

March 1994

DESCRIPTION

The SSI 32R2020R/2021R/2023R are bipolar 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 ten channels. The SSI 32R2020R/2021R/2023R provide internal 320Ω damping resistors. Damping 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 controlling the read channel common mode output voltage shift in the write mode. The 32R2021R option provides the user with a controllable write current adjustment feature.

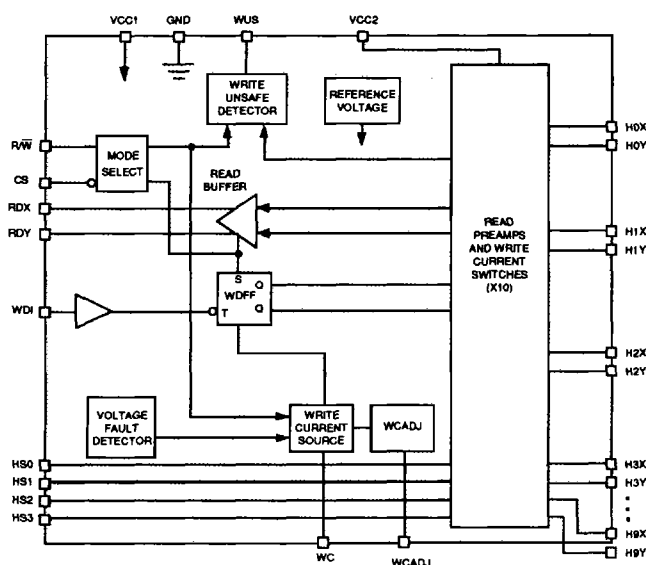
The SSI 32R2020R/2021R/2023R require only +5V power supplies and are available in a variety of packages. They are hardware compatible with the 32R4610A/4611A read/write devices.

FEATURES

- +5V ±10% supply
- Low power
 - PD = 130 mW read mode (Nom)
 - PD = 3.3 mW Idle (Nom)
- High Performance:
 - Multiple gain options
 - Input noise = 0.56 nV/√Hz (Nom)
 - Input capacitance = 16 pF (Nom)
 - Write current range = 5-35 mA
- Self switching damping resistance
- Designed for two-terminal thin-film or MIG heads with inductance up to 5.0 μH
- Pin compatible with the 32R4610AR/4611AR
- Write unsafe detection
- Power supply fault protection
- Head short to ground protection

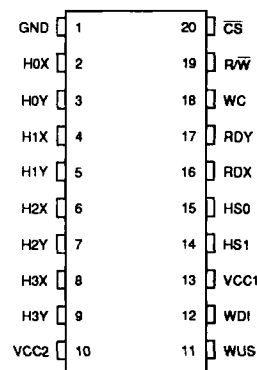
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BLOCK DIAGRAM



WCADJ available on the 32R2021R-4 24-pin option only

PIN DIAGRAM



20-Lead SOL

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

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5V, 2, 4, 6, 10-Channel

Thin-Film Read/Write Device

FUNCTIONAL DESCRIPTION

The SSI 32R2020R/2021R/2023R have the ability to address up to 10 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, HS1, HS2 and HS3 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

HS3	HS2	HS1	HS0	Head
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

WRITE MODE

Taking both \overline{CS} and R/W low selects write mode which configures the SSI 32R2020R/2021R/2023R 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:

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

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 320 Ω damping resistor is switched in across the Hx, Hy ports.

The 32R2021R 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 $V_{CC}/2$. 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. A TTL gate can be used as a switch with a small degradation in accuracy. The amount of write current decrease is shown below:

$$I_w \text{ head (decrease) (mA)} = (29 \cdot V_{WCADJ}/R_{WCADJ})$$

where:

$$V_{WCADJ} = V_{CC}/2 \text{ (volts)}$$

$$R_{WCADJ} = \text{write current adjust setting resistor (k}\Omega\text{)}$$

Example: For a 7.25 mA head current decrease,
 $R_{WCADJ} = (29 \cdot 2.5) / 7.25 = 10 \text{ k}\Omega$

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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 2020R/2021R/2023R 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 (not active on 32R2023R)
- 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·μH·MHz. To insure no false WUS trigger, the product of head current and head resistance ($I_x \cdot R_h$) 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.

