

## 4ch. Read/Write Amplifier for Thin Film Head of Hard Disk Drive

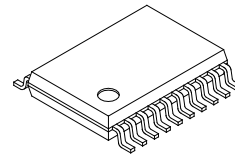
### Description

The CXA1940N is a Read/Write Amplifier for the thin film head of hard disk drives and designed to handle up to 4-channel heads.

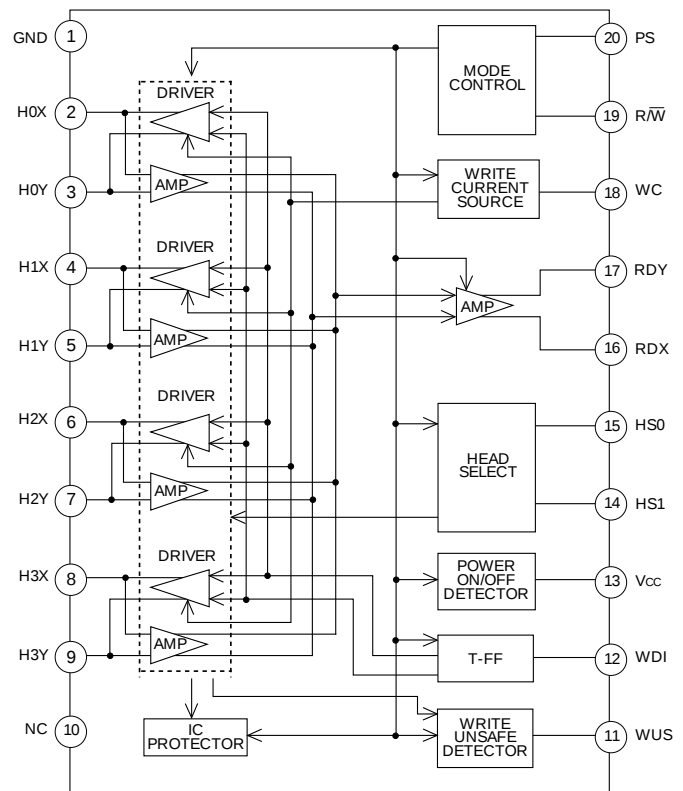
### Features

- Operate on single +5V power supply.
- Low power consumption.  
Read : 95mW  
Write ( $I_w=20\text{mA}$ ) :  $130\text{mW}+I_w \times 5$   
Power save : 5.5mW
- Write current can be varied through an external resistor. Built-in stabilizing circuit provides stable current during voltage and temperature drift.
- Drives up to 4 heads.
- Designed for two-terminal thin-film or MIG heads.
- Built-in power save function.
- Read amplifier emitter follower output featuring 290 times gain (Typ.).
- Built-in Write unsafe detection circuit.
- Built-in supply voltage monitor circuit prohibits incorrect Write during power on or abnormal voltage.
- Built-in IC protection circuit for short of head and GND.
- Differential input capacitance for Read : 14pF (Typ.).
- Write data input minimum pulse width : 10ns
- Read data output become high impedance in write mode to improve read data offset when switching from write to read mode.
- Unselected head DC voltage is GND potential.
- Self switching damping resistance ( $R_D=310\Omega$ )

20 pin SSOP (Plastic)



### Block Diagram and Pin Configuration



**Structure**

Bipolar silicon monolithic IC

**Function**

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

**Absolute Maximum Rating (Ta=25°C)**

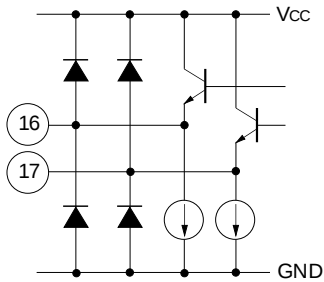
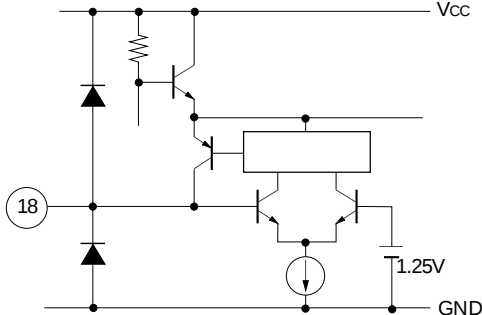
|                               |                  |             |       |
|-------------------------------|------------------|-------------|-------|
| • Supply voltage              | V <sub>CC</sub>  | 7           | V     |
| • Write current               | I <sub>w</sub>   | 25          | mAo-p |
| • Operating temperature       | T <sub>opr</sub> | −20 to +75  | °C    |
| • Storage temperature         | T <sub>stg</sub> | −55 to +150 | °C    |
| • Allowable power dissipation | P <sub>D</sub>   | 375         | mW    |

**Recommended Operating Conditions**

|                  |                 |         |       |
|------------------|-----------------|---------|-------|
| • Supply voltage | V <sub>CC</sub> | 5V±10   | %     |
| • Write current  | I <sub>w</sub>  | 5 to 20 | mAo-p |

