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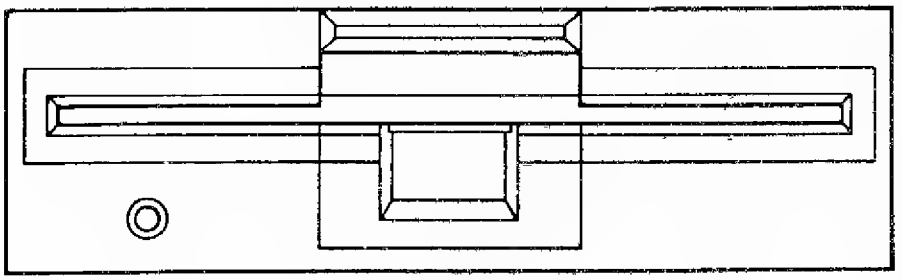
MITSUBISHI MINI FLEXIBLE-DISK DRIVE M4854/M4855 (HALF HEIGHT)

Technical Manual



MITSUBISHI ELECTRIC CORPORATION

5.25-INCH FLEXIBLE DISK DRIVE

M4854/M4855

TECHNICAL MANUAL

CONTENTS

CHAPTER 1 GENERAL

This manual describes the mechanical assembly and control circuit of the M4854/ M4855 Flexible Disk Drives.

The M4854 has a capacity of 1.6 megabytes with a rotation speed of 360 rpm, and the M4855 has a capacity of 2 megabytes with a rotation speed of 300 rpm. Both have a transmission rate of 2 microseconds.

The bit densities are 9646 FRPI for M4854 and 11844 FRPI for M4855. The M4854 has 77 cylinders and the M4855 has 80 cylinders. Except for spindle motor, head, and printed-circuit board, therefore, both drives consist of the same parts. In the following description, M4854 is described unless otherwise noted.

1.1 Functional Description of Mechanical Assembly

The mechanical assembly is functionally divided as follows:

- o Door latch and diskette ejector assembly
- o Disk drive and clamp assembly
- o Magnetic head-positioning assembly
- o Magnetic head/carriage assembly
- o Head load/unload assembly
- o Sensors (index, write-protect, track 00)

1.2 Functional Description of Electrical Circuit

The electrical circuit consists of two printed-circuit boards and is functionally divided as follows (the spindle motor drive circuit is an independent circuit board integrated into the motor unit):

- o Signal interface circuit and drive selector circuit
- o Power-on reset circuit
- o Panel indicator drive circuit
- o Index pulse generation circuit and ready circuit
- o Head load solenoid drive circuit
- o Step motor drive circuit

- Track 00 detection circuit
- Side selector circuit
- Write/erase circuit
- Write-protect circuit
- Read circuit
- Spindle motor drive circuit

CHAPTER 2 DESCRIPTION OF MECHANICAL ASSEMBLY OPERATION

'igure 2-1 shows the overall structure of the mechanical assembly.

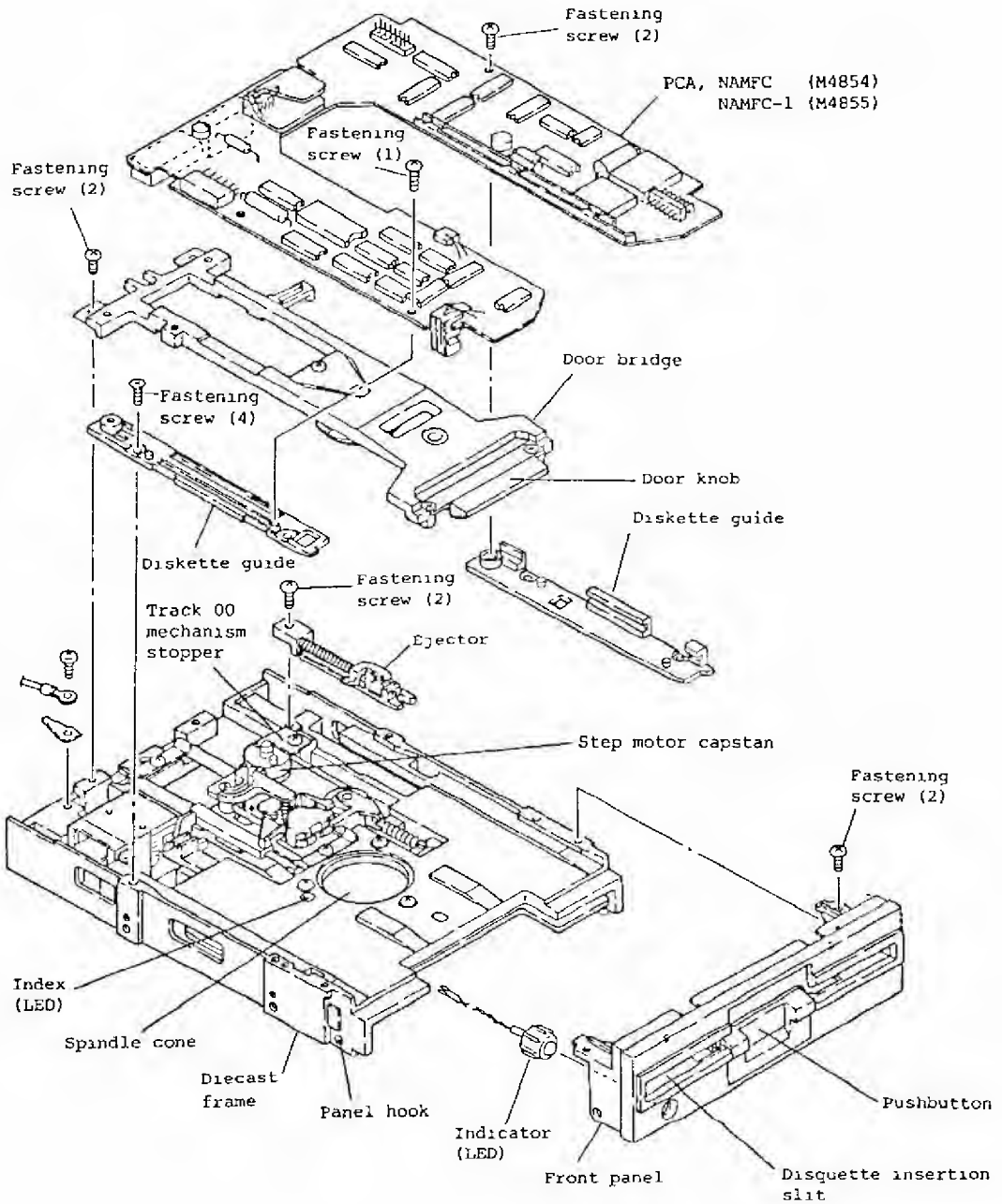


Figure 2-1 M4854 Mechanical Assembly Structure

2.1 Door Latch and Diskette Ejector Assembly

This device uses a pushbutton-type diskette mounting assembly.

To insert a diskette, press the pushbutton to open the door.

Insert the diskette in the slit and push it against the latch. Push farther together with the pushbutton until the diskette slider in the ejector assembly latches and the diskette touches the stopper. When the diskette is latched, it stays in place.

Push the handle to close the door. When the door touches the pushbutton latch, the pushbutton drops inward and then returns and latches.

During this time, the trigger pin on the door pushes the ejector slider, releases the latch, touches against the two-level trigger pin stopper, and prevents the slider from pushing the diskette any farther.

When the pushbutton is pressed, the door opens, the ejector slider is released from the trigger pin, and the diskette is ejected.

Figure 2-2 shows the relationship between the ejector aseembly and trigger pin.

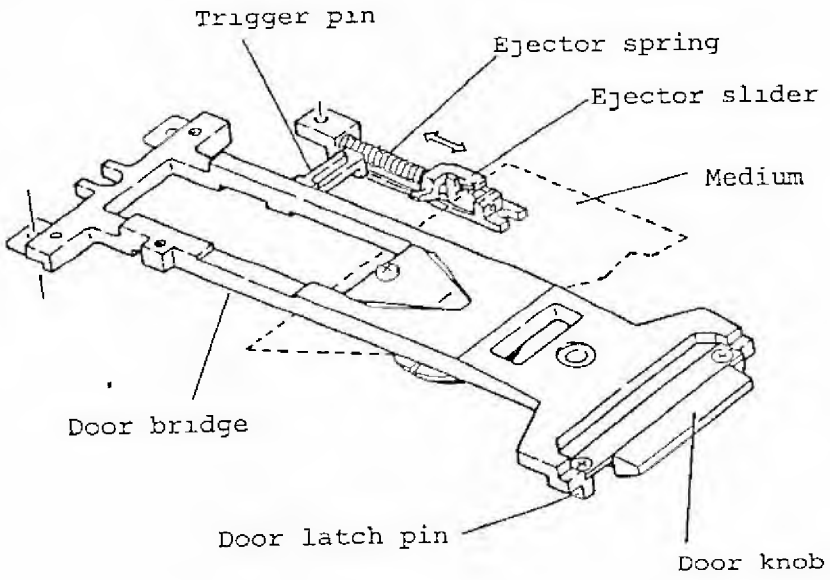


Figure 2-2 Diskette Ejector Assembly

2.2 Disk Drive and Clamp Assembly

The disk drive motor is a flat DC servomotor. This is a brushless motor, which detects the phase switching in the winding with a Hall element, and its life is equivalent to that of an AC motor.

It is a direct drive assembly; the rotor connects directly to the spindle without any belt. This also contributes to its long life and makes the drive assembly completely maintenance free.

The spindle motor turns at 360 rpm. The controller consists of a frequency generator coil printed on a circuit board integrated into the motor unit. This detects the rotation and forms a servo circuit (300 rpm for M4855).

The disk clamp, inserted between the spindle cone and the collet on the door, positions the disk inside the spindle cone with a collet and provides compatibility between the diskette and the device.

The collet is tapered so that misalignment of disk and the hole in the spindle cone can be corrected.

Figure 2-3 shows the spindle motor and collet.

An index sensor LED for detecting disk rotation is mounted on the spindle motor servo circuit board. The phototransistor is mounted on another printed-circuit board (NAMFC).

