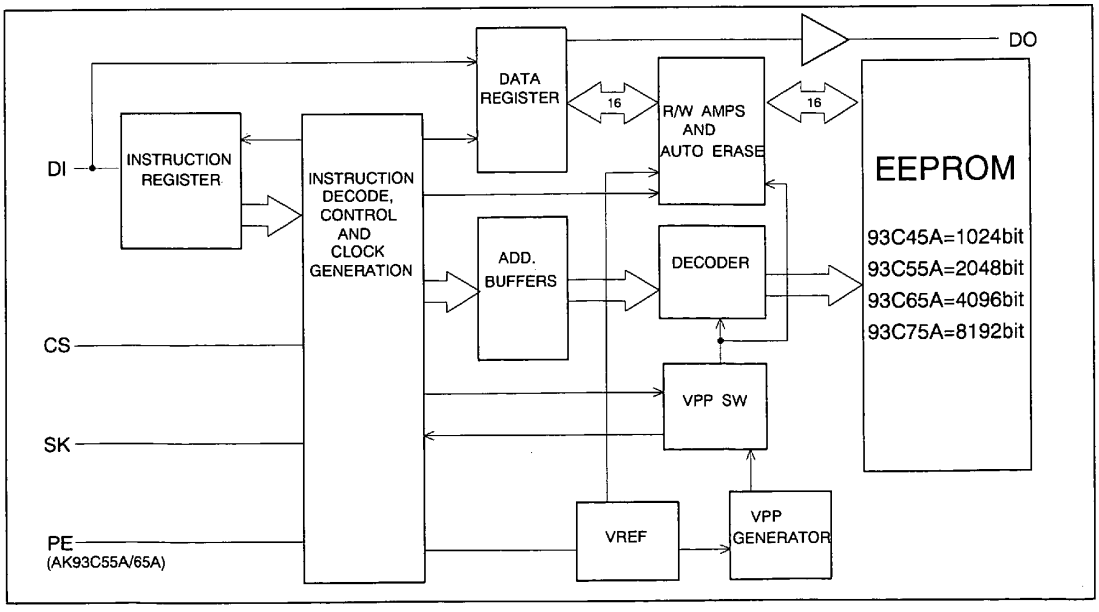
AK93C45A / 55A / 65A / 75A

1K / 2K / 4K / 8Kbit Serial CMOS EEPROM

Features

- ADVANCED CMOS EEPROM TECHNOLOGY
- READ/WRITE NON-VOLATILE MEMORY
- WIDE VCC OPERATION ··· Vcc = 1.8V ~ 5.5V
- AK93C45A · · · 1024 bits, 64 × 16 organization
  AK93C55A · · · 2048 bits, 128 × 16 organization
  AK93C65A · · · 4096 bits, 256 × 16 organization
  AK93C75A · · · 8192 bits, 512 × 16 organization
- SERIAL INTERFACE
  - Interfaces with popular microcontrollers and standard microprocessors
- LOW POWER CONSUMPTION
  - 0.5mA max. Read Operation
  - 0.8μA Max. Standby
- HIGH RELIABILITY
  -Endurance : 100K cycles
  -Data Retention : 10 years
- Automatic address increment (READ)
- Automatic write cycle time-out with auto-ERASE
- Busy/Ready status signal
- Software controlled write protection
- IDEAL FOR LOW DENSITY DATA STORAGE
  - Low cost, space saving, 8-pin package



Block Diagram

General Description

The AK93C45A/55A/65A/75A is a 1024/2048/4096/8192-bit serial CMOS EEPROM divided into 64/128/256/512 registers of 16 bits each.
The AK93C45A/55A/65A/75A has 4 instructions such as READ, WRITE, EWEN and EWDS. Those instructions control the AK93C45A/55A/65A/75A.
The AK93C45A/55A/65A/75A can operate full function under wide operating voltage range from 1.8V to 5.5V.
The charge up circuit is integrated for high voltage generation that is used for write operation.
A serial interface of AK93C45A/55A/65A/75A, consisting of chip select (CS), serial clock (SK), data-in (DI) and data-out (DO), can easily be controlled by popular microcontrollers or standard microprocessors.
AK93C45A/55A/65A/75A takes in the write data from data input pin (DI) to a register synchronously with rising edge of input pulse of serial clock pin (SK). And at read operation, AK93C45A/55A/65A/75A takes out the read data from a register to data output pin (DO) synchronously with rising edge of SK.
The DO pin is usually in high impedance state. The DO pin outputs "L" or "H" in case of data output or $\overline{\text{Busy}}$/Ready signal output.