Pin Description

| No.                                  | Symbol                                               | Equivalent circuit | Description                                                                                                           |
|--------------------------------------|------------------------------------------------------|--------------------|-----------------------------------------------------------------------------------------------------------------------|
| 1                                    | GND                                                  |                    |                                                                                                                       |
| 2<br>3<br>4<br>5<br>6<br>7<br>8<br>9 | H0X<br>H0Y<br>H1X<br>H1Y<br>H2X<br>H2Y<br>H3X<br>H3Y |                    | Head.<br>4 channels provided.                                                                                         |
| 10                                   | NC                                                   |                    |                                                                                                                       |
| 11                                   | WUS                                                  |                    | Write unsafe detection output.<br>Open collector output. When it is off in Write mode, it means an error is detected. |
| 12                                   | WDI                                                  |                    | Write data input.<br>At "High" → "Low",<br>input is triggered.                                                        |
| 13                                   | Vcc                                                  |                    | 5V power supply                                                                                                       |
| 14<br>15                             | HS1<br>HS0                                           |                    | Head select signal input.<br>Selects one of 4 heads according to Table 2.                                             |
| 19                                   | R/W                                                  |                    | Read/Write signal input.<br>At "High": Read,<br>at "Low": Write.                                                      |
| 20                                   | PS                                                   |                    | Power save signal input.<br>At "High": Power save.                                                                    |

| No.      | Symbol     | Equivalent circuit                                                                | Description                                                                           |
|----------|------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 16<br>17 | RDX<br>RDY |  | Read Amplifier output.                                                                |
| 18       | WC         |  | A setting resistor for the write current value is connected between this pin and GND. |

## Electrical Characteristics

(Unless otherwise specified, V<sub>CC</sub>=5V, T<sub>a</sub>=25°C, Write current I<sub>w</sub>=20mA)

| No. | Item                                           | Sym-<br>bol      | SW Conditions |   |   |   |   |   |   |   |   |    |    |    | Measurement conditions                                                                                                                                                                                                                                                                 | Min.                  | Typ.                  | Max.                  | Unit              |
|-----|------------------------------------------------|------------------|---------------|---|---|---|---|---|---|---|---|----|----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|-----------------------|-------------------|
|     |                                                |                  | 1             | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |                                                                                                                                                                                                                                                                                        |                       |                       |                       |                   |
| 1-1 | Current consumption for Read                   | I <sub>R</sub>   | b             | a | a | a | a | b | a | a | a | a  | b  | a  | Test point : I <sub>4</sub>                                                                                                                                                                                                                                                            | 12                    | 19                    | 26                    | mA                |
| 1-2 | Current consumption for Write                  | I <sub>w</sub>   | b             | a | a | a | a | b | a | a | a | a  | a  | a  | Test point : I <sub>4</sub>                                                                                                                                                                                                                                                            | 17<br>+I <sub>w</sub> | 26<br>+I <sub>w</sub> | 35<br>+I <sub>w</sub> | mA                |
| 1-3 | Current consumption for Power save             | I <sub>P</sub>   | b             | a | a | a | a | b | a | a | a | a  | b  | b  | Test point : I <sub>4</sub>                                                                                                                                                                                                                                                            | 0.6                   | 1.1                   | 1.5                   | mA                |
| 2-1 | Digital input "Low" input voltage              | V <sub>IL</sub>  |               |   |   |   |   |   |   |   |   |    |    |    | Digital input :<br>Pins 12, 14, 15, 19, 20                                                                                                                                                                                                                                             |                       |                       | 0.8                   | V                 |
| 2-2 | Digital input "High" input voltage             | V <sub>IH</sub>  |               |   |   |   |   |   |   |   |   |    |    |    |                                                                                                                                                                                                                                                                                        | 2.0                   |                       |                       | V                 |
| 2-3 | Digital input "Low" input current              | I <sub>IL</sub>  | a             | a | a | a | a | a | a | a | a | a  | a  | a  | "High" applied voltage : 5V<br>"Low" applied voltage : 0V                                                                                                                                                                                                                              | -20                   |                       |                       | μA                |
| 2-4 | Digital input "High" input current             | I <sub>IH</sub>  | a             | a | a | a | a | b | a | b | b | a  | b  | b  | Test point : I <sub>3</sub> , I <sub>5</sub> , I <sub>6</sub> , I <sub>7</sub> , I <sub>8</sub>                                                                                                                                                                                        |                       |                       | 70                    | μA                |
| 3-1 | Write unsafe output saturation voltage         | V <sub>WUS</sub> | b             | a | a | a | b | c | a | a | a | a  | a  | a  | Output current : 1mA<br>Test point : V <sub>1</sub>                                                                                                                                                                                                                                    |                       |                       | 0.5                   | V                 |
| 3-2 | Write unsafe output leak current               | I <sub>WUS</sub> | b             | a | a | a | e | c | a | a | a | a  | a  | a  | Test point : I <sub>2</sub>                                                                                                                                                                                                                                                            |                       |                       | 20                    | μA                |
| 4   | Supply power ON/OFF detector threshold voltage | V <sub>TH</sub>  | b             | a | a | a | a | b | a | a | a | a  | a  | a  | When V <sub>CC</sub> is lowered from 5V in Write mode and I <sub>w</sub> does not flow anymore, V <sub>CC</sub> voltage is set to V <sub>THOFF</sub> . When V <sub>CC</sub> is raised from 3V and I <sub>w</sub> starts to flow, V <sub>CC</sub> voltage is set to V <sub>THON</sub> . | 3.6                   | 3.9                   | 4.3                   | V                 |
| 5   | Write current setting range                    | I <sub>w</sub>   | b             | a | a | a | a | b | a | a | a | a  | a  | a  |                                                                                                                                                                                                                                                                                        | 5                     |                       | 20                    | mA <sub>o-p</sub> |
| 6   | Write current tolerance                        | ΔI <sub>w</sub>  | b             | a | a | a | a | b | a | a | a | a  | a  | a  |                                                                                                                                                                                                                                                                                        | -8                    |                       | 8                     | %                 |
| 7   | Read amplifier differential voltage gain       | A <sub>v</sub>   | b             | a | a | a | c | b | a | a | a | b  | b  | a  | Input voltage SG1 :<br>1mVp-p, 300kHz<br>Load resistance (RDX, RDY) : 1kΩ<br>Test point : V <sub>4</sub> [Vp-p]<br>$AV = \frac{V_4}{SG1}$                                                                                                                                              | 245                   | 290                   | 335                   | V/V               |
| 8   | Frequency band width (-3dB)                    | BW               | b             | a | a | a | c | b | a | a | a | b  | b  | a  | Frequency at which A <sub>v</sub> lowers by 3dB                                                                                                                                                                                                                                        | 30                    |                       |                       | MHz               |

