

December 1993

**DESCRIPTION**

The SSI 32R2011R is an integrated read/write circuit designed for use with two terminal heads in disk drive systems. The device contains up to ten channels of read amplifiers and write drivers and also has an internal write current source. An internal 300Ω damping resistor is supplied in Write mode, which is switched to 1 kΩ in Read mode.

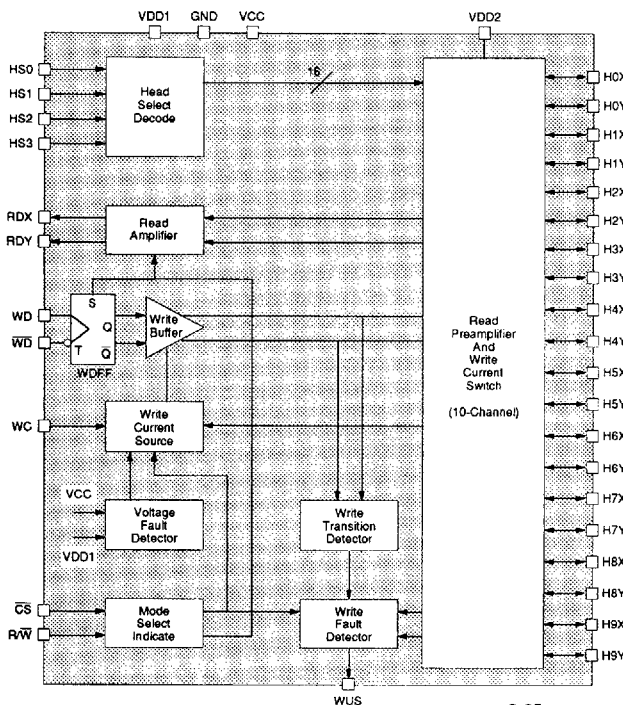
The circuit operates on +5V and +12V power supplies and is available in a 10-channel, 36-pin SO package.

**FEATURES**

- High performance
  - Read Mode Gain = 150 Typ V/V
  - Input Noise = 0.58 nV/√Hz typ.
  - Input Capacitance = 15 pF typ.
  - Write Current Range = 10 mA to 25 mA
  - Write Current Rise Time = 4 ns
  - Head Voltage Swing = 7 Vpp min
- Write unsafe detection
- Differential, ECL-like write data input
- Open collector read data output
- Switch from 300Ω damping resistor to 1 kΩ read input resistance
- Power supply fault protection
- +5V, +12V power supplies ±10%

**3**

**BLOCK DIAGRAM**



**PIN DIAGRAM**

H0X	1	36	GND
H0Y	2	35	HS3
H1X	3	34	CS
H1Y	4	33	R/W
H2X	5	32	WC
H2Y	6	31	RDY
H3X	7	30	RDX
H3Y	8	29	HS0
H4X	9	28	HS1
H4Y	10	27	HS2
H5X	11	26	VCC
H5Y	12	25	WD
H6X	13	24	WD
H6Y	14	23	WUS
H7X	15	22	VDD1
H7Y	16	21	VDD2
H8X	17	20	H9Y
H8Y	18	19	H9X

**36-Lead SOM**

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

# SSI 32R2011R

## 10-Channel Thin Film Read/Write Device

### FUNCTIONAL DESCRIPTION

The SSI 32R2011R addresses up to 10 channels with logic control inputs which are TTL compatible. Head selection is accomplished as shown in Table 1. Mode selection is accomplished as shown in Table 2. The mode select inputs have internal pull up circuits so that if an input is open it will rise to the upper logic level and force the device into a non-writing condition.

### WRITE MODE

In Write Mode ( $\overline{R/W}$  and  $\overline{CS}$  low) the circuit functions as a current switch. The Head Select Inputs HS0, HS1, HS2 and HS3 determine the selected head. The write data inputs ( $WD$ ,  $\overline{WD}$ ) determine the polarity of the head current. Write current is toggled between the X and Y direction of the selected head on each low to high transition of  $WD$  (see Figure 1). A preceding read operation initializes the Write Data Flip Flop (WDFF) to pass write current in the X-direction of the head (i.e., into the X-port).

The write current magnitude is adjusted by an external resistor,  $R_{wc}$ , from WC to GND, and is given by:

$$I_w = V_{wc}/R_{wc}$$

Note that actual head current,  $I_{hd}$ , is:

$$I_{hd} = I_w / (1 + \frac{R_h}{R_d}) + I_{offset}$$

where  $R_h$  is head resistance,  $R_d$  is write damping resistance and  $I_{offset}$  is a constant DC offset current.

