MOTOROLA
SEMICONDUCTORS
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MC3469P

Specifications and Applications Information

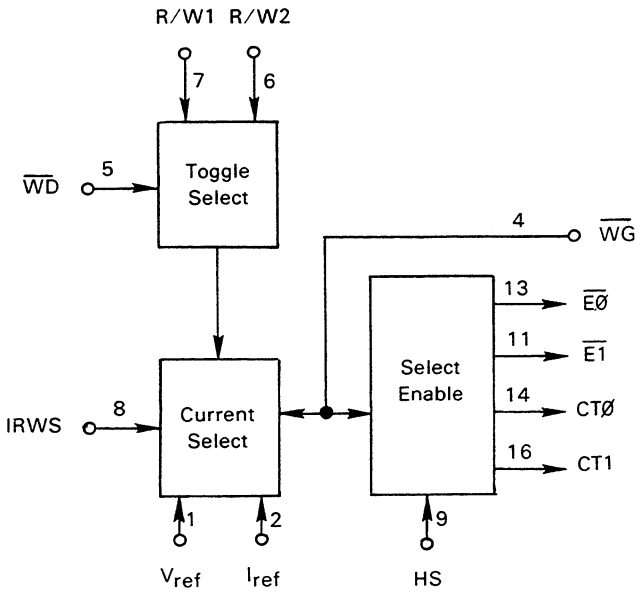
FLOPPY DISK WRITE CONTROLLER

The MC3469 is a monolithic WRITE Current Controller designed to provide the entire interface between floppy disk heads and the head control and write data signals for stradle-erase heads.

Provisions are made for selecting a range of accurately controlled write currents and for head selection during both read and write operation. Additionally, provisions are included for externally adjusting degauss period and inner/outer track compensation.

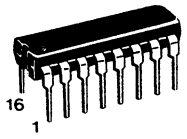
- Head Selection — Current Steering Through Write Head and Erase Coil in Write Mode
- Provides High Impedance (Read Data Enable) During Read Mode
- Head Current (Write) Guaranteed Using Laser Trimmed Internal Resistor (3.0 mA using R_{ext} = 10 kΩ)
- IRW Select Input Provides for Inner/Outer Track Compensation
- Degauss Period Externally Adjustable
- Specified With ±10% Logic Supply and Head Supply (V_{BB}) from 10.8 V to 26.4 V
- Minimizes External Components

BLOCK DIAGRAM



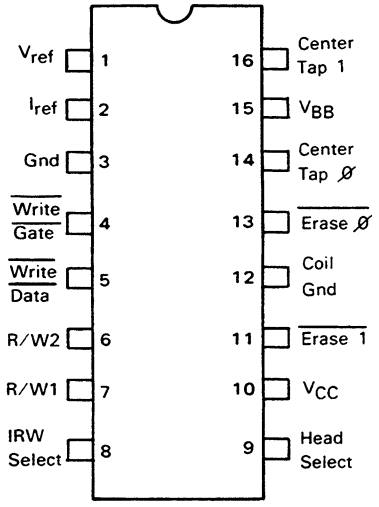
FLOPPY DISK WRITE CONTROLLER

SILICON MONOLITHIC INTEGRATED CIRCUIT



P SUFFIX
PLASTIC PACKAGE
CASE 648

PIN CONNECTIONS



ABSOLUTE MAXIMUM RATINGS (Note 1) (T_A = 25°C)

Rating	Symbol	Value	Unit
Power Supply Voltage (Pin 10)	V_{CC}	7.0	Vdc
Power Supply Voltage (Pin 15)	V_{BB}	30	Vdc
Input Voltage (Pins 4, 5, 8, 9)	V_I	5.75	Vdc
Storage Temperature	T_{stg}	-55 to +150	°C
Operating Junction Temperature	T_J	150	°C

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

RECOMMENDED OPERATING CONDITIONS

Rating	Symbol	Value	Unit
Power Supply Voltage (Pin 10)	V_{CC}	+4.5 to +5.5	Vdc
Power Supply Voltage (Pin 15)	V_{BB}	+10.8 to +26.4	Vdc
Operating Ambient Temperature Range	T_A	0 to +70	°C

ELECTRICAL CHARACTERISTICS (T_A = 0 to +70°C, V_{CC} = 4.5 to 5.5 V, V_{BB} = 10.8 to 26.4 V unless otherwise noted. Typicals given for V_{CC} = 5.0 V, V_{BB} = 12 V and T_A = 25°C unless otherwise noted.)

Characteristics	Pins	Symbol	Min	Typ	Max	Unit
DIGITAL INPUT VOLTAGES						
Power Supply Current — V_{CC} V_{BB}		I_{CC} I_{BB}	— —	22 15	50 30	mA
High Level Input Voltage (V_{CC} = 4.5 V)	4, 8, 9	V_{IH}	2.0	—	—	V
Low Level Input Voltage (V_{CC} = 5.5 V)	4, 8, 9	V_{IL}	—	—	0.8	V
Input Clamp Voltage (I_{IK} = -12 mA)	4, 5, 8, 9	V_{IK}	—	-0.87	-1.5	V
Positive Threshold (V_{CC} = 5.0)	5	$V_{T(+)}$	1.5	1.75	2.0	V
Negative Threshold (V_{CC} = 5.0)	5	$V_{T(-)}$	0 7	0.98	1.3	V
Hysteresis ($V_{T(+)}$ - $V_{T(-)}$) T_A = 0°C to +70°C T_A = 25°C		V_{HTS}	 0 2 0 4	 — 0.76	 — —	V
DIGITAL INPUT CURRENTS						
High Level Input Current (V_{CC} = 5.5 V, V_{BB} = 26.4 V, V_I = 2.4 V)	4, 5, 8, 9	I_{IH}	—	0.1	40	μA
Low Level Input Current (V_{CC} = 5.5 V, V_{BB} = 26.4 V, T_A = 25°C unless noted below)	4, 5, 8, 9	I_{IL}	—	—	-1.6	mA
V_{BB} = 12 V	4		—	0.36	—	
V_{BB} = 24 V	4		—	0.76	—	
V_{CC} = 5.0 V	5		—	0.46	—	
V_{CC} = 5.0 V	8, 9		—	0.39	—	

ELECTRICAL CHARACTERISTICS (continued) (T_A = 0 to +70°C, V_{CC} = 4.5 to 5.5 V, V_{BB} = 10.8 to 26.4 V unless otherwise noted. Typicals given for V_{CC} = 5.0 V, V_{BB} = 12 V and T_A = 25°C unless otherwise noted.)

