

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

For the availability of this product, please contact the sales office.

Description

The CXA3510N is a Read/Write Amplifier for the thin film head of hard disk drive and designed to handle up to 4 channel heads.

Features

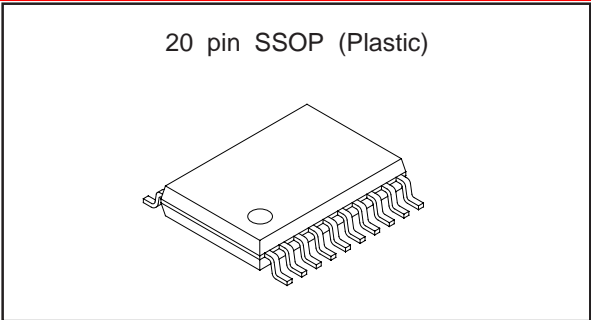
- Operate on single +5 V power supply
- Low power consumption
 - Read : 85 mW
 - Write : 115 mW + $I_w \times 5$
 - Idle : 8 mW
- Designed for two terminal thin-film or MIG heads
- Read amplifier emitter follower output featuring 360 times gain (typ).
- Differential input capacitance for Read : 6pF (typ)
- Input noise : $0.47 \text{ nV} / \sqrt{\text{Hz}}$ (typ)
- Write current range : 5 to 15 mA
- Differential Head voltage swing : 9 Vp-p (typ)
- I_w Rise / Fall times : 3.7 ns (typ)
($L_H=540 \text{ nH}$, $R_H=25 \Omega$, $I_w=10 \text{ mA}$)
- Differential P-ECL write data input
- Built-in write unsafe detection circuit.
- Built-in Servo write function (2/4 ch).
- Built-in IC protection circuit for short of head to GND.
- Read data outputs are high impedance in write mode.
- Unselected head voltage is GND potential.
- Built-in supply voltage monitor circuit prohibits incorrect write during power on or abnormal voltage.
- Self switching damping resistance ($R_D = 360 \Omega$).

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)

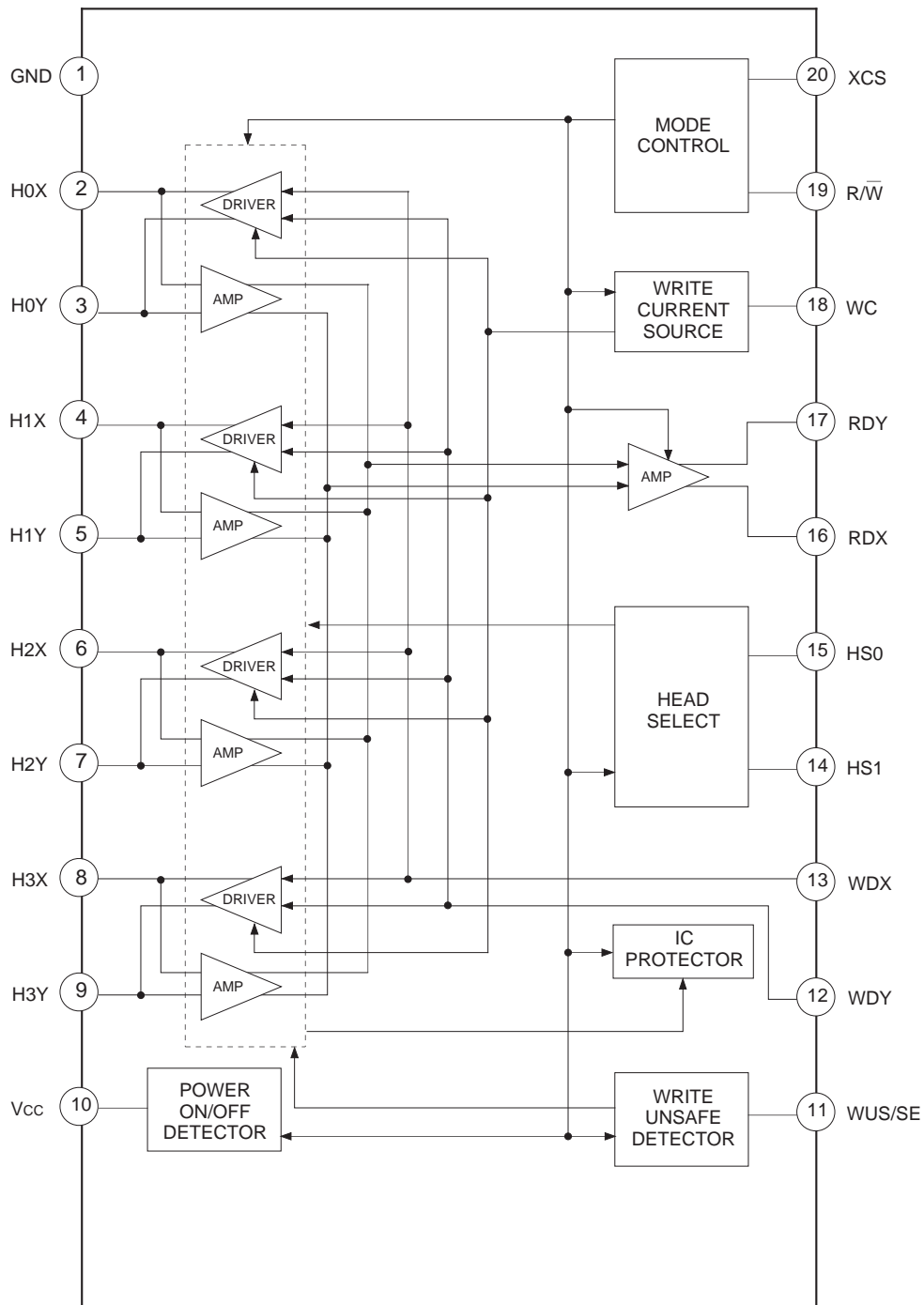
| | | | |
|-------------------------------|-----------|-------------|-------|
| • Supply voltage | V_{CC} | 6 | V |
| • Write current | I_w | 20 | mAo-p |
| • Operating temperature | T_{opr} | -20 to +75 | °C |
| • Storage temperature | T_{stg} | -55 to +150 | °C |
| • Allowable power dissipation | P_D | 620 | mW |
| • WUS/SE pin input current | I_{SEH} | 15 | mA |

