

# HA166024FP/025FP Under Development

Read/Write IC for Hard Disk Drive

## Description

The HA166024FP/025FP are 2 and 4-channel read and write circuit with very low noise amplifier for small hard disk drives.

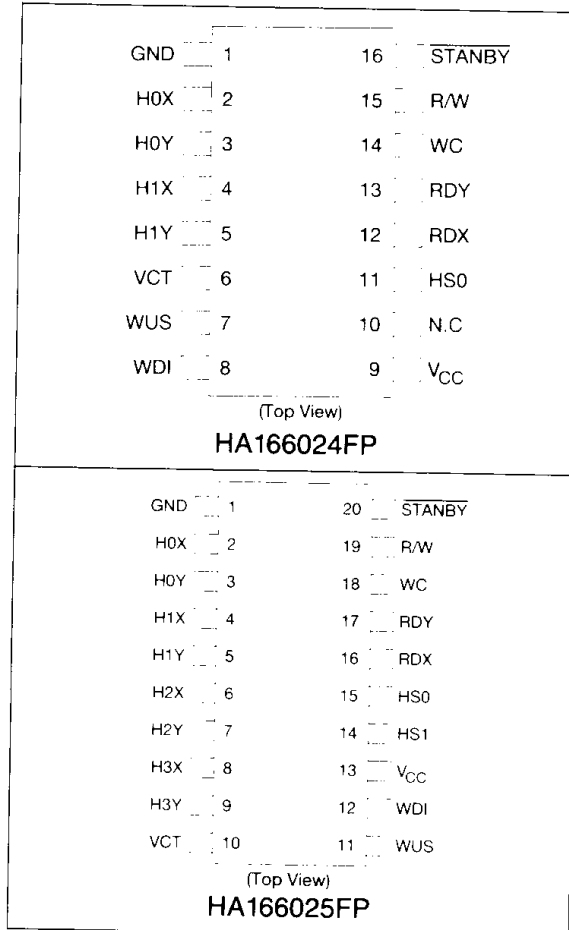
## Functions

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

## Features

- Single power supply +5V
- Low noise  $\leq 1 \text{ nv}/\sqrt{\text{Hz}}$
- The HA166024FP/025FP incorporates a standby function and realizes low power consumption in the idle mode (3.5mW typ).
- Read amplifier has high differential voltage gain of 200 typ.
- Emitter follower read amplifier outputs
- Adjustable write current with an external resistor
- Supply voltage monitor circuit inhibit miss writing at the lower supply voltage.
- TTL compatible interface
- I/O pin separated pin arrangement

