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

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DESCRIPTION

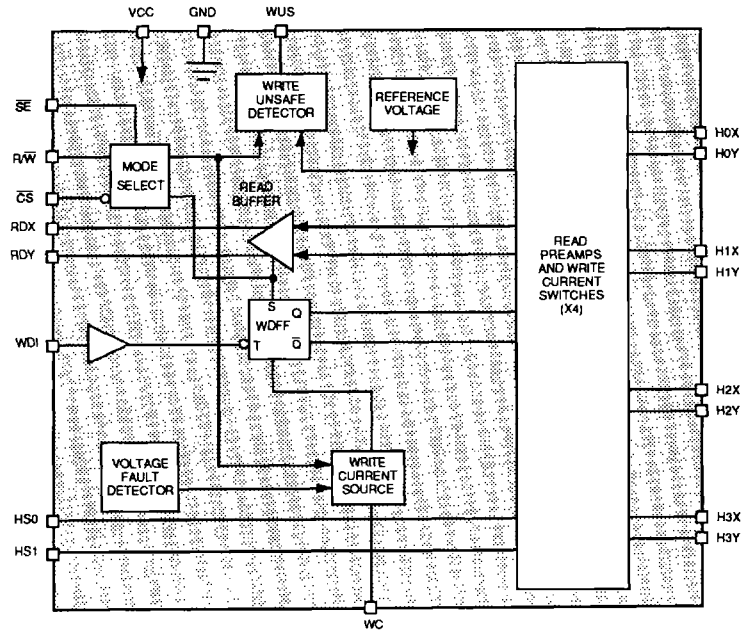
The SSI 32R2320/21/22/23/24 are BiCMOS monolithic integrated circuit designed for use with two-terminal recording heads. They provide a low noise read amplifier, write current control, and data protection circuitry for up to four channels. This family of devices has been designed to support servo bank 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 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

- +3V - 5.5V voltage supply
- Low power
  - PD = 73 mW read mode (Nom) (@3.3V supply)
  - PD = 75 µW Idle (Max @ Vcc = 3.3V)
- High Performance:
  - Read mode gain = 250 V/V
  - Input noise = 0.5 nV/√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 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

$\overline{CS}$	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 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:

$$Iw = Aw \cdot \frac{Vwc}{Rwc} = K/Rwc$$

where Aw is the write current gain.

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

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

where:

Rh = Head resistance plus external wire resistance
Rd = Damping resistance

In write mode a 350Ω damping resistor is switched in across the Hx, Hy ports.

SERVO WRITE MODE

This mode allows for writing to multiple channels at once, which is useful during servo formatting. When this mode is activated the write driver will drive all channels simultaneously.

The servo write mode can be enabled by either using the $\overline{SE}$/SE logic input or the WUS/SE bi-directional pin depending on the device option (table 1). Both the $\overline{CS}$ and R/$\overline{W}$ inputs have to be low to activate servo bank write. When using the WUS/SE pin to enable servo write, the pin voltage is driven to 1.5V (nom) above VCC. The $\overline{SE}$ is a TTL active low input; the SE is a TTL active high input. The WUS/SE pin voltage should not exceed VCC + 2V or +7V, whichever is greater. The servo enable delay is about 1µs typical.

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

WUS is valid in the write current/head characteristic region defined by 5 < Ih • Lh < 50 mA • µH, and 1 < Rh < 1.25/Ih. 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 $\overline{CS}$ 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 $\overline{CS}$, input is greater than (Vcc - 0.3V).

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PIN DESCRIPTION

NAME	TYPE	DESCRIPTION
HS0, HS1 †	I	Head Select: selects one of four heads
$\overline{CS}$	I	Chip Select: a high inhibits the chip
R/$\overline{W}$ †	I	Read/Write: a high selects read mode
WUS †	O	Write Unsafe: a high indicates an unsafe writing condition
WDI/$\overline{WDI}$ †	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 $\overline{WDI}$ changes the direction of the current in the recording head. $\overline{WDI}$ 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
VCC	I	Power Supply
GND	I	Ground
$\overline{SE}$/SE	I	Servo Enable: A low input on $\overline{SE}$, or a high input on SE (32R2322 only) enables the servo bank write mode when $\overline{CS}$ and R/$\overline{W}$ 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 $\overline{CS}$ and R/$\overline{W}$ 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 that one R/W device is used, signals can be wire OR'ed

ELECTRICAL SPECIFICATIONS

Recommended conditions apply unless otherwise specified.

