

# LH521002

CMOS 256K × 4 Static RAM

## FEATURES

- Fast Access Times: 20/25/35 ns
- JEDEC Standard Pinouts
- Low Power Standby when Deselected
- TTL Compatible I/O
- 5 V ±10% Supply
- Fully Static Operation
- Common I/O for Low Pin Count
- Package: 28-Pin, 400-mil SOJ

## FUNCTIONAL DESCRIPTION

The LH521002 is a high-speed 1M-bit static RAM organized as 256K × 4. A fast, efficient design is obtained with a CMOS periphery and a matrix constructed with polysilicon load memory cells.

This RAM is fully static in operation. The Chip Enable ( $\bar{E}$ ) reduces power to the chip when  $\bar{E}$  is HIGH. Standby power drops to its lowest level ( $I_{SB1}$ ) when  $\bar{E}$  is raised to within 0.2 V of  $V_{CC}$ .

Write cycles occur when both ( $\bar{E}$ ) and Write Enable ( $\bar{W}$ ) are LOW. Data is transferred from the DQ pins to the memory location specified by the 18 address lines.

Read cycles occur when  $\bar{E}$  is LOW and  $\bar{W}$  is HIGH. A Read cycle will begin upon an address transition, on a falling edge of  $\bar{E}$ , or on a rising edge of  $\bar{W}$ .

High-frequency design techniques should be employed to obtain the best performance from this device. Solid, low-impedance power and ground planes, with high-frequency decoupling capacitors, are desirable. Series termination of the inputs should be considered when transmission line effects occur.

## PIN CONNECTIONS

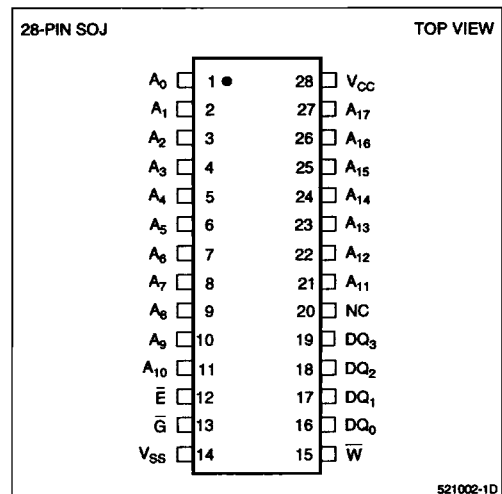


Figure 1. Pin Connections for SOJ Package

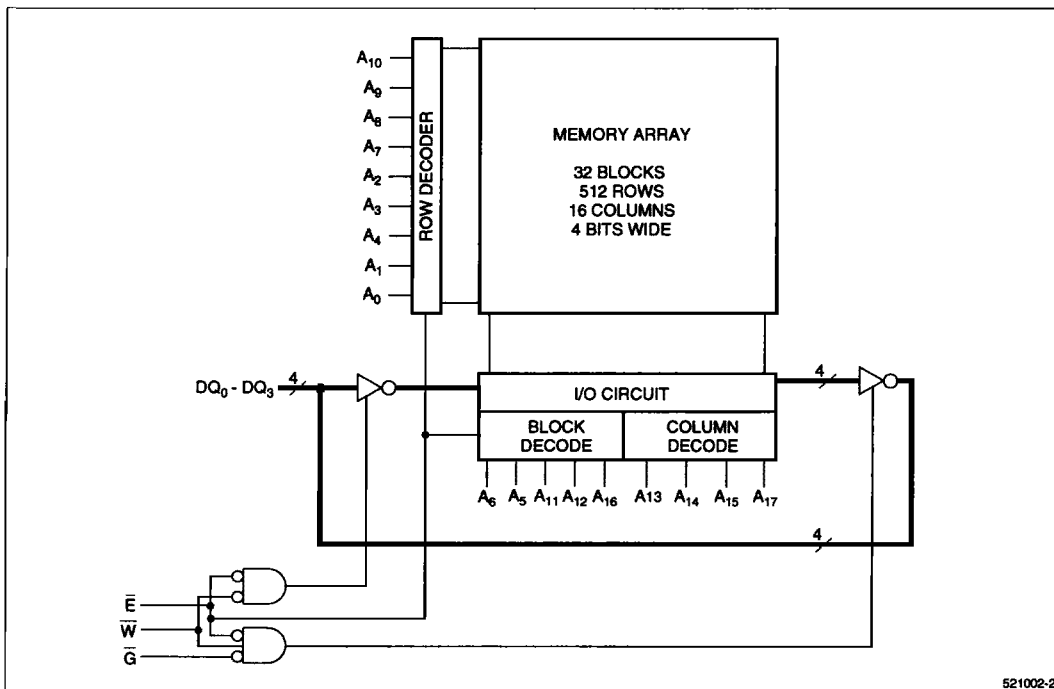


Figure 2. LH521002 Block Diagram

**TRUTH TABLE**

$\bar{E}$	$\bar{G}$	$\bar{W}$	MODE	DQ	I <sub>cc</sub>
H	X	X	Standby	High-Z	Standby
L	H	H	Selected	High-Z	Active
L	L	H	Read	Data Out	Active
L	X	L	Write	Data In	Active

