CONTENTS OF ANY REGISTER EXCEPT R2 IN WHICH IT RETURNS THE TRACK  * 01065000
1066                *  ADDRESS SAMPLE.                                                   * 01066000
1067                *    THE ROUTINE BEGINS BY WRITING A 7 TO THE FLAG REGISTER (XR2).   * 01067000
1068                *  THIS CLEARS THE EOG FLAG (END OF GAP).  THE NEXT TWO INSTRUCTIONS * 01068000
1069                *  TEST THE EOF FLAG AND LOOPS UNTIL IT SETS, THUS WAITING FOR THE   * 01069000
1070                *  END OF THE SECTOR GAP TO ARRIVE BEFORE CONTINUING.  THE FOLLOWING * 01070000
1071                *  INSTRUCTION LOADS THE FAILURE COUNT (FCNT) INTO R2.  FCNT IS A     * 01071000
1072                *  IS A VALUE THAT WAS INITIALIZED TO TMOUT AT THE START OF THE SEEK * 01072000
1073                *  AND IS DECREMENTED EACH TIME THIS ROUTINE IS CALLED (ONCE EACH    * 01073000
1074                *  SAMPLE TIME); IF IT EVER REACHES ZERO BEFORE THE SEEK COMPLETES,  * 01074000
1075                *  THE SEEK IS ABORTED.  THE NEXT INSTRUCTION DECREMENTS THE FAILURE * 01075000
1076                *  COUNT (R2) AND THE FOLLOWING INSTRUCTION BRANCHES TO THE FAILURE  * 01076000
1077                *  CODE IF THE COUNT HAS REACHED ZERO; OTHERWISE, THE FAILURE COUNT  * 01077000
1078                *  IS STORED BACK INTO MEMORY BY THE FOLLOWING INSTRUCTION.          * 01078000
1079                *    THE NEXT TWO INSTRUCTIONS LOAD R2 WITH A DELAY INDEX AND CALL   * 01079000
1080                *  THE DELAY ROUTINE.  THIS SHORT DELAY IS NECESSARY TO INSURE THAT  * 01080000
1081                *  THE TRACK ADDRESS SAMPLE HAS BEEN LOADED INTO THE SPIBF (XR3)     * 01081000
1082                *  BEFORE THAT REGISTER IS READ.  THE FOLLOWING INSTRUCTION LOADS    * 01082000
1083                *  THE GROUND TRUE TRACK ADDRESS INTO R2 FROM THE SPIBF (XR3).  THE  * 01083000
1084                *  NEXT INSTRUCTION COMPLEMENTS R2 LEVING IT WITH HIGH TRUE DATA.    * 01084000
1085                *    THE TRACK ADDRESS SAMPLE AS READ FROM THE SPIBF HAS THE TRACK   * 01085000
1086                *  ADDRESS VALUE IN THE HIGH ORDER 14 BITS WITH GARBAGE IN THE TWO   * 01086000
1087                *  LOW ORDER BITS.  THE NEXT TWO INSTRUCTIONS THEREFORE SHIFT OUT    * 01087000
1088                *  THE GARBAGE BITS LEAVING R2 WITH THE TRACK ADDRESS SAMPLE.  THE   * 01088000
1089                *  NEXT INSTRUCTION RETURNS TO THE CALLING CODE.                     * 01089000
1090                *                                                                    * 01090000
1091                ********************************************************************** 01091000
```

```
1093   F8DD  EA07  7  SGAP        XR2 = 7          * CLEAR FOG FLAG          01093000
1094   F8DE  2AFC  8        BTST  R2 = XR4(15)     * TEST FOG FLAG           01094000
1095   F8DF  820E  6        GOTO  *-1   IF =       * LOOP UNTIL FLAG SETS    01095000
1096   F8E0  C002 12        LOAD  R2 = FCNT        * R2 := TIMEOUT COUNT     01096000
       F8E1  0068
1097   F8E2  0A01  6              R2 = R2-1        * DECREMENT COUNT         01097000
1098   F8E3  82EE  6        GOTO  SFAIL IF =       * BRANCH IF TIMEOUT FAILURE 01098000
1099   F8E4  D002 12        STOR  FCNT = R2        * STORE UPDATED TIMEOUT COUNT 01099000
       F8E5  0068
1100   F8E6  E201  6              R2 = 1           * R2 := DELAY INDEX       01100000
1101   F8E7  97DA  9        CALL  SDLAY            * CALL SHORT DELAY ROUTINE 01101000
1102   F8E8  5228  8              R2 = XR3         * R2 := TRACK ADDRESS (*16) 01102000
1103   F8E9  B302  6              R2 = NOT R2      * R2 := HIGH TRUE ADDRESS (*16) 01103000
1104   F8EA  8542  6        LSR   R2               * R2 := TRACK ADDRESS * 8 01104000
1105   F8EB  8542  6        LSR   R2               * R2 := TRACK ADDRESS * 4 01105000
1106   F8EC  9FFB  9        CALL  TRSET,I          * ANALYSIS PATCH          01106000
1107   F8ED  8100 10        RTRN                   * RETURN                  01107000
```

```
1109          ************************************************************************  01109000
1110          *                                                                      *  01110000
1111          *       AT SFAIL:                                    STACK:          *  01111000
1112          *  R0 := SGAP RETURN ADDRESS                                           *  01112000
1113          *  R2 := 0                                      SSLIM VALUE            *  01113000
1114          *  R3 := SCRATCH                                TERMINATION COUNT      *  01114000
1115          *  R4 := SCRATCH                                SEEK RETURN ADDRESS    *  01115000
1116          *  R5 := SCRATCH                                                       *  01116000
1117          *  R6 := SCRATCH                                                       *  01117000
1118          *  R7 := SCRATCH                                                       *  01118000
1119          *                                                                      *  01119000
1120          ************************************************************************  01120000

1122          ************************************************************************  01122000
1123          *                                                                      *  01123000
1124          *     THE FOLLOWING CODE IS ENTERED FROM THE SGAP ROUTINE IF THE       *  01124000
1125          *  SEEK FAILS TO COMPLETE WITHIN 200 MSEC.  THE PURPOSE OF THIS CODE   *  01125000
1126          *  IS TO PUT THE HEAD IN THE LANDING ZONE, TURN OFF CURRENT IN THE     *  01126000
1127          *  ARM, RETURN R2 EQUAL TO ZERO IN ORDER TO REPORT SEEK FAILURE, AND   *  01127000
1128          *  RESTORE THE STACK BEFORE RETURNING TO THE CALLING PROGRAM.          *  01128000
1129          *     THE FIRST INSTRUCTION LOADS R7 WITH A SEEK ICW VALUE.  THE       *  01129000
1130          *  FOLLOWING INSTRUCTION OUTPUTS THIS VALUE TO THE ICW THUS INVOKING   *  01130000
1131          *  SEEK SERVO AND ENABLING THE SCW TO MOVE THE ARM TO THE LANDING      *  01131000
1132          *  ZONE.  THE FOLLOWING INSTRUCTION LOADS THE SCW WITH A VALUE THAT    *  01132000
1133          *  ACCELERATES THE ARM TOWARD THE LANDING ZONE AT HALF MAXIMUM         *  01133000
1134          *  ACCELERATION.  THE NEXT INSTRUCTION CALLS THE DELAY ROUTINE WHICH   *  01134000
1135          *  (SINCE THE DELAY INDEX (R2) = 0) DELAYS FOR ABOUT 187 MSEC.  THIS   *  01135000
1136          *  IS SUFFICIENT TIME FOR THE ARM TO REACH THE LANDING ZONE.  THE      *  01136000
1137          *  NEXT INSTRUCTION OUTPUTS A ZERO TO THE SCW WHICH TURNS OFF THE      *  01137000
1138          *  CURRENT IN THE ACTUATOR.  THE NEXT TWO INSTRUCTIONS REMOVE THE      *  01138000
1139          *  TOP TWO ITEMS IN THE STACK (SSLIM AND THE TERMINATION COUNT).       *  01139000
1140          *                                                                      *  01140000
1141          ************************************************************************  01141000
```

```
1143  F8EE  D807  0  SFAIL LLII  R7 = FVAL      * R7 = TCW VALUE FOR SEEK FAILURE      01143000
      F8EF  AFFE
1144  F8F0  5827  8              XR0 = R7       * SET TCW                              01144000
1145  F8F1  E910  7              XR1 = SCW16    * SET SCW TO HALF INWARD CURRENT       01145000
1146  F8F2  97DA  9        CALL  DELAY          * DELAY = APPROX. 187 MSEC.            01146000
1147  F8F3  E900  7              XR1 = SCW0     * SET SCW TO 0 (NO ACCELERATION)       01147000
1148  F8F4  B900  9        POP   R0             * R0 = SSUM VALUE                      01148000
1149  F8F5  B900  9        POP   R0             * R0 = TERMINATION COUNT               01149000
```

```
1151                    ************************************************************************  01151000
1152                    *                                                                      *  01152000
1153                    *        AT EXIT:                                      STACK:          *  01153000
1154                    *   R0 := SCRATCH                                                      *  01154000
1155                    *   R2 := SEEK TERMINATION STATUS                 SEEK RETURN ADDRESS  *  01155000
1156                    *   R3 := SCRATCH                                                      *  01156000
1157                    *   R4 := SCRATCH                                                      *  01157000
1158                    *   R5 := SCRATCH                                                      *  01158000
1159                    *   R6 := SCRATCH                                                      *  01159000
1160                    *   R7 := SCRATCH                                                      *  01160000
1161                    *                                                                      *  01161000
1162                    ************************************************************************  01162000


1164                    ************************************************************************  01164000
1165                    *                                                                      *  01165000
1166                    *      AT ENTRY INTO THE FOLLOWING CODE, EITHER THE SEEK HAS BEEN      *  01166000
1167                    *   SUCCESSFULLY COMPLETED AND THE HEAD IS LATCHED UP ON THE TARGET     *  01167000
1168                    *   TRACK (R7=0) OR THE SEEK FAILED AND THE HEAD IS IN THE LANDING      *  01168000
1169                    *   ZONE (R7 NOT EQUAL 0).  THE PURPOSE OF THE FOLLOWING CODE IS TO     *  01169000
1170                    *   RESTORE THE STACK AND RETURN TO THE CALLING PROGRAM.                *  01170000
1171                    *      THE FIRST INSTRUCTION RESTORES THE STACK BY POPPING THE SEEK     *  01171000
1172                    *   RETURN ADDRESS BACK TO THE TOP OF THE STACK (R0).  THE FOLLOWING    *  01172000
1173                    *   INSTRUCTION THEN RETURNS TO THE CALLING PROGRAM.                    *  01173000
1174                    *                                                                      *  01174000
1175                    ************************************************************************  01175000