・Software and Hardware controlled write protection
When Vcc is applied to the part, the part automatically powers up in the ERASE/WRITE Disable state. In the ERASE/WRITE disable state, execution of WRITE instruction is disabled. Before WRITE instruction is executed, EWEN instruction must be executed. The ERASE/WRITE enable state continues until EWDS instruction is executed or Vcc is removed from the part.
Execution of a read instruction is independent of both EWEN and EWDS instructions.
The PE is internally pulled up to VCC. If the PE is left unconnected, the part will accept WRITE, EWEN and EWDS instructions.・・AK93C55A/65A

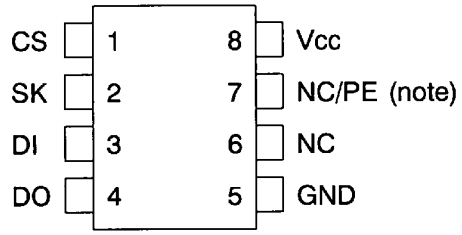
・$\overline{\text{Busy}}$/Ready status signal
After a write instruction, the DO output serves as a $\overline{\text{Busy}}$/Ready status indicator. After the falling edge of the CS initiates the self-timed programming cycle, the DO indicates the $\overline{\text{Busy}}$/Ready status of the chip if the CS is brought high after a minimum of 250ns (Tcs). DO=logical "0" indicates that programming is still in progress. DO=logical "1" indicates that the register at the address specified in the instruction has been written with the new data pattern contained in the instruction and the part is ready for a next instruction.
The $\overline{\text{Busy}}$/Ready status indicator is only valid when CS is active (high). When CS is low, the DO output goes into a high impedance state.
The $\overline{\text{Busy}}$/Ready signal outputs until a start bit (Logic"1") of the next instruction is given to the part.

■ **Type of Products**

Model	Memory size	Temp.Range	Vcc	Package
AK93C45AF	1Kbits	-40°C~85°C	1.8V~5.5V	8pin Plastic SOP
AK93C45ANF		-40°C~85°C	1.8V~5.5V	8pin Plastic SOP
AK93C45AV		-40°C~85°C	1.8V~5.5V	8pin Plastic TSSOP
AK93C55AF	2Kbits	-40°C~85°C	1.8V~5.5V	8pin Plastic SOP
AK93C55ANF		-40°C~85°C	1.8V~5.5V	8pin Plastic SOP
AK93C55AV		-40°C~85°C	1.8V~5.5V	8pin Plastic TSSOP
AK93C65AF	4Kbits	-40°C~85°C	1.8V~5.5V	8pin Plastic SOP
AK93C65ANF		-40°C~85°C	1.8V~5.5V	8pin Plastic SOP
AK93C65AV		-40°C~85°C	1.8V~5.5V	8pin Plastic TSSOP
AK93C75AF	8Kbits	-40°C~85°C	1.8V~5.5V	8pin Plastic SOP
AK93C75ANF		-40°C~85°C	1.8V~5.5V	8pin Plastic SOP
AK93C75AV		-40°C~85°C	1.8V~5.5V	8pin Plastic TSSOP

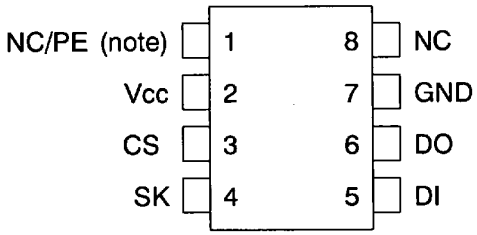
Pin arrangement

AK93C45ANF/55ANF/65ANF/75ANF



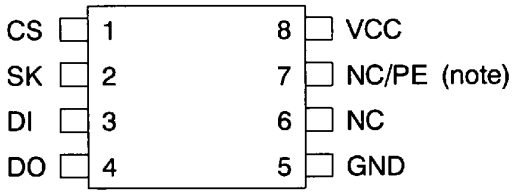
8pinSOP

AK93C45AF/55AF/65AF/75AF



8pinSOP

AK93C45AV/55AV/65AV/75AV



8pinTSSOP

(note) AK93C45A/75A ・・ NC, AK93C55A/65A ・・ PE

Pin Name	Function
CS	Chip Select
SK	Serial Data Clock
DI	Serial Data Input
DO	Serial Data Output
GND	Ground
PE	Program Enable
Vcc	Power Supply
NC	Not Connected

(note) The PE is internally pulled up to VCC (R = typ.2.5MΩ, VCC=5V).