ABSOLUTE MAXIMUM RATINGS

Operation above maximum ratings may permanently damage the device.

PARAMETER		RATING
DC Supply Voltage	VCC	-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
WUS pin Voltage	Vwus	+7 VDC
Output Current: RDX, RDY	I0	-10 mA
	WUS	+8 mA
Storage Temperature	Tstg	-55 to +150°

RECOMMENDED OPERATING CONDITIONS

PARAMETER		RATING
DC Supply Voltage		3.3 ±10%, 5 ±10% VDC
Recommended Head Load Range	Lh	0.3 - 5 µH
WUS Operating Range, Iw • Lh		5 - 50 mA • µH
Head Differential Load Capacitance		15 pF max
Ambient Operating Temperature*	Ta	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
VCC Supply Current	Vcc = 3.3V ±10% read		22	30	mA
	Vcc = 3.3V ±10% write		5+1.2 • Iw	9+1.4 • Iw	mA
	Vcc = 3.3V ±10% servo		6+4.5 • Iw	11+4.7 • Iw	mA
	Vcc = 3.3V ±10% idle, CS = Vcc		3	20	µA
	Vcc = 3.3V ±10% idle, CS = 2.7V		30	200	µA
Power Dissipation	Vcc = 3.3V ±10% read		73	110	mW
	Vcc = 3.3V ±10% write		17+4 • Iw	33+5 • Iw	mW
	Vcc = 3.3V ±10% servo		20+15 • Iw	40+17 • Iw	mW
	Vcc = 3.3V ±10% idle, CS = Vcc		9	75	µW
	Vcc = 3.3V ±10% idle, CS = 2.7V		100	730	µW

DC CHARACTERISTICS (continued)

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
VCC Supply Current	Vcc = 5V ±10% read		23	32	mA
	Vcc = 5V ±10% write		6+1.2 • Iw	10+1.3 • Iw	mA
	Vcc = 5V ±10% servo		7+4.4 • Iw	12+4.7 • Iw	mA
	Vcc = 5V ±10% idle, $\overline{CS}$ = Vcc		5	30	µA
	Vcc = 5V ±10% idle, $\overline{CS}$ = 2.7V		250	450	µA
Power Dissipation	Vcc = 5V ±10% read		115	180	mW
	Vcc = 5V ±10% write		30+6 • Iw	55+7 • Iw	mW
	Vcc = 5V ±10% servo		35+22 • Iw	66+26 • Iw	mW
	Vcc = 5V ±10% idle, $\overline{CS}$ = Vcc		0.03	0.17	mW
	Vcc = 5V ±10% idle, CS = 2.7V		1.25	2.5	mW

DIGITAL INPUTS

Input Low voltage	VIL	$\overline{CS}$, R/$\overline{W}$, WDI, HSn and $\overline{SE}$			0.8	VDC
Input High Voltage	VIH	$\overline{CS}$, R/$\overline{W}$, WDI, HSn and $\overline{SE}$	2			VDC
Input Low Current		VIL = 0.4 Vcc = 3.6V	-0.4	-.09		mA
		$\overline{CS}$, R/$\overline{W}$, WDI, SE Vcc = 5.5V	-0.4	-0.13		mA
Input High Current		VIH = 2.7V $\overline{CS}$, R/$\overline{W}$, WDI, $\overline{SE}$		0	20	mA
WUS Output Low Voltage	VOL	Iol = 2 mA max		0.35	0.5	VDC
Input Low Current		HSn and $\overline{SE}$ VIL = 0.4V		10	40	µA
Input High Current		HSn and $\overline{SE}$ VIH = 2.7V		100	400	µA
Input Low Voltage		WD, $\overline{WD}$	Vcc -1		Vcc -0.4	V
Input High Voltage		WD, $\overline{WD}$	Vcc -2		Vcc -0.8	V
Δ VIN		|WD - $\overline{WD}$|	0.4	0.8		V
Input Low Current		WD, $\overline{WD}$ Vcc = 5V VIH = Vcc - 0.8V		100	200	µA
Input High Current		WD, $\overline{WD}$ Vcc = 5V VIL = Vcc - 1.6V		75	150	µA

ELECTRICAL SPECIFICATIONS (continued)

WRITE CHARACTERISTICS

Recommended operating conditions apply unless otherwise specirfied.