Device in read mode and chip disabled will flag WUS if R/W is high or \overline{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 $V_{CC}/I_w < 0.25 \text{ V/mA}$ (not active on 32R2023R).

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 32R2020R/2021R/2023R 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, † HS2, HS3	I	Head Select: selects one of ten 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 - H9X; H0Y - H9Y	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 fine tune the write current
VCC1	I	+5V Supply
VCC2	I	+5V Supply for Write current drivers
GND	I	Ground
* Available on 32R2021R-4 24-pin option only		
† When more than one R/W device is used, signals can be wire OR'ed		

ELECTRICAL SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Operation above maximum ratings may permanently damage the device.

PARAMETER		RATING
DC Supply Voltage	VCC1	-0.3 to +6 VDC
	VCC2	-0.3 to +6 VDC
Write Current	I _w	60 mA
Digital Input Voltage	V _{in}	-0.3 to VCC1 +0.3 VDC
Head Port Voltage	V _H	-0.3 to VCC2 +0.3 VDC
Output Current: RDX, RDY	I _O	-6 mA
	WUS	+8 mA
Storage Temperature	T _{stg}	-65 to +150°C

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RECOMMENDED OPERATING CONDITIONS

PARAMETER		RATING
DC Supply Voltage	VCC1 = VCC2	5 ±10% VDC
Operating Junction Temperature	T _j	+25 to +135°C
Recommended Head Load Range	L _h	0.3 - 5.0 μH

DC CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified.

PARAMETER	CONDITION	MIN	NOM	MAX	UNIT
VCC1 Supply Current	Read Mode		18	25	mA
	Write Mode		22	29	mA
	Idle Mode		0.6	0.95	mA
VCC2 Supply Current	Read Mode		8	11	mA
	Write Mode		4 + I _w	7 + I _w	mA
	Idle Mode		0	0.2	mA
Power Dissipation	Read Mode		130	200	mW
	Write Mode		130 + 4 I _w	200 + 4.3 I _w	mW
	Idle Mode		3.3	6.5	mW
VCC1 Fault Voltage	I _w < 0.2 mA	3.5	3.9	4.2	VDC

DIGITAL INPUTS

Input Low Voltage (V _{il})				0.8	VDC
Input High Voltage (V _{ih})		2.0			VDC
Input Low Current	V _{il} = 0.8V	-0.4			mA
Input High Current	V _{ih} = 2.0V			100	mA
WUS Output Low Voltage (V _{ol})	I _{ol} = 2 mA max			0.5	VDC

WRITE CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified.

Write Current Constant	"K"			0.99	
Write Current Voltage	V _{wc}	1.15	1.25	1.35	V
WCADJ Voltage	I _{wCADJ} = 0 to 0.5 mA	2.0	VCC/2	3.0	VDC
I _{head} (Decrease)/I _{wCADJ}		23	27	31	mA/mA
I _{wCADJ} Range		0.0		0.5	mA

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WRITE CHARACTERISTICS (continued)

Recommended operating conditions apply unless otherwise specified.

