

**2ch. Read/Write Amplifier for Thin Film Head of Hard Disk Drive**

**Description**

The CXA3188N is a Read/Write Amplifier for the thin film head of hard disk drive and designed to handle up to 2 channel heads.

**Features**

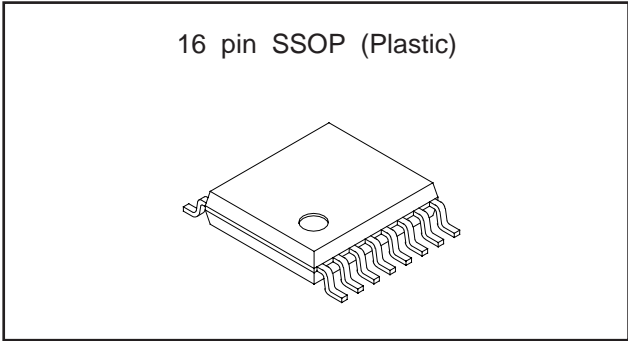
- Operate on single +5 V power supply
- Low power consumption
  - Read : 90 mW
  - Write : 115 mW +  $I_w \times 5$
  - Idle : 8 mW
- Designed for two terminal thin-film or MIG heads.
- Read amplifier emitter follower output featuring 200 times gain(typ).
- Differential input capacitance for Read : 6pF (typ)
- Input noise :  $0.47 \text{ nV} / \sqrt{\text{Hz}}$  (typ)
- Write current range : 10 to 20 mA
- Differential Head voltage swing : 9 Vp-p (typ)
- Differential P-ECL write data input.
- Built-in write unsafe detection circuit.
- Built-in Servo write function.
- Read data outputs are high impedance in write mode.
- Unselected head voltage is high impedance.
- Self switching damping resistor 380  $\Omega$ .
- Built-in supply voltage monitor circuit prohibits incorrect write during power on or abnormal voltage.

**Function**

Read, Write and Write unsafe detection for HDD, power supply ON/OFF detection.

**Structure**

Bipolar silicon monolithic IC



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

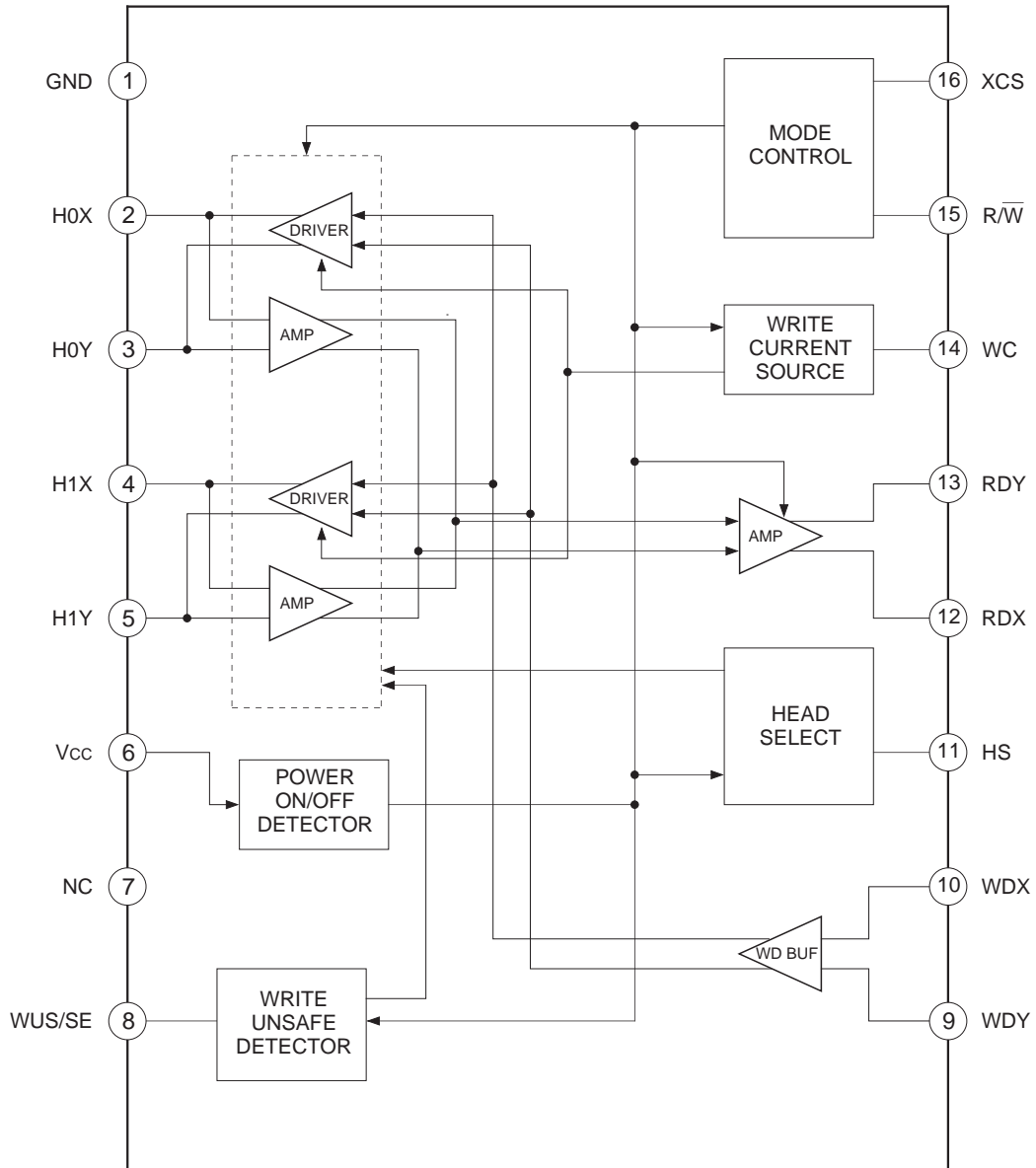
• Supply voltage	V <sub>CC</sub>	6	V
• Operating temperature	T <sub>opr</sub>	-20 to +70	°C
• Storage temperature	T <sub>stg</sub>	-55 to +150	°C
• Allowable power dissipation (on board)	P <sub>D</sub>	760	mW
• Write current	I <sub>w</sub>	22	mA
• WUS/SE pin input current	I <sub>SEH</sub>	15	mA

