5V, R/W Preamplifier for 2 Terminal Recording Heads, 2 or 4 Channels

GENERAL DESCRIPTION

The XR-9030/9030R are bipolar monolithic integrated circuits commonly used in two terminal thin film recording head applications. The circuitry on the device includes a low noise preamplifier, write current control circuitry and data protection. It is available for both two and four channel applications. Power supply fault detection circuitry present on the device disables the write current generator in various power down modes. The read recovery time is improved by control of the read channel common mode output shift when in write mode. The read write device in the XR-9030R option offers internal 700 Ohm damping resistors.

The XR-9030 operates on a single 5V power supply making it ideal for low power applications. Both versions are available in a variety of low profile packaging options.

FEATURES

5V Supply Voltage Only
Low Power Device (150mW Typ in Read mode)
High Performance Circuitry
- -Low Input Noise = 0.85nV/$\sqrt{Hz}$ max
- -Read Mode Gain = 200V/V
- -Input Capacitance = 35pF max
- -Write Current Range = 2-35mA

Programmable Write Current Source
Write Unsafe Detect/Indicator
Power Supply Fault Protection
Head Short to Ground Protection
Enhanced Write to Read Recovery Time
Designed for Use With Two Terminal Thin Film Heads

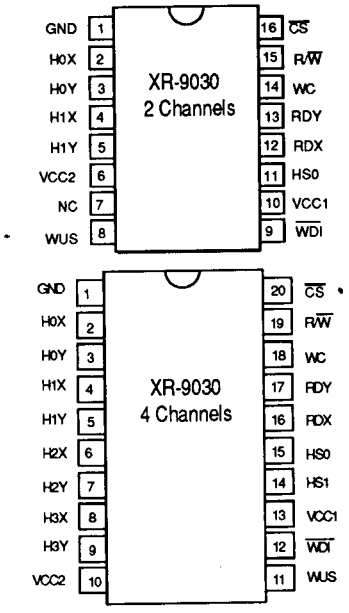
APPLICATIONS

Thin Film Recording Heads in Hard Disk Drives

ABSOLUTE MAXIMUM RATINGS

DC Supply Voltage	-0.3 to +7 VDC
Write Current IW	80mA
Digital Input Voltage	-0.3 to VCC1 +0.3 VDC
Head Port Voltage	-0.3 to VCC2 +0.3 VDC
Output Current Maximum	
Pins: RDX, RDY	±10mA
WUS	+12mA
Storage Temperature Range	-65°C to +150°C

PIN ASSIGNMENT



ORDERING INFORMATION

Part Number	Package	Operating Temperature
XR-9030/9030R-4D	20 Pin SOP	0°C to 70°C
XR-9030/9030R-2D	16 Pin SOP	0°C to 70°C
XR-9030/9030R-4D	20 Pin SSOP	0°C to 70°C

SYSTEM DESCRIPTION

The XR-9030/9030R is a low power, two or four channel hard disk drive Read / Write preamplifier for thin film (2 terminal) heads. The XR-9030/9030R provides superior recording performance, and uses only a +5V power supply. Its low power consumption suits it for drives used in battery powered laptop computers. The read amplifier consists of a 60 MHz bandwidth 0.55 nV/$\sqrt{Hz}$ input noise (both typical) differential amplifier with a fixed gain of 200 V/V. The write driver has a current range of 2 to 35 mA and is disabled automatically when a voltage fault is detected. The write mode also has a write unsafe detection circuit.

ELECTRICAL CHARACTERISTICS

Test Conditions: L_H = 1.0µH R_H = 30 Ω, I_W = 20mA, f(Data) = 5MHz, $V_{CC1} = V_{CC2}$ = 5V ±5%