1177  F8F6  8900  9 EXIT  POP   R0          * R0 := SEEK RETURN ADDRESS                          01177000
1178  F8F7  8100 10       RTRN              * RETURN FROM SEEK                                   01178000
```

SEEK ANALYSIS PATCHES

```
1180                ********************************************************************** 01180000
1181                *                                                                    * 01181000
1182                *     THE FOLLOWING DATA VALUES PROVIDE THE LINK BETWEEN THE SEEK    * 01182000
1183                *  ROUTINE ANALYSIS HOOKS AND THE DATA EXTRACTION ROUTINES IN THE    * 01183000
1184                *  SEEK CONTROL PROGRAM.                                             * 01184000
1185                *                                                                    * 01185000
1186                ********************************************************************** 01186000

1188  F8FA  FA01    SKSET DATA  ORG+X'201'    * LINK TO SKSET ROUTINE                    01188000
1189  F8F9  FA02    SKCLR DATA  ORG+X'202'    * LINK TO SKCLR ROUTINE                    01189000
1190  F8FA  FA03    SCWST DATA  ORG+X'203'    * LINK TO SCWST ROUTINE                    01190000
1191  F8FB  FA04    TKSET DATA  ORG+X'204'    * LINK TO TKSET ROUTINE                    01191000
1192  F8FC  FA05    EKSET DATA  ORG+X'205'    * LINK TO EKSET ROUTINE                    01192000
```

```
          SEEK ROUTINE      LINK TO SGAP ROUTINE

1194                        PORG  ORG+!15F                                    01194000
1195                        DORG  *                                          01195000

1197                  ************************************************************ 01197000
1198                  *                                                          * 01198000
1199                  *     LINK TO SGAP ROUTINE (USED IN LOGICAL SEEK ROUTINE)  * 01199000
1200                  *                                                          * 01200000
1201                  ************************************************************ 01201000

1203   F95F  F8DD     IGAP  DATA  SGAP        * LINK TO SGAP ROUTINE             01203000
```

```
1205                ************************************************************************  01205000
1206                *                                                                      *  01206000
1207                *     THIS ROUTINE COMPUTES THE MODEL POSITION FROM THE ETASQ VALUE    *  01207000
1208                *  AND THE MODEL ACCELERATION.  AT ENTRY INTO THIS ROUTINE, ETASQ IS   *  01208000
1209                *  CONTAINED IN R4 (THE ETA SQUARED VALUE), AND THE PTARG VALUE IS     *  01209000
1210                *  CONTAINED IN R3.  PTARG IS THE ADJUSTED TARGET VALUE FOR MODEL      *  01210000
1211                *  COMPUTATIONS; IT IS POSTIVE FOR OUTWARD SEEKS AND NEGATIVE FOR      *  01211000
1212                *  INWARD SEEKS.                                                       *  01212000
1213                *     THE MODEL POSITION IS COMPUTED USING THE PTARG VALUE AND THE     *  01213000
1214                *  EQUATION X=A*T**2/2, WHERE X IS DISTANCE, A IS ACCELLERATION, AND   *  01214000
1215                *  T IS TIME.  IN THIS EQUATION IF T**2 IS EQUAL TO ETASQ AND A IS     *  01215000
1216                *  EQUAL TO THE MODEL ACCELERATION, THEN X WILL BE THE DISTANCE        *  01216000
1217                *  FROM THE MODEL TARGET (PTARG).  SINCE THE MODEL POSITION IS TO BE   *  01217000
1218                *  COMPUTED IN FIGHTHS OF TRACKS, THE EQUATION MUST BE MULTIPLIED BY   *  01218000
1219                *  EIGHT TO YIELD X=4*A*ETASQ (IN EIGHTHS OF TRACKS).  ACCELLERATION   *  01219000
1220                *  OF THE MODEL IS EQUAL TO 75% OF THE FULL ACCELERATION OF THE ARM.   *  01220000
1221                *  THIS VALUE IS A CONSTANT EQUAL TO .1796875 TRACKS/SAMPLE**2.  THE   *  01221000
1222                *  VALUE OF 4*A IS THEREFORE EQUAL TO .71875 TRACKS/SAMPLE**2.  THE    *  01222000
1223                *  EQUATION IS THEREFORE Y=ETASQ*.71875.  THIS COMPUTATION IS DONE     *  01223000
1224                *  BY THE FIRST TEN INSTRUCTIONS WHICH MULTIPLY ETASQ (R4) BY THE      *  01224000
1225                *  VALUE .71875 AND LEAVE THE ROUNDED RESULT IN R5.                    *  01225000
1226                *     THE NEAT INSTRUCTION ADDS THIS VALUE TO PTARG.  FOR OUTWARD      *  01226000
1227                *  SEEKS THIS VALUE IS PTARG+X WHICH EQUALS THE MODEL POSITION AND     *  01227000
1228                *  FOR INWARD SEEKS THIS VALUE IS -(ABS(PTARG)-X) WHICH EQUALS THE     *  01228000
1229                *  NEGATIVE MODEL POSTION.  THE NEXT TWO INSTRUCTIONS CONVERT THE      *  01229000
1230                *  MODEL POSITION TO A POSITIVE VALUE WHICH IS STORED IN M BY THE      *  01230000
1231                *  FOLLOWING INSTRUCTION.  THE ROUTINE THEN RETURNS WITH THE MODEL     *  01231000
1232                *  POSITION IN R5.                                                     *  01232000
1233                *                                                                      *  01233000
1234                ************************************************************************  01234000
```

```
1236   F960   b524  7  MCOMP       R5 = R4          * R5 := R4*.71875 := M*8          01236000
1237   F961   B545  6        LSR   R5                                                 01237000
1238   F962   7524  7              R5 = R5+R4                                         01238000
1239   F963   B545  6        LSR   R5                                                 01239000
1240   F964   7524  7              R5 = R5+R4                                         01240000
1241   F965   B545  6        LSR   R5                                                 01241000
1242   F966   B545  6        LSR   R5                                                 01242000
1243   F967   7524  7              R5 = R5+R4                                         01243000
1244   F968   B545  6        LSR   R5                                                 01244000
1245   F969   B225  6        ADDC. R5         * ROUND TO NEAREST EIGHTH OF A TRACK    01245000
1246   F96A   7523  7              R5 = R5+R3  * ADD ADJUSTED TARGET VALUE             01246000
1247   F96B   B160  6        GOTO  *+2   IF > * SKIP IF POSITIVE                      01247000
1248   F96C   B335  6              R5 = -R5    * R5 := MODEL POSITION * 8           01248000
1249   F96D   b005  12       STOR  M = R5     * STOR NEW MODEL POSTION VALUE          01249000
       F96E   006C
1250   F96F   B100  10       RTRN             * RETURN                                01250000
```

```
SEEK ROUTINE     END OF ROUTINE

1252                ********************************************************************** 01252000
1253                *                                                                    * 01253000
1254                *                          END OF SEEK ROUTINE                       * 01254000
1255                *                                                                    * 01255000
1256                ********************************************************************** 01256000


1238                     END                                                               01258000
```

CROSS REFERENCE TABLE

CICW	100	LIT [78]	958	871						
CTRK	102	LIT [77]	782							
DLY1	408	LIT [118]	741							
DLY2	556	LIT [119]	745							
DOFF1	24	LIT [284]	314							
DOFF2	11	LIT [285]	316							
DOFF3	9	LIT [286]	317							
ERSET	F8FC	ROM [1192]	601	514						
ETA2	107	LIT [73]	787	698	693	454				
ETASQ	106	LIT [74]	702	699	452					
EXIT	F8F6	ROM [1177]	922							
FCNT	104	LIT [75]	1099	1096						
FVAL	-20482	LIT [112]	1143							
ICOMP	F8D9	ROM [1017]	704	455						
IGAP	F95F	ROM [1203]								
M	108	LIT [72]	1249	784	597					
MAXV	60	LIT [111]	510							
MCOMP	F960	ROM [1236]	1017							
ORG	-2048	LIT [28]	1194	1192	1191	1190	1189	1188	121	
PTARG	103	LIT [76]	703	325						
SCW0	0	LIT [108]	1147							
SCW16	16	LIT [109]	1145							
SCW31	31	LIT [106]	202							
SCW63	63	LIT [107]	156							
SCWMX	31	LIT [113]	654	652						
SCWST	F8FA	ROM [1190]	747	662	232					
SDLAY	F8DA	ROM [1052]	1146	1101	1053	746	742			
SEEK	F800	ROM [152]								
SFAIL	F8EE	ROM [1143]	1098							
SGAP	F8DD	ROM [1093]	1203	598	502	500	499	164	163	
SINIT	F81A	ROM [314]								
SINT1	F82A	ROM [364]	378							

```
SINT2   F837  NUM (377) 373
SINT3   F840  NUM (440) 451
SINT4   F8D6  NUM (1013) 408    406
SK01    F8UF  NUM (200) 160
SK02    F812  NUM (203) 159
SK03    F856  NUM (501) 511     506
SK04    F866  NUM (558) 966     705
SK05    F804  NUM (661) 516
SK06    F896  NUM (741) 236
SK07    F8A1  NUM (748) 165
SK08    F8A5  NUM (782) 697
SK09    F8AE  NUM (834) 695
SK10    F8BE  NUM (911) 839
SK11    F8C6  NUM (919) 914
SK12    F8CA  NUM (958) 912
SK13    F8CF  NUM (963) 868
SK14    F8D0  NUM (965) 920     918   875   870
SKCLR   F8F9  NUM (1189) 873
SKSET   F8F8  NUM (1188) 961    234
SSLIM   H0    REG (79)
TCNT1   3     LIT (114) 963     153
TCNT2   8     LIT (116) 916     674