**Operating Conditions**

Supply voltage	V <sub>CC</sub>	5±0.5	V
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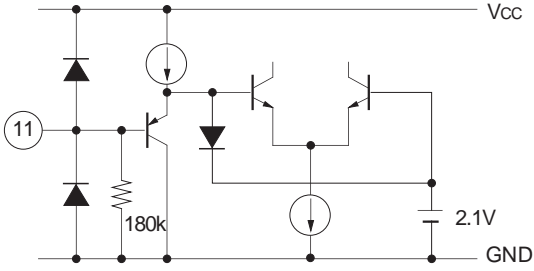
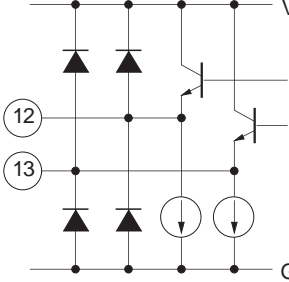
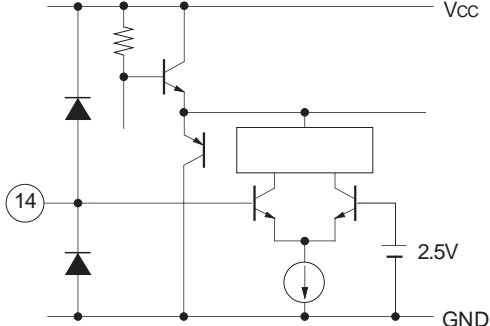
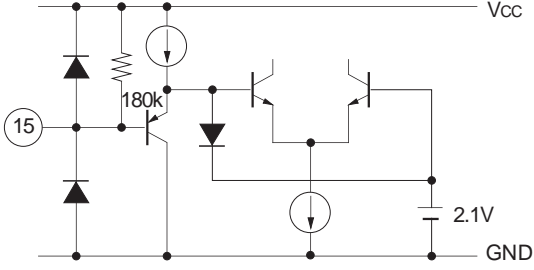
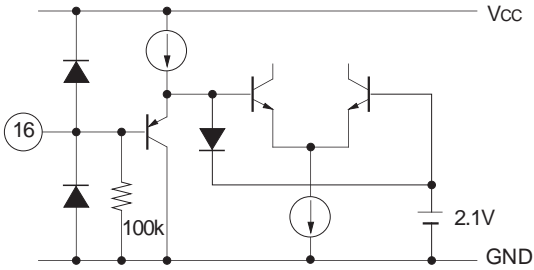
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Block Diagram and Pin Configuration



Pin Description

No.	Symbol	Equivalent circuit	Description
1	GND		
2 3 4 5	H0X H0Y H1X H1Y		Head. 2 channels provided.
6	Vcc		5 V power supply.
7	NC		
8	WUS/SE		Write unsafe detection output / Servo Enable signal input.
9 10	WDY WDX		Differential P-ECL write data input.

No.	Symbol	Equivalent circuit	Description
11	HS	 <p>The circuit for pin 11 (HS) shows a pull-up resistor of 180kΩ connected to Vcc. The input signal is connected to the base of a PNP transistor. The emitter of this transistor is connected to Vcc, and its collector is connected to the base of an NPN transistor. The emitter of the NPN transistor is connected to GND, and its collector is connected to the base of another NPN transistor. The emitter of this second NPN transistor is connected to GND, and its collector is connected to the input of a 2.1V diode. The other end of the diode is connected to GND.</p>	<p>Head select signal input.                      At "Low" : Head0                      at "High" : Head1</p>
12 13	RDY RDX	 <p>The circuit for pins 12 (RDY) and 13 (RDX) shows two parallel paths. Each path starts with a pull-up resistor to Vcc. The signal is connected to the base of a PNP transistor. The emitter of this transistor is connected to Vcc, and its collector is connected to the base of an NPN transistor. The emitter of the NPN transistor is connected to GND, and its collector is connected to the input of a 2.1V diode. The other end of the diode is connected to GND.</p>	<p>Read amplifier output.</p>
14	WC	 <p>The circuit for pin 14 (WC) shows a pull-up resistor to Vcc. The input signal is connected to the base of a PNP transistor. The emitter of this transistor is connected to Vcc, and its collector is connected to the base of an NPN transistor. The emitter of the NPN transistor is connected to GND, and its collector is connected to the base of another NPN transistor. The emitter of this second NPN transistor is connected to GND, and its collector is connected to the input of a 2.5V diode. The other end of the diode is connected to GND.</p>	<p>A setting resistor for the write current value is connected between this pin and GND.</p>
15	R/W	 <p>The circuit for pin 15 (R/W) is identical to the HS pin circuit, featuring a 180kΩ pull-up resistor to Vcc and a 2.1V diode connected to GND.</p>	<p>Read/Write signal input.                      At "High" : Read                      at "Low" : Write</p>
16	XCS	 <p>The circuit for pin 16 (XCS) is similar to the HS pin circuit, but with a 100kΩ pull-up resistor to Vcc and a 2.1V diode connected to GND.</p>	<p>Power save signal input                      At "High" : Power saving.</p>