SYMBOL	PARAMETERS	MIN	TYP	MAX	UNITS	CONDITIONS
DIGITAL INPUTS						
V_{IL}	Input Low Voltage			0.8	V	
V_{IH}	Input High Voltage	2.0			V	
I_{IL}	Input Low Current	-400			µA	VIL = 0.8V
I_{IH}	Input High Current			100	µA	VIH = 2.0V
WUS VOL	WUS Output Low Voltage			0.5	V	I_{OL} = 2mA
VF	VCC1 Fault Voltage Fault to No Fault			4.2	V	Note 1
VF	VCC1 Fault Voltage No Fault to Fault	3.8			V	
WRITE CHARACTERISTICS						
Vwc	Write Current Voltage	1.15		1.35	V	
	Differential Head Voltage Swing	3.4			V	
	Unselected Head Current			1	mA pk	
	Head Differential Load Capacitance			25	pF	
	Head Differential Load Resistance	560	700	950		R Option
	Head Differential Load Resistance	4K				
	$\overline{WDI}$ Transition Frequency	1			MHz	I_W = 5mA
Iw	Write Current Range	2		35	mA	
READ CHARACTERISTICS Recommended operating conditions apply, unless otherwise stated. R_L(RDX,RDY) = 1KΩ, C_L(RDX,RDY) <20 pF, f = 5MHz						
Av	Differential Voltage Gain	160	200	240	V/V	
BW	Bandwidth -3dB	35	60		MHz	
eni	Equivalent Input Noise		0.55	0.85	nV/√Hz	BW= 15 MHz L_H= 0, R_H = 0
C_{IN}	Differential Input Capacitance			35	pF	
R_{IN}	Differential Input Resistance	835	2K		Ω	
R_{IN}	Differential Input Resistance		700		Ω	R Option
	Dynamic Range to 90% of Gain	3			mV pp	
CMRR	Common Mode Rejection Ratio	45			dB	
PSRR	Power Supply Rejection Ration	40			dB	100mV_{pp} 5MHz sin on V_{CC}
	Channel Rejection Ratio	45			dB	Unselected channels driven with100mV_{pp} 5MHz sin
	Output Offset Voltage	-300		300	mV	
R_O	Single Ended Output Resistance			40	Ω	
I_O	Output Current	1.4			mA	AC coupled load, RDX to RDY
V_{CM}	Common Mode Output Voltage	2		3.5	V	

DC CHARACTERISTICS

SYMBOL	PARAMETERS	MIN	TYP	MAX	UNITS	CONDITIONS
$I_{CC}1$	VCC1 Supply Current			33	mA	READ Mode
				27	mA	WRITE Mode
				12	mA	IDLE Mode
$I_{CC}2$	VCC2 Supply Current			11	mA	READ Mode
				10+ IW	mA	WRITE Mode
				400	µA	IDLE Mode
P_D	Power Dissipation			230	mW	READ Mode
				190+4IW	mW	WRITE Mode
			35	45	mW	IDLE Mode

Note 1: On the Fault to No Fault transition, all devices will be No Fault at 4.2V.
On the No Fault to Fault transition, all devices will be Fault at 3.8V.

4

SWITCHING CHARACTERISTICS - Recommended operating conditions apply unless otherwise specified.
Iw = 20 mA, Lh = 1.0 µH, Rh = 30Ω, f(Data) = 5 MHz

SYMBOL	PARAMETER	MIN	TYP	MAX	UNITS	CONDITIONS
	R/$\overline{W}$ Read to Write		0.1	1.0	µs	R/$\overline{W}$ to 90% of write current
	Write to Read		0.5	1.0	µs	R/$\overline{W}$ to 90% of 100mV 10 MHz Read signal envelope
	$\overline{CS}$ Unselect to Select		0.4	1.0	µs	$\overline{CS}$ to 90% of write current or to 90% of 100mV 10MHz Read signal envelope
	Select to Unselect		0.4	1.0	µs	$\overline{CS}$ to 10% of write current
	HS0,1 to any Head		0.2	1.0	µs	To 90% of 100mV 10MHz Read signal envelope
TD1	WUS: Safe to Unsafe	0.6	2.0	3.6	µs	
TD2	Unsafe to Safe		0.2	1.0	µs	
	Head Current:					Lh = 0, Rh = 0
TD3	$\overline{WDI}$ to Ix - Iy			32	ns	from 50% level
	Asymmetry			1.0	ns	$\overline{WDI}$ has 1 ns rise/fall time
	Rise/Fall Time			12	ns	10% to 90% level

