SSI 32R2112R
20-Channel Thin Film Read/Write Device

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A TDK Group Company

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DESCRIPTION

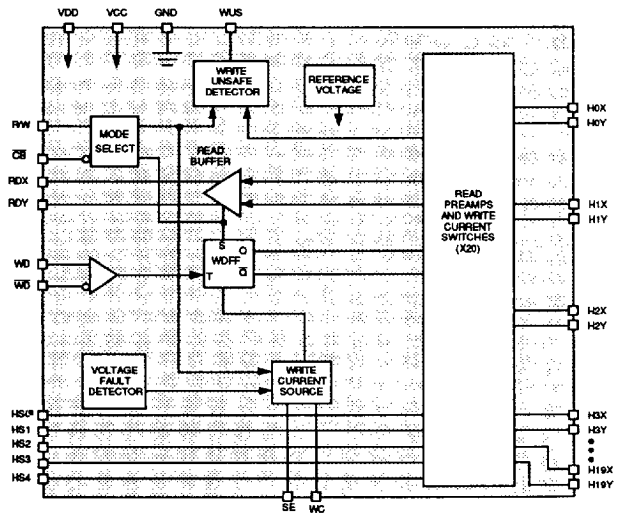
The SSI 32R2112R is a BiCMOS monolithic integrated circuit designed for use with two-terminal recording heads. They provide a low noise read amplifier, a high performance write driver, write current control, and data protection circuitry for up to 20 channels. The SSI 32R2110R/2111R option provides internal 250Ω damping resistors. Damping resistors are switched in during Write mode and switched out during Read mode. The SSI 32R2112 option does not provide 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 making the read channel outputs high impedance. The device also offers multiple channel "servo bank write" capability to assist in servo writing operations.

The SSI 32R2112R requires 5V and 12V power supplies.

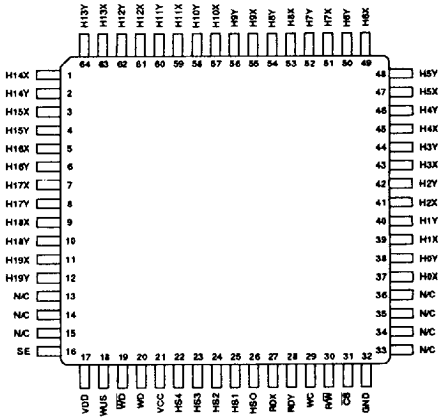
FEATURES

- **5V ± 10%, 12V ± 10% supply**
- **Low power**
  - **PD = 235 mW read mode (Nom)**
  - **PD = 12 mW idle (Max)**
- **High Performance:**
  - **Read mode gain = 150 V/V**
  - **Input noise = 0.45 nV/√Hz (Nom)**
  - **Input capacitance = 10 pF (Nom)**
  - **Write current range = 10-40 mA**
  - **Max write current rise/fall time = 7 ns (typical head)**
  - **Head voltage swing = 11 Vp-p min**
- **Servo bank-write capability**
- **Self switching damping resistance**
- **Write unsafe detection**
- **Power supply fault protection**
- **Head short to ground protection**
- **Differential ECL-like write data inputs**

BLOCK DIAGRAM



PIN DIAGRAM



64-Lead, 20-Channel TQFP

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

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CIRCUIT OPERATION

The SSI 32R2112R has the ability to address up to 20 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 CS have internal pull-up circuitry to prevent an accidental write condition. HS0, HS1, HS2, HS3, HS4 and SE have internal pulldown circuitry. Internal clamp circuitry will protect the IC from a head short to ground condition in any write mode.

TABLE 1: Mode Select

$\overline{CS}$	R/$\overline{W}$	SE	Mode
0	0	0	Single Channel Write. See Table 2.
0	0	1	Servo/Bank Write. See Table 2.
0	1	X	Single Channel Read. See Table 2.
1	X	X	Idle.

TABLE 2: Head Select*

Head Selected (SE =0)	Head Selected (servo bank write) (SE = 1)	HS4	HS3	HS2	HS1	HS0
0	no heads selected	0	0	0	0	0
1	no heads selected	0	0	0	0	1
2	H0, H1, H2, H3	0	0	0	1	0
3	no heads selected	0	0	0	1	1
4	no heads selected	0	0	1	0	0
5	no heads selected	0	0	1	0	1
6	H4, H5, H6, H7	0	0	1	1	0
7	no heads selected	0	0	1	1	1
8	no heads selected	0	1	0	0	0
9	no heads selected	0	1	0	0	1
10	H8, H9, H10, H11	0	1	0	1	0
11	no heads selected	0	1	0	1	1
12	no heads selected	0	1	1	0	0
13	no heads selected	0	1	1	0	1
14	H12, H13, H14, H15	0	1	1	1	0
15	no heads selected	0	1	1	1	1
16	no heads selected	1	0	0	0	0
17	no heads selected	1	0	0	0	1
18	H16, H17, H18, H19	1	0	0	0	1
19	no heads selected	1	0	0	1	1

*Do not use invalid HS combinatons.