**Electrical Characteristics** (Unless otherwise specified,  $V_{CC}=5\text{ V}$ ,  $T_a=25\text{ }^\circ\text{C}$ , Write current  $I_w=20\text{ mA}$ )

Item	Symbol	Test condition	Min.	Typ.	Max.	Unit.
Current consumption for read	$I_{CCR}$		11	18	25	mA
Current consumption for write	$I_{CCW}$	$I_w=20\text{ mA}$	14 + $I_w$	23 + $I_w$	33 + $I_w$	mA
Current consumption for idle	$I_{CCI}$		1.1	1.6	2.1	mA
Digital input "Low" input voltage	$V_{IL}$				0.8	V
Digital input "High" input voltage	$V_{IH}$		2.0			V
Digital input "Low" input current	$I_{IL}$	"H" applied voltage: 5 V	-100			$\mu\text{A}$
Digital input "High" input current	$I_{IH}$	"L" applied voltage: 0 V			100	$\mu\text{A}$
Write data input current	$I_{WD}$				50	$\mu\text{A}$
Write data input voltage range	$V_{WDV}$		$V_{CC}-2.5$		$V_{CC}$	V
WD input amplitude	$V_{WDA}$		0.3		1	V
Power supply ON/OFF detector threshold voltage	$V_{TH}$		3.4	3.9	4.3	V
Write current setting range	$I_w$		10		20	mAo-p
Write current voltage	$V_{WC}$		2.25	2.5	2.75	V
Write current gain	$A_w$	$I_w=A_w \cdot V_{WC}/R_{WC}$	18	20	22	mA/mA
Write current setting constant	$K_w$	When write current is " $I_w[\text{mA}]$ ", $I_w=K_w/R_{WC}$ . ( $R_{WC}=3.3\text{ k}\Omega$ )	46	51	56	
Write unsafe output leak current	$I_{WUS}$				50	$\mu\text{A}$
Write unsafe output Low voltage	$V_{WUSL}$	Output current: 1 mA			0.5	V
WUS/SE input current	$I_{SEH}$	Servo write Enabled	5		14	mA
WUS/SE High input voltage	$V_{SEH}$	Servo write Enabled	$V_{CC}$ +1.5		$V_{CC}$ +1.6	V

Item	Symbol	Test condition	Min.	Typ.	Max.	Unit.
Read amplifier differential voltage gain	$A_v$	Input voltage: 1 mVp-p, 300 kHz load resistor: (RDX, RDY) 1 k $\Omega$	170	200	230	V/V
Frequency band width	Bw1	Frequency at which $A_v$ lower by 1dB	35	60		MHz
	Bw2	Frequency at which $A_v$ lower by 3dB	75	120		MHz
Input referred noise voltage	$E_N$	Head impedance: 0 $\Omega$		0.47	0.65	$\frac{nV}{\sqrt{Hz}}$
Common mode rejection ratio	CMRR	Common input voltage: 100 mVp-p, 20 MHz	50			dB
Supply voltage rejection ratio	PSRR	Ripple voltage: 100 mVp-p, 20 MHz	50			dB
Channel Separation	CS	Selected head input voltage: 0 mVp-p Unselected head input voltage: 100 mVp-p, 20 MHz	50			dB
Read data output offset voltage for Read	$V_{OFF}$		-300		300	mV
RDX, RDY common mode output voltage difference between modes	$V_{diff}$	$C_{RD}=0.1 \mu$	-300		300	mV
RDX, RDY common mode output voltage for Read	$V_{RD}$			$V_{CC}$ -2.3		V

Unless otherwise specified,  $V_{CC}=5$  V,  $T_a=25$  °C,  $f_{WD}$  (Write data frequency) =5 MHz,  $I_w=15$  mA,  $L_H$  (Head inductance) =1  $\mu$ H,  $R_H$  (Head DC resistance value) =30  $\Omega$

Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Unit.
Head differential voltage amplitude	$V_{SW}$	Differential voltage between HX pin and HY pin at switching of Write current		9		Vp-p
Mode switching time Read to Write	$T_{RW}$	$T_{RW}$ is the time required for Write current to turn to 90 % after Pin 15 changes from "High" to "Low".		0.13	0.3	$\mu$ s
Mode switching time Write to Read	$T_{WR1}$	$T_{WR1}$ is the time required for the Read amplifier output* to turn to 90 % after Pin 15 changes from "Low" to "High".		0.2	0.3	$\mu$ s
	$T_{WR2}$	$T_{WR2}$ is the time required for Write current to decrease to 10 % after Pin 15 changes from "Low" to "High".		0.1	0.3	$\mu$ s
Mode switching time Power saving to Read	$T_{IR}$	$T_{IR}$ is the time required for the Read amplifier output* to turn to 90 % after Pin 16 changes from "High" to "Low".			1	$\mu$ s
Mode switching time safe to unsafe	$T_{SA1}$	$T_{SA1}$ is the time required for Pin 8 to turn "High" after the last transition of Write data when Write data is stopped in Write mode.	1.0	2.3	3.0	$\mu$ s
Mode switching time unsafe to safe	$T_{SA2}$	$T_{SA2}$ is the time required for Pin 8 to turn "Low" after the first transition of Write data in Write mode.			0.6	$\mu$ s
Head switching time	$T_H$	$T_H$ is the time required for the Read amplifier output* to reach 90 % when the selected head switched in Read mode.			0.6	$\mu$ s
Write current propagation delay time	$T_{PD}$	$T_{PD}$ is the time required for Write current to reach 90 % after the Write data falling edge.		2	7	ns
Write current rise/fall time	$T_R/T_F$	$T_R$ is the time required for Write current to reach 90 % from 10 %; $T_F$ is the same time required to reach 10 % from 90 %. $L_H=0$ $\mu$ H, $R_H=0$ $\Omega$		1	3	ns