**PIN DESCRIPTIONS**

PIN	DESCRIPTION
A <sub>0</sub> - A <sub>17</sub>	Address Inputs
DQ <sub>0</sub> - DQ <sub>3</sub>	Data Inputs/Outputs
$\bar{E}$	Chip Enable
$\bar{W}$	Write Enable
$\bar{G}$	Output Enable
V <sub>CC</sub>	Positive Power Supply
V <sub>SS</sub>	Ground

**ABSOLUTE MAXIMUM RATINGS**<sup>1</sup>

PARAMETER	RATING
V <sub>CC</sub> to V <sub>SS</sub> Potential	-0.5 V to 7 V
Input Voltage Range	-0.5 V to V <sub>CC</sub> + 0.5 V
DC Output Current <sup>2</sup>	± 40 mA
Storage Temperature Range	-65°C to 150°C
Power Dissipation (Package Limit)	1.0 W

**NOTES:**

- Stresses greater than those listed under 'Absolute Maximum Ratings' may cause permanent damage to the device. This is a stress rating for transient conditions only. Functional operation of the device at these or any other conditions above those indicated in the 'Operating Range' of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
- Outputs should not be shorted for more than 30 seconds. No more than one output should be shorted at any time.

**OPERATING RANGES**

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT
T <sub>A</sub>	Temperature, Ambient	0		70	°C
V <sub>CC</sub>	Supply Voltage	4.5		5.5	V
V <sub>SS</sub>	Supply Voltage	0		0	V
V <sub>IL</sub>	Logic '0' Input Voltage <sup>1</sup>	-0.5		0.8	V
V <sub>IH</sub>	Logic '1' Input Voltage	2.2		V <sub>CC</sub> + 0.5	V

**NOTE:**

- Outputs should not be shorted for more than 30 seconds. No more than one output should be shorted at any time.

**DC ELECTRICAL CHARACTERISTICS**

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
I <sub>CC1</sub>	Operating Current <sup>1</sup>	t <sub>CYCLE</sub> = 20 ns E = V <sub>IL</sub> , W = V <sub>IL</sub> or V <sub>IH</sub>			180	mA
I <sub>CC1</sub>	Operating Current <sup>1</sup>	t <sub>CYCLE</sub> = 25 ns E = V <sub>IL</sub> , W = V <sub>IL</sub> or V <sub>IH</sub>			180	mA
I <sub>CC1</sub>	Operating Current <sup>1</sup>	t <sub>CYCLE</sub> = 35 ns E = V <sub>IL</sub> , W = V <sub>IL</sub> or V <sub>IH</sub>			150	mA
I <sub>SB1</sub>	Standby Current	E ≥ V <sub>CC</sub> - 0.2 V		0.4	2	mA
I <sub>SB2</sub>	Standby Current	E ≥ V <sub>IH</sub>			20	mA
I <sub>LI</sub>	Input Leakage Current	V <sub>IN</sub> = 0 V to V <sub>CC</sub>	-2		2	μA
I <sub>LO</sub>	I/O Leakage Current	V <sub>IN</sub> = 0 V to V <sub>CC</sub>	-2		2	μA
V <sub>OH</sub>	Output High Voltage	I <sub>OH</sub> = -4.0 mA	2.4			V
V <sub>OL</sub>	Output Low Voltage	I <sub>OL</sub> = 8.0 mA			0.4	V
V <sub>DR</sub>	Data Retention Voltage	E ≥ V <sub>CC</sub> - 0.2 V	2		5.5	V
I <sub>DR</sub>	Data Retention Current	V <sub>CC</sub> = 3 V, E ≥ V <sub>CC</sub> - 0.2 V			500	μA

**NOTE:**

- I<sub>CC</sub> is dependent upon output loading and cycle rates. Specified values are with outputs open.