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WRITE MODE

Taking both $\overline{CS}$ and R/$\overline{W}$ low selects write mode which configures the SSI 32R2112R 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 low to high transition of WD-$\overline{WD}$. 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 c', 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 250Ω damping resistor is switched in across the Hx, Hy ports. Unselected heads are at ground potential.

SERVO WRITE MODE

Taking SE high and R/$\overline{W}$ low activates servo write mode. This mode allows for writing to multiple channels at once, which is useful during servo formatting. In this mode, the bank of channels will be selected according to Table 2.

In order to properly activate servo write mode, the SE pin must be pulled high at least 20 ns before R/$\overline{W}$ is pulled low. This is a safety feature to prevent glitches on the SE pin from affecting normal write mode.

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.

HEAD SHORT TO GROUND PROTECTION

The SSI 32R2112R provides a head short to ground protection circuit in any mode. In idle or read mode, or for an unselected head in write mode, current out of the head port will not exceed 3 mA. If a selected head in write mode is shorted to ground, the write current generator will turn off, and remain off until the user exits write mode and then returns to 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
- Device in servo write mode
- No head current
- Open head
- Head short to ground
- Power supply fault

To prevent false WUS flags, the head inductance and resistance should be less than 1 μH and 50Ω respectively.

WDI frequency too low is detected if the WDI frequency falls below 1 MHz (typ). Consult the WUS Safe to Unsafe timing for range of frequency detection.

Device in read mode, Device in servo write mode and **Device not selected** will flag WUS if R/$\overline{W}$ is high, if SE is high, or $\overline{CS}$ is high.

No head current will flag WUS if Rwc > 50 kΩ.

Head opened will flag WUS if Rh = ∞.

Head short to ground is described in the preceding paragraph.

Upon entering write mode, WUS is valid within the specified R/$\overline{W}$ timing.

After the low frequency foult condition is removed, one positive transition of WD-WD is required to clear WUS.

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READ MODE

The read mode configures the SSI 32R2112R 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.

In read mode, unselected heads are at ground potential.

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.

In idle mode, all heads are at ground potential.

PIN DESCRIPTION

CONTROL/STATUS († When more than one Read/Write device is used, signals can be wire OR'ed.)

NAME	TYPE	DESCRIPTION
$\overline{CS}$	I	Chip Select Input. A logical low level enables the device.
R/$\overline{W}$†	I	Read/Write. A logical high level enables read mode. A logical low level enables write mode.
SE	I	Servo Enable. A high level enables servo bank write mode. See Servo Enable section.
HS0, HS1, HS2	I	Head Select. Decoded address selects one of 20 channels. See Table 2.
HS3, HS4		
WUS†	I	Write Unsafe. A high level indicates an unsafe writing condition. See WUS section.
WC†	I	Write Current. Sets the write current through the recording head.

HEAD TERMINAL CONNECTIONS

H0X-H19X H0Y-H19Y	I	X,Y Head Connections

DATA INPUT/OUTPUT

WD,$\overline{WD}$†	I	Differential Write Data In. A positive transition of WD-$\overline{WD}$ changes the direction of current in the recording head.
RDX,RDY†	O	Differential Read Data Out. Emitter follower output.

POWER

VCC	I	5V power supply
VDD	I	12V power supply
GND	I	Ground

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ELECTRICAL SPECIFICATIONS

Current maximums are currents with the highest absolute value.

ABSOLUTE MAXIMUM RATINGS

Operation beyond the maximum ratings may damage the device.

PARAMETER			RATING
DC Supply Voltage		VCC	-0.3 to 6 Vdc
		VDD	-0.3 to 14 Vdc
Write Current		Iw	100 mA
Digital Input Voltage		Vin	-0.3 to VCC + 0.3V
Head Port Voltage		VH	-0.3 to VCC + 0.3V
WUS Pin Voltage		Vwus	VCC + 2V
Output Current	RDX,RDY	Io	-6 mA
	$\overline{WUS}$	Iwus	12 mA
Junction Operating Temperature		Tj	135°
Storage Temperature			-65 to 150°

RECOMMENDED OPERATING CONDITIONS

DC Supply Voltage	VCC	5 ± 10%V
	VDD	12 ± 10%V
Ambient Operating Temperature	Ta	0° < Ta < 75°
Head Inductance	Lh	Lh < 1 µH
Head Resistance, Valid WUS	Rh	Rh < 50Ω

TEST CONDITIONS

Recommended operating conditions apply.