Characteristics	Pins	Symbol	Min	Typ	Max	Unit
CENTER-TAP and ERASE OUTPUTS						
Output High Voltage (See Figure 9) (I_{OH} = -100 mA, V_{CC} = 4.5 V) V_{BB} = 10.8 to 26.4 V	14, 16	V_{OH}	V_{BB}-1.5	V_{BB}-1.0	—	V
Output Low Voltage (See Figure 9) (I_{OL} = 1.0 mA) V_{BB} = 12 V V_{BB} = 24 V	14, 16	V_{OL}	— —	70 70	150 150	mV
Output High Leakage (V_{OH} = 24 V, V_{CC} = 4.5 V, V_{BB} = 24 V)	11, 13	I_{OH}	—	0.01	100	μA
Output Low Voltage (See Figure 10) (I_{OL} = 90 mA, V_{CC} = 4.5 V) V_{BB} = 12 V V_{BB} = 24 V	11, 13	V_{OL}	— —	0.27 0.27	0.60 0.60	V
CURRENT SOURCE						
Reference Voltage	1	V_{ref}	—	5.7	—	V
Degauss Voltage (See Text) (Voltage Pin 1 – Voltage Pin 2)	1	V_{DEG}	—	1.0	—	V
Bias Voltage	2	V_F	—	0.7	—	V
Write Current Off Leakage (V_{OH} = 35 V)	6, 7	I_{OH}	—	0.03	15	μA
Saturation Voltage (V_{BB} = 12 V)	6, 7	V_{sat}	—	0.85	2.7	V
Current Sink Compliance (For $V_{6,7}$ = 4.0 V to 24 V, $V_{\overline{WG}}$ = 0.8 V)	6, 7	$\triangle I/RW2, 1$	—	15	40	μA
Average Value Write Current $\left(\frac{(I_{Pin\ 6} + I_{Pin\ 7})}{2}\right.$ for V_{BB} = 10.8 to 26.4 V)	6, 7					
@ $I_{R/W} = I_{LOW}$, R = 10 k		$\overline{I_{R/W(L)}}$				mA
T_A = 25°C			2.91	3.0	3.09	
T_A = 0 to +70°C			2.84	—	3.16	
@ $I_{R/W} = I_{LOW}$, R = 5.0 k						
T_A = 25°C			5.64	5.89	6.14	
T_A = 0 to +70°C			5.51	—	6.28	
@ $I_{R/W} = I_{HI}$, R = 10 k ($I_{HI} = I_{LOW}$ + % I_{LOW})		$\overline{\Delta I_{R/W(H)}}$				%
T_A = 25°C			31.3	33.3	35.5	
T_A = 0 to +70°C			30.3	33.3	36.6	
Difference in Write Current $(\lvert I_{Pin\ 6} - I_{Pin\ 7} \rvert$ @ $I_{R/W} = I_{LOW}$, V_{BB} = 10.8 V to 26.4 V)	6, 7					
R = 10 k		$I_{R/W\Delta}$				mA
T_A = 25°C			—	0.003	0.015	
T_A = 0 to +70°C			—	—	0.023	
R = 5.0 k						
T_A = 25°C			—	—	0.030	
T_A = 0 to +70°C			—	—	0.046	

AC SWITCHING CHARACTERISTICS (V_{CC} = 5.0 V, T_A = 25°C, V_{BB} = 24 V, I_{RWS} = 0.4 and $I_{R/W}$ = 3.0 mA unless otherwise noted — refer to Figure 2 and Figure 11.)