| No. | Item                                     | Sym-<br>bol | SW Conditions |   |   |   |   |   |   |   |   |    |    |    | Measurement conditions                                                                                                                                                                                                                                                                            | Min. | Typ. | Max. | Unit                   |
|-----|------------------------------------------|-------------|---------------|---|---|---|---|---|---|---|---|----|----|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------------------|
|     |                                          |             | 1             | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |                                                                                                                                                                                                                                                                                                   |      |      |      |                        |
| 9   | Input referred noise                     | EN          | a             | a | a | a | a | b | a | a | a | b  | b  | a  | Head impedance : 0Ω,<br>when the read amplifier<br>output voltage is<br>amplified 100 times and<br>voltage passed though<br>a LPF (low pass filter of<br>cutoff frequency<br>15MHz) is V <sub>N</sub> [Vrms],<br><br>$EN = \frac{V_N}{100 \cdot A_V \cdot \sqrt{15 \times 10^6}}$ Test point : V5 |      | 0.55 | 0.7  | $\frac{nV}{\sqrt{Hz}}$ |
| 10  | Common mode rejection ratio              | CMRR        | b             | a | a | a | d | b | a | a | a | b  | b  | a  | In-phase input voltage<br>SG2 : 100mVp-p, 5MHz<br>When the Read<br>amplifier output is V <sub>CM</sub><br>[mVp-p],<br><br>$CMRR = 20 \log \frac{100}{V_{CM}} + 20 \log A_V$ Test point : V4                                                                                                       | 50   |      |      | dB                     |
| 11  | Power Supply rejection ratio             | PSRR        | a             | a | a | a | a | b | b | a | a | b  | b  | a  | Ripple voltage SG3 :<br>100mVp-p, 5MHz<br>When the Read<br>amplifier output is V <sub>P</sub><br>[mVp-p],<br><br>$PSRR = 20 \log \frac{100}{V_P} + 20 \log A_V$ Test point : V4                                                                                                                   | 50   |      |      | dB                     |
| 12  | Channel separation                       | CS          | a             | b | a | a | c | b | a | a | a | b  | b  | a  | Selected head input<br>voltage : 0mVp-p<br>Unselected head input<br>voltage SG1 : 100mVp-p,<br>5MHz<br>When the Read amplifier<br>output is V <sub>CS</sub> [mVp-p],<br><br>$CS = 20 \log \frac{100}{V_{CS}} + 20 \log A_V$ Test point : V4                                                       | 50   |      |      | dB                     |
| 13  | Read data output offset voltage for Read | VOFFR       | b             | a | a | a | a | b | a | a | a | a  | b  | a  | VOFFR=V <sub>2</sub> -V <sub>3</sub><br>Test point : V <sub>2</sub> , V <sub>3</sub>                                                                                                                                                                                                              | -200 |      | 200  | mV                     |

Unless otherwise specified,  $V_{CC}=5V$ ,  $T_a=25^{\circ}C$ ,  $f_{WD}$  (Write data frequency)=5MHz,  $I_w=20mA$ ,  $L_H$  (Head inductance)= $1\mu H$ ,  $R_H$  (Head DC resistance value)= $30\Omega$

Refer to Fig. 2 to Fig. 4

| No.  | Item                                   | Sym-<br>bol | Measurement conditions                                                                                                                                           | Min. | Typ. | Max. | Unit    |
|------|----------------------------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------|
| 14   | Head differential voltage amplitude    | VSW         | Differential voltage between HX pin and HY pin at switching of Write current                                                                                     | 4.4  | 5.2  |      | Vp-p    |
| 15   | Write unsafe detection max. frequency  | FWUS        | FWUS is the max. Write data frequency when Pin 11 turns "High" in Write mode.                                                                                    |      | 280  | 1000 | kHz     |
| 16-1 | Mode switching time Read to Write      | TRW         | TRW is the time required for Write current to turn to 90% after Pin 19 changes from "High" to "Low".                                                             |      |      | 0.6  | $\mu s$ |
| 16-2 | Mode switching time Write to Read      | TWR         | TWR is the time required for either Write current to decrease to 10% or for the Read amplifier output* to turn to 90% after Pin 19 changes from "Low" to "High". |      |      | 0.6  | $\mu s$ |
| 17-1 | Mode switching time safe to unsafe     | TSA1        | TSA1 is the time required for Pin 11 to turn "High" after the last transition of Write data when Write data is stopped in Write mode.                            | 3    | 7    | 11   | $\mu s$ |
| 17-2 | Mode switching time unsafe to safe     | TSA2        | TSA2 is the time required for Pin 11 to turn "Low" after the first transition of Write in Write mode.                                                            |      |      | 1.0  | $\mu s$ |
| 18   | Mode switching time Power save to Read | TPR         | TPR is the time required for Read amplifier output to turn to 90% after Pin 20 changes from "High" to "Low".                                                     |      |      | 1.0  | $\mu s$ |
| 19   | Head switching time                    | TH          | TH is the time required for the Read amplifier output* to reach 90% when the selected head switched in Read mode.                                                |      |      | 0.6  | $\mu s$ |
| 20   | Write current propagation delay time   | TPD         | TPD is the time required for Write current to reach 90% after the Write data falling edge.<br>$L_H=0\mu H$ , $R_H=0\Omega$                                       |      |      | 30   | ns      |
| 21   | Write current rise/fall time           | TR/TF       | TR is the time required for Write current to reach 90% from 10%; TF is the same time required to reach 10% from 90%. $L_H=0\mu H$ , $R_H=0\Omega$                |      | 5    | 10   | ns      |