**AC TEST CONDITIONS**

PARAMETER	RATING
Input Pulse Levels	V <sub>SS</sub> to 3 V
Input Rise and Fall Times	5 ns
Input and Output Timing Ref. Levels	1.5 V
Output Load, Timing Tests	Figure 3

**CAPACITANCE** <sup>1,2</sup>

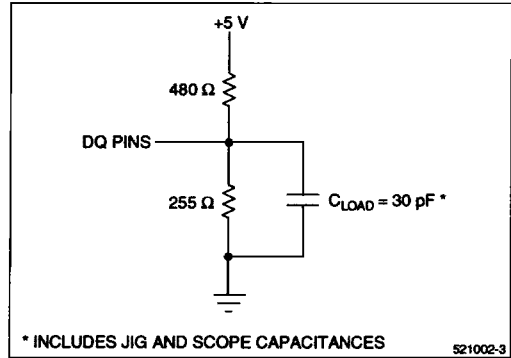
PARAMETER	RATING
C <sub>IN</sub> (Input Capacitance)	6 pF
C <sub>DQ</sub> (I/O Capacitance)	8 pF

**NOTES:**

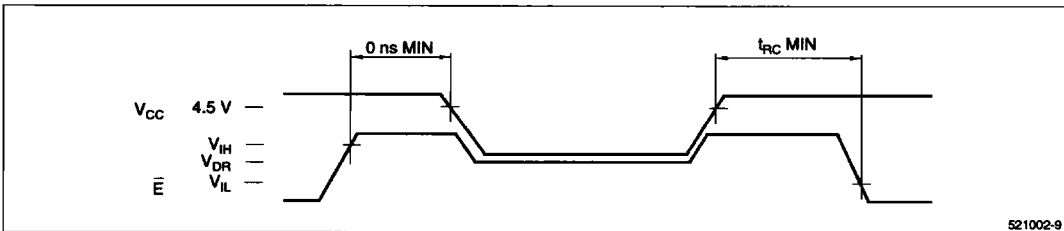
1. Capacitances are maximum values at 25°C measured at 1.0 MHz with V<sub>Bas</sub> = 0 V and V<sub>CC</sub> = 5.0 V.
2. This parameter is sampled and not production tested.

**DATA RETENTION TIMING**

$\bar{E}$  must be held above the lesser of V<sub>IH</sub> or V<sub>CC</sub> - 0.2 V to prevent improper operation when V<sub>CC</sub> < 4.5 V.  $\bar{E}$  must be V<sub>CC</sub> - 0.2 V or greater to meet I<sub>DR</sub> specification. All other inputs are 'Don't Care.'



**Figure 3. Output Load Circuit**



**Figure 4. Data Retention Timing**

AC ELECTRICAL CHARACTERISTICS <sup>6</sup> (Over Operating Range)

SYMBOL	DESCRIPTION	-20		-25		-35		UNITS
		MIN	MAX	MIN	MAX	MIN	MAX	
<b>READ CYCLE</b>								
t <sub>RC</sub>	Read Cycle Timing	20		25		35		ns
t <sub>AA</sub>	Address Access Time		20		25		35	ns
t <sub>OH</sub>	Output Hold from Address Change	3		3		3		ns
t <sub>EA</sub>	$\bar{E}$ Low to Valid Data		20		25		35	ns
t <sub>ELZ</sub>	$\bar{E}$ Low to Output Active <sup>7,8</sup>	3		3		3		ns
t <sub>EHZ</sub>	$\bar{E}$ High to Output High-Z <sup>7,8</sup>		10		12		20	ns
t <sub>GA</sub>	$\bar{G}$ Low to Valid Data		8		10		20	ns
t <sub>GLZ</sub>	$\bar{G}$ Low to Output Active <sup>7,8</sup>	0		0		0		ns
t <sub>GHZ</sub>	$\bar{G}$ High to Output High-Z <sup>7,8</sup>		8		10		20	ns
t <sub>PU</sub>	$\bar{E}$ Low to Power Up Time <sup>8</sup>	0		0		0		ns
t <sub>PD</sub>	$\bar{E}$ High to Power Down Time <sup>8</sup>		20		25		35	ns
<b>WRITE CYCLE</b>								
t <sub>WC</sub>	Write Cycle Time	20		25		35		ns
t <sub>EW</sub>	$\bar{E}$ Low to End of Write	15		20		30		ns
t <sub>AW</sub>	Address Valid to End of Write	15		20		30		ns
t <sub>AS</sub>	Address Setup	0		0		0		ns
t <sub>AH</sub>	Address Hold From End of Write	0		0		0		ns
t <sub>WP</sub>	$\bar{W}$ Pulse Width	15		20		25		ns
t <sub>DW</sub>	Input Data Setup Time	12		15		15		ns
t <sub>DH</sub>	Input Data Hold Time	0		0		0		
t <sub>WHZ</sub>	$\bar{W}$ Low to Output High-Z <sup>7,8</sup>		8		10		15	ns
t <sub>WLZ</sub>	$\bar{W}$ High to Output Active <sup>7,8</sup>	3		3		3		ns

## NOTES:

- AC Electrical Characteristics specified at 'AC Test Conditions' levels.
- Active output to High-Z and High-Z to output active tests specified for a ±500 mV transition from steady state levels into the test load.  
C<sub>Load</sub> = 5 pF.
- This parameter is sampled and not production tested.