Characteristics (Note 2)	f_{in} (Note 3)	Min	Typ	Max	Unit
1. Delay from Head Select going low through 0.8 V to CT0 going high through 20 V.	HS, Pin 9	—	1.6	4.0	μs
2. Delay from Head Select going low through 0.8 V to CT1 going low through 1.0 V.	HS, Pin 9	—	2.1	4.0	μs
3. Delay from Head Select going high through 2.4 V to CT0 going low through 1.0 V.	HS, Pin 9	—	1.7	4.0	μs
4. Delay from Head Select going high through 2.4 V to CT1 going high through 20 V.	HS, Pin 9	—	1.4	4.0	μs
5. Delay from $\overline{WG}$ going low through 0.8 V to CT0 going low through 1.0 V.	$\overline{WG}$, Pin 4	—	1.3	4.0	μs
6. Delay from $\overline{WG}$ going low through 0.8 V to CT1 going high through 20 V.	$\overline{WG}$, Pin 4	—	0.8	4.0	μs
7. Delay from $\overline{WG}$ going low through 0.8 V to CT0 going high through 20 V.	$\overline{WG}$, Pin 4	—	0.75	4.0	μs
8. Delay from $\overline{WG}$ going low through 0.8 V to CT1 going low through 1.0 V.	$\overline{WG}$, Pin 4	—	1.2	4.0	μs
9. After $\overline{WG}$ goes high, delay from R/W1 turning off through 10% to CT0 going high through 20 V.	$\overline{WG}$, Pin 4	20	750	—	ns
10. After $\overline{WG}$ goes high, delay from R/W1 turning off through 10% to CT1 going low through 1.0 V.	$\overline{WG}$, Pin 4	20	1200	—	ns
11. After $\overline{WG}$ goes high, delay from R/W2 turning off through 10% to CT0 going low through 1.0 V.	$\overline{WG}$, Pin 4	20	1200	—	ns
12. After $\overline{WG}$ goes high, delay from R/W2 turning off through 10% to CT1 going high through 20 V.	$\overline{WG}$, Pin 4	20	600	—	ns
13. Delay from $\overline{WG}$ going low through 0.8 V to $\overline{E0}$ going low through 1.0 V.	$\overline{WG}$, Pin 4	—	0.085	4.0	μs
14. Delay from $\overline{WG}$ going low through 0.8 V to $\overline{E1}$ going low through 1.0 V.	$\overline{WG}$, Pin 4	—	0.085	4.0	μs
15. Delay from $\overline{WG}$ going high through 2.0 V to $\overline{E0}$ going high through 23 V.	$\overline{WG}$, Pin 4	—	0.7	4.0	μs
16. Delay from $\overline{WG}$ going high through 2.0 V to $\overline{E1}$ going high through 23 V.	$\overline{WG}$, Pin 4	—	0.7	4.0	μs
17. After $\overline{WG}$ goes low, delay from CT0 going low through 1.0 V to R/W1 turning on through 10%.	$\overline{WG}$, Pin 4	20	750	—	ns
18. After $\overline{WG}$ goes low, delay from CT1 going low through 1.0 V to R/W2 turning on through 10%.	$\overline{WG}$, Pin 4	20	750	—	ns
19. After $\overline{WG}$ goes low, fall time (10% to 90%) of R/W1.	$\overline{WG}$, Pin 4	—	5.0	200	ns
20. After $\overline{WG}$ goes low, fall time (10% to 90%) of R/W2.	$\overline{WG}$, Pin 4	—	5.0	200	ns
21. Setup time, Head Select going low before $\overline{WG}$ going low.	$\overline{WG}$, Pin 4	4.0	—	—	μs
22. $\overline{\text{Write Data}}$ low Hold Time	$\overline{WD}$, Pin 5	200	—	—	ns
23. $\overline{\text{Write Data}}$ high Hold Time	$\overline{WD}$, Pin 5	500	—	—	ns
24. Delay from $\overline{WG}$ going high through 2.0 V to R/W 1 turning off through 10% of on value.	$\overline{WG}$, Pin 4	—	3.9	—	μs

Note 2: Test numbers refer to encircled numbers in Figure 2.
Note 3: AC test waveforms applied to the designated pins as follows:

Pin	f_{in}	Amplitude	Duty Cycle
HS, Pin 9	50 KHz	0.4 to 2.4 V	50%
$\overline{WG}$, Pin 4	50 KHz	0.4 to 2.4 V	50%
$\overline{WD}$, Pin 5	1.0 MHz	0.2 to 2.4 V	50%

AC SWITCHING CHARACTERISTICS (continued)

(V_{CC} = 5.0 V, T_A = 25°C, V_{BB} = 24 V, $\overline{WG}$ = 0.4 unless otherwise noted — refer to Figure 3 and Figure 11.)

Characteristics (Note 4)	Min	Typ	Max	Unit
1. Delay from $\overline{\text{Write Data}}$ going low through 0.9 V to R/W1 turning on through 50%.	—	85	—	ns
2. Delay skew, difference of R/W1 turning off and R/W2 turning on through 50% after $\overline{\text{Write Data}}$ going low through 0.9 V.	—	1.0	±40	ns
3. Delay from $\overline{\text{Write Data}}$ going low through 0.9 V to R/W1 turning off through 50%.	—	80	—	ns
4. Delay skew, difference of R/W1 turning on and R/W2 turning off 50% after $\overline{\text{Write Data}}$ going low through 0.9 V.	—	1.0	±40	ns
5. Rise time, 10% to 90%, of R/W1	—	1.7	200	ns
6. Rise time, 10% to 90%, of R/W2	—	1.7	200	ns
7. Fall time, 90% to 10%, of R/W1	—	12	200	ns
8. Fall time, 90% to 10%, of R/W2	—	12	200	ns

Note 4: Test numbers refer to encircled numbers in Figure 4.
f_{in} = 1.0 MHz, 50% Duty Cycle and Amplitude of 0.2 V to 2.4 V.

PIN DESCRIPTION TABLE

Name	Symbol	Pin	Description
Head Select	HS	9	Head Select input selects between the head I/O pins: center-tap, erase, and read/write. A HIGH selects Head 0 and a LOW selects Head 1.
$\overline{\text{Write Gate}}$	$\overline{WG}$	4	$\overline{\text{Write Gate}}$ input selects the mode of operation. HIGH selects the read mode, while LOW selects the Write Control mode and forces the write current.
$\overline{\text{Write Data}}$	$\overline{WD}$	5	$\overline{\text{Write Data}}$ input controls the turn on/off of the write current. The internal divide-by-two flip-flop toggles on the negative going edge of this input to direct the current alternately to the two halves of the head coils.
IRW Select	IRWS	8	IRW Select input selects the amount of write current to be used. When LOW, the current equals the value found in Figure 5, according to the external resistor. When HIGH, the current equals the low current + 33%.
V_{ref} I_{ref}	V_{ref} I_{ref}	1 2	A resistor between these pins sets the write current. Laser trimming reliably produces 3 mA of current for a 10 k resistor. A capacitor from V_{ref} to Gnd will adjust the Degauss period.
Center-tap 0	CT0	14	Center-tap 0 output is connected to the center tap of Head 0. It will be pulled to Gnd or V_{BB} (+12 or +24) depending on mode and head selection.
$\overline{\text{Erase 0}}$	$\overline{E0}$	13	$\overline{\text{Erase 0}}$ will be LOW for writing on Head 0, and floating for other conditions.
Center-tap 1	CT1	16	Center-tap 1 output is connected to the center tap of Head 1. It will be pulled to Gnd or V_{BB} (+12 or +24) depending on mode and head selection.
$\overline{\text{Erase 1}}$	$\overline{E1}$	11	$\overline{\text{Erase 1}}$ will be LOW for writing on Head 1, and floating for other conditions.
R/W2	R/W2	6	R/W2 input is one of the differential inputs that sinks current during writing, being the opposite phase of R/W1. It will be connected to one side of the heads.
R/W1	R/W1	7	R/W1 input is one of the differential inputs that sinks current during writing, being the opposite phase of R/W2. It will be connected to one side of the heads.
	V_{CC}	10	+5 V Power
	V_{BB}	15	+12 V or + 24 V Power
	Gnd	12	Coil grounds
	Gnd	3	Reference and logic ground

