SSI 32R2028R
5V, 10-Channel
Thin-Film Read/Write Device

Advance Information

December 1993

DESCRIPTION

The SSI 32R2028R is a bipolar monolithic integrated circuit designed for use with two-terminal recording heads. It provides a low noise read amplifier, write current control, and data protection circuitry for up to ten channels. The device provides internal 320Ω damping resistors that 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 device also provides the user with a controllable write current adjustment feature. The SSI 32R2028R requires only a +5V power supply.

FEATURES

- +5V ±10% supply
- Low power
  - PD = 130 mW Read mode (Nom)
  - PD = 5 mW idle (Max)
- High Performance:
  - Read mode gain = 300 V/V
  - 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
- Differential ECL-like Write Data Input
- Write unsafe detection
- Power supply fault protection
- Head short to ground protection

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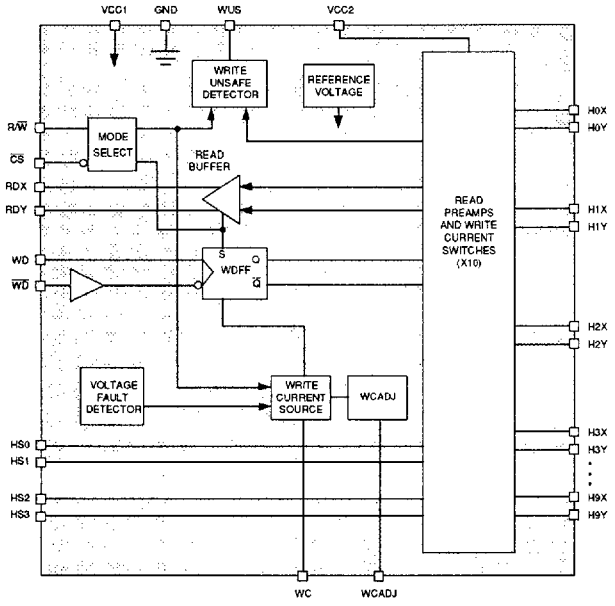
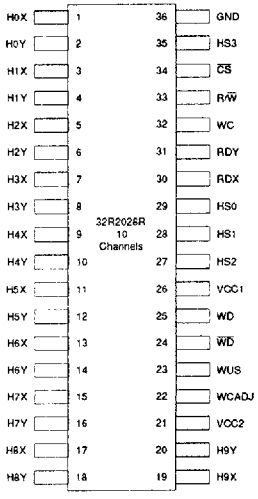
BLOCK DIAGRAM



PIN DIAGRAM



36-Lead SOM

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

CIRCUIT OPERATION

The SSI 32R2028R has 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/$\overline{W}$ 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/$\overline{W}$	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

PIN DESCRIPTION

NAME	TYPE	DESCRIPTION
HS0, HS1, † HS2, HS3	I	Head Select: selects one of ten 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
WD, $\overline{WD}$ †	I	Differential Write Data Input: a negative transition of (WD - $\overline{WD}$) toggles the direction of the head current
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
†When more than one R/W device is used, signals can be wire OR'ed		

WRITE MODE

Taking both $\overline{CS}$ and R/$\overline{W}$ low selects Write mode which configures the SSI 32R2028R 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 differential signal WD - $\overline{WD}$. 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:

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

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

The SSI 32R2028R includes a feature which allows the user to adjust the Iw 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 VCC/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:

Iw head (decrease) (mA) = (29 • V_{WCADJ}/R_{WCADJ})

where:

V_{WCADJ} = VCC/2 (volts)

R_{WCADJ} = write current adjust setting resistor (kΩ)

Example: For a 7.25 mA head current decrease, R_{WCADJ} = (27 • 2.5) / 7.25 = 10 kΩ

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 SSI 32R2028R 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.

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WRITE UNSAFE

Any of the following conditions will be indicated as a high level on the Write Unsafe, WUS, open collector output.

- WD frequency too low
- Device in Read mode
- Chip disabled
- No head current
- Head opened
- Head short to ground

To insure proper WUS operation, the product of write current, WD 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 (Ix,y•Rh) should be between 100 mV and 1.7V.

WD frequency too low is detected if the WD 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/$\overline{W}$ is high or $\overline{CS}$ is high.

No head current will flag WUS if Rwc = ∞ and the selected head is present.

Head opened will flag WUS if Rh = ∞ and under the condition that VCC/Iw < 0.25 V/mA.

Head short to ground is described in the preceding paragraph.

Upon entering Write mode, WUS is valid after two transitions of WD following the required Read-Write transition time (0.6 μs max).

CIRCUIT OPERATION (continued)

READ MODE

The Read mode configures the SSI 32R2028R 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.

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	Iw	60 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 WUS	I0	-6 mA +8 mA
Storage Temperature	Tstg	-65 to +150 °C

RECOMMENDED OPERATING CONDITIONS

DC Supply Voltage	VCC1 = VCC2	5 ±10%	VDC
Operating Junction Temperature	Tj	+25 to +135	°C
Recommended Head Load Range	Lh	0.3 - 5.0	µH

DC CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified.

