

December 1993

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**DESCRIPTION**

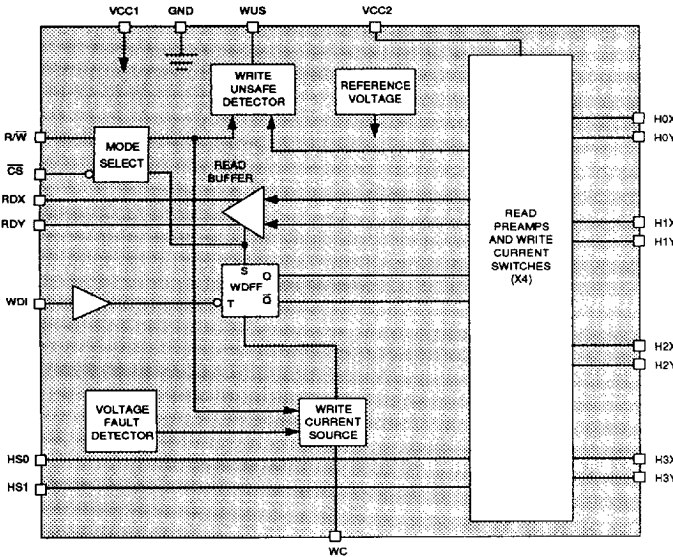
The SSI 32R2300/2300R are BiCMOS monolithic integrated circuits designed for use with two-terminal recording heads. They provide a low noise read amplifier, write current control, and data protection circuitry for up to four channels. The SSI 2300R option provides internal 350Ω damping resistors. Damping resistors are switched in during Write mode and switched out during Read mode. The SSI 32R2300 option does not provide a damping resistor. 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 making the read channel outputs high impedance.

The SSI 32R2300/2300R require only a +3.3V power supply and are available in a variety of packages. They are hardware compatible with the SSI 32R4610A and SSI 32R2020R Read/Write devices. The SSI 32R2301/2301R is identical to the SSI 32R2300/2300R, but comes in 24-pin package.

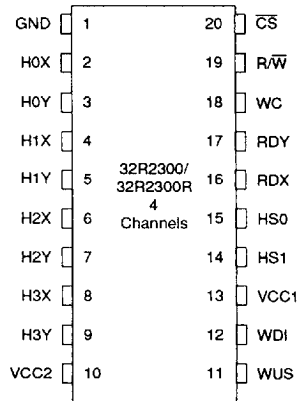
**FEATURES**

- +3.0V to +5.5V voltage supply
- Low power
  - PD = 63 mW Read mode (Nom) (@3.3V supply)
  - PD = 1 mW Idle (Max) (@3.3V)
- High Performance:
  - Read mode gain = 200 V/V
  - Input noise = 0.50 nV/√Hz (Nom)
  - Input capacitance = 9 pF (Nom)
  - Write current range = 2-30 mA
- Self switching damping resistance
- Pin compatible with the SSI 32R4610AR and SSI 32R2020R
- Write unsafe detection
- Power supply fault protection

**BLOCK DIAGRAM**



**PIN DIAGRAM**



**20-Lead SOL, VSOP**

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

# SSI 32R2300/2300R/2301/2301R

## 3.3V, 5V, 2, 4-Channel

### 2-Terminal Read/Write Device

#### CIRCUIT OPERATION

The SSI 32R2300/2300R have 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, CS, HSO and HS1 have internal pull-up resistors.

**TABLE 1: Mode Select**

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

#### 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: a negative transition on WDI 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
VCC1	I	Power Supply
VCC2	I	Power Supply for Write current drivers
GND	I	Ground

† When more than one R/W device is used, signals can be wire OR'ed

#### WRITE MODE

Taking both CS and R/W low selects Write mode which configures the SSI 32R2300/2300R 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). Note that a preceding Read to Write transition or Idle to Write transition

initializes the Write Data Flip-Flop to pass write current into the "X" side of the device. In this case, the Y side is higher potential than the X side. The magnitude of the write current (0-pk) is given by:

$$I_w = A_w \cdot \frac{V_{wc}}{R_{wc}} = K/R_{wc}$$

where  $A_w$  is the write current gain. RWC is connected from pin WC to GND. Note the actual head current  $I_x, y$  is given by:

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

# SSI 32R2300/2300R/2301/2301R

## 3.3V, 5V, 2, 4-Channel

### 2-Terminal Read/Write Device

Where:

Rh = Head resistance plus external wire resistance

Rd = Damping resistance

In Write mode a 350 Ω damping resistor is switched in across the Hx, Hy ports (32R2300R only).

