

SEAGATE TECHNOLOGY

ST-506 MICROWINCHESTER

SERVICE MANUAL

MAY 1, 1982

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
1.0 INTRODUCTION.....	1
1.1 General Description.....	1
1.2 Specification Summary.....	2
1.2.1 Physical.....	2
1.2.2 Reliability.....	2
1.2.3 Performance.....	3
1.2.4 Functional.....	3
2.0 THEORY OF OPERATIONS.....	4
2.1 General.....	4
2.1.1 Recording Format.....	4
2.1.2 Track Format.....	4
2.1.3 Winchester Heads.....	6
2.1.4 Discs.....	6
2.1.5 Air Filtration System.....	6
2.2 Mechanical Theory.....	7
2.2.1 Track \emptyset Sensor.....	7
2.2.2 Index Sensor.....	7
2.2.3 Ground Spring.....	7
2.2.4 Spindle Brake.....	8
2.3 Electrical Theory/Flowchart.....	9
2.3.1 Motor Speed Control.....	9
2.3.2 Auto Recalibration.....	11
2.3.3 Drive Selection.....	13

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
2.3.4 Step Operation.....	14
2.3.5 Read Operation.....	17
2.3.6 Write Operation.....	19
2.3.7 Fault Detection.....	20
2.4 Test Point Description.....	22
2.5 Schematics.....	28
3.0 MAINTENANCE/REPAIR.....	34
3.1 Introduction.....	34
3.2 Removals And Adjustments.....	35
3.2.1 Main Control P.C.B.....	35
3.2.2 Motor Control P.C.B.....	35
3.2.3 Spindle Brake.....	36
3.2.4 Index Sensor.....	36
3.2.5 Ground Spring.....	37
3.2.6 Track \emptyset Sensor.....	37
3.2.7 Front Cover.....	38
3.2.8 Front Cover LED.....	38
3.2.9 Side Frames.....	38
4.0 ILLUSTRATED PARTS CATALOG.....	40
4.1 Physical Locations.....	40
4.1.1 Drive Exploded View.....	41
4.1.2 Connectors Exploded View.....	42
4.2 Component Locations.....	43

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
4.2.1 Main Control P.C.B. P/N 20019.....	44
4.2.2 Main Control P.C.B. P/N 20040.....	45
4.2.3 Motor Control P.C.B. P/N 20003.....	46
4.3 Parts Lists.....	47
4.3.1 Main Control P.C.B. P/N 20019.....	48
4.3.2 Main Control P.C.B. P/N 20040.....	50
4.3.3 Motor Control P.C.B. P/N 20003.....	52
4.3.4 Spare Parts List.....	53

LIST OF ILLUSTRATIONS

<u>FIGURE</u>	<u>PAGE</u>
2.1 Track Format.....	5
2.2 Test Point 1 Timing.....	24
2.3 Test Point 2 Timing.....	24
2.4 Test Point 4 Timing.....	24
2.5 Test Point 5 Timing.....	24
2.6 Test Point 7 and 8 Timing.....	25
2.7 Test Point 11 and 13 Timing.....	25
2.8 Test Point Layout - P.C.B. P/N 20019.....	26
2.9 Test Point Layout - P.C.B. P/N 20040.....	27

LIST OF TABLES

<u>TABLE</u>	<u>PAGE</u>
2.1 Step Pulse Encoding/Phase Sequencing.....	16

1.0 INTRODUCTION

1.1 General Description

The ST-506 disc drive is a random access storage device with two non-removable 5 1/4 inch discs as storage media. Each disc surface employs one moveable head to service 153 data tracks. The total formatted capacity of the four heads and surfaces is 5 megabytes (32 sectors per track, 256 bytes per sector, 612 tracks). Up to four drives may be daisy chain connected in one system.

Low cost and unit reliability are achieved through the use of a band actuator and open loop stepper head positioning mechanism. The inherent simplicity of mechanical construction and electronic controls allows maintenance free operation throughout the life of the drive. Both electronic PCB's are mounted outside the HDA for field serviceability.

Mechanical and contamination protection for the heads, actuator and discs are provided by an impact resistant aluminum enclosure. A self contained recirculating system supplies clean air through a 0.3 micron filter. A second port in the filter assembly allows pressure equalization with ambient air without chance of contamination. A patented spindle pump assures adequate air flow and uniform temperature distribution throughout the head and disc area. Thermal isolation of the stepper and spindle motor assemblies from the disc enclosure yields a very low temperature rise within the enclosure, providing significantly greater off-track margin and the ability to immediately perform read and write operations after power up with no thermal stabilization delay.

The ST-506 electrical interface is similar to the Shugart Associates SA1000 family of 8 inch fixed disc drives. The ST-506 size and mounting are identical to the industry standard minifloppy disc drives and uses the same DC voltage and connector. No AC power is required.

1.2 Specification Summary

1.2.1 Physical Specifications

Environmental Limits

Ambient Temperature:

Operating = 40° to 122° F (4° to 50° C)
 Non-operating = -40° to 140° F (-40° to 60° C)

Temperature Gradient:

Operating = 18° F / Hour (10° C)
 Non-operating = Below condensation

Relative Humidity = 8 to 80% Non-condensing

Maximum elevation:

Operating = 10,000 Feet
 Non-operating = -1000 to 30,000 Feet

Shock:

Operating = 10G's (On side frames)
 Non-operating = 20G's (On side frames)

D.C. Power Requirements:

+12V $\pm 5\%$, 1.8A Typical, 4.5A At power on
 +5V $\pm 5\%$, .7A Typical, 1.0A Maximum
 Maximum Ripple = 50mv peak to peak (12V, 5V)

Mechanical Dimensions:

Height = 3.25 Inches
 Width = 5.75 Inches
 Depth = 8.00 Inches
 Weight = 4.6 Pounds (2.1Kg)
 Shipping Weight = 7.0 Pounds (3.2Kg)

Heat Dissipation:

Typical = 25 Watts
 Maximum = 29 Watts

1.2.2 Reliability Specifications

MIBF = 11,000 PCH, Typical usage
 MTTR = 30 Minutes
 PM = Not required
 Component design life = 5 Years

Error Rates:

Soft Read Errors =	1 per 10 ¹⁰ bits read
Hard Read Errors* =	1 per 10 ¹² bits read
Seek Errors =	1 per 10 ⁶ seeks

*Not recoverable within 16 retries

1.2.3 Performance Specifications

Capacity

Unformatted:

Per Drive =	6.38 Megabytes
Per Surface =	1.59 Megabytes
Per Track =	10416 Bytes

Formatted:

Per Drive =	5.0 Megabytes
Per Surface =	1.25 Megabytes
Per Track =	8192 Bytes
Per Sector =	256 Bytes
Sectors per Track =	32

Access Time:

Track to Track =	3 milliseconds
Average* =	170 milliseconds
Maximum** =	500 milliseconds
Settling Time =	15 milliseconds typical

*Reducible to 85 ms using fast seek algorithm

**Reducible to 205 ms using fast seek algorithm

Transfer Rate:	5.0 Megabits per second
----------------	-------------------------

Average Latency:	8.33 milliseconds
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1.2.4 Functional Specifications:

Rotational Speed =	3600 RPM $\pm 1\%$
Recording Density =	7690 BPI Maximum
Flux Density =	7690 FCI Maximum
Track Density =	255 TPI
Cylinders =	153
Tracks =	612
Read/Write Heads =	4
Discs =	2

2.0 THEORY OF OPERATIONS

2.1 General

2.1.1 Recording Format

The ST-506 uses modified frequency modulation (MFM) as the encoding method implemented to record data on the drive. This double-density encoding scheme increases disc data capacity by replacing clock bits with data bits. Clock bits are written only when data bits are not present in both the preceding and the current bit cell. Clock bits are written at the beginning of the bit cell, while data bits are written in the middle.

Due to predictable bit-shift phenomena, write data may require precompensation. This function must be provided by the controller to insure data integrity at the specified error rate. The ST-506 requires precompensation of write data on cylinders 128 through 152. The data pattern determines which bits must be precompensated. The recommended amount of this precompensation is 12ns for both early and late written bits. All other data patterns are written on time.

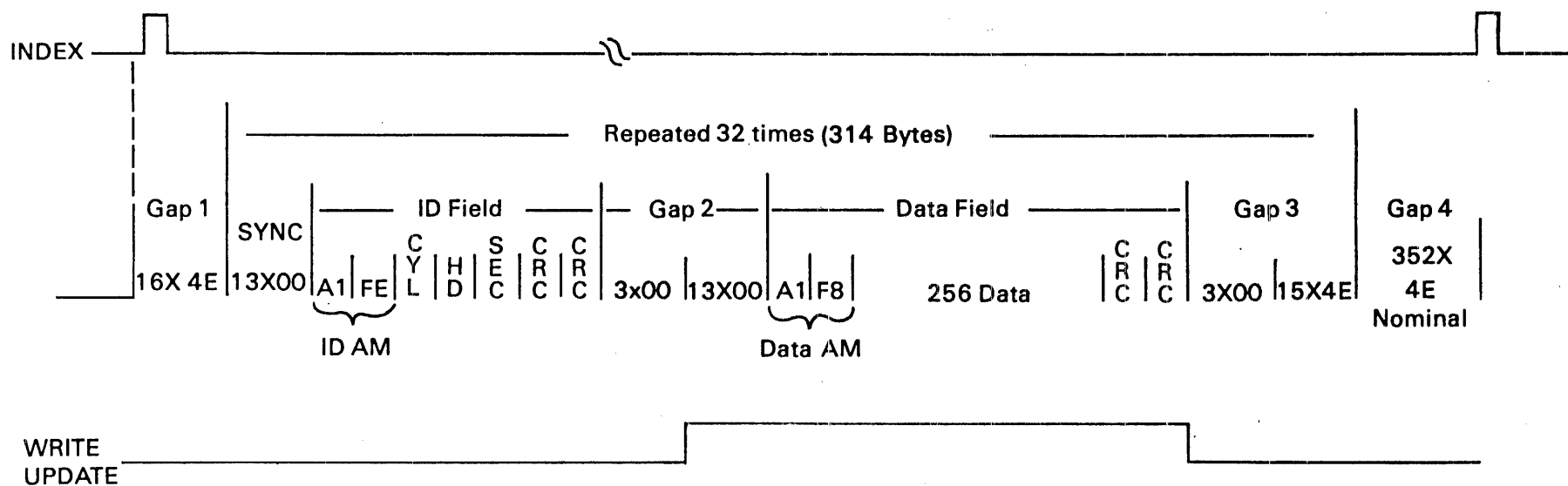
2.1.2 Track Format

The track format used on the Seagate ST-506 disc drive is a slightly modified version of the IBM System 34 double density format. This format is common to many industry standard floppy disc drives. All ST-506 drives are formatted at the factory before shipping. Data fields contain the bit pattern 0000. Refer to Figure 2.1 (Track Format).

The Seagate soft-sector format divides each track into 32 sectors with each containing 256 bytes of data. Total track capacity is 10416 bytes, of which 8192 bytes are data. Each sector is identified by an identification field that is different than any other on the drive. The ID field contains cylinder, head, and sector information as well as address mark and error checking polynomials.

It should be noted that the format used by Seagate is recommended and not required. Use of any other format requires careful evaluation, as the format is an integral part of the drives' performance and operation. The Seagate format uses Cyclic Redundancy Checking (CRC) for error evaluation. The format also allows for a plus or minus speed variation of 3%. The ST-506 specification for spindle speed variation is 1% over the specified environmental and power limits.

FIGURE 20
TRACK FORMAT AS SHIPPED



PAGE 5

- NOTES:**
1. Nominal Track Capacity = 10416 Bytes
 2. Total Data Bytes/Track = 256 x 32 = 8,192
 3. Sector interleave factor is 4. Sequential ID Fields are sector numbered 0, 8, 16, 24, 1, 9, 17, 25, 2, 10, 18, 26,...etc.
 4. Data Fields contain the bit pattern 0000 as shipped
 5. CRC Fire Code = $x^{16} + x^{12} + x^5 + 1$
 6. Bit 7 of Head Byte ID Field equals 1 in a defective sector (Cylinder 0 is error free)
 7. Bit 5 of Head Byte reserved for numbering cylinders greater than 256
 8. Bit 6 of Head Byte reserved for numbering cylinders greater than 512

2.1.3 Winchester Heads

The Seagate Technology ST-506 uses conventional Winchester head technology. The head/flexure (supporting arm) assembly is designed for contact start-stop operation. Bit packing density is 7690 BPI and the radial track density is 255 TPI. The heads, when operational, are supported on an air bearing created by the rotating disc.

The Winchester heads used are loaded toward the disc surface at 9.5 grams. This is the typical value to allow required stability in all operating conditions. The flying height of the heads at the innermost cylinder is 19 microinches with a tolerance of ± 3 microinches. The flying height of the heads at the outermost cylinder is 24 microinches, ± 3 microinches.

The load force of 9.5 grams is sufficient enough so that various mounting orientations of the disc drive will not affect the flying height of the Winchester heads to any significant degree. Additionally, the head/flexure assembly incorporates an extremely low mass design that is resistive to head and/or media damage when shipping.

2.1.4 Discs

The ST-506 disc drive uses two non-removable double sided 5 1/4 inch discs as the recording media. The discs are designed upon current iron oxide technology. The actual disc dimensions are 40mm inside diameter by 130mm outside diameter. Thickness of the magnetic coating is 20 to 40 microinches increasing linearly from the inside diameter to the outside diameter.

The disc surface is coated with a Teflon lubricant 40 to 60 angstroms in thickness. This value is equivalent to a uniform monomolecular film. The disc lubricant has sufficient abrasion resistance to withstand a minimum of 10,000 start/stop cycles. The magnetic discs have a life expectancy of 5 years.

2.1.5 Air Filtration System

All drives manufactured by Seagate Technology incorporate an integral air filtration system. No maintenance or adjustments are needed throughout the life of the drive. The integral 0.3 micron air filter performs two functions. First, the filter maintains Class 100 standards inside the sealed Head/Disc Assembly throughout the life of the drive. Second, an auxillary port allows pressure equalization with ambient air. During normal operation there is no measurable air flow between the HDA and the outside environment.

2.2 Mechanical

2.2.1 Track \emptyset Sensor

The Track \emptyset optical interrupter provides an output whenever the Winchester heads are positioned over cylinder \emptyset . This signal is used by the internal drive control electronics during the power-on auto-recalibrate routine. The Track \emptyset signal is also output to the drive interface for use by the controller. Note that the signal at the interface is really Track \emptyset /Phase "A".

The Track \emptyset optical interrupter incorporates an infrared light-emitting-diode and an infrared sensitive photo-transistor. When the heads are positioned at cylinder \emptyset , an interrupter arm attached to the stepper motor shaft mechanically breaks the light beam between the two components of the sensor. The sensor will output a valid Track \emptyset signal as long as the light beam remains broken.

2.2.2 Index Sensor

The Index sensor provides an index pulse to the recalibration circuit and to the interface of the ST-506 drive. Once each revolution (16.67 ms), the Index sensor outputs a pulse that is typically 200 microseconds in width.

The Index sensor used on the ST-506 drive is of the reluctance transducer type. This cylindrical sensor incorporates a built-in preamplifier. The case of the sensor is grounded electrically which ties the drive DC returns to the drive casting.