PARAMETER	CONDITION	MIN	NOM	MAX	UNIT
Differential Head Voltage Swing		4.2	5.6		V _{pp}
	Open Head I _w = 20 mA	3.4	5.0		V _{pp}
Unselected Head Current				1	mA (pk)
Head Differential Damping Resistance (R _d)	32R2020		2650		Ω
	32R2020R		320		Ω
WDI Pulse Width	V _{il} ≥ 0.2V				
	PWH	10			ns
	PWL	5			ns
Write Current Range (I _w)		5		35	mA
Head Differential Load Capacitance				25	pF

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	(V)	160	200	240	V/V
			250	300	350	V/V
		(Z)		400		V/V
Voltage BW	-1dB	Z _s < 5Ω, Vin = 1 mVpp	20			MHz
	-3dB	Z _s < 5Ω, Vin = 1 mVpp	45			MHz
Input Noise Voltage	BW = 15 MHz, L _h = 0, R _h = 0			0.56	0.75	nV/√Hz
Differential Input Capacitance	Vin = 1 mVpp, f = 5 MHz			16	22	pF
Differential Input Resistance	Vin = 1 mVpp, f = 5 MHz		720	1200		Ω
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	Vin = 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 Vin = 0 VDC + 100 mVpp		55			dB
Output Offset Voltage		(V)			±300	mV
					±300	mV
		(Z)			±400	mV
Single Ended Output Resistance	f = 5 MHz				50	Ω
Output Current	AC coupled load, RDX to RDY		0.9			mA

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READ CHARACTERISTICS (continued)

PARAMETER	CONDITION	MIN	NOM	MAX	UNIT
RDX, RDY Common Mode Output Voltage		0.4 VCC	VCC/2	0.6 VCC	VDC

SWITCHING CHARACTERISTICS

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

PARAMETER		CONDITIONS	MIN	NOM	MAX	UNIT
R/W	Read to Write	R/W to 90% of write current		0.1	0.6	μs
	Write to Read	R/W to 90% of 100 mV Read signal envelope		0.1	0.6	μs
CS	Unselect to Select	CS to 90% of write current or to 90% of 100 mV 10 MHz		0.2	1	μs
	Select to Unselect	CS to 10% of write current		0.11	0.6	μs
HS0,1 to any Head		To 90% of 100 mV 10 MHz Read signal envelope		0.11	0.6	μs
WUS:	Safe to Unsafe (TD1)	Write mode, loss of WDI transitions. Defines maximum WDI period for WUS operation	0.6	2.0	3.6	μs
	Unsafe to Safe (TD2)	Fault cleared, from first neg WDI transition		0.1	0.6	μs
Head Current:						
	WDI to Ix - Iy (TD3)	from 50% points, Lh = 0, Rh = 0		3	10	ns
	Asymmetry	WDI has 1 ns rise/fall time, Lh = 0, Rh = 0			1.0	ns
	Rise/fall Time	10% to 90% points, Lh = 0, Rh = 0		4	6	ns
	Rise/fall Time	Lh = 1 μH, Rh = 30Ω		15		ns