TERR1   2     LIT (1151  867
TERR2   4     LIT (117) 911
TRSET   F8F8  NUM (1191) 1106
ZMULT   F8U2  NUM (999) 564     562   561
        NUMBER OF PASS 2 ERRORS=0
        NUMBER OF PASS 2 WARNINGS=0
```

Int. Re: Case 1205
Hewlett-Packard Company

22th August 1978

C L A I M S :

1. Apparatus for controlling the movement of the data head in a moving-head data recording system, characterized by:
signal conditioner (41) for receiving electronic signals representing data from the data head (46 a/b), said data including informational data recorded along tracks on a recording medium, and track following data and track addresses recorded at regular intervals in the informational data along the tracks;
track following means (42) coupled to the signal conditioner (41) for guiding the data head (46 a/b) along a track of recorded data in response to electronic signals representing track following data received from the signal conditioner (41); and
track locating means (43, 44, 45) coupled to the signal conditioner (41) and track following means (42) for moving the data head from one data track to another in response to the electronic signals representing track addresses and track following data received from the signal conditioner (41).

2. Apparatus as in claim 1, characterized in that the track following means (42) includes means for producing additional track locating data from the electronic signals representing track following data received from the signal conditioner (41).

3. Apparatus as in claims 1 or 2, characterized in that the informational data is recorded in sectors on magnetic recording medium, and