The hub of the spindle motor has two metal tabs attached; one is of a ferrous composition and the other is non-magnetic. Each revolution of the spindle motor causes the ferrous tab to pass within close proximity of the Index sensor, therefore inducing the pulse output.

Note: The dimension between the spindle motor tab and the Index sensor is set to 30 mils (.030") at the factory.

2.2.3 Ground Spring

The ST-506 incorporates a grounding contact between the spindle motor hub and the drive casting. This ground spring performs the task of removing all unwanted static electrical charges from the spindle motor hub.

2.2.4 Spindle Brake

The ST-506 uses an electromechanical brake to slow the spindle motor when DC power is removed. The spindle brake is energized directly from the +12V supply. When +12V is removed from the drive, the brake engages against the spindle motor hub to slow the motor.

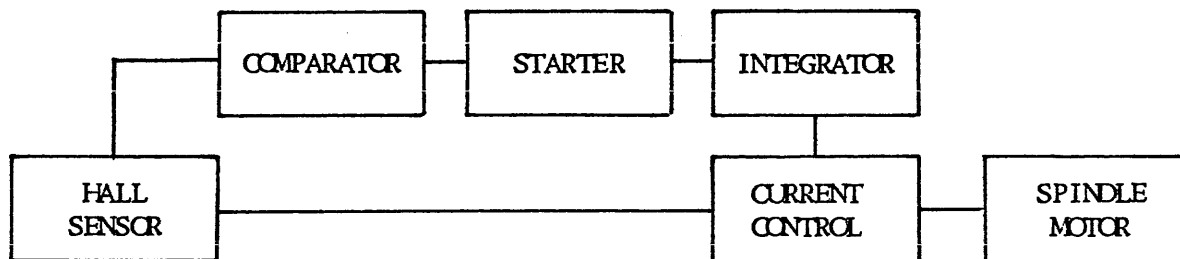
The pad contact material is of a rubber-cork composition with wear life designed to exceed 20,000 cycles. When energized, the brake will draw a maximum current of 267 milliamps.

The brake must be adjusted so that the contour of the pad contact matches the spindle motor hub. When disengaged, the dimension between the spindle motor hub and the pad contact should be set at 10 mils (.010").

2.3 Electrical Theory/Flowchart

2.3.1 Motor Speed Control

Block Diagram-



Functional Description-

Initially, when power is first applied, the disk is stationary and the Hall effect transistor will output a high or low level, depending on the physical position of the motor. This DC level will keep Q1 turned off, allowing C5 to charge up. Pin 1 of Comparator A2 will output a low level that travels through R12 and forces pin 7 of A2 high. As a result, A1 will be off and maximum current will flow into the coil selected by the level of the Hall effect sensor.

As the motor speeds up, the Hall effect becomes a square wave responsible for both selecting the motor coil to receive current and controlling the amount of current applied. Current is supplied alternately to coils A and B as the Hall device senses the motors physical position. Depending on the time between high going edges of the Hall effect sensor, Q1 will be turned off long enough for C5 to charge to more than 4 volts and force pin 1 of Comparator A2 low. This low pulse will turn on pin 7 of A1 whose resulting 6 volt output pulse will direct pin 7 of Integrator A2 to allow more current to enter the motor coils.

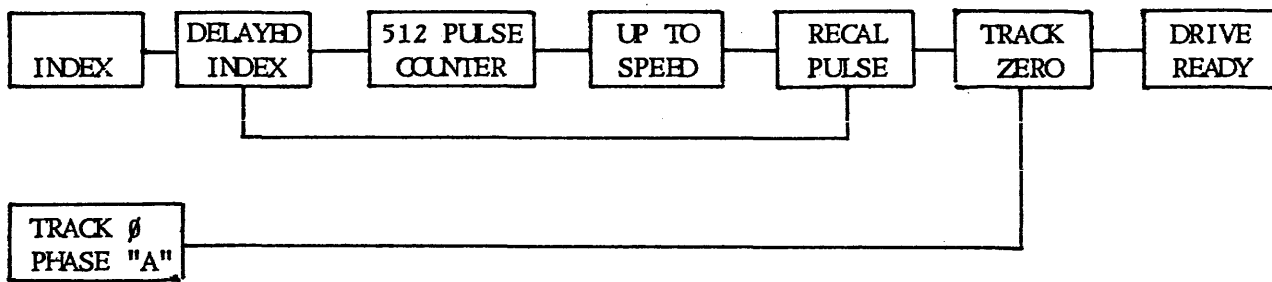
The sequence of normal operation is as follows:

- 1) The Hall effect sensor relays speed and position information to the speed error comparator and to the current controller.
- 2) The speed error comparator, pin 1 of A2, generates a low spike whose duration is dependent on the speed error. A slow speed will result in the low pulse being longer.

- 3) The speed error information enters the starting circuit which functions to pass a low frequency signal directly to the integrator indicating maximum error during start up. The starting circuit also inverts the speed error information and combines it with a carrier that properly biases the integrator.
- 4) Pin 7 of Integrator A2 translates the error information into a level appropriate for biasing both halves of IC A1, which functions to control the current source.
- 5) The current control, IC A3, supplies the proper amount of current for attaining proper speed as directed by IC A1.

2.3.2 Auto Recalibration

Block Diagram-



Functional Description-

Upon initial power application, the up-to-speed counter, up-to-speed latch, and recalibration latch are all reset. Before the drive can perform any read, write, or seek operations, it must first become Ready. At power-on, Ready is a combination of the drive being up-to-speed and an active Track 0.

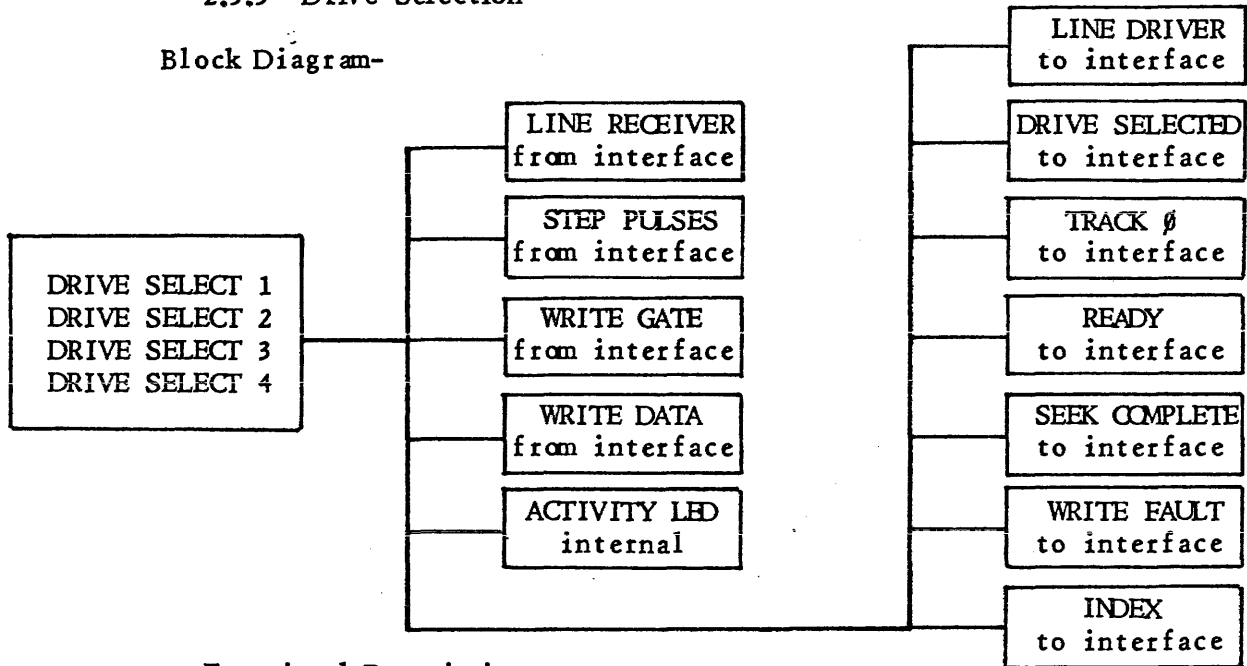
As the drive begins to spin, an index pulse from the Index sensor is supplied to the index counter once each revolution. When the index counter reaches 512, the drive is assumed to be rotating at its full speed of 3600 revolutions per minute. The output from the up-to-speed counter clocks the up-to-speed latch. Since the recalibration latch was reset at power-on, it will force the direction of the stepper motor outward. If the heads are not positioned over Track 0, each successive index pulse will increment the up/down counter. For each increment of the counter, the phase encoder will select a stepper phase that moves the heads one half of a track closer to Track 0. If the heads are behind Track 0, they will move to Track 0 immediately, since at power-on the up down counter will be reset to Phase "A".

When the heads reach Track 0, the recalibration latch will be clocked high. In its high condition, the recalibration latch will release the Direction line and block any future index pulses from being gated through as a step pulse. The recalibration latch, in conjunction with the up-to-speed latch, will provide the Ready signal to the drive interface. Approximately 15 milliseconds later, the seek complete timer will cause the Seek Complete signal to go true.

The active state of Seek Complete is a signal to the controller that normal operations can begin. The up-to-speed and recalibration latches will stay set until power is interrupted or drops more than 20% below normal. If this occurs, the recalibration sequence will again be initiated.

2.3.3 Drive Selection

Block Diagram-

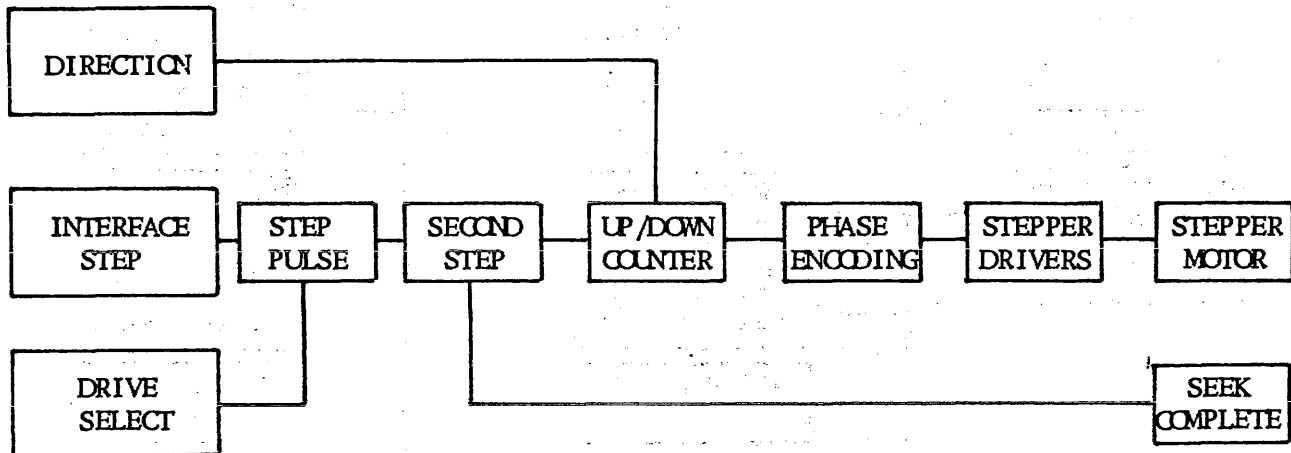


Functional Description-

Drive Select serves only to gate other signals to or from the drive interface. Without Drive Select, the drive cannot read, write, or seek.

2.3.4 Step Operation

Block Diagram-



Functional Description-

In order to step, the following conditions must be true:

- 1) Write Gate inactive.
- 2) Write Fault inactive.
- 3) Direction In if Track 0 is true.
- 4) Drive Ready
- 5) Step pulse on the interface.

When a step pulse is applied to the drive interface, the step circuitry will immediately process it. The pulse is changed to 1.0 microsecond in width by the monostable multivibrator and is then gated through to the up/down counter. The counter will count up if the Direction line is low and will count down if the Direction line is high. An increasing count will cause the PROM to select motor phases that move the heads toward Track 0. The outputs from the PROM are active low which turn off the pre-driver transistors. The inactive state of any pre-driver transistor causes a current flow through the Darlington drivers.

To ensure fast head settling, the stepper motor is always locked between two phases. For this reason, the stepper circuitry must receive two steps for each single track increment. Subsequent to receiving an interface step pulse, an internal step pulse is output by the second step generator. This second pulse is injected 2.8 milliseconds after the first. This time interval is the optimum value to take advantage of the motor momentum and obtain the quickest settling time.

Approximately 15 milliseconds after the last internal step pulse, the retriggerable monostable multivibrator will time out and generate the Seek Complete signal. Note that during the stepping routine, the multivibrator is constantly triggered which maintains an inactive signal on the Seek Complete line.

TABLE 2.1

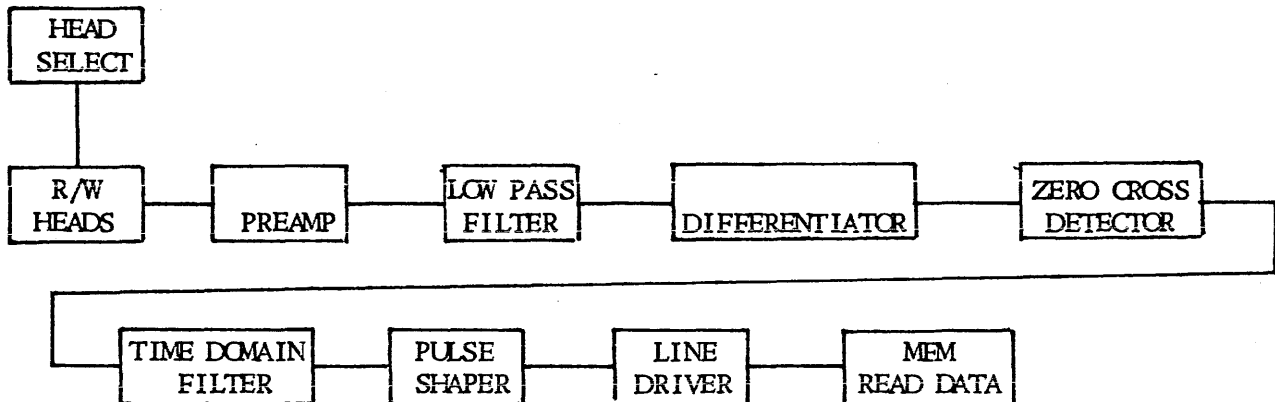
TRACK	0	1	2	3	4	5	6	7	8
STEP	0	1	2	3	4	5	6	7	8
2C - PIN 3	1	0	1	0	1	0	1	0	1
2C - PIN 2	1	1	0	0	1	1	0	0	1
2C - PIN 6	1	1	1	1	0	0	0	0	1
2D - PIN 1	1	1	1	1	0	0	0	1	1
2D - PIN 2	0	0	0	1	1	1	1	1	0
2D - PIN 3	1	1	0	0	0	1	1	1	1
2D - PIN 4	0	1	1	1	1	1	0	0	0

IC 2C = Step pulse encoding.

IC 2D = Phase sequencing.

2.3.5 Read Operation

Block Diagram-



Functional Description-

In order to read, the following conditions must be true:

- 1) Write Gate inactive.
- 2) Write Fault inactive.
- 3) Drive Select active.
- 4) Head Select active.