Recommended Operating Conditions

| | | | |
|------------------|----------|----------|-------|
| • Supply voltage | V_{CC} | 5.0 V±10 | % |
| • Write current | I_w | 5 to 15 | mAo-p |

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Block Diagram and Pin Configuration



Pin Description

| No. | Symbol | Equivalent circuit | Description |
|--------------------------------------|--|--------------------|---|
| 1 | GND | | |
| 2 3 4 5 6 7 8 9 | H0X H0Y H1X H1Y H2X H2Y H3X H3Y | | Head. 4 channels provided. |
| 10 | Vcc | | 5 V power supply. |
| 11 | WUS/SE | | Write unsafe detection output / Servo Enable signal input. |
| 12 13 | WDY WDX | | Differential P-ECL write data input. |

| No. | Symbol | Equivalent circuit | Description |
|----------|------------|--------------------|---|
| 14 15 | HS1 HS0 | | Head select signal input. Selects one of 4 heads according to Table 2. |
| 16 17 | RDX RDY | | Read Amplifier output. |
| 18 | WC | | A setting resistor for the write current value is connected between this pin and GND. |
| 19 | R/W | | Read/Write signal input At "High" : Read, at "Low" : Write. |
| 20 | XCS | | Power save signal input At "High" : Power saving. |

(Unless otherwise specified, $V_{CC}=5\text{ V}$, $T_a=25\text{ }^\circ\text{C}$, Write current $I_{w}=15\text{ mA}$)
Refer to Fig.1

Electrical Characteristics

| No. | Item | Symbol | SW conditions | | | | | | | | | | | | | | Measurement conditions | Min. | Typ. | Max. | Unit |
|-----|--|-------------|---------------|---|---|---|---|---|---|---|---|----|----|----|----|----|------------------------|--------|-----------|---------------|------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | | | | | |
| 1-1 | Current consumption for Read | I_{CCR} | a | a | a | a | a | a | a | a | a | a | b | a | a | | 11 | 17 | 26 | mA | |
| 1-2 | Current consumption for Write | I_{CCW} | a | a | a | a | a | a | b | a | a | b | a | a | a | | 16 +Iw | 22 +Iw | 36 +Iw | mA | |
| 1-3 | Current consumption for idle | I_{CCI} | a | a | a | a | a | a | b | a | a | b | a | a | b | | 1.0 | 1.6 | 2.3 | mA | |
| 2-1 | Digital input "Low" input voltage | V_{IL} | | | | | | | | | | | | | | | | | 0.8 | V | |
| 2-2 | Digital input "High" input voltage | V_{IH} | | | | | | | | | | | | | | | 2.0 | | | V | |
| 2-3 | Digital input "Low" input current | I_{IL} | a | a | a | a | a | a | b | a | a | b | a | a | a | | -100 | | | μA | |
| 2-4 | Digital input "High" input current | I_{IH} | a | a | a | a | a | a | b | a | b | b | b | b | b | | | 100 | | μA | |
| 2-5 | Write data input "Low" input voltage | V_{WDL} | | | | | | | | | | | | | | | V_{WDH} | | V_{WDH} | V | |
| 2-6 | Write data input "High" input voltage | V_{WDH} | | | | | | | | | | | | | | | V_{CC} | | V_{CC} | V | |
| 2-7 | Write data input current | I_{WD} | a | a | a | a | a | a | b | a | a | b | a | a | a | | | | 50 | μA | |
| 2-8 | Unselected head voltage | V_{unsel} | | | | | | | | | | | | | | | | | 0.3 | V | |
| 3-1 | Write unsafe output saturation voltage | V_{WUS} | b | a | a | a | b | a | c | c | c | c | b | a | a | | | | 0.5 | V | |
| 3-2 | Write unsafe output leak current | I_{WUS} | a | a | a | a | a | a | a | a | b | a | a | a | a | | | | 50 | μA | |