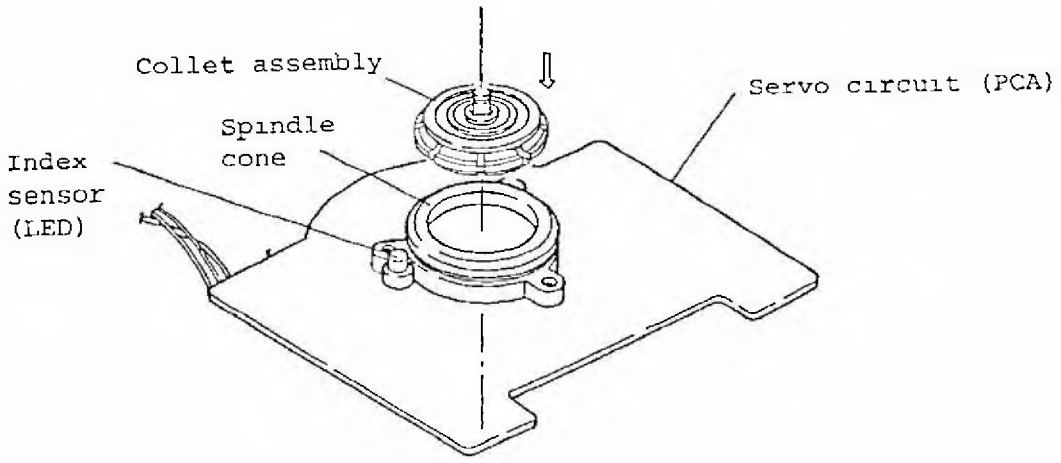


Figure 2-3 Spindle Motor and Collet

2.3 Head-Positioning Assembly

The head is positioned on each track (cylinder) by a flat stepping motor. A thin steel band loop is attached to the capstan on the spindle of this stepping motor, and an idler pulley is placed on the other side of the band and pulled with a spring. A head/carriage assembly held with two guide rods is attached to this steel band; when the stepping motor turns one revolution, the head moves across one track.

Figure 2-4 shows the structure of positioning assembly.

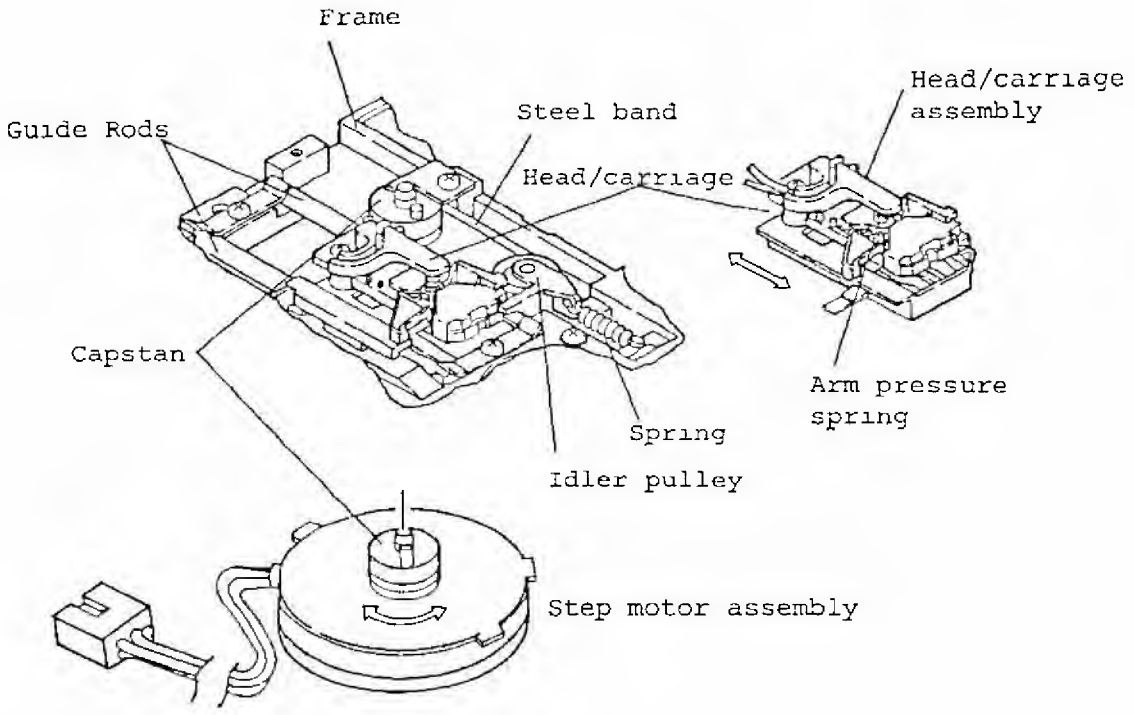


Figure 2-4 Head-Positioning Assembly

2.4 Head/Carriage Assembly

The head/carriage assembly consists of two-head slider supported by a round gimbal spring and a plastic carriage. The side 0 head is mounted on the carriage main frame and the side 1 head is mounted on a movable arm for head load and unload. The movable arm is held with a coil spring to provide constant pressure during head load. The carriage assembly is shown in figure 2-4, and the gimbal spring/head assembly is shown in figure 2-5.

The head consists of three ferrite core chips and a ceramic support slider. The center core is for read/write and the erase head cores are on both sides.

Figure 2-6 shows the head slider.

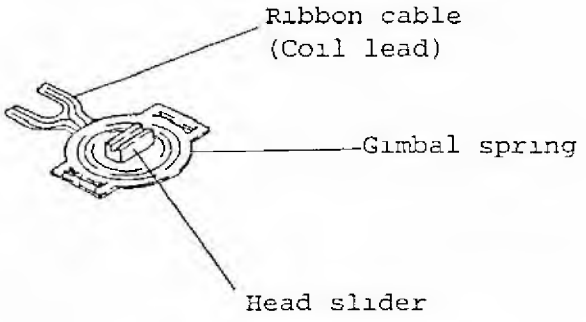


Figure 2-5 Gimbal Spring and Head Assembly

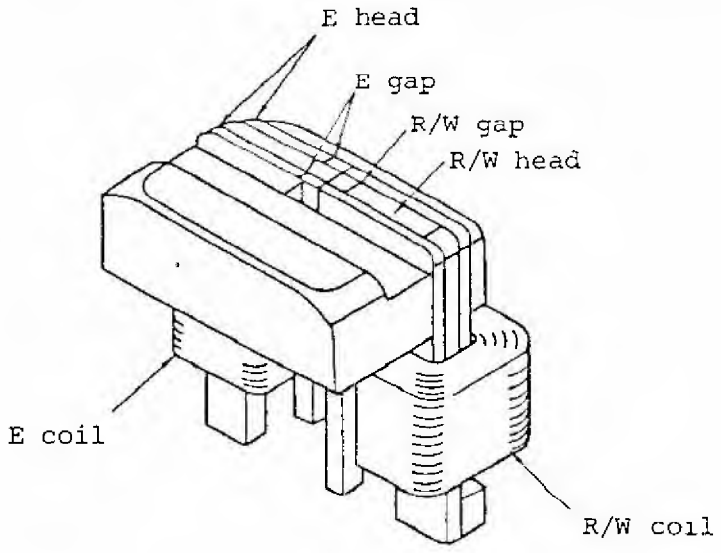


Figure 2-6 Head Slider

2.5 Head Load/Unload Assembly

Head load/unload operation is performed by transferring the vertical movement of the lift bar on the head-load solenoid to the movable arm by the side 1 head on the head/carriage assembly.

When there is no current in the head-load solenoid, the lift bar and hea arm are lifted by a spring and the head does not touch the disk surface (unload). When there is a current in the solenoid, the lift bar is pulled down, the head touches the disk surface, and the lift bar and hea arm separate.

A period of 50 milliseconds or less is required for the head to touch th disk surface after current is passed through the head-load solenoid, so read/write is not performed during this time.

Figure 2-7 shows the relationship between the head-load solenoid and head/carriage assembly.

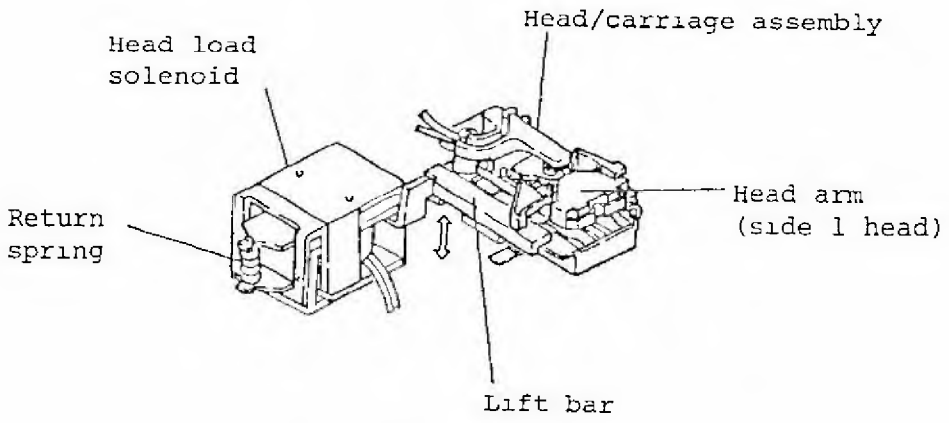


Figure 2-7 Head Load Solenoid

2.6 Sensor (index, write-protect, track 00)

2.6.1 Index sensor

The index sensor is used to detect disk rotation. It consists of a transmitter (LED) and receiver (phototransistor) with the LED attached to the servo printed-circuit assembly of the spindle motor (figure 2-3) and the phototransistor attached to the main control printed-circuit assembly (NAMFC).

The timing (position) of the index sensor is adjusted by turning the screw attaching it to the NAMFC frame.

Figure 2-8 shows the phototransistor of the index sensor.

2.6.2 Write-protect sensor

The write-protect sensor detects the status of the write-protect notch of the diskette and inhibits write operation.

This prevents read-only diskettes, such as program diskettes, from being damaged.

A diskette is write-protected if the notch is covered with non-transparent tape or a seal. Transparent material cannot be used to write-protect a diskette.

The write-protect sensor is mounted on the NAMFC, as shown in figure 2-8.