FIGURE 1 — LOGIC DIAGRAM

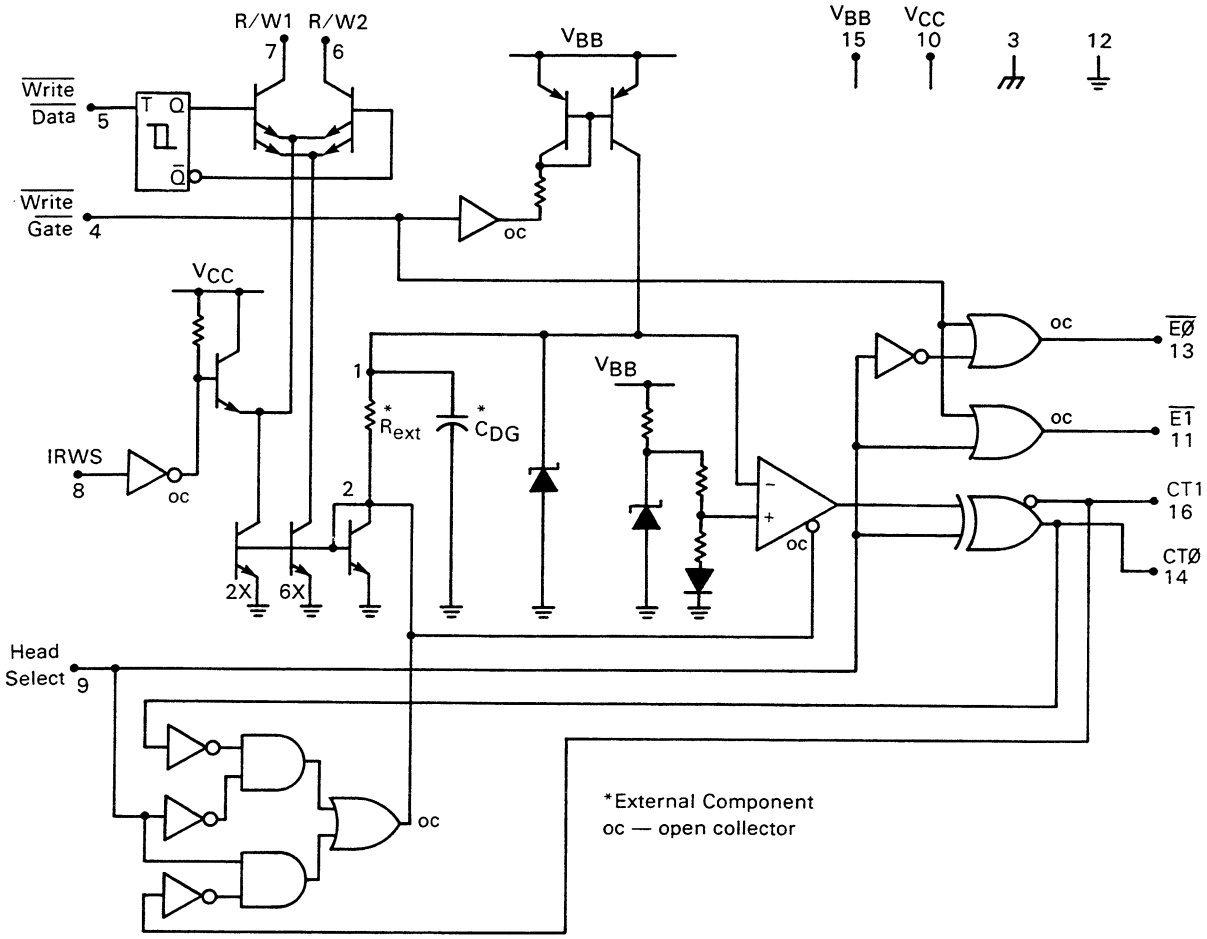


FIGURE 2 — AC TIMING DIAGRAM

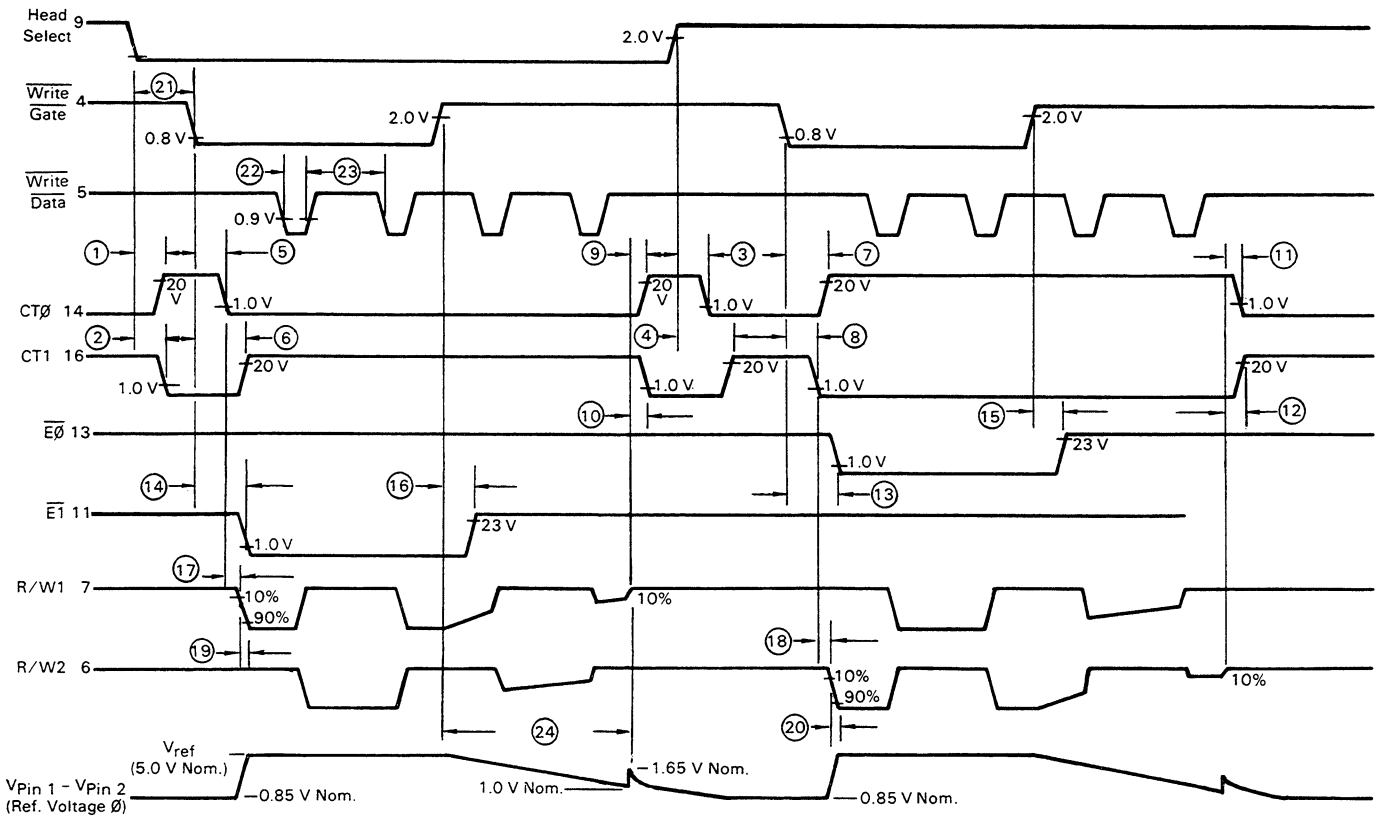
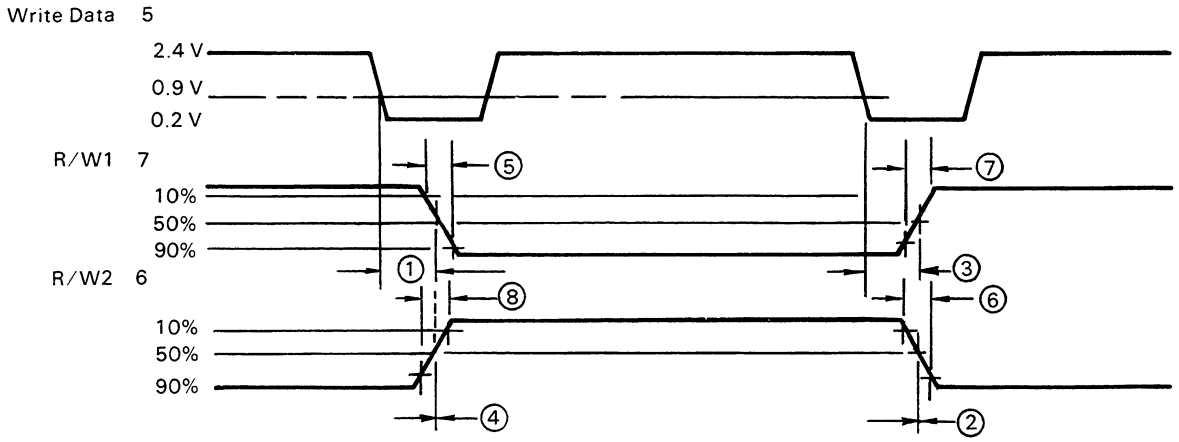


FIGURE 3 — R/W1 AND R/W2 RELATIONSHIP



APPLICATION INFORMATION

The MC3469P serves as a complete interface between the Write Control functional signals (Head Select, Write Data, Write Gate and inner track compensation, IRWS) and the head itself. A typical configuration is shown in Figure 4. L_E's are erase coils.

WRITE CURRENT SELECTION

Although the MC3469P has been specified for 3.0 mA write current (with a 10 kΩ external resistor), a range of write current values can be chosen by varying R_{ext} using the plot in Figure 5. This current can also be derived using the relationship $I_{Write}\,(mA) = \frac{30}{R_{ext}(k\Omega)}$

I_{ref}, the current flowing in R_{ext} (required only for dissipation calculations) can be worst case using the fact that the differential voltage between pins 1 and 2 (V_{ref}) shown in Figure 2 never exceeds 5.0 volts with a low value of R_{ext} = 1.0 kΩ, P_D = 25 mW.

WRITE CURRENT DAMPING

Referring to Figure 4, resistors R_D are used to dampen any ringing that results from applying the relatively fast risetime write current pulse to the inductive head load. Values chosen will be a function of head characteristics and the desired damping. R_P serves as a common pull-up resistor to the head supply V_{BB}.