### WRITE MODE FAULT DETECT CIRCUIT

Several circuits are dedicated to detecting fault conditions associated with the Write mode. A logical high (off) level will be present at the Write Unsafe (WUS) terminal if any of the following write fault conditions are present:

- Open head circuit ( $I_w \geq 20$  mA)
- Head shorted to ground
- Write current transition frequency too low
- Write mode not logically selected

After the fault condition is removed, two transitions of the write data input lines are required to clear WUS. The Write Unsafe output is open-collector and is usually terminated by an external resistor connected to VCC.

Additionally, power voltage monitoring circuits are used to detect VCC and VDD1 voltage levels. If either is too low to permit valid data recording, write current is inhibited.

### READ MODE

In Read Mode, ( $\overline{R/W}$  high and  $\overline{CS}$  low), the circuit functions as a low noise differential amplifier. The read amplifier input terminals are determined by the Head Select inputs. The read amplifier outputs ( $RDX$ ,  $RDY$ ) are open collector, requiring external load resistors ( $100\Omega$ ) connected to VCC. The amplifier gain polarity is non-inverting between  $HnX$ ,  $HnY$  inputs and  $RDX$ ,  $RDY$  outputs.

The switch from Write to Read modes also changes the resistance across  $HnX$  and  $HnY$  from its write damping value of  $300\Omega$  to its read mode input value of  $1$  k $\Omega$ .

### 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 internal write current source. This facilitates multi device installations by allowing the read outputs to be wired OR'ed and the write current programming resistor to be common to all devices.

TABLE 1: Head Select

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

# SSI 32R2011R

## 10-Channel Thin Film Read/Write Device

**TABLE 2: Mode Select**

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

### PIN DESCRIPTION

#### CONTROL INPUT PINS

NAME	TYPE	DESCRIPTION
$\overline{CS}$	I	Chip Select Input. A logical low level enables the circuit for a read or write operation. Has internal pull up.
R/ $\overline{W}$	I	Read/write select. A logical low level enables the write mode (when $\overline{CS}$ is low). Has internal pull up.
HS0, HS1, HS2, HS3	I	Head select inputs. Logical combinations select one of sixteen heads. See Table 1. Has internal pull down resistors.

#### HEAD TERMINAL PINS

H0X-H9X, H0Y-H9Y	I/O	X, Y Head connections: Current in the X-direction flows into the X-port.
---------------------	-----	--

#### DATA INPUT/OUTPUT PINS

WD, $\overline{WD}$	I	Differential write data input.
RDX, RDY	O	Differential Read Data output. These open collector outputs are normally terminated in 100 $\Omega$ resistors to VCC.

#### EXTERNAL COMPONENT CONNECTION PINS

WC	I/O	Resistor connected to GND to provide desired value of write current.
----	-----	--

#### CIRCUIT MONITOR PINS

WUS	O	Write Unsafe is an open-collector output with the off-state indicating that conditions are not proper for a write operation.
-----	---	--

#### POWER, GROUND PINS

VCC	I	+5V Logic circuit supply.
VDD1	I	+12V power supply.
VDD2	I	+12V power supply for write current drivers.
GND	I	Power supply common.

# SSI 32R2011R

## 10-Channel Thin Film

### Read/Write Device

#### ELECTRICAL SPECIFICATIONS

##### ABSOLUTE MAXIMUM RATINGS

Operation above maximum ratings may permanently damage the device.

PARAMETER	RATING
Positive Supply Voltage, VCC	6 VDC
Supply Voltage, VDD1, 2	13.5 VDC
Operating Junction Temperature	+130°C
Storage Temperature	-65 to +130°C
Package Temperature (20 sec. reflow)	215°C

##### INPUT VOLTAGES

HS0, HS1, HS2, HS3, CS, R/W	-0.2 to VCC + 0.2 VDC
-----------------------------	-----------------------

##### OUTPUTS

Read Data (RDX, RDY)	VCC -2.5 to VCC + 0.3 VDC
Write Unsafe (WUS)	-0.2V to VCC + 0.2V
Current Reference (WC)	-80 mA to 1.0 mA
Head Outputs (Write Mode)	-80 mA to 1.0 mA

##### POWER SUPPLY

Unless otherwise specified,  $4.5V \leq VCC \leq 5.5V$ ,  $10.8V \leq VDD1, 2 \leq 13.2V$ ,  $0^\circ C \leq T$  (ambient)  $\leq 70^\circ C$ .