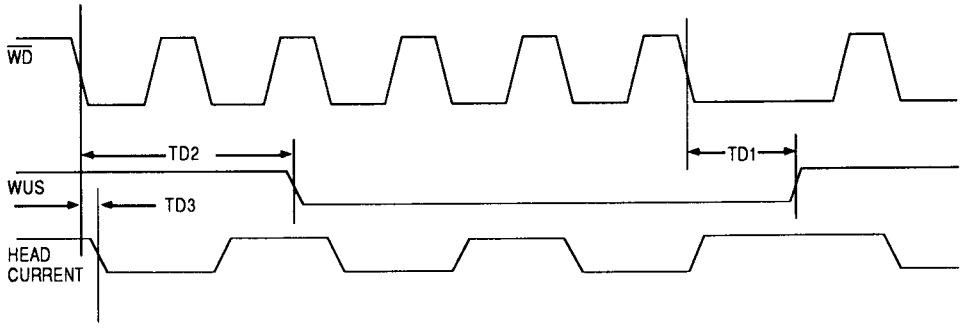


Figure 1. Write Mode Timing Diagram

PIN DESCRIPTION

Pin #	Symbol	I/O	Description
14,15	HS0,HS1	I	Head Select. Select one of four heads.
20	$\overline{CS}$	I	Chip Select. High inhibits the chip.
19	R/$\overline{W}$	I	Read/Write. High selects Read mode.
11	WUS*	O	Write Unsafe. High indicates an unsafe writing condition.
12	$\overline{WDI}$	I	Write Data In. Changes the direction of the current in the recording head.

Pin #	Symbol	I/O	Description
2,4,6,8 3,5,7,9	H0X-H3X; H0Y-H3Y	I/O	X,Y Head Connections
16,17	RDX, RDY*	O	X,Y Read Data. Differential read data output.
18	WC		Write Current. Used to set the magnitude of the write current.
13	VCC1	I	+5V Supply
10	VCC2	I	+5V Supply for Write current drivers.
1	GND	I	Ground