#### VOLTAGE FAULT

A voltage Fault detection circuit improves data security by disabling the write current generator during a voltage fault or power startup in Read or Write mode.

#### 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
- Device not selected
- Open head
- Head short to ground

WUS is valid in the write current/head characteristic region defined by  $5 < I_h \cdot L_h < 50 \text{ mA} \cdot \mu\text{H}$ , and  $1 < R_h < 1.25/I_h$ . After the fault condition is removed, one negative transition on WDI is required to clear WUS. Overcurrent protection during a head short to ground is

accomplished by placing a series resistor between VCC1 and VCC2. The write current driver will shut down when  $VCC1 - VCC2 \geq 0.3\text{V}$ . The resistor must be sized so that  $VCC1 - VCC2 \leq 0.15\text{V}$  in normal operation.

#### READ MODE

The Read mode configures the SSI 32R2300/2300R 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 HnX, HnY inputs are non-inverting to the RDX, RDY 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 change 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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## ELECTRICAL SPECIFICATIONS

### ABSOLUTE MAXIMUM RATINGS

Operation above maximum ratings may permanently damage the device.

PARAMETER		RATING
DC Supply Voltage	VCC1	-0.3 to +7 VDC
	VCC2	-0.3 to +7 VDC
Write Current	Iw	30 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	+8 mA
Storage Temperature	Tstg	-55 to +150°C

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**SSI 32R2300/2300R/2301/2301R**  
**3.3V, 5V, 2, 4-Channel**  
**2-Terminal Read/Write Device**

**RECOMMENDED OPERATING CONDITIONS**

PARAMETER	RATING
DC Supply Voltage VCC1 = VCC2	3.3±10%, 5.0±10% VDC
Recommended Head Load Range Lh	0.3 - 5.0 μH
WUS Operating Range Iw • Lh	5.0 - 50.0 mA • μH
Head Differential Load Capacitance	15 pF max
Ambient Operating Temperature	0 - 70 °C

**DC CHARACTERISTICS**

Recommended operating conditions apply unless otherwise specified.

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
VCC1 Supply Current	Read Mode Vcc = 3.3V ±10%		19	29	mA
	Write Mode Vcc = 3.3V ±10%		2 + 0.2 Iw	3 + 0.3 Iw	mA
	Idle Mode Vcc = 3.3V ±10%		0.15	0.27	mA
VCC2 Supply Current	Read Mode Vcc = 3.3V ±10%		-	0.1	mA
	Write Mode Vcc = 3.3V ±10%		1.0 + Iw	3.0 + Iw	mA
	Idle Mode Vcc = 3.3V ±10%		-	0.01	mA
Power Dissipation	Read Mode Vcc = 3.3V ±10%		63	105	mW
	Write Mode Vcc = 3.3V ±10%		10 + 4 • Iw	20 + 5 • Iw	mW
	Idle Mode Vcc = 3.3V ±10%		0.5	1	mW
VCC1 Supply Current	Read Mode Vcc = 5.0V ±10%		20	32	mA
	Write Mode Vcc = 5.0V ±10%		3 + 0.2 Iw	5 + 0.3 Iw	mA
	Idle Mode Vcc = 5.0V ±10%		0.25	0.45	mA
VCC2 Supply Current	Read Mode Vcc = 5.0V ±10%			0.1	mA
	Write Mode Vcc = 5.0V ±10%		2.0 + Iw	4.0 + Iw	mA
	Idle Mode Vcc = 5.0V ±10%			0.01	mA
Power Dissipation	Read Mode Vcc = 5.0V ±10%		100	180	mW
	Write Mode Vcc = 5.0V ±10%		20 + 6 • Iw	45 + 7.2 Iw	mW
	Idle Mode Vcc = 5.0V ±10%		1.25	2.5	mW

**DIGITAL INPUTS**

Input Low voltage (VIL)				0.8	VDC
Input High Voltage (VIH)		2.0			VDC
Input Low Current	VIL = 0.4	Vcc = 3.6V	-0.4	-0.09	mA
		Vcc = 5.5V	-0.4	-0.13	mA
Input High Current	VIH = 2.7V	0	20		μA
WUS Output Low Voltage (VOL)	Iol = 2 mA max	.35	0.5		VDC
Input Low Current	2 channel version for HSO	Vcc = 3.6V	-0.4	-0.22	
		Vcc = 5.5V	-0.6	-0.35	

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**SSI 32R2300/2300R/2301/2301R**  
**3.3V, 5V, 2, 4-Channel**  
**2-Terminal Read/Write Device**

**WRITE CHARACTERISTICS**

Recommended operating conditions apply unless otherwise specified.