the track following data and track addresses are recorded in the inter-sector gap between informational data sectors.

4. Apparatus as in any of claims1 through 3, characterized in that the track addresses are recorded in a unit distance code format.

5. Apparatus as in any of claims 1 through 4, characterized in that the track following data for each track comprises two magnetic transitions serially disposed along the data track each extending from approximately the midpoint of the track to approximately the midpoint of the distance between tracks.

6. Apparatus as in claim 4 or 5, characterized in that the unit distance code format is a Gray code.

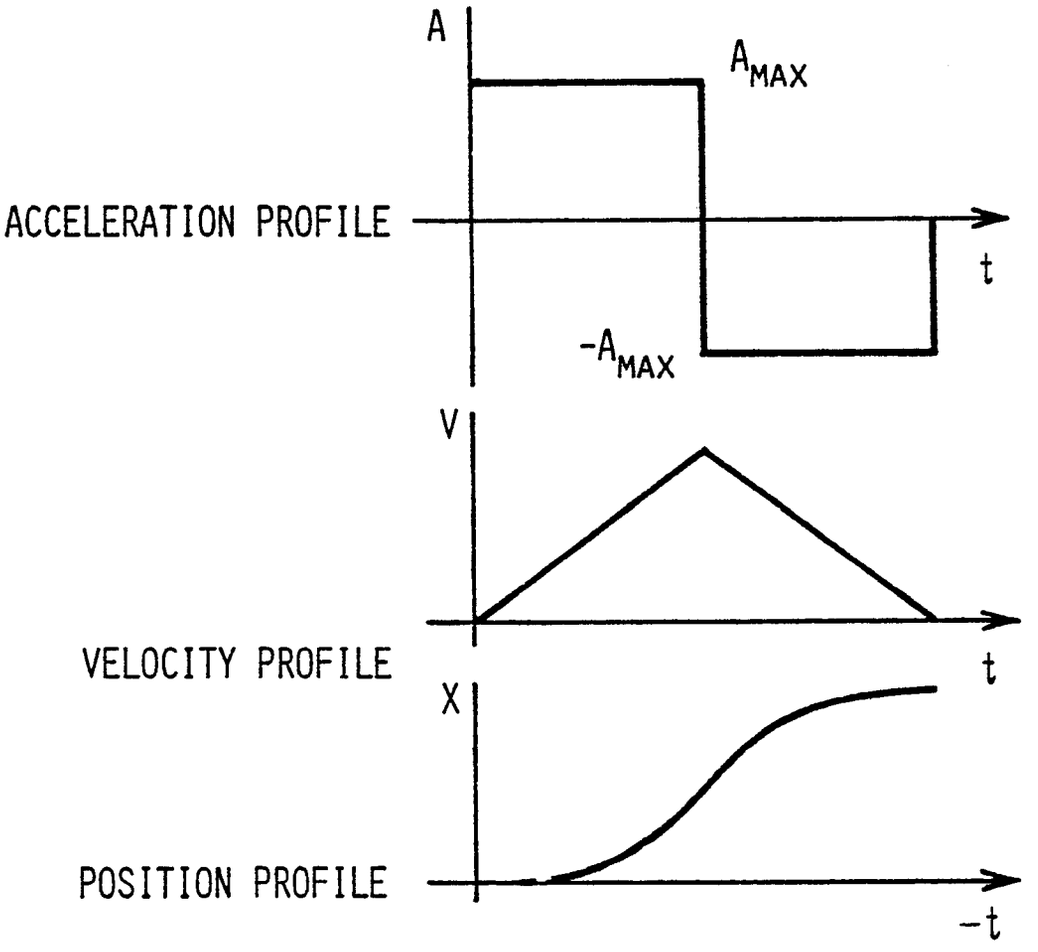
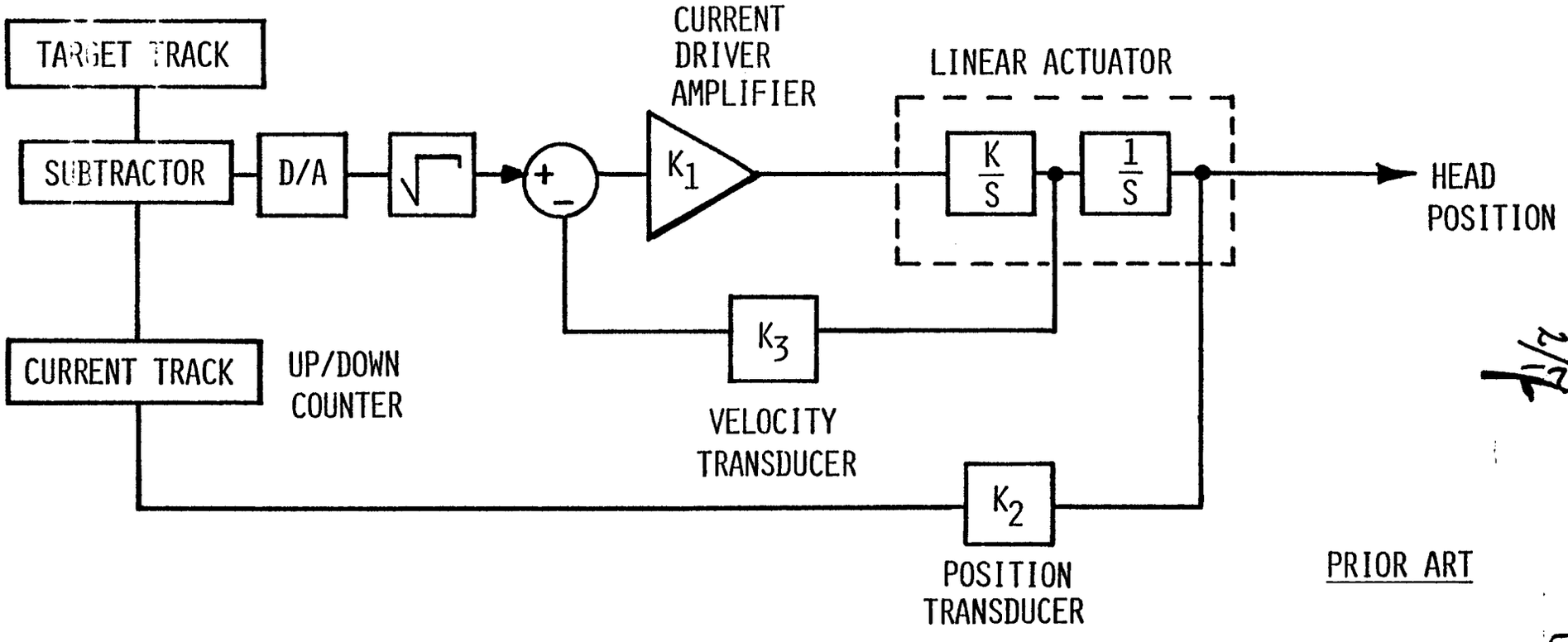

A
A_{MAX}
