

HA166008MP, HA166009MP, HA166010MP

Preliminary

Read/Write Circuit

Description

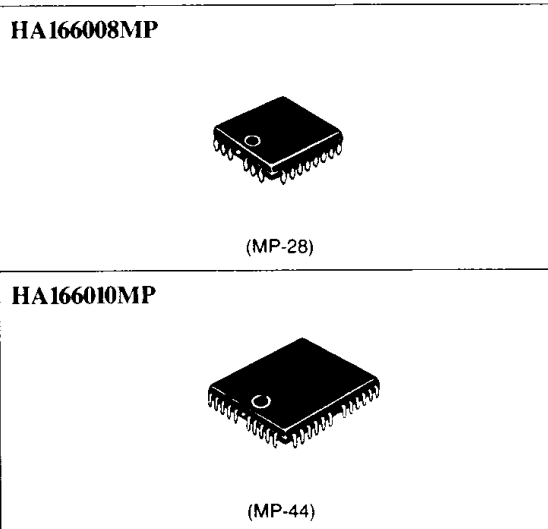
The HA166008MP/009MP/010MP are 4, 6 and 8-channel read and write circuit with very low noise amplifier for small hard disk drives.

Functions

- Read amplifier circuit
- Write driver circuit
- Write unsafe detection circuit
- Write current source circuit

Features

- Single polarity power supplies +5V, +12V
- Low noise $\leq 1\text{nV}/\sqrt{\text{Hz}}$
- Read amplifier has a high differential voltage gain of 200typ.
- Emitter followed read amplifier outputs
- Adjustable write current with an external resistor
- Supply voltage monitor circuit (+5V, +12V) inhibit miss writing at the lower supply voltage.
- TTL compatible interface
- Small surface mount package
- I/O pin separated pin arrangement.



Ordering Information

| Type No. | Channel | Package |
|------------|---------|---------|
| HA166008MP | 4 | MP-28 |
| HA166009MP | 6 | MP-28 |
| HA166010MP | 8 | MP-44 |