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
VCC1 Fault Voltage	$I_w < 0.2 \text{ mA}$		2.5	2.75	VDC
Write Current Gain	$I_w = 2\text{-}5 \text{ mA}$ $V_{CC} = 3.3\text{V} \pm 10\%$	18.0	22.0	24.9	mA/mA
	$I_w = 5\text{-}30 \text{ mA}$ $V_{CC} = 3.3\text{V} \pm 10\%$	18.3	20.5	23.0	mA/mA
	$I_w = 2\text{-}5 \text{ mA}$ $V_{CC} = 5.0\text{V} \pm 10\%$	18.6	23.1	26.0	mA/mA
	$I_w = 5\text{-}30 \text{ mA}$ $V_{CC} = 5.0\text{V} \pm 10\%$	18.9	21.7	24.1	mA/mA
Write Current Voltage (VWC)		1.2	1.3	1.4	V
Differential Head Voltage Swing	Open head	4.0	4.8		V <sub>pp</sub>
Unselected Head Current	AC			0.1 $I_w$	mA (pk)
	DC			0.1	mA
Head Differential Load Resistance (R <sub>d</sub> )	32R2300	2400	3000	3600	$\Omega$
	32R2300R	250	350	450	$\Omega$
WDI Pulse Width	$V_{il} \leq 0.8\text{V}$ , $V_{ih} \geq 2.0\text{V}$ PWH	5			ns
	$t_r = t_f = 1\text{ ns}$ PWL	10			ns
Write Current Range ( $I_w$ )		2		30	mA

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**READ CHARACTERISTICS**

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

Differential Voltage Gain	$V_{in} = 1 \text{ mVpp}$ @1 MHz	160	200	240	V/V
Voltage BW	-1dB $ Z_s  < 5\Omega$ , $V_{in} = 1 \text{ mVpp}$	20	35		MHz
	-3dB	40	70		MHz
Input Noise Voltage	BW = 15 MHz, L <sub>h</sub> = 0, R <sub>h</sub> = 0		0.50	0.75	nV/ $\sqrt{\text{Hz}}$
Input Noise Current			3		pA/ $\sqrt{\text{Hz}}$
Differential Input Capacitance	$V_{in} = 1 \text{ mVpp}$ , f = 5 MHz		9	14	pF
Differential Input Resistance	$V_{in} = 1 \text{ mVpp}$ , f = 5 MHz				
	32R2300	500	750	1800	$\Omega$
	32R2300R	500	750	1800	$\Omega$
Dynamic Range	AC input voltage where gain falls to 90% of its small signal gain value, f = 5 MHz	2	5		mV <sub>pp</sub>
Common Mode Rejection Ratio	$V_{in} = 0 \text{ VDC} + 100 \text{ mVpp}$ @ 5 MHz	45	60		dB
Power Supply Rejection Ratio	100 mV <sub>pp</sub> @ 5 MHz on VCC	40	70		dB
Channel Separation	Unselected channels driven with $V_{in} = 0 \text{ VDC} + 100 \text{ mVpp}$	45	60		dB

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# SSI 32R2300/2300R/2301/2301R

## 3.3V, 5V, 2, 4-Channel

### 2-Terminal Read/Write Device

#### READ CHARACTERISTICS (continued)

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
Output Offset Voltage	Head shorted	-200		+200	mV
	Head opened	-250		+250	mV
Single Ended Output Resistance	f = 5 MHz		60	100	$\Omega$
Output Current	AC coupled load, RDX to RDY	1.0	2.0		mA
RDX, RDY Common Mode Output Voltage		V <sub>cc</sub> -1.0	V <sub>cc</sub> -1.35	V <sub>cc</sub> -1.70	VDC

#### SWITCHING CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified. I<sub>W</sub> = 15 mA, L<sub>h</sub> = 1.0  $\mu$ H, R<sub>h</sub> = 30 $\Omega$ , f(Data) = 5 MHz.

R/W	Read to Write	R/W to 90% of write current; WUS valid		0.3	1.0	$\mu$ s
	Write to Read	R/W to 90% of 100 mV Read signal envelope		0.4	1	$\mu$ s
CS	Unselect to Select	CS to 90% of 100 mV 10 MHz Read signal envelope		0.6	2	$\mu$ s
	Select to Unselect	CS to 10% of write current		0.1	1	$\mu$ s
HS0,1 to any Head		To 90% of 100 mV 10 MHz Read signal envelope		0.2	1	$\mu$ s
WUS*	Safe to Unsafe (TD1)	Write mode, loss of WDI transitions; Defines max WDI period for WUS operation	0.6	2.0	3.6	$\mu$ s
	Unsafe to Safe (TD2)	Fault cleared: from first negative WDI transition		0.2	1.0	$\mu$ s
WDI	Frequency Range	Valid WUS	1.67		25	MHz
Head Current	WDI to I <sub>x</sub> - I <sub>y</sub> (TD3)	L <sub>h</sub> = 0, R <sub>h</sub> = 0 from 50% points		25	40	ns
	Asymmetry	WDI has 1 ns rise/fall time			1.5	ns
	Rise/fall Time	10% to 90% points I <sub>w</sub> = 15 mA, R <sub>h</sub> = 0, L <sub>h</sub> = 0		6	9	ns
		I <sub>w</sub> = 15 mA, R <sub>h</sub> = 30 $\Omega$ , L <sub>h</sub> = 1 $\mu$ H		14	18	ns