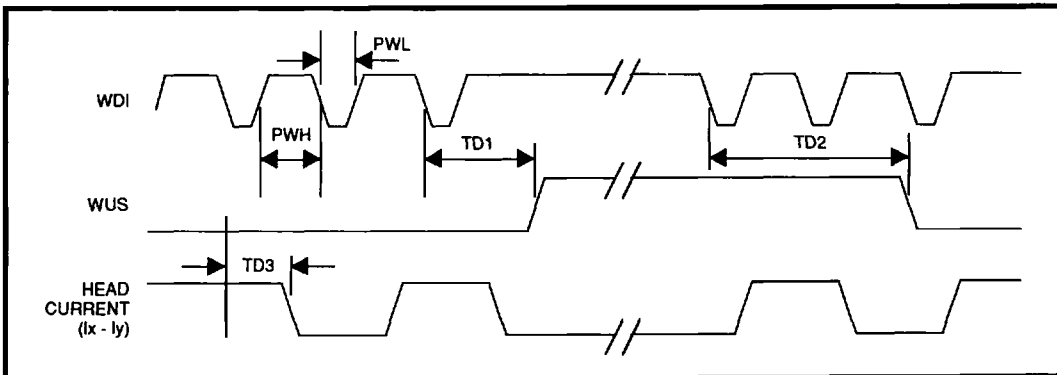


FIGURE 1: Write Mode Timing Diagram

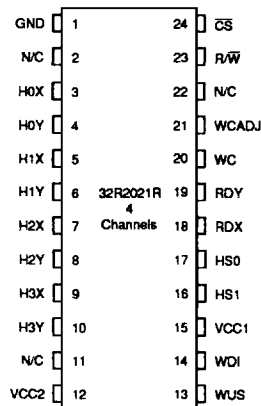
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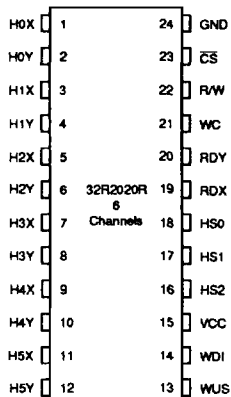
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PACKAGE PIN DESIGNATIONS

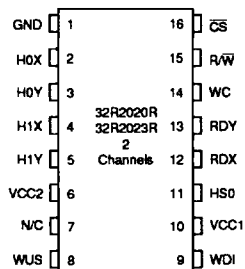
(Top View)



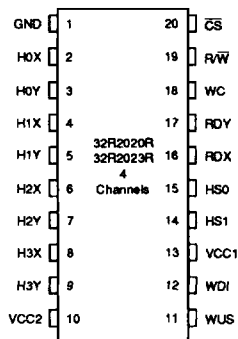
24-Lead SOL, SOV



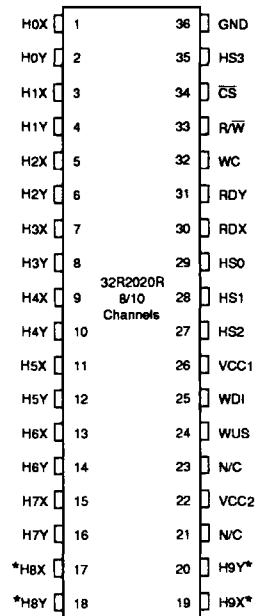
24-Lead SOV



16-Lead SOL, SON



20-Lead SOL, SOV



36-Lead SOM

* These pins are No Connect on the 8-Channel version

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

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Thin-Film Read/Write Device

ORDERING INFORMATION

DEVICE	CHANNELS	PACKAGE	READ GAIN	DAMPING RESISTOR	ORDER NUMBER	PACKAGE MARK
32R2020R	2	16 SOL	300	320Ω	32R2020R-2CL	32R2020R-2CL
	2	16 SON	300	320Ω	32R2020R-2CN	32R2020R-2CN
	4	20 SOL	300	320Ω	32R2020R-4CL	32R2020R-4CL
	4	20 SOV	300	320Ω	32R2020R-4CV	32R2020R-4CV
	4	20 SOL	200	-	32R2020V-4CL	32R2020V-4CL
	4	20 SOV	400	320Ω	32R2020RZ-4CV	32R2020RZ-4CV
	6	24 SOV	300	320Ω	32R2020R-6CV	32R2020R-6CV
	6	36 SOV	300	-	32R2020-6CV	32R2020-6CM
	8	36 SOM	300	320Ω	32R2020R-8CM	32R2020R-8CM
	8	36 SOM	300	-	32R2020-8CM	32R2020-8CM
	10	36 SOM	300	320Ω	32R2020R-10CM	32R2020R-10CM
	10	36 SOM	300	-	32R2020-10CM	32R2020-10CM
32R2021	4	24 SOV	300	3.20Ω	32R2021R-10CV	32R2021R-10CV
32R2023	2	16 SOL	300	320Ω	32R2023R-2CL	32R2023R-2CL
	2	16 SON	300	320Ω	32R2023R-2CN	32R2023R-2CN
	4	20 SOV	300	320Ω	32R2023R-4CV	32R2023R-4CV

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