\*Read amplifier output 100mVp-p 10MHz

## Test Circuit 1

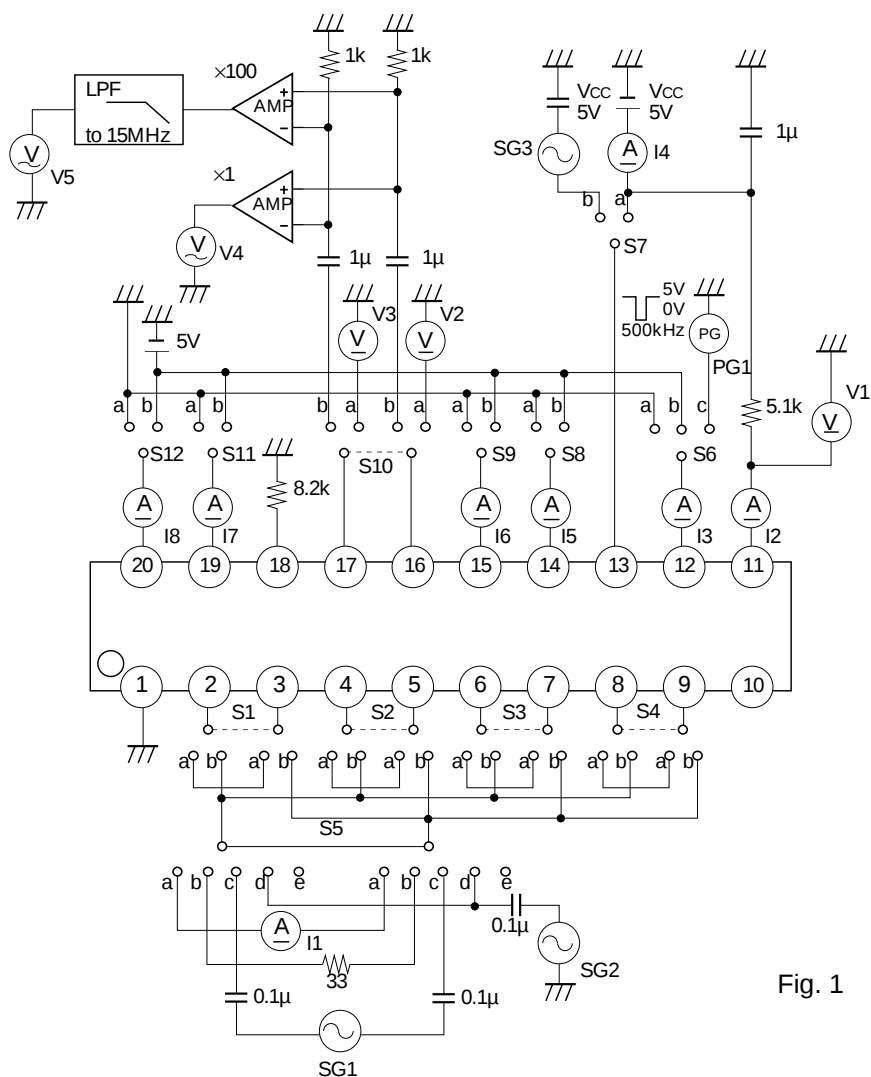


Fig. 1

## Test Circuit 2

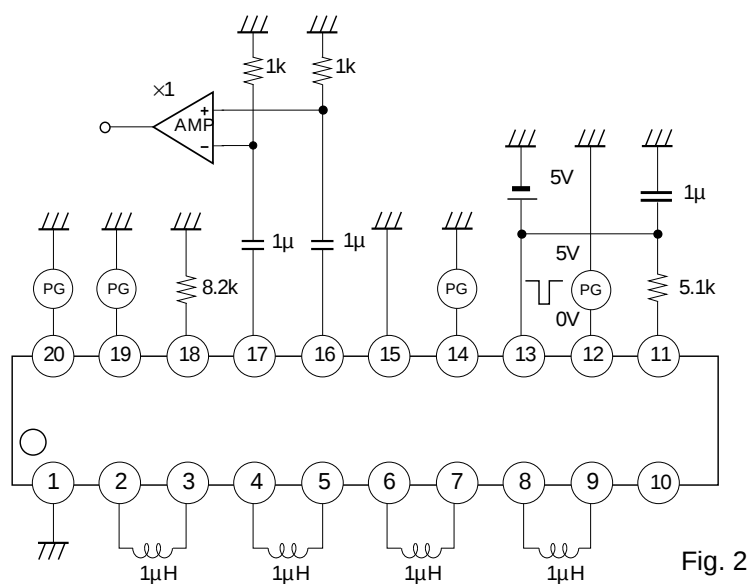


Fig. 2

Note) Write current is measured with current probe. Use an oscilloscope to test items related to time.