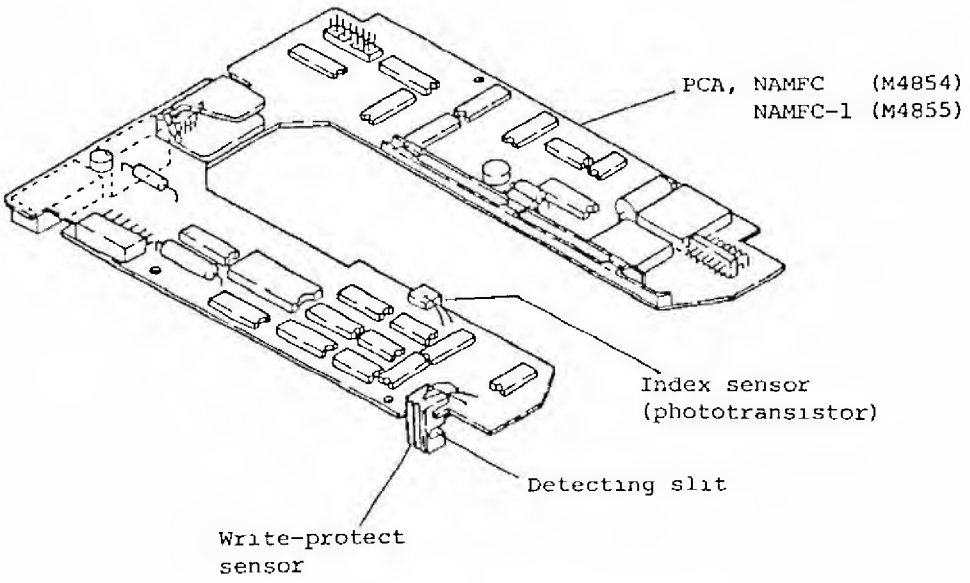


Figure 2-8 Index and Write-Protect Sensors

2.6.3 Track 00 sensor

The track 00 sensor detects that the head is at track 00 and protects tl
head/carriage from moving any farther even if there are extra step pulse

The track 00 sensor detects the position of the light shielding plate o:
the head/carriage assembly. The sensor is fixed on the die-cast frame
with a screw. Turn this screw to adjust the position.

Figure 2-9 shows the relationship between the track 00 sensor and head/
carriage assembly.

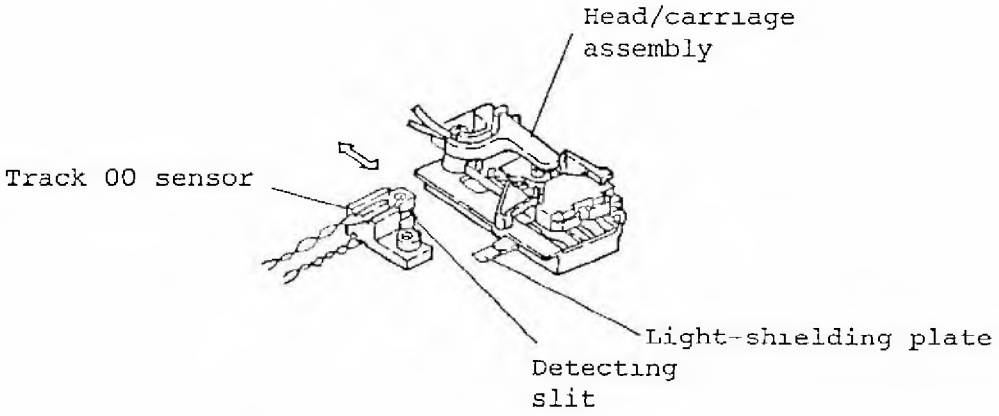


Figure 2-9 Track 00 Sensor and Head/Carriage Assembly

CHAPTER 3 ELECTRICAL CIRCUIT

Figure 3-1 shows the circuit configuration and signals of the M4854/M4855.

The spindle drive circuit enclosed in dotted lines is on a separate circuit board integrated with the motor.

The portion enclosed in dot-dahs lines is the mechanical assembly.

The M4854/M4855 electrical circuit consists of an LSI (gate array) with all the main control circuits. The details of this LSI are described at the end of this manual in the section titled "M4854/M4855 Gate Array Timing Chart."

For a detailed circuit description, refer to the "Schematic and Logic Manual."

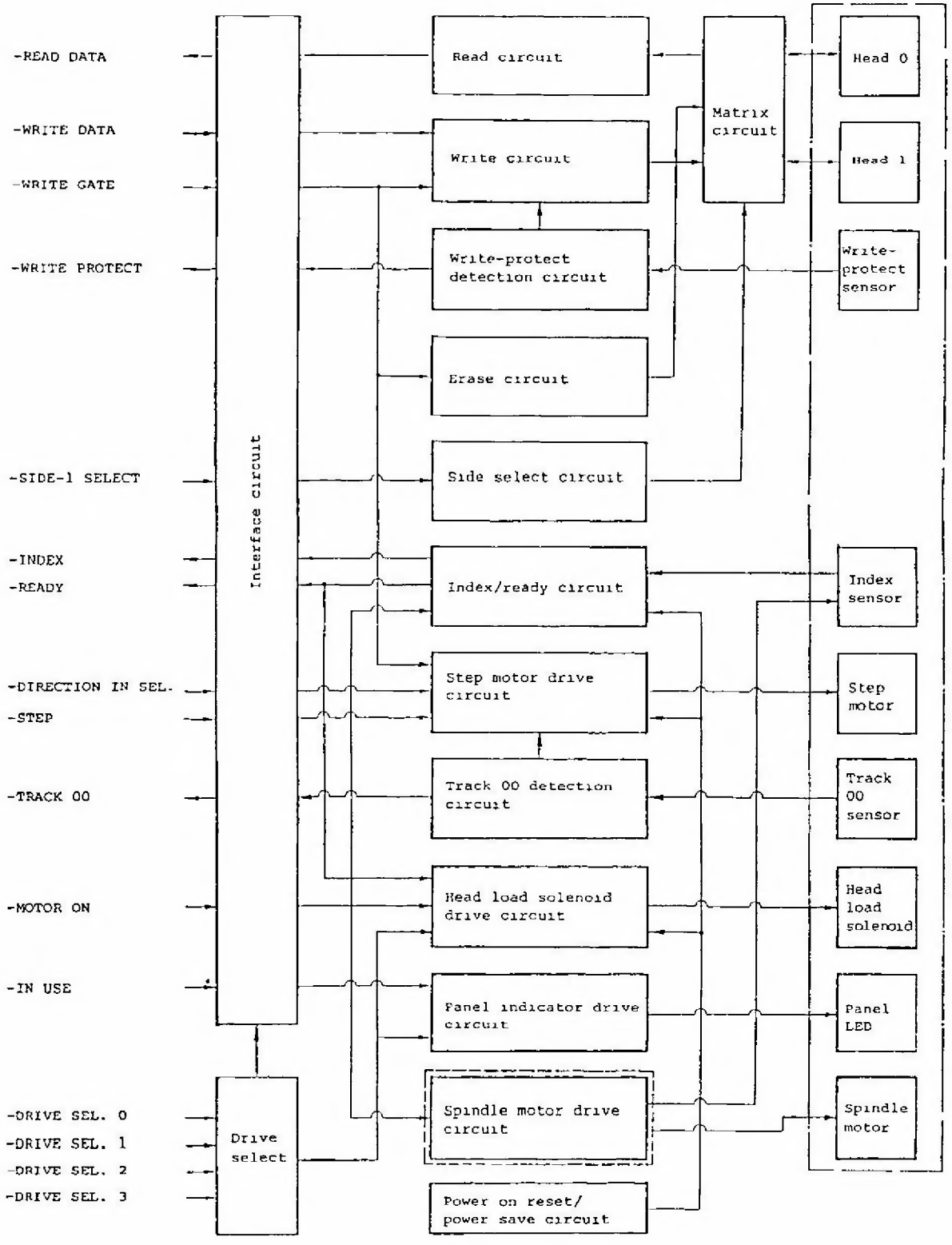


Figure 3-1 M4854/M4855 Electrical Circuit

3.1 Interface and Drive Select Circuit

3.1.1 Receive circuit

Each input terminal for receiving signals from the host controller is pulled up to +5 volts with a 150-ohm terminal resistor. The host driver, therefore, must use an element with drive performance greater than 40 mA. An SN7438N or equivalent open collector drive is recommended.

If multiple (maximum of four) devices are connected in a daisy chain, the terminal resistor must be removed from each device except the last. To remove the terminal resistor, remove the jumper plug on the printed-circuit board.

3.1.2 Transmitting circuit

An S7438N or equivalent open collector gate is used as the line driver on the device side. The terminal resistor at the host must be 150 ohms or greater.

All line driver input signals are gated by the drive select signal. When multiple devices are connected in a daisy chain, therefore, only the signal from the selected device is sent to the host.

3.1.3 Drive selector circuit

The drive selector selects one of the four or less devices connected to the same cable with four interface lines (DS0 to DS3).

Jumper plugs corresponding to the four selector lines are provided on the circuit board for selecting a line. Do not set multiple devices on the same line to the same plug number.

This select signal gates the select signals of other interfaces and also acts as a head-load solenoid drive signal.

The drive selector also turns on the panel indicator LED.

For a system that requires no drive selection, set the drive selector line jumper plug to MX to keep it constantly in select state.

3.2 Power Reset and Power Save Circuit

3.2.1 Power-on reset circuit

The power-on reset circuit is a level-detection type reset circuit and is used to initialize the phase counter of the stepping motor drive circuit and to reset the index pulse interval detection one-shot of the ready circuit.

The power supply level-detection circuit, which prevents errors during write circuit power-on, is provided in the write circuit and does not use the output from this circuit.

3.2.2 Power save circuit

The power save circuit controls the current in the stepping motor and head-load solenoid according to operation status and prevents the device from heating due to unnecessary power consumption.

A single timer (one-shot) controls both the stepping motor and the head-load solenoid. The timer is set to 30 milliseconds. The timing chart is shown in figure 3-2.