**TIMING DIAGRAMS – READ CYCLE**

**Read Cycle No. 1**

Chip is in Read Mode:  $\bar{W}$  is HIGH,  $\bar{E}$  and  $\bar{G}$  are LOW. Read cycle timing is referenced from when all addresses are stable until the first address transition. Following an Address transition, Data Out is guaranteed valid at  $t_{AA}$ .

**Read Cycle No. 2**

Chip is in Read Mode:  $\bar{W}$  is HIGH. Timing illustrated for the case when addresses are valid while  $\bar{E}$  goes LOW. Data Out is not specified to be valid until  $t_{EA}$ , but may become valid as soon as  $t_{ELZ}$ . Outputs will transition from High-Z to Valid Data Out. Data Out is valid after both  $t_{EA}$  and  $t_{GA}$  are met.

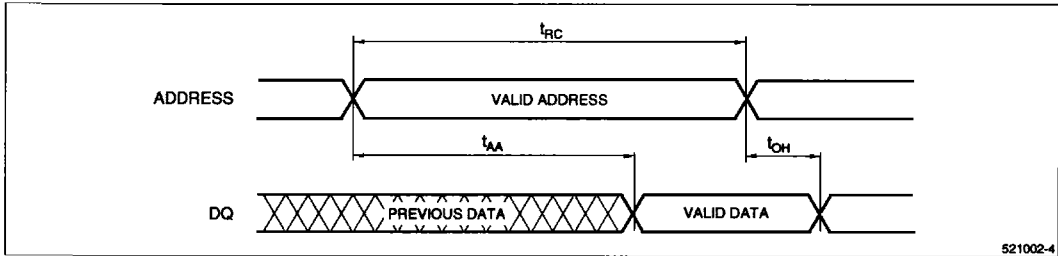


Figure 5. Read Cycle No. 1

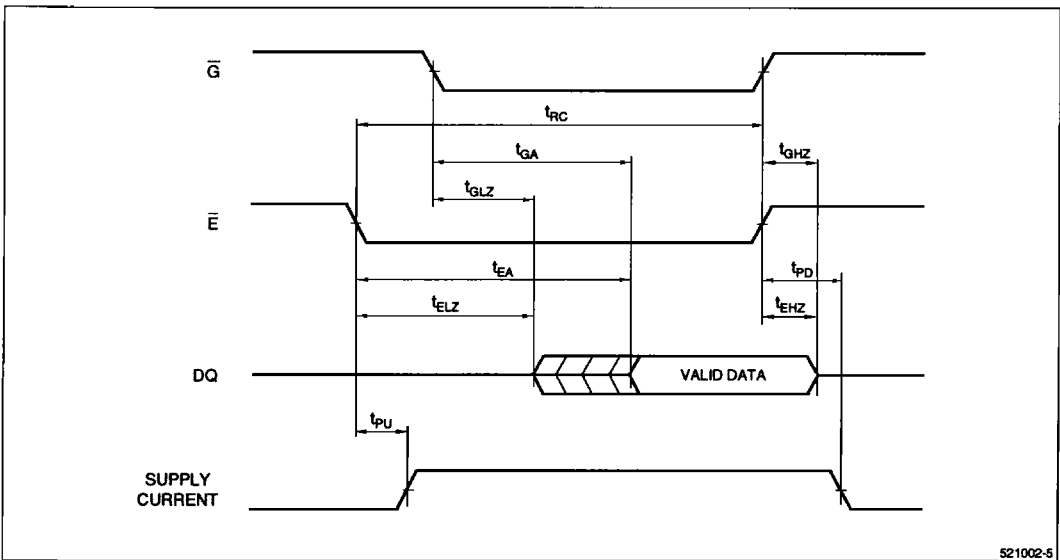


Figure 6. Read Cycle No. 2

**TIMING DIAGRAMS – WRITE CYCLE**

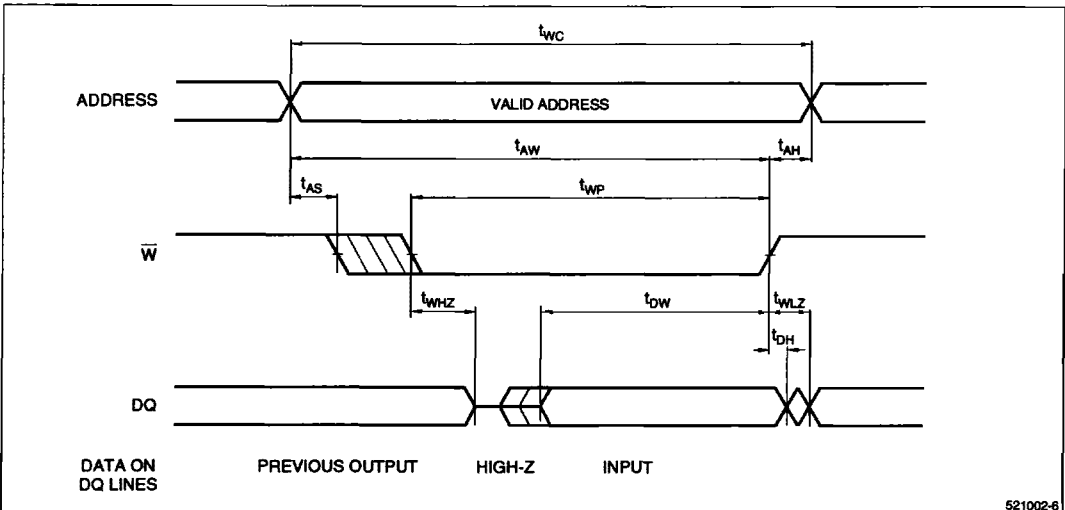