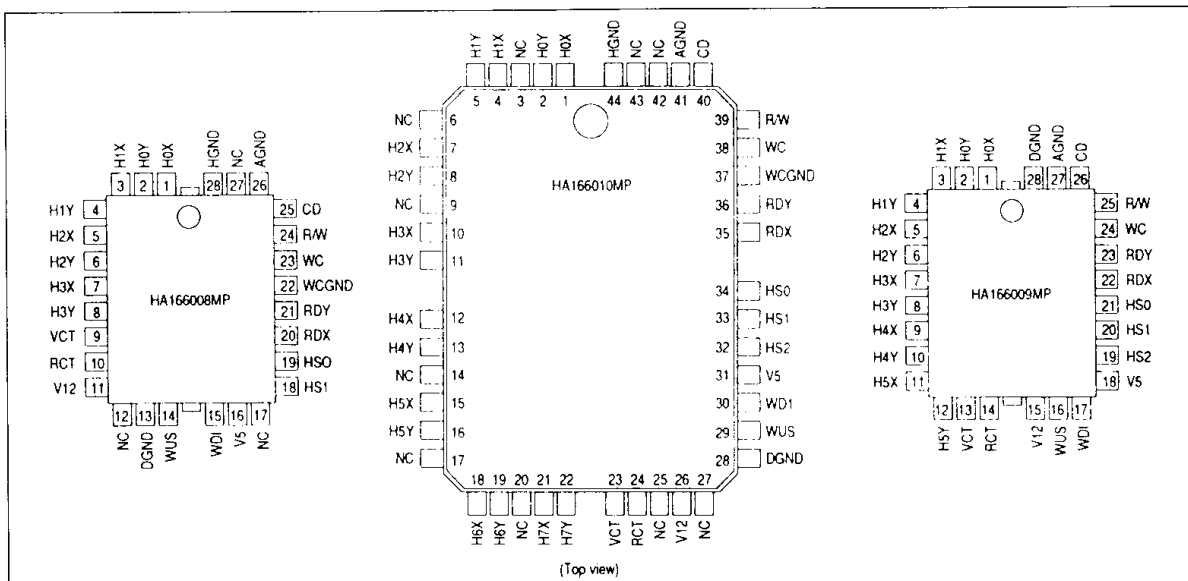


Figure 1 Pin Arrangements



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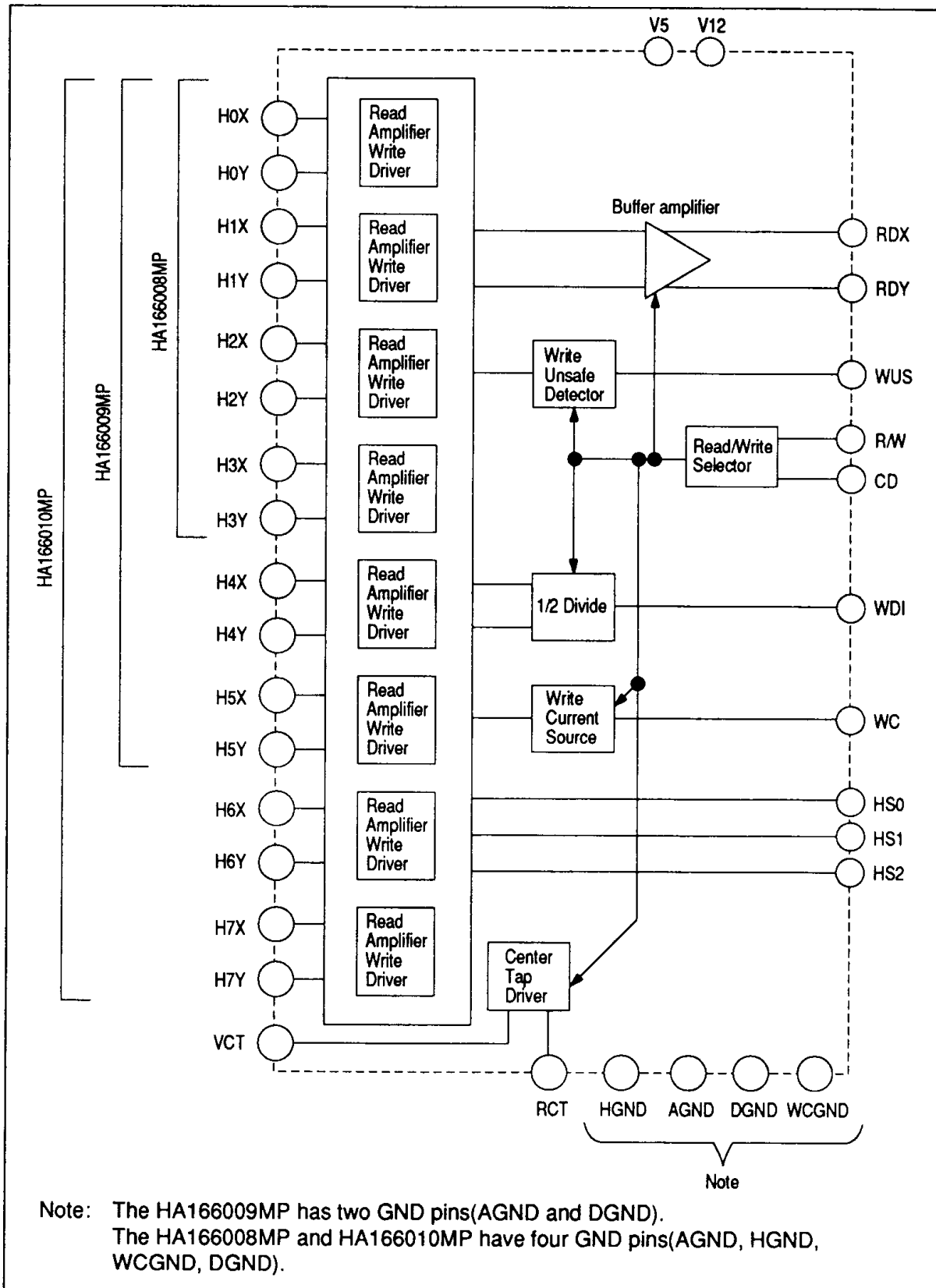