Write Current	Iw	20 mA
Head Inductance	Lh	1 µH
Head Resistance	Rh	30Ω
WD/$\overline{WD}$ Frequency		5 MHz
WD/$\overline{WD}$ rise/fall time		1 ns

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ELECTRICAL SPECIFICATIONS (continued)

POWER DISSIPATION

Recommended operating conditions apply.

PARAMETER	CONDITION	MIN	NOM	MAX	UNIT
VCC Supply Current	Read mode		46	75	mA
	Write mode		20	29	mA
	Servo write mode (4 heads)		50	65	mA
	Idle mode		0.5	1	mA
VDD Supply Current	Read mode		0.4	0.7	mA
	Write mode		Iw+7	Iw+12	mA
	Servo write mode (4 heads)		28 + 4 • Iw	40 + 4 • Iw	mA
	Idle mode		0.4	0.6	mA
Power Dissipation	Read mode		235	424	mW
	Write mode		184 +12 Iw	318 +13.2 Iw	mW
	Servo write mode (4 heads)		645 + 4 • Iw • VDD	886 + 4 • Iw • VDD	mA
	Idle mode		6.3	12	mW

DIGITAL INPUTS

Input High Voltage HSX, $\overline{CS}$, R/$\overline{W}$, SE	Vih		2			VDC
Input Low Voltage HSX, $\overline{CS}$, R/$\overline{W}$, SE	Vil				0.8	VDC
Input High Current HSX, $\overline{CS}$, R/$\overline{W}$, SE	Iih	Vih = 2V			100	µA
Input Low Current HSX, $\overline{CS}$, R/$\overline{W}$, SE	Iil	Vil = 0.8V	-400			µA
WD/$\overline{WD}$ Input High Voltage	Vih		2		Vcc - 0.2	VDC
WD/$\overline{WD}$ Input Low Voltage	Vil		Vih - 2		Vih - 0.3	VDC
WD/$\overline{WD}$ Input Voltage Difference			0.3		2	V
WD/$\overline{WD}$ Input High Current		Vih = Vcc-0.75V (32R2200R)		60	110	µA
WD/WD Input Low Current		Vih = Vcc-1.75V (32R2200R)		50	100	µA

DIGITAL OUTPUTS

WUS Output Low Voltage	Vol	Iol = 2 mA max			0.5	VDC
WUS Output High Current	Ioh	Voh = Vcc	-100	0	100	µA

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WRITE CHARACTERISTICS

Test conditions apply unless otherwise specified.

PARAMETER		CONDITION	MIN	NOM	MAX	UNIT
Write Current Voltage	Vwc			2.0		V
Write Current Gain	Awc	Iw = Aw•Vwc/Rwc		25		mA/mA
Write Current Constant "K"		Iw = K/Rwc	45	50	55	V
Differential Head Voltage Swing		Open Head, Iw = 20 mA	11	13		Vp-p
Head Differential Load Resistance	Rd	32R2112R	200	250	300	Ω
		32R2112	1000	1500	2000	Ω
WD/$\overline{WD}$ Pulse Width		PWH	5			ns
		PWL	5			ns
Unselected Head Voltage					0.1	VDC
Unselected Head Current					0.2	mA
VCC Fault Voltage		Iw ≤ 0.2 mA	3.9	4.1	4.3	V
VDD Fault Voltage		Iw ≤ 0.2 mA	8.5	9.3	10	V
Head Current	HnX,HnY	VCC, VDD low voltage fault condition	-0.2		0.2	mA

SERVO WRITE CHARACTERISTICS

Write Current Range		10		20	mA
Write Current Matching	Between channels		±10%		

READ CHARACTERISTICS

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

Differential Voltage Gain		Vin = 1 mVp-p @1 MHz 32R2112RU	120	150	180	V/V
Voltage BW	-1 dB	|Zs| < 5Ω, Vin = 1 mVp-p	45			MHz
	-3 dB		85			MHz
Input Noise Voltage		BW = 20 MHz, Lh = 0, Rh = 0		0.45	0.63	nV/√Hz
Input Noise Current		BW = 20 MHz, Lh = 0, Rh = 0		4	10	pA/√Hz
Differential Input Capacitance		Vin = 1 mVp-p, f = 5 MHz		10	15	pF
Differential Input Resistance		Vin = 1 mVp-p, f = 5 MHz	450	750	1800	Ω
Dynamic Range		AC input voltage where gain falls to 90% of its small signal gain value, f = 5 MHz	2	4		mVp-p

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ELECTRICAL SPECIFICATIONS (continued)

READ CHARACTERISTICS

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

PARAMETER	CONDITION	MIN	NOM	MAX	UNIT
Common Mode Rejection Ratio	Vin = 0 VDC + 100 mVp-p @ 5 MHz	50	60		dB
Power Supply Rejection Ratio	100 mVp-p @ 5 MHz on VCC	50	70		dB
Channel Separation	Unselected channels driven with Vin = 0 VDC + 100 mVp-p	50	60		dB
Output Offset Voltage	Lh = 0, Rh = 0	-190		+190	mV
Single Ended Output Resistance	f = 5 MHz		30		Ω
Output Current	AC coupled load, RDX to RDY	1	5		mA
RDX, RDY Common Mode Output Voltage			Vcc-2.2		VDC

SWITCHING CHARACTERISTICS

Test conditions apply unless otherwise specified.