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
VCC Fault Voltage	Iw < 0.2 mA		2.5	2.75	VDC
Write Current Gain Aw	Iw = 2-5 mAVcc = 3.3V±10%	20	24	29	mA/mA
	Iw = 5-30 mAVcc = 3.3V±10%	19	22	25	mA/mA
	Iw = 2-5 mAVcc = 5.0V±10%	21	25	30	mA/mA
	Iw = 5-30 mAVcc = 5.0V±10%	20	23	26	mA/mA
Write Current Error	Rwc = 2 kΩ, head to head @ write mode*	-5		+5	%
	Rwc = 2 kΩ, head to head @ servo mode*	-5		+5	%
	Rwc = 2 kΩ, 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	4.8		Vp-p
	open head, Vcc = 5V, $\overline{SE}$ = 0	4	4.8		Vp-p
	open head, Vcc = 3.3V, $\overline{SE}$ = 0	3.4	4.8		Vp-p
Unselected Head Current	AC			1	mA (pk)
	DC			0.1	mA
Head Differential Load Resistance Rd	R version	300	400	500	Ω
	non-R version	2400	3000	3600	Ω
WDI Pulse Width	Vil ≤ 0.8V, Vih ≥ 2V PWH	5			ns
	$t_f = t_r$ = 1 ns PWL	10			ns
Write Current Range Iw		2		30	mA

* Error from average of the four heads.

SERVO WRITE CHARACTERISTICS

WUS/SE Voltage	servo bank write enabled	VCC + 1.5		VCC + 2	V
WUS/SE Sink Current	servo bank write ennabled Vwus = VCC +1.5V		70	200	µA

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 mVp-p @1 MHz	200	250	300	V/V
Voltage BW -1 dB	|Zs| < 5Ω, Vin = 1 mVp-p	20	40		MHz
-3 dB		40	80		MHz
Input Noise Voltage	BW = 15 MHz, Lh = 0, Rh = 0		0.5	0.75	nV/√Hz
Differential Input Capacitance	Vin = 1 mVp-p, f = 5 MHz		9	14	pF
Differential Input Resistance	Vin = 1 mVp-p, f = 5 MHz	500	750	1800	Ω
Dynamic Range	AC input voltage where gain falls to 90% of its small signal gain value, f = 5 MHz	2	5		mVp-p
Common Mode Rejection Ratio	Vin = 0 VDC + 100 mVp-p @ 5 MHz	45	60		dB
Power Supply RejectionRatio	100 mVp-p @ 5 MHz on VCC	40	70		dB
Channel Separation	Unselected channels driven with Vin = 0 VDC + 100 mVp-p	45	60		dB
Output Offset Voltage	Head shorted	-250		+250	mV
	Head loaded 200Ω	-400		+400	mV
Single Ended Output Resistance	f = 5 MHz		60	100	Ω
Output Current	AC coupled load, RDX to RDY	1	2		mA
RDX, RDY Common Mode Output Voltage		Vcc-1	Vcc-1.35	Vcc-1.7	VDC

SWITCHING CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified. Rwc = 2kΩ, Lh = 1.0 µH, Rh = 30Ω f(Data) = 5 MHz.

PARAMETER		CONDITIONS	MIN	NOM	MAX	UNIT
R/$\overline{W}$	Read to Write	R/$\overline{W}$ to 90% of write current; WUS valid		0.3	1	µs
	Write to Read	R/$\overline{W}$ to 90% of 100 mV Read signal envelope		0.4	1	µs
$\overline{CS}$	Unselect to Select	$\overline{CS}$ to 90% of 100 mV 10 MHz Read signal envelope		0.6	2	µs
	Select to Unselect	$\overline{CS}$ to 10% of write current		0.4	1	µs
HS0,1 to any Head		To 90% of 100 mV 10 MHz Read signal envelope		0.2	1	µs
WUS*	Safe to Unsafe TD1	Write mode, loss of WDI transitions; Defines max WDI period for WUS operation	0.6	2	3.6	µs
	Unsafe to Safe TD2	Fault cleared: from first negative WDI transition		0.2	1	µs
WDI	Frequency Range	Valid WUS	1.67		25	MHz
Head Current	WDI to Ix - Iy TD3	Lh = 0, Rh = 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 Rwc = 2 kΩ, Rh = 0, Lh = 0		2	9	ns
		Rwc = 2 kΩ, Rh = 30Ω, Lh = 1µH		14	18	ns

