

**DESCRIPTION**

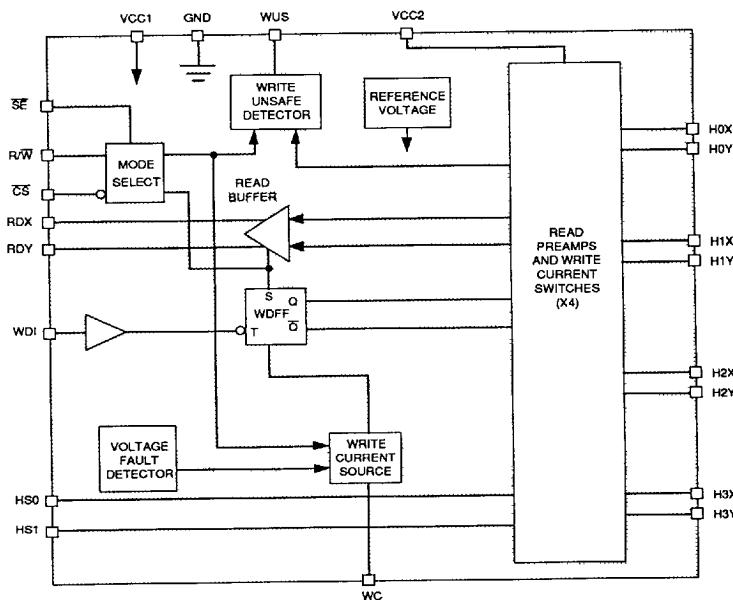
The SSI 32R2320/21/22/23/24 are BiCMOS monolithic integrated circuit designed for use with two-terminal recording heads. They provide a low noise read amplifier, write current control, and data protection circuitry for up to four channels. This family of devices has been designed to support servo bank write, TTL or ECL write data input, and write unsafe output through various bond options. In addition, versions of the devices are available with or without internal damping resistors. When configured with damping resistors, the resistors 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 making the read channel outputs high impedance.

The SSI 32R2320/21/22/23/24 require a single 3.0 to 5.5V power supply and are available in a variety of packages. They are hardware compatible with the SSI 32R4610A and SSI 32R2020R Read/Write devices.

**FEATURES**

- +3.0V - 5.5V voltage supply
- Low power
  - PD = 73 mW Read mode (Nom) (@3.3V supply)
  - PD = 75  $\mu$ W Idle (Max @ Vcc = 3.3V)
- High Performance:
  - Read mode gain = 250 V/V
  - Input noise = 0.50 nV/ $\sqrt$ Hz (Nom)
  - Input capacitance = 9 pF (Nom)
  - Write current range = 2-30 mA
- Bond options for:
  - Self switching damping resistance
  - Servo bank write
  - TTL or ECL write data input
  - Write unsafe detection
- Power supply fault protection

**BLOCK DIAGRAM**



# SSI 32R2320/21/22/23/24

## 3V, 5V, 4-Channel

### 2-Terminal Read/Write Device

#### FUNCTIONAL DESCRIPTION

The SSI 32R2320/21/22/23/24 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  $\overline{R/\overline{W}}$ ,  $\overline{CS}$  and DMP have internal pull-up resistors. The TTL inputs HS0 and HS1 have internal pull down resistors.

**TABLE 1: Mode Select**

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

**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  $\overline{R/\overline{W}}$  low selects write mode which configures the device 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:

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

where  $A_w$  is the write current gain.  $R_{wc}$  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 350 $\Omega$  damping resistor is switched in across the Hx, Hy ports.

#### 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
- No write current

# SSI 32R2320/21/22/23/24

## 3V, 5V, 4-Channel

### 2-Terminal Read/Write Device

#### WRITE UNSAFE (continued)

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.

#### READ MODE

The Read mode configures the SSI 32R2320RZ 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  $\overline{\text{CS}}$  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 at  $\overline{\text{CS}}$ , input is greater than ( $V_{cc} - 0.3V$ ).