ACCELERATION PROFILE
t
$-A_{MAX}$
V
VELOCITY PROFILE
t
X
POSITION PROFILE
-t

Figure 1



PRIOR ART

Figure 2

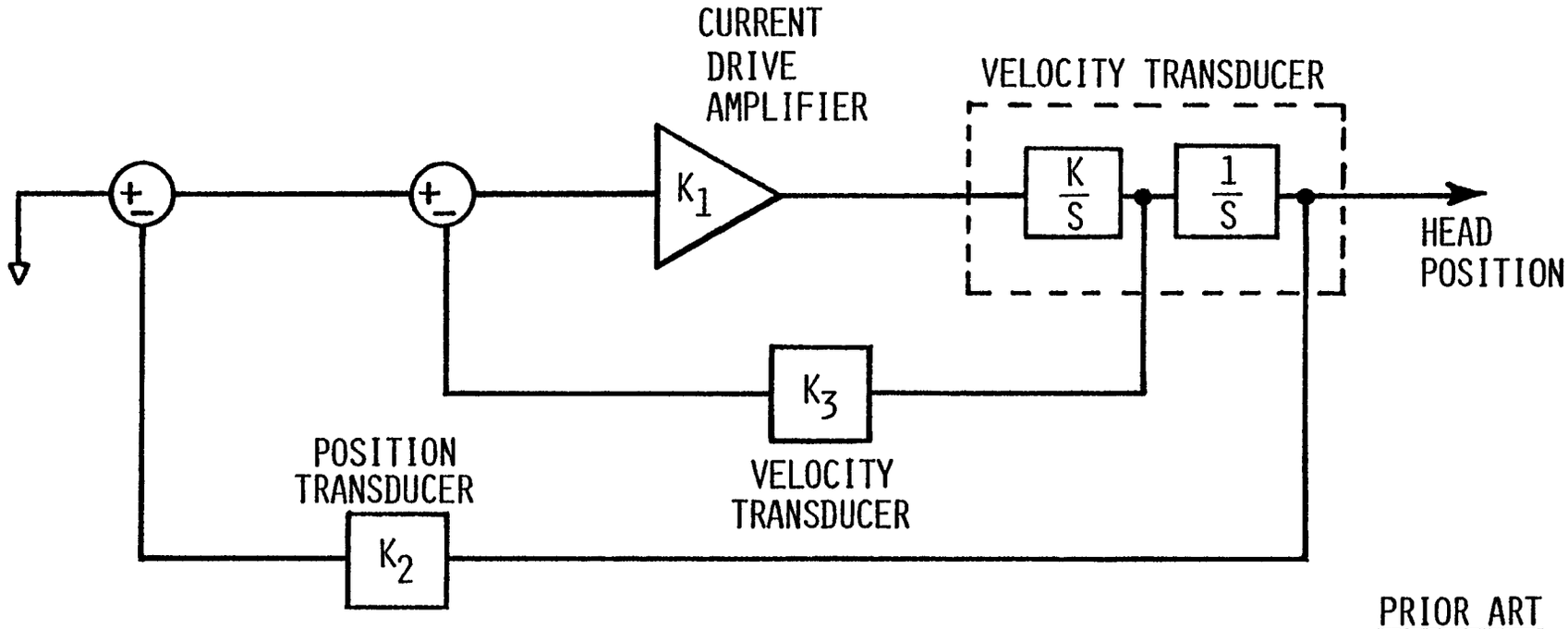


Figure 3

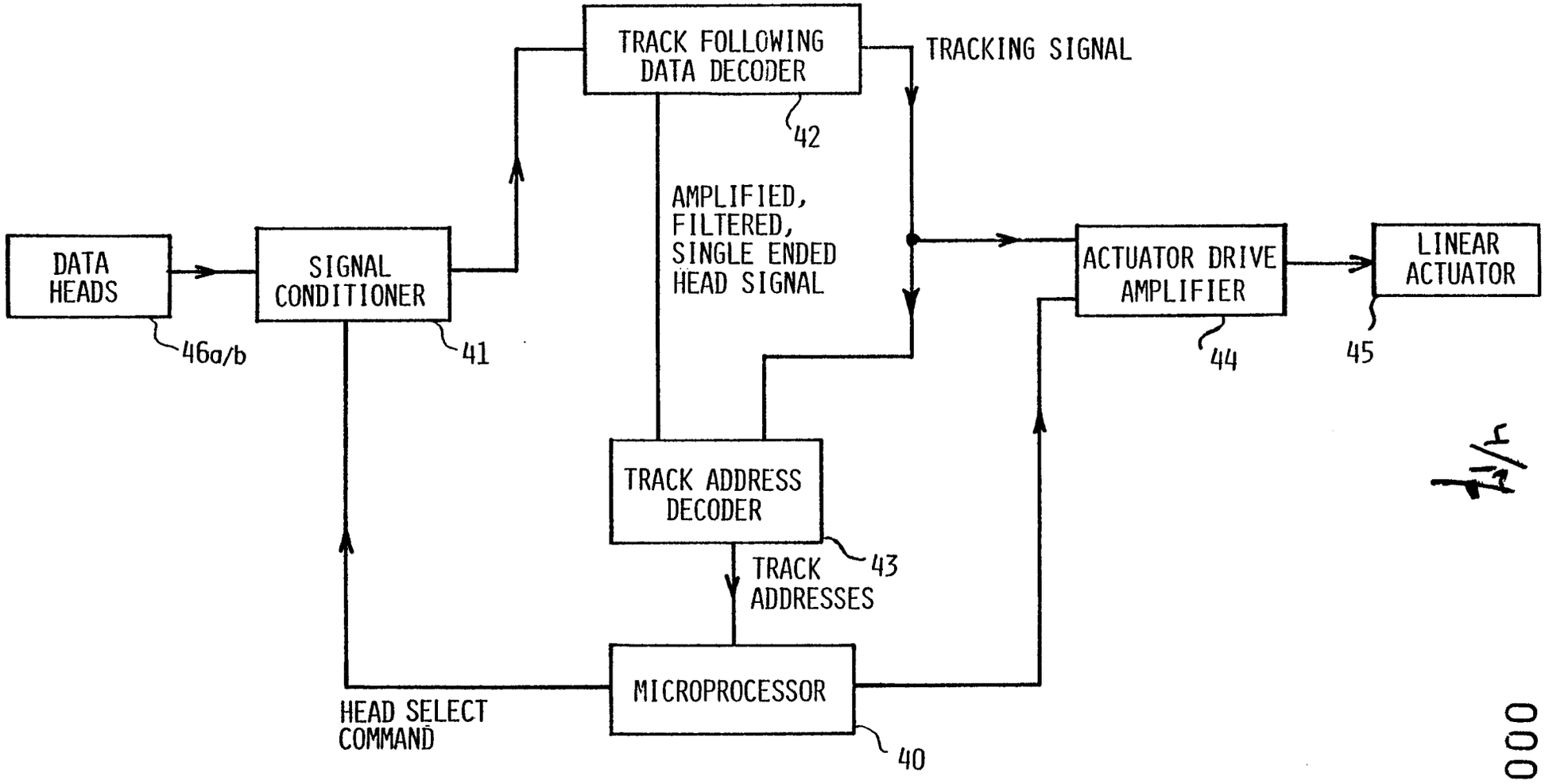


Figure 4

4/4

0009460

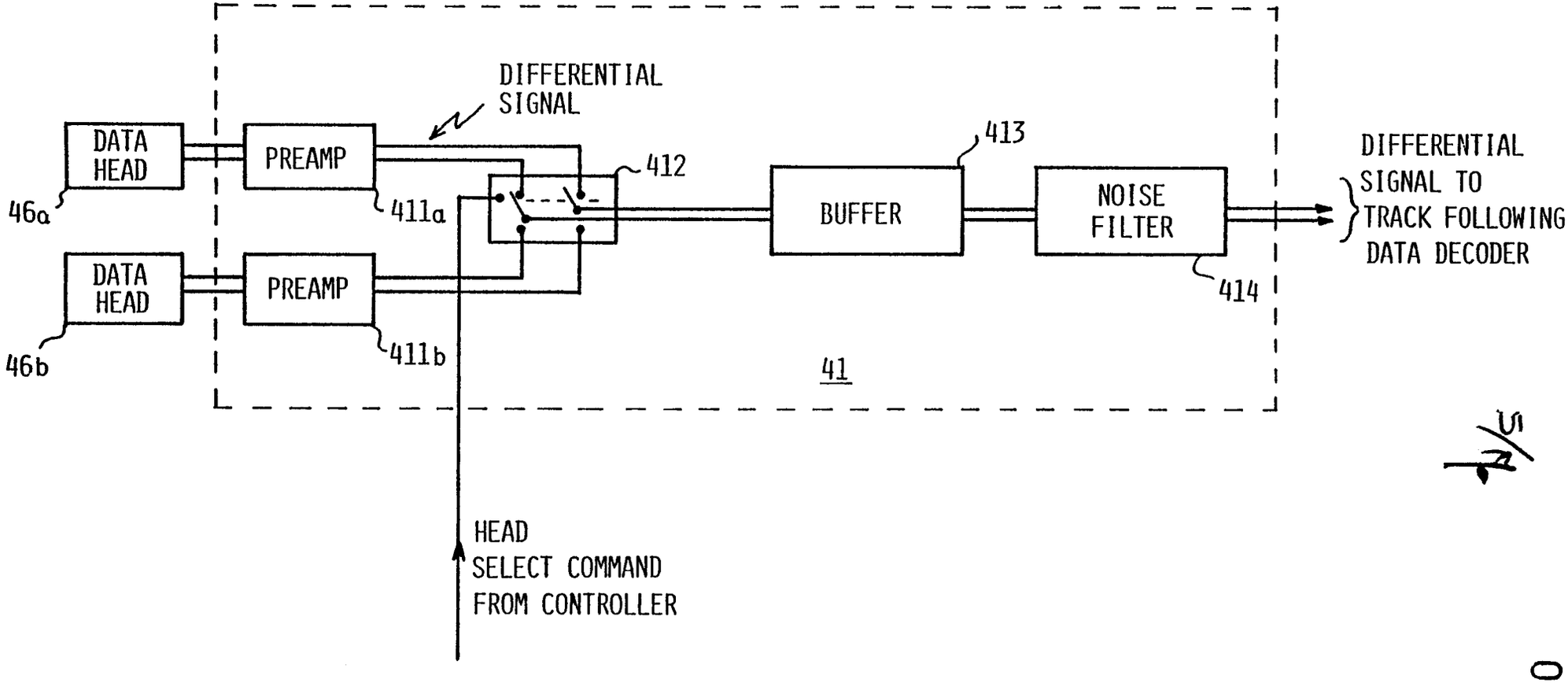


Figure 5

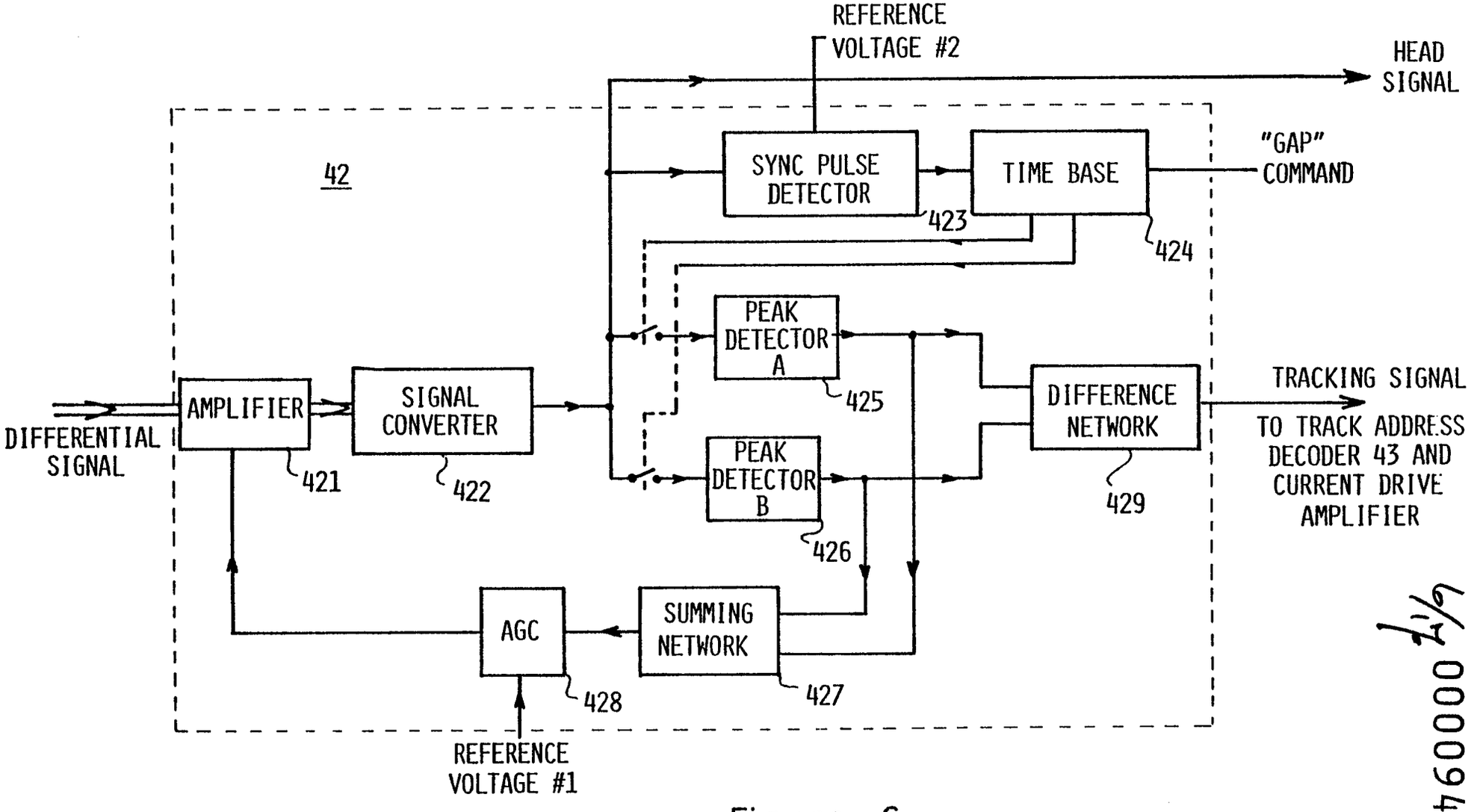


Figure 6

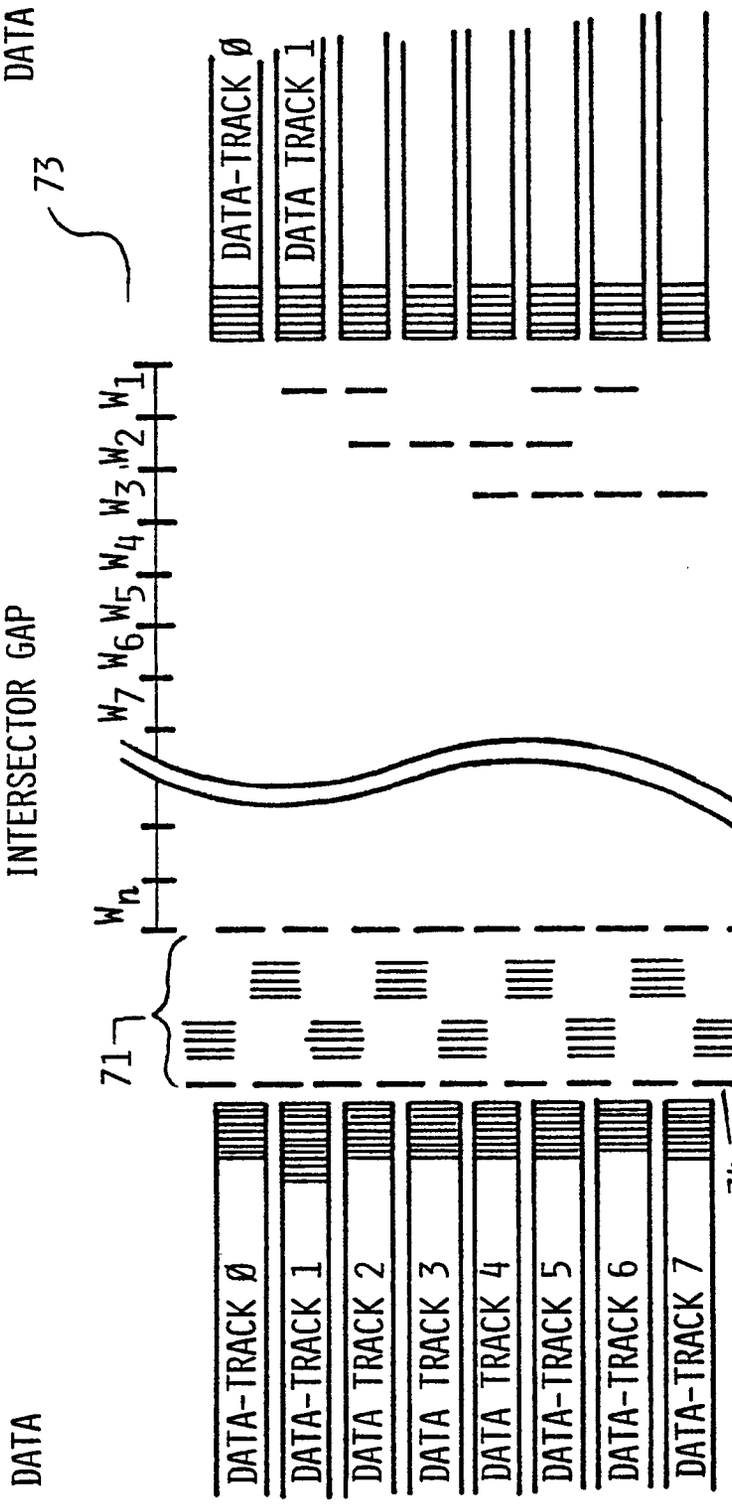

DATA
DATA
INTERSECTOR GAP
73
W_n
W_7 W_6 W_5 W_4 W_3 W_2 W_1
71
72
70
74
DATA-TRACK Ø
DATA-TRACK 1
DATA TRACK 2
DATA TRACK 3
DATA TRACK 4
DATA-TRACK 5
DATA-TRACK 6
DATA-TRACK 7
DATA-TRACK Ø
DATA TRACK 1

Figure 7

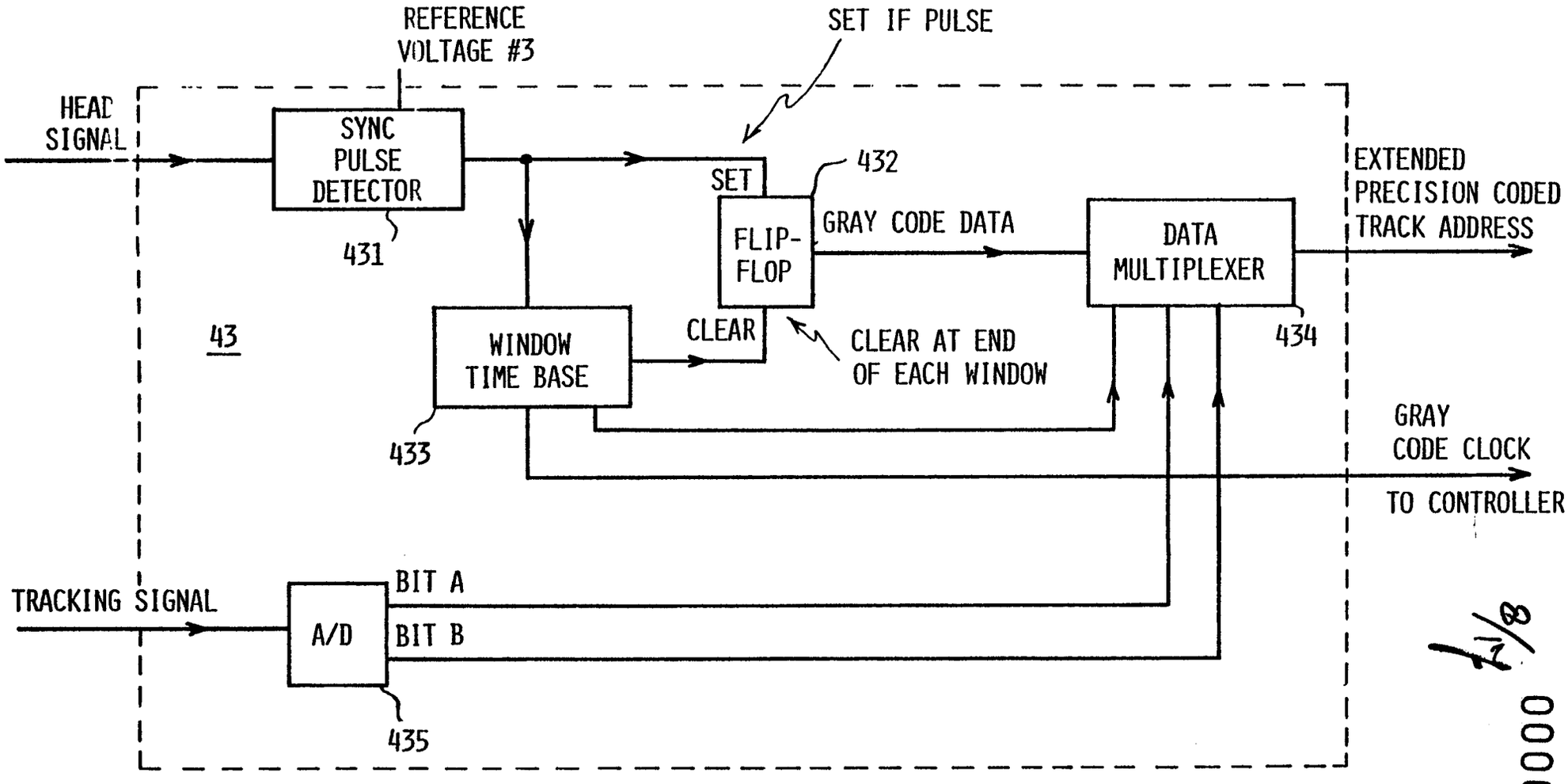


Figure 8

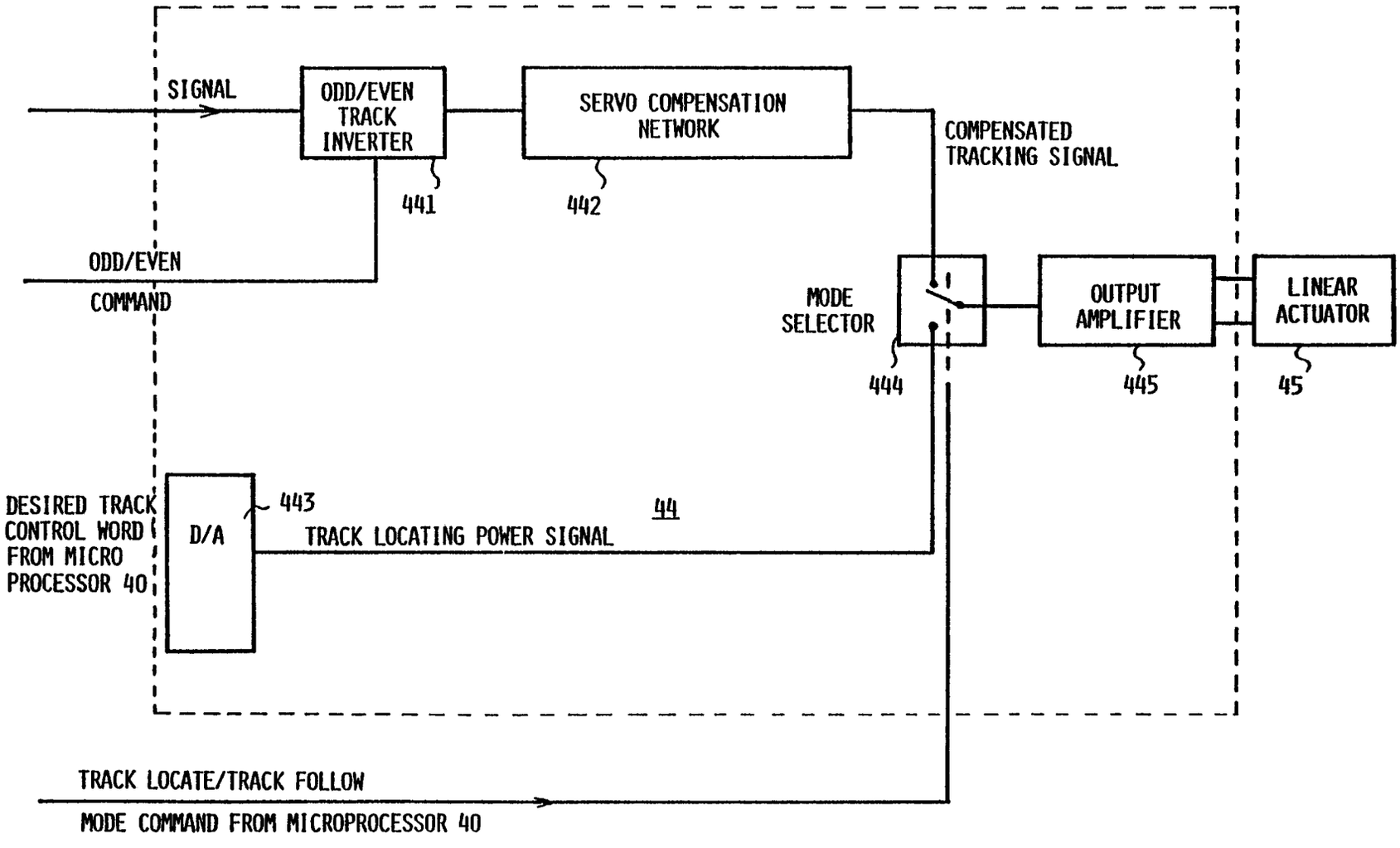


Figure 9

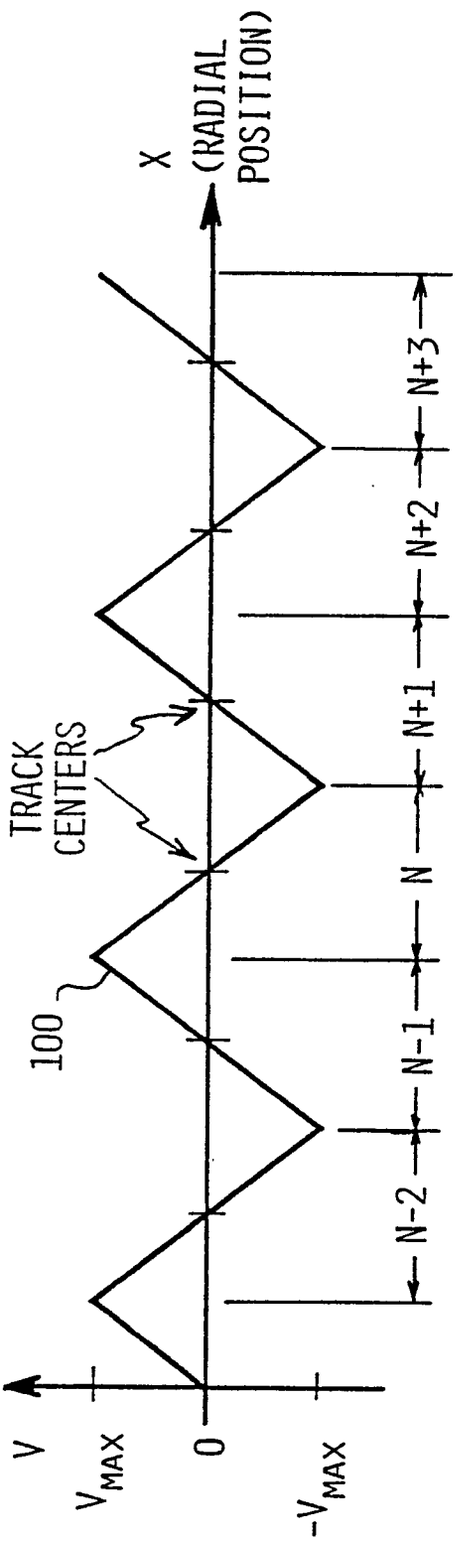

X
(RADIAL
POSITION)
TRACK
CENTERS
100
V
V_{MAX}
0