| No. | Item | Symbol | SW conditions | | | | | | | | | | | | | | Measurement conditions | Min. | Typ. | Max. | Unit |
|-----|--|------------------|---------------|---|---|---|---|---|---|---|---|----|----|----|----|----|------------------------|------|----------------------|-------------------|------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | | | | | |
| 4 | Supply power ON/OFF detector threshold voltage | V _{TH} | b | a | a | a | a | b | a | a | b | a | a | b | a | a | 3.4 | 3.9 | 4.3 | V | |
| 5-1 | Write current setting range | I _w | | | | | | | | | | | | | | | 5 | | 15 | mA _{o-p} | |
| 5-2 | Write current voltage | V _{wc} | a | a | a | a | b | a | a | b | a | a | b | a | a | | 2.25 | 2.5 | 2.75 | V | |
| 5-3 | Write current gain | A _w | | | | | | | | | | | | | | | 18 | 20 | 22 | mA/mA | |
| 5-4 | Write current setting constant | K _w | b | a | a | a | b | a | a | b | a | a | b | a | a | | 45 | 50 | 55 | | |
| 6-1 | WUS/SE voltage | V _{SEH} | | | | | | | | | | | | | | | V _{CC} +1.5 | | V _{CC} +1.6 | V | |
| 6-2 | WUS/SE sink current | I _{SEH} | b | a | a | a | b | a | a | b | a | a | b | a | a | | 5 | | 14 | mA | |
| 7 | Read amplifier differential voltage gain | A _v | b | a | a | a | b | a | a | b | a | a | b | a | a | | 305 | 360 | 415 | V/V | |
| 8 | Frequency band width (-3 dB) | BW | b | a | a | a | b | a | a | b | a | a | b | a | a | | 100 | 140 | | MHz | |

| No. | Item | Symbol | SW conditions | | | | | | | | | | | | | | Measurement conditions | Min. | Typ. | Max. | Unit | | | | | | | | |
|-----|---------------------------------|--------|---------------|--------------------------------|------|---|---|---|---|---|---|----|----|----|----|----|------------------------|------|--|--|------|-----|------------------------|---|---|--|----|--|----|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | | | | | | | | | | | | | |
| 9 | Input referred noise | EN | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | Head impedance : 0 Ω, when the read amplifier output voltage is amplified 100 times and voltage passed through a LPF (low pass filter of cutoff frequency 15 MHz) is V_N [Vrms], $EN = \frac{V_N}{100 \cdot AV \sqrt{15 \times 10^6}}$ Test point : V_5 | 0.47 | 0.6 | $\frac{nV}{\sqrt{Hz}}$ | | | | | | |
| | | | b | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | | | | | | | | | | |
| | | | c | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | | | | | a | | | | | |
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| | | | k | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | | | | | a | a | | | | |
| | | | l | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | | | | | a | a | | | | |
| | | | 10 | Common mode rejection ratio | CMRR | b | a | a | a | a | a | a | a | a | a | a | a | a | a | | | | | a | a | In-phase input voltage SG2 : 100 mVp-p, 20 MHz When the Read amplifier output is V_{CM} [mVp-p], $CMRR = 20 \log \frac{100}{V_{CM}} + 20 \log A_V$ Test point : V_4 | 50 | | dB |
| | | | c | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | | | | | a | | | | | |
| d | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | | | | | | | | | | | | |
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| 11 | Power supply rejection ratio | PSRR | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | Ripple voltage SG3 : 100 mVp-p, 20 MHz When the Read amplifier output is V_P [mVp-p], $PSRR = 20 \log \frac{100}{V_P} + 20 \log A_V$ Test point : V_4 | 50 | | dB | | | | | | | |
| b | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | | | | | | | | | | | | |
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| k | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | | | | | | | | | | | | |
| l | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | a | | | | | | | | | | | | |

| No. | Item | Symbol | SW conditions | | | | | | | | | | | | | | Measurement conditions | Min. | Typ. | Max. | Unit | | | |
|-----|--|--------|---------------|---|---|---|---|---|---|---|---|----|----|----|----|----|------------------------|--|-------------|-------------|------|--|--|--|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | | | | | | | | |
| 12 | Channel separation | CS | a | b | a | a | a | c | b | a | a | a | b | a | a | b | a | 50 | | | dB | | | |
| | | | | | | | | | | | | | | | | | | Selected head input voltage : 0 mVp-p Unselected head input voltage SG1 : 100 mVp-p, 20 MHz When the Read amplifier output is Vcs [mVp-p], $CS = 20 \log \frac{100}{V_{cs}}$ +20 log Av Test point : V4 VOFFR = V2-V3 Test point : V2, V3 | | | | | | |
| 13 | Read data output offset voltage for Read | VOFFR | a | a | a | a | e | b | a | a | a | a | b | a | a | b | a | -250 | | 250 | mV | | | |
| 14 | RDX, RDY common mode output voltage difference between modes | Vdiff | a | a | a | a | e | b | a | a | a | b | a | a | a | c | a | -300 | | 300 | mV | | | |
| 15 | RDX, RDY common mode output voltage for Read | VRD | a | a | a | a | e | b | a | a | a | a | b | a | a | b | a | Vcc -2.6 | Vcc -2.3 | Vcc -2.0 | 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 μ H, R_H (Head DC resistance value) =30 Ω

