

December 1992

**DESCRIPTION**

The SSI 32R4610A/4611A and SSI 32R4610B are bipolar monolithic integrated circuits designed for use with two-terminal thin-film recording heads. They provide a low noise read amplifier, write current control, and data protection circuitry for up to eight channels. The SSI 32R4610AR/4611AR option provides internal 700Ω damping resistors. 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 32R4611A option provides for an additional feature providing the user with a controllable write current adjustment feature.

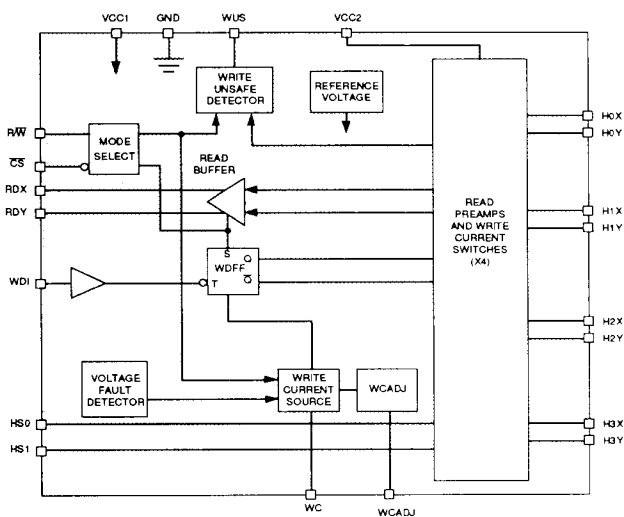
The SSI 32R4610B is an 8 channel device which improves the write unsafe performance over the SSI 32R4610A-8. In all other areas, performance is identical to the SSI 32R4610A-8.

The SSI 32R4610/4611 and SSI 32R4610B require only +5V power supplies and are available in a variety of packages.

**FEATURES**

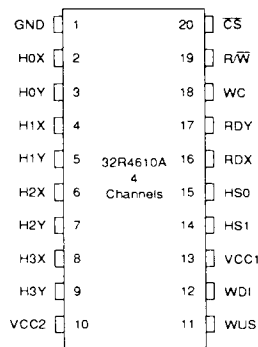
- **5V ±10%**
- **Low power**
  - PD = 175 mW read mode (Nom)
- **High Performance:**
  - Read mode gain = 200 V/V
  - Input noise = 0.85 nV/√Hz max
  - Input capacitance = 35 pF max
  - Write current range = 10-35 mA
- **Designed for two-terminal thin-film heads**
- **Programmable write current source**
- **Write unsafe detection**
- **Enhanced system write to read recovery time**
- **Power supply fault protection**
- **Head short to ground protection**

**BLOCK DIAGRAM**



WCADJ available on the 32R4611A 24-pin option only

**PIN DIAGRAM**



**20-PIN SOL**

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

**SSI 32R4610A/4611A**  
**5V, 2, 4, 8-Channel Thin-Film**  
**SSI 32R4610B**  
**5V, 8 Channel Thin-Film**  
**Read/Write Device**

**CIRCUIT OPERATION**

The SSI 32R4610A/4611A and SSI 32R4610B have the ability to address up to 8 two-terminal thin-film heads and provide write drive or read amplification. Head selection and mode control are described in Tables 2 and 3. The TTL inputs R/W and CS have internal pull-up resistors to prevent an accidental write condition. HS0, HS1 and HS2 have internal pulldowns. 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**

HS2	HS1	HS0	Head
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

**PIN DESCRIPTION**

NAME	TYPE	DESCRIPTION
HS0, HS1, HS2 †	I	Head Select: selects one of four heads
$\overline{CS}$	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 - H7X; H0Y - H7Y	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
WCADJ* †		Write Current Adjust: Used to decrease the write current by a finite amount
VCC1	I	+5V Supply
VCC2	I	+5V Supply for Write current drivers
GND	I	Ground
*Available on 32R4611A 24-pin option only		
† These signals can be wire OR'ed		

## WRITE MODE

Taking both  $\overline{CS}$  and  $R/\overline{W}$  low selects Write mode which configures the SSI 32R4610A/4611A and SSI 32R4610B 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). The WDI input pulse width requirement is amplitude dependent and pull ups are recommended at higher data rates, please refer to the WDI pulse width specifications. Note that a preceding Read or Idle mode select initializes the Write Data Flip-Flop to pass write current through the "X" side of the head. The magnitude of the write current (0-pk) is given by:

$$IW = \frac{K \cdot VWC}{RWC}$$

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

## WUS

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 write current
- Head opened\*

After fault condition is removed, one negative transition on WDI is required to clear WUS.

