

# HA16688MP

## Read/Write Circuit

### Description

The HA16688MP is a low-noise, 8-channel read/write circuit developed for use with small hard disk drives.

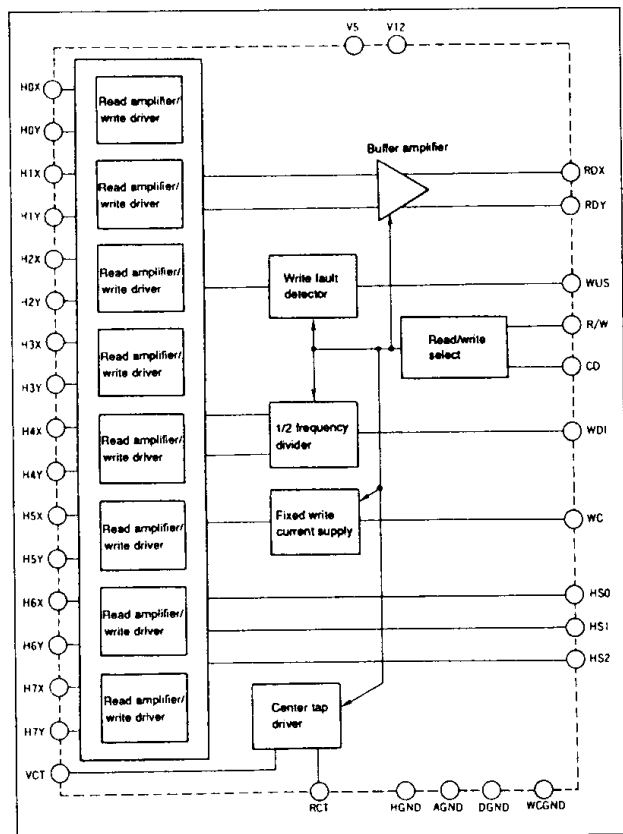
### Functions

- Read amplifier
- Write driver
- Write fault detector
- Fixed write current select

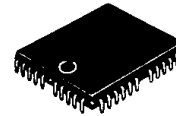
### Features

- Two-power supply design (+5 V and +12 V)
- Easily extendable for systems with more than 8 channels
- Low noise read amplifier has differential gain of 200 (typ)
- Emitter-follower fixed current read amplifier output
- Write current can be selected by an external resistor
- Built-in power supply monitor for both 5 V and 12 V prevents incorrect writes
- TTL-compatible interface
- Compact surface-mount package
- Symmetrical arrangement of head input/output and controller signal/pins

### Block Diagram

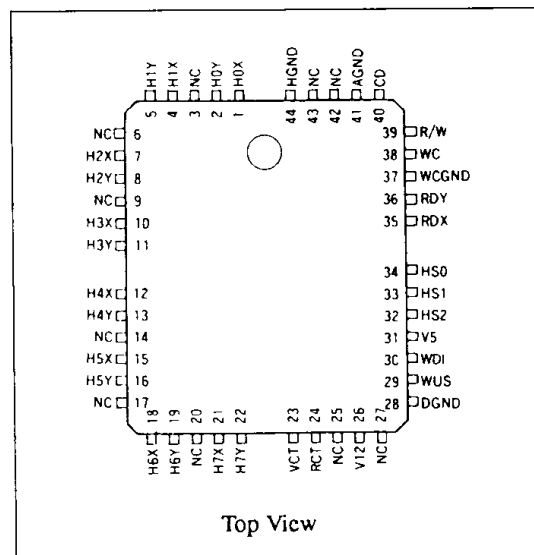


### HA16688MP



(MP-44)