Refer to Fig. 2 to Fig. 4

| No. | Item | Symbol | Measurement conditions | Min. | Typ. | Max. | Unit |
|------|--|-----------|---|------|------|------|---------|
| 14 | Head differential voltage amplitude | V_{SW} | Differential voltage between HX pin and HY pin at switching of Write current | | 9 | | Vp-p |
| 15-1 | Mode switching time Read to Write | T_{RW} | T_{RW} is the time required for Write current to turn to 90 % after Pin 19 changes from "High" to "Low". | | 130 | 150 | ns |
| 15-2 | 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 19 changes from "Low" to "High". | | 180 | 220 | ns |
| | | T_{WR2} | T_{WR2} is the time required for Write current to decrease to 10 % after Pin 19 changes from "Low" to "High". | | 100 | 200 | ns |
| 16 | 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 20 changes from "High" to "Low". | | | 1 | μ s |
| 17-1 | Mode switching time safe to unsafe | T_{SA1} | T_{SA1} 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. | 1.0 | 2.3 | 3.0 | μ s |
| 17-2 | Mode switching time unsafe to safe | T_{SA2} | T_{SA2} is the time required for Pin 11 to turn "Low" after the first transition of Write data in Write mode. | | | 0.6 | μ s |
| 18 | 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 | μ s |
| 19 | 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 |
| 20-1 | 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 %. $L_H=0$ μ H, $R_H=0$ Ω | | 1 | 3 | ns |
| 20-2 | Write current rise/fall time | T_R/T_F | $L_H=540$ nH, $R_H=25$ Ω , $I_w=10$ mA 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 %. | | 3.7 | | ns |