## Pin Arrangement

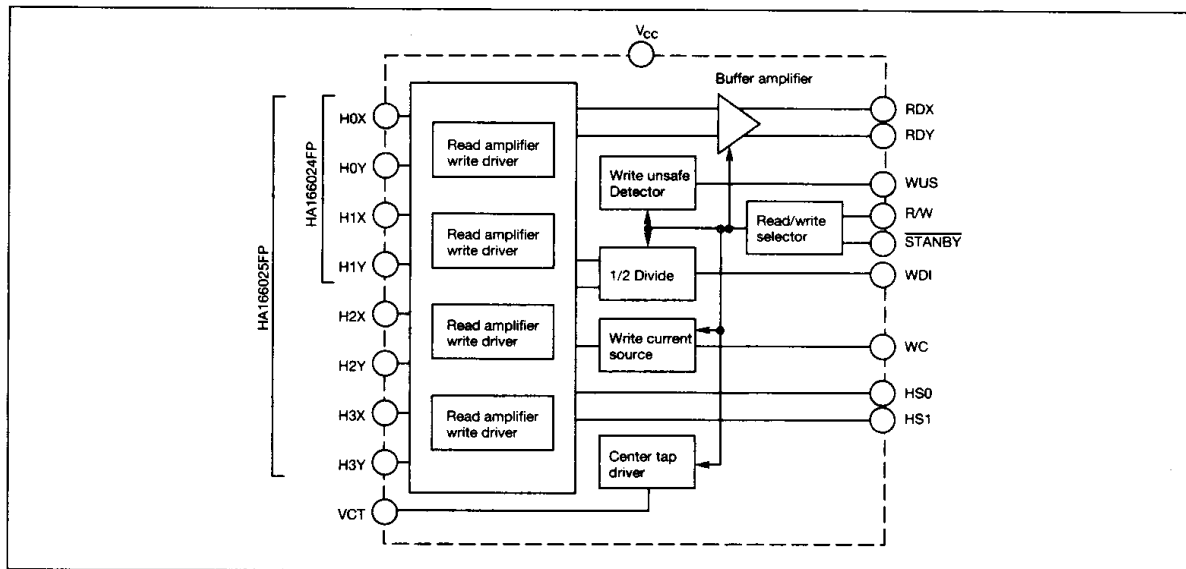


**Pin Description**

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.
<u>STANBY</u>	Standby	Circuits go into the standby state and low power consumption state when this pin set to 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.
HS0 HS1	Head select 0 Head select 1	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.
WC	Write current setting	Write current setting pin. The write current is defined as the equation (1) by connecting the external resistance Rwc between this pin and GND. $\text{WRITE CURRENT} = K/RWC \text{ [A] } \dots (1)$
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. <ol style="list-style-type: none"> <li>1. Short-circuit to ground</li> <li>2. Open</li> </ol> Others <ol style="list-style-type: none"> <li>3. Center tap open</li> <li>4. Extremely low WDI input frequency</li> <li>5. No write current flow</li> <li>6. All the combinations of the above conditions</li> <li>7. In the read mode</li> <li>8. Chip unselected</li> </ol>
Vcc	5V	5V Power supply
GND	Ground	GND pins

# HA166024FP/025FP

## Block Diagram



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

Item	Symbol	Rating	Unit	Application terminal
Supply voltage	Vs	-0.3 to 6.0	V	Vcc
Write current	Iw	60	mA	
Interface input voltage	Vin	-0.3 to Vs + 0.3	V	HS0, HS1, WD1, R/W, STANBY
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 swing	Vh	6.0	VP-P	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 HA166024FP has H0X, H0Y to H1X, H1Y.  
The HA166025FP has H0X, H0Y to H3X, H3Y.

### Power Supply (Ta = 25°C)

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	Note
Supply voltage range	Vcc	4.5	5.0	5.5	V		
+5V Supply current	Is	—	26	35	mA	Read mode Vcc = 5.5V	
			33 + Iw	48 + Iw		Write mode Vcc = 5.5V	
			0.7	1.2		Standby mode Vcc = 5.5V	
			27	36		Read mode Vcc = 5.5V	
			35 + Iw	50 + Iw		Write mode Vcc = 5.5V	
0.7	1.2	Idle mode Vcc = 5.5V					

Notes: 1. Apply for the HA166024FP.

2. Apply for the HA166025FP.



**Electrical Characteristics (VCC = 5V, Ta = 25°C Unless otherwise specified)**

**Digital Input**

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Low level input voltage	Vil	-0.3		0.8	V	
Low level input current	Iil	-400		—	μA	Vil = 0.8V, (WDI in apply)
		-100				Vil = 0.8V, (HS0, HS1, STANBY, R/W in apply)
High level input voltage	Vih	2.0		VCC + 0.3	V	
High level input current	Iih			100	Vih = 2.0V	μA
Read/Write transition time	Trw		—			R/W to 90% VCT write voltage
Write/Read transition time	Trr	—		600	ns	R/W to 90% VCT read voltage
Head select switching delay time	T <sub>hs</sub>					Read or write mode
Chip disable transition	T <sub>irw</sub>					R/W to idle or idle to R/W

**Write Faults Detection**

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Low level US voltage	Vol			0.5		V <sub>Lol</sub> = 8mA
High level US current	Ioh	—	—	100		μA Voh = 5.0V
Unsafe to safe delay time	Td2			1.0		μS
Safe to unsafe delay time	Td1	1.6		8.0		