Figure 2 Block Diagram



Table 1 Pin Description

| Symbol | Name | Description |
|-------------------|---|--|
| RDX RDY | Read amplifier Output | Differential output pins for the read amp The signal read out from the head coil is amplified and provided on these pins. |
| R/W | R/W switch | Mode select switch for changing over the bias condition of the head coil A low level selects the write mode, while a high level selects the read mode. |
| CD | Chip disable | Chip select pin. This pin enables more chips to be used for multi channel systems. When selecting a chip, set this pin "Low". |
| VCT | Center tap voltage output | Center tap voltage output pin for the head coil Current corresponding to the write current flows out from this pin in the write mode. |
| RCT | Power supply for center tap | The chip power dissipation is reduced by pulling up this pin to the +12V supply with 1/2W and a 130Ω resistor. When the power dissipation has no problem, RCT pin can be pulled up to V ₁₂ voltage directly. |
| HS0 HS1 HS2 | Head select 0 Head select 1 Head select 2 | Input pins for head select signals. The combination of these signals selects each one head. Compare with head select table. |
| H0X, H0Y | Head 0X, 0Y | These pins are connected to the R/W head coil of channel 0. |
| H1X, H1Y | Head 1X, 1Y | These pins are connected to the R/W head coil of channel 1. |
| H2X, H2Y | Head 2X, 2Y | These pins are connected to the R/W head coil of channel 2. |
| H3X, H3Y | Head 3X, 3Y | These pins are connected to the R/W head coil of channel 3. |
| H4X, H4Y | Head 4X, 4Y | These pins are connected to the R/W head coil of channel 4. |
| H5X, H5Y | Head 5X, 5Y | These pins are connected to the R/W head coil of channel 5. |
| H6X, H6Y | Head 6X, 6Y | These pins are connected to the R/W head coil of channel 6. |

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Pin Description (cont)

| | | |
|----------|-------------------------------|---|
| H7X, H7Y | Head 7X, 7Y | These pins are connected to the R/W head coil of channel 7. |
| WC | Write current setting | Write current setting pin. The write current is defined as the equation (1) by connecting the external resistance R_{wc} between this pin and GND. $WRITE\ CURRENT = K/R_{WC} [A] \dots (1)$ |
| WDI | Write data input | Write data input pin. The signal is divided through the F/F circuit in the IC, and drives the write driver. |
| WUS | Write unsafe detection output | A high level output indicates the unsafe writing conditions. Unsafe conditions are shown as follows, At head pins 1. Short - circuit to ground 2. Open Others 3. Center tap open 4. Extremely low WDI input frequency 5. No write current flow 6. All the combinations of the above conditions 7. In the read mode 8. Chip unselected |
| V5 | 5V | 5V power supply |
| V12 | 12V | 12V power supply |
| HGND | Head ground | These are all GND pins. |
| AGND | Analogue ground | |
| DGND | Digital ground | |
| WCGND | WC ground | |

Table 2 Absolute Maximum Ratings (Ta=25 °C)

| Item | Symbol | Rating | Unit | Application Terminal |
|-------------------------|-----------------|----------------|------|-----------------------------|
| Supply Voltage | V5 | -0.3 to 6.0 | V | V5 |
| Supply Voltage | V12 | -0.3 to 14.0 | V | V12 |
| Write Current | I _w | 60 | mA | |
| Interface Input Voltage | V _{in} | -0.3 to V5+0.3 | V | HS0, HS1, HS2, WDI, R/W, CD |



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

| | | | | |
|---------------------------|------|--------------|----|----------|
| WUS voltage | Vwus | 14.0 | V | WUS |
| WUS output current | Iwus | 12 | mA | WUS |
| Center tap output current | Ico | -60 | mA | VCT |
| Read data output current | Iro | -10 | mA | RDX, RDY |
| Head voltage | Vh | -0.3 to 10.0 | V | Note |
| Operating temperature | Topr | 0 to +70 | °C | |
| Storage temperature | Tstg | -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.