* $5 < Iw \cdot Lh < 50$ mA • µH, $1 < Rh \leq 1.25/Iw$, WUS available in bonding option.

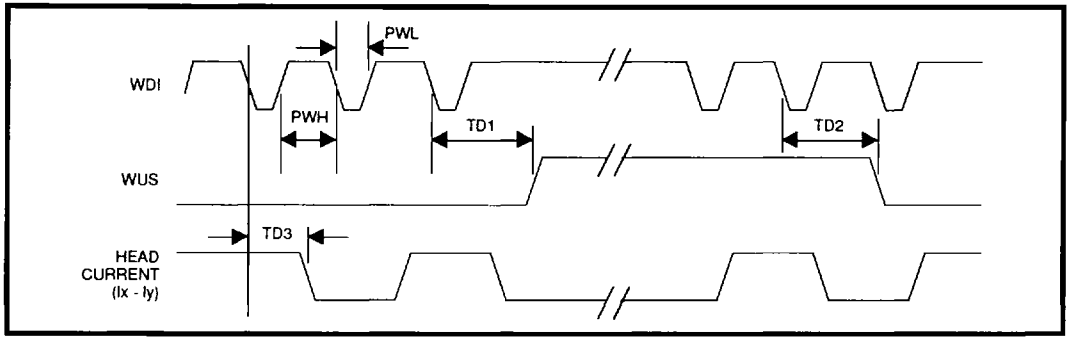

FIGURE 1: Write Mode Timing Diagram

TABLE 3: 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

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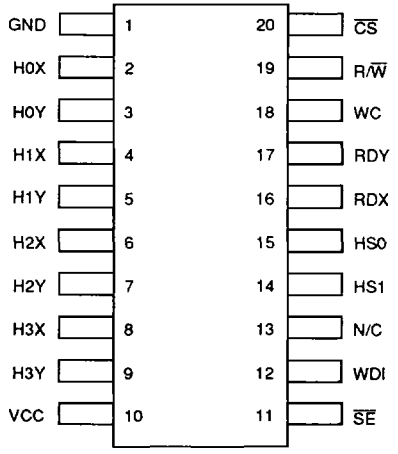
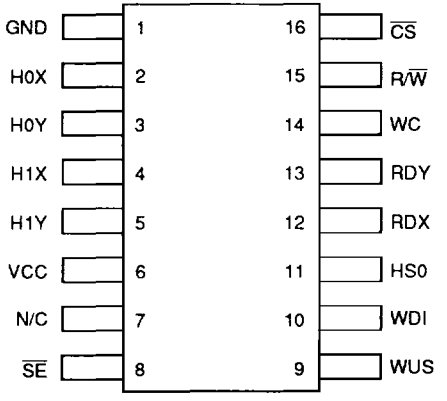
PACKAGE PIN DESIGNATIONS
(Top View)