**Head Select**

HS1	Hs0	Head Select
L	L	0
	H	1
H	L	2
	H	3

**Mode Select**

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

# HA166024FP/025FP

## Read Amplifier

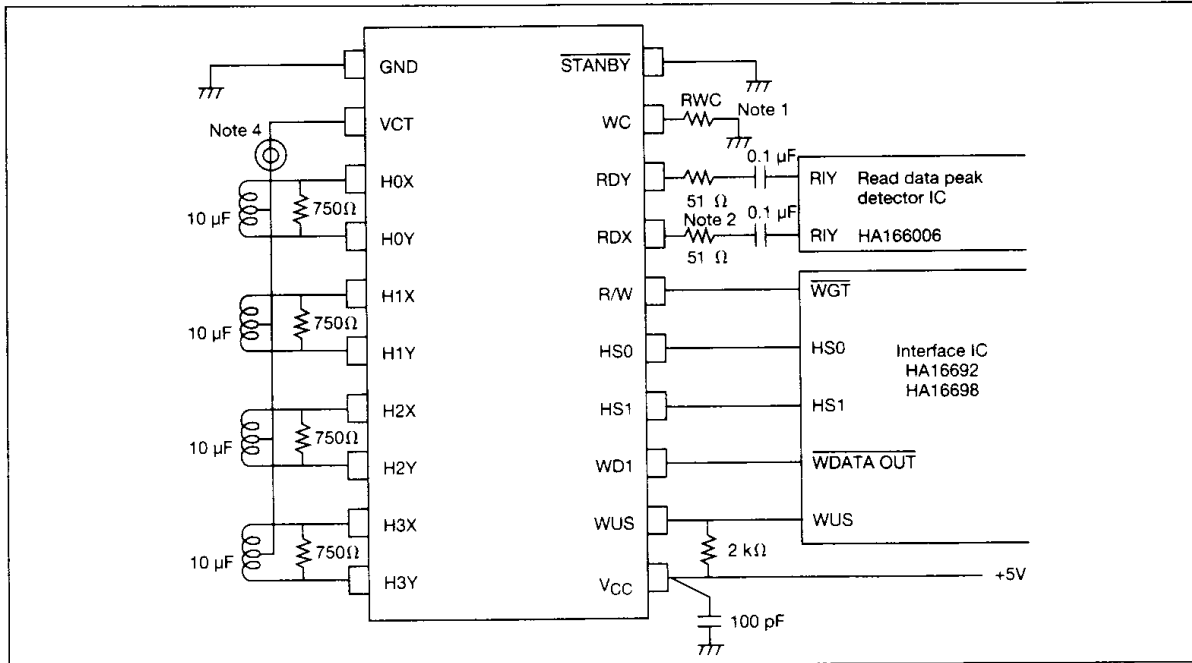
Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Differential voltage gain	$A_{vd}$	170	200	230	V/V	$f = 300 \text{ kHz}$
Band width (-3 dB)	BW	40	—	—	MHz	
Input noise voltage	$V_n$	—	—	1.0	$\text{nV}/\sqrt{\text{Hz}}$	$f \leq 15 \text{ MHz}$ , Input short
Input bias current	$I_b$	—	55	120	$\mu\text{A}$	Read mode
Common mode rejection	CMRR	50	—	—		$V_{in(cm)} = V_{CT} + 100\text{mV}_{PP}$ , 0.0 VDC, $f = 5 \text{ MHz}$
Power supply rejection ratio	PSRR	45	—	—		$V_{CC} \pm 100\text{mV}_{PP}$ , $f = 5 \text{ MHz}$
Channel separation	Sep	60	80	—	dB	$V_{in} = 100\text{mV}_{PP}$ , $f = 5 \text{ MHz}$ on unselected channels and $V_{in} = 0\text{mV}_{PP}$ on selected channels
Output offset voltage	$V_o$	-600	—	600	mV	Input short
Differential input impedance	$R_{in}$	—	2.3	—	$\text{k}\Omega$	$f = 300\text{kHz}$ $f = 5\text{MHz}$
Common mode output voltage	$V_{ocm}$	2.5	3.0	3.5	V	
Output source current	—	—	-10	—	mA	
Output sink current	$I_{os}$	2.0	2.5	—		

## Write Driver

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Write current setting range	$I_w$	10	—	50	mA	$I_w \cdot L_{head} > 200\text{mA} \cdot \mu\text{H}$
Head current rise time	$T_{hcx}$	—	—	20		$L_h = 0\mu\text{H}$ , $R_h = 0\Omega$ , 10% to 90% point
Head current switching delay time	$T_{d3}$	—	—	25	ns	$R_h = 0\Omega$ , $L_h = 0\mu\text{H}$ , from 50% point
Head current switching symmetry	$T_{d4}$	—	—	2		WDI duty = 50%, rise/fall time = 1ns
WDI minimum input frequency	$F_w$	125	—	—	kHz	WUS = LOW
Head current gain	$I_h/I_{WC}$	—	40	—		Head current/ $I_{wc}$
VCT output voltage	VCT	1.8	2.1	2.4	V	Read mode $I_b = -120 \mu\text{A}$ Write mode $I_{wc} = -45\text{mA}$
Write current accuracy 1	$I_{h1}$	9.3	10	10.7		$R_{wc1} = 2.7\text{k}\Omega$
Write current accuracy 2	$I_{h2}$	27.9	30.0	32.1	mA	$R_{wc2} = 0.85\text{k}\Omega$
Write current accuracy 3	$I_{h3}$	46.5	50.0	53.5		$R_{wc3} = 0.49\Omega$



An Example of Application Circuit



Notes: 1. External resistance value, RWC is determined by the following equation:

$$RWC[k\Omega] = \frac{26 \text{ (typ)}}{\text{Write current [mA]}}$$

To damp the ringing 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. Ferrite beads (or LR filter) control overshoot of write current, ringing and so on.