Timing Chart 1

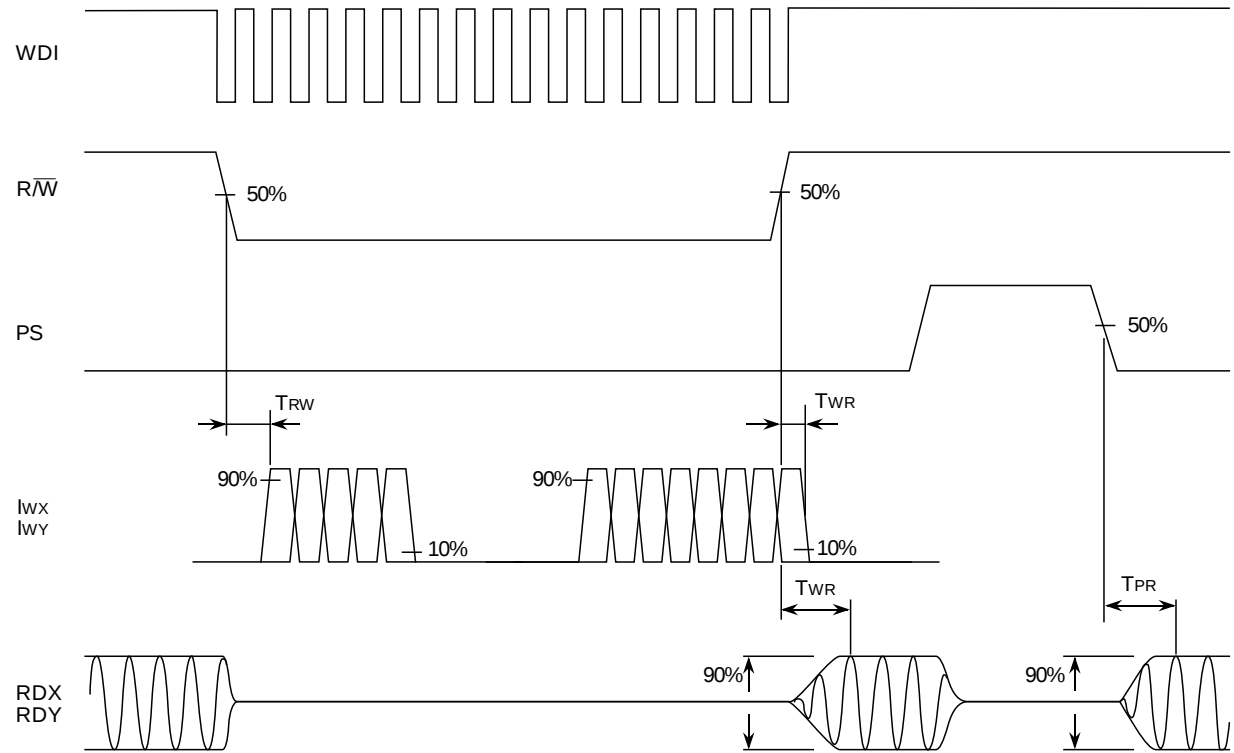


Fig. 3

Timing Chart 2

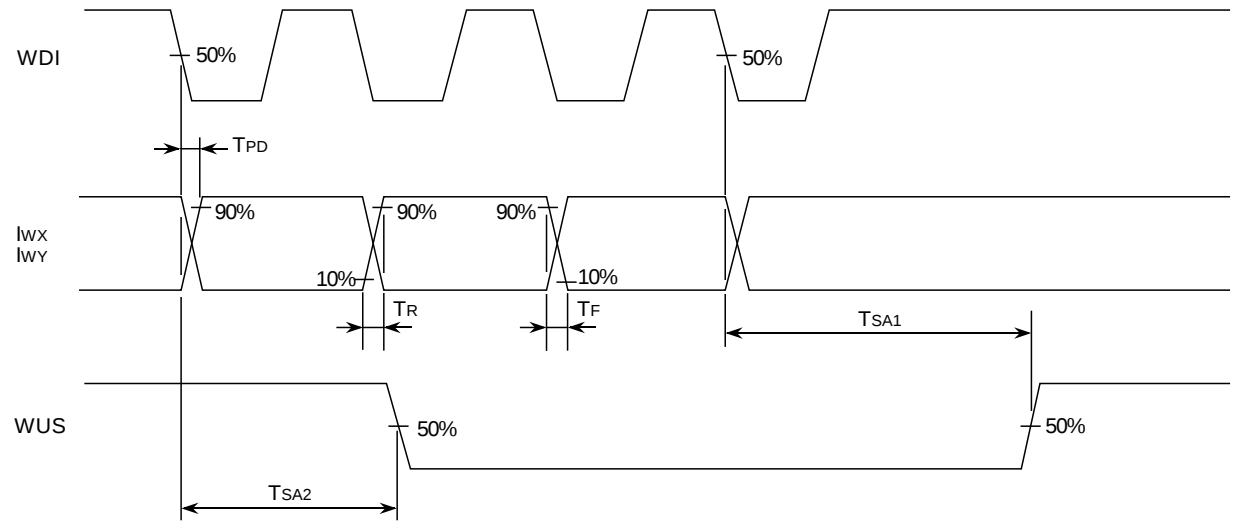


Fig. 4

## Description Functions

### Read amplifier

This is a low noise amplifier amplifying the signals from the head and is an emitter follower output. It outputs to RDX and RDY pins differentially. The head X side and RDX pin, the head Y side and RDY pin have the same polarity. RDX, RDY outputs become high impedance in write mode (when these outputs is AC coupled to the load).

### Write circuit

Write data which is input to WDI pin passes through a T flip-flop and frequency is divided into 1/2. It then drives the Write switch circuit and flows Write current to the head.

Write data is triggered where from “High” to “Low” and Write current is switched.

Write current flows from X side when Read changes to Write.