R/$\overline{W}$	Read to Write	R/$\overline{W}$ to 90% of write current			0.3	µs
	Write to Read	R/$\overline{W}$ to 90% of 100 mV Read signal envelope			0.3	µs
$\overline{CS}$	Unselect to Select	CS to 90% of 100 mV 10 MHz Read signal envelope			0.2	µs
	Select to Unselect	CS to 10% of write current			0.15	µs
HS0,1, 2, 3, 4 to any Head		To 90% of 100 mV 10 MHz Read signal envelope			0.15	µs
WUS	Safe to Unsafe (TD1)	Write mode, loss of (WD - $\overline{WD}$) transitions; Defines max (WD - $\overline{WD}$) period for WUS operation	0.6	2	3.6	µs
	Unsafe to Safe (TD2)	Fault cleared: from first (WD - $\overline{WD}$) transition		0.2	1	µs
WDI	Frequency Range		1		100	MHz
Head Current		Lh = 0, Rh = 0				
(WD - $\overline{WD}$) to Ix - Iy (TD3)		from 50% points		3	5	ns
	Asymmetry	(WD - $\overline{WD}$) has 1 ns rise/fall time			0.5	ns
	Rise/fall Time	10% to 90% points Iw = 20 mA, Rh = 0, Lh = 0			3	ns
		Iw = 20 mA, Rh = 20Ω, Lh = 600 nH			7	ns

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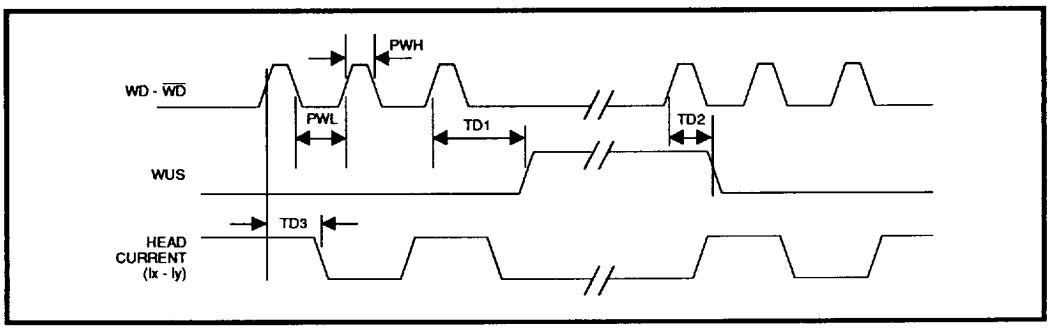

FIGURE 1: Write Mode Timing Diagram

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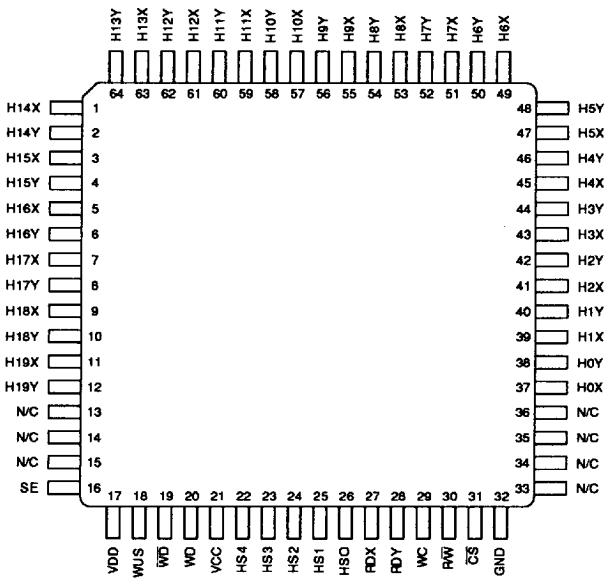
SSI 32R2112R
20-Channel Thin Film Read/Write Device

PACKAGE PIN DESIGNATIONS
(Top View)

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



64-Lead, 20-Channel TQFP

ORDERING INFORMATION

PART DESCRIPTION	ORDER NUMBER	PACKAGE MARK
SSI 32R2112RU 64-Lead TQFP	32R2112RU-20CGT	32R2112RU-20

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