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
Power Dissipation (Does not include power dissipation through RDX, RDY load resistors)	Idle mode		195	295	mW
	Read mode		440	775	mW
	Write mode		350 + 10 lw	530 + 11.2 lw	mW
Positive Supply Current ICC (Includes RDX, RDY currents)	Idle Mode		13	20	mA
	Read Mode		27	35	mA
	Write Mode		22	26	mA
Positive Supply Current IDD1	Idle Mode		10	14	mA
	Read Mode		32	49	mA
	Write Mode		23	28	mA
Positive Supply Current IDD2	Idle Mode		0.5	2	mA
	Read Mode		1	1.5	mA
	Write Mode		1 + lw	2 + lw	mA

# SSI 32R2011R

## 10-Channel Thin Film Read/Write Device

### DC CHARACTERISTICS

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
High-level Input Voltage $V_{IH}$ ( $\overline{CS}$ , R/W, HS0, HS1, HS2, HS3)		2.0			V
Low-level Input Voltage $V_{IL}$ ( $\overline{CS}$ , R/W, HS0, HS1, HS2, HS3)				0.8	V
High-level Input Current $I_{IH}$ ( $\overline{CS}$ , R/W, HS0, HS1, HS2, HS3)	$V_{IH} = 2.7V$			100	$\mu A$
Low-level Input Current $I_{IL}$ ( $\overline{CS}$ , R/W, HS0, HS1, HS2, HS3)	$V_{IL} = 0.4V$			-400	$\mu A$
High-level Input Voltage $V_{IHl}$ (WD, WD)		$V_{CC} - 1.0$		$V_{CC} - 0.72$	V
Low-level Input Voltage $V_{ILl}$ (WD, WD)		$V_{CC} - 1.87$		$V_{CC} - 1.625$	V
WUS, Low Level Voltage	$I_{LUS} = 4 \text{ mA}$ (denotes safe condition)			0.5	V
WUS, High Level Current	$V_{HUS} = 5.0V$ (denotes unsafe condition)			100	$\mu A$

### WRITE MODE

Test Conditions (Unless otherwise specified).  $V_{CC} = 4.5$  to  $5.5V$ ,  $T_a = 0$  to  $+70^\circ C$ ,  $V_{DD} = 10.8$  to  $13.2V$ ,  $L_h = 470 \text{ nH}$ ,  $R_h = 25\Omega$ , WD  $T_r$ ,  $T_f < 2 \text{ ns}$ ,  $I_w = 20 \text{ mA}$ .

Current Range, $I_w$		10		25	mA
Write Current Voltage, $V_{wc}$		1.95	2.05	2.15	V
Differential Head voltage Swing		7.0	7.6		$V_{pp}$
loffset			0.5		mA
Unselected Head Transient Current	Non adjacent heads tested to minimize external coupling effects			1	mA(pk)
Head Damping Resistance		240	300	360	$\Omega$
Differential Output Capacitance				20	pF

# SSI 32R2011R

## 10-Channel Thin Film

### Read/Write Device

#### ELECTRICAL SPECIFICATIONS (continued)

##### FAULT DETECTION CHARACTERISTICS

Test conditions same as Write Mode above (unless otherwise specified.)

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
VCC Value for Write Current Turn off	$I_h < 1 \text{ mA}$	3.7	4.0	4.3	V
VDD Value for Write Current Turn off	$I_h < 1 \text{ mA}$	8.8	9.5	10.2	V
WD, $\overline{\text{WD}}$ Transition Frequency	WUS = Low (Guaranteed safe)	2.0			MHz

##### READ MODE

Tests performed with 100 $\Omega$  load resistors from RDX and RDY to VCC. Test conditions same as Write mode (unless otherwise specified.)

Differential Voltage Gain	$V_{in} = 1 \text{ mVpp}, f = 300 \text{ kHz}$	120	150	180	V/V
Voltage Bandwidth	-3 dB $Z_s < 5\Omega, V_{in} = 1 \text{ mVpp}$	50	65		MHz
	-1 dB $Z_s < 5\Omega, V_{in} = 1 \text{ mVpp}$	20	35		MHz
Input Noise Voltage	$Z_s = 0\Omega, V_{in} = 0V,$ Power Bandwidth = 20 MHz		0.58	0.75	nV/ $\sqrt{\text{Hz}}$
Differential Input Capacitance	$V_{in} = 0V, f = 5 \text{ MHz}$		15	20	pF
Differential Input Resistance	$V_{in} = 0V, f = 5 \text{ MHz}$	400		1500	$\Omega$
Dynamic Range @ 5 MHz	Input voltage where AC gain falls to 90% of the gain	4			mVpp
Common Mode Rejection Ratio	$V_{in} = 100 \text{ mVpp}, 0V \text{ DC}$ $f = 5 \text{ MHz}$	60	90		dB
Power Supply Rejection Ratio	VCC or VDD = 100 mVpp $f = 5 \text{ MHz}$	55	75		dB
Channel Separation	Unselected channels are driven with $V_{in} = 20 \text{ mVpp}$ @ 5 MHz	60	90		dB
Output Offset Voltage	$R_h = 0, L_h = 0$	-250		250	mV
Output Leakage Current	Idle Mode			20	$\mu\text{A}$
Output Common Mode Voltage	$R_h = 0, L_h = 0$	VCC - 0.9	VCC - 0.5	VCC - 0.3	V
Output Voltage Compliance	Adjust RDX, Y load voltage source for <5% THD of either output.	VCC - 1.6		VCC	V

# SSI 32R2011R

## 10-Channel Thin Film Read/Write Device

### SWITCHING CHARACTERISTICS

Test conditions same as Write Mode plus RDX, Y connected VCC through 100Ω resistors, WUS with 1 kΩ to VCC.