### Mode control

Modes are set as shown in Table 1 using  $\overline{R/W}$  and PS pins.

| $\overline{R/W}$ | PS | Mode       |
|------------------|----|------------|
| L                | L  | Write      |
| H                | L  | Read       |
| H                | H  | Power save |

Table 1. Mode selection

### Head selection

Heads are selected as shown in Table 2 using HS0 and HS1 pins.

| HS0 | HS1 | Head |
|-----|-----|------|
| L   | L   | 0    |
| H   | L   | 1    |
| L   | H   | 2    |
| H   | H   | 3    |

Table 2. Head selection

#### Write unsafe detection circuit

Abnormal Write mode is detected.

In normal Write mode, WUS output turns to “Low” and in the following other conditions, WUS output turns to “High”.

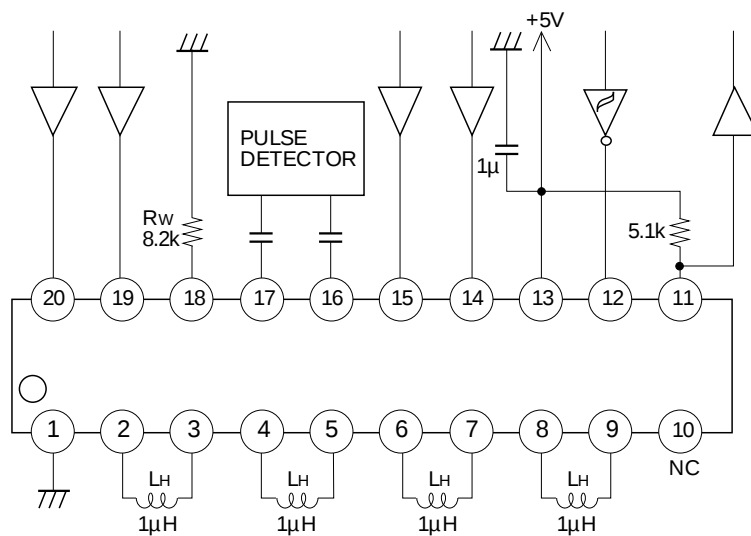
- Head input is open.
- Head input is shorted to GND.
- Write data frequency is abnormally low.
- No write current
- In read
- In power save

#### Power supply ON/OFF detection

Vcc is monitored to avoid incorrecting Write.

Recording and Playback functions are inhibited as detected as abnormal when Vcc decreases below the power supply ON/OFF detector threshold voltage ( $V_{TH}$ ). When Vcc is higher than  $V_{TH}$ , the above inhibition is released.

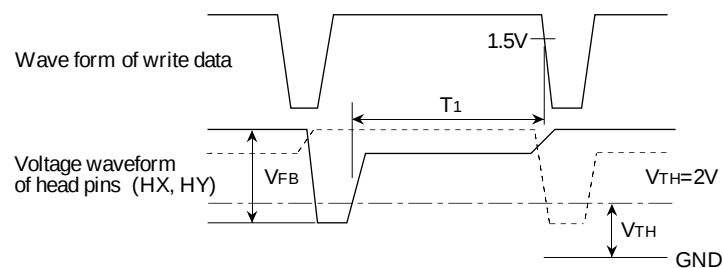
# Application Circuit



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 and other right due to same.

### Notes on operation

- This device handles high frequency and high gain signals. Please note the following;
  - ◆ Connect Vcc decoupling capacitor of approximately 1000pF near the device.
  - ◆ Make the GND area as large as possible.
- When using as 2-channel, short-circuit the X and Y sides of unused head pins or leave them open.
- Write data pulse width  
Set the pulse width to 10ns or more at 1.5V to prevent misoperation.
- The WC pin is a constant voltage pin. When noise affects this pin, it creates noise in Write current. Therefore, locate Rw as close to the device as possible .
- Write unsafe detection circuit  
This circuit uses the voltage waveforms of the head pins for detection.



- ◆ The condition of  $T_1 > 10\text{ns}$  must be met for the WUS detection circuit to operate properly.
- ◆  $V_{FB}$  must be more than 2V. When  $V_{FB} < 2V$ , it is possible that Write unsafe detection maximum frequency becomes more than 1MHz.
- ◆ The normal operating area of write unsafe detection circuit is changed by head inductance, head DC resistance, write current and other.

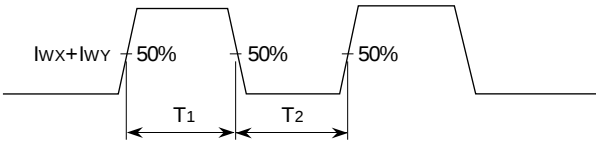
Application Notes

Use the following characteristics for reference.

Vcc=5V, Ta=25°C

| Item                                               |                                 | Sym-<br>bol       | Conditions                                                       | Min. | Typ. | Max. | Unit              |
|----------------------------------------------------|---------------------------------|-------------------|------------------------------------------------------------------|------|------|------|-------------------|
| Write mode                                         | Differential output capacitance | Co                | Between head input pins                                          |      |      | 15   | pF                |
|                                                    | Differential output resistance  | Ro                |                                                                  | 230  | 310  | 390  | Ω                 |
| Read mode                                          | Differential input capacitance  | CI                | Between head input pins<br>f=5MHz                                |      | 14   | 20   | pF                |
|                                                    | Differential input resistance   | RI                |                                                                  | 0.7  | 1.4  |      | kΩ                |
|                                                    | Output resistance               | R <sub>RD</sub>   | RDX or RDY, f=5MHz                                               |      | 40   | 60   | Ω                 |
| Unselected head differential current in Write mode |                                 | I <sub>US</sub>   | L <sub>H</sub> =1μH, R <sub>H</sub> =30Ω<br>I <sub>w</sub> =20mA |      |      | 0.2  | mA <sub>p-p</sub> |
| Write current symmetry                             |                                 | T <sub>AS</sub> * | L <sub>H</sub> =0μH, R <sub>H</sub> =0Ω<br>I <sub>w</sub> =20mA  | -1   |      | 1    | 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>w</sub> (kΩ) at Pin 18.