*Read amplifier output 100 mVp-p 10 MHz

Test Circuit 1

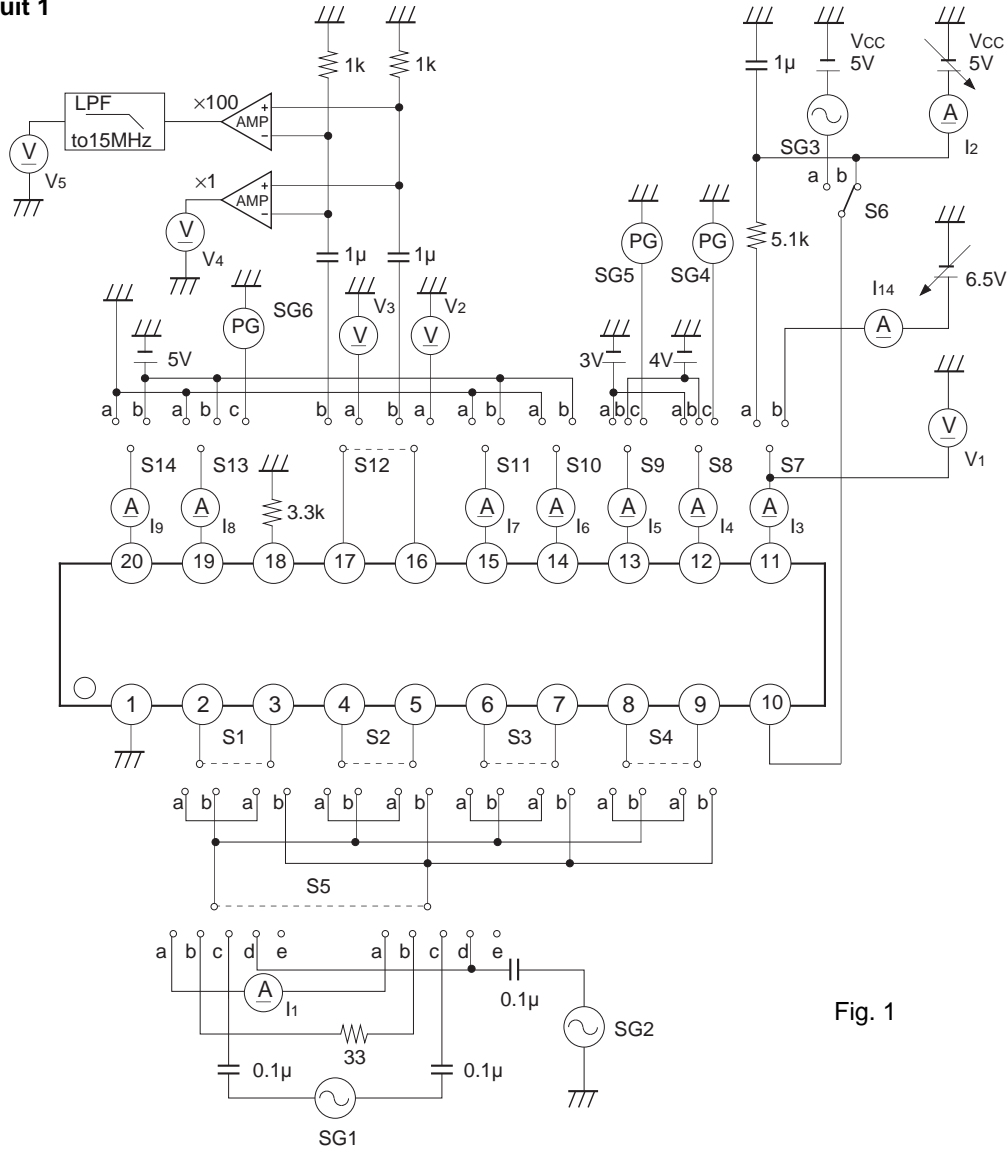


Fig. 1

Test Circuit 2

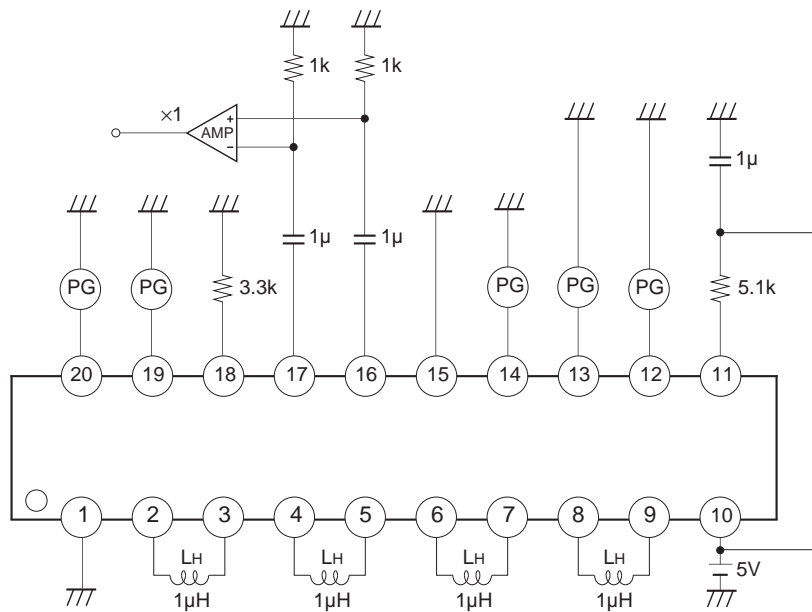


Fig. 2

Timing Chart 1

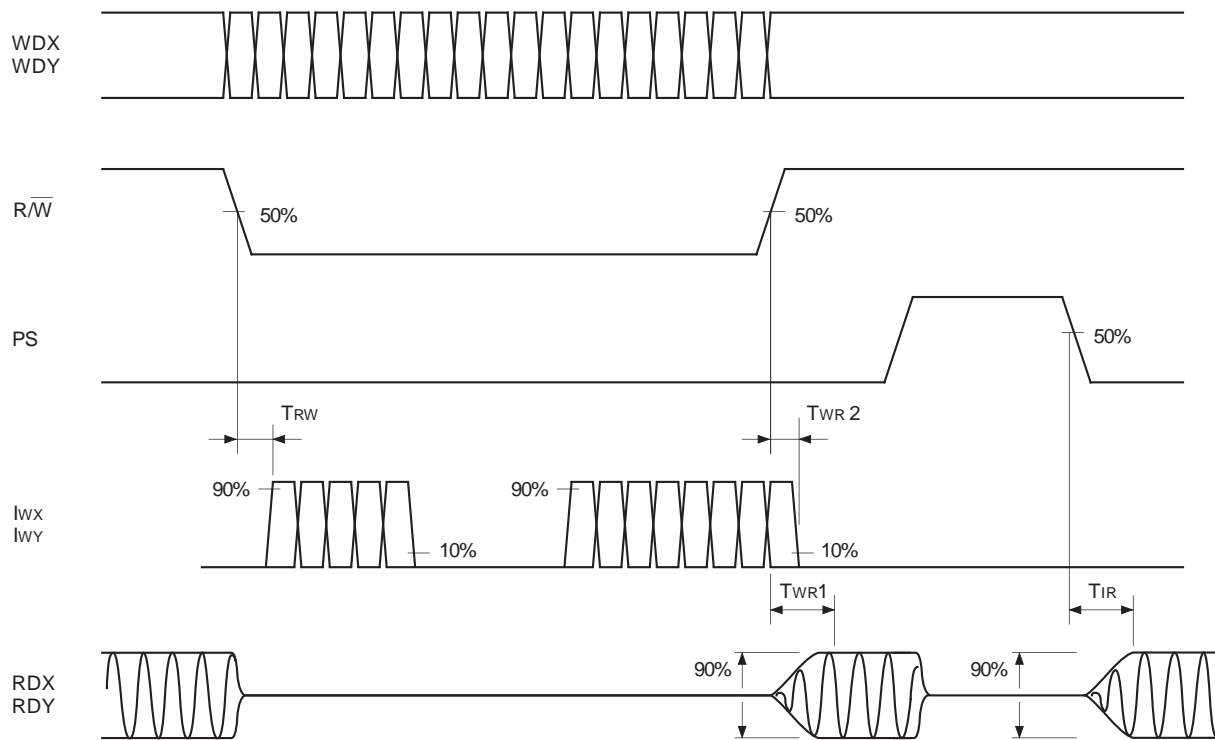


Fig. 3

Timing Chart 2

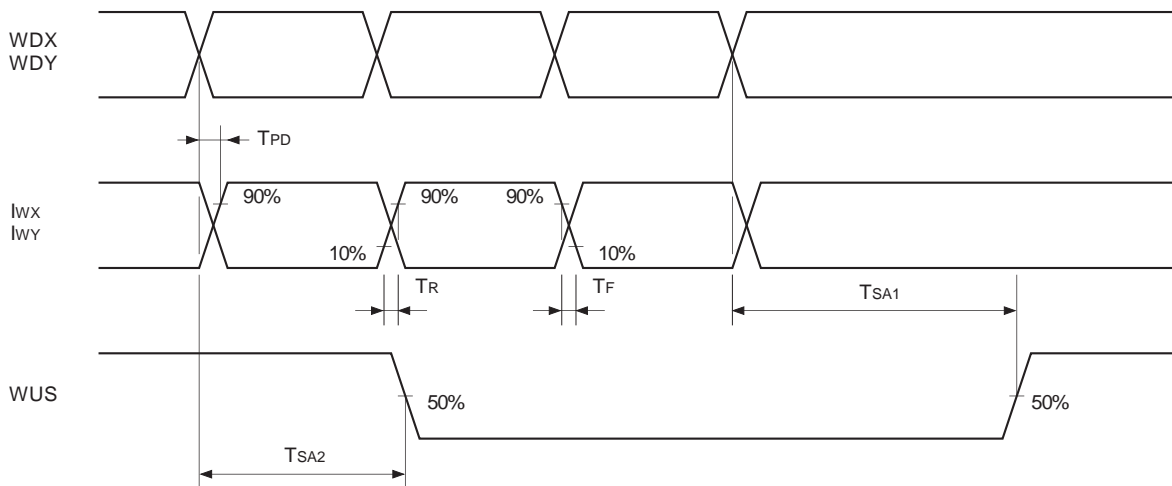


Fig. 4

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 whose polarity between the RDX and X side of the head input is same.

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 XCS, $\overline{R/W}$ and WUS/SE.

| XCS | $\overline{R/W}$ | WUS/SE | HS0 | HS1 | Mode |
|-----|------------------|--------|-------------|-----|--------------|
| L | L | X | See Table 2 | | Write |
| L | H | X | | | Read |
| L | L | ** | See Table 3 | | Servo Write |
| H | X | X | X | X | Power saving |

Table 1. Mode selection

Head selection

The heads are selected as shown in Table 2 by the HS0 and HS1 pins.

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

Table 2. Head selection

Servo write mode **