\* 5 < I<sub>w</sub> · L<sub>h</sub> < 50 mA ·  $\mu$ H, 1 < R<sub>h</sub> ≤ 1.25/I<sub>w</sub>

SSI 32R2300/2300R/2301/2301R  
3.3V, 5V, 2, 4-Channel  
2-Terminal Read/Write Device

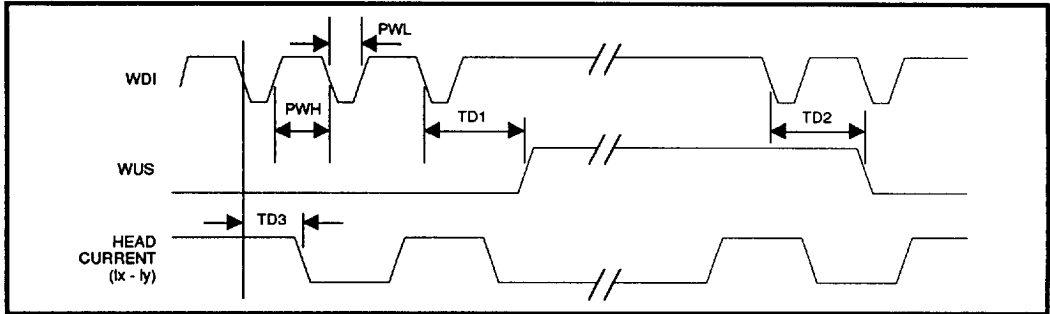


FIGURE 1: Write Mode Timing Diagram

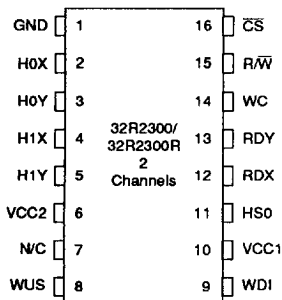
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## 3.3V, 5V, 2, 4-Channel

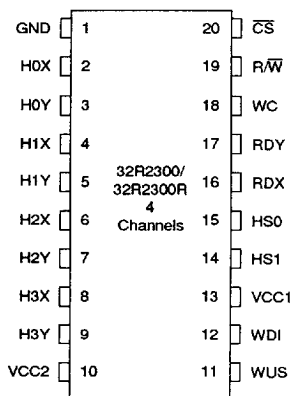
### 2-Terminal Read/Write Device

#### PACKAGE PIN DESIGNATIONS

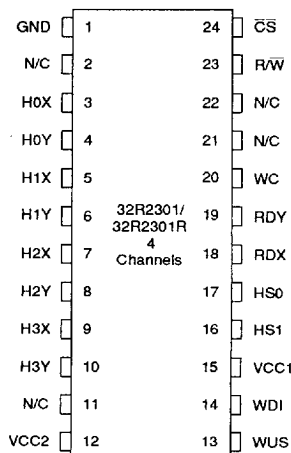
(Top View)



**16-Lead SOL**



**20-Lead SOL, VSOP**



**24-Lead VSOP**

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

#### ORDERING INFORMATION

PART DESCRIPTION	ORDERING NUMBER	PACKAGE MARK
SSI 32R2300R/2301R R Version		
2-Channel 16-Lead SOL	32R2300R-2CL	32R2300R-2CL
4-Channel 20-Lead SOL	32R2300R-4CL	32R2300R-4CL
4-Channel 20-Lead SOV	32R2300R-4CV	32R2300R-4CV
4-Channel 24-Lead SOV	32R2301R-4CV	32R2301R-4CV
SSI 32R2300/2301 Non-R Version		
2-Channel 16-Lead SOL	32R2300-2CL	32R2300-2CL
4-Channel 20-Lead SOL	32R2300-4CL	32R2300-4CL
4-Channel 20-Lead SOV	32R2300-4CV	32R2300-4CV
4-Channel 24-Lead SOV	32R2301-4CV	32R2301-4CV

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Patent Pending  
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