I<sub>w</sub>=K/R<sub>w</sub> (mA) Refer to Fig. 5 and 6.

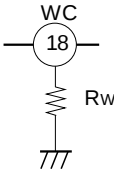


Fig.5 Write current vs. R<sub>w</sub>

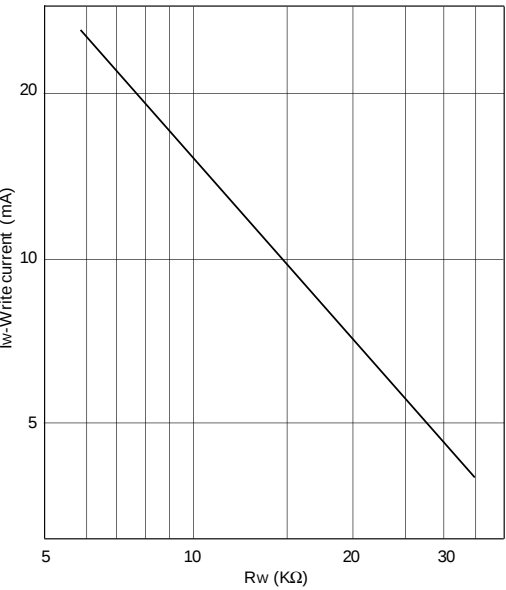


Fig. 6 Write current setting constant vs Write current

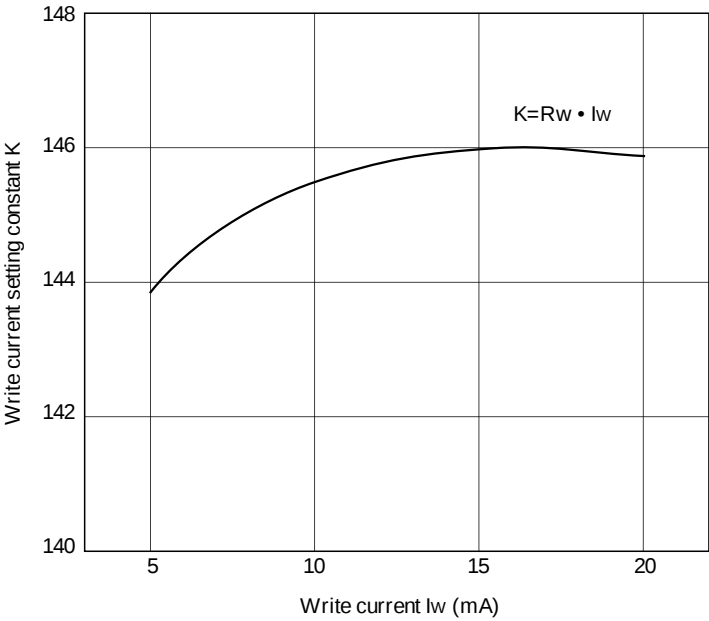


Fig.7 Normalized write current vs Supply voltage

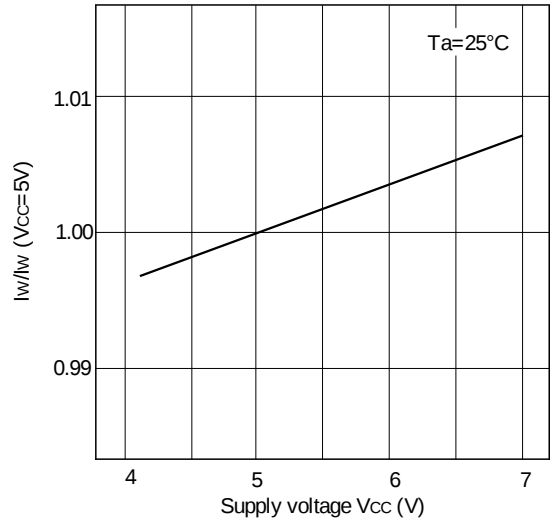


Fig. 8 Normalized write current vs Ambient temperature

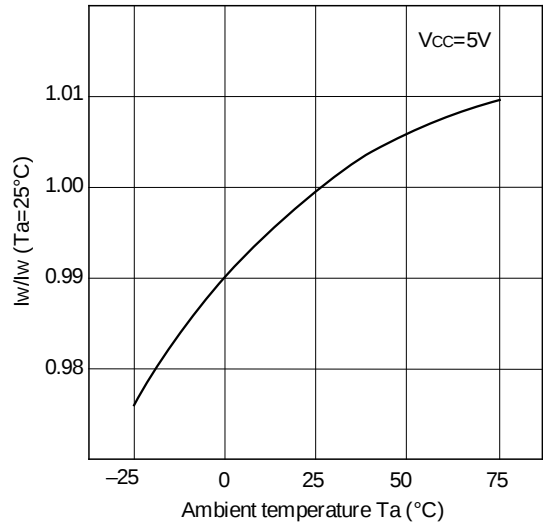


Fig. 9 Normalized read amplifier voltage gain vs Supply voltage

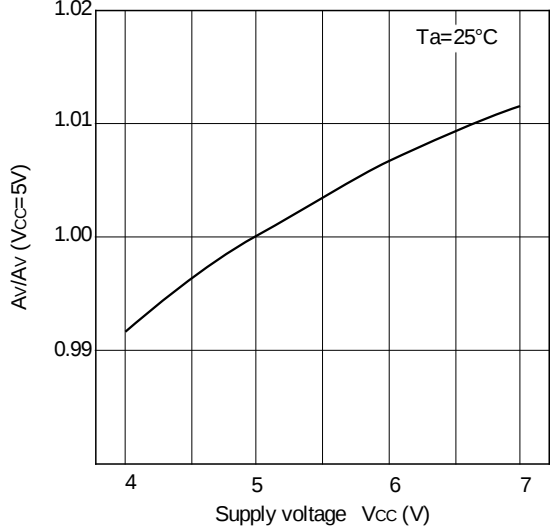


Fig. 10 Normalized read amplifier voltage gain vs Ambient temperature

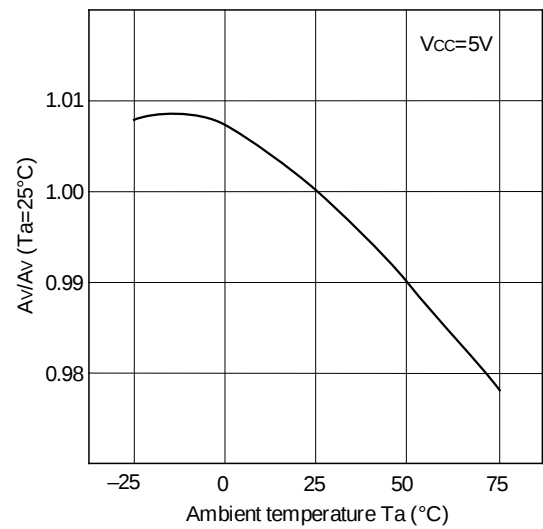
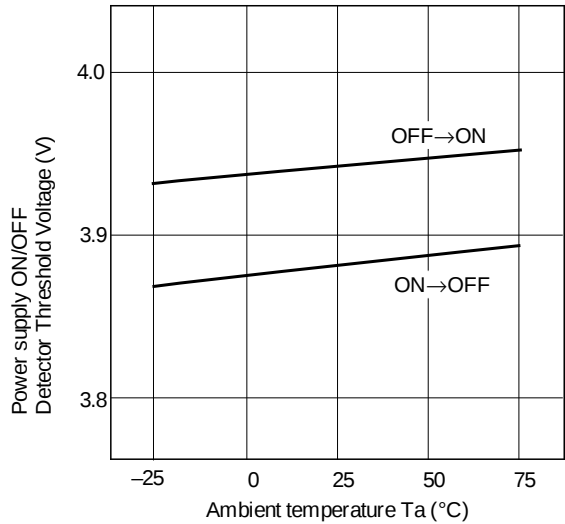