\*Read amplifier output 100 mVp-p 10 MHz

Test Circuit 1

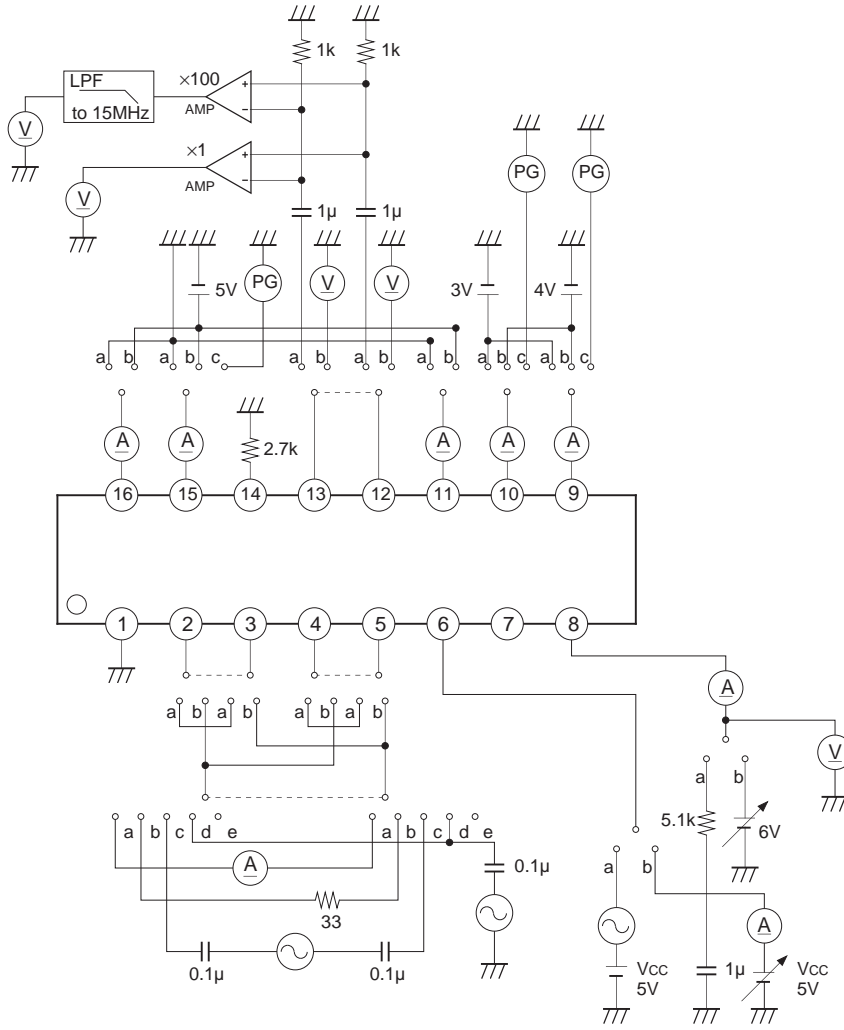


Fig. 1

Test Circuit 2

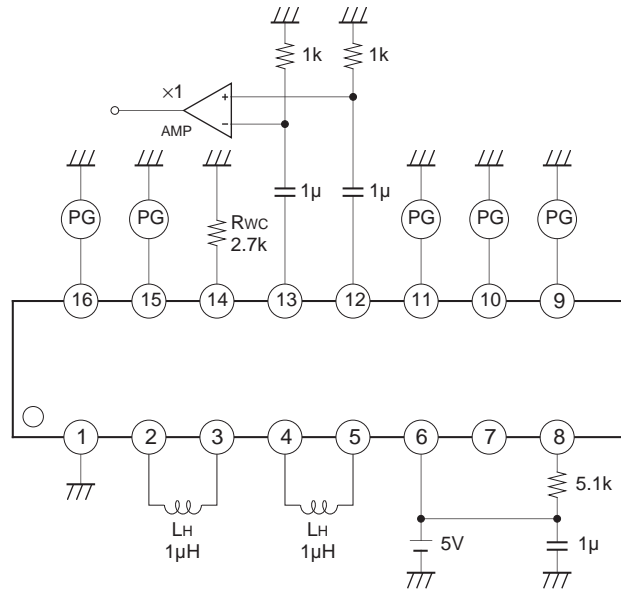


Fig. 2



Timing Chart 1

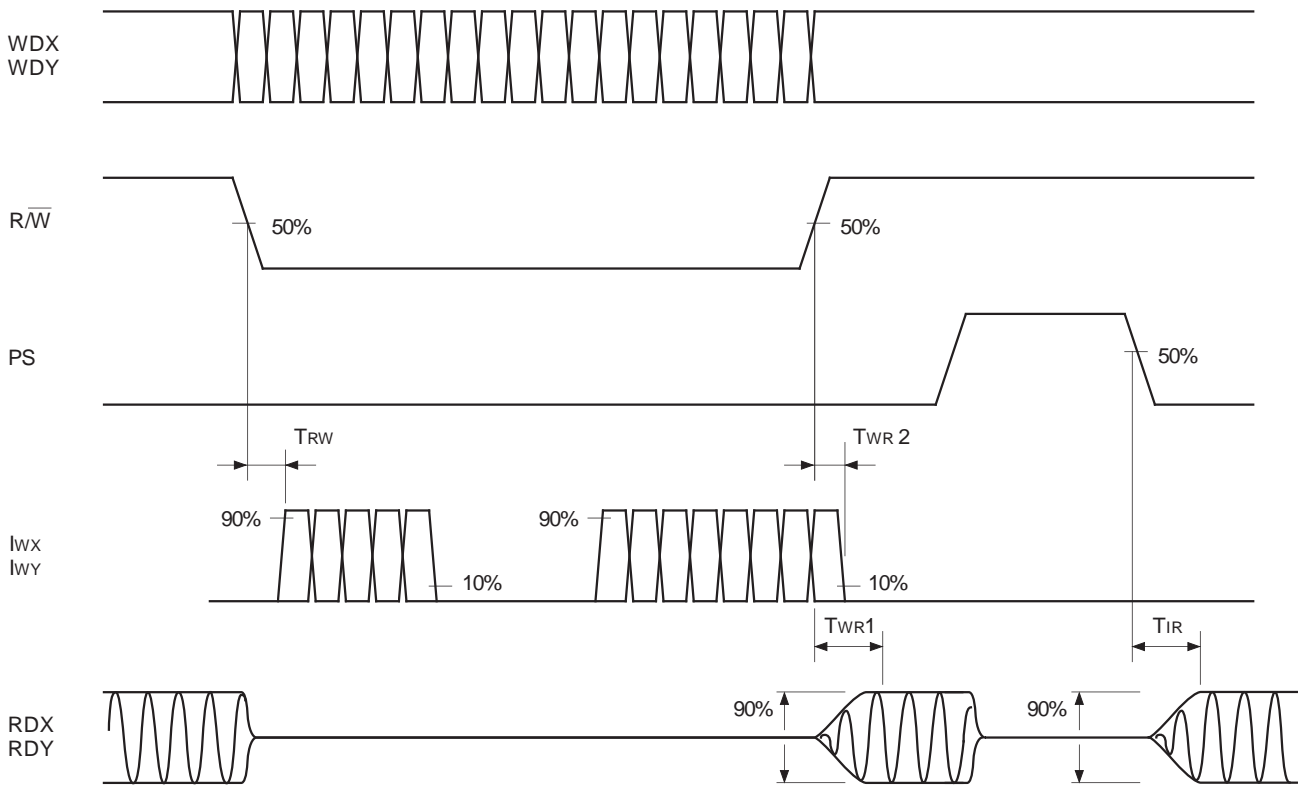


Fig. 3

Timing Chart 2

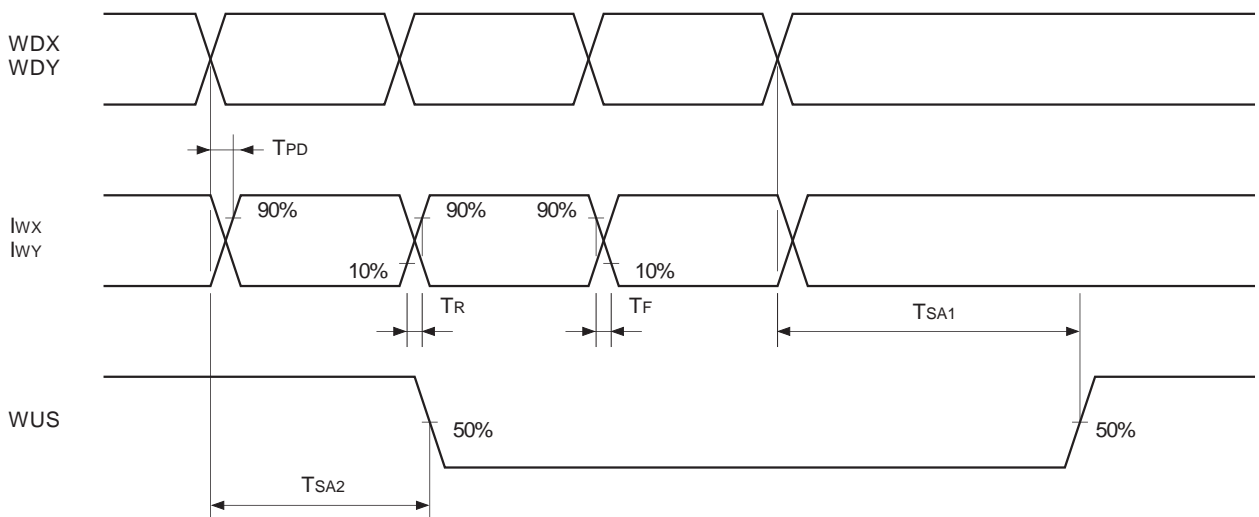


Fig. 4

## Description of Functions

### Read amplifier

This is a low noise amplifier for amplifying the signals from the heads with an emitter follower output.

The RDX and RDY are the outputs of the differential amplifier, the X side of the head input and RDX pin and the Y side of the head inputs and RDY pin have the same polarity.