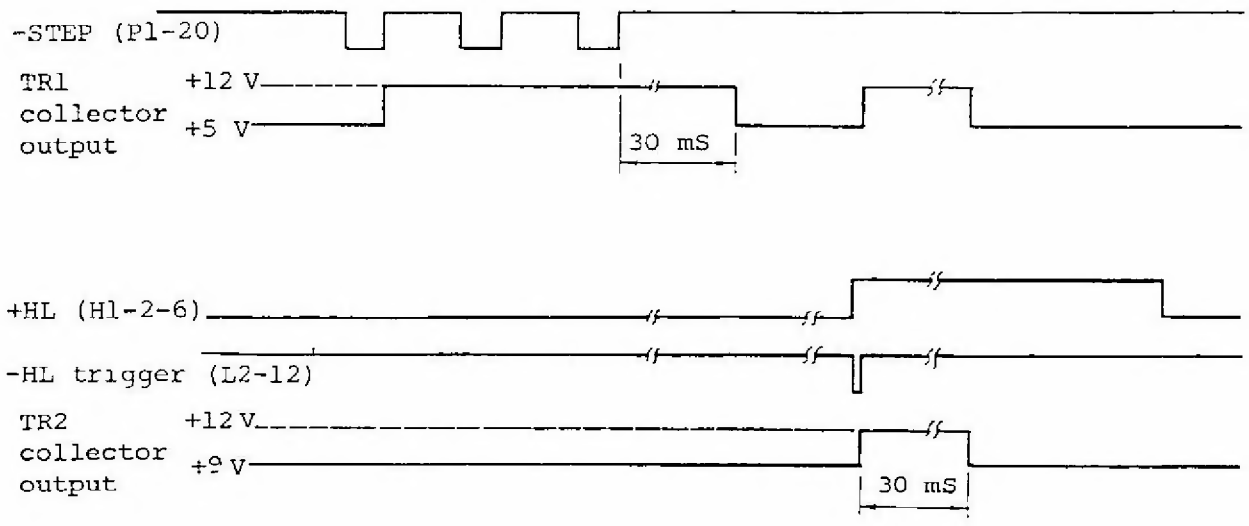


Figure 3-2 Power Save Circuit Timing Chart

3.3 Panel Indicator Circuit

The panel indicator functions can be set by selecting the drive select signal and interface signal with jumper plugs.

The details of jumper plug selection and functions are described in "M4854 Standard Specifications."

If a drive is selected with jumper MX, however, the drive select lamp does not light.

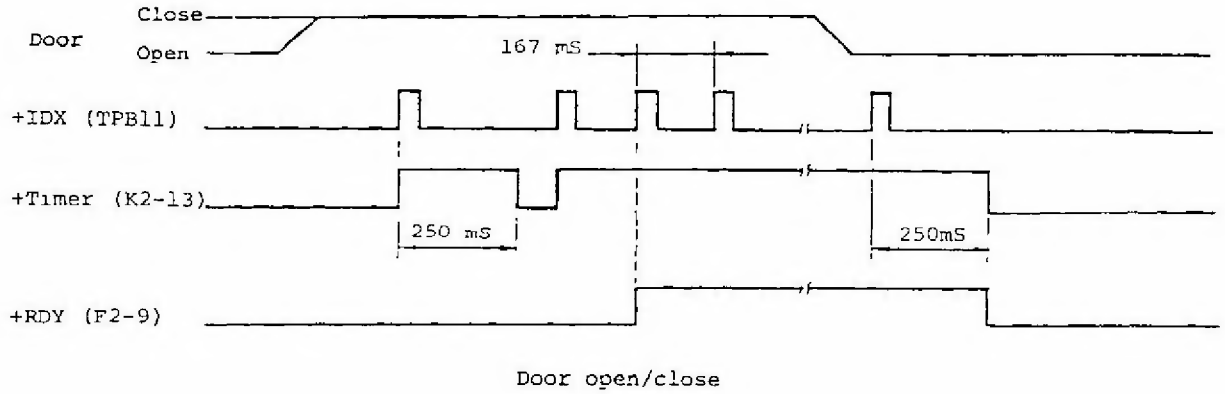
3.4 Index Sensor and Ready Circuit

The index sensor circuit detects index holes on the disk with a sensor and generates logic signals.

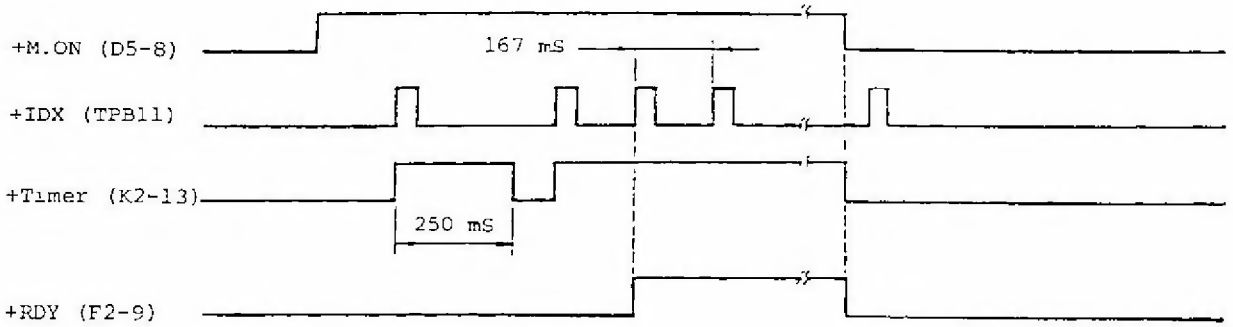
The ready circuit checks the index pulse interval with a timer and becomes ready when it is less than 250 milliseconds and the next pulse is generated.

When the door is opened and the disk stops rotating, the ready signal is reset 250 milliseconds after the last index pulse. When the motor-on signal is off and the disk stops rotating, the ready signal is reset immediately at motor off timing.

Figure 3-3 shows the timing chart.



Door open/close



Motor on/off

Figure 3-3 Index Sensor and Ready Circuit Timing

3.5 Head-Load Solenoid Drive Circuit

The head-load solenoid is controlled by the drive select signal and the motor-on signal. Head load operation is disabled when the device is not ready.

To minimize power consumption during head-load solenoid operation, the pickup current flows only for 30 milliseconds after an input signal is given and the head-load solenoid is held thereafter with hold current (25% less). Figure 3-2 shows the timing chart.

To reduce the noise level for operations such as increment, seek, read, and write that repeat head load and unload, the head does not unload until two index pulses are counted after the load signal becomes inactive.

By changing the jumper plug from IU to HL, interface P1-4 becomes -HEAD LOAD and head loading can be controlled directly. In this case, the HM/HS jumper must be set to HS.

3.6 Stepping Motor Drive Circuit

A two-phase bipolar stepping motor operates with a stepping angle of 1.8 degrees. It is controlled by two source/sink type drivers that produce currents in four different modes.

These four modes are created by a quadruple up/down counter using two flip-flops.

In the stepping motor drive circuit, the power supply to the motor drive circuit is switched when the rotor is stationary (not seeking) in order to decrease power consumption. During seek, a +12-volt level is supplied to the driver; if the next step pulse does not occur within 30 milliseconds, it drops to +5 volts. Figure 3-4 shows the timing chart.

In the stepping motor drive circuit, the step pulse is blocked with a write gate so that seek is not performed during write operation (excluding erase delay time). Also the step pulse is blocked when the track 00 sensor output is on so that seek is not performed any farther.

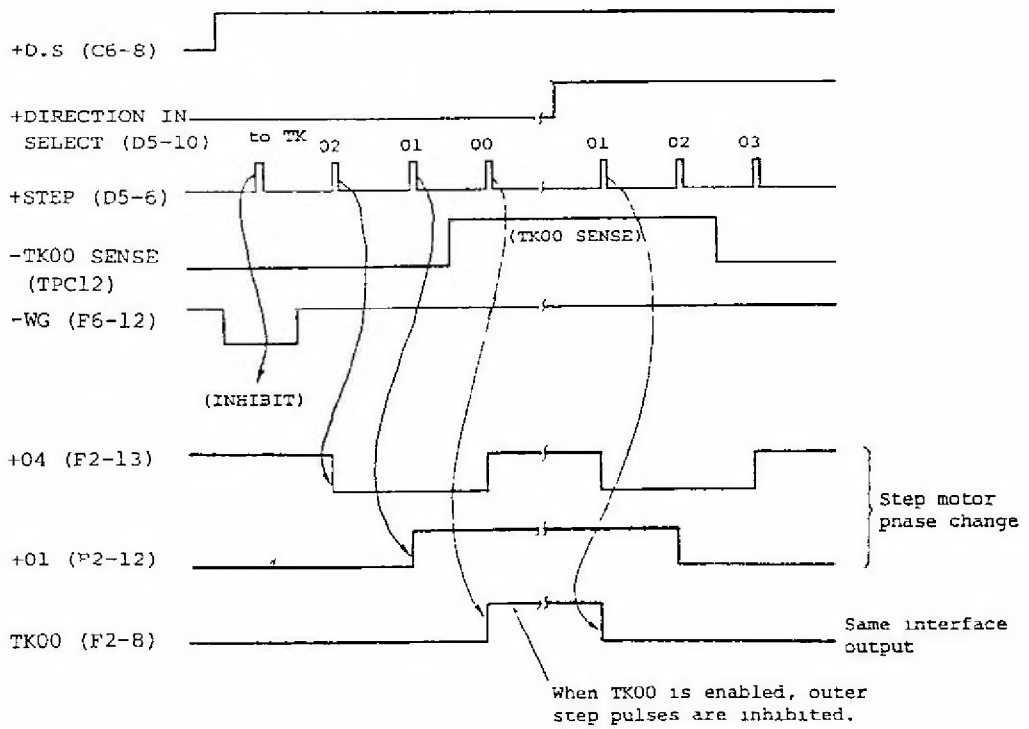


Figure 3-4 Stepping Drive Circuit Timing

3.7 Track 00 Detection Circuit

The track 00 detection circuit creates the track 00 signal by taking th logical product of the output produced when the position of the light shield on the head/carriage assembly is detected by a sensor, and the stepping motor drive phase (TK00). Therefore, the signal is not output when drive phase is not track 00, even if the sensor output is on.

Figure 3-4 shows the timing chart.

3.8 Side Select Circuit

Side selection is performed by switching the center tap of each head fr approximately 11 volts (off) to 1 volt (on).

A write current flows alternately from R/W1 (R/W11) or R/W2 (R/W12) to center tap CT0 (CT1) and erase current flows from ER0 to CT0. During read, a bias current flows from R/W1 (R/W11) and R/W2 (R/W12) to CT0 (C and voltage is induced between R/W1 (R/W11) and R/W2 (R/W12).

If the -SIDE ONE SELECT from the host system is low, side 1 is selected if it is high, side 0 is selected.

Figure 3-5 shows the block diagram of side select circuit.