* *These signals can be wire OR'ed.*

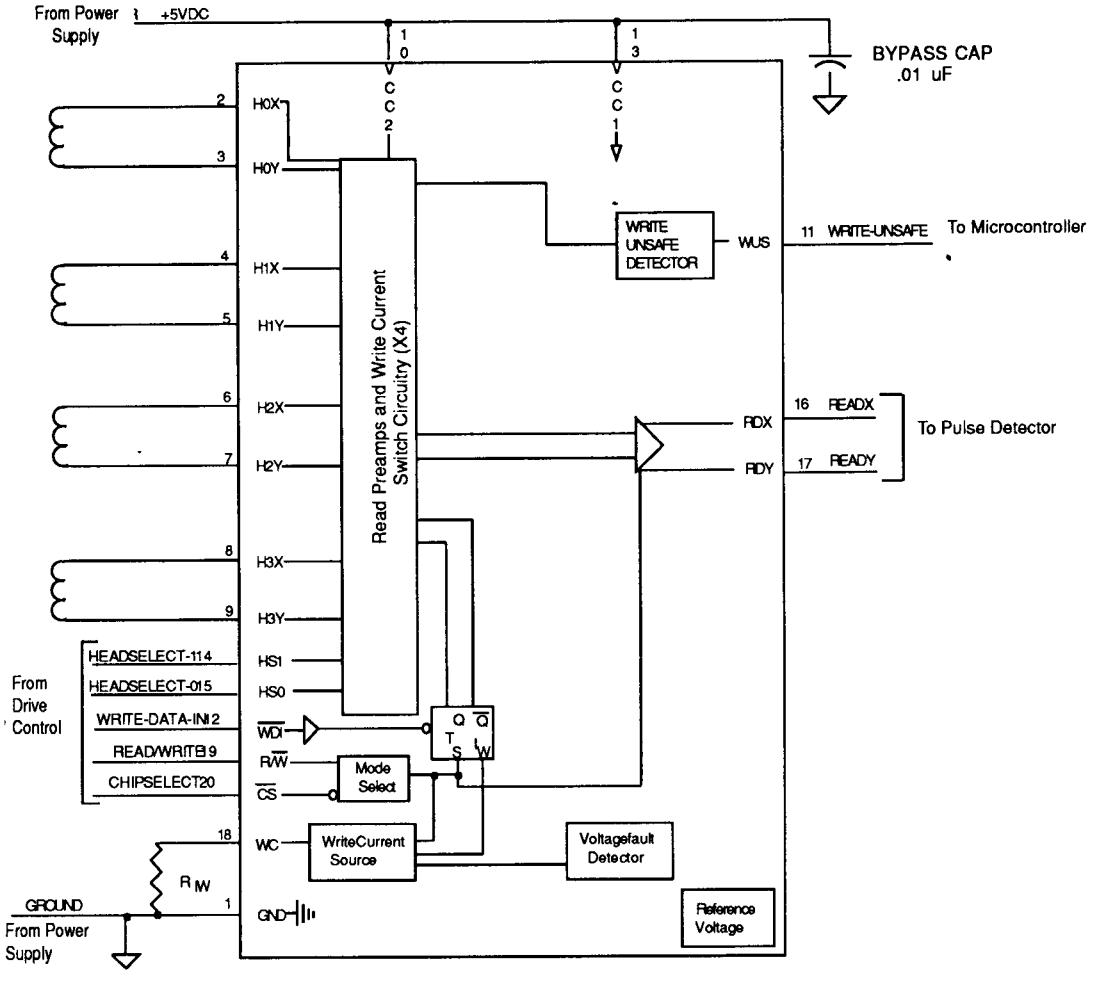


Figure 2. IC Interconnection and Block Diagram

CIRCUIT OPERATION

The XR-9030/9030R read/write device is intended for use in thin film head hard disk drives with up to four heads. Head selection and mode selection instructions are shown in Tables 1 and 2 respectively. The TTL inputs R/$\overline{W}$ and $\overline{CS}$ protect from accidental write current by internal pull up resistors. HS0 and HS1 have internal pull down resistors. The pin descriptions are shown on page 4.

Read Mode

In read mode operation, the low noise preamplifier circuit reads and amplifies pulses detected on the disk surface caused by magnetic transitions in the media. In this mode write current operations are disabled. RDX and RDY are emitter follower outputs which provide differential read data output pulses. These should be AC coupled to the load. In Write mode and in Idle mode these outputs go into a high impedance state. This allows wire-oring of these outputs in multi-chip applications where more than four head capability is required.

Write Mode

Write mode is selected when both R/$\overline{W}$ and $\overline{CS}$ are taken low. The head current direction of the selected head is toggled by each negative going transition on the write data input pin, $\overline{WDI}$. A preceding read or idle mode select initializes the write data flip-flop to pass current through the X side of the head. This current is set by and external resistor, Rw, where:

$$Iw = \frac{Vwc}{Rw}$$

Rw is connected between the pins WC and GND. The actual head current is also a function of the head resistance and external wire resistance (Rh) and the damping resistance (Rd), so that:

$$Ix,y = \frac{Iw}{1 + Rh/Rd}$$

The write unsafe detector is also activated in this state.
The pin WUS is an open collector output which should be tied to VCC by a 2KΩ to 10KΩ resistor.

Idle Mode

This mode is selected by taking the pin $\overline{CS}$ high. The pins RDX and RDY are placed in a high impedance mode to minimize device power consumption and allow another chip to drive these common lines.

Voltage Fault

The write current function is disabled when either a voltage fault or power startup mode is detected, to avoid going into Write mode and contaminating the disks.
The following conditions will indicate a Write Unsafe, but will not stop the Write operation:

- -Device in Read Mode
- -Chip Disabled
- -$\overline{WDI}$ Frequency too Low
- -No Write Current
- -Head Opened

MODE DESCRIPTION

HS1	HS0	Head
0	0	0
0	1	1
1	0	2
1	1	3

Table 1. Head Select

$\overline{CS}$	R/$\overline{W}$	Mode
0	0	Write
0	1	Read
1	0	Idle
1	1	Idle

Table 2. Mode Select