The binary decoder decodes the two Head Select lines, the Write Gate line, and the Write Fault line. Assuming Write Gate is inactive and there is no write fault, the inactive state of both head select lines will select head 0. The center tap of the selected head is set to approximately +5 volts by the use of series resistors. By changing the reference to +5 volts, 0 volts appears as -5 volts and the use of an actual negative voltage is precluded. Raw data riding on the +5 volt signal is amplified by the differential two-stage amplifier before entering the low pass filter which attenuates the higher unused frequencies.

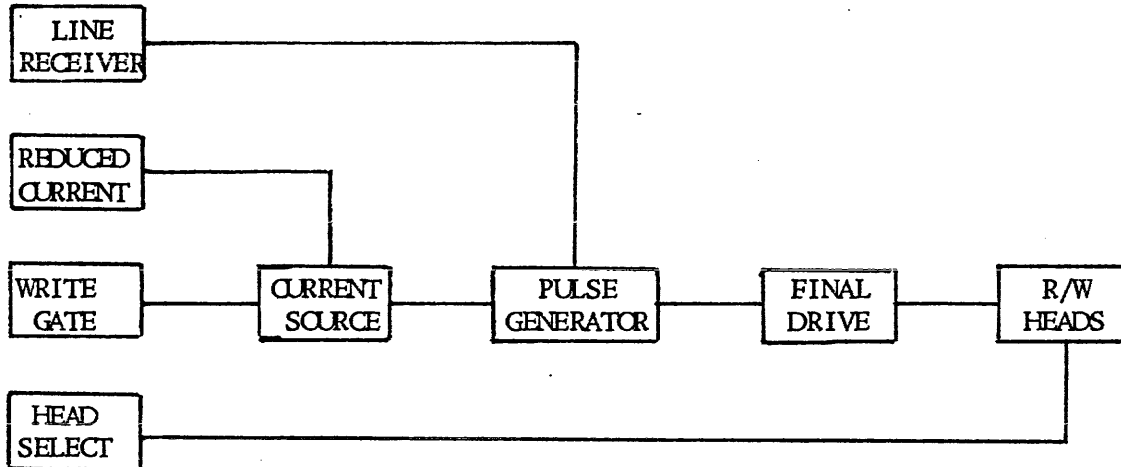
The differentiator shifts the data by 90° causing the data peaks to become zero crossings. The zero crossing detector senses this and converts the analog input to TTL levels. The time domain filter inhibits any false zero crossings that may be found on the outer edge of the disc surface. These false crossings are primarily caused by excessive third harmonics in the analog signal.

The differential receiver and 2-input Exclusive-OR gate form a bidirectional monostable multivibrator. The output of this device is delayed 60ns by the four Hex Schmitt triggers. This delay is used to clock the output of the zero cross detector into the D-type flip-flop. Any false clocks caused by a false zero crossing does not change the state of the flip-flop.

The last differential receiver and 2-input Exclusive-OR gate form a bidirectional monostable multivibrator that establishes the width of the data pulse output from the drive. The line driver converts the data pulse to differential RS-422 levels.

2.3.6 Write Operation

Block Diagram-



Functional Description-

In order to write, the following conditions must be true:

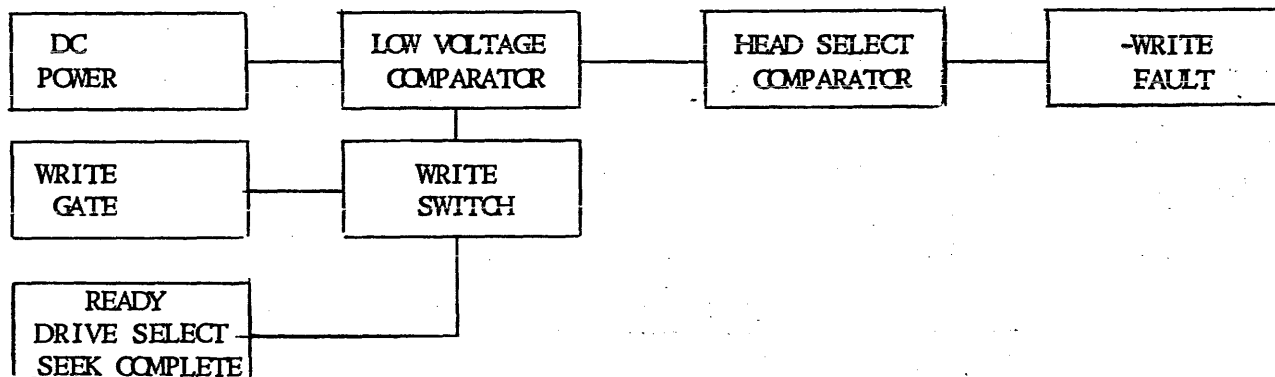
- 1) Write Fault inactive.
- 2) Drive Select active.
- 3) Drive Ready active.
- 4) Seek Complete active.
- 5) Write Gate active.

With write gate active and all the above conditions true, +12V is supplied to the write circuit current source which provides a constant 25ma (50 ma peak to peak). When active, Reduced Write Current will pull approximately 2ma out of the current source. This reduces the peak to peak write current to approximately 46ma.

MFM write data is received by the line receiver and clocks the D-type flip-flop. The driver transistors alternate write current between the windings of the selected head. The center tap of the selected head is at ground potential when Write Gate is active. When Write Gate goes false, the D-type flip-flop is both reset and preset. Both driver transistors are biased off and +12V is removed from the write circuit.

2.3.7 Fault Detection

Block Diagram-



Functional Description-

Any combination of the following events will cause a Write Fault condition and will prevent the drive from writing:

- 1) Multiple heads selected.
- 2) DC voltages more than 20% low.
- 3) Write Gate active and no write current.
- 4) Write Gate inactive and write current.
- 5) Seek Complete inactive.
- 6) Drive Select inactive.
- 7) Ready inactive.

The Head Unsafe circuit monitors the head select output for the following conditions:

- 1) No head selected.
- 2) Multiple heads selected.
- 3) Head selected for read during write.
- 4) Head selected for write during read.

The above circuit constantly sums the head center tap voltage. If the voltage exceeds the upper or lower threshold established by the resistor divider, the circuit provides a Head Unsafe output. The upper and lower thresholds shift correspondingly when Write Gate is active. A capacitor delays this change to allow for the change from read to write. If any unsafe condition is sensed, the Write Fault line is activated and +12V is removed from the write circuit.

If the DC power degrades by more than 20%, the power unsafe detector circuit will select a nonexistent head, activate Write Fault, turn off write current, and initiate a recalibration sequence. Plus 5 volts dropping below 4 volts will force the +5 volt comparator to a high level. Plus 12 volts dropping below 10 volts will force the +12 volt comparator to a high level. When either comparator turns on, the resulting low level is gated through to the head select decoder and output to the drive interface as an active Write Fault signal. A low voltage fault condition will also turn off the write current source. Additionally, this fault condition will reset the up-to-speed and recalibration latches, initiating an auto recalibration sequence.

Write Gate and write current are continuously tested. If one is ever active when the other is not, a fault condition will occur. This signal is gated to the drive interface and head select decoder. It will also be gated to turn off the write current source. In addition to the three above listed fault conditions, Write Gate is compared with Drive Select, Seek Complete, and Ready. If an improper condition exists with any of these signals, write current will be shut off.

2.4 Test Point Description

Test Point 1 (Step Pulse):

Test Point 1 may be used to monitor the interface step pulses. Only the trailing edge of the pulse may be considered valid (transition from negative to positive). If step pulses are issued at a 3.0 millisecond rate, the signal at Test Point 1 should resemble Figure 3.1.

Test Point 2 (Step Timing):

Test Point 2 may be used to monitor the internal step circuitry. For each step pulse on the interface (Test Point 1), two step pulses must be seen at Test Point 2. Note that if the Half Step ("H") option is activated, the second internal pulse will be defeated.

To adjust the internal step circuitry, trigger on Test Point 1 and adjust R63 for a delay of 2.8 milliseconds (+0.0, -.05) at Test Point 2. Only the trailing edge of the pulses may be considered valid. If step pulses are issued at a 3.0 millisecond rate, the signal at Test Point 2 should resemble Figure 3.2.

Test Point 3 (Track Zero Sensor):

Test Point 3 may be used to monitor the Track Zero sensor. A low logic level is a valid Track Zero indication.

Test Point 4 (Index Sensor):

Test Point 4 may be used to monitor the Index sensor. A high logic level is a valid Index indication. Only the leading edge of the pulse may be considered valid. The typical signal at Test Point 4 should resemble Figure 3.3.

Test Point 4 may be used to adjust the spindle motor speed. Monitor Test Point 4 and adjust R3 on the Motor Control P.C.B. (accessible through the side frame) for a period of 16.67 milliseconds, $\pm 1\%$.

Test Point 5 (Seek Complete Timer):

Test Point 5 may be used to monitor the Seek Complete timer. The timer should go true approximately 18 milliseconds after the last interface step pulse is received. To observe the Seek Complete timer, trigger on Test Point 1 and monitor the delay at Test Point 5. Only the trailing edge of the pulses may be considered valid. The typical signal at Test Point 5 should resemble Figure 3.4.

Test Point 6 (Track Zero/Phase "A"):

Test Point 6 may be used to check the operation of the Track Zero/Phase "A" circuitry. A high logic level indicates the drive is at Track Zero with the stepper motor phase "A" active.

Test Points 7 and 8 (Differential Read Filter):

Test Points 7 and 8 may be used to observe the differential read data. The typical amplitude of the signal resulting from adding the two channels is 250 millivolts. It is important that Test Points 9 and 10 are used as ground.

Components of 1.25, 1.66, and 2.5 MHz should be observed. A full track record of high frequency data (0000 or 1111) should resemble figure 3.5.

Test Points 11 and 13 (Time Domain Filter):

Test Points 11 and 13 may be used to observe the operation of the Time Domain Filter. Trigger on Test Point 11 and monitor the delay at Test Point 13. Typically, the delay observed should be 50 to 60 nanoseconds. A full track record of high frequency data (0000 or 1111) should resemble Figure 3.6.

Test Point 15 (Force Seek Outward):

Test Point 15 may be used to force the drive outward past Track 0. Grounding this test point defeats the crash stop prevention circuitry and allows the additional stepper motor travel. This is a convenience feature for use in the drive manufacturing process.

Note: Improper use of this function may permanently damage the drive.

Test Point 16 (Half Step):

Note: This test point applies to Main Control P.C.B. P/N 20040 and greater.

Test Point 16 may be used to temporarily activate the Half Step ("H") option. Grounding this test point performs the same function as activating the Half Step option at I.C. position 6B (6C on P.C.B. P/N 20019). This is a convenience feature for use in the drive manufacturing process.

Test Points 9, 10, 12, and 14 (Convenience Ground):

For any of the above functions, use the ground test point that is in closest proximity to the active test point.

