



STK11C68

CMOS nvSRAM

High Performance

8K x 8 Nonvolatile Static RAM

FEATURES

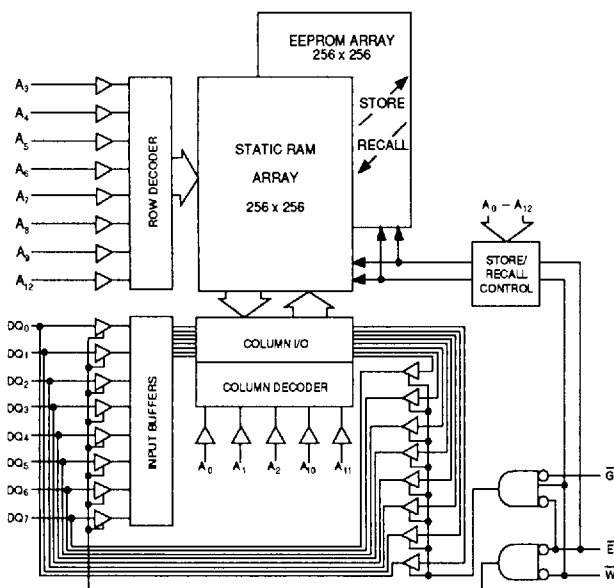
- 25, 30, 35 and 45ns Access Times
- 12, 15, 20 and 25ns Output Enable Access
- Unlimited Read and Write to SRAM
- Software *STORE* Initiation
- Automatic *STORE* Timing
- 10^4 or 10^5 *STORE* cycles to EEPROM
- 10 year data retention in EEPROM
- Automatic *RECALL* on Power Up
- Software *RECALL* Initiation
- Unlimited *RECALL* cycles from EEPROM
- Single $5V \pm 10\%$ Operation
- Commercial and Industrial Temperatures
- Available in multiple standard packages

DESCRIPTION

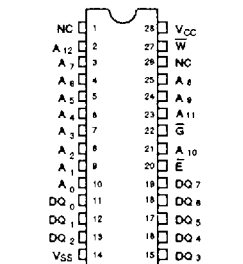
The Simtek STK11C68 is a fast static RAM (25, 30, 35, 45ns), with a nonvolatile electrically-erasable PROM (EEPROM) element incorporated in each static memory cell. The SRAM can be read and written an unlimited number of times, while independent nonvolatile data resides in EEPROM. Data transfers from the SRAM to the EEPROM (*STORE*), or from the EEPROM to the SRAM (*RECALL*) are initiated through software sequences. It combines the high performance and ease of use of a fast SRAM with nonvolatile data integrity.

The STK11C68 is pin compatible with industry standard SRAMs and is available in a 28-pin 300 mil ceramic and plastic DIP, a 28 pin 600 mil PDIP and a 28-pin SOIC. MIL-STD-883 and Standard Military Drawing (SMD 5962-92324) devices are also available.

LOGIC BLOCK DIAGRAM



PIN CONFIGURATIONS



28 - 300 C-DIP 28 - 600 P-DIP
28 - 300 P-DIP 28 - 350 SOIC

PIN NAMES

$A_0 - A_{12}$	Address Inputs
W	Write Enable
$DQ_0 - DQ_7$	Data In/Out
E	Chip Enable
G	Output Enable
V _{CC}	Power (+5V)
V _{SS}	Ground

ABSOLUTE MAXIMUM RATINGS^a

Voltage on typical input relative to V_{SS}	-0.6V to 7.0V
Voltage on $DQ_{0,7}$ and $\bar{G}$	-0.5V to $(V_{CC}+0.5V)$
Temperature under bias	-55°C to 125°C
Storage temperature	-65°C to 150°C
Power dissipation	1W
DC output current	15mA

(One output at a time, one second duration)

Note a: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

DC CHARACTERISTICS

($V_{CC} = 5.0V \pm 10\%$)