\*Open head detect is not always detected on the SSI 32R4610A-8. This circuit is improved in the SSI 32R4610B-8.

## WCADJ

The 32R4611A adds a feature which allows the user to adjust the  $I_w$  current by a finite amount. The WCADJ pin is used to adjust write current for write operations on

different zones of the disk. It is used by switching a separate write current adjust resistor in and out on the WCADJ pin or by connecting a DAC to that pin to sink a controllable amount of current. The WCADJ pin is nominally biased to  $VCC/2$ . Sinking current from this pin to ground will divert a proportional amount of current from the actual head current while maintaining a constant current through the WC resistor and VCC. Allowing WCADJ to float or pulling it high will cut off the circuit and it will have no effect. For example, if the nominal head current is set to 30 mA through WC with WCADJ open, then for a 7.25 mA head current decrease, a 10 k $\Omega$  resistor would be connected from the WCADJ pin to ground. A TTL gate could be used as a switch with a small degradation in accuracy. To perform the same function, a DAC could be used, by programming it to sink 0.25 mA from the WCADJ pin.

$I_w$  head (Decrease) =  $(29 \cdot V_{WCADJ} / R_{WCADJ})$

Where:

$V_{WCADJ}$  = Voltage on WCADJ pin =  $VCC/2$

$R_{WCADJ}$  = Write current adjust setting resistor

## VOLTAGE FAULT

A voltage fault detection circuit improves data security by disabling the write current generator during a voltage fault or power startup regardless of mode.

## READ MODE

The Read mode configures the SSI 32R4610A/4611A and SSI 32R4610B as a low noise differential amplifier and deactivates the write current generator. 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.

**SSI 32R4610A/4611A**  
**5V, 2, 4, 8-Channel Thin-Film**  
**SSI 32R4610B**  
**5V, 8 Channel Thin-Film**  
**Read/Write Device**

**ELECTRICAL SPECIFICATIONS**

**ABSOLUTE MAXIMUM RATINGS**

Operation above maximum ratings may permanently damage the device.

PARAMETER		RATING	UNIT
DC Supply Voltage	VCC1	-0.3 to +7	VDC
	VCC2	-0.3 to +7	VDC
Write Current	IW	80	mA
Digital Input Voltage	Vin	-0.3 to VCC1 +0.3	VDC
Head Port Voltage	VH	-0.3 to VCC2 +0.3	VDC
Output Current: RDX, RDY	I0	-10	mA
	WUS	+12	mA
Storage Temperature	Tstg	-65 to +150	°C

**RECOMMENDED OPERATING CONDITIONS**

DC Supply Voltage	VCC1	5 ±10%	VDC
	VCC2	5 ±10%	VDC
Operating Junction Temperature	Tj	+25 to +110	°C

**DC CHARACTERISTICS**

Recommended operating conditions apply unless otherwise specified.

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT	
VCC1 Supply Current	Read Mode (Vcc ±5%) (Vcc ±10%)	23	28	33	mA	
		19	28	37	mA	
	Write Mode (Vcc ±5%) (Vcc ±10%)	21	24	27	mA	
		17	24	31	mA	
<i>*Head Select Pins</i> (HS0, HS1, HS2) Floating	*Idle Mode (Vcc ±5%) (Vcc ±10%)	6	9	12	mA	
		4	9	14	mA	
	VCC2 Supply Current	Read Mode (Vcc ±5%) (Vcc ±10%)	5	8	11	mA
			4	8	12	mA
	Write Mode (Vcc ±5%) (Vcc ±10%)	6	8 + Iw	10 + Iw	mA	
		5	8 + Iw	11 + Iw	mA	
	Idle Mode (Vcc ±5%) (Vcc ±10%)	0.1	0.2	0.4	mA	
		0.1	0.2	0.5	mA	
Power Dissipation	Read Mode (Vcc ±5%) (Vcc ±10%)		175	230	mW	
				270	mW	