#### PIN DESCRIPTION

NAME	TYPE	DESCRIPTION
HS0, HS1 †	I	Head Select: selects one of four heads
$\overline{\text{CS}}$	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/ $\overline{\text{WDI}}$ †	I	Write Data Input: On TTL versions, a negative transition on WDI changes the direction of the current in the recording head. On ECL versions, a positive transition on the WDI (negative transition on $\overline{\text{WDI}}$ changes the direction of the current in the recording head. $\overline{\text{WDI}}$ is only present on the ECL versions.
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
GND	I	Ground
$\overline{\text{SE}}$	I	Servo Enable: A low input on this line enables the servo bank write mode when $\overline{\text{CS}}$ and R/W are both low.
WUS/SE	I	Write Unsafe/Servo Enable (32R2323/24 only): Under normal operation, a high level output on this pin indicates a write unsafe condition. When this pin is driven externally above VCC and $\overline{\text{CS}}$ and R/W are both low, servo write mode is activated.
DMP	I	Damping Resistor Enable (32R2322 only): A high (or open) level on this input enables the switchable damping resistor. A low level on this input disables the damping resistor.

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

# SSI 32R2320/21/22/23/24

## 3V, 5V, 4-Channel

### 2-Terminal Read/Write Device

#### 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	I <sub>w</sub>	30 mA
Digital Input Voltage	V <sub>in</sub>	-0.3 to VCC1 +0.3 VDC
Head Port Voltage	V <sub>H</sub>	-0.3 to VCC2 +0.3 VDC
Output Current: RDX, RDY	I <sub>O</sub>	-10 mA
	WUS	+8 mA
Storage Temperature	T <sub>stg</sub>	-55 to +150°

##### RECOMMENDED OPERATING CONDITIONS

PARAMETER		RATING
DC Supply Voltage		3.3 ±10%, 5.0 ±10% VDC
Recommended Head Load Range	L <sub>h</sub>	0.3 - 5.0 μH
WUS Operating Range	I <sub>w</sub> • L <sub>h</sub>	5.0 - 50.0 mA • μH
Head Differential Load Capacitance		15 pF max
Ambient Operating Temperature*		0 - 70 °C

\* Derating is required when in Servo Write mode.

##### DC CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified.

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
VCC1 Supply Current	V <sub>cc</sub> = 3.3V ±10% Read		22.0	30.0	mA
	V <sub>cc</sub> = 3.3V ±10% Write		5+1.2 • I <sub>w</sub>	9+1.4 • I <sub>w</sub>	mA
	V <sub>cc</sub> = 3.3V ±10% Servo		6+4.5 • I <sub>w</sub>	11+4.7 • I <sub>w</sub>	mA
	V <sub>cc</sub> = 3.3V ±10% Idle, $\overline{CS} = V_{cc}$		3	20	μA
	V <sub>cc</sub> = 3.3V ±10% Idle, $\overline{CS} = 2.7V$		30	200	μA
Power Dissipation	V <sub>cc</sub> = 3.3V ±10% Read		73	110	mW
	V <sub>cc</sub> = 3.3V ±10% Write		17+4 • I <sub>w</sub>	33+5 • I <sub>w</sub>	mW
	V <sub>cc</sub> = 3.3V ±10% Servo		20+15 • I <sub>w</sub>	40+17 • I <sub>w</sub>	mW
	V <sub>cc</sub> = 3.3V ±10% Idle, $\overline{CS} = V_{cc}$		9	75	μW
	V <sub>cc</sub> = 3.3V ±10% Idle, $\overline{CS} = 2.7V$		100	730	μW

**SSI 32R2320/21/22/23/24**  
**3V, 5V, 4-Channel**  
**2-Terminal Read/Write Device**

**DC CHARACTERISTICS** (continued)

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
VCC1 Supply Current	Vcc = 5.0V ±10% Read		23.0	32.0	mA
	Vcc = 5.0V ±10% Write		6+1.2 · Iw	10+1.3 · Iw	mA
	Vcc = 5.0V ±10% Servo		7+4.4 · Iw	12+4.7 · Iw	mA
	Vcc = 5.0V ±10% Idle, CS = Vcc		5	30	µA
	Vcc = 5.0V ±10% Idle, CS = 2.7V		250	450	µA
Power Dissipation	Vcc = 5.0V ±10% Read		115	180	mW
	Vcc = 5.0V ±10% Write		30+6 · Iw	55+7 · Iw	mW
	Vcc = 5.0V ±10% Servo		35+22 · Iw	66+26 · Iw	mW
	Vcc = 5.0V ±10% Idle, CS = Vcc		0.03	0.17	mW
	Vcc = 5.0V ±10% Idle, CS = 2.7V		1.25	2.5	mW