SYMBOL	PARAMETER	COMMERCIAL		INDUSTRIAL		UNITS	NOTES
		MIN	MAX	MIN	MAX		
I_{CC1}^b	Average V_{CC} Current		85		95	mA	$t_{AVAV} = 25ns$
			80		85	mA	$t_{AVAV} = 30ns$
			75		80	mA	$t_{AVAV} = 35ns$
			65		75	mA	$t_{AVAV} = 45ns$
I_{CC2}^d	Average V_{CC} Current during STORE cycle		50		50	mA	$\bar{E} \geq (V_{CC} - 0.2V)$ all others $V_{IN} \leq 0.2V$ or $\geq (V_{CC} - 0.2V)$
I_{SB1}^c	Average V_{CC} Current (Standby, Cycling TTL Input Levels)		30		34	mA	$t_{AVAV} = 25ns$
			27		30	mA	$t_{AVAV} = 30ns$
			23		27	mA	$t_{AVAV} = 35ns$
			20		23	mA	$t_{AVAV} = 45ns$
I_{SB2}^c	Average V_{CC} Current (Standby, Stable CMOS Input Levels)		1		1	mA	$\bar{E} \geq V_{IH}$; all others cycling $\bar{E} \geq (V_{CC} - 0.2V)$ all others $V_{IN} \leq 0.2V$ or $\geq (V_{CC} - 0.2V)$
I_{ILK}	Input Leakage Current (Any Input)		± 1		± 1	μA	$V_{CC} = \max$ $V_{IN} = V_{SS}$ to V_{CC}
I_{OLK}	Off State Output Leakage Current		± 5		± 5	μA	$V_{CC} = \max$ $V_{IN} = V_{SS}$ to V_{CC}
V_{IH}	Input Logic "1" Voltage	2.2	$V_{CC}+5$	2.2	$V_{CC}+5$	V	All Inputs
V_{IL}	Input Logic "0" Voltage	$V_{SS}-5$	0.8	$V_{SS}-5$	0.8	V	All Inputs
V_{OH}	Output Logic "1" Voltage	2.4		2.4		V	$I_{OUT} = -4mA$
V_{OL}	Output Logic "0" Voltage		0.4		0.4	V	$I_{OUT} = 8mA$
T_A	Operating Temperature	0	70	-40	85	°C	

Note b: I_{CC1} is dependent on output loading and cycle rate. The specified values are obtained with outputs unloaded.

Note c: Bringing $\bar{E} \geq V_{IH}$ will not produce standby current levels until any nonvolatile cycle in progress has timed out. See MODE SELECTION table.

Note d: I_{CC2} is the average current required for the duration of the store cycle (t_{STORE}) after the sequence (t_{WC}) that initiates the cycle.

AC TEST CONDITIONS

Input Pulse Levels	V_{SS} to 3V
Input Rise and Fall Times	$\leq 5ns$
Input and Output Timing Reference Levels	1.5V
Output Load	See Figure 1

CAPACITANCE ($T_A=25^\circ C$, $f=1.0MHz$)^e

SYMBOL	PARAMETER	MAX	UNITS	CONDITIONS
C_{IN}	Input Capacitance	5	pF	$\Delta V = 0$ to 3V
C_{OUT}	Output Capacitance	7	pF	$\Delta V = 0$ to 3V

Note e: These parameters are guaranteed but not tested.

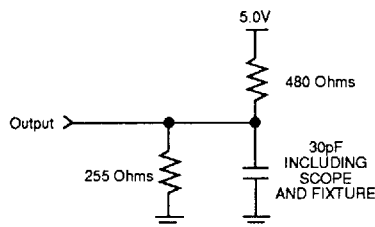


Figure 1: AC Output Loading

READ CYCLES #1 & #2

 $(V_{CC} = 5.0V \pm 10\%)$

NO.	SYMBOLS		PARAMETER	STK11C68-25		STK11C68-30		STK11C68-35		STK11C68-45		UNITS
	#1, #2	AIL		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
1	t_{ELQV}	t_{ACS}	Chip Enable Access Time		25		30		35		45	ns
2	t_{AVAVR}^g	t_{RC}	Read Cycle Time	25		30		35		45		ns
3	t_{AVQV}^h	t_{AA}	Address Access time		25		30		35		45	ns
4	t_{GLQV}	t_{OE}	Output Enable to Data Valid		12		15		20		25	ns
5	t_{AXQX}	t_{OH}	Output Hold After Address Change	5		5		5		5		ns
6	t_{ELQX}	t_{LZ}	Chip Enable to Output Active	5		5		5		5		ns
7	t_{EHQZ}^j	t_{HZ}	Chip Disable to Output Inactive		13		15		17		20	ns
8	t_{GLQX}	t_{OLZ}	Output Enable to Output Active	0		0		0		0		ns
9	t_{GHQZ}^j	t_{OHZ}	Output Disable to Output Inactive		13		15		17		20	ns
10	t_{ELCCH}^e	t_{PA}	Chip Enable to Power Active	0		0		0		0		ns
11	$t_{EHICCL}^{c,e}$	t_{PS}	Chip Disable to Power Standby		25		25		25		25	ns
11A	t_{WHQV}	t_{WR}	Write Recovery Time		30		35		45		55	ns