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
VCC1 Supply Current	Read Mode		18	25	mA
	Write Mode		22	29	mA
	Idle Mode		0.6	0.9	mA
VCC2 Supply Current	Read Mode		8	11	mA
	Write Mode		4 + Iw	7 + Iw	mA
	Idle Mode		0	0.2	mA

DC CHARACTERISTICS (continued)

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
Power Dissipation	Read Mode		130	200	mW
	Write Mode		130 + 4 Iw	200 + 4.3 Iw	mW
	Idle Mode		3	5	mW
VCC1 Fault Voltage	Iw < 0.2 mA	3.5	3.9	4.2	VDC

DIGITAL INPUTS

Input Low voltage (Vil) HSX, $\overline{CS}$, R/$\overline{W}$				0.8	VDC
Input High Voltage (Vil) HSX, $\overline{CS}$, R/$\overline{W}$		2.0			VDC
Input Low Current, HSX, $\overline{CS}$, R/$\overline{W}$	Vil = 0.8V	-0.4			mA
Input High Current, HSX, $\overline{CS}$, R/$\overline{W}$	Vih = 2.0V			100	µA
WD, $\overline{WD}$ Input Low Current	Vil = VCC - 1.75V		70	100	µA
WD, $\overline{WD}$ Input High Current	Vih = VCC - 0.75V		85	125	µA
WD, $\overline{WD}$ Input Low Voltage Vil		Vcc -1.870		Vcc - 1.625	VDC
WD, $\overline{WD}$ Input High Voltage Vih		Vcc - 1.50		Vcc - 0.5	VDC
WUS Output Low Voltage (Vol)	Iol = 2 mA max			0.5	VDC

WRITE CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified.

Write Current Constant "K"				0.99		
Write Current Voltage (Vwc)			1.15	1.25	1.35	V
WCADJ Voltage	I_{WCADJ} = 0 to .5 mA		2.0	VCC/2	3.0	VDC
Ihead(Decrease)/I_{WCADJ}			23	27	31	mA/mA
I_{WCADJ} Range			0.0		0.5	mA
Differential Head Voltage Swing			4.2	5.6		Vpp
	Open Head, Iw = 20 mA		3.4	5.0		
Unselected Head Current					1	mA (pk)
Head Differential Damping Resistance (Rd)				320		Ω
WD Pulse Width	Vil ≥ 0.2V	PWH	10		ns	
		PWL	5			ns
Write Current Range (Iw)			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.

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
Differential Voltage Gain	Vin = 1 mVpp @1 MHz	250	300	350	V/V
Voltage BW -1dB	|Zs| < 5Ω, Vin = 1 mVpp	20			MHz
-3dB	|Zs| < 5Ω, Vin = 1 mVpp	40	45		MHz
Input Noise Voltage	BW = 15 MHz, Lh = 0, Rh = 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				±300	mV
Single Ended Output Resistance	f = 5 MHz			50	Ω
Output Current	AC coupled load, RDX to RDY	0.9			mA
RDX, RDY Common Mode Output Voltage		0.4 VCC	VCC/2	0.6 VCC	VDC

SWITCHING CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified. IW = 20 mA, Lh = 1.0 µH, Rh = 30Ω f(Data) = 5 MHz.

R/$\overline{W}$	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
$\overline{CS}$	Unselect to Select	$\overline{CS}$ to 90% of write current or to 90% of 100 mV 10 MHz		0.2	1	µs
	Select to Unselect	$\overline{CS}$ 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 0.6 transitions. Defines maximum WDI period for WUS operation	2.0	3.6	µs	
	Unsafe to Safe (TD2)	Fault cleared, from first neg WDI transition		0.1	0.6	µs

SWITCHING CHARACTERISTICS

Recommended operating conditions apply unless otherwise specified. IW = 20 mA, Lh = 1.0 µH, Rh = 30Ω

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
Head Current:					
WD to Ix - Iy (TD3)	from 50% points, Lh = 0, Rh = 0		8	12	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

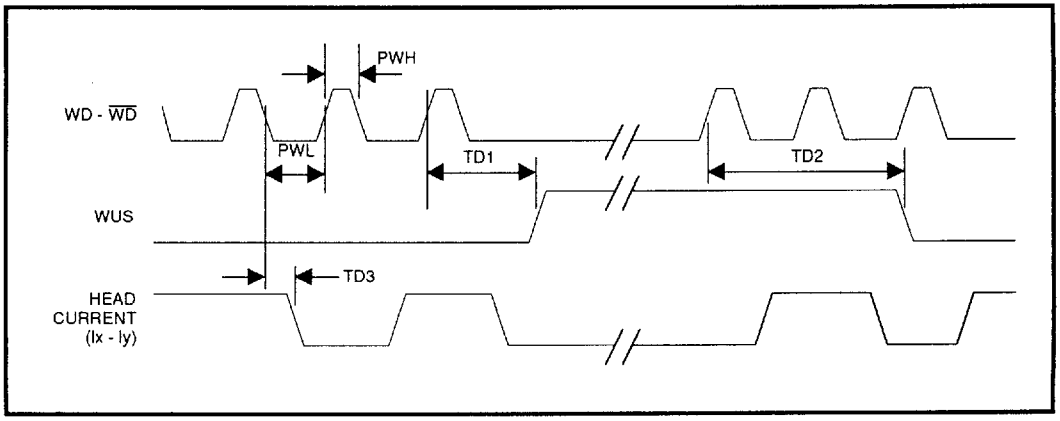

FIGURE 1: Write Mode Timing Diagram

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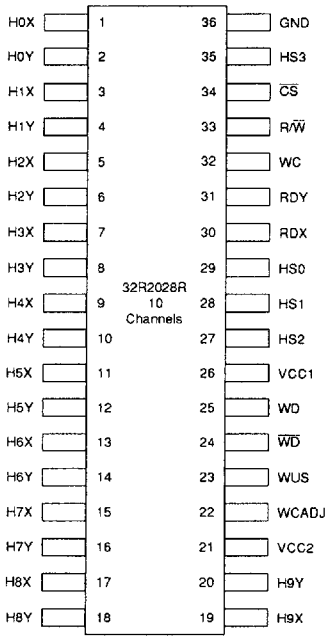
PACKAGE PIN DESIGNATIONS

(Top View)



36-Lead SOM

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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