This mode allows for writing to multiple channels at once.

To enable servo write mode follow these steps:

- (1) Place the device in the Read mode.
- (2) Set HS0 and HS1 following Table 3.
- (3) Set WUS/SE to V_{SEH} , or input I_{SEH} to WUS/SE.
- (4) While maintaing step (2) and (3) above make $\overline{R/W}$ low, placing the device in servo write mode.

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 inputs is open (under the condition which. $RH=\infty$ and Write data frequency is ≤ 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).

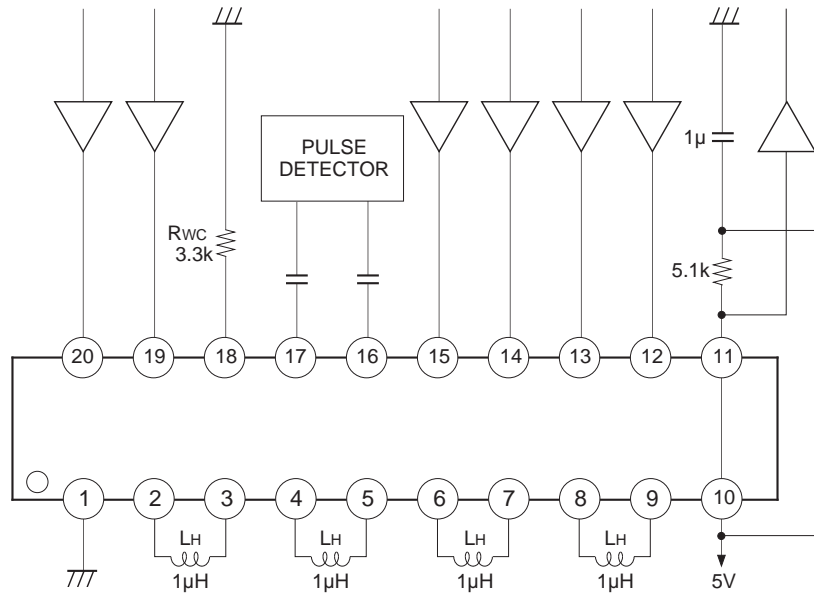
Power supply ON/OFF detection

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.

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

Table 3. Head selection in Servo Write mode

Application Circuit



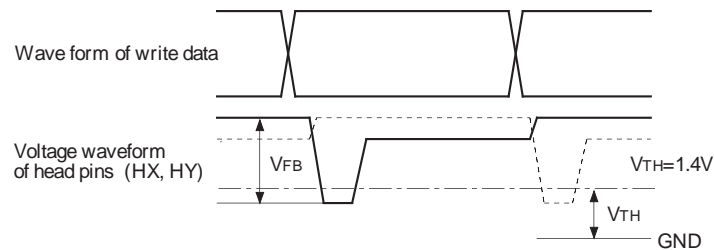
Application circuits shown are typical examples illustrating the operation of the devices. Sony cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party patent and other right due to same.