TEST POINT TIMING

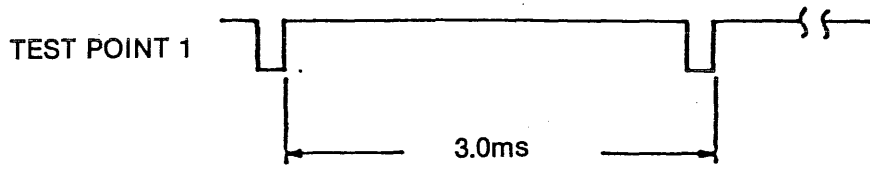


FIGURE 3.1
TEST POINT 1
STEP PULSE

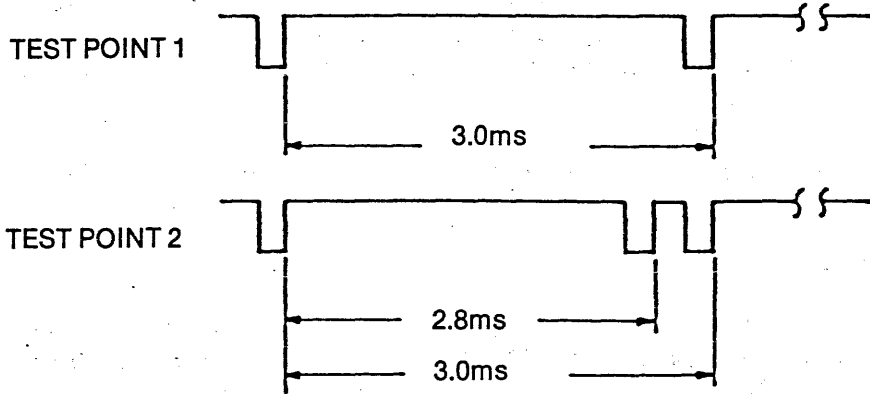


FIGURE 3.2
TEST POINT 2
STEP TIMING

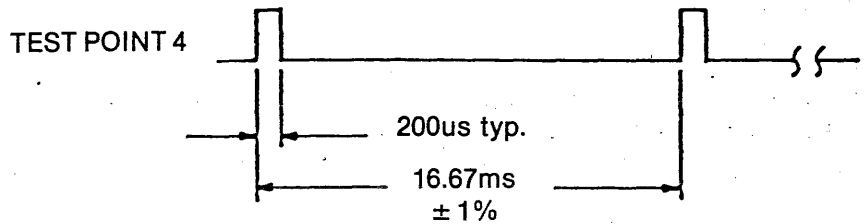


FIGURE 3.3
TEST POINT 4
INDEX SENSOR

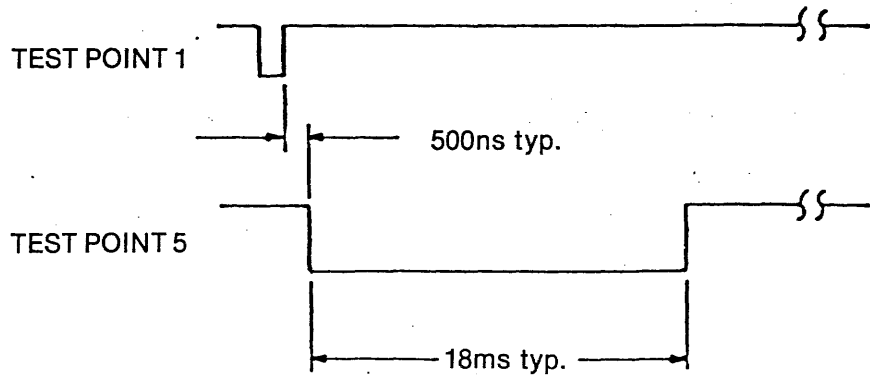


FIGURE 3.4
TEST POINT 5
SEEK COMPLETE TIMER

TEST POINT TIMING

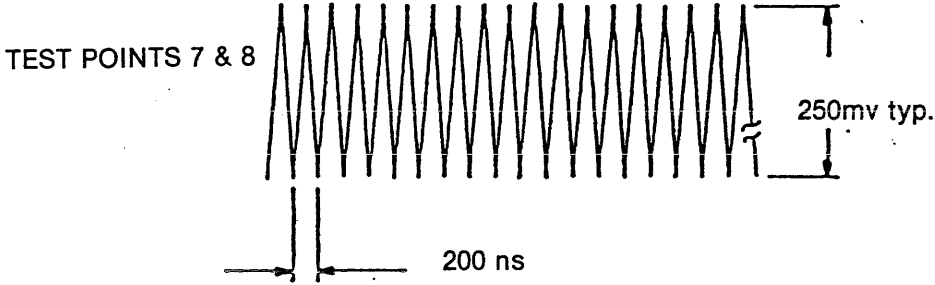


FIGURE 3.5
TEST POINTS 7 & 8
DIFFERENTIAL READ FILTER

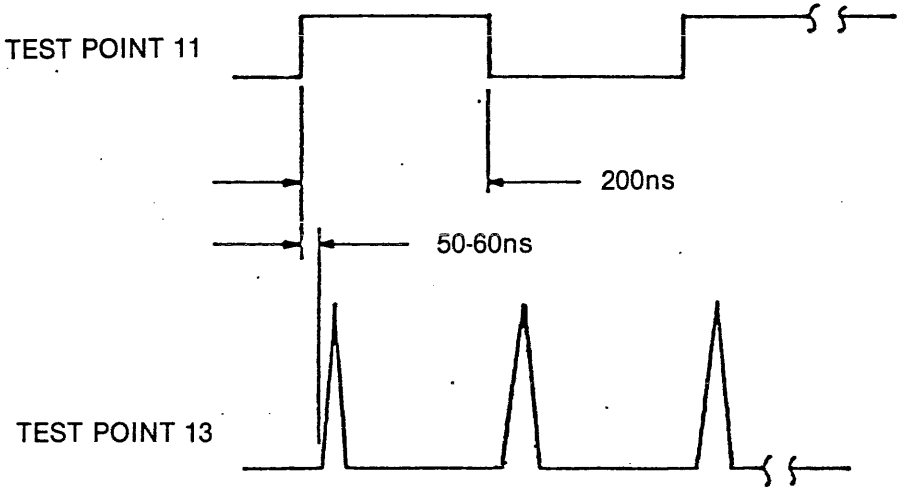
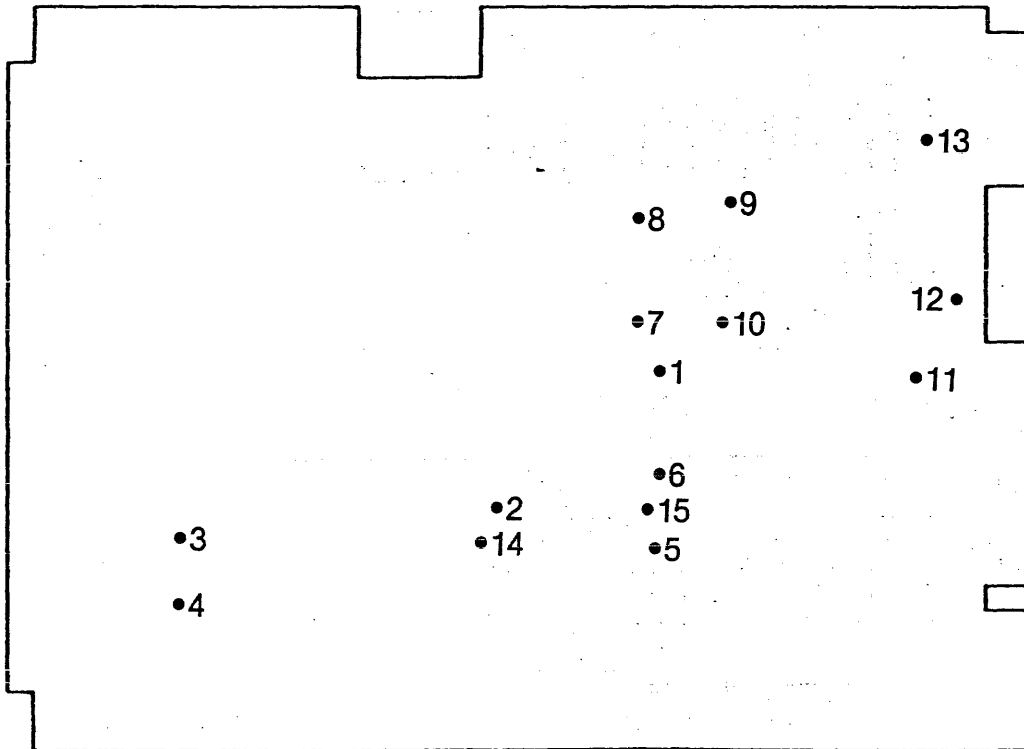
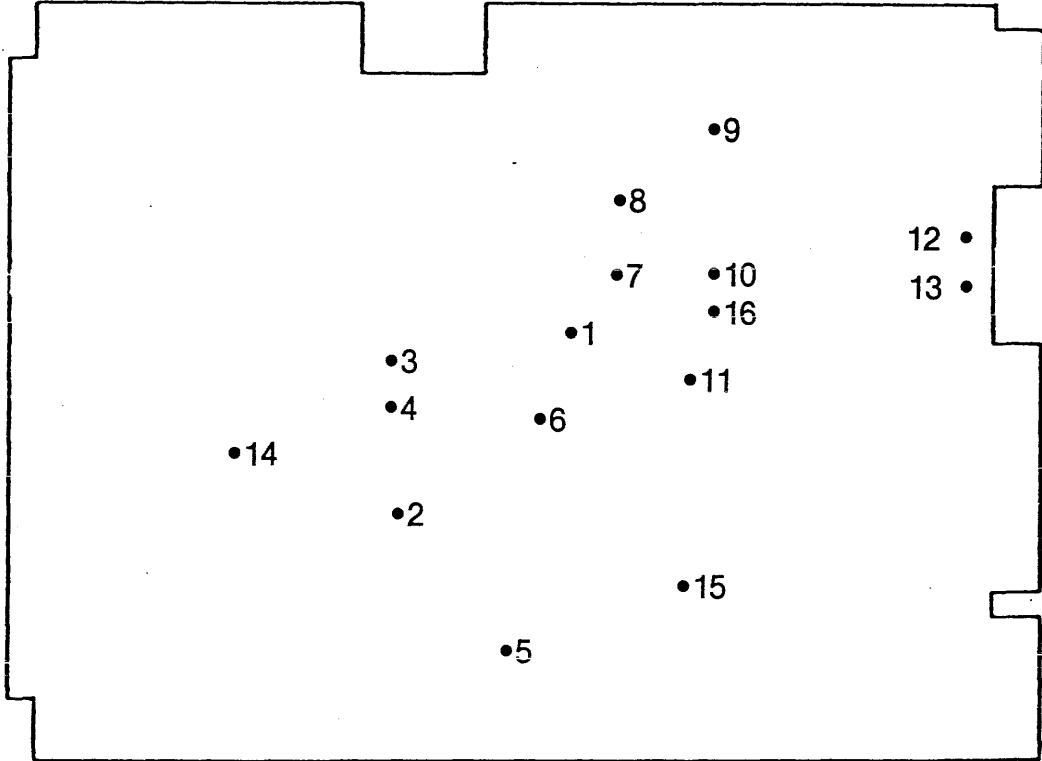


FIGURE 3.6
TEST POINTS 11 & 13
TIME DOMAIN FILTER

TEST POINT LAYOUT — P.C.B. P/N 20019

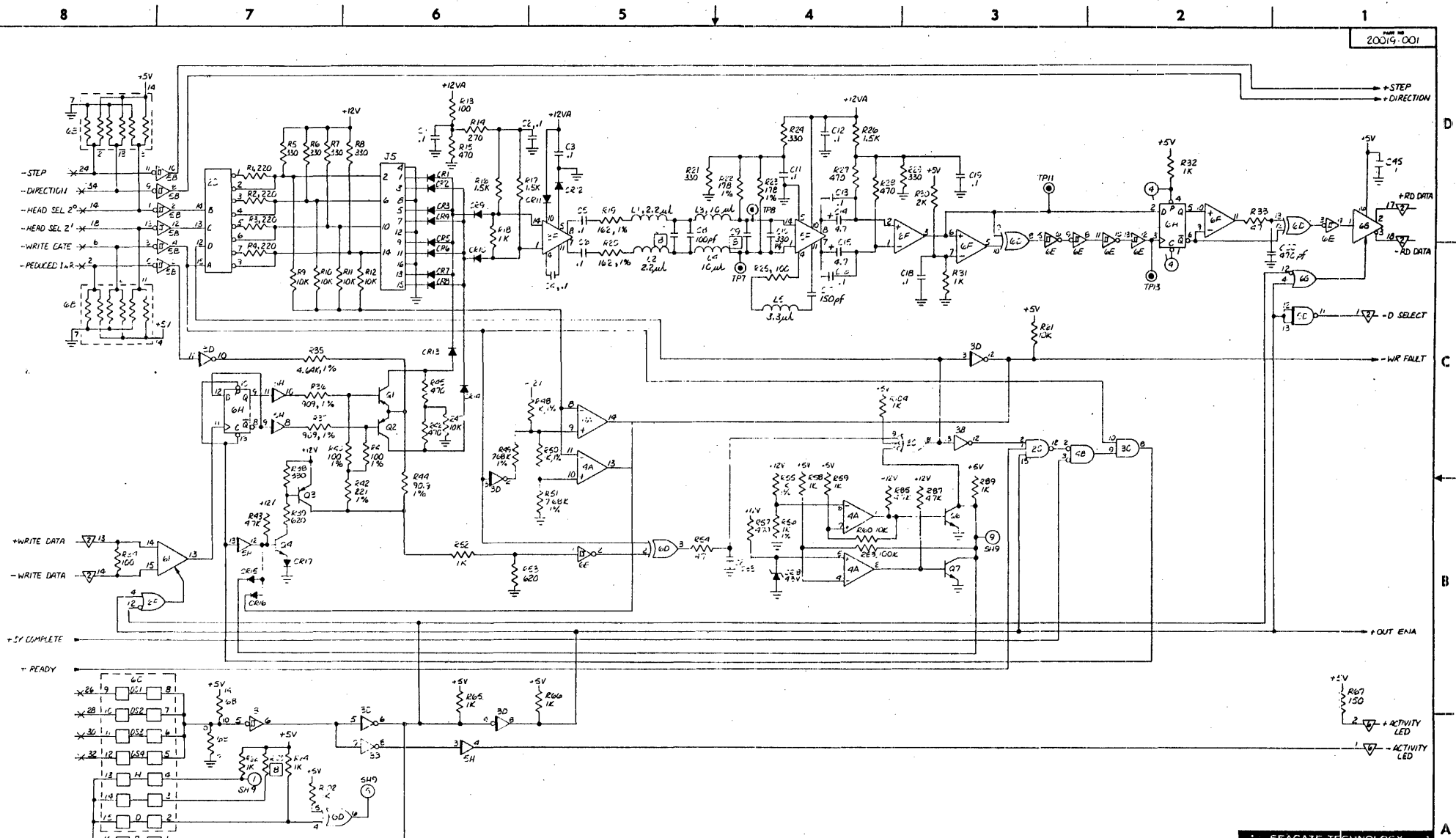


TEST POINT LAYOUT — P.C.B. P/N 20040



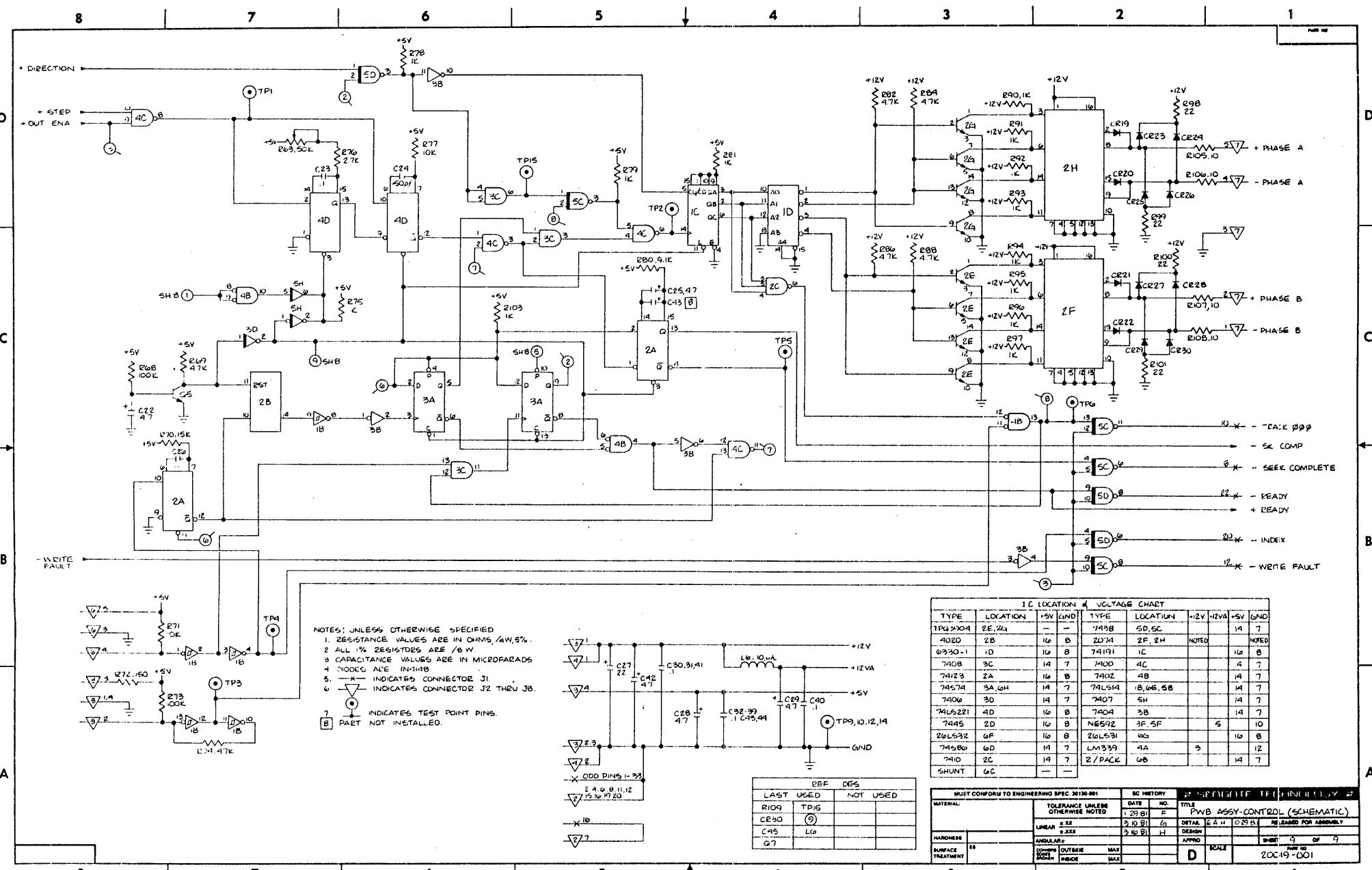
2.5 ST-506 Schematics

Main Control P.C.B. P/N 20019
Main Control P.C.B. P/N 20040
Motor Control P.C.B. P/N 20003



PAGE 70

MUST CONFORM TO ENGINEERING SPEC.		EC HISTORY		SEAGATE TECHNOLOGY	
MATERIAL	TOLERANCE UNLESS OTHERWISE NOTED	DATE	NO.	TITLE	REV.
		12/81	F	5 1/4" ASSY - CONTROL (SCHEMATIC)	
CASE DEPTH	LINEAR ±.001	DESIGN	DETAIL		RELEASED FOR ASSEMBLY
HARDWARE	ANGULAR ±.005	APPRO			
SURFACE FINISH	COMPL. OUTLINE	SCALE	SHEET	OF	
TREATMENT	SOIL. WERSE		D	20019-001	