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

32R2320 Package Options

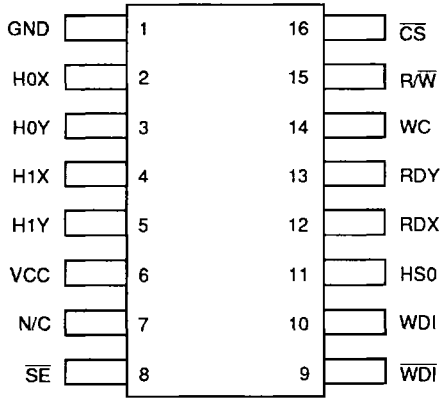


20-Lead SOL, VSOP, VTSOP

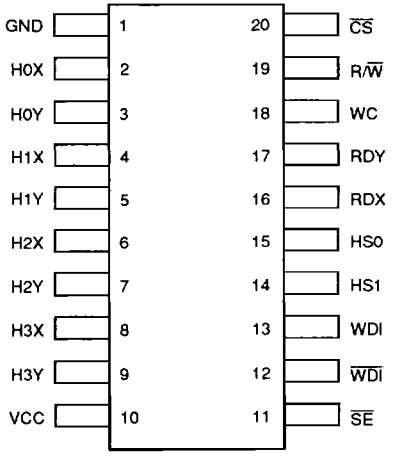


16-Lead SOL, SON

32R2321 Package Options

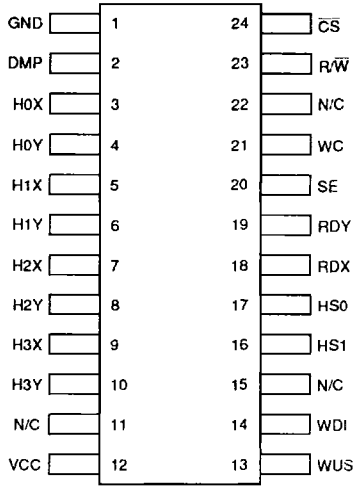


16-Lead SOL, SON



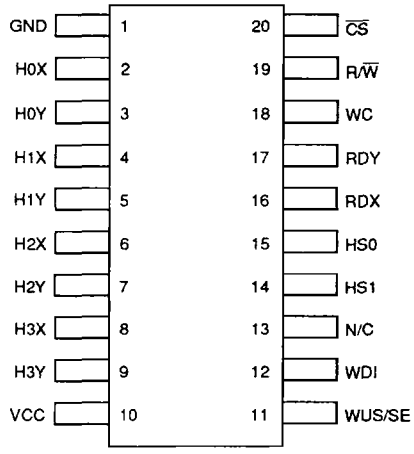
20-Lead SOL, VSOP, VTSOP

32R2322 Package Option



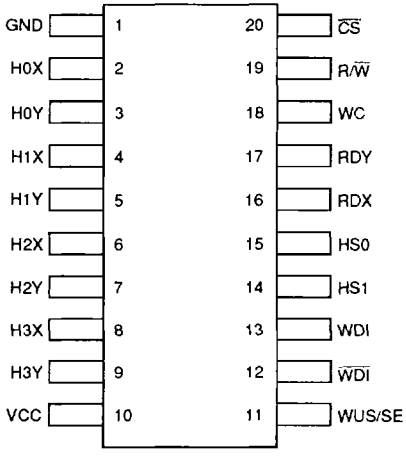
24-Lead VTSOP

32R2323 Package Option



20-Lead VSOP

32R2324 Package Option



20-Lead VSOP

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ORDERING INFORMATION

PART DESCRIPTION		ORDER NUMBER	PACKAGE MARK
SSI 32R2320R			
2-Channel	16-Lead SOL	32R2320RW-2CL	32R2320RW
	16-Lead SON	32R2320RW-2CN	32R2320RW
4-Channel	20-Lead SOL	32R2320RW-4CL	32R2320RW
	20-Lead VSOP	32R2320RW-4CV	32R2320RW
	20-Lead VTSOP	32R2320RW-4CVT	32R2320RW
SSI 32R2321R			
2-Channel	16-Lead SOL	32R2321RW-2CL	32R2321RW
	16-Lead SON	32R2321RW-2CN	32R2321RW
4-Channel	20-Lead SOL	32R2321RW-4CL	32R2321RW
	20-Lead VSOP	32R2321RW-4CV	32R2321RW
	20-Lead VTSOP	32R2321RW-4CVT	32R2321RW
SSI 32R2322R			
4-Channel	24-Lead VTSOP	32R2322RW-4CVT	32R2322RW
SSI 32R2323R			
4-Channel	20-Lead VSOP	32R2323RW-4CV	32R2323RW
SSI 32R2324R			
4-Channel	24-Lead VSOP	32R2324RW-4CV	32R2324RW

NOTE: These devices can be ordered with and without damping resistors. To specify devices without damping resistors, remove the "R" suffix: e.g., 32R2324W-4CV.

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