**DC CHARACTERISTICS (Continued)**

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
	Write Mode (Vcc ±5%)		150 + 4Iw	190 + 4Iw	mW
	(Vcc ±10%)			230 + 4.4Iw	mW
	Idle Mode (Vcc ±5%)		50	65	mW
	(Vcc ±10%)			80	mW
VCC1 Fault Voltage	IW < 0.2 mA	3.8	4.0	4.2	VDC

**DIGITAL INPUTS**

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.

Write Current Constant "K"		.96	.99		
Write Current Voltage (VWC)		1.15	1.25	1.35	V
WCADJ Voltage SSI 32R4611A/4611AR	IWCADJ = 0 to .5 mA	2.0	VCC/2	3.0	VDC
Ihead(Decrease)/IWCADJ SSI 32R4611A/4611AR		26	29	32	mA/mA
IWCADJ Range SSI 32R4611A/4611AR		0.0		0.5	mA
Differential Head Voltage Swing	Ih (p-p) • Rh not to exceed 3.4V (Head Swing Min)	3.4			Vpp
Unselected Head Current				0.02 Iw	mApk
Head Differential Load Capacitance				25	pF
Head Differential Load Resistance (Rd)	SSI 32R4610A/32R4611A	4K			Ω
	SSI 32R4610AR/32R4611AR	560	700	950	Ω
WDI Pulse Width (Ref: Figure 1)	Vil = 0.2V, Vih = 2.4V	PWH	37		ns
		PWL	5		ns
	Vil = 0.2V, Vih = VCC	PWH	20		ns
		PWL	5		ns
Write Current Range (IW)		10		35	mA

**SSI 32R4610A/4611A**  
**5V, 2, 4, 8-Channel Thin-Film**  
**SSI 32R4610B**  
**5V, 8 Channel Thin-Film**  
**Read/Write Device**

**READ CHARACTERISTICS**

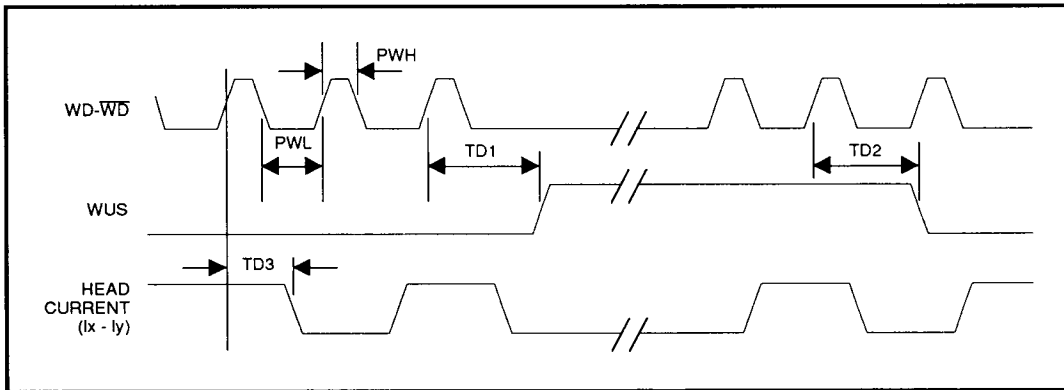
Recommended operating conditions apply unless otherwise specified. CL (RDX, RDY) < 20 pF,  
 RL (RDX, RDY) = 1 kΩ.