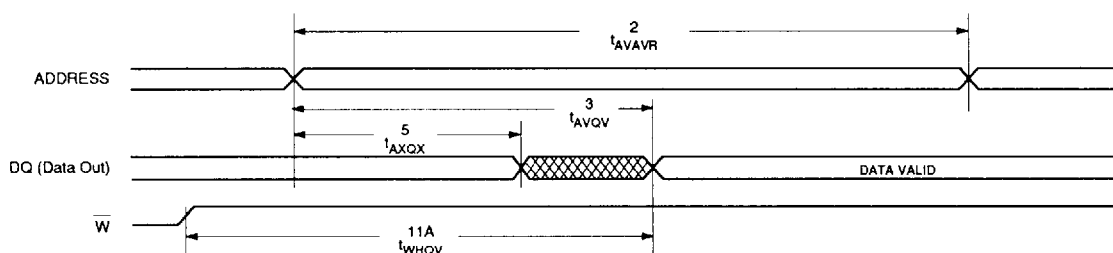
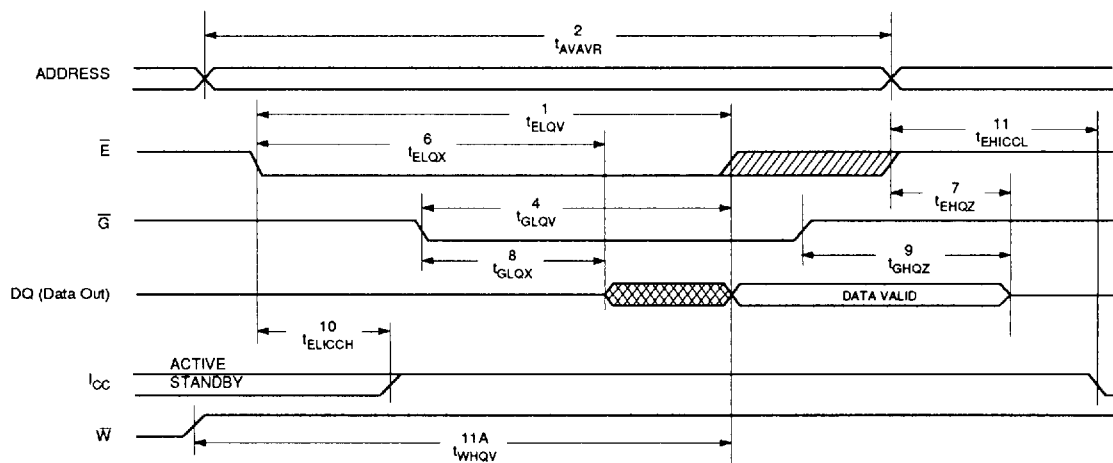
Note c: Bringing $\bar{E}$ high will not produce standby currents until any nonvolatile cycle in progress has timed out. See MODE SELECTION table.

Note e: Parameter guaranteed but not tested.

Note g: For READ CYCLE #1 and #2, $\bar{W}$ must be high for entire cycle.

Note h: Device is continuously selected with $\bar{E}$ low and $\bar{G}$ low.

Note i: Measured $\pm 200mV$ from steady state output voltage.