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
Idle to Read/Write Transition Time	Delay to 90% of Read Output or Write Current		75	150	ns
Read/Write to Idle Transition Time	Delay to 10% of Read Output or Write Current		85	150	ns
Read to Write Transition Time	VLCS = 0.8V, Delay to 90% of Iw		85	150	ns
Write to Read Transition Time	VLCS = 0.8V, Delay to 90% of 10 MHz Read Signal, 100 mV envelope		350	600	ns
Head Select Switching Delay	Read or Write Mode			500	ns
Head Current Rise and Fall Times 10% to 90%	Iw = 25 mA, Lh = 0 nH Rh = 0Ω		2.5	4.0	ns
	Iw = 15 mA, Lh = 1 μH Rh = 45Ω		6		ns
Head Current Rise and Fall Difference				0.5	ns
Head Current Switching Delay Difference (Asymmetry)	WD, WD transitions 2 ns, switching time asymmetry 0.2 ns			0.5	ns
Head Current Propagation Delay	TD3 50% WD to 50% Iw		8	15	ns
Unsafe to Safe Delay After Write Data Begins	WUS TD2 f(data) = 5 MHz Write Mode (After 2 transitions of WD)			200	ns
Unsafe to Safe Delay After Write Mode Selected	WUS			0.5 + Tw*	μs
Safe to Unsafe Delay	WUS TD1 After Write Mode fault condition occurs			1.5	μs
Safe to Unsafe Delay	WUS After exiting Write Mode			0.5	μs

\*Tw is the period of the write data input.

SSI 32R2011R  
10-Channel Thin Film  
Read/Write Device

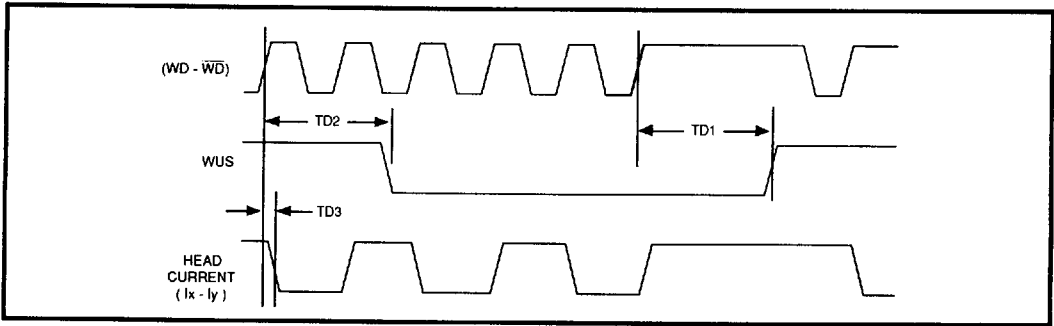


FIGURE 1: Write Mode Timing Diagram



# SSI 32R2011R

## 10-Channel Thin Film Read/Write Device

### PACKAGE PIN DESIGNATIONS

(Top View)

H0X	1	36	GND
H0Y	2	35	HS3
H1X	3	34	$\overline{CS}$
H1Y	4	33	$R/\overline{W}$
H2X	5	32	WC
H2Y	6	31	RDY
H3X	7	30	RDX
H3Y	8	29	HS0
H4X	9	28	HS1
H4Y	10	27	HS2
H5X	11	26	VCC
H5Y	12	25	WD
H6X	13	24	$\overline{WD}$
H6Y	14	23	WUS
H7X	15	22	VDD1
H7Y	16	21	VDD2
H8X	17	20	H9Y
H8Y	18	19	H9X

**36-Lead SOM**

### THERMAL CHARACTERISTICS: $\theta_{jA}$

36-Lead SOM	75°C/W
-------------	--------

3

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.

No responsibility is assumed by Silicon Systems for use of this product nor for any infringements of patents and trademarks or other rights of third parties resulting from its use. No license is granted under any patents, patent rights or trademarks of Silicon Systems. Silicon Systems reserves the right to make changes in specifications at any time without notice. Accordingly, the reader is cautioned to verify that the data sheet is current before placing orders.

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