### Pin Assignment



Top View

### Ordering Information

Type No.	Package
HA16688MP	MP-44



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## Pin Descriptions

Symbol	Pin No.	Name	Function
RDX	35	Read amplifier output	Differential output for a pre-amplifier. Outputs amplified read signal from the head coil.
RDY	36		
R/W	39	R/W select	Selects head coil bias for read/write. When R/W is low, write mode is selected; when it is high, read mode is selected.
CD	40	Chip disable	CD input can be used as a chip select for systems requiring more than 8 channels. CD low selects the chip, CD high disables it.
VCT	23	Center tap voltage output	Head center tap voltage output. In write mode, outputs a current proportional to write current.
RCT	24	Power supply for center tap	Power consumption can be reduced by connecting RCT to V12 through a 130 Ω (1/2 W) resistor. When power consumption is not a concern, RCT can be tied directly to V12.
HS0	34	Head select 0	Head select signal inputs. Select from head channels 0 to 7 (see table 1).
HS1	33	Head select 1	
HS2	32	Head select 2	
H0X, H0Y	1, 2	Head 0X, 0Y	
H1X, H1Y	4, 5	Head 1X, 1Y	Channel 1 head coil input/output.
H2X, H2Y	7, 8	Head 2X, 2Y	Channel 2 head coil input/output.
H3X, H3Y	10, 11	Head 3X, 3Y	Channel 3 head coil input/output.
H4X, H4Y	12, 13	Head 4X, 4Y	Channel 4 head coil input/output.
H5X, H5Y	15, 16	Head 5X, 5Y	Channel 5 head coil input/output.
H6X, H6Y	18, 19	Head 6X, 6Y	Channel 6 head coil input/output.
H7X, H7Y	21, 22	Head 7X, 7Y	Channel 7 head coil input/output.
WC	38	Write current select	The write current can be selected by connecting resistor $R_{WC}$ between WC and GND: $\text{WRITE CURRENT} = K/R_{WC} \text{ [A]}$
WDi	30	Write data input	The write data signal frequency is divided by two, then fed to a write driver.
WUS	29	Write fault detector output	WUS goes high when a write fault is detected. WUS will go high if: 1. Head coil is shorted to ground or open-circuited 2. Center tap is open-circuited 3. WDi input frequency is too low 4. There is no write current 5. Chip is in read mode 6. Chip is not selected
V5	31	5 V power supply	Digital power supply.
V12	26	12 V power supply	Analog power supply.
HGND	44	Head ground	Ground for head coil input/outputs.
AGND	41	Analog ground	Analog ground.
DGND	28	Digital ground	Digital ground.
WCGND	37	WC ground	Ground for fixed write current source.



**Absolute Maximum Ratings** (Ta = 25°C)

Parameter	Symbol	Rating	Unit	Pins
Digital power supply	V5	6.0	V	V5
Analog power supply	V12	14.0	V	V12
Write current	I <sub>W</sub>	60	mA	
Input voltage	V <sub>in</sub>	-0.3 to V5 +0.3	V	HS0, HS1, HS2, WDi, R/W, CD
WUS voltage	V <sub>WUS</sub>	14.0	V	WUS
WUS output current	I <sub>WUS</sub>	12	mA	WUS
Center tap output current	I <sub>CO</sub>	-60	mA	VCT
Read data output current	I <sub>RO</sub>	-10	mA	RDX, RDY
Head voltage	V <sub>h</sub>	-0.3 to 14	V	HOX, HOY to H7X, H7Y
Operating temperature	T <sub>opr</sub>	0 to +70	°C	
Storage temperature	T <sub>stg</sub>	-55 to +125	°C	

The absolute maximum ratings are limiting values, to be applied individually, beyond which the device may be permanently damaged. Functional operation under any of these conditions is not guaranteed. Exposing a circuit to its absolute maximum rating for extended periods of time may affect the device's reliability.

**Electrical Characteristics** (V12 = 12 V, V5 = 5 V, Ta = 25°C, unless otherwise specified)

**Power Supply**

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Power supply voltage	V5	4.5	5.0	5.5	V	
	V12	10.8	12.0	13.2	V	
+5 V power supply current	I <sub>5</sub>	—	—	25	mA	Read mode
	I <sub>5</sub>	—	—	30	mA	Write mode
	I <sub>5</sub>	—	—	20	mA	Idle mode
+12 V power supply current	I <sub>12</sub>	—	—	35	mA	Read mode
	I <sub>12</sub>	—	—	20 + I <sub>W</sub>	mA	Write mode
	I <sub>12</sub>	—	—	20	mA	Idle mode