Addresses must be stable during Write cycles.  $\bar{E}$  or  $\bar{W}$  must be HIGH during address transitions. The outputs will remain in the High-Z state if  $\bar{W}$  is LOW when  $\bar{E}$  goes LOW. Care should be taken so that the output drivers are disabled prior to placing the Input Data on the DQ lines. This will prevent bus contention, reducing system noise.

**Write Cycle No. 1 ( $\bar{W}$  Controlled)**

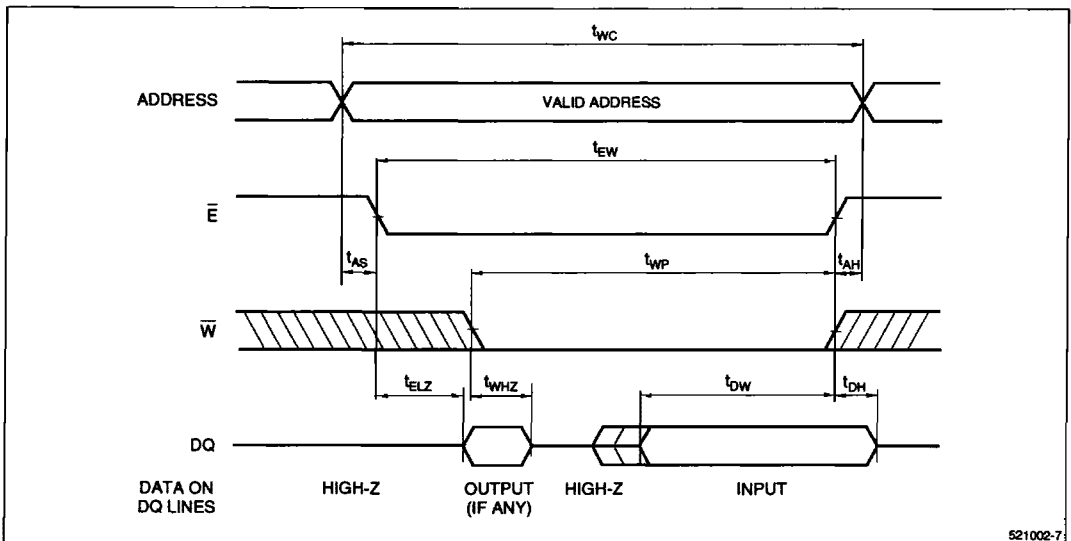
Chip is selected:  $\bar{E}$  and  $\bar{G}$  are LOW. Using only  $\bar{W}$  to control Write cycles may not offer the best device performance, since both  $t_{WHZ}$  and  $t_{DW}$  timing specifications must be met.

**Write Cycle No. 2 ( $\bar{E}$  Controlled)**

$\bar{G}$  is LOW. DQ lines may transition to Low-Z if the falling edge of  $\bar{W}$  occurs after the falling edge of  $\bar{E}$ .



**Figure 7. Write Cycle No. 1**



**Figure 8. Write Cycle No. 2**

**ORDERING INFORMATION**