READ CYCLE #1 ^{g,h}READ CYCLE #2 ^g

WRITE CYCLES #1 & #2

(V_{CC} = 5.0V ± 10%)

NO.	SYMBOLS			PARAMETER	STK11C68-25		STK11C68-30		STK11C68-35		STK11C68-45		UNITS
	#1	#2	#3		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
12	t _{AVAVW}	t _{AVAVW}	t _{WC}	Write Cycle Time	25		30		35		45		ns
13	t _{WLWH}	t _{WLEH}	t _{WP}	Write Pulse Width	20		25		30		35		ns
14	t _{ELWH}	t _{ELEH}	t _{CW}	Chip Enable to End of Write	20		25		30		35		ns
15	t _{DVWH}	t _{DVEH}	t _{DW}	Data Set-up to End of Write	12		15		15		20		ns
16	t _{WHDX}	t _{EHDX}	t _{DH}	Data Hold After End of Write	0		0		0		0		ns
17	t _{AVWH}	t _{AVEH}	t _{AW}	Address Set-up to End of Write	20		25		30		35		ns
18	t _{AVWL}	t _{AVEL}	t _{AS}	Address Set-up to Start of Write	0		0		0		0		ns
19	t _{WHAX}	t _{EHAX}	t _{WR}	Address Hold After End of Write	0		0		0		0		ns
20	t _{WLOZ} ^m		t _{WZ}	Write Enable to Output Disable		35		35		35		35	ns
21	t _{WHOX}		t _{OW}	Output Active After End of Write	5		5		5		5		ns

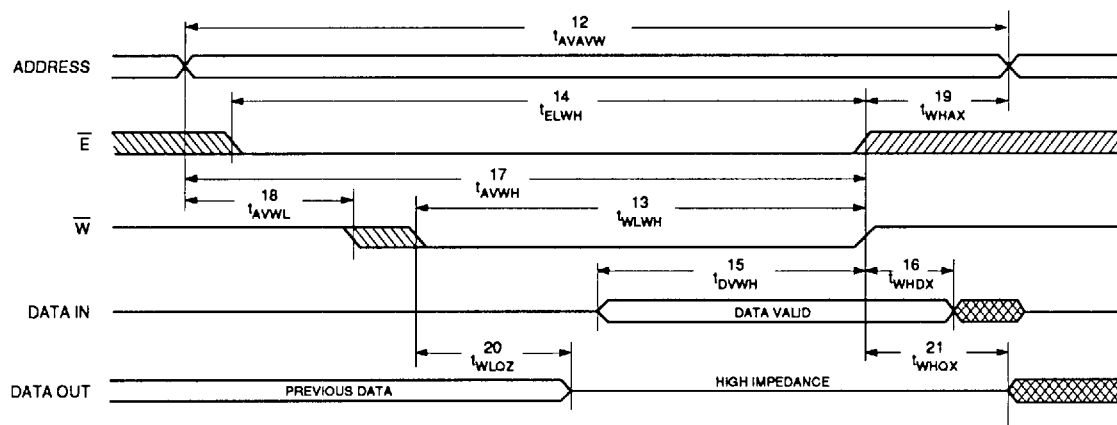
Note l: Measured ±200mV from steady state output voltage.

Note k: $\bar{E}$ or $\bar{W}$ must be ≥ high during address transitions.

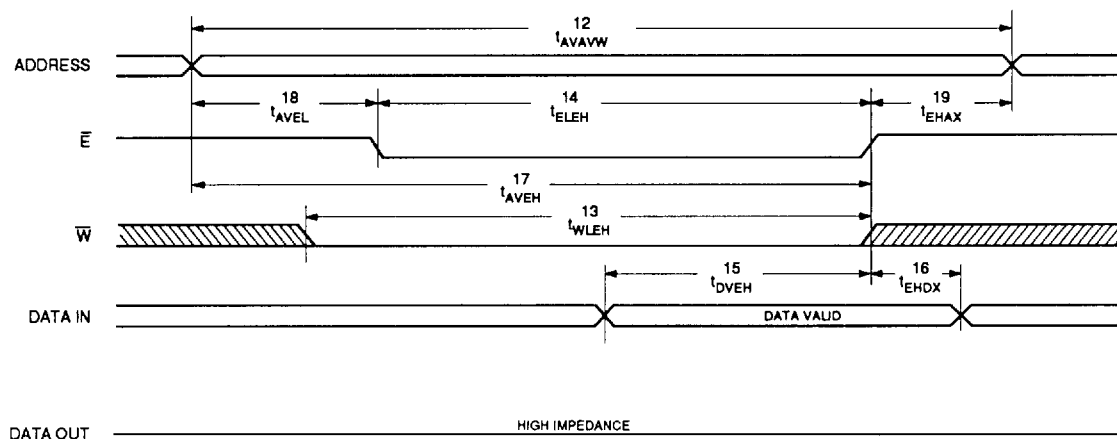
Note m: If $\bar{W}$ is low when $\bar{E}$ goes low, the outputs remain in the high impedance state.