Functional Description

The AK93C45A/55A/65A/75A has 4 instructions such as READ, WRITE, EWEN and EWDS. A valid instruction consists of a Start Bit (Logic"1"), the appropriate Op Code and the desired memory Address location.

The CS pin must be brought low for a minimum of 250ns (Tcs) between each instruction when the instruction is continuously executed.

Instruction	Start Bit	Op Code	Address	Data	Comments
READ	1	10	A5-A0	D15-D0	Reads data stored in memory, at specified address.
WRITE	1	01	A5-A0	D15-D0	Writes register.
EWEN	1	00	11XXXX		Write enable must precede all programming modes.
EWDS	1	00	00XXXX		Disables all programming instructions.
WRAL	1	00	01XXXX	D15-D0	Writes all registers.

X: Don't care

table 1. Instruction Set for the AK93C45A

Instruction	Start Bit	Op Code	Address	Data	Comments
READ	1	10	X A6-A0	D15-D0	Reads data stored in memory, at specified address.
WRITE	1	01	X A6-A0	D15-D0	Writes register.
EWEN	1	00	11XXXXXX		Write enable must precede all programming modes.
EWDS	1	00	00XXXXXX		Disables all programming instructions.
WRAL	1	00	01XXXXXX	D15-D0	Writes all registers.

X: Don't care

table 2. Instruction Set for the AK93C55A

Instruction	Start Bit	Op Code	Address	Data	Comments
READ	1	10	A7-A0	D15-D0	Reads data stored in memory, at specified address.
WRITE	1	01	A7-A0	D15-D0	Writes register.
EWEN	1	00	11XXXXXX		Write enable must precede all programming modes.
EWDS	1	00	00XXXXXX		Disables all programming instructions.
WRAL	1	00	01XXXXXX	D15-D0	Writes all registers.

X: Don't care

table 3. Instruction Set for the AK93C65A

Instruction	Start Bit	Op Code	Address	Data	Comments
READ	1	10	XA8-A0	D15-D0	Reads data stored in memory, at specified address.
WRITE	1	01	XA8-A0	D15-D0	Writes register.
EWEN	1	00	11XXXXXXXX		Write enable must precede all programming modes.
EWDS	1	00	00XXXXXXXX		Disables all programming instructions.
WRAL	1	00	01XXXXXXXX	D15-D0	Writes all registers.