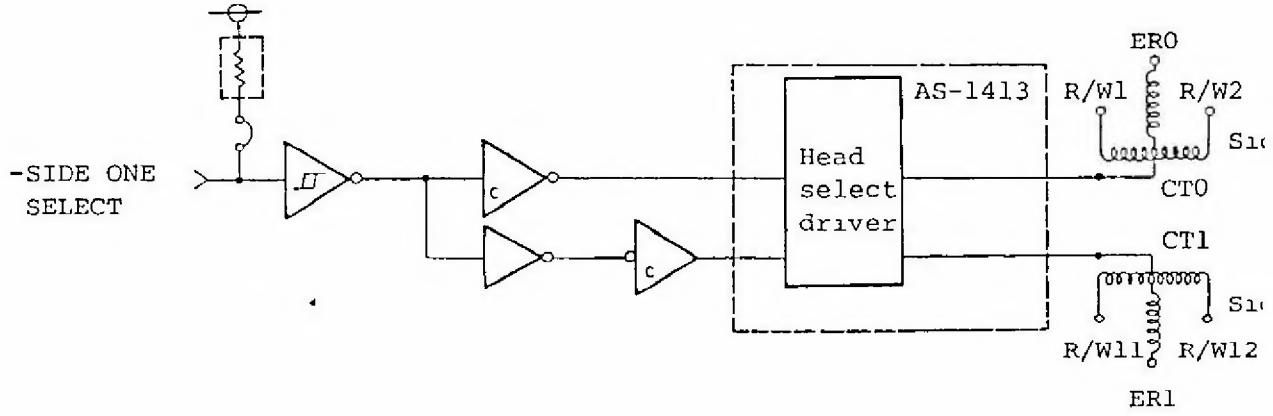


Figure 3-5 Side Select Circuit Block Diagram

3.9 Write/Erase Circuit

The write circuit, which is used to write data on the disk surface, starts to write when a WRITE GATE is opened to the selected head. Writing is not performed, however, if diskette write-protection is detected.

The erase circuit erases both ends of a data pulse. This prevents cross-talk from old data when new data is written over old data, preventing old data from remaining at both sides of the new data due to minute misalignment of the head.

The write circuit is divided as follows:

- Write toggle flip-flop
- Write pre-driver
- Write driver
- Read/write matrix
- Write current source
- Power driver

Write starts when write gate is input and the write toggle flip-flop and write pre-driver are enabled.

The write data is halved by the write toggle flip-flop, and a differential signal that is synchronized to the write data is created.

This differential signal is input to the write pre-driver and switches the write driver. The write driver switches the current to the read/write, and the current flowing in the read/write head is created by the write current source and sent to the write driver.

In the read/write matrix, the write circuit gate is opened by WRITE GATE and current is sent to the head selected with SIDE ONE SELECT.

Figure 3-6 shows the erase function, and figure 3-7 shows the write circuit block diagram.

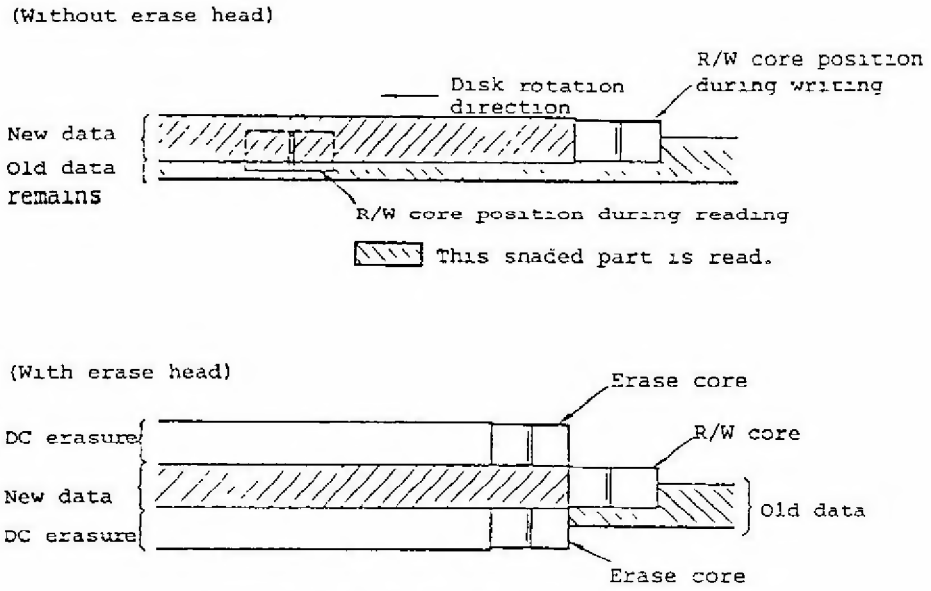


Figure 3-6 Erase Function

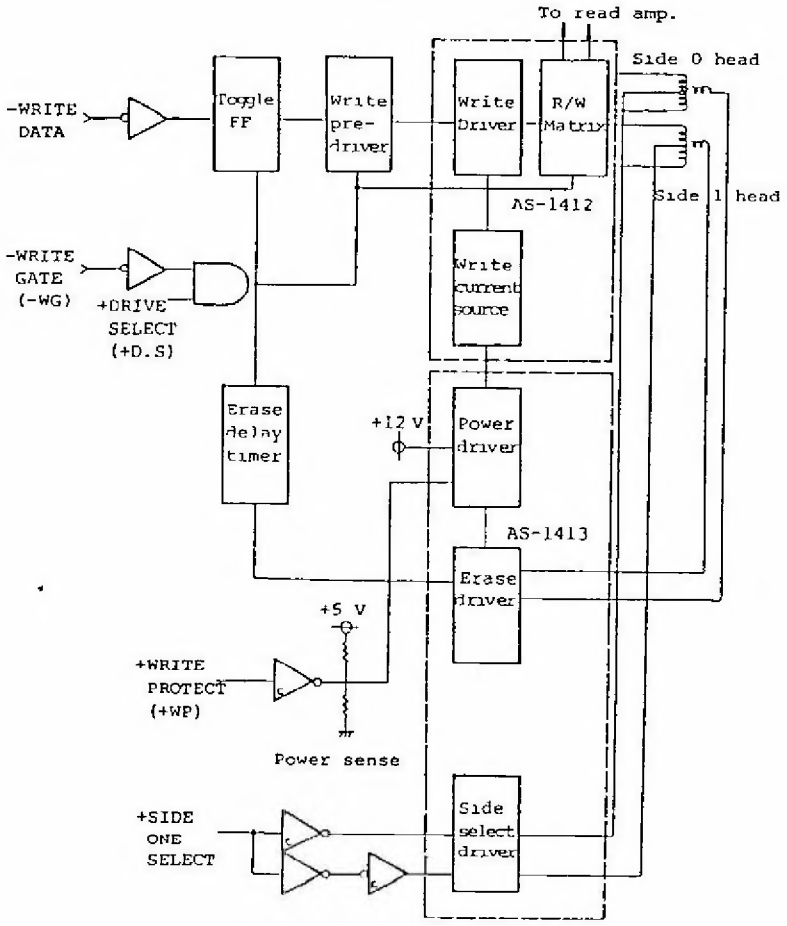


Figure 3-7 Write Circuit Block Diagram

The magnetic field in the read/write head is reversed by alternating between the two current paths, R/W1 to CT0 and R/W2 to CT0, according to the differential signal.

The erase area starts from point E, which is before the write area start point C, and ends at point F, which is after write end point D.

The difference in alignment between the read/write core and erase core is approximately 0.6 mm, and the erase core reaches the point passed by the read/write core gap approximately 350 microseconds (around TK32) later.

Therefore a delay operation shown, in figure 3-9, is required after WRITE GATE is opened until the erase driver turns on or after WRITE GATE is closed until the erase driver turns off. An erase delay timer is used to control the erase driver for this purpose.

A head consequently remains on a track for approximately 590 microseconds after WRITE GATE is closed, and that track must be kept selected.

Erase is performed by applying a constant magnetic field in one direction on the disk surface.

Figure 3-8 shows the outline of write operation, and figure 3-9 shows the erase delay operation timing.

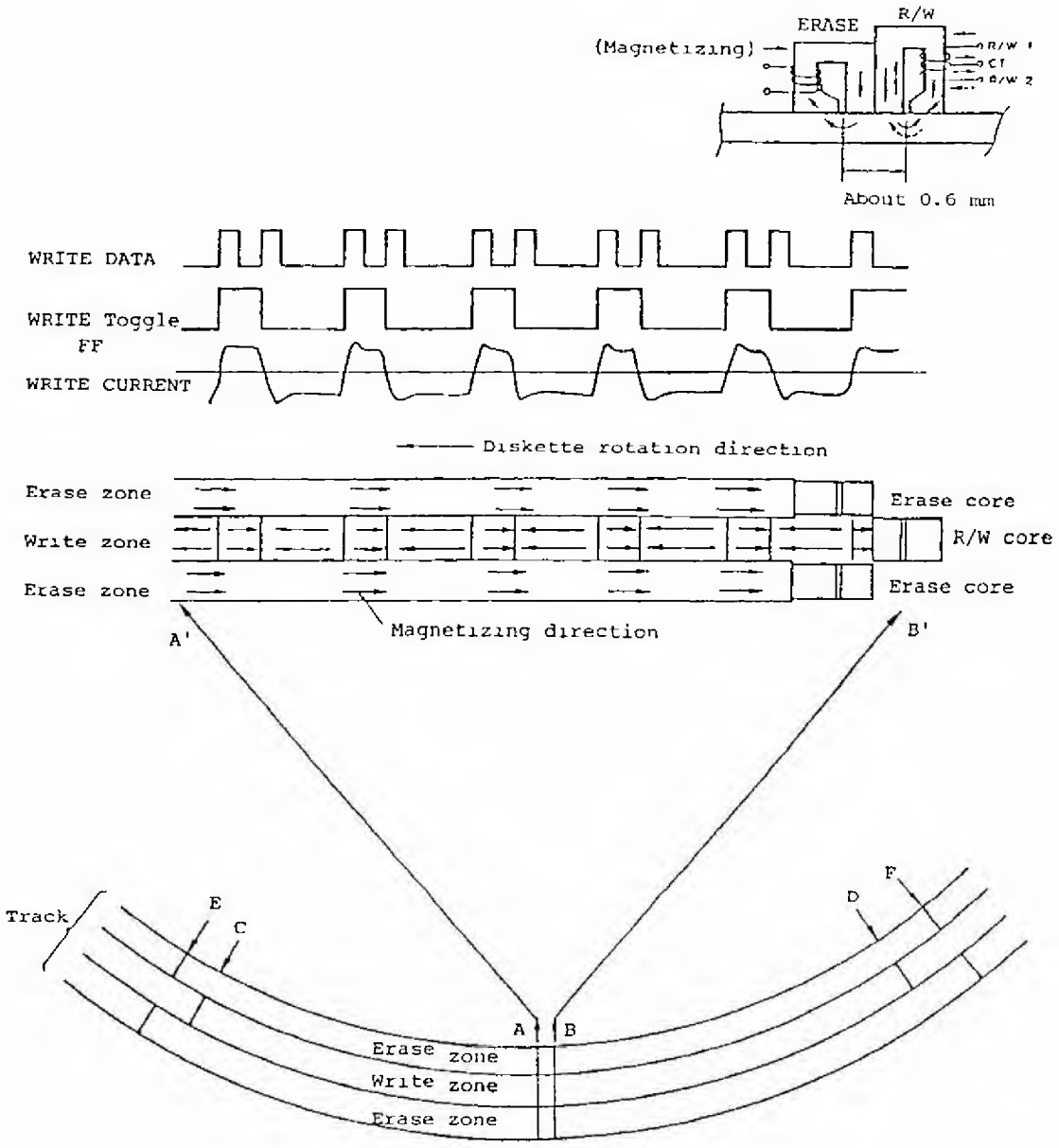


Figure 3-8 Write Operation Outline

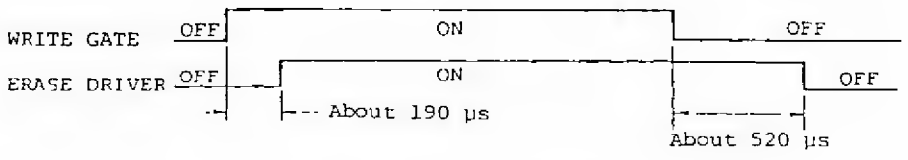


Figure 3-9 Erase Delay Operation Timing

3.10 Write-Protect Circuit

The write-protect circuit detects a notch in a diskette (on the jacket) with a sensor, and it inhibits write and outputs a write-protect signal when a write gate signal is given from the interface.