### Write circuit

The Write data input to WDX pin and WDY pin passes through the buffer amp. It drives the Write switch circuit which supplies the Write current to the heads.

The Write current flows into the X side when WDX is "Low" and WDY is "High".

## Mode control

The mode are set as shown Table 1 by  $\overline{R/W}$  and WUS/SE.

$\overline{CS}$	$\overline{R/W}$	WUS/SE	Mode
L	L	X	Write
L	H	X	Read
L	L	**	Servo Write
H	X	X	Power Save

Table 1. Mode selection

### Servo write mode \*\*

This mode allows for writing to multiple channels at once. In this mode the write driver will drive all channels simultaneously.

To enable servo write mode follow these steps:

- (1) Place the device in the Read mode.
- (2) Set WUS/SE to  $V_{SEH}$  volts, or input  $I_{SEH}$  to WUS/SE.
- (3) Initiate the write operation by setting  $\overline{R/W}$  Low.

### Write unsafe detection circuit

This circuit detects write errors.

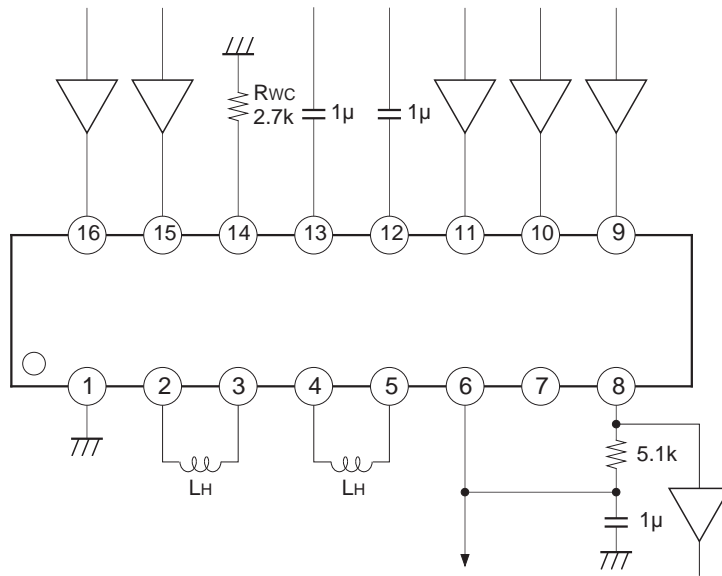
In normal Write mode, the WUS output is low; in the conditions listed below, it is high.

- Head input is open (under the condition which  $R_H = \infty$  and Write data frequency is  $\leq 10$  MHz)
- Head input is shorted to GND or  $V_{CC}$ .
- Write data frequency is abnormally low.
- No Write current.
- In read mode.
- Supply voltage is abnormal (see "power supply ON/OFF detection").

### Power supply ON/OFF detection

This circuit monitors  $V_{CC}$  to detect erroneous Writes. The error status is established when  $V_{CC}$  falls below the threshold voltage ( $V_{TH}$ ) of the power supply ON/OFF detector, in which case the recording and playback functions are prohibited. When  $V_{CC}$  rises above,  $V_{TH}$ , the prohibition of these functions is released.

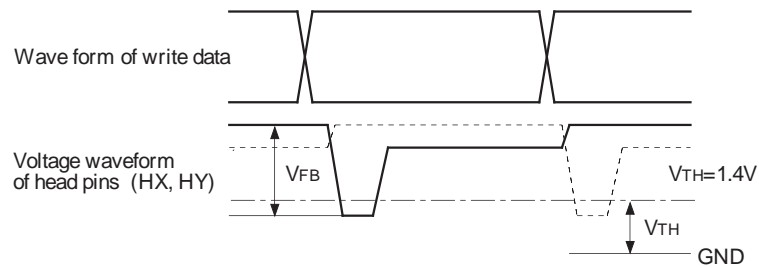
Application Circuit



Application circuits shown are typical examples illustrating the operation of the devices. Sony cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party patent and other right due to same.

**Notes on operation**

- This device handles high frequency and high gain signals. Please note the following;
  - ◆ Connect  $V_{CC}$  decoupling capacitor of approximately 1000 pF near the device.
  - ◆ Make the GND area as large as possible.
- The WC pin is a constant voltage pin. When noise affects this pin, it creates noise in Write current. Therefore, locate  $R_{wc}$  as close to the device as possible.
- Write unsafe detection circuit  
This circuit uses the voltage waveforms of the head pins for detection.



- ◆  $V_{FB}$  must be more than 2 V. When  $V_{FB} < 2 V$ , it is possible that Write unsafe detection maximum frequency becomes more than 1 MHz.
- ◆ The normal operating area of write unsafe detection circuit is changed by head inductance, head DC resistance, write current and other.