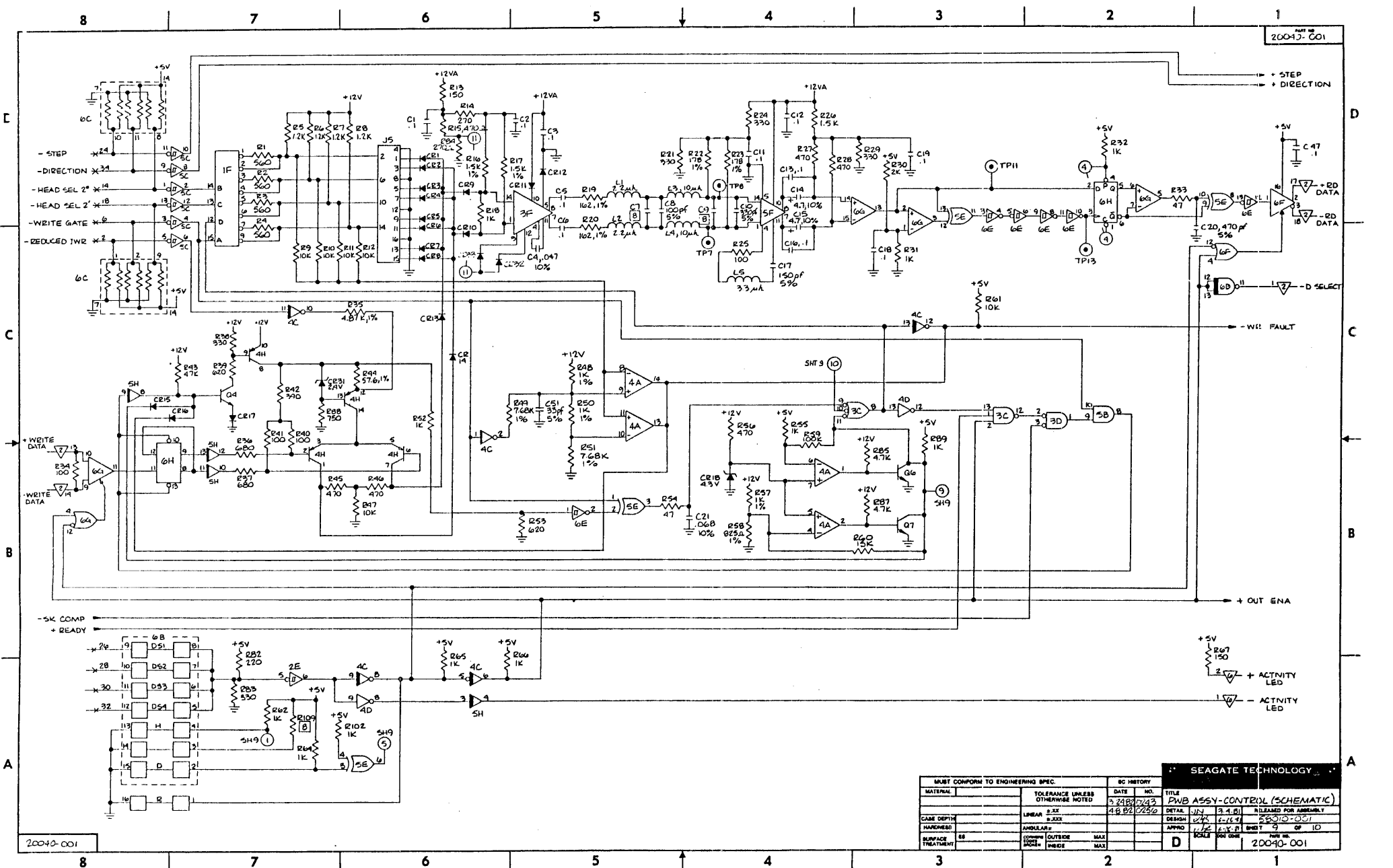


NOTES: UNLESS OTHERWISE SPECIFIED
 1. RESISTANCE VALUES ARE IN OHMS, Ω , μ , K , M , $\%$.
 2. ALL $\frac{1}{2}\%$ RESISTORS ARE $\frac{1}{6}$ W.
 3. CAPACITANCE VALUES ARE IN MICROFARADS
 4. DIODES ARE IN K
 5. ---K INDICATES CONNECTOR J1
 6. ---J INDICATES CONNECTOR J2 THRU J8.
 7 \odot INDICATES TEST POINT PINS.
 8 \square PART NOT INSTALLED.

IC LOCATION		VOLTAGE CHART					
TYPE	LOCATION	+5V	GND	+12V	+12VA	+5V	GND
1PQ3004	2E, 2a	---	---	7498	50, 5C	1A	7
402D	2B	10	B	2U14	2F, 2H	NOTED	---
6390-1	1D	10	B	74191	1C	10	B
740B	3C	1A	7	740D	4C	4	7
74123	2A	10	B	7402	4B	1A	7
7457A	3A, 6H	1A	7	74LS14	1B, 6E, 5B	1A	7
7406	3D	1A	7	7407	5H	1A	7
74LS221	4D	10	B	7404	3B	1A	7
7445	2D	10	B	NE592	3F, 5F	5	10
20LS32	6F	10	B	20LS31	6C	10	B
74S80	6D	1A	7	LM339	4A	3	12
7410	2C	1A	7	2/PACK	6B	1A	7
SHUNT	6C	---	---	---	---	---	---

REF DES	
LAST USED	NOT USED
R109	TP15
CE90	(5)
C45	L6
G7	

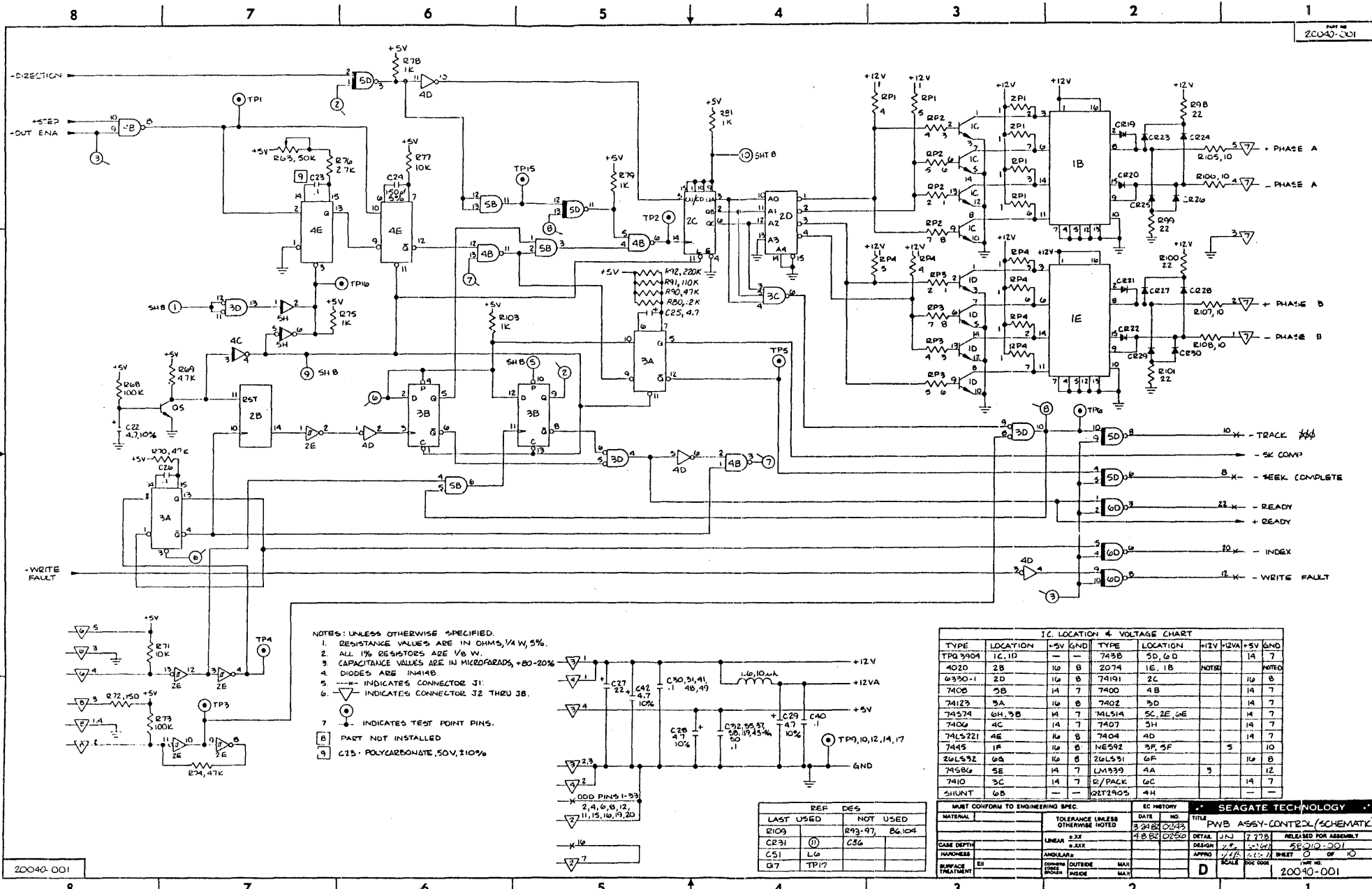
MATERIAL		SC HISTORY		REPRODUCTION	
TOLERANCE UNLESS OTHERWISE NOTED		DATE	NO.	TITLE	
LINEAR $\pm .01$		1 29 81	F	PWB ASSY-CONTROL (SCHEMATIC)	
HARDNESS $\pm .005$		3 10 81	G	DETAIL	E A H 0 29 81
SURFACE TREATMENT		3 10 81	H	DERIV	
ANODIZING				APPRO	
CONFORMAL COATING				SCALE	
EXTENSIVE				REV	5 OF 9
INSPECTION				DATE	20C19-001



20040-001

MUST CONFORM TO ENGINEERING SPEC.		DATE		NO.		TITLE	
MATERIAL	TOLERANCE UNLESS OTHERWISE NOTED	3/28/83	0243	46	02250	PNB ASSY-CONTROL (SCHEMATIC)	
CAM DEPTH	LINEAR .5XX			DETAIL	UN	3.4.01	RELEASED FOR ASSEMBLY
FINISHES	.5XX	DESIGN	UN	1-1-83	20010-001		
SURFACE TREATMENT	ANODIZED	APPROV	UN	1-1-83	DRY	9	OP 10
CS	CONFORM TO OUTSIDE SPEC.	SCALE	1:1	REV	001	20040-001	

SEAGATE TECHNOLOGY



- NOTES: UNLESS OTHERWISE SPECIFIED.
1. RESISTANCE VALUES ARE IN OHMS, 1/4 W, 5%.
 2. ALL 1% RESISTORS ARE 1/8 W.
 3. CAPACITANCE VALUES ARE IN MICROFARADS, +20-20%.
 4. DIODES ARE IN 1N4148.
 5. --- INDICATES CONNECTOR J1.
 6. --- INDICATES CONNECTOR J2 THRU J8.
 7. ● INDICATES TEST POINT PINS.
 8. PART NOT INSTALLED.
 9. C25 - POLYCARBONATE, 50V, ±10%

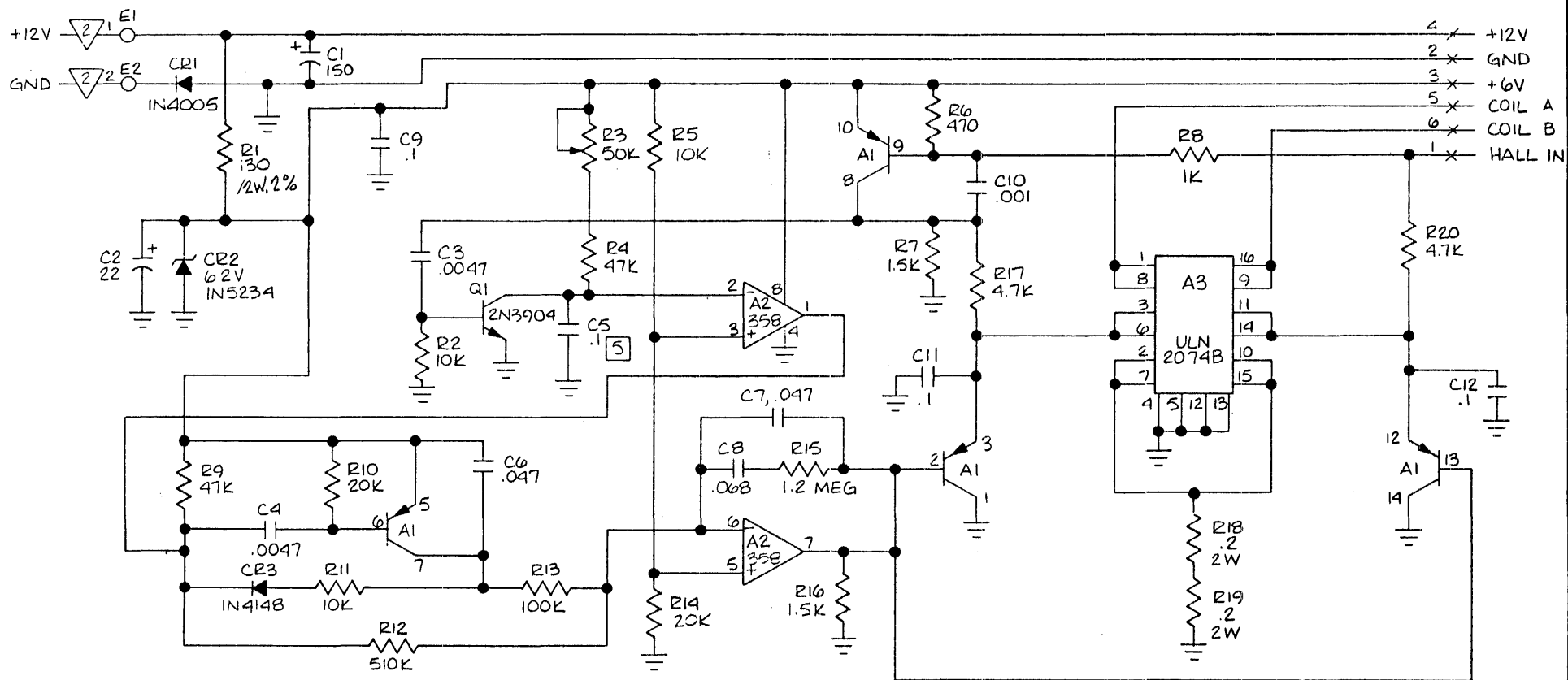
I.C. LOCATION & VOLTAGE CHART

TYPE	LOCATION	+5V	GND	TYPE	LOCATION	+12V	+12VA	+5V	GND
TPQ 9404	IC 1D			7438	5D, 6D			1A	7
4020	2B	10	8	2074	1E, 1B	NOTED		NOTED	
6330-1	2D	10	8	74191	2C			10	8
7408	3B	14	7	7400	4B			14	7
74123	3A	10	8	7402	3D			14	7
74574	6H, 3B	14	7	74LS14	5C, 2E, 6E			14	7
7406	4C	14	7	7407	5H			14	7
74LS221	4E	10	8	7404	4D			14	7
7445	1F	10	8	NE592	3F, 5F		3	14	7
20LS92	6A	10	8	20LS91	6F			10	8
74586	5E	14	7	LM939	4A		3	14	7
7410	3C	14	7	6/PAK	6C			14	7
SHUNT	6B			02T1905	4H				



REF	DES	NOT USED
R109		R93-97, R6, 104
CR31	(1)	C36
C51	L6	
G7	TP17	

MATERIAL		TOLERANCE UNLESS OTHERWISE NOTED		DATE		NO.		TITLE	
				3/28/82		D223		PWB ASSY-CONTROL/SCHEMATIC	
CASE DEPTH		LINEAR ±.01		DESIGN		UNJ		7/78	
HARDNESS		ANODULAR		APPRO		1/1		58-210-001	
SURFACE TREATMENT		FORMING OUTSIDE		SCALE		D		20040-001	

PART NO.
20003-001



NOTES: UNLESS OTHERWISE SPECIFIED.