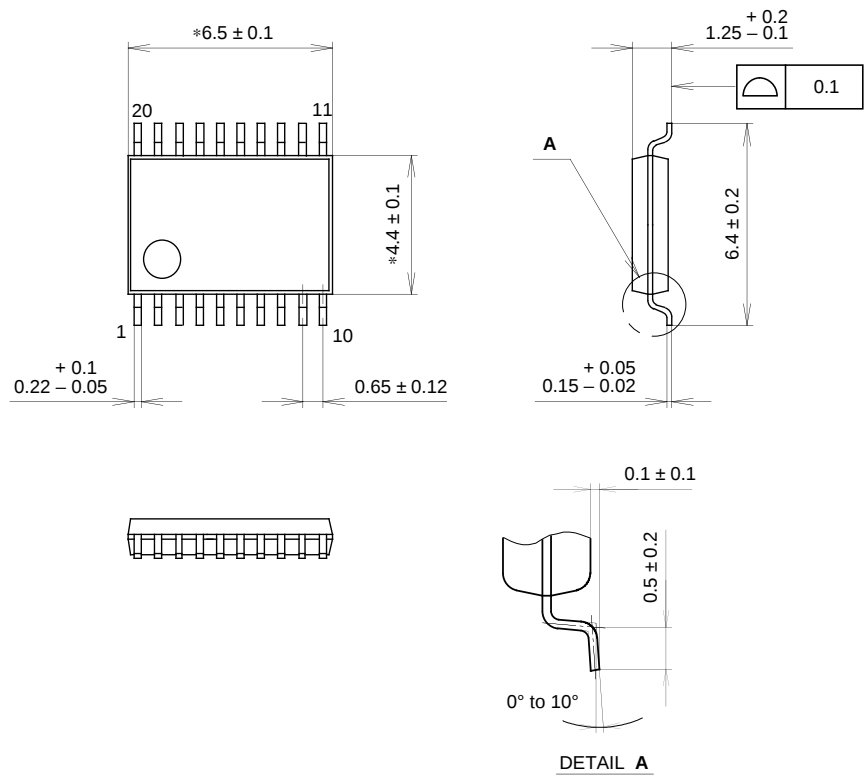


Fig. 11 Power supply ON/OFF detector threshold voltage vs Ambient temperature



Package Outline    Unit : mm

20PIN SSOP (PLASTIC)



NOTE: Dimension “\*” does not include mold protrusion.

PACKAGE STRUCTURE

|            |                |
|------------|----------------|
| SONY CODE  | SSOP-20P-L01   |
| EIAJ CODE  | SSOP020-P-0044 |
| JEDEC CODE | _____          |

|                  |                            |
|------------------|----------------------------|
| PACKAGE MATERIAL | EPOXY RESIN                |
| LEAD TREATMENT   | SOLDER / PALLADIUM PLATING |
| LEAD MATERIAL    | COPPER / 42 ALLOY          |
| PACKAGE WEIGHT   | 0.1g                       |