**DIGITAL INPUTS**

Input Low voltage (VIL)	CS, R/W, WDI, HSn and SE			0.8	VDC
Input High Voltage (VIH)	CS, R/W, WDI, HSn and SE	2.0			VDC
Input Low Current	VIL = 0.4 Vcc = 3.6V	-0.4	-0.09		mA
	CS, R/W, WDI, SE Vcc = 5.5V	-0.4	-0.13		mA
Input High Current	VIH = 2.7V CS, R/W, WDI, SE		0	20	µA
WUS Output Low Voltage (VOL)	Iol = 2 mA max		0.35	0.5	VDC
Input Low Current	HSn and SE VIL = 0.4V		10	40	µA
Input High Current	HSn and SE VIH = 2.7V		100	400	µA
Input Low Voltage	WD, WD	Vcc -1.0		Vcc -0.4	V
Input High Voltage	WD, WD	Vcc -2.0		Vcc -0.8	V
Δ VIN	WD - WD	0.4	0.8		V
Input Low Current	WD, WD Vcc = 5V		100	200	µA
	VIH = Vcc - 0.8V				
Input High Current	WD, WD Vcc = 5V		75	150	µA
	VIL = Vcc - 1.6V				

# SSI 32R2320/21/22/23/24

## 3V, 5V, 4-Channel

### 2-Terminal Read/Write Device

#### ELECTRICAL SPECIFICATIONS (continued)

##### 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 ( $A_w$ )	$I_w = 2-5 \text{ mA}$ $V_{cc} = 3.3V \pm 10\%$	19.5	22.0	26.4	mA/mA
	$I_w = 5-30 \text{ mA}$ $V_{cc} = 3.3V \pm 10\%$	18.3	20.5	23.0	mA/mA
	$I_w = 2-5 \text{ mA}$ $V_{cc} = 5.0V \pm 10\%$	20.6	23.1	28.0	mA/mA
	$I_w = 5-30 \text{ mA}$ $V_{cc} = 5.0V \pm 10\%$	19.3	21.7	24.5	mA/mA
Write Current Error	$R_{wc} = 2 \text{ k}\Omega$ , head to head @ Write mode*	-5		+5	%
	$R_{wc} = 2 \text{ k}\Omega$ , head to head @ Servo mode*	-5		+5	%
	$R_{wc} = 2 \text{ k}\Omega$ , Write to Servo	-7		+7	%
Write Current Voltage (VWC)		1.2	1.3	1.4	V
Differential Head Voltage Swing	Open head, $\overline{SE} = 1$	4.0	4.8		V <sub>pp</sub>
	Open head, $V_{cc} = 5V$ , $\overline{SE} = 0$	4.0	4.8		V <sub>pp</sub>
	Open head, $V_{cc} = 3.3V$ , $\overline{SE} = 0$	3.4	4.8		V <sub>pp</sub>
Unselected Head Current	AC			1	mA (pk)
	DC			0.1	mA
Head Differential Load Resistance ( $R_d$ )	R version	300	400	500	$\Omega$
	non-R version	2400	3000	3600	$\Omega$
WDI Pulse Width	$V_{il} \leq 0.8V$ , $V_{ih} \geq 2.0V$ PWH	5			ns
	$t_f = t_r = 1 \text{ ns}$ PWL	10			ns
Write Current Range ( $I_w$ )		2		30	mA

\* Error from average of the four heads.

##### 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	200	250	300	V/V
Voltage BW	$ Z_s  < 5\Omega$ , $V_{in} = 1 \text{ mVpp}$	-1dB	20	40	MHz
		-3dB	40	80	MHz
Input Noise Voltage	BW = 15 MHz, L <sub>h</sub> = 0, R <sub>h</sub> = 0		0.50	0.75	nV/ $\sqrt{\text{Hz}}$
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	500	750	1800	$\Omega$

# SSI 32R2320/21/22/23/24

## 3V, 5V, 4-Channel

### 2-Terminal Read/Write Device

#### 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	5		mVpp
Common Mode Rejection Ratio	Vin = 0 VDC + 100 mVpp @ 5 MHz	45	60		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	60		dB
Output Offset Voltage	Head shorted	-250		+250	mV
	Head opened	-300		+300	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		Vcc-1.0	Vcc-1.35	Vcc-1.70	VDC

#### SWITCHING CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified. Rwc = 2k $\Omega$ , Lh = 1.0  $\mu$ H, Rh = 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		0.4	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

\*  $5 < I_w \cdot L_h < 50 \text{ mA} \cdot \mu\text{H}$ ,  $1 < R_h \leq 1.25/I_w$ , WUS available in bonding option.