1. ALL RESISTORS ARE IN OHMS, 1/4W, 5%
2. ALL CAPACITORS ARE IN MICROFARADS, 10%
3. X INDICATES J1
4.  INDICATES J2
5.  C5 - POLYCARBONATE, 50V, ±10%

MUST CONFORM TO ENGINEERING SPEC. 30130-001				EC HISTORY		SERGATE TECHNOLOGY			
MATERIAL:		TOLERANCE UNLESS OTHERWISE NOTED		DATE	NO.	TITLE PWB ASSY - MTR CNTL (SCHEMATIC)			
		LINEAR	±.XX	2-9-82	0220	DETAIL	JN	4-20-81	RELEASED FOR ASSEMBLY
			±.XXX	3-12-82	0235	DESIGN			
HARDNESS		ANGULAR±				APPRO			SHEET 6 OF 6
SURFACE TREATMENT	ES	CORNERS EDGES BROKEN	OUTSIDE MAX			B	SCALE		PART NO. 20003-001
			INSIDE MAX						

3.0 MAINTENANCE/REPAIR

3.1 Introduction

The Seagate Technology ST-506 Microwinchester disc drive does not require preventive maintenance. Additionally, all units shipped are covered by a one year factory warranty. If field maintenance or repair is required, certain restrictions apply. Primarily, the environmentally sealed Head/Disc Assembly (HDA) must not be opened. Seagate Technology considers a drive to be out of warranty if the HDA has been tampered with. Any special tools or additional restrictions will be covered under the appropriate sections.

This section of the ST-506 Service Manual will attempt to cover adjustments and repair of the field serviceable portion of the disc drive. Any questions that are not covered in this document should be referred to the Technical Support department at Seagate Technology.

3.2 Removals/Adjustments

Note: Removal of any assembly not covered in this section is not possible without special clean room facilities and tools.

3.2.1 Main Control P.C.B.

Tools Required: 5/64" Hex Driver
Loctite #242

- 1) Remove (4) 6-32 x 1/4" Main Control P.C.B. mounting screws.
- 2) Disconnect P1 through P8, noting their positions.
- 3) Slide the Main Control P.C.B. toward the rear of the drive and remove.
- 4) To reinstall, reverse the above procedure using Loctite on the first three threads of all 6-32 screws.

Note: Avoid flexing the Printed Circuit Cable when removing P5.

3.2.2 Motor Control P.C.B.

Tools Required: 5/64" Hex Driver
Loctite #242

- 1) Remove (4) 6-32 x 1/4" Main Control P.C.B. mounting screws.
- 2) Disconnect P1 through P8, noting their positions.
- 3) Slide the Main Control P.C.B. toward the rear of the drive and remove.
- 4) Disconnect Motor Control P.C.B. P1 and P2, noting their orientation.
- 5) Remove (2) 6-32 x 1/4" Motor Control P.C.B. mounting screws.
- 6) Remove the Motor Control P.C.B.
- 7) To reinstall, reverse the above procedure using Loctite on the first three threads of all 6-32 screws.

Note: Whenever the Motor Control P.C.B. is replaced, or if any of its components are changed, the spindle speed must be adjusted. Connect a frequency counter to Test Point 4 (Index) and adjust R3 on the Motor Control P.C.B. (accessible through the sideframe) for a period of 16.67 milliseconds. The frequency counter must average 100 samples per minute minimum. Additionally, if C5 is replaced, the Motor Control P.C.B. must be burned in for at least 12 hours to settle the capacitor before adjusting the speed.

3.2.3 Spindle Brake

Tools Required: 5/64" Hex Driver
Loctite #242
10 Mil Shim (.010") (Flexible)

- 1) Remove (4) 6-32 x 1/4" Main Control P.C.B. mounting screws.
- 2) Disconnect P1 through P8, noting their positions.
- 3) Slide the Main Control P.C.B. toward the rear of the drive and remove.
- 4) Disconnect P2 at the Motor Control P.C.B. and free the brake wires from the retaining clip.
- 5) Remove (1) 6-32 x 1" brake mounting screw, washer, and spacer.
- 6) Remove the brake solenoid.
- 7) To reinstall, apply Loctite to the first 3 threads of the brake mounting screw. Replace the brake solenoid, spacer, washer, and mounting screw but do not tighten.
- 8) Insert the flexible 10 mil shim between the brake pad and the spindle motor housing.
- 9) Move the brake toward the spindle motor housing until the solenoid spring assembly is compressed and a slight resistance is felt on the shim.
- 10) Tighten the 6-32 brake mounting screw and verify that the contour of the brake pad aligns with the spindle motor housing.
- 11) Route the brake solenoid wires through the retaining clip and connect P2 to the Motor Control P.C.B.
- 12) Reverse steps 1 through 3 to replace the Main Control P.C.B. using Loctite on the first 3 threads of all 6-32 screws.

3.2.4 Index Sensor

Tools Required: 5/64" Hex Driver
Loctite #242
30 Mil Shim (.030")

- 1) Remove (4) 6-32 x 1/4" Main Control P.C.B. mounting screws.
- 2) Disconnect P1 through P8, noting their positions.
- 3) Slide the Main Control P.C.B. toward the rear of the drive and remove.
- 4) Remove the connector from the front panel LED, noting the orientation of the connector.
- 5) Free the index sensor wires from the retaining clip.
- 6) Remove (2) 6-32 x 1/8" index sensor mounting screws and mounting clamp.
- 7) Remove the index sensor.
- 8) To reinstall, apply Loctite to the first three threads of the index sensor mounting screws. Replace the index sensor, mounting clamp, and mounting screws but do not tighten.
- 9) Rotate the spindle motor housing until the silver index tab aligns with the index sensor.

- 10) Using the 30 mil shim, adjust the gap between the index sensor and the index tab.
- 11) Tighten the 2 mounting clamp screws and verify that the gap is 30 mils.
- 12) Route the index sensor wires through the retaining clip and reconnect the LED.
- 13) Reverse steps 1 through 3 to replace the Main Control P.C.B. using loctite on the first three threads of all 6-32 screws.

3.2.5 Ground Spring

Tools Required: 5/64" Hex Driver
Loctite #242

- 1) Remove (4) 6-32 x 1/4" Main Control P.C.B. mounting screws.
- 2) Disconnect P1 through P8, noting their positions.
- 3) Slide the Main Control P.C.B. toward the rear of the drive and remove.
- 4) Remove (1) 6-32 x 1/8" ground spring mounting screw and spacer.
- 5) Remove the ground spring.
- 6) To reinstall, apply Loctite to the first 3 threads of the ground spring mounting screw. Replace the ground spring, spacer, and mounting screw.
- 7) Center the ground spring over the spindle motor contact ball and tighten.
- 8) Verify that the ground spring button and spindle motor ball are clean and making good contact.
- 9) Reverse steps 1 through 3 to replace the Main Control P.C.B. using Loctite on the first 3 threads of all 6-32 screws.

3.2.6 Track \emptyset Sensor

Tools Required: 5/64" Hex Driver
.050" Hex Driver
Loctite #242

- 1) Remove (4) 6-32 x 1/4" Main Control P.C.B. mounting screws.
- 2) Disconnect P1 through P8, noting their positions.
- 3) Slide the Main Control P.C.B. toward the rear of the drive and remove.
- 4) Remove (2) 6-32 x 1/8" front panel mounting screws.
- 5) Remove the front panel. It is not necessary to remove the LED connector.
- 6) Remove (2) 2-56 x 1/8" track \emptyset sensor mounting bracket retaining screws.
- 7) Remove the mounting bracket and track \emptyset sensor, noting the orientation of the track \emptyset sensor.
- 8) To reinstall, reverse the above procedure using Loctite on the first 3 threads of all screws.

Note: Proper positioning of the Track \emptyset sensor is important. It is recommended that this adjustment be performed at the factory.

3.2.7 Front Cover

Tools Required: 5/64" Hex Driver
Loctite #242

- 1) Remove (4) 6-32 x 1/4" Main Control P.C.B. mounting screws.
- 2) Disconnect P1 through P8, noting their positions.
- 3) Slide the Main Control P.C.B. toward the rear of the drive and remove.
- 4) Remove the connector from the front panel LED, noting the orientation of the connector.
- 5) Remove (2) 6-32 x 1/8" front panel mounting screws.
- 6) Remove the LED and grommet from the front panel, noting the orientation of the LED.
- 7) Remove the front panel.
- 8) To reinstall, reverse the above procedure using Loctite on the first three threads of all 6-32 screws.

Note: A water base hot melt glue may be used to secure the LED/grommet assembly.

3.2.8 Front Cover LED

Tools Required: 5/64" Hex Driver
Loctite #242

- 1) Remove (4) 6-32 x 1/4" Main Control P.C.B. mounting screws.
- 2) Disconnect P1 through P8, noting their positions.
- 3) Slide the Main Control P.C.B. toward the rear of the drive and remove.
- 4) Remove the connector from the front panel LED, noting the orientation of the connector (Black wire to single dot).
- 5) Remove the LED and grommet from the front panel, noting the orientation of the LED.
- 6) To reinstall, reverse the above procedure using Loctite on the first three threads of all 6-32 screws.

Note: A water base hot melt glue may be used to secure the LED/grommet assembly.

3.2.9 Side Frames

Tools Required: 5/64" Hex Driver
Loctite #242

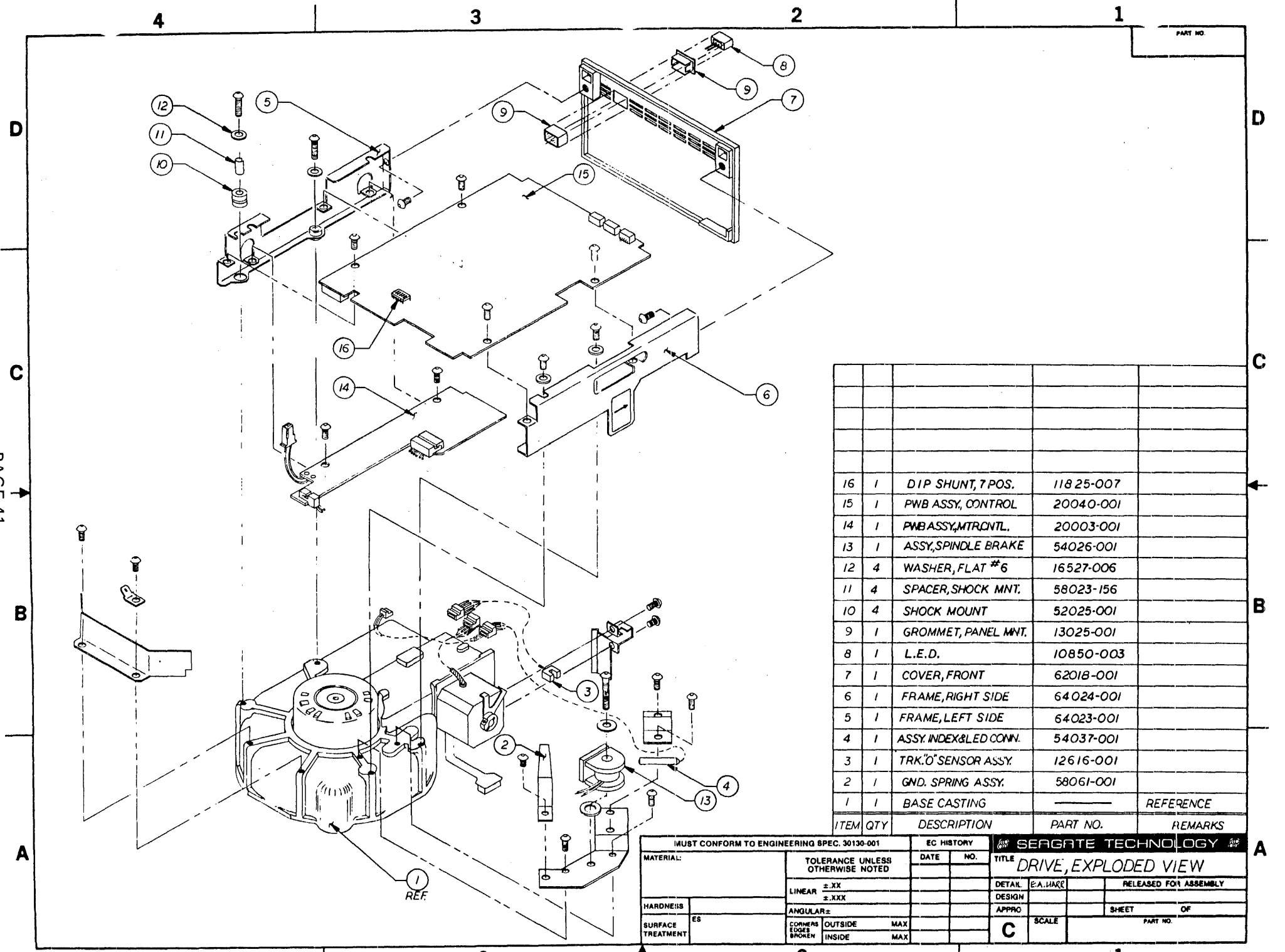
- 1) Remove (4) 6-32 x 1/4" Main Control P.C.B. mounting screws.
- 2) Disconnect P1 through P8, noting their positions.
- 3) Slide the Main Control P.C.B. toward the rear of the drive and remove.
- 4) Remove (2) 6-32 x 1/8" front cover mounting screws. It is not necessary to remove the LED connector.
- 5) Remove (4) 6-32 x 5/16" side frame mounting screws, washers, grommets and spacers.
- 6) Remove the right and left side frames.
- 7) To reinstall, reverse the above procedure using Loctite on the first three threads of all 6-32 screws.

4.0 ILLUSTRATED PARTS CATALOG

4.1 Physical Locations

4.1.1 Drive Exploded View

4.1.2 Connectors Exploded View



PART NO.