**Digital Inputs**

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Input low voltage	V <sub>IL</sub>	-0.3	—	0.8	V	
Input low current	I <sub>IL</sub>	-400	—	—	μA	V <sub>IL</sub> = 0.8 V (applies to WDi)
	I <sub>IL</sub>	-100	—	—	μA	V <sub>IL</sub> = 0.8 V (applies to HS0, HS1, HS2, CD, and R/W)
Input high voltage	V <sub>IH</sub>	2.0	—	V5 + 0.3	V	
Input high current	I <sub>IH</sub>	—	—	100	μA	V <sub>IH</sub> = 2.0 V
Read/write transition time	t <sub>rw</sub>	—	—	600	ns	R/W to 90% VCT write voltage
Write/read transition time	t <sub>wr</sub>	—	—	600	ns	R/W to 90% VCT read voltage
Head select delay	t <sub>hs</sub>	—	—	600	ns	Read or write mode
Chip disable delay	t <sub>rw</sub>	—	—	600	ns	R/W to idle or Idle to R/W

**Write Fault Detector**

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
US low voltage	V <sub>OL</sub>	—	—	0.5	V	I <sub>ol</sub> = 8 mA
US high current	I <sub>OH</sub>	—	—	100	μA	V <sub>oh</sub> = 5.0 V
Fault to no-fault delay	t <sub>d2</sub>	—	—	1.0	μs	
No-fault to fault delay	t <sub>d1</sub>	1.6	—	8.0	μs	



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## Read Amplifiers

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Differential voltage gain	$A_{vd}$	170	200	230	V/V	$f = 300 \text{ kHz}$
Bandwidth (-3 dB)	$B_W$	—	30	—	MHz	
Input noise voltage	$V_n$	—	1.5	—	nV/√Hz	$f \leq 15 \text{ MHz}$ , Input shorted
Input bias current	$I_b$	—	—	35	μA	Read mode
Common mode rejection ratio	CMRR	50	—	—	dB	$V_{in(Cm)} = V_{CT} + 100 \text{ mV}_{p-p}$ $0.0 \text{ VDC}$ , $f = 5 \text{ MHz}$
Supply voltage rejection ratio	PSRR	45	—	—	dB	$V_5, V_{12} \pm 100 \text{ mV}_{p-p}$ , $f = 5 \text{ MHz}$
Channel separation	Sep	45	—	—	dB	$V_{in} = 100 \text{ mV}_{p-p}$ on unselected channels and $V_{in} = 0 \text{ mV}_{p-p}$ on selected channel $f = 1 \text{ MHz}$
Output offset voltage	$V_o$	-600	—	600	mV	Input shorted
Differential input impedance	$R_{in}$	8.0	15.5	—	kΩ	$f = 300 \text{ kHz}$
	$R_{in}$	—	0.8	—	kΩ	$f = 5 \text{ MHz}$
Common mode output voltage	$V_{ocm}$	5.0	6.0	7.5	V	
Output source current	$I_{ORD}$	—	-10	—	mA	
Output sink current	$I_{OSRD}$	1.5	2.2	—	mA	

## Write Drivers

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Write current select range	$I_W$	10	—	50	mA	$I_W \cdot L_{head} > 200 \text{ mA } \mu\text{H}$
Head current rise time	$T_{hcx}$	—	—	20	ns	$L_h = 0 \text{ } \mu\text{H}$ , $R_h = 0 \text{ } \Omega$ , 10% to 90% point
Head current switching delay time	$T_{d3}$	—	—	25	ns	$R_h = 0 \text{ } \Omega$ , $L_h = 0 \text{ } \mu\text{H}$ , From 50% point
Head current switching symmetry	$T_{d4}$	—	—	2	ns	WDI duty cycle = 50% Rise/fall time = 1 ns
WDI minimum input frequency	$F_W$	125	—	—	kHz	WUS = Low
Head current gain	$I_h/I_{WC}$	—	20	—		Head current/ $I_{WC}$
VCT output voltage	VCT	3.8	4.3	5.0	V	Read mode $I_d = -35 \text{ } \mu\text{A}$
	VCT	5.0	6.0	6.6	V	Write mode $I_{WC} = -45 \text{ mA}$
Write current select coefficient	K	131	140	149	V	