Note l: Spec numbers 12 to 15 & 17 apply w G is high during the write cycle. These specifications are changes from previous data sheets and are effective 1/1/94.

WRITE CYCLE #1: $\bar{W}$ CONTROLLED^k



WRITE CYCLE #2: $\bar{E}$ CONTROLLED^k



NONVOLATILE MEMORY OPERATION

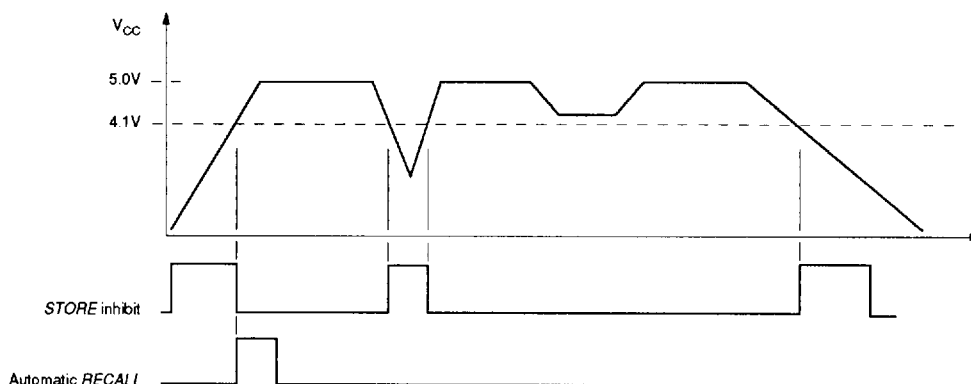
MODE SELECTION

$\bar{E}$	$\bar{W}$	$A_{12} - A_0(\text{hex})$	MODE	I/O	POWER	NOTES
H	X	X	Not Selected	Output High Z	Standby	
L	H	X	Read SRAM	Output Data	Active	o
L	L	X	Write SRAM	Input Data	Active	
L	H	0000	Read SRAM	Output Data	Active I_{CC2}	n,o
		1555	Read SRAM	Output Data		n,o
		0AAA	Read SRAM	Output Data		n,o
		1FFF	Read SRAM	Output Data		n,o
		10F0	Read SRAM	Output Data		n,o
		0F0F	Nonvolatile STORE	Output High Z		n
L	H	0000	Read SRAM	Output Data	Active	n,o
		1555	Read SRAM	Output Data		n,o
		0AAA	Read SRAM	Output Data		n,o
		1FFF	Read SRAM	Output Data		n,o
		10F0	Read SRAM	Output Data		n,o
		0F0E	Nonvolatile RECALL	Output High Z		n

Note n: The six consecutive addresses must be in order listed - (0000, 1555, 0AAA, 1FFF, 10F0, 0F0F) for a *STORE* cycle or (0000, 1555, 0AAA, 1FFF, 10F0, 0F0E) for a *RECALL* cycle. $\bar{W}$ must be high during all six consecutive cycles. See *STORE* cycle and *RECALL* cycle tables and diagrams for further details.

Note o: I/O state assumes that $\bar{G} \leq V_{IL}$. Initiation and operation of nonvolatile cycles does not depend on the state of $\bar{G}$.