FIGURE 4 — TYPICAL APPLICATION

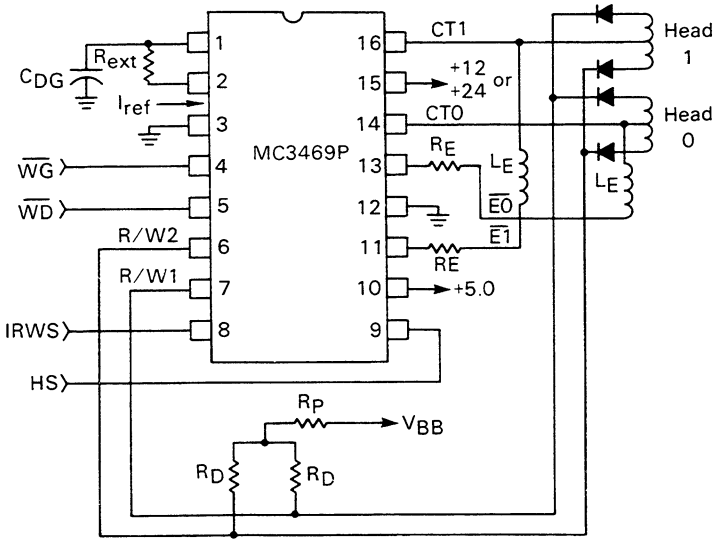
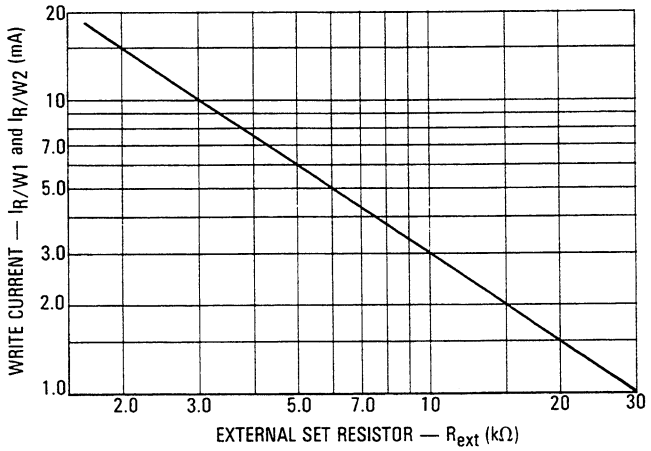


FIGURE 5 — WRITE CURRENT versus R_{ext}



DEGAUSS PERIOD

Degauss of the read/write head can be accomplished at the end of each write operation by attaching a capacitor from pin 1 to ground. The timing relationship that results is shown in Figure 7. A simplified diagram of this function is shown in Figure 6.

While $\overline{WG}$ is low, the selected write current flows into pin 6 or pin 7 (R/W1 or R/W2) and is mirrored through the external resistor, R_{ext}. The degauss capacitor, C_{DG}, will be charged to approximately 5.7 volts. After $\overline{WG}$ goes high, the voltage on C_{DG} begins to decay toward 0.7 V. When the voltage reaches the comparator threshold of 1.7 V, the comparator output triggers the internal logic to completely turn off the write current. At this point, the pulse amplitude on the R/W1 and R/W2 pins has returned to 10% of its maximum value.

Figure 7, Degauss Period shows the relationship between C_{DG} and Degauss Period for R_{ext} = 10 kΩ. This period is equal to the exponential delay time for the voltage as mentioned plus some internal delay times.

POWER UP WRITE CURRENT CONTROL

During power up, under certain conditions (V_{BB} comes up first while $\overline{WG}$ is low), there can be a write current transient on pins 6 and 7 (R/W1 and R/W2) of sufficient magnitude to cause writing to occur if the head is loaded.

This transient can be eliminated by placing a capacitor of approximately 150 pF from pin 2 to ground. This also delays the write current when $\overline{WG}$ goes low and this delay must be accounted for when the capacitor on pin 2 is used. The delay is 3.0 μs for a 150 pF capacitor.

FIGURE 6 — SIMPLIFIED DEGAUSS CIRCUIT

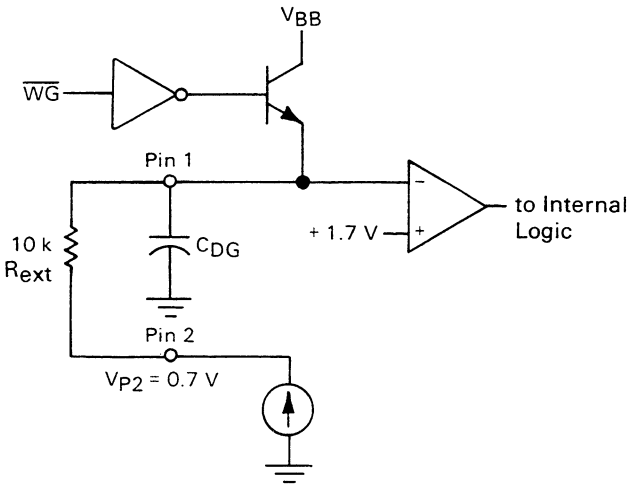


FIGURE 7 — DEGAUSS PERIOD versus CAPACITANCE (C_{DG})