$-V_{MAX}$
N-2
N-1
N
N+1
N+2
N+3

Figure 10

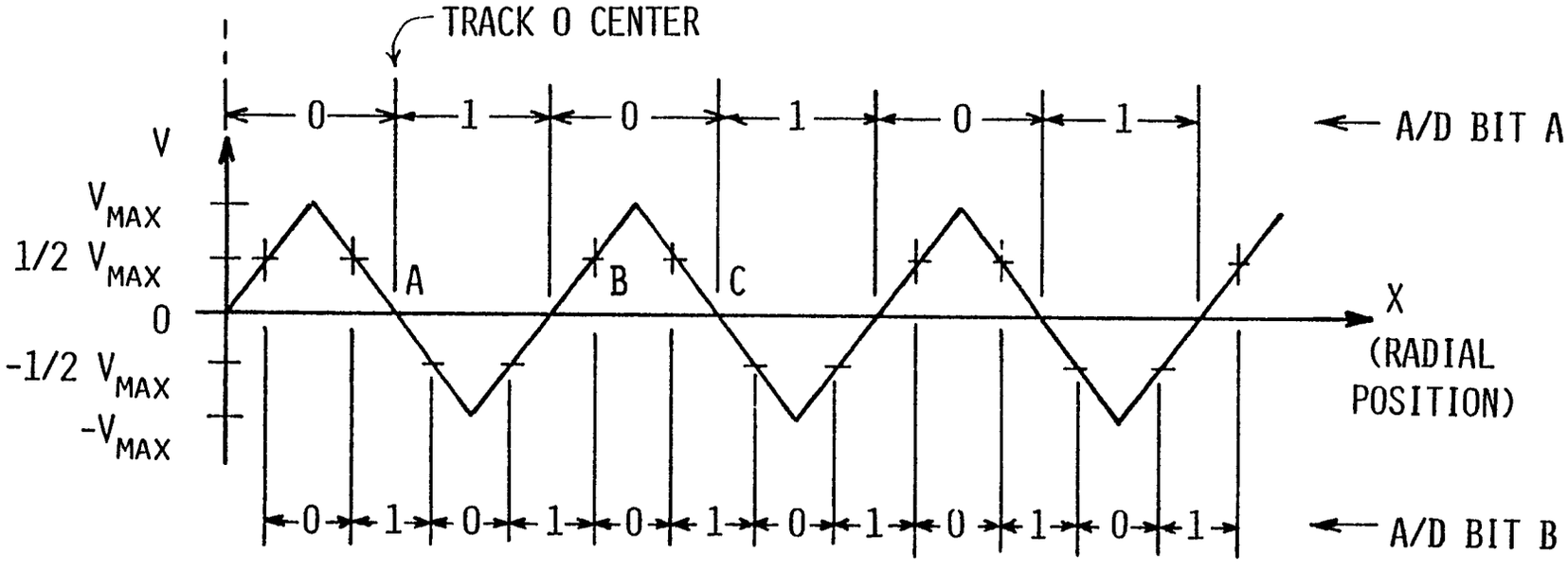


Figure 11

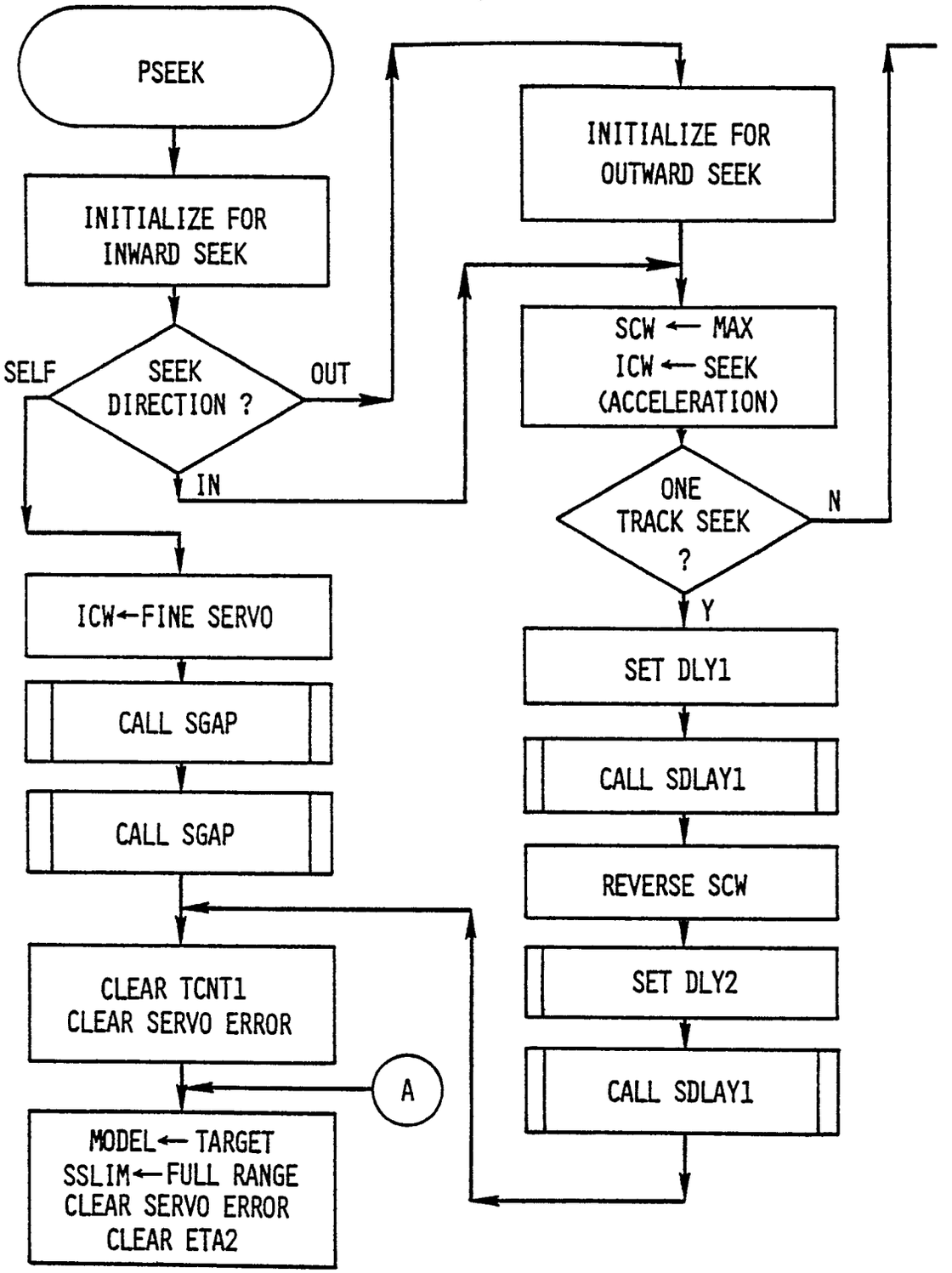

PSEEK
INITIALIZE FOR INWARD SEEK
SELF
SEEK DIRECTION ?
OUT
IN
INITIALIZE FOR OUTWARD SEEK
SCW ← MAX
ICW ← SEEK
(ACCELERATION)
ONE TRACK SEEK ?
N
Y
ICW←FINE SERVO
CALL SGAP
CALL SGAP
SET DLY1
CALL SDLAY1
REVERSE SCW
SET DLY2
CALL SDLAY1
CLEAR TCNT1
CLEAR SERVO ERROR
A
MODEL← TARGET
SSLIM←FULL RANGE
CLEAR SERVO ERROR
CLEAR ETA2

Figure 12A-1

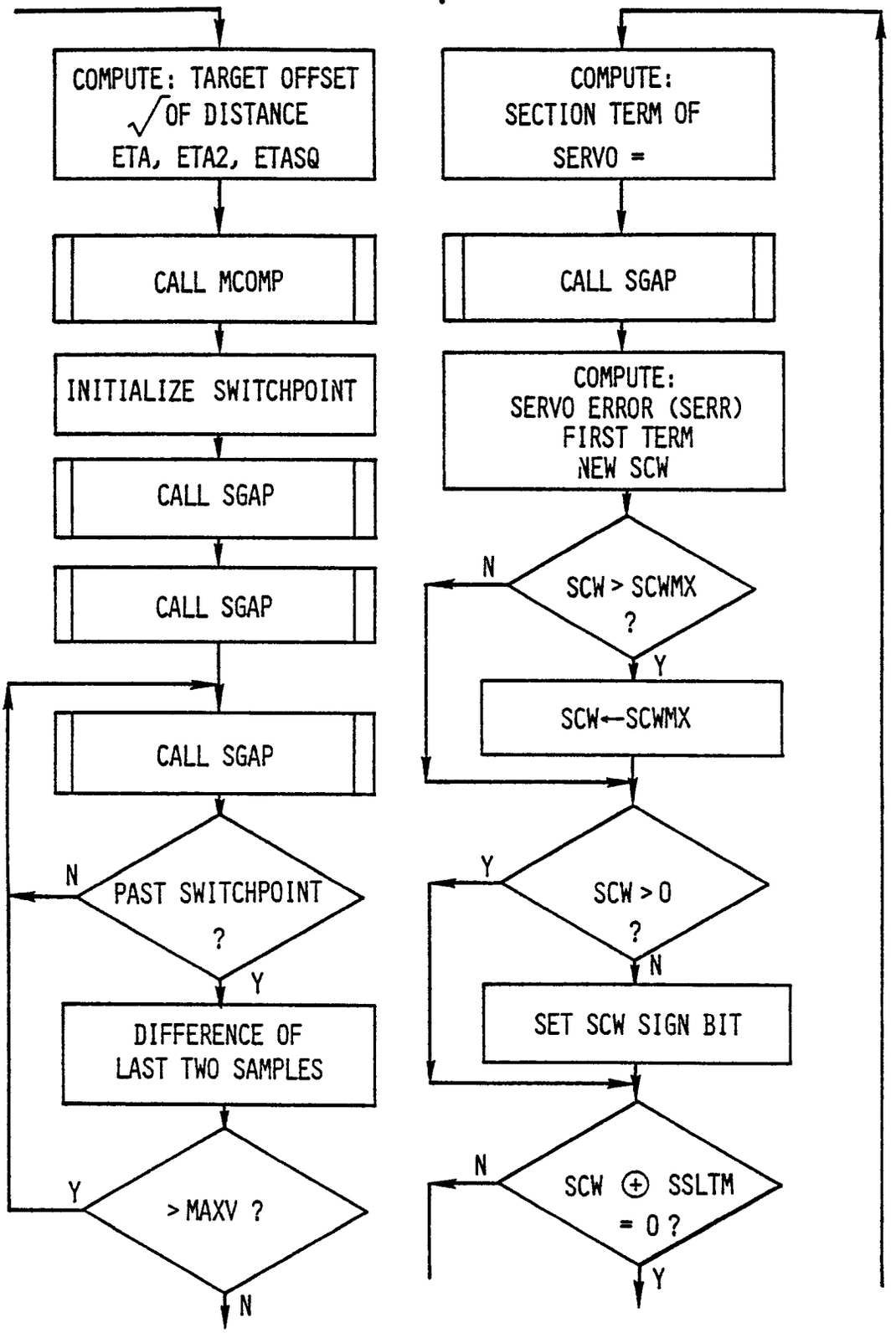

COMPUTE: TARGET OFFSET
√OF DISTANCE
ETA, ETA2, ETASQ
CALL MCOMP
INITIALIZE SWITCHPOINT
CALL SGAP
CALL SGAP
CALL SGAP
PAST SWITCHPOINT ?
N
Y
DIFFERENCE OF LAST TWO SAMPLES
> MAXV ?
Y
N
COMPUTE: SECTION TERM OF SERVO =
CALL SGAP
COMPUTE: SERVO ERROR (SERR) FIRST TERM NEW SCW