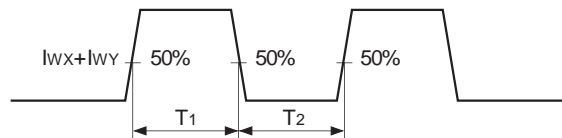
**Application Notes**

Use the following characteristics for reference

V<sub>CC</sub>=5 V, T<sub>a</sub>=25 °C

Item		Symbol	Condition	Min.	Typ.	Max.	Unit
Write mode	Differential output capacitance	C <sub>O</sub>	Between head input pins		4.5	6	pF
	Differential output resistance	R <sub>D</sub>		250	380	490	Ω
Read mode	Differential input capacitance	C <sub>I</sub>	Between head input pins f=5MHz		6	10	pF
	Differential input resistance	R <sub>I</sub>		0.4	1.2		kΩ
	Output resistance	R <sub>RD</sub>	RDX or RDY, f=5MHz		45	60	Ω
Unselected head differential current at write mode		I <sub>US</sub>	L <sub>H</sub> =2 μH, R <sub>H</sub> =30 Ω I <sub>W</sub> =15 mA			0.2	mAp-p
Write current symmetry		T <sub>ASY</sub>	L <sub>H</sub> =0 μH, R <sub>H</sub> =0 Ω I <sub>W</sub> =15 mA	-0.5		0.5	ns

\*T<sub>AS</sub>=T<sub>1</sub>-T<sub>2</sub>



**Setting of Write current**

Write current can be set with resistor R<sub>wc</sub> (kΩ) at Pin 14.

I<sub>w</sub>=K/R<sub>wc</sub> (mA) Refer to Fig. 5.

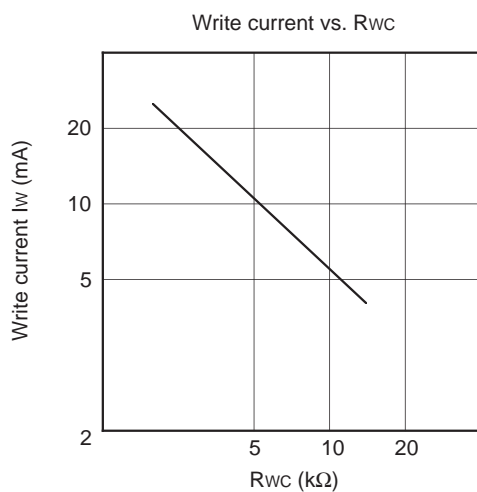


Fig. 5

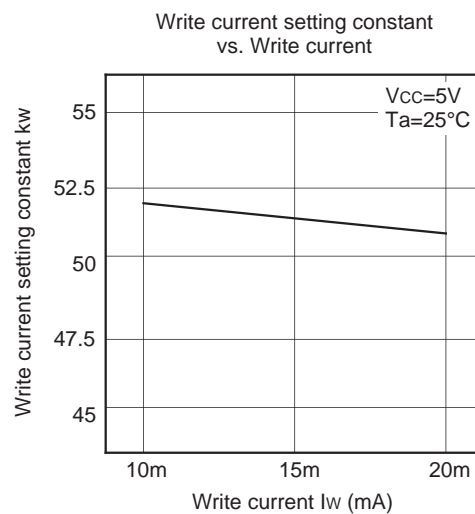
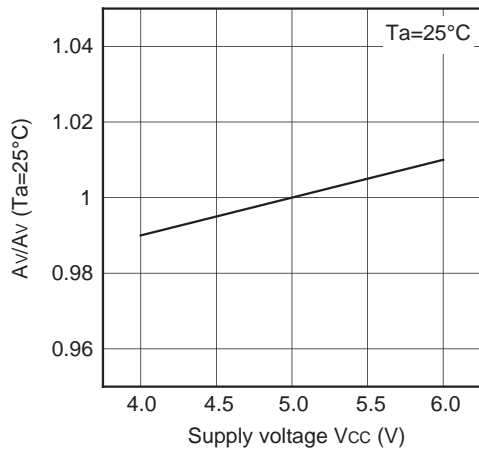
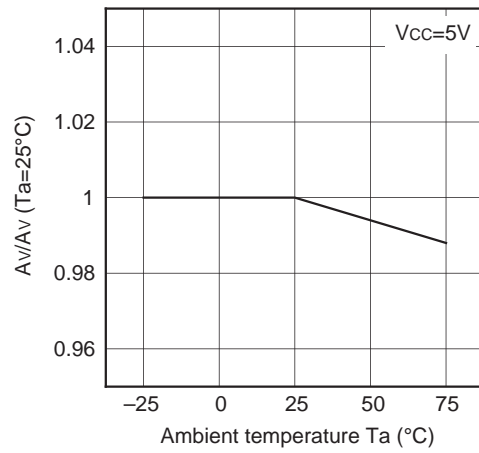


Fig. 6

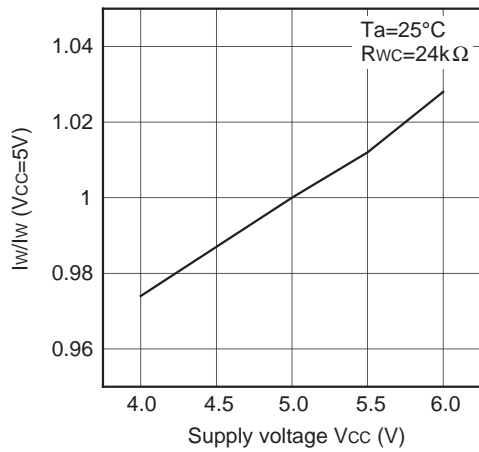
Normalized read amplifier voltage gain vs. Supply voltage



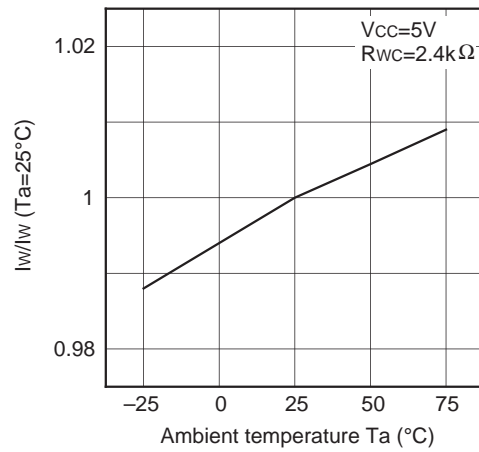
Normalized read amplifier voltage gain vs. Ambient temperature



