

November 1993

DESCRIPTION

The SSI 32R2024R is a bipolar monolithic integrated circuit designed for use with two-terminal recording heads. It provides a low noise read amplifier, write current control, and data protection circuitry for up to four channels. The SSI 32R2024R provides internal 400Ω damping resistors that are switched in during Write mode and switched out during Read mode. Power supply fault protection is provided by disabling the write current generator during power sequencing. System write to read recovery time is significantly improved by controlling the Read Channel Common mode output voltage shift in the Write mode.

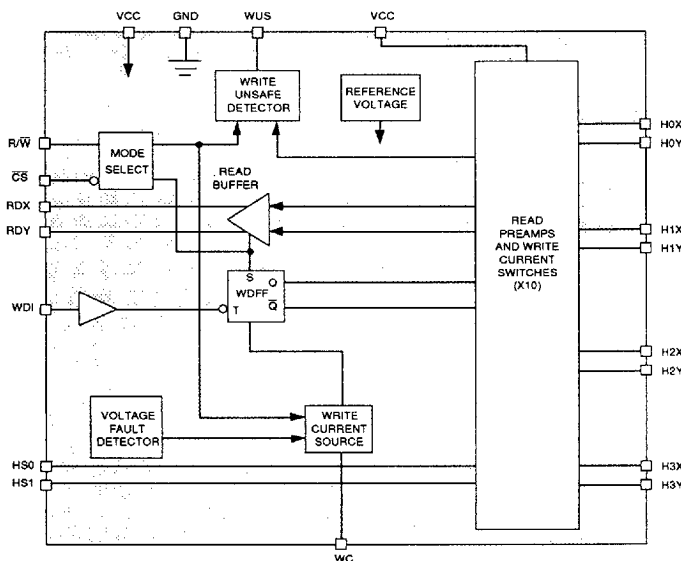
The SSI 32R2024R requires only +5V power supplies and is available in a variety of packages.

FEATURES

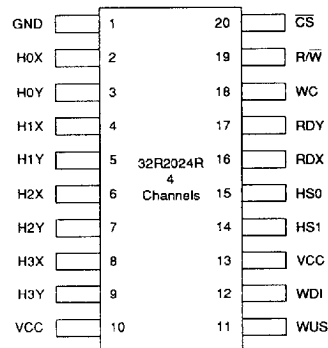
- +5V ±10% supply
- Low power
 - PD = 160 mW Read mode (Nom)
 - PD = 5.5 mW Idle (Max)
- High Performance:
 - Read gain options: 150, 200, 300 V/V
 - Input noise = 0.56 nV/√Hz (Nom)
 - Input capacitance = 16 pF (Nom)
 - Write current range = 5 - 40 mA
- Self switching damping resistance
- Designed for two-terminal thin-film or MIG heads with inductance up to 5.0 μH
- Write unsafe detection
- Power supply fault protection
- Head short to ground protection

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BLOCK DIAGRAM



PIN DIAGRAM



20-Lead SOL, SOV

CAUTION: Use handling procedures necessary for a static sensitive component.

1193 - rev.

3-85

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SSI 32R2024R

5V, 4-Channel

Thin-Film Read/Write Device

FUNCTIONAL DESCRIPTION

The SSI 32R2024R has the ability to address up to 4 two-terminal heads and provide write drive or read amplification. Mode control and head selection are described in Tables 1 and 2. The TTL inputs R/W and \overline{CS} have internal pull-up resistors to prevent an accidental write condition. HS0 and HS1 have internal pulldown resistors. Internal clamp circuitry will protect the IC from a head short to ground condition in any mode.