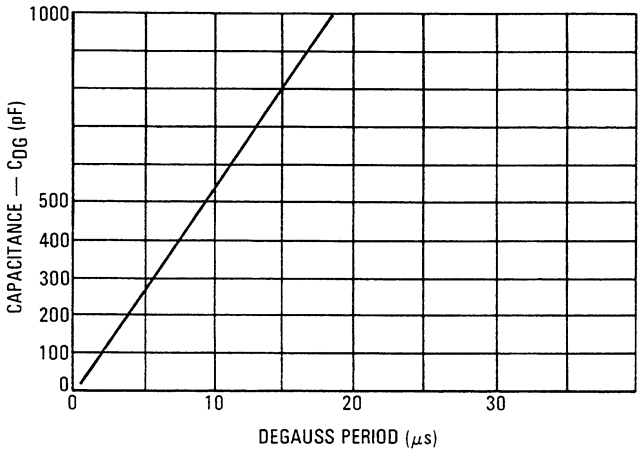
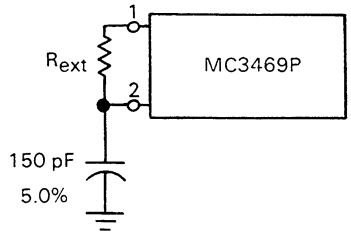
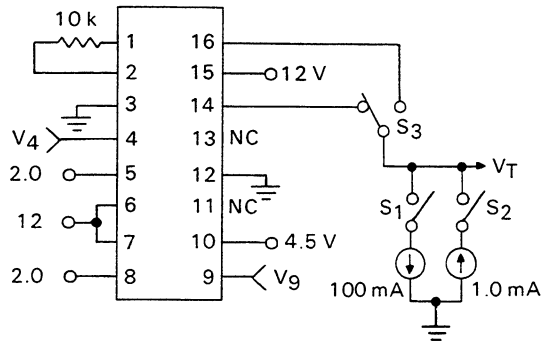


FIGURE 8 — TURN-ON WRITE PROTECTION



TEST FIGURES

FIGURE 9 — CENTER TAP OUTPUT VOLTAGE (PINS 14 AND 16)

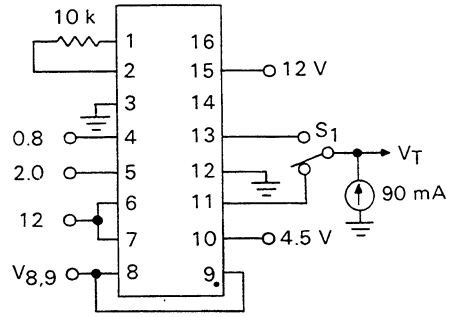


CONDITIONS

Measure V_T	Set S_1	S_2	S_3	V_4*	V_9*
V_{OH} (P14)	On	Off	P14	0.8	2.0
				2.0	0.8
V_{OH} (P16)	On	Off	P16	2.0	2.0
				0.8	0.8
V_{OL} (P14)	Off	On	P14	0.8	0.8
				2.0	2.0
V_{OL} (P16)	Off	On	P16	2.0	0.8
				0.8	2.0

*Volts

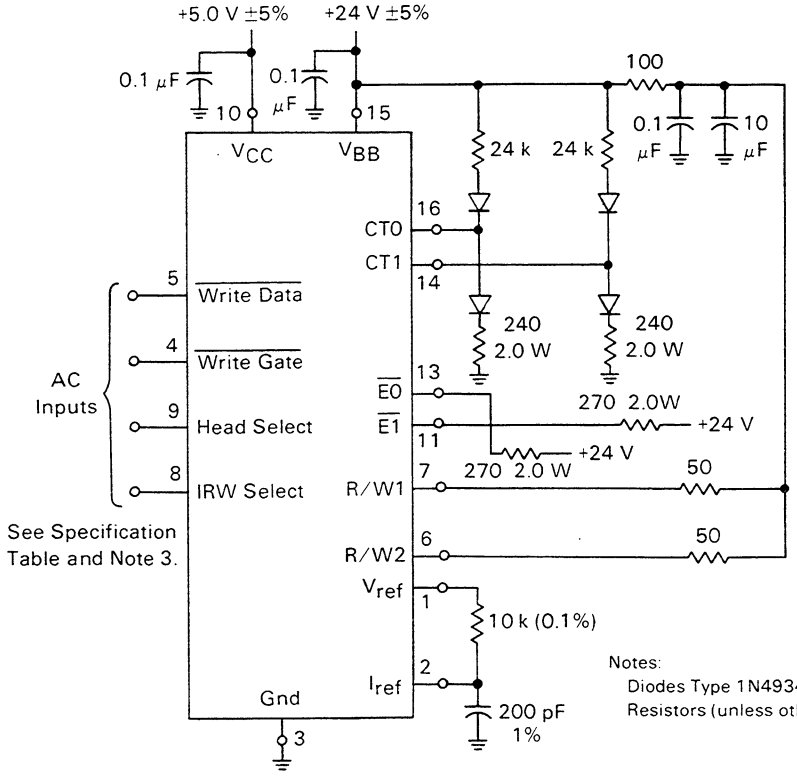
FIGURE 10 — ERASE OUTPUT LOW VOLTAGE (PINS 11 AND 13)



CONDITIONS

Measure V_T	Set S_1	$V_{8,9}$
V_{OL} (P11)	P11	0.8V
V_{OL} (P13)	P13	2.0 V

FIGURE 11 — TIMING TEST CIRCUIT



Notes:
Diodes Type 1N4934.
Resistors (unless otherwise noted) are 1/4 W, 5%

ERASE CURRENT

The value of R_E, the erase current set resistor, is found by referring to Figure 12 and selecting the desired erase current.

Looking at the simplified erase current path in Figure 12, when writing, CT0 will be high ($V_{OH(min)}$ = 21 V) and E0 will be low ($V_{OL(max)}$ = 0.6 V). If the erase coil resistance is 10 Ω and 40 mA of erase current is desired, then:

$$(R_E + 10\ \Omega) \times 40\ mA = (21 - 0.6)\ V$$

or

$$R_E = \frac{20.4\ V}{0.04\ A} - 10\ \Omega = 500\ \Omega$$

$$P_D = (0.04)(20.4) = 0.816\ W \text{ or } 1.0\ W$$

This gives the minimum value R_E for worst case V_{OH}/V_{OL} conditions. It is also recommended that a diode be used as required for inductive back emf suppression.

Erase timing is provided internally and is active during Write Gate low for the selected head.