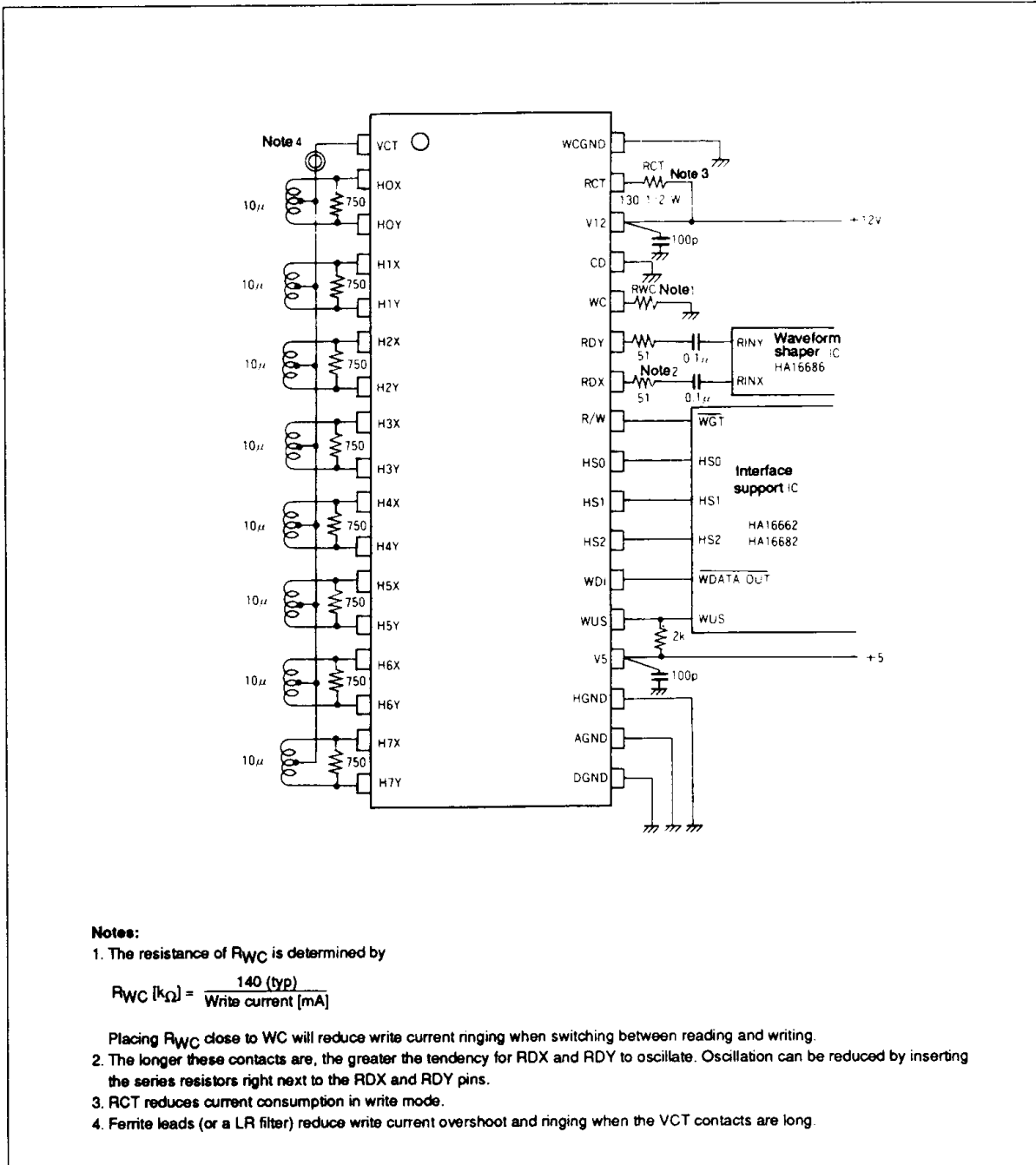
Table 1 Head Select

HS2	HS1	HS0	Head Select
Low	Low	Low	0
Low	Low	High	1
Low	High	Low	2
Low	High	High	3
High	Low	Low	4
High	Low	High	5
High	High	Low	6
High	High	High	7

Table 2 Mode Select

CD	R/W	Mode
Low	Low	Write
Low	High	Read
High	Low	Idle
High	High	Idle

Circuit Example



Notes:

1. The resistance of  $R_{WC}$  is determined by

$$R_{WC} [k\Omega] = \frac{140 \text{ (typ)}}{\text{Write current (mA)}}$$

- Placing  $R_{WC}$  close to WC will reduce write current ringing when switching between reading and writing.
- 2. The longer these contacts are, the greater the tendency for RDX and RDY to oscillate. Oscillation can be reduced by inserting the series resistors right next to the RDX and RDY pins.
- 3. RCT reduces current consumption in write mode.
- 4. Ferrite leads (or a LR filter) reduce write current overshoot and ringing when the VCT contacts are long.