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.
- When using as 2-channel, short-circuit the X and Y sides of unused head pins or leave them open.
- 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.

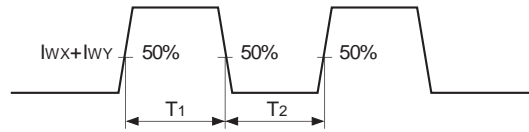
Application Notes

Use the following characteristics for reference.

Vcc=5 V, Ta=25 °C

| Item | | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|--|---------------------------------|-------------------|---|------|------|------|-------|
| Write mode | Differential output capacitance | Co | Between head input pins | | 4.5 | 6 | pF |
| | Differential output resistance | Ro | | 260 | 360 | 470 | Ω |
| Read mode | Differential input capacitance | Cl | Between head input pins f=5 MHz | | 6 | 10 | pF |
| | Differential input resistance | Ri | | 650 | 1500 | 3000 | Ω |
| | Output resistance | R _{RD} | RDX or RDY, f=5 MHz | | | 50 | Ω |
| Unselected head differential current in Write mode | | I _{us} | L _H =1 μH, R _H =30 Ω I _w =15 mA | | | 0.2 | mAp-p |
| Write current symmetry | | T _{AS} * | L _H =0 μH, R _H =0 Ω I _w =15 mA | -0.5 | | 0.5 | ns |

*T_{AS}=T₁-T₂



Setting of Write current

Write current can be set with resistor R_{wc} (kΩ) at Pin 18.

I_w=K/R_{wc} (mA) Refer to Fig. 5.

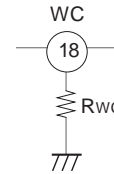


Fig.5 Write current vs. R_{wc}

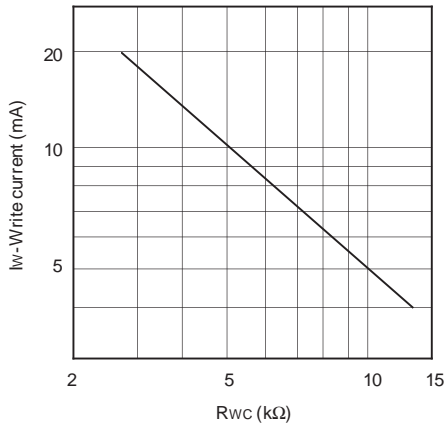
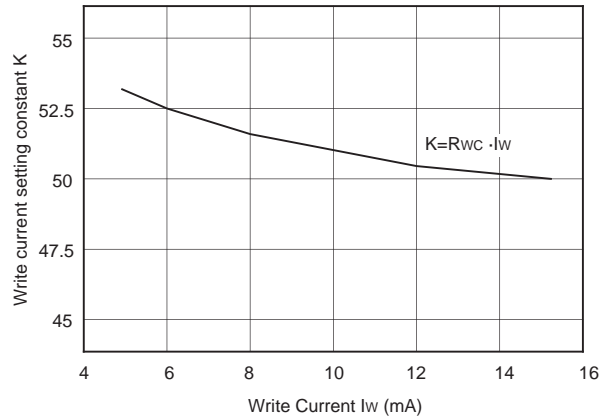
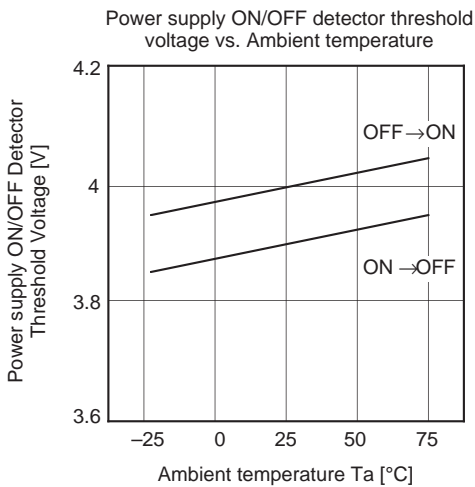
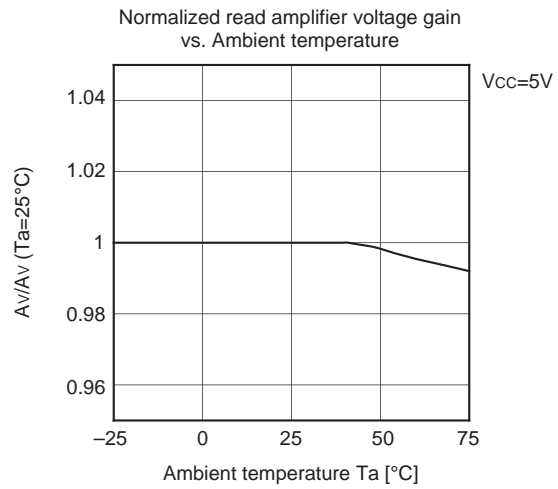
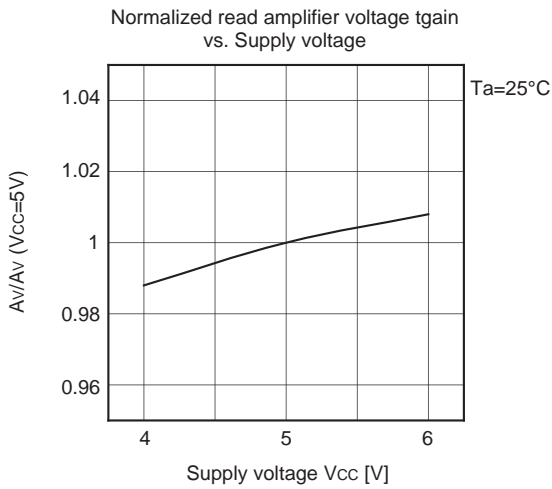
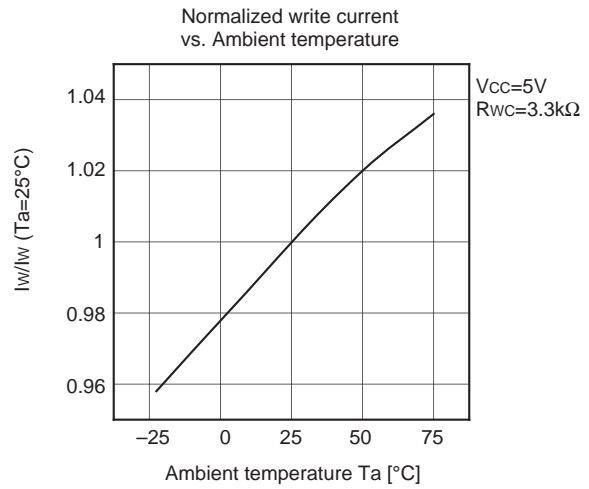
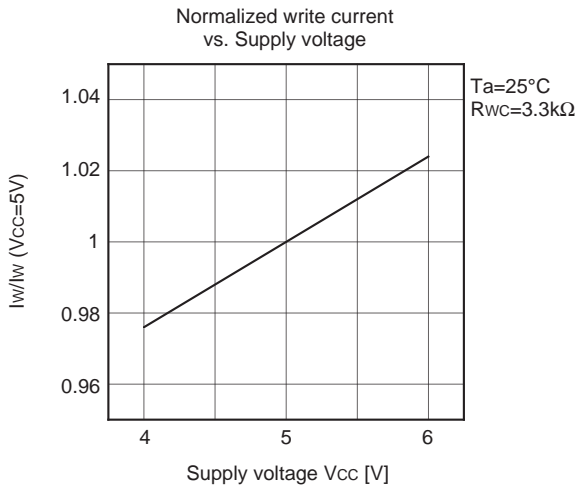