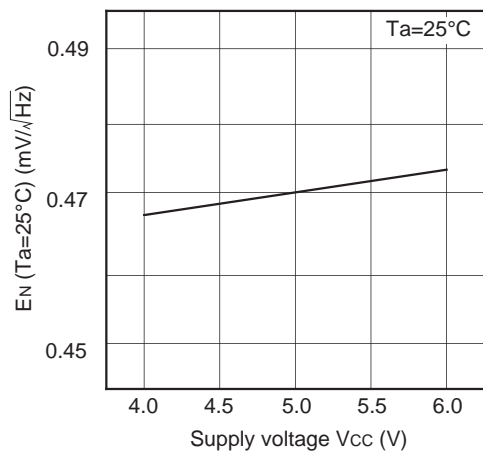
Normalized write current vs. Supply voltage



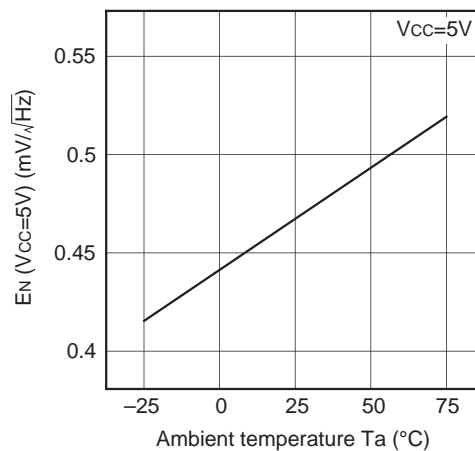
Normalized write current vs. Ambient temperature



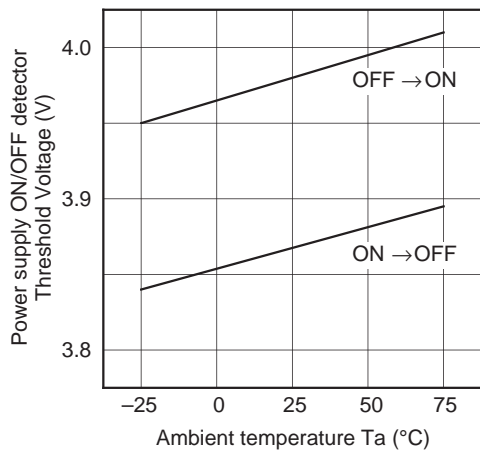
Input referred noise voltage vs. Supply voltage



Input referred noise voltage vs. Ambient temperature

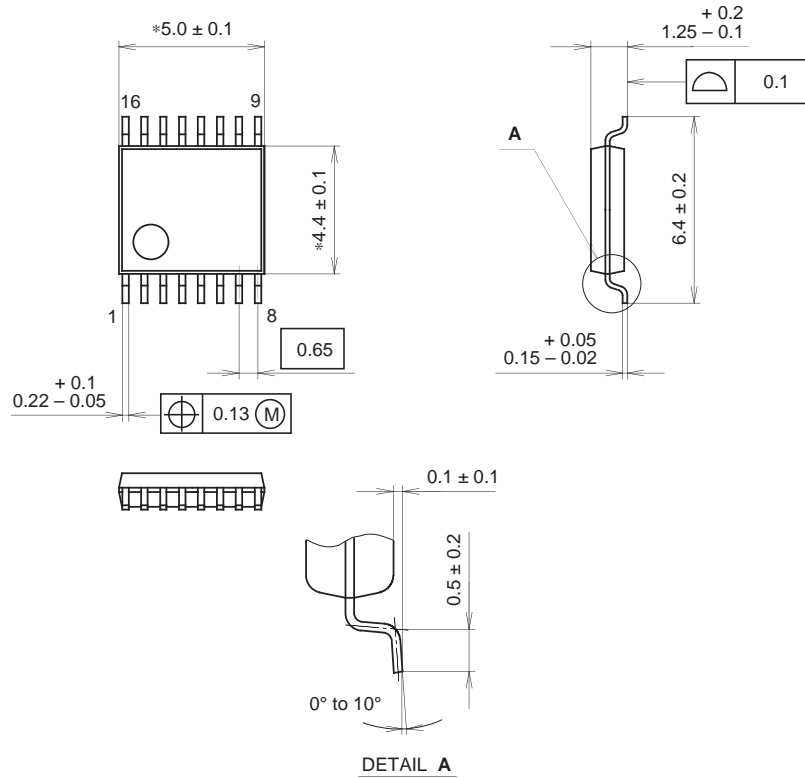


Power supply ON/OFF detector threshold voltage vs. Ambient temperature



Package Outline Unit : mm

16PIN SSOP (PLASTIC)



NOTE: Dimension "\*" does not include mold protrusion.

PACKAGE STRUCTURE

SONY CODE	SSOP-16P-L01
EIAJ CODE	SSOP016-P-0044
JEDEC CODE	_____

PACKAGE MATERIAL	EPOXY RESIN
LEAD TREATMENT	SOLDER / PALLADIUM PLATING
LEAD MATERIAL	42/COPPER ALLOY
PACKAGE MASS	0.1g

NOTE : PALLADIUM PLATING  
 This product uses S-PdPPF (Sony Spec.-Palladium Pre-Plated Lead Frame).