3.11 Read Circuit

The device is in read status when the WRITE GATE and the erase driver are closed.

When the read/write core is on a track, the head is loaded, and the head is selected, the data previously written is read by the core and a voltage is induced across both ends (between R/W1 and R/W2) of the read/write coil. This voltage passes through the read/write matrix and goes to the read preamplifier.

The read preamplifier amplifies the few millivolts that is induced by about 100 times and creates the differential signal. The read signal from the read preamplifier is passed through a low-pass filter to cut unnecessary high frequencies.

The reversal of magnetism occurs at the peak of the readout signal and is passed through a peak detection circuit to generate a READ DATA pulse.

The peak detection circuit consists of the following three blocks:

- Differentiator
- Comparator
- Time domain filter

The differentiator performs a differential operation to detect the peak, and the peak is converted to a zero crossing point. The differentiated signal is passed through a comparator and A/D conversion is performed. The changing point of this digital pulse becomes the actual data pulse.

FM or MFM frequency modulation is used. The magnetism reversal interval is 4 and 2 microseconds for FM and 4, 3, and 2 microseconds for MFM; this is equivalent to a maximum frequency of 250 kHz and minimum frequency of 125 kHz. The electromagnetically converted magnetization reversal waveforms interfere with each other, and the combined waveform becomes the readout waveform. If the magnetization reversal interval is long, the interference decreases and shoulders are generated. When shoulders appear, the differentiated waveform crosses zero and an incorrect data pulse is detected. The time domain filter is used to remove this incorrect data pulse.

The time domain filter generates a one-shot signal from the zero crossin reversal point output from the comparator. After a certain interval, if the comparator output level is same as the previous state, it is output true READ DATA.

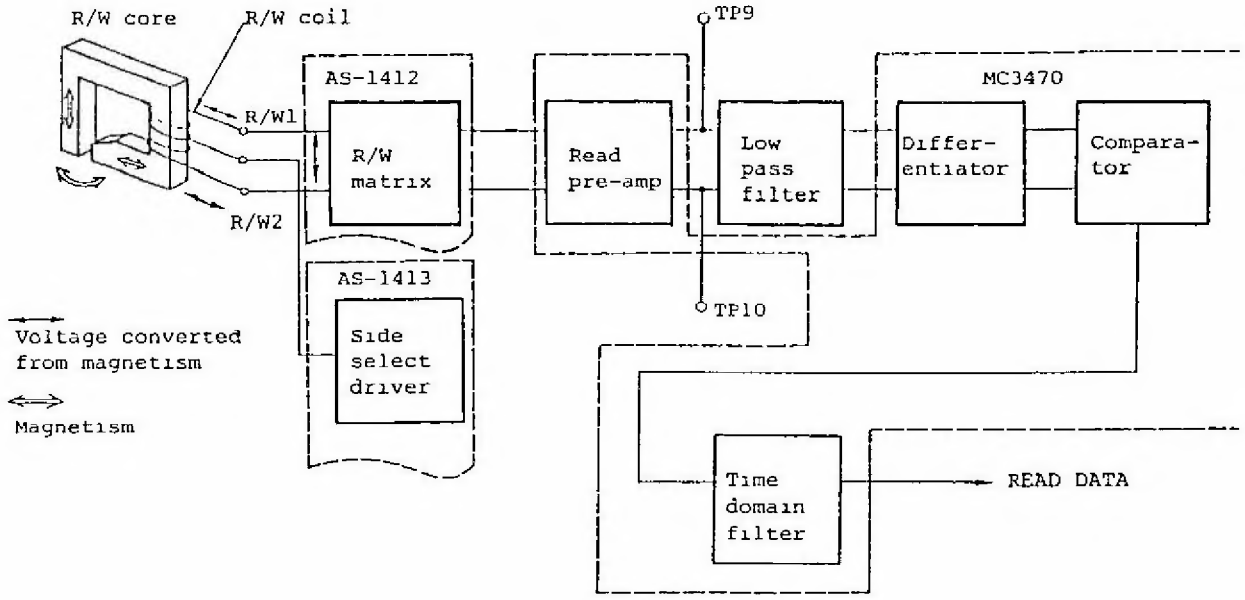


Figure 3-10 Read Circuit Block Diagram

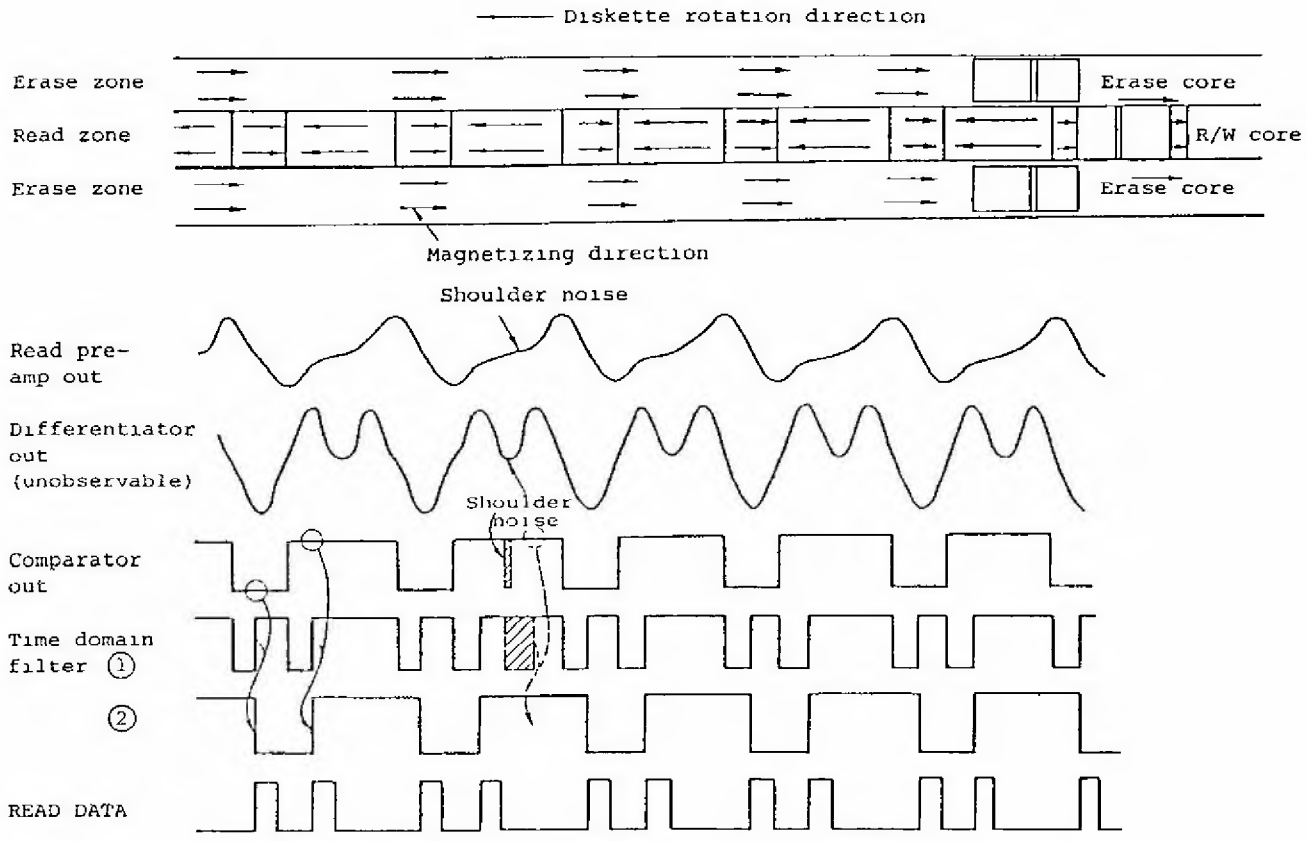


Figure 3-11 Read Timing

The READ DATA thus generated is sent to the host system.

Figure 3-10 shows the read circuit block diagram, and figure 3-11 shows the read timing chart.

3.12 Spindle Motor Drive Circuit

The spindle motor is a DC direct brushless motor, and a feedback servo circuit is used to provide a constant rotation. This circuit consists of a separate circuit board integrated with the motor.

It is connected to the main control circuit with +12 VDC, 0 VDC, and motor-on signal lines.

This feedback circuit uses position feedback with Hall elements and speed feedback with a frequency generator to achieve constant rotation.

The direction of the spindle is detected by Hall elements positioned symmetrically on the spindle. The information is passed to the pre-driver, and drivers 1 and 2 are switched alternately.

At the same time, the speed signal from the frequency generator is rectified and converted to speed voltage, is compared with the reference speed voltage, and is used to feed back the amount of current to be pass through the coil.

Figure 3-12 shows the spindle drive circuit block diagram, and figure 3- shows the spindle motor drive circuit waveform.