Note: The HA166008MP has H0X, H0Y to H3X, H3Y.
 The HA166009MP has H0X, H0Y to H5X, H5Y.
 The HA166010MP has H0X, H0Y to H7X, H7Y.

Table 3 Power Supply (Ta=25 °C)

| Item | Symbol | Min | Typ | Max | Unit | Test Conditions | Note |
|----------------------|--------|------|-------|-------|------|------------------------------------|------|
| Supply voltage range | V5 | 4.5 | 5.0 | 5.5 | V | | 1 |
| Supply voltage range | V12 | 10.8 | 12 | 13.2 | V | | ↓ |
| +5V supply current | I5 | — | 15 | 25 | mA | Read mode V12=13.2V V5=5.5V | ↓ |
| +5V supply current | I5 | — | 20 | 30 | mA | Write mode V12=13.2V V5=5.5V | ↓ |
| +5V supply current | I5 | — | 8 | 13 | mA | Idle mode V12=13.2V V5=5.5V | ↓ |
| +12V supply current | I12 | — | 38 | 55 | mA | Read mode V12=13.2V V5=5.5V | 2 |
| +12V supply current | I12 | — | 15+Iw | 25+Iw | mA | Write mode V12=13.2V V5=5.5V | ↓ |



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Power Supply (Ta=25 °C) (cont)

| | | | | | | | |
|---------------------|-----|---|-------|-------|----|------------------------------------|---|
| +12V supply current | I12 | — | 16 | 25 | mA | Idle mode V12=13.2V V5=5.5V | ↓ |
| +12V supply current | I12 | — | 40 | 60 | mA | Read mode V12=13.2V V5=5.5V | 3 |
| +12V supply current | I12 | — | 18+lw | 30+lw | mA | Write mode V12=13.2V V5=5.5V | ↓ |
| +12V supply current | I12 | — | 19 | 30 | mA | Idle mode V12=13.2V V5=5.5V | ↓ |

- Notes: 1. These specifications apply for the HA166008MP/009MP/010MP.
 2. Apply for the HA166008MP.
 3. Apply for the HA166009MP/010MP.

Table 4 Electrical Characteristics (HA166008MP/009MP/010MP)
 (V12=12V, V5=5V, Ta=25°C Unless otherwise specified.)

Digital Input

| Item | Symbol | Min | Typ | Max | Unit | Test Conditions |
|----------------------------------|------------------|------|-----|--------|------|--|
| Low level input voltage | V _{IL} | -0.3 | — | -0.8 | V | |
| Low level input current | I _{IL} | -400 | — | — | μA | V _{IL} =0.8V, (WDI in apply) |
| Low level input current | I _{IL} | -100 | — | — | μA | V _{IL} =0.8V, (HS0, HS1, HS2, CD, R/W in apply) |
| High level input voltage | V _{IH} | 2.0 | — | V5+0.3 | V | |
| High level input current | I _{IH} | — | — | 100 | μs | V _{IH} =2.0V |
| Read/write transition time | t _{rw} | — | — | 600 | ns | R/W to 90% VCT write voltage |
| Write/read transition time | t _{wr} | — | — | 600 | ns | R/W to 90% VCT read voltage |
| Head select switching delay time | t _{hs} | — | — | 600 | ns | Read or write mode |
| Chip disable transition time | t _{irw} | — | — | 600 | ns | R/W to idle or idle to R/W |



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Write Faults Detection

| Item | Symbol | Min | Typ | Max | Unit | Test Conditions |
|---------------------------|----------|-----|-----|-----|---------|-----------------|
| Low level US voltage | V_{OL} | — | — | 0.5 | V | $I_{OL}=8mA$ |
| High level US current | I_{OH} | — | — | 100 | μA | $V_{OH}=5.0V$ |
| Unsafe to safe delay time | t_{d2} | — | — | 1.0 | μs | |
| Safe to unsafe delay time | t_{d1} | 1.6 | — | 8.0 | μs | |