TABLE 1: Mode Select

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

TABLE 2: Head Select

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

WRITE MODE

Taking both \overline{CS} and R/W low selects Write mode which configures the SSI 32R2024R as a current switch and activates the Write Unsafe (WUS) detector circuitry. Head current is toggled between the X and Y side of the selected head on each high to low transition of the Write Data Input (WDI). Changing from Read or Idle mode to Write mode initializes the Write Data Flip-Flop to pass write current into the "X" pin. In this case, the Y side of the head will be higher potential than the X side. The magnitude of the write current (0-pk) is given by:

$$I_w = \frac{A_1 \cdot V_{wc}}{R_{wc}} = \frac{K_w}{R_{wc}}$$

Rwc is connected from pin WC to GND. Note the actual head current I_x, y is given by:

$$I_x, y = \frac{I_w}{1 + R_h/R_d}$$

where:

R_h = Head resistance plus external wire resistance

R_d = Damping resistance

In Write mode a 400 Ω damping resistor is across the Hx, Hy ports.

POWER SUPPLY FAULT PROTECTION

A voltage fault detection circuit improves data security by disabling the write current generator during a voltage fault or power startup regardless of mode. Note that WUS does not necessarily turn on to flag a power supply fault condition.

HEAD SHORT TO GROUND PROTECTION

The SSI 32R2024R provides a head short to ground protection circuit in any mode. In Idle or Read mode, current out of the head port will not exceed 20 mA if any head is shorted to ground. In Write mode, if any head is shorted to ground (regardless if it is selected or not) the write current generator will turn off, the WUS flag will go high, and current will be limited to less than 1 mA out of the head port.

WRITE UNSAFE

Any of the following conditions will be indicated as a high level on the Write Unsafe, WUS, open collector output.

- WDI frequency too low
- Device in Read mode
- Chip disabled
- No head current
- Head opened
- Head short to ground

To insure proper WUS operation, the product of write current, WDI frequency, and head inductance should be less than 500 mA $\cdot\mu$ H \cdot MHz. To insure no false WUS trigger, the product of head current and head resistance ($I_x, y \cdot R_h$) should be between 100 mV and 1.7V.

WDI frequency too low is detected if the WDI frequency falls below 500 kHz (typ). Consult the WUS Safe to Unsafe timing for range of frequency detection.

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Device in Read mode and **Chip disabled** will flag WUS if R/W is high or CS is high.

No head current will flag WUS if $R_{wc} = \infty$ and the selected head is present.

Head opened will flag WUS if $R_h = \infty$ and under the condition that $I_w \cdot R_d > 3.9V$.

Head short to ground is described in the preceding paragraph.

Upon entering Write mode, WUS is valid after two high to low transitions of WDI following the required Read-Write transition time (0.6 μs max).

READ MODE

The Read mode configures the SSI 32R2024R as a low noise differential amplifier and deactivates the write current generator. The damping resistor is switched out of the circuit allowing a high impedance input to the

read amplifier. The RDX and RDY output are driven by emitter followers. They should be AC coupled to the load. The (X,Y) inputs are non-inverting to the (X,Y) outputs.

Note that in Idle or Write mode, the read amplifier is deactivated and RDX, RDY outputs become high impedance. This facilitates multiple R/W applications (wired-OR RDX, RDY) and minimizes voltage drifts when switching from Write to Read mode. Note also that the write current source is deactivated for both the Read and Idle mode.

IDLE MODE

Taking \overline{CS} high selects the Idle mode which switches the RDX and RDY outputs into a high impedance state and deactivates the device. Power consumption in this mode is held to a minimum.

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PIN DESCRIPTION

NAME	TYPE	DESCRIPTION
HS0, HS1	†	I Head Select: selects one of four heads
CS	I	Chip Select: a high inhibits the chip
R/W	†	I Read/Write: a high selects Read mode
WUS	†	O Write Unsafe: a high indicates an unsafe writing condition
WDI	†	I Write Data In: changes the direction of the current in the recording head
H0X - H3X; H0Y - H3Y	I/O	X, Y Head Connections
RDX, RDY	†	O X, Y Read Data: differential read data output
WC	†	Write Current: used to set the magnitude of the write current
VCC	I	+5V Supply
GND	I	Ground
†When more than one R/W device is used, signals can be wire OR'ed		

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ELECTRICAL SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Operation above maximum ratings may permanently damage the device.