SCW > SCWMX ?
N
Y
SCW←SCWMX
SCW > 0 ?
Y
N
SET SCW SIGN BIT
SCW ⊕ SSLTM = 0 ?
N
Y

Figure 12A-2

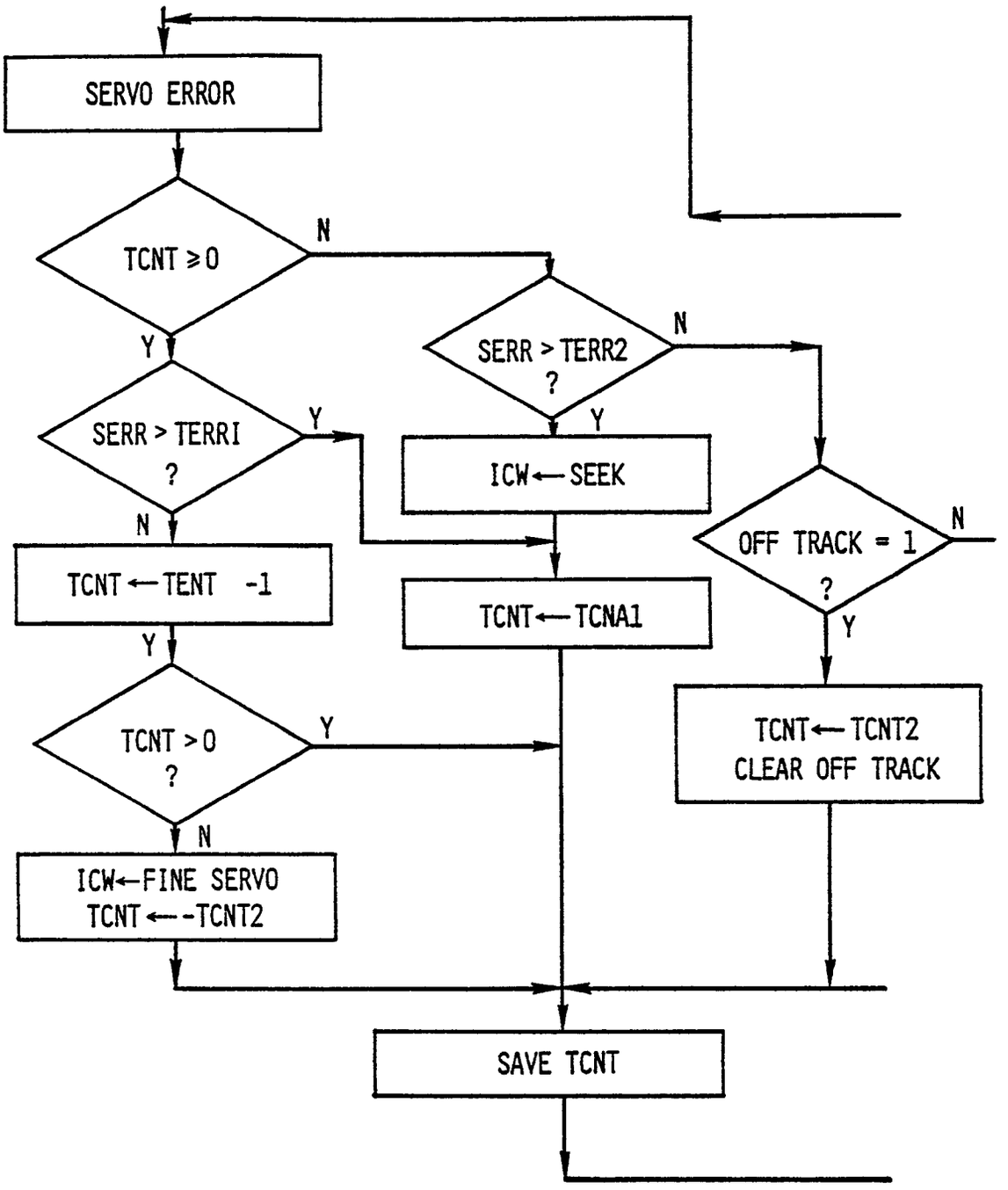

SERVO ERROR
TCNT ≥ 0
N
Y
SERR > TERR2 ?
N
Y
SERR > TERRI ?
Y
ICW ← SEEK
N
OFF TRACK = 1 ?
N
Y
TCNT ← TENT -1
TCNT ← TCNA1
Y
TCNT > 0 ?
Y
TCNT ← TCNT2
CLEAR OFF TRACK
N
ICW ← FINE SERVO
TCNT ← -TCNT2
SAVE TCNT

Figure 12A-3

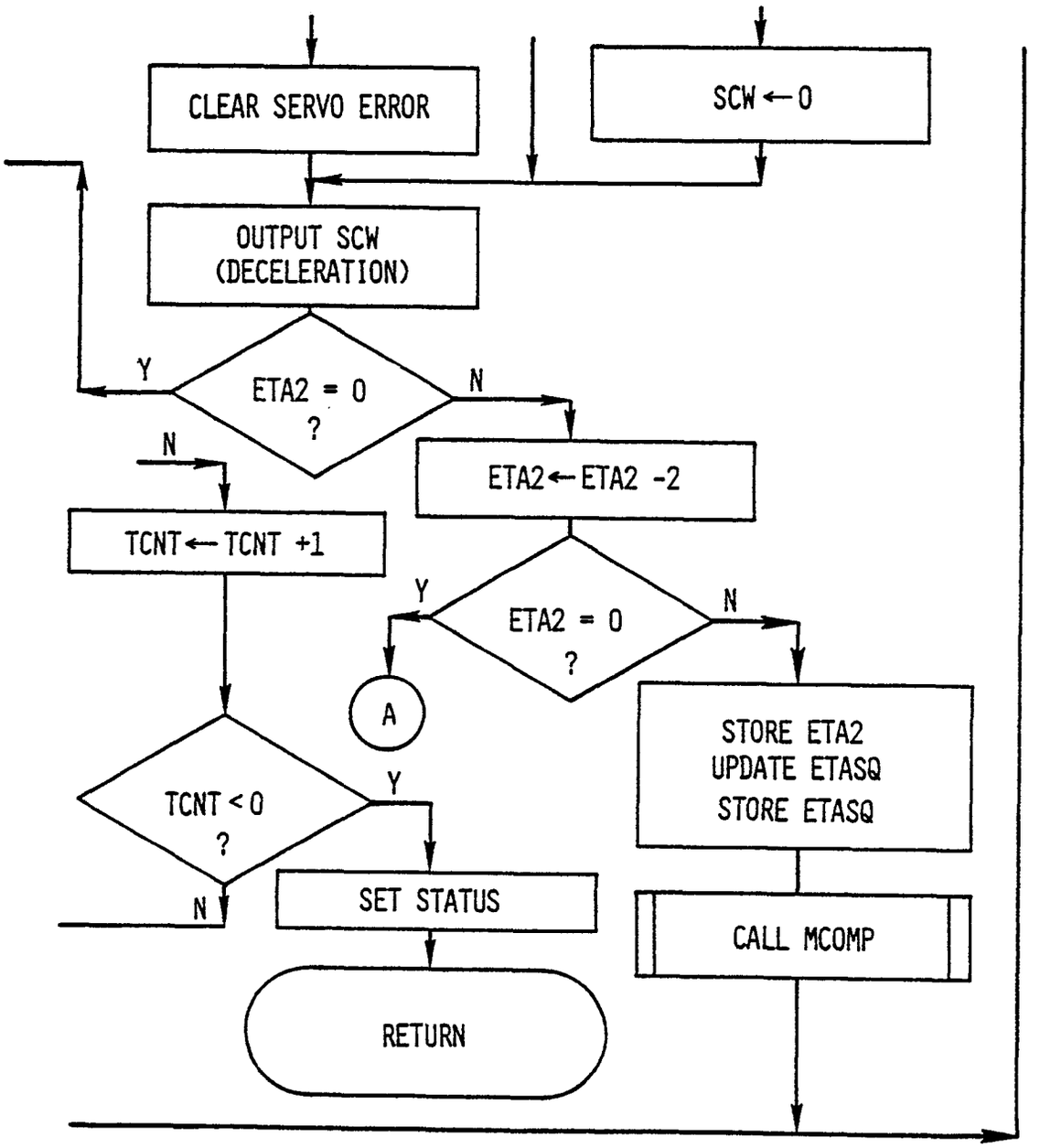

CLEAR SERVO ERROR
SCW ← 0
OUTPUT SCW
(DECELERATION)
ETA2 = 0
?
Y
N
ETA2 ← ETA2 -2
TCNT ← TCNT +1
ETA2 = 0
?
Y
N
A
STORE ETA2
UPDATE ETASQ
STORE ETASQ
TCNT < 0
?
Y
N
SET STATUS
CALL MCOMP
RETURN

Figure 12A-4

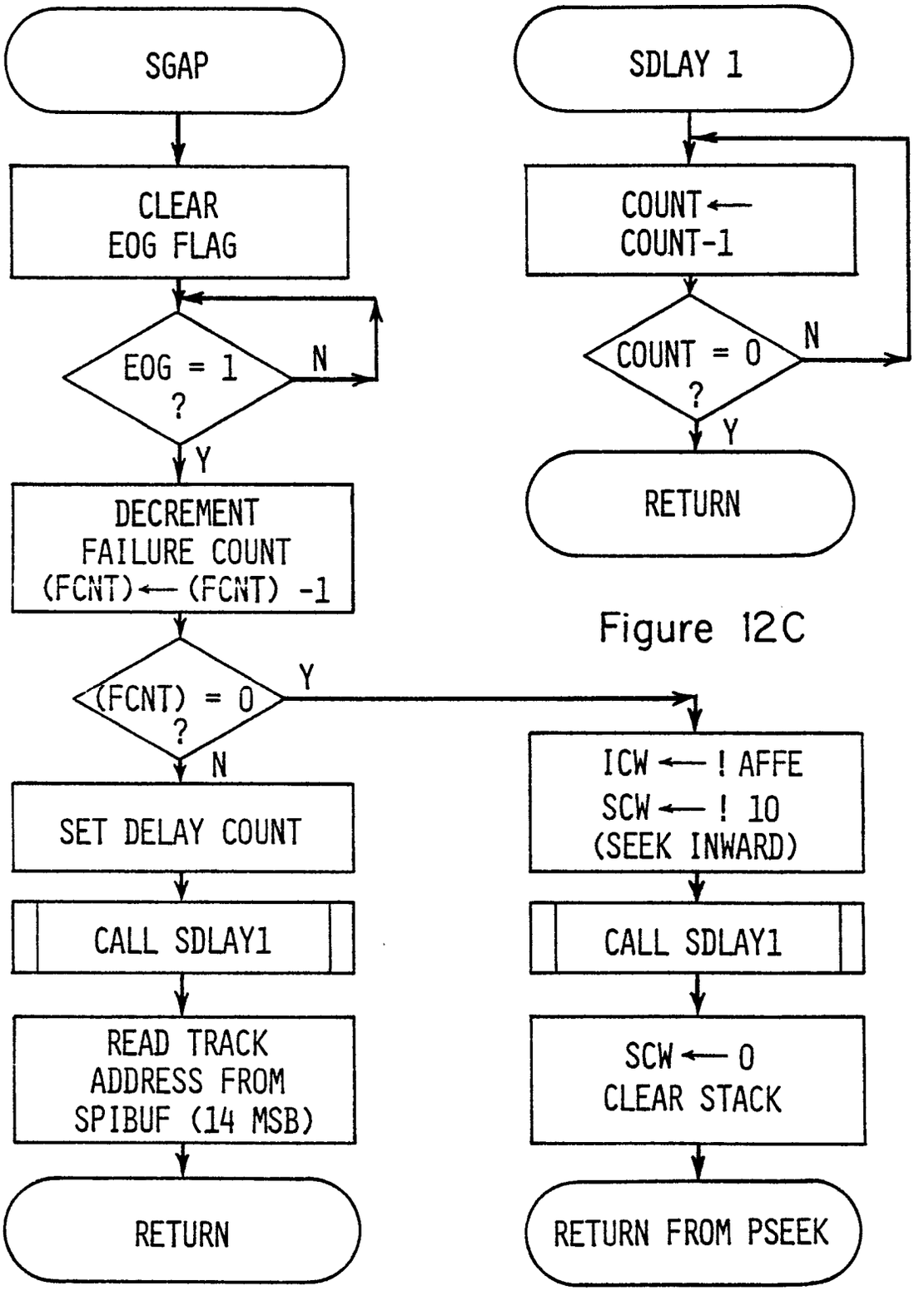


Figure 12C

Figure 12B

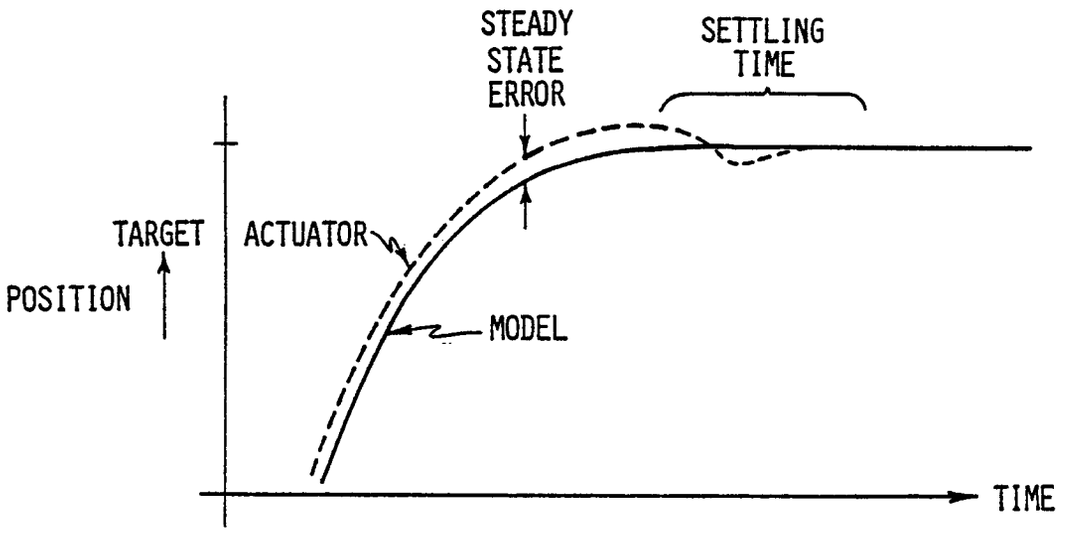


Figure 13A

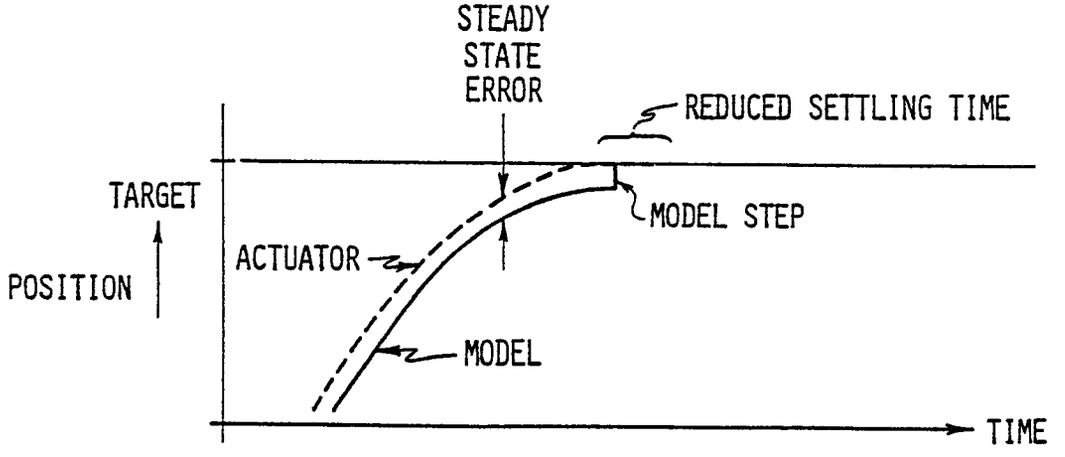


Figure 13B