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
Differential Voltage Gain	Vin = 1 mVpp @1 MHz	160	200	240	V/V
Voltage BW	Zs  < 5Ω, Vin = 1 mVpp	-1dB	20	81	MHz
		-3dB	35	91	MHz
Input Noise Voltage	BW = 15 MHz, Lh = 0, Rh = 0		0.6	0.85	nV/√Hz
Differential Input Capacitance	Vin = 1 mVpp, f = 5 MHz		27	35	pF
Differential Input Resistance	Vin = 1 mVpp, f = 5 MHz SSI 32R4610A/4611A	835	2600		Ω
	SSI 32R4610AR/4611AR	360	550		Ω
Dynamic Range	AC input voltage where gain falls to 90% of its small signal gain value, f = 5 MHz	3	6		mVpp
Common Mode Rejection Ratio	Vin = 0 VDC + 100 mVpp @ 5 MHz	45	80		dB
Power Supply Rejection Ratio	100 mVpp @ 5 MHz on VCC	40	70		dB
Channel Separation	Unselected channels driven with Vin = 0 VDC + 100 mVpp	45			dB
Output Offset Voltage		-300		+300	mV
Single Ended Output Resistance	f = 5 MHz			40	Ω
Output Current	AC coupled load, RDX to RDY	1.4			mA
RDX, RDY Common Mode Output Voltage		2.0	VCC1/2	3.5	VDC

**SWITCHING CHARACTERISTICS**

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

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
R/ $\bar{W}$	Read to Write		0.1	1.0	$\mu\text{s}$
	Write to Read		0.5	1.0	$\mu\text{s}$
$\bar{CS}$	Unselect to Select		0.4	1.0	$\mu\text{s}$
	Select to Unselect		0.4	1.0	$\mu\text{s}$
HS0,1 to any Head	To 90% of 100 mV 10 MHz Read signal envelope		0.2	1.0	$\mu\text{s}$
WUS: Safe to Unsafe (TD1)	Write mode, loss of WDI transitions. Defines maximum WDI period for WUS operation	0.6	2.0	3.6	$\mu\text{s}$
	Unsafe to Safe (TD2)		0.2	1.0	$\mu\text{s}$
Head Current:	$L_h = 0$ , $R_h = 0$				
WDI to $I_x - I_y$ (TD3)	from 50% points		20	32	ns
Asymmetry	WDI has 1 ns rise/fall time			1.0	ns
Rise/fall Time	10% to 90% points		6	12	ns



**FIGURE 1: Write Mode Timing Diagram**

**SSI 32R4610A/4611A**  
**5V, 2, 4, 8-Channel Thin-Film**  
**SSI 32R4610B**  
**5V, 8 Channel Thin-Film**  
**Read/Write Device**

**Worst Case Read Input Noise Voltage vs. Input Impedance for SSI 32R4610AR/4611AR and SSI 32R4610B**

Case 1: IC Base sheet resistance = Maximum  
Hence, IC bias Current = Minimum

	T <sub>j</sub> = 25°C	T <sub>j</sub> = 110°C	Units
V <sub>n</sub> (Max)	.7	0.85	nV/√Hz
R <sub>in</sub> (Min)	450	475	Ω
C <sub>in</sub> (Max)	28	30	pF

Case 2: IC Base sheet resistance = Minimum  
Hence, IC bias Current = Maximum

	T <sub>j</sub> = 25°C	T <sub>j</sub> = 110°C	Units
V <sub>n</sub> (Max)	.58	.65	nV/√Hz
R <sub>in</sub> (Min)	360	400	Ω
C <sub>in</sub> (Max)	33	35	pF

**Worst Case Read Input Noise Voltage vs. Input Impedance for SSI 32R4610A/4611A and SSI 32R4610B**

Case 1: IC Base sheet resistance = Maximum  
Hence, IC bias Current = Minimum

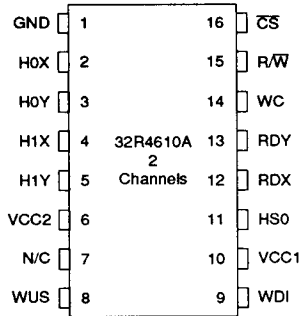
	T <sub>j</sub> = 25°C	T <sub>j</sub> = 110°C	Units
V <sub>n</sub> (Max)	.7	0.85	nV/√Hz
R <sub>in</sub> (Min)	1525	1895	Ω
C <sub>in</sub> (Max)	28	30	pF