PARAMETER		RATING
DC Supply Voltage	VCC	-0.3 to +6 VDC
Write Current	I _w	60 mA
Digital Input Voltage	V _{in}	-0.3 to VCC +0.3 VDC
Head Port Voltage	V _H	-0.3 to VCC +0.3 VDC
Output Current: RDX, RDY	I _O	-6 mA
WUS		+8 mA
Storage Temperature	T _{stg}	-65 to +150°C

RECOMMENDED OPERATING CONDITIONS

DC Supply Voltage		5 ± 10% VDC
Operating Junction Temperature	T _j	+25 to +135°C
Recommended Head Load Range	L _h	0.3 - 5.0 μH
Operating Ambient Temperature	T _a	0 to 70°C

DC CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified.

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
VCC	Read Mode		32	41	mA
	Write Mode		25 + I _w	37 + I _w	mA
	Idle Mode		0.6	1	mA
Power Dissipation	Read Mode		160	225	mW
	Write Mode (I _w = 20 mA)		225	315	mW
	Idle Mode		3	5.5	mW
VCC Fault Voltage	I _w < 0.2 mA	3.5	3.9	4.2	VDC

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DIGITAL INPUTS

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
Input Low voltage (Vil)				0.8	VDC
Input High Voltage (Vih)		2.0			VDC
Input Low Current	Vil = 0.8V	-0.4			mA
Input High Current	Vih = 2.0V			100	μA
WUS Output Low Voltage (Vol)	Iol = 2 mA max			0.5	VDC

WRITE CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified.

Iwc to Head Current Gain (Ai)	Iw = Ai • VWC/RWC		20		mA/mA
Write Current Constant (Kw)	Kw = Ai • VWC	45	51	57	V
Write Current Voltage (Vwc)			2.55		V
Differential Head Voltage Swing	Open Head Iw = 20 mA	4.2	5.6		Vpp
Unselected Head Current				1	mA (pk)
Head Differential Load Capacitance				25	pF
Head Differential Damping Resistance (Rd)			400		Ω
WDI Pulse Width	Vil ≥ 0.2V	PWH	10		ns
		PWL	5		ns
Write Current Range (Iw)		5		40	mA
RDX, RDY Common Mode Output Voltage			VCC/2		V

READ CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified. CL (RDX, RDY) < 20 pF, RL (RDX, RDY) = 1 kΩ.

Differential Voltage Gain	Vin = 1 mVpp @1 MHz				
	32R2024U		100	150	200
	32R2024RV		166	200	234
	32R2024RX		249	300	351
Voltage BW	-1 dB	Zs < 5Ω, Vin = 1 mVpp	20		
	-3 dB	Zs < 5Ω, Vin = 1 mVpp	45		
Input Noise Voltage	BW = 15 MHz, Lh = 0, Rh = 0			0.56	0.75
Differential Input Capacitance	Vin = 1 mVpp, f = 5 MHz			16	22
Differential Input Resistance	Vin = 1 mVpp, f = 5 MHz		720	1200	

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READ CHARACTERISTICS (continued)

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
Dynamic Range	AC input voltage where gain falls to 90% of its small signal gain value, $f = 5$ MHz	2			mVpp
Common Mode Rejection Ratio	$V_{in} = 0$ VDC + 100 mVpp @ 5 MHz	55			dB
Power Supply Rejection Ratio	100 mVpp @ 5 MHz on VCC	50			dB
Channel Separation	Unselected channels driven with $V_{in} = 0$ VDC + 100 mVpp	55			dB
Output Offset Voltage				± 300	mV
Single Ended Output Resistance	$f = 5$ MHz			50	Ω
Output Current	AC coupled load, RDX to RDY	0.9			mA
RDX, RDY Common Mode Output Voltage		0.4 VCC	VCC/2	0.6 VCC	VDC

SWITCHING CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified. $I_W = 20$ mA, $L_h = 1.0$ μ H, $R_h = 30\Omega$, $f(\text{Data}) = 5$ MHz.