# SSI 32R2320/21/22/23/24

## 3V, 5V, 4-Channel

### 2-Terminal Read/Write Device

#### SWITCHING CHARACTERISTICS (continued)

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
Head Current	Lh = 0, Rh = 0				
WDI to lx - ly (TD3)	from 50% points		25	40	ns
Asymmetry	WDI has 1 ns rise/fall time			1.5	ns
Rise/fall Time	10% to 90% points				
	Rwc = 2kΩ, Rh = 0, Lh = 0		2	9	ns
	Rwc = 2kΩ, Rh = 30Ω, Lh = 1μH		14	18	ns

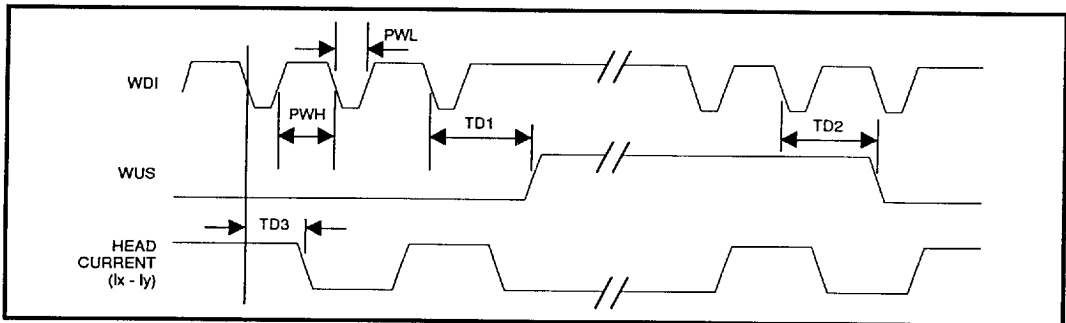


FIGURE 1: Write Mode Timing Diagram

TABLE 1: Device Option Summary

Device #	WDI Type	Servo Enable	Damping Resistor	WUS
32R2320W	TTL	$\overline{SE}$	No	No
32R2320RW	TTL	$\overline{SE}$	350Ω	No
32R2321W	ECL	$\overline{SE}$	No	No
32R2321RW	ECL	$\overline{SE}$	350Ω	No
32R2322RW	TTL	SE	DMP pin	Yes
32R2323W	TTL	WUS/SE	No	Yes
32R2323RW	TTL	WUS/SE	350Ω	Yes
32R2324W	ECL	WUS/SE	No	Yes
32R2324RW	ECL	WUS/SE	350Ω	Yes



# SSI 32R2320/21/22/23/24

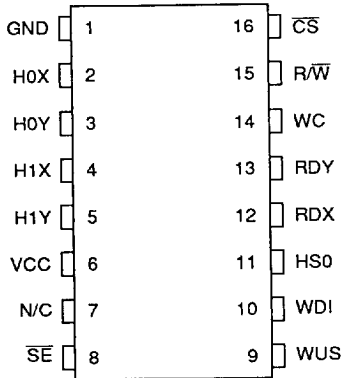
## 3V, 5V, 4-Channel

### 2-Terminal Read/Write Device

#### PACKAGE PIN DESIGNATIONS

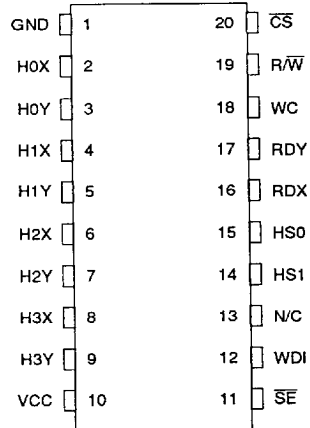
(Top View)

#### 32R2320 Package Options



#### 16-Pin Packages:

- 32R2320RW-2CL (SOL)
- 32R2320W-2CL (SOL)
- 32R2320RW-2CN (SON)
- 32R2320W-2CN (SON)