FIGURE 12 — ERASE CURRENT (R_E Selection)

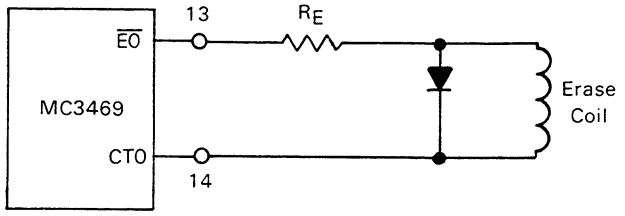
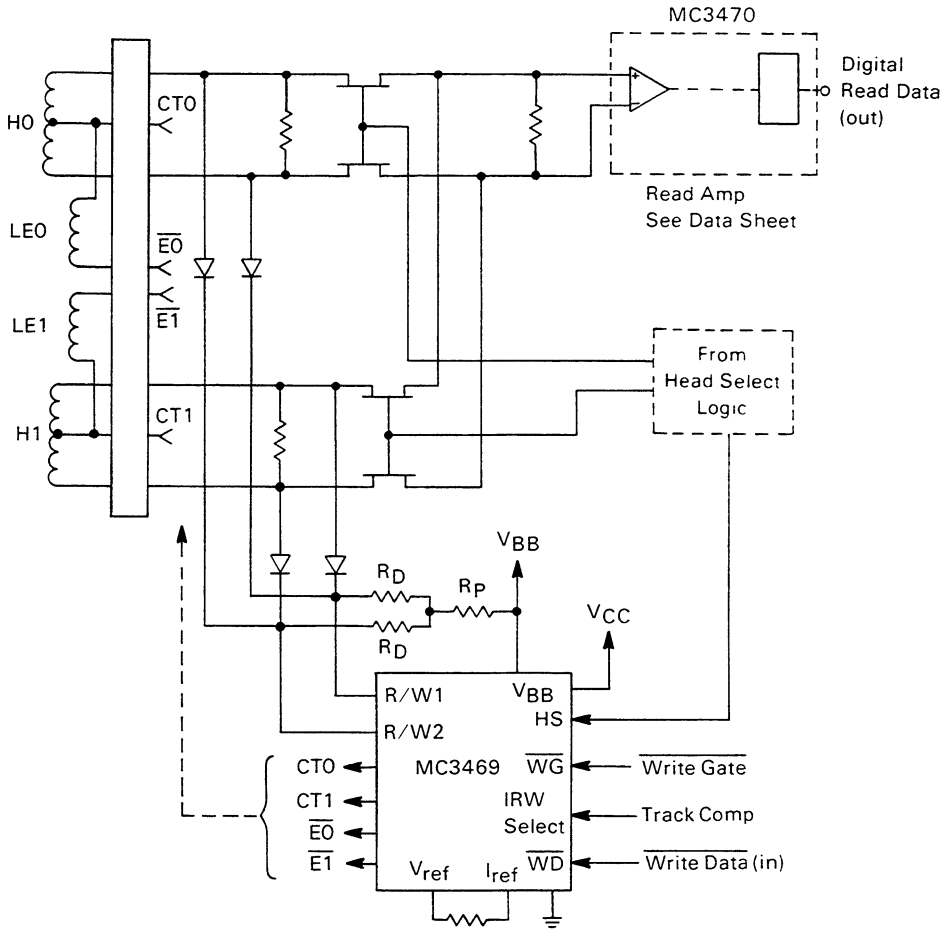
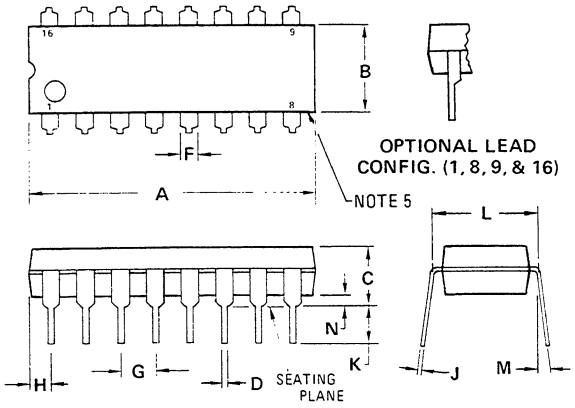


FIGURE 13 — TYPICAL DUAL HEAD FLOPPY DISK SYSTEM USING FET GATE READ CHANNEL SELECTION AND MC3469/MC3470



OUTLINE DIMENSIONS



NOTES:
1. LEADS WITHIN 0.13 mm (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION "B" DOES NOT INCLUDE MOLD FLASH.
4. "F" DIMENSION IS FOR FULL LEADS. "HALF" LEADS ARE OPTIONAL AT LEAD POSITIONS 1, 8, 9, and 16).
5. ROUNDED CORNERS OPTIONAL.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	18.80	21.34	0.740	0.840
B	6.10	6.60	0.240	0.260
C	4.06	5.08	0.160	0.200
D	0.38	0.53	0.015	0.021
F	1.02	1.78	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	0.38	2.41	0.015	0.095
J	0.20	0.38	0.008	0.015
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	0°	10°	0°	10°
N	0.51	1.02	0.020	0.040

P SUFFIX
PLASTIC PACKAGE
CASE 648

THERMAL INFORMATION

The maximum power consumption an integrated circuit can tolerate at a given operating ambient temperature, can be found from the equation:

$$P_{D(T_A)} = \frac{T_{J(max)} - T_A}{R_{\theta JA(Typ)}} \geqslant V_I I_S - V_O I_O$$

Where: $P_{D(T_A)}$ = Power Dissipation allowable at a given operating ambient temperature.

$T_{J(max)}$ = Maximum Operating Junction Temperature as listed in the Maximum Ratings Section

T_A = Maximum Desired Operating Ambient Temperature

$R_{\theta JA}(Typ)$ = Typical Thermal Resistance Junction to Ambient

I_S = Total Supply Current

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