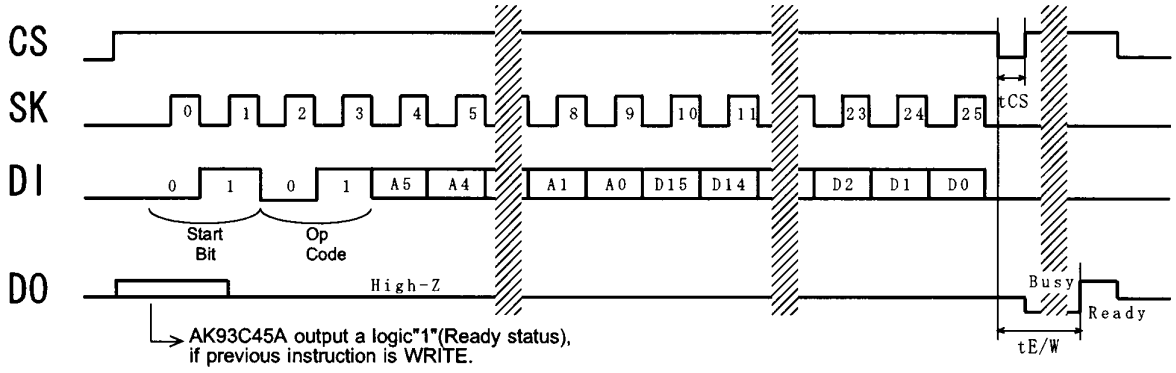
X: Don't care

table 4. Instruction Set for the AK93C75A

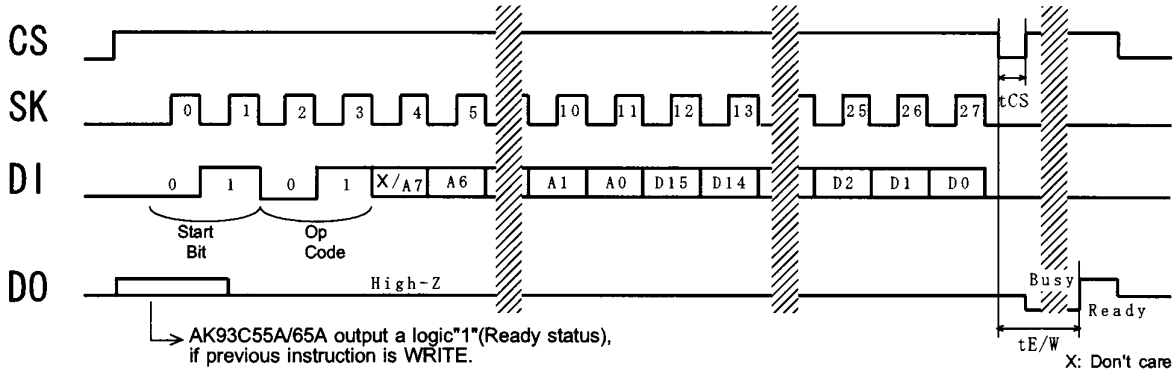
(Note) ・The WRAL instruction are used for factory function test only.
User can't use the WRAL instruction.
・The AK93C45A/55A/65A/75A perceives the start bit in the logic"1" and also "01".

Write

The write instruction is followed by 16 bits of data to be written into the specified address. After the last bit of data is put on the DI pin, the CS pin must be brought low before the next rising edge of the SK clock. This falling edge of the CS initiates the self-timed programming cycle. The DO indicates the $\overline{\text{Busy}}$/Ready status of the chip if the CS is brought high after a minimum of 250ns (Tcs). DO=logical "0" indicates that programming is still in progress. DO=logical "1" indicates that the register at the address specified in the instruction has been written with the new data pattern contained in the instruction and the part is ready for a next instruction.

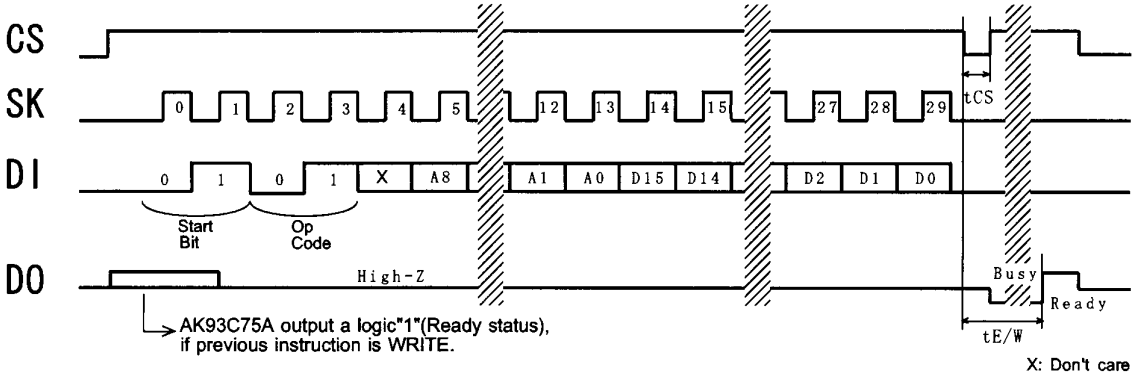


WRITE (AK93C45A)



*Address bit A7 becomes a "don't care" for AK93C55A.

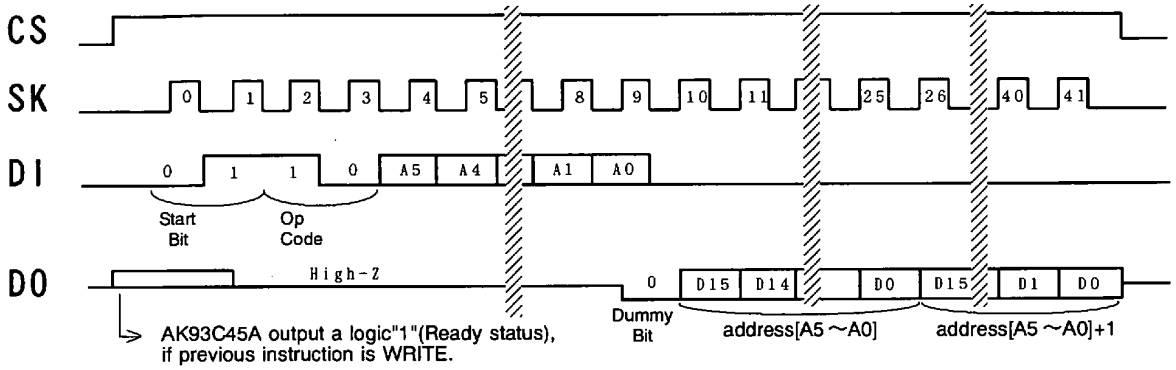
WRITE (AK93C55A/65A)