R/W	Read to Write	R/W to 90% of write current		0.1	0.6	μ s
	Write to Read	R/W to 90% of 100 mV Read signal envelope		0.1	0.6	μ s
\overline{CS}	Unselect to Select	\overline{CS} to 90% of write current or to 90% of 100 mV 10 MHz		0.2	0.6	μ s
	Select to Unselect	\overline{CS} to 10% of write current		0.11	0.6	μ s
HS0,1 to any Head		To 90% of 100 mV 10 MHz Read signal envelope		0.11	0.6	μ s
WUS: Safe to Unsafe (TD1)		Write mode, loss of WDI transitions. Defines maximum WDI period for WUS operation	0.6	2.0	3.6	μ s
Unsafe to Safe (TD2)		Fault cleared, from first neg WDI transition		0.1	0.6	μ s
Head Current:						
WDI to Ix - Iy (TD3)		from 50% points, $L_h = 0$, $R_h = 0$		3	10	ns
Asymmetry		WDI has 1 ns rise/fall time, $L_h = 0$, $R_h = 0$			1.0	ns
Rise/fall Time		10% to 90% points, $L_h = 0$, $R_h = 50\Omega$		4	6	ns
Rise/fall Time		$L_h = 1$ μ H, $R_h = 30\Omega$		15		ns

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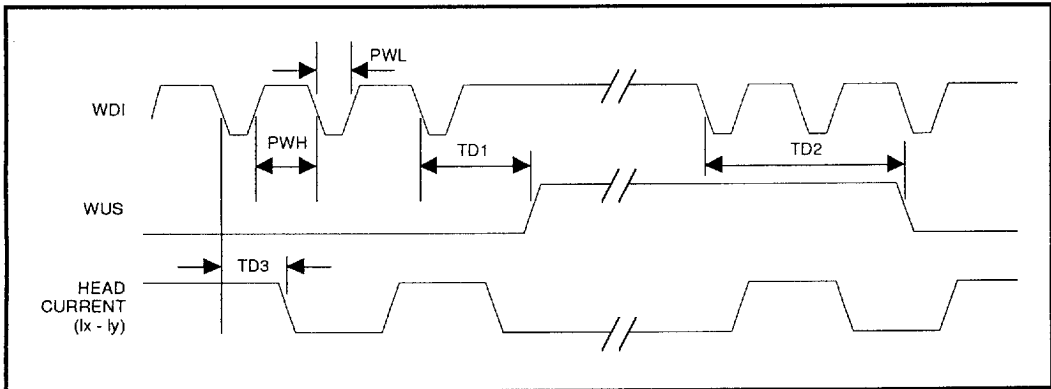
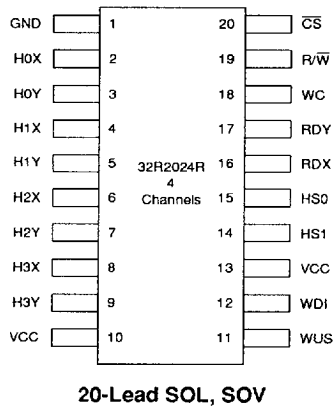


FIGURE 1: Write Mode Timing Diagram

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PACKAGE PIN DESIGNATIONS
(Top View)



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ORDERING INFORMATION

PART DESCRIPTION	ORDER NUMBER	PACKAGE MARK
SSI 32R2024R 20-Lead SOL	32R2024R-CL	32R2024R-CL
20-Lead SOV	32R2024R-CV	32R2024R-CV

Preliminary Data: Indicates a product not completely released to production. The specifications are based on preliminary evaluations and are not guaranteed. Small quantities are available, and Silicon Systems should be consulted for current information.

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