#### 20-Pin Packages:

- 32R2320RW-4CL (SOL)
- 32R2320W-4CL (SOL)
- 32R2320RW-4CV (VSOP)
- 32R2320W-4CV (VSOP)
- 32R2320RW-4CVT (VTSOP)
- 32R2320W-4CVT (VTSOP)

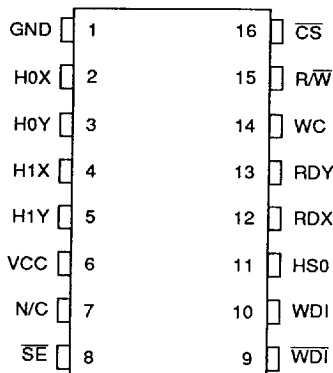
CAUTION: Use handling procedures necessary for a static sensitive component.

# SSI 32R2320/21/22/23/24

## 3V, 5V, 4-Channel

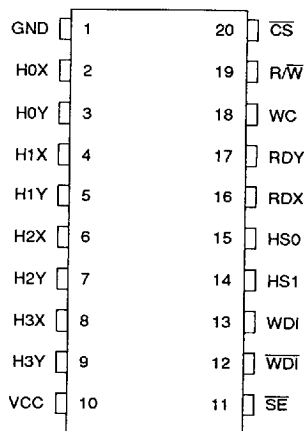
### 2-Terminal Read/Write Device

#### 32R2321 Package Options



16-Pin Packages:

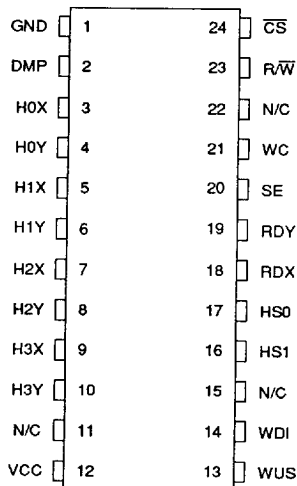
- 32R2321RW-2CL (SOL)
- 32R2321W-2CL (SOL)
- 32R2321RW-2CN (SON)
- 32R2321W-2CN (SON)



20-Pin Packages:

- 32R2321RW-4CL (SOL)
- 32R2321W-4CL (SOL)
- 32R2321RW-4CV (VSOP)
- 32R2321W-4CV (VSOP)
- 32R2321RW-4CVT (VTSOP)
- 32R2321W-4CVT (VTSOP)

#### 32R2322 Package Options



24-Pin Packages:  
32R2322RW-4CVT (VTSOP)

CAUTION: Use handling procedures necessary for a static sensitive component

# SSI 32R2320/21/22/23/24

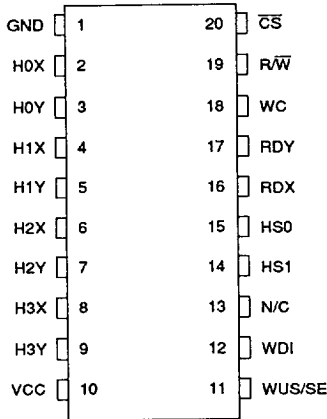
## 3V, 5V, 4-Channel

### 2-Terminal Read/Write Device

#### PACKAGE PIN DESIGNATIONS (continued)

(Top View)

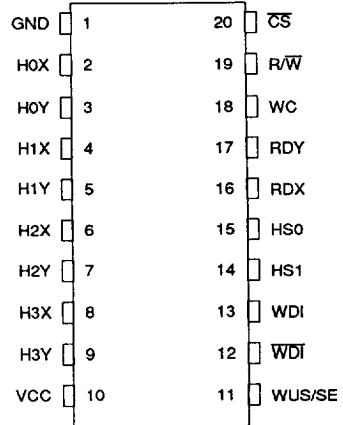
#### 32R2323 Package Options



20-Pin Packages:

**32R2323RW-4CV (VSOP)**  
**32R2323W-4CV (VSOP)**

#### 32R2324 Package Options



20-Pin Packages:

**32R2324RW-4CV (VSOP)**  
**32R2324W-4CV (VSOP)**

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

**Advance Information:** Indicates a product still in the design cycle, and any specifications are based on design goals only. Do not use for final design

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Silicon Systems, Inc., 14351 Myford Road, Tustin, CA 92680-7022 (714) 573-6000, FAX (714) 573-6914

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