STORE CYCLE INHIBIT and AUTOMATIC POWER-UP RECALL



STORE/RECALL CYCLE

 $(V_{CC} = 5.0V \pm 10\%)$

NO.	SYMBOLS		PARAMETER	STK11C68-25		STK11C68-30		STK11C68-35		STK11C68-45		UNITS
	#1	#2		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
24	t_{AVAVN}	t_{RC}	STORE/RECALL Initiation Cycle Time	25		30		35		45		ns
25	t_{ELQZ}^p		Chip Enable to Output Inactive		75		75		75		75	ns
26	t_{ELQXS}	t_{STORE}^q	STORE Cycle Time		10		10		10		10	ms
27	t_{ELQXR}	t_{RECALL}^r	RECALL Cycle Time		20		20		20		20	μs
28	t_{AVELN}^s	t_{AE}	Address Set-up to Chip Enable	0		0		0		0		ns
29	$t_{ELEHN}^{s,t}$	t_{EP}	Chip Enable Pulse Width	15		20		25		35		ns
30	t_{EHAXN}^s	t_{EA}	Chip Disable to Address Change	0		0		0		0		ns

Note p: Once the software STORE or RECALL cycle is initiated, it completes automatically, ignoring all inputs.

Note q: Note that STORE cycles (but not RECALLs) are aborted by $V_{CC} < 4.1V$ (STORE inhibit).

Note r: A RECALL cycle is initiated automatically at power up when V_{CC} exceeds 4.1V. t_{RECALL} is measured from the point at which V_{CC} exceeds 4.5V.

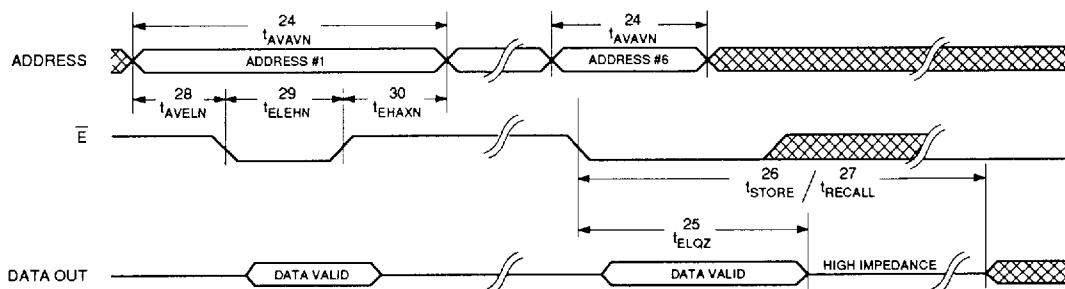
Note s: Noise on the $\bar{E}$ pin may trigger multiple read cycles from the same address and abort the address sequence.

Note t: If the Chip Enable Pulse Width is less than t_{ELQV} (see READ CYCLE #2) but greater than or equal to t_{ELEHN} , then the data may not be valid at the end of the low pulse, however the STORE or RECALL will still be initiated.

Note u: $\bar{W}$ must be HIGH when $\bar{E}$ is LOW during the address sequence in order to initiate a nonvolatile cycle. $\bar{G}$ may be either HIGH or LOW throughout.

Addresses #1 through #6 are found in the MODE SELECTION table. Address #6 determines whether the STK11C68 performs a STORE or RECALL.

STORE/RECALL CYCLE ^u



DEVICE OPERATION

The STK11C68 has two separate modes of operation: SRAM mode and nonvolatile mode. In SRAM mode, the memory operates as an ordinary static RAM. In nonvolatile operation, data is transferred from SRAM to EEPROM or from EEPROM to SRAM. In this mode SRAM functions are disabled.

SRAM READ

The STK11C68 performs a READ cycle whenever $\bar{E}$ and $\bar{G}$ are LOW while $\bar{W}$ is HIGH. The address specified on pins A_{0-12} determines which of the 8192 data bytes will be accessed. When the READ is initiated by an address transition, the outputs will be valid after a delay of t_{AVQV} (READ CYCLE #1). If the READ is initiated by $\bar{E}$ or $\bar{G}$, the outputs will be valid at t_{ELQV} or at t_{GLQV} , whichever is later (READ CYCLE #2). The data outputs will repeatedly respond to address changes within the t_{AVQV} access time without the need for transitions on any control input pins, and will remain valid until another address change or until $\bar{E}$ or $\bar{G}$ is brought HIGH or $\bar{W}$ is brought LOW.

SRAM WRITE

A write cycle is performed whenever $\bar{E}$ and $\bar{W}$ are LOW. The address inputs must be stable prior to entering the WRITE cycle and must remain stable until either $\bar{E}$ or $\bar{W}$ go HIGH at the end of the cycle. The data on pins DQ_{0-7} will be written into the memory if it is valid t_{DVWH} before the end of a $\bar{W}$ controlled WRITE or t_{DVEH} before the end of an $\bar{E}$ controlled WRITE.