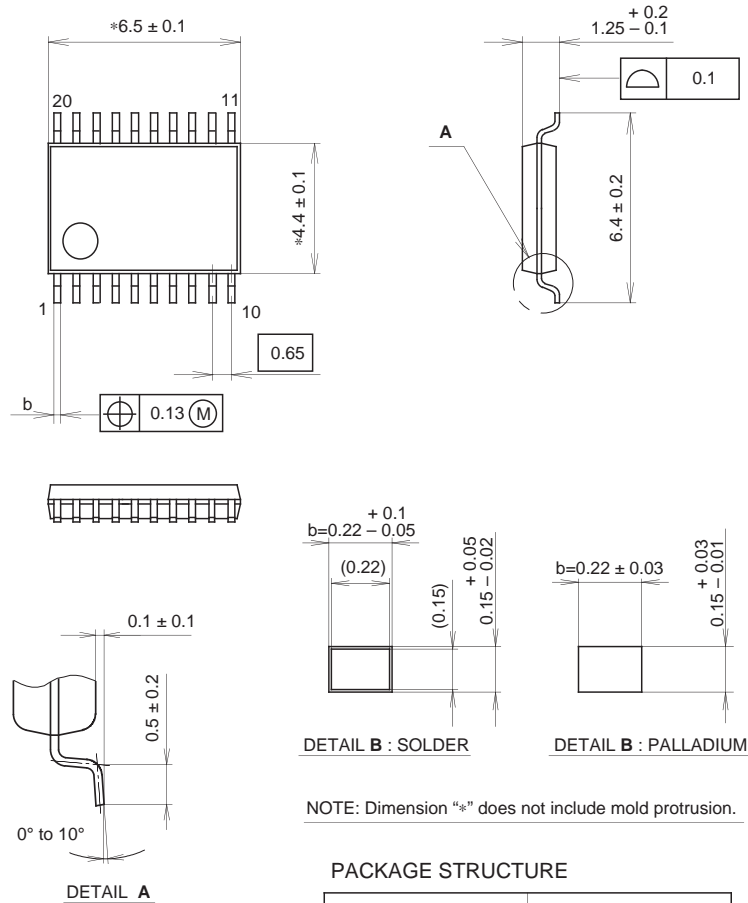
Fig.6 Write current setting constant vs. Write current





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 | 42/COPPER ALLOY |
| PACKAGE MASS | 0.1g |

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