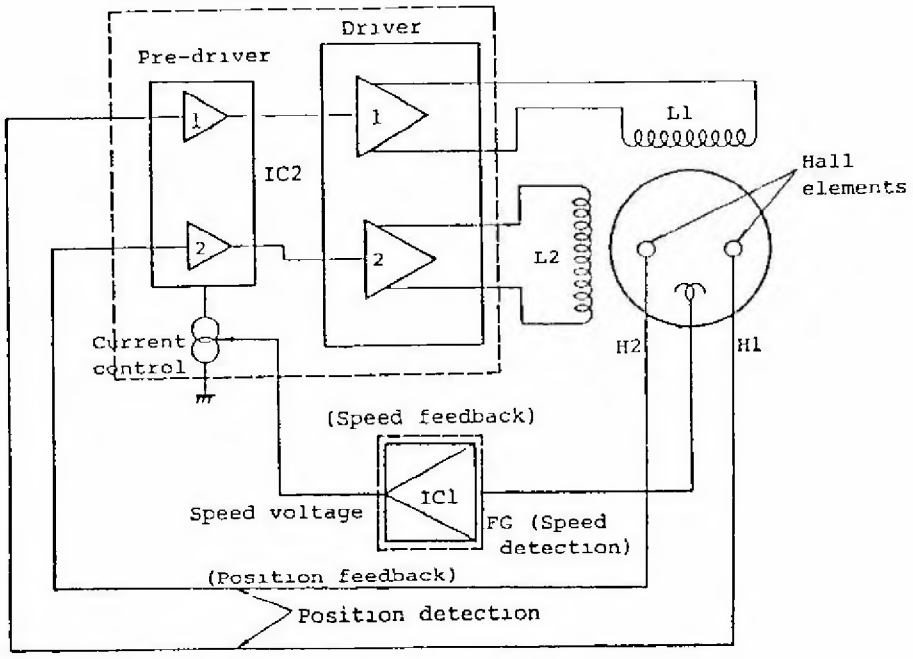


Figure 3-12 Spindle Motor Drive Circuit Block Diagram

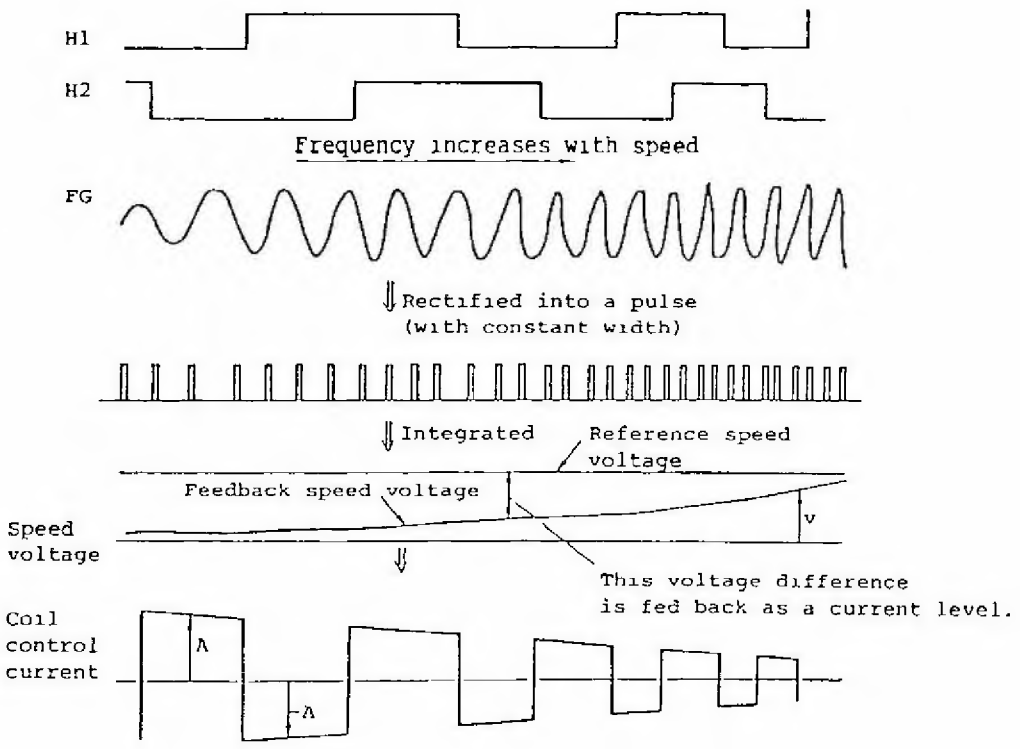
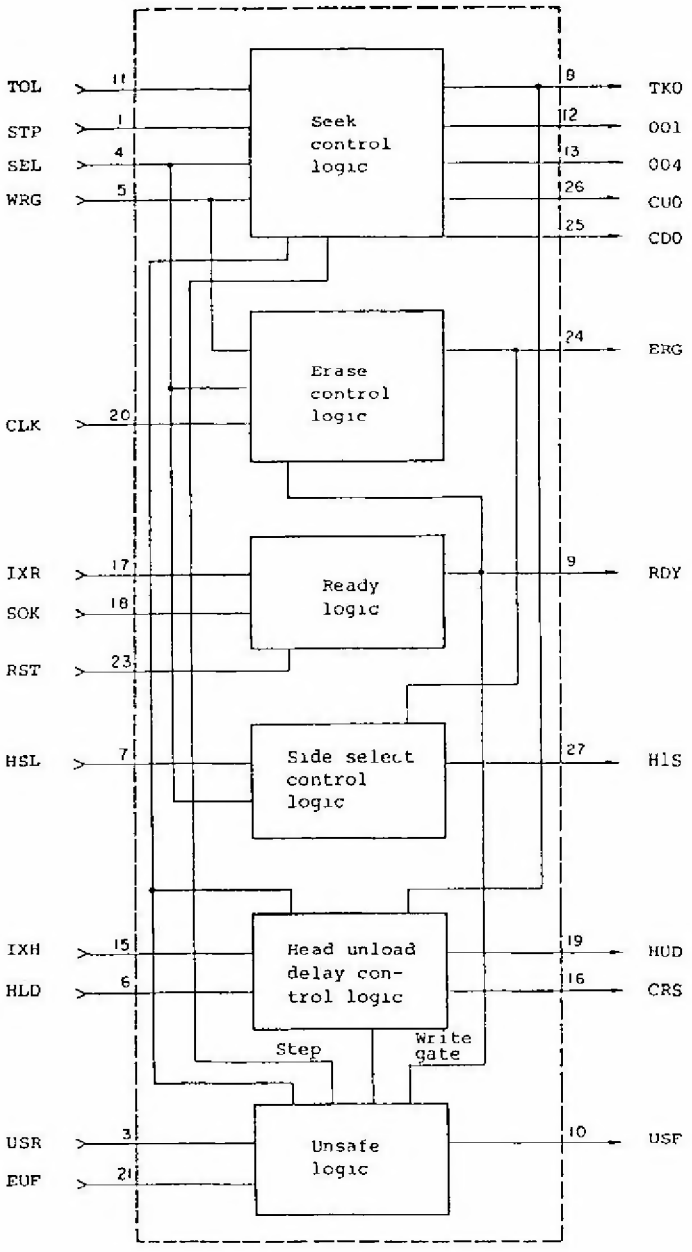