It is recommended that $\bar{G}$ be kept HIGH during the entire WRITE cycle to avoid data bus contention on common I/O lines. If $\bar{G}$ is left LOW, internal circuitry will turn off the output buffers t_{WLQZ} after $\bar{W}$ goes LOW.

Keeping $\bar{G}$ high during write cycles also enables use of the faster write specifications.

NONVOLATILE STORE

The STK11C68 *STORE* cycle is initiated by executing

sequential READ cycles from six specific address locations. By relying on READ cycles only, the STK11C68 implements nonvolatile operation while remaining pin-for-pin compatible with standard 8Kx8 SRAMs. During the *STORE* cycle, an erase of the previous nonvolatile data is first performed, followed by a program of the nonvolatile elements. The program operation copies the SRAM data into nonvolatile elements. Once a *STORE* cycle is initiated, further input and output are disabled until the cycle is completed.

Because a sequence of reads from specific addresses is used for *STORE* initiation, it is important that no other read or write accesses intervene in the sequence or the sequence will be aborted and no *STORE* or *RECALL* will take place.

To initiate the *STORE* cycle the following READ sequence must be performed:

1. Read address	0000 (hex)	Valid READ
2. Read address	1555 (hex)	Valid READ
3. Read address	0AAA (hex)	Valid READ
4. Read address	1FFF (hex)	Valid READ
5. Read address	10F0 (hex)	Valid READ
6. Read address	0F0F (hex)	Initiate <i>STORE</i> Cycle

Once the sixth address in the sequence has been entered, the *STORE* cycle will commence and the chip will be disabled. It is important that READ cycles and not WRITE cycles be used in the sequence, although it is not necessary that $\bar{G}$ be LOW for the sequence to be valid. After the t_{STORE} cycle time has been fulfilled, the SRAM will again be activated for READ and WRITE operation.

HARDWARE PROTECT

The STK11C68 offers hardware protection against inadvertent *STORE* cycles through V_{CC} Sense. A *STORE* cycle will not be initiated, and one in progress will discontinue, if V_{CC} goes below 4.1V. 4.1V is a typical, characterized value.

3

NONVOLATILE RECALL

A *RECALL* cycle of the EEPROM data into the SRAM is initiated with a sequence of READ operations in a manner similar to the *STORE* initiation. To initiate the *RECALL* cycle the following sequence of READ operations must be performed:

- | | | |
|-----------------|------------|------------------------------|
| 1. Read address | 0000 (hex) | Valid READ |
| 2. Read address | 1555 (hex) | Valid READ |
| 3. Read address | 0AAA (hex) | Valid READ |
| 4. Read address | 1FFF (hex) | Valid READ |
| 5. Read address | 10F0 (hex) | Valid READ |
| 6. Read address | 0F0E (hex) | Initiate <i>RECALL</i> Cycle |

Internally, *RECALL* is a two step procedure. First, the SRAM data is cleared and second, the nonvolatile

information is transferred into the SRAM cells. The *RECALL* operation in no way alters the data in the EEPROM cells. The nonvolatile data can be recalled an unlimited number of times.

On power-up, once V_{CC} exceeds the V_{CC} sense voltage of 4.1V, a *RECALL* cycle is automatically initiated. The voltage on the V_{CC} pin must not drop below 4.1V once it has risen above it in order for the *RECALL* to operate properly. Due to this automatic *RECALL*, SRAM operation cannot commence until t_{RECALL} after V_{CC} exceeds 4.1V. 4.1V is a typical, characterized value.

ORDERING INFORMATION

STK11C68 - 5 C 30 I

Temperature Range

blank = Commercial (0 to 70 degrees C)

I = Industrial (-40 to 85 degrees C)

Access Time

25 = 25ns

30 = 30ns

35 = 35ns

45 = 45ns

Package

C = Ceramic 28 pin 300 mil DIP

P = Plastic 28 pin 300 mil DIP

S = Plastic 28 pin SOIC

W = Plastic 28 pin 600 mil DIP

Retention / Endurance

blank = 10 years / 10,000 cycles

5 = 10 years / 100,000 cycles

3