Case 2: IC Base sheet resistance = Minimum  
Hence, IC bias Current = Maximum

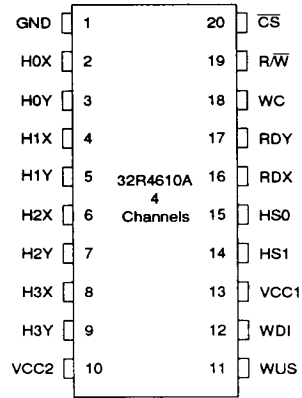
	T <sub>j</sub> = 25°C	T <sub>j</sub> = 110°C	Units
V <sub>n</sub> (Max)	.58	.65	nV/√Hz
R <sub>in</sub> (Min)	835	1100	Ω
C <sub>in</sub> (Max)	33	35	pF



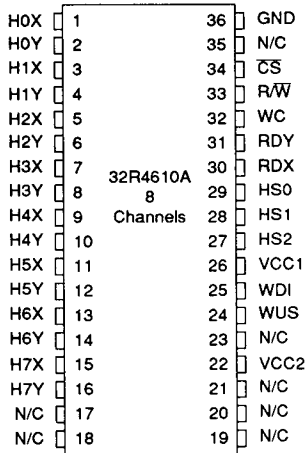
**PACKAGE PIN DESIGNATIONS**  
 (Top View)



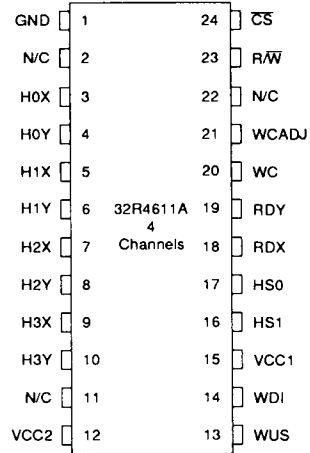
**16-Pin SOL**



**20-Pin SOL, SOV**



**36-Pin SOM**



**24-Pin SOL, SOV**

**SSI 32R4610A/4611A**  
**5V, 2, 4, 8-Channel Thin-Film**  
**SSI 32R4610B**  
**5V, 8 Channel Thin-Film**  
**Read/Write Device**

**ORDERING INFORMATION**

PART DESCRIPTION		ORDER NUMBER	PACKAGE MARK
SSI 32R4610A			
2-Channel	16-lead SOL	32R4610A-2CL	32R4610A-2CL
4-Channel	20-lead SOL	32R4610A-4CL	32R4610A-4CL
4-Channel	20-lead SOV	32R4610A-4CV	32R4610A-4CV
8-Channel	36-lead SOM	32R4610A-8CM	32R4610A-8CM
SSI 32R4610B Improves WUS from SSI 32R4610A-8			
8-Channel	36-lead SOM	32R4610B-8CM	32R4610B-8CM
SSI 32R4610AR Includes 700Ω Resistor			
2-Channel	16-lead SOL	32R4610AR-2CL	32R4610AR-2CL
4-Channel	20-lead SOL	32R4610AR-4CL	32R4610AR-4CL
4-Channel	20-lead SOV	32R4610AR-4CV	32R4610AR-4CV
8-Channel	36-lead SOM	32R4610AR-8CM	32R4610AR-8CM
SSI 32R4610BR Improves WUS from SSI 32R4610AR-8			
8-Channel	36-lead SOM	32R4610BR-8CM	32R4610BR-8CM
SSI 32R4611A Includes WCADJ Function			
4-Channel	24-lead SOL	32R4611A-4CL	32R4611A-4CL
4-Channel	24-lead SOV	32R4611A-4CV	32R4611A-4CV
SSI 32R4611AR Includes 700Ω Resistor			
4-Channel	24-lead SOL	32R4611AR-4CL	32R4611AR-4CL
4-Channel	24-lead SOV	32R4611AR-4CV	32R4611AR-4CV

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