Figure 3-13 Spindle Motor Drive Circuit Waveform

APPENDIX

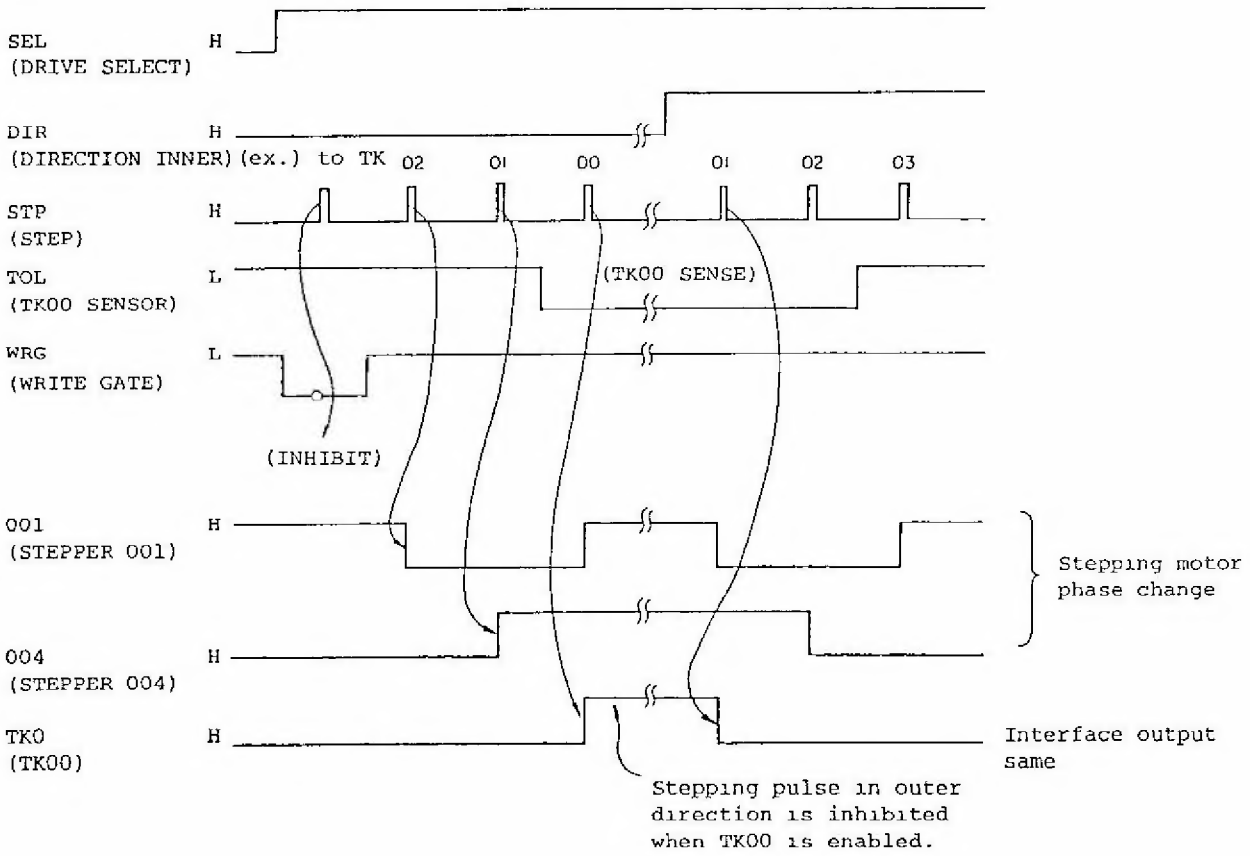
M4854/M4855 GATE ARRAY TIMING CHART

Section 1. Function Block Diagram

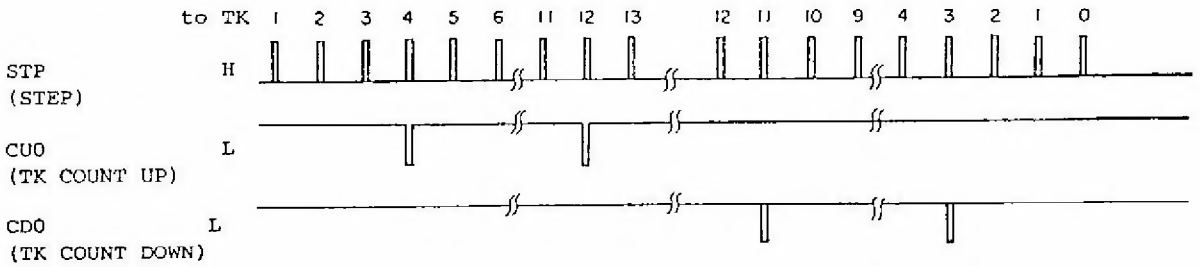


Section 2. Timing Chart

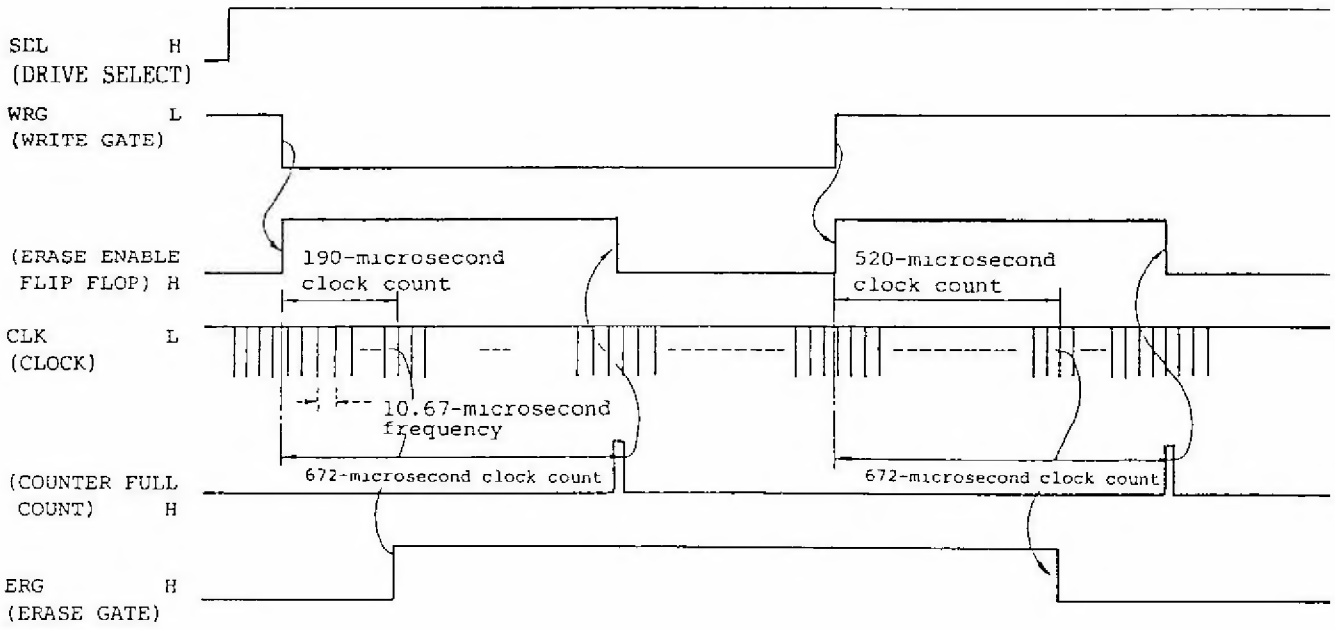
(1) Seek control logic



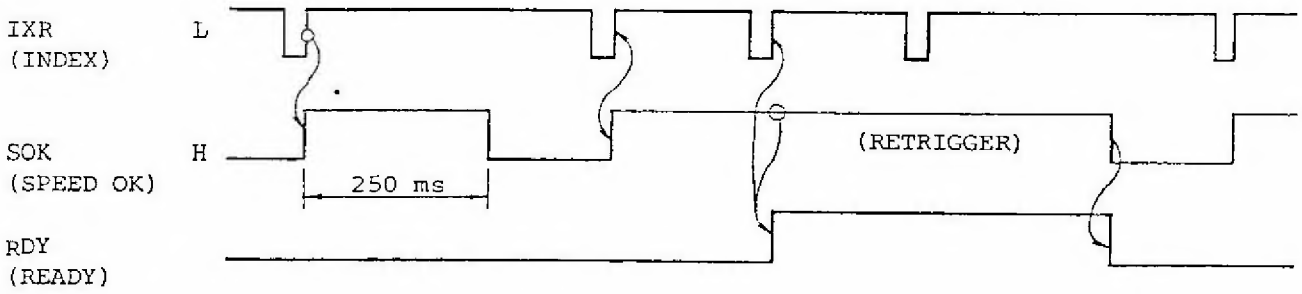
CU0 counts up the track counter K1-1 every eight step pulses.
CUD counts down the track counter K1-1 every eight step pulses.



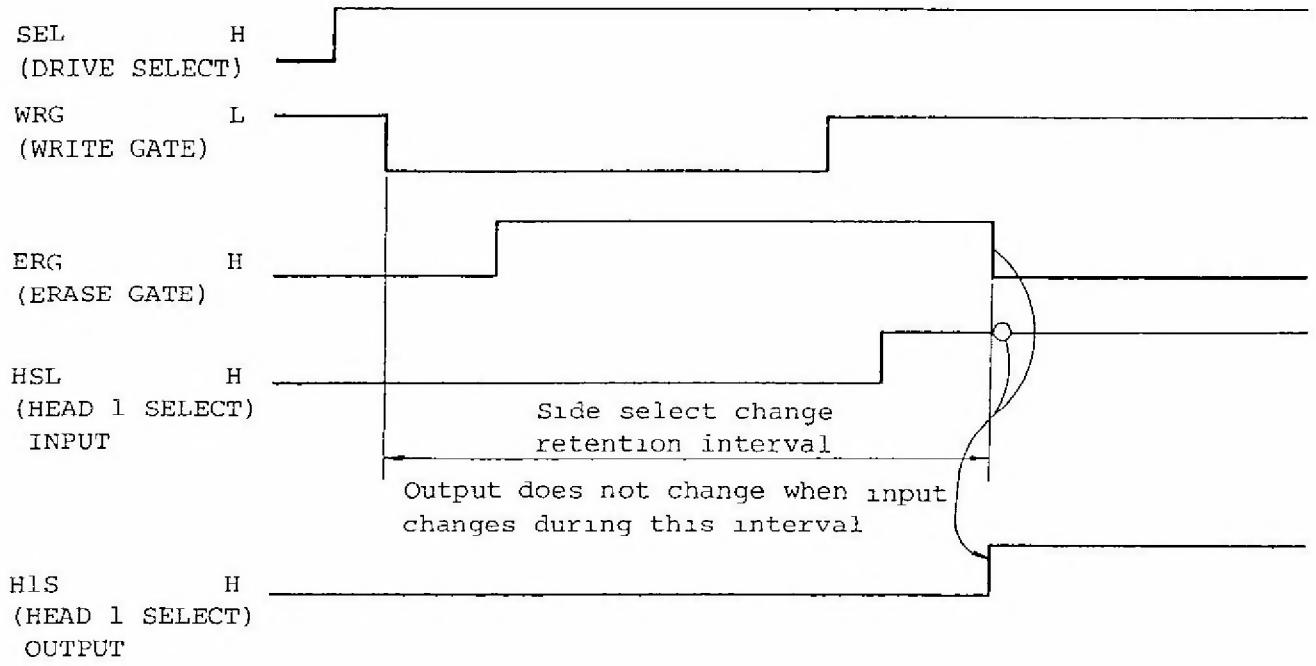
(2) Erase control logic



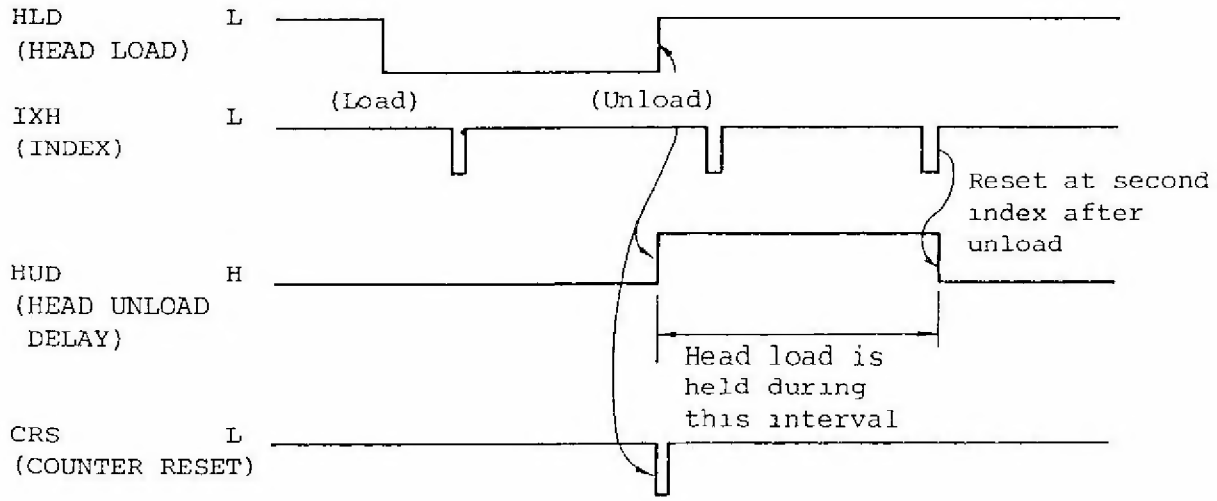
(3) Ready logic



(4) Side select control logic



(5) Head unload delay control logic



(6) Unsafe logic (This function is not used)

USF (unsafe) is set when RDY drops or STEP is input during WRITE GATE.

It is reset with RST (power on reset) or USR (unsafe reset).

Unsafe condition during WRITE GATE can be expanded with EUF (unsafe expander).