Head Select • Table

| HS2 | HS1 | HS0 | Head Select |
|-----|-----|-----|-------------|
| L | L | L | 0 |
| L | L | H | 1 |
| L | H | L | 2 |
| L | H | H | 3 |
| H | L | L | 4 |
| H | L | H | 5 |
| H | H | L | 6 |
| H | H | H | 7 |

Mode Select • Table

| CD | R/W | Mode |
|----|-----|-------|
| L | L | Write |
| L | H | Read |
| H | L | Idle |
| H | H | Idle |

Read Amplifier

| Item | Symbol | Min | Typ | Max | Unit | Test Conditions |
|-----------------------------|----------|-----|-----|-----|----------------|--|
| Differential voltage gain | A_{vd} | 170 | 200 | 230 | V/V | $f=300kHz$ |
| Band width (−3dB) | BW | 40 | — | — | MHz | |
| Input noise voltage | V_n | — | — | 1.0 | nV/\sqrt{Hz} | $f \leq 15MHz$, Input short |
| Input bias current | I_b | — | 60 | 120 | μA | Read mode (per side) |
| Common mode rejection ratio | CMRR | 50 | — | — | dB | $V_{in(cm)}=V_{CT}$ $+100mV_{pp}$, 0.0VDC, $f=5MHz$ |



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Read Amplifier (cont)

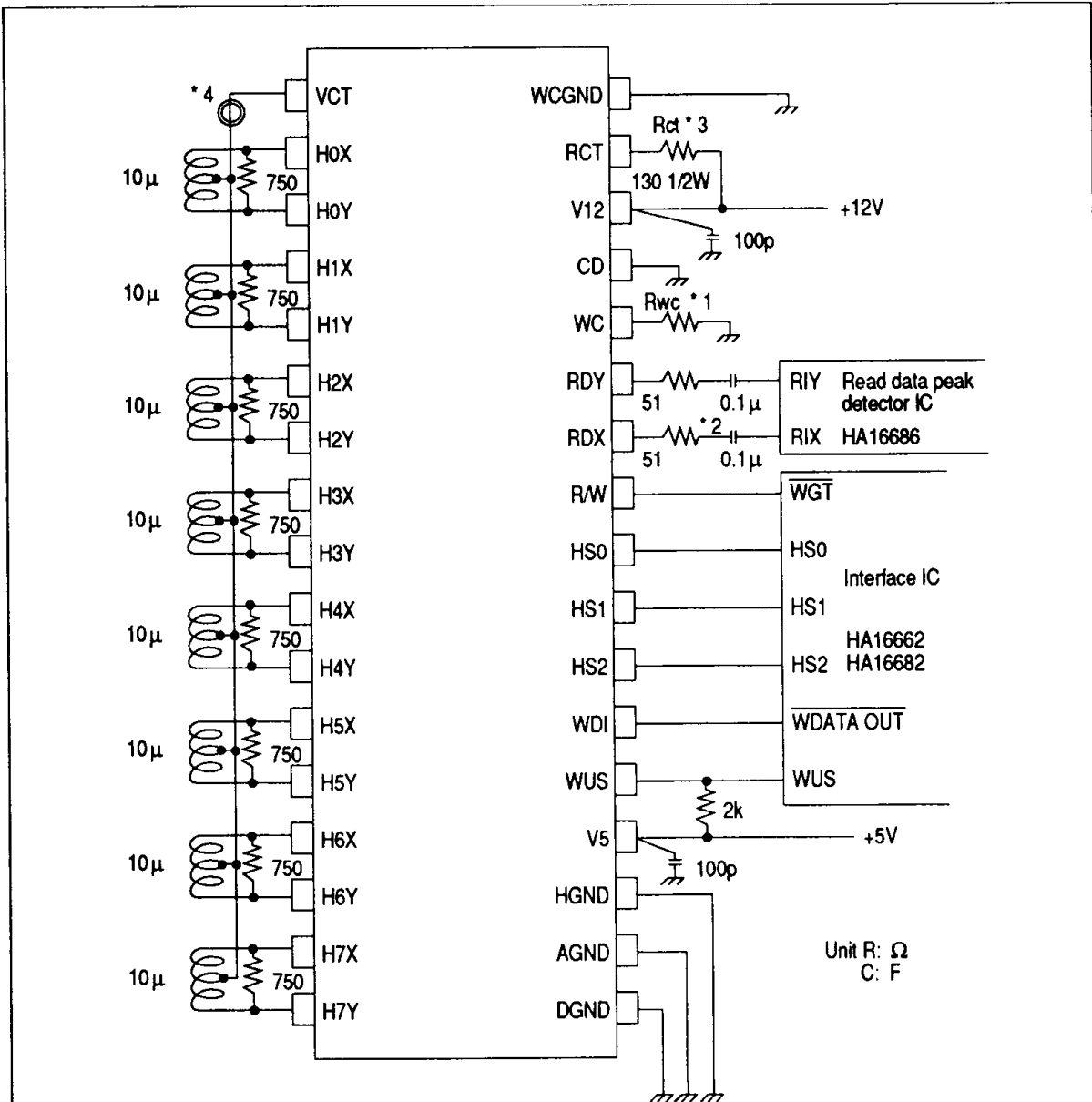
| | | | | | | |
|------------------------------|------|------|-----|-----|----|---|
| Power supply rejection ratio | PSRR | 45 | — | — | dB | V5, V12±100mVpp, f=5MHz |
| Channel separation | Sep | 45 | — | — | dB | Vin=100mVpp, f=5MHz on unselected channels and Vin=0mVpp on selected channels |
| Output offset voltage | Vo | -600 | — | 600 | mV | Input short |
| Differential input impedance | Rin | — | 2.0 | — | kΩ | f=300MHz |
| Differential input impedance | Rin | — | 1.3 | — | kΩ | f=5MHz |
| Common mode output voltage | Vocm | 5.0 | 6.0 | 7.0 | V | |
| Output source current | | — | -10 | — | mA | |
| Output sink current | Ios | 2.0 | 2.5 | — | mA | |