ITEM	QTY	DESCRIPTION	PART NO.	REMARKS
16	1	DIP SHUNT, 7 POS.	118 25-007	
15	1	PWB ASSY, CONTROL	20040-001	
14	1	PWB ASSY, MTRCNTRL.	20003-001	
13	1	ASSY, SPINDLE BRAKE	54026-001	
12	4	WASHER, FLAT #6	16527-006	
11	4	SPACER, SHOCK MNT.	58023-156	
10	4	SHOCK MOUNT	52025-001	
9	1	GROMMET, PANEL MNT.	13025-001	
8	1	L.E.D.	10850-003	
7	1	COVER, FRONT	62018-001	
6	1	FRAME, RIGHT SIDE	64024-001	
5	1	FRAME, LEFT SIDE	64023-001	
4	1	ASSY. INDEX & LED CONN.	54037-001	
3	1	TRK. 0° SENSOR ASSY.	12616-001	
2	1	GND. SPRING ASSY.	58061-001	
1	1	BASE CASTING		REFERENCE

MUST CONFORM TO ENGINEERING SPEC. 30130-001		EC HISTORY		SERGATE TECHNOLOGY	
MATERIAL:		DATE	NO.	TITLE DRIVE, EXPLODED VIEW	
TOLERANCE UNLESS OTHERWISE NOTED				DETAIL	E.A. WARR
LINEAR ±.XX				DESIGN	RELEASED FOR ASSEMBLY
ANGULAR ±.XXX				APPRO	SHEET OF
HARDNESS				SCALE	PART NO.
SURFACE TREATMENT	ES			C	
	CORNERS BROKEN	OUTSIDE	MAX		
		INSIDE	MAX		

PAGE 41

D

C

B

A

D

C

B

A

4

3

2

1

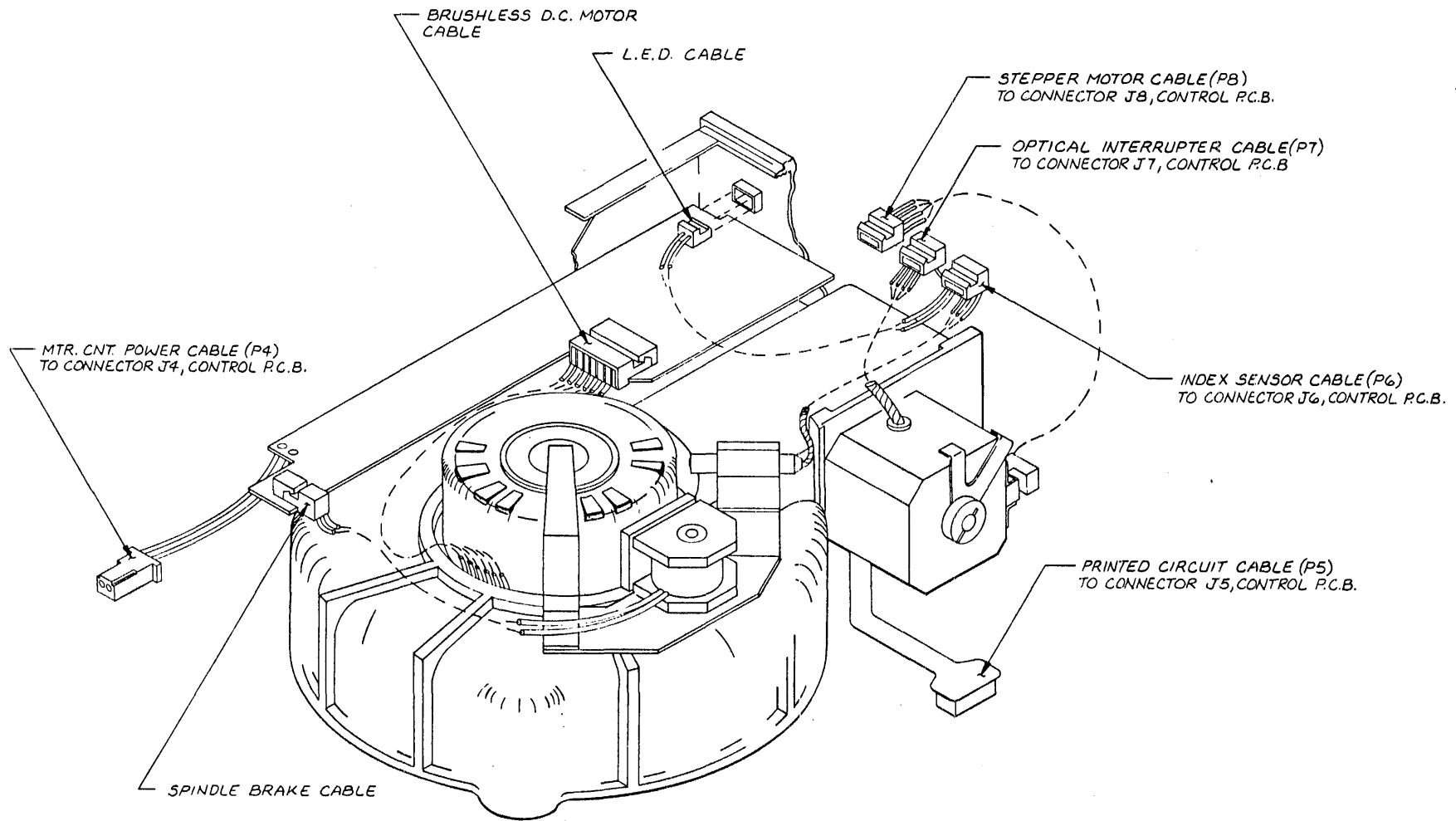
4

3

2

1

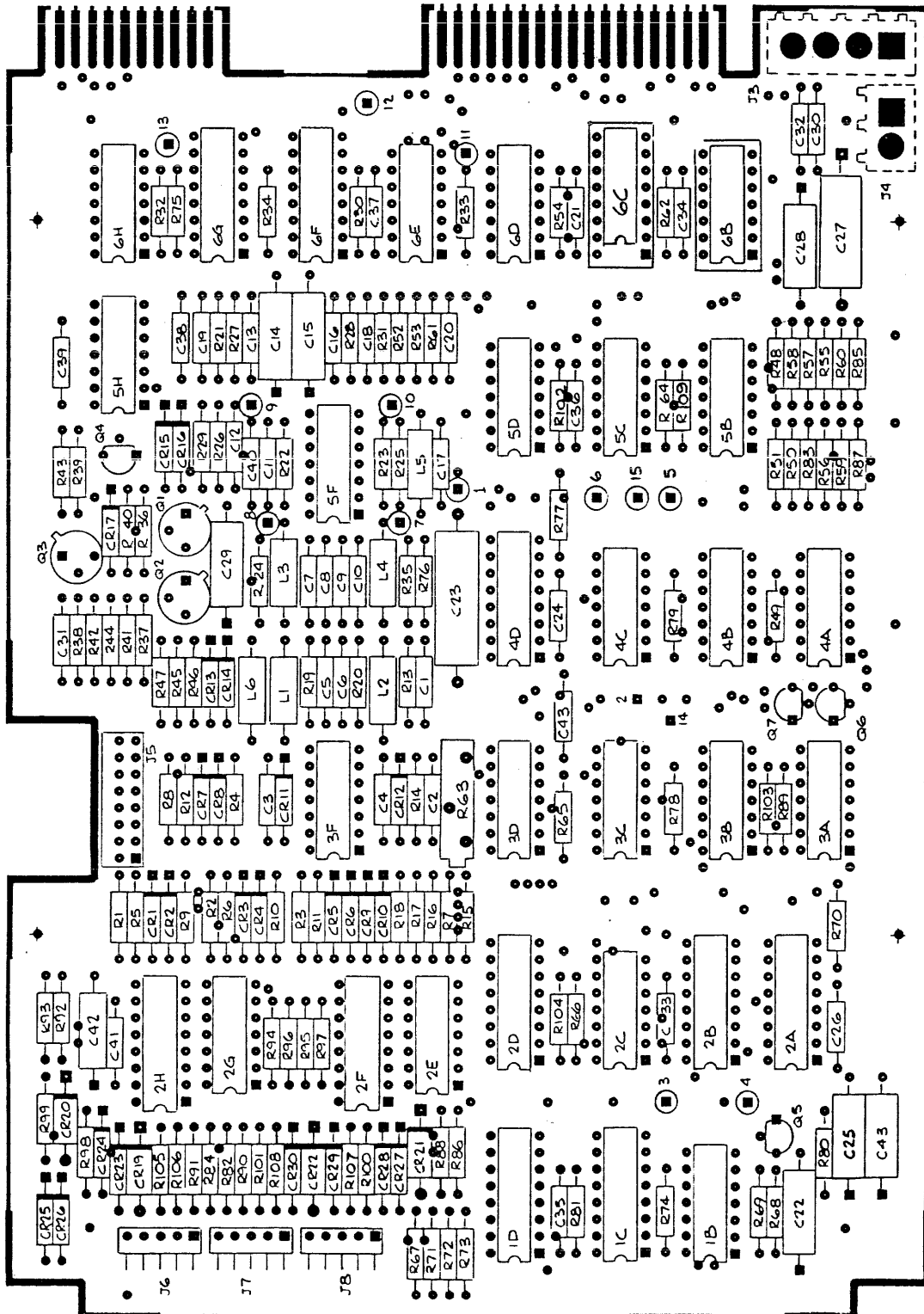
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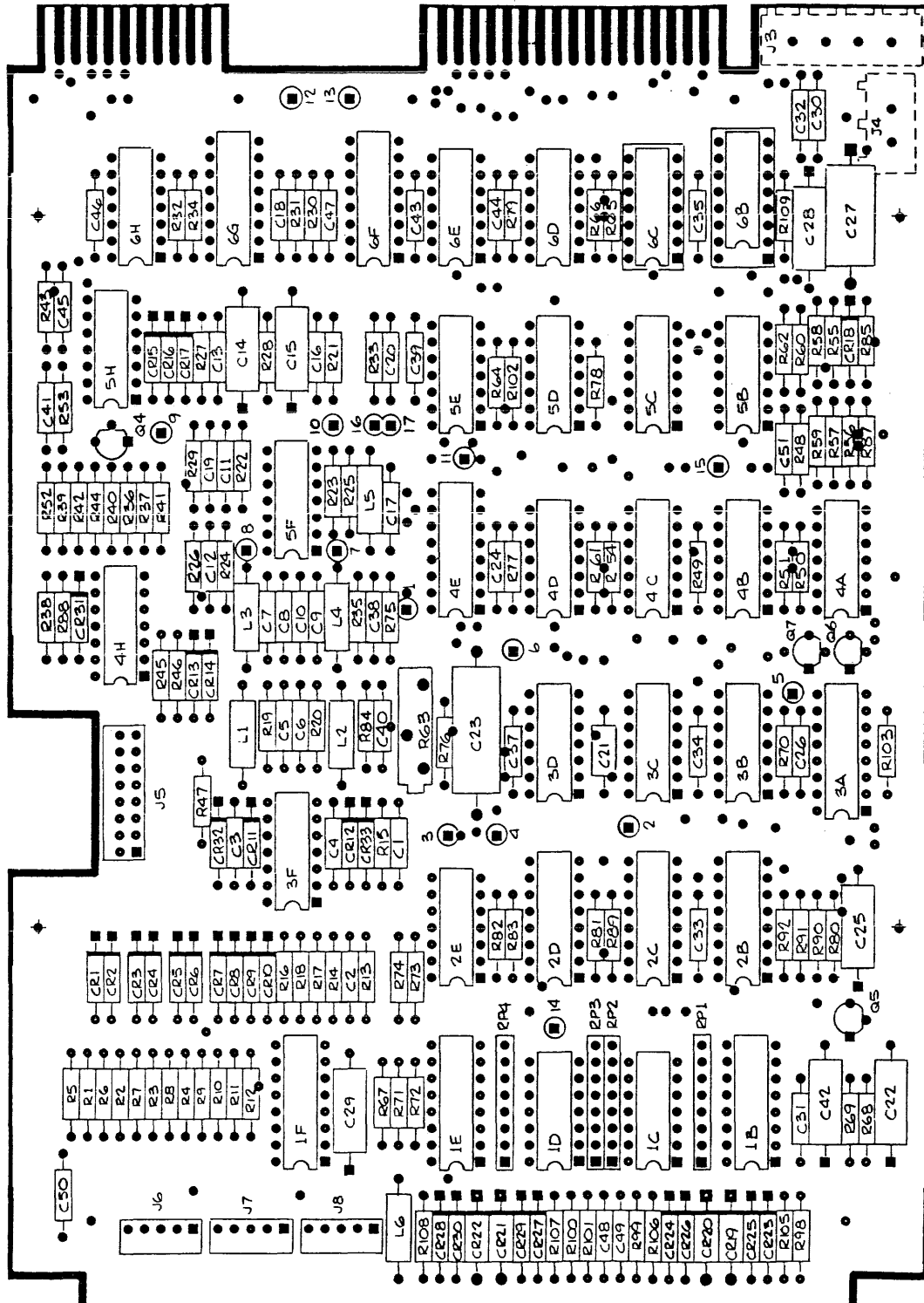


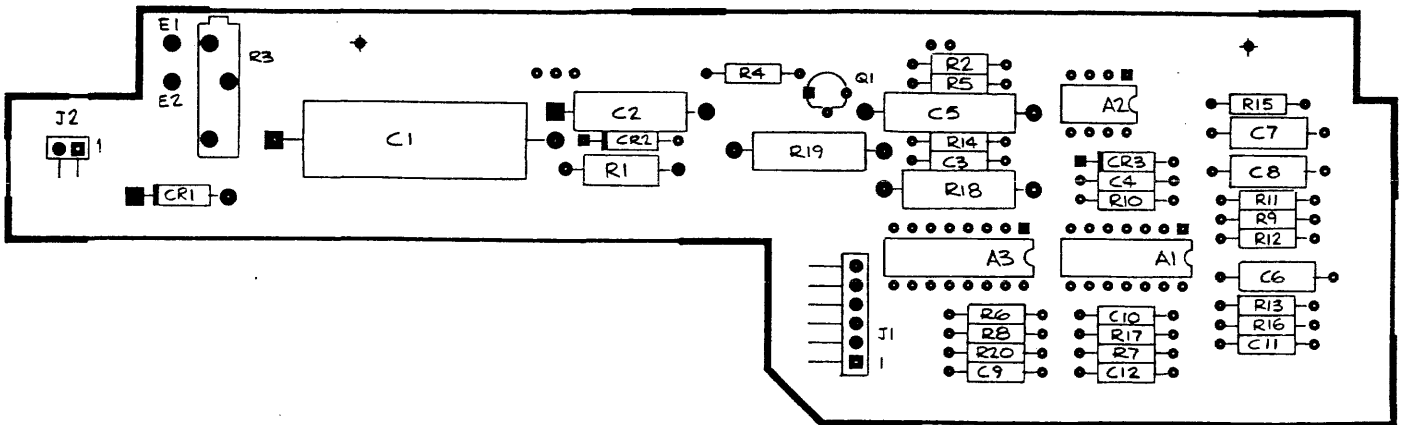
MUST CONFORM TO ENGINEERING SPEC.			EC HISTORY		SEAGATE TECHNOLOGY		
MATERIAL	TOLERANCE UNLESS OTHERWISE NOTED		DATE	NO.	TITLE		
	LINEAR	±.XX	1-7-81	A	DETAIL	E. A. H. 1-7-81	RELEASED FOR ASSEMBLY
CASE DEPTH		±.XXX			DESIGN		
HARDNESS	ANGULAR	±			APPRO		SHEET (X)
SURFACE TREATMENT	ES	CORNERS BROKEN	OUTSIDE	MAX	C	SCALE	DOC CODE
		INSIDE	MAX			NONE	PART NO.