Write Driver

| Item | Symbol | Min | Typ | Max | Unit | Test Conditions |
|-----------------------------------|--------|------|------|------|------|-------------------------------------|
| Write current setting range | Iw | 10 | — | 50 | mA | Iw·Lhead>200mA·μH |
| Head current rise time | thcx | — | — | 20 | ns | Lh=0μH, Rh=0Ω, 10% to 90% point |
| Head current switching delay time | td3 | — | — | 25 | ns | Rh=0Ω, Lh=0μH, from 50% point |
| Head current switching symmetry | td4 | — | — | 2 | ns | WDI Duty=50%, rise/fall time=1ns |
| WDI minimum input frequency | fw | 125 | — | — | kHz | WUS=LOW |
| Head current gain | Ih/Iwc | — | 20 | — | | Head current/Iwc |
| VCT output voltage | VCT | 3.8 | 4.3 | 4.8 | V | Read mode Ib=-120μA |
| | VCT | 5.0 | 6.0 | 6.6 | V | Write mode Iwc=-45mA |
| Write current accuracy | Ih1 | 9.3 | 10.0 | 10.7 | mA | Rwc=9.38kΩ |
| | Ih2 | 27.9 | 30.0 | 32.1 | mA | Rwc=3.00kΩ |
| | Ih3 | 46.5 | 50.0 | 53.5 | mA | Rwc=1.73kΩ |

K is calculated by the following equation $K=95.51-0.176 \cdot I_h$ (mA)





Notes: *1. External resistance value, Rwc is determined by following equation.

$$R_{wc}[k\Omega] = \frac{K}{\text{Write current}[mA]}$$

To damp the ringings of write current at the transient period of read to write, put Rwc just near the WC pin.

- *2. To avoid abnormal oscillation of RD outputs, shorten the pattern length or put series resistor as shown.
- *3. External resistance Rct restricts the power dissipation in an IC chip.
- *4. Ferrite beads (or LR filter) control overshoot of write current, ringing and so on.

Figure 3 Circuit Example