4.2 Component Locations

- 4.2.1 Main Control P.C.B. P/N 20019
- 4.2.2 Main Control P.C.B. P/N 20040
- 4.2.3 Motor Control P.C.B. P/N 20003







4.3 Parts Lists

- 4.3.1 Main Control P.C.B. P/N 20019
- 4.3.2 Main Control P.C.B. P/N 20040
- 4.3.3 Motor Control P.C.B. P/N 20003
- 4.2.4 Spare Parts List

4.3.1 Main Control P.C.B. P/N 20019

<u>Item No.</u>	<u>Quantity</u>	<u>Description</u>	<u>Location</u>
1	2	I.C. TPQ3904	2E, 2G
2	1	I.C. 4020	2B
3	1	I.C. 6330-1	1D
4	1	I.C. 7408	3C
5	1	I.C. 74123	2A
6	2	I.C. 74S74	3A, 6H
7	1	I.C. 7406	3D
8	1	I.C. 74LS221	4D
9	1	I.C. 7445	2D
10	1	I.C. 26LS32	6F
11	1	I.C. 74S86	6D
12	1	I.C. 7410	2C
13	2	I.C. 7438	5C, 5D
14	2	I.C. 2074	2F, 2H
15	1	I.C. 74191	1C
16	1	I.C. 7400	4C
17	1	I.C. 7402	4B
18	3	I.C. 74LS14	1B, 5B, 6E
19	1	I.C. 7407	5H
20	1	I.C. 7404	3B
21	2	I.C. NE592	3F, 5F
22	1	I.C. 26LS31	6G
23	1	I.C. LM339	4A
24	1	R/PACK 220/330 OHM	6B
25	1	SHUNT, 7 POS, AMP-435704-7	6C
26	1	I.C. SOCKET, 16 PIN	6C
27	1	I.C. SOCKET, 14 PIN	6B
28	1	CAP, ELECTROLYTIC, 22uf, 16V	C27
29	7	CAP, TANT, 4.7uf, 35V, 10%	C14, 15, 22, 25, 28, 29, 42
30	2	CAP, CERAMIC, 150pf, NPO, 5%	C17, 24
31	1	CAP, CERAMIC, .033uf, X7R, 10%	C21
32	1	CAP, CERAMIC, 100pf, NPO, 5%	C8
33	1	CAP, CERAMIC, 330pf, NPO, 5%	C10
34	1	CAP, CERAMIC, 470pf, NPO, 5%	C20
35	28	CAP, CERAMIC, .1uf, Z5U, +80, -20%	C1-6, 11-13, 16, 18, 19, 26, 30-41, 43, 44, 45
36	1	CAP, POLYCARB, .1uf, 50V, 10%	C23
37	25	DIODE, 1N4148	CR1-17, 23-30
38	4	DIODE, 1N4003	CR19-22
39	1	DIODE, ZENER, 4.3V, 1N5229B	CR18
40	2	INDUCTOR, 2.2uh	L1, 2
41	3	INDUCTOR, 10uh	L3, 4, 6
42	1	INDUCTOR, 3.3uh	L5

<u>Item No.</u>	<u>Quantity</u>	<u>Description</u>	<u>Location</u>
43	3	TRANSISTOR, 2N3468	Q1,2,3
44	4	TRANSISTOR, 2N3904	Q4,5,6,7
45	1	RESISTOR, 1/8W, 1%, 90.9 OHM	R44
46	2	RESISTOR, 1/8W, 1%, 100 OHM	R40,41
47	2	RESISTOR, 1/8W, 1%, 162 OHM	R19,20
48	2	RESISTOR, 1/8W, 1%, 178 OHM	R22,23
49	1	RESISTOR, 1/8W, 1%, 221 OHM	R42
50	2	RESISTOR, 1/8W, 1%, 909 OHM	R36,37
51	4	RESISTOR, 1/8W, 1%, 1K	R48,50,55
52	1	RESISTOR, 1/8W, 1%, 4.64K	R35
53	2	RESISTOR, 1/8W, 1%, 7.68K	R49,51
54	1	RESISTOR, 1/4W, 5%, 9.1K	R80
55	4	RESISTOR, 1/4W, 5%, 22 OHM	R98,99,100,101
56	2	RESISTOR, 1/4W, 5%, 47 OHM	R33,54
57	3	RESISTOR, 1/4W, 5%, 100 OHM	R13,25,34
58	2	RESISTOR, 1/4W, 5%, 150 OHM	R67,72
59	4	RESISTOR, 1/4W, 5%, 220 OHM	R1,2,3,4
60	1	RESISTOR, 1/4W, 5%, 270 OHM	R14
61	8	RESISTOR, 1/4W, 5%, 330 OHM	R5,6,7,8,21,24,29, 38
62	5	RESISTOR, 1/4W, 5%, 470 OHM	R15,27,28,45,46
63	2	RESISTOR, 1/4W, 5%, 620 OHM	R39,53
64	26	RESISTOR, 1/4W, 5%, 1K	R18,31,32,52,58, 59,62,64-66,75,78, 79,81,89,90-97, 102-104
65	3	RESISTOR, 1/4W, 5%, 1.5K	R16,17,26
66	1	RESISTOR, 1/4W, 5%, 2K	R30
67	1	RESISTOR, 1/4W, 5%, 2.7K	R76
68	8	RESISTOR, 1/4W, 5%, 4.7K	R43,69,82,84-88
69	9	RESISTOR, 1/4W, 5%, 10K	R9-12,47,60,61,71, 77
70	1	RESISTOR, 1/4W, 5%, 15K	R70
71	3	RESISTOR, 1/4W, 5%, 100K	R68,73,83
72	1	RESISTOR, 1/4W, 5%, 47K	R74
73	4	RESISTOR, 1/4W, 5%, 10 OHM	R105-108
74	3	INSULATOR TO5 THERMALLOY-4005-15	Q1,2,3
75	1	HEADER, 16 PIN, AMP-86479-2	J5
76	3	HEADER, 5 PIN, AMP-640457-5	J6,7,8
77	1	HEADER, 2 PIN, AMP-350209-1	J4
78	1	HEADER, 4 PIN, AMP-350211-1	J3
79	15	POST, .025" SQUARE	TP1-15
80	1	POT, 3/4W, ±10%, 50K	R63

4.3.2 Main Control P.C.B. P/N 20040

<u>Item No.</u>	<u>Quantity</u>	<u>Description</u>	<u>Location</u>
1	2	I.C. TPQ3904	1C, 1D
2	1	I.C. 4020	2B
3	1	I.C. 6330-1	2D
4	1	I.C. 7408	5B
5	1	I.C. 74123	3A
6	2	I.C. 74S74	3B, 6H
7	1	I.C. 7406	4C
8	1	I.C. 74LS221	4E
9	1	I.C. 7445	1F
10	1	I.C. 26LS32	6G
11	1	I.C. 74S86	5E
12	1	I.C. 7410, 74S10, CR 74LS10	3C
13	2	I.C. 7438	5D, 6D
14	2	I.C. 2074	1B, 1E
15	1	I.C. 74191	2C
16	1	I.C. 7400, 74S00, CR 74LS00	4B
17	1	I.C. 7402, 74S02, CR 74LS02	3D
18	3	I.C. 74LS14	5C, 2E, 6E
19	1	I.C. 7407	5H
20	1	I.C. 7404, 74S04, CR 74LS04	4D
21	1	I.C. NE592	5F
22	1	I.C. 26LS31	6F
23	1	I.C. LM339	4A
24	1	R/PACK 220/330 OHM	6C
25	1	SHUNT, 7 POS, AMP-435704-7	6B
26	1	TRANS ARRAY, TPQ2907 CR Q2T2905	4H
27	1	I.C. SOCKET, 16 PIN	6B
28	1	I.C. SOCKET, 14 PIN	6C
29	1	CAP, CERAMIC, .047uf, X7R, 10%	C4
30	1	CAP, CERAMIC, 33pf, NPO, 5%	C51
31	1	CAP, ELECTROLYTIC, 22uf, 16V	C27
32	7	CAP, TANT, 4.7uf, 35V, 10%	C14, 15, 22, 25, 28, 29
33	2	CAP, CERAMIC, 150pf, NPO, 5%	C17, 24
34	1	CAP, CERAMIC, .068uf, X7R, 10%	C21
35	1	CAP, CERAMIC, 100pf, NPO, 5%	C8
36	1	CAP, CERAMIC, 330pf, NPO, 5%	C10
37	1	CAP, CERAMIC, 470pf, NPO, 5%	C20
38	31	CAP, CERAMIC, .1uf, Z5U +80, -20%	C1-3, 5, 6, 11-13, 16, 18, 19, 26, 30-35, 37-41, 43-50
39	1	CAP, POLYCARB, .1uf, 50V, 10%	C23
40	1	DIODE, ZENER, 2.4V, 2%, 1N5221	CR31
41	13	DIODE, 1N4148	CR11, 12, 15-17, 23-30
42	4	DIODE, 1N4003	CR19-22
43	1	DIODE, ZENER, 4.3V, 5%, 1N5229B	CR18
44	1	CAP, TANT, 1.0uf, 35V, 10%	C43

<u>Item No.</u>	<u>Quantity</u>	<u>Description</u>	<u>Location</u>
45	2	INDUCTOR, 2.2uh	L1,2
46	3	INDUCTOR, 10uh	L3,4,6
47	1	INDUCTOR, 3.3uh	L5
48	14	DIODE, UNITRODE NDP767	CR1-10,13,14,32,33
49	4	TRANSISTOR, 2N3904	Q4,5,6,7
50	1	I.C. NE592 (LOW NOISE)	3F
51	2	RESISTOR, 1/8W, 1%, 1.5K	R16,17
52	2	RESISTOR, 1/8W, 1%, 162 Ω M	R19,20
53	2	RESISTOR, 1/8W, 1%, 178 Ω M	R22,23
54	1	RESISTOR, 1/8W, 1%, 57.6 Ω M	R44
55	1	RESISTOR, 1/8W, 1%, 825 Ω M	R58
56	3	RESISTOR, 1/8W, 1%, 1K	R48,50,57
57	1	RESISTOR, 1/8W, 1%, 4.87K	R35
58	2	RESISTOR, 1/8W, 1%, 7.68K	R49,51
59	1	RESISTOR, 1/4W, 5%, 390 Ω M	R42
60	4	RESISTOR, 1/4W, 5%, 560 Ω M	R1,2,3,4
61	1	RESISTOR, 1/4W, 5%, 12K	R80
62	4	RESISTOR, 1/4W, 5%, 22 Ω M	R98,99,100,101
63	2	RESISTOR, 1/4W, 5%, 47 Ω M	R33,54
64	4	RESISTOR, 1/4W, 5%, 100 Ω M	R25,34,40,41
65	3	RESISTOR, 1/4W, 5%, 150 Ω M	R13,67,72
66	1	RESISTOR, 1/4W, 5%, 750 Ω M	R88
67	2	RESISTOR, 1/4W, 5%, 270 Ω M	R14,84
68	5	RESISTOR, 1/4W, 5%, 330 Ω M	R21,24,29,38,83
69	6	RESISTOR, 1/4W, 5%, 470 Ω M	R15,27,28,45,46,56
70	2	RESISTOR, 1/4W, 5%, 620 Ω M	R39,53
71	16	RESISTOR, 1/4W, 5%, 1K	R18,31,32,52,55, 62,64-66,75,78,79, 81,89,102,103
72	1	RESISTOR, 1/4W, 5%, 1.5K	R26
73	1	RESISTOR, 1/4W, 5%, 2K	R30
74	4	RESISTOR, 1/4W, 5%, 4.7K	R43,69,85,87
75	8	RESISTOR, 1/4W, 5%, 10K	R9-12,47,61,71,77
76	2	RESISTOR, 1/4W, 5%, 15K	R60,70
77	1	RESISTOR, 1/4W, 5%, 2.7K	R76
78	3	RESISTOR, 1/4W, 5%, 100K	R59,68,73
79	2	RESISTOR, 1/4W, 5%, 47K	R74,90
80	4	RESISTOR, 1/4W, 5%, 10 Ω M	R105-108
81	4	RESISTOR, 1/4W, 5%, 1.2K	R5,6,7,8
82	1	RESISTOR, 1/4W, 5%, 220 Ω M	R82
83	2	RESISTOR, 1/4W, 5%, 680 Ω M	R36,37
84	1	HEADER, 16 PIN, AMP-86479-2	J5
85	3	HEADER, 5 PIN, AMP-640457-5	J6,7,8
86	1	HEADER, 2 PIN, AMP-350209-1	J4
87	1	HEADER, 4 PIN, AMP-350211-1	J3
88	16	POST, .025" SQUARE	TP1-16
89	1	POT, 3/4W, $\pm 10\%$, 50K	R63
90	2	RES. PACK, (8 PIN SIP), 2.2K	RP1,4
91	2	RES. PACK, (8 PIN SIP), 47 Ω M	RP2,3

4.3.3 Motor Control P.C.B. P/N 20003

<u>Item No.</u>	<u>Quantity</u>	<u>Description</u>	<u>Location</u>
1	1	TRANS ARRAY, TPQ2907 OR TPQ3906	A1
2	1	I.C. LM358	A2
3	1	I.C. ULN2074B	A3
4	1	CAP, POLYCARB, .1uf, 50V, 10%	C5
5	1	CAP, ALUM. ELECT., 150uf, 25V	C1
6	1	CAP, ALUM. ELECT., 22uf, 16V	C2
7	2	CAP, CERAMIC, .0047uf, X7R	C3,4
8	2	CAP, CERAMIC, .047uf, X7R	C6,7
9	1	CAP, CERAMIC, .068uf, X7R	C8
10	1	CAP, CERAMIC, .001uf, X7R	C10
11	3	CAP, CERAMIC, .1uf, Z5U	C9,11,12
12	1	DIODE, 1N4005	CR1
13	1	DIODE, ZENER, 6.2V, 1N5234	CR2
14	1	DIODE, 1N4148	CR3
15	1	TRANSISTOR, 2N3904	Q1
16	2	RESISTOR, 1/4W, 5%, 10K	R2,11
17	2	RESISTOR, 1/4W, 5%, 47K	R4,9
18	2	RESISTOR, 1/4W, 5%, 1K	R5,8
19	1	RESISTOR, 1/4W, 5%, 470 OHM	R6
20	2	RESISTOR, 1/4W, 5%, 1.5K	R7,16
21	1	RESISTOR, 1/4W, 5%, 20K	R10
22	1	RESISTOR, 1/4W, 5%, 510K	R12
23	1	RESISTOR, 1/4W, 5%, 100K	R13
24	1	RESISTOR, 1/4W, 5%, 1.2 MEG	R15
25	2	RESISTOR, 1/4W, 5%, 4.7K	R17,20
26	1	RESISTOR, 1/2W, 2%, 130 OHM	R1
27	2	RESISTOR, 2W, 5%, .20 OHM	R18,19
28	1	POT, 3/4W, 10%, 50K	R3
29	1	HEADER, 6 PIN	J1
30	1	HEADER, 2 PIN	J2
31	1	PLUG	P4

4.3.4 Spare Parts List

<u>Item No.</u>	<u>Qty/Drive</u>	<u>Description</u>	<u>S/T Part No.</u>
1	1	Motor Control P.C.B. Assembly	20003-001
2	1	Main Control P.C.B. Assembly	20040-001
3	1	Spindle Brake Assembly	54026-001
4	1	Index, LED Assembly	54037-001
5	1	Ground Spring Assembly	58061-001
6	4	Shock Mount	52025-001
7	4	Shock Mount Spacer	58023-156
8	4	Shock Mount Washer	16527-006
9	1	Track \emptyset Sensor (Optical Inter.)	12616-001
10	1	Left Side Frame	64023-001
11	1	Right Side Frame	64024-001
12	1	Front Cover	62018-001
13	1	Front Cover LED	10850-003
14	1	Front Cover LED Grommet	13025-001
15	1	DIP Shunt, 7 Position	11825-007