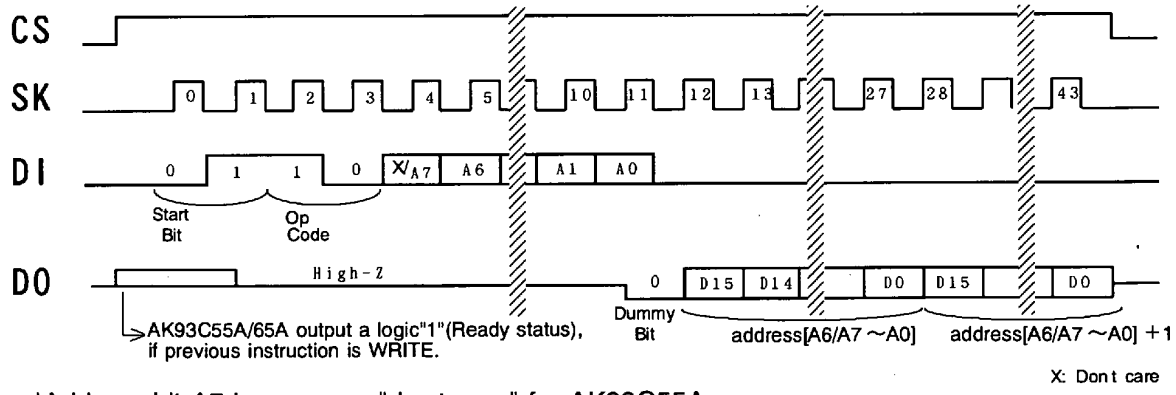
WRITE (AK93C75A)

Read

The read instruction is the only instruction which outputs serial data on the DO pin.
Following the Start bit, first Op code and address are decoded, then the data from the selected memory location is available at the DO pin. A dummy bit (logical "0") precedes the 16-bit data from the selected memory location. The output data changes are synchronized with the rising edges of the serial clock (SK).
The data in the next address can be read sequentially by continuing to provide clock. The address automatically cycles to the next higher address after the 16bit data shifted out.
When the highest address is reached, the address counter rolls over to address $00 or $000 allowing the read cycle to be continued indefinitely.

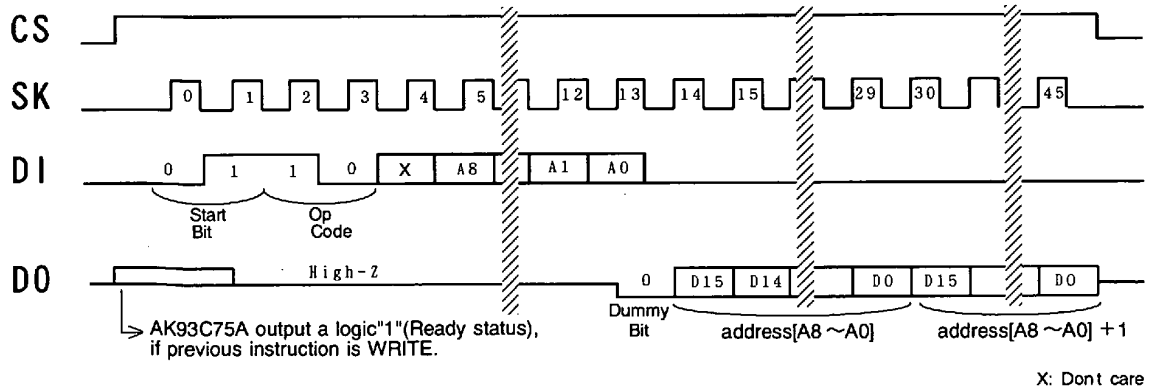


READ (AK93C45A)



*Address bit A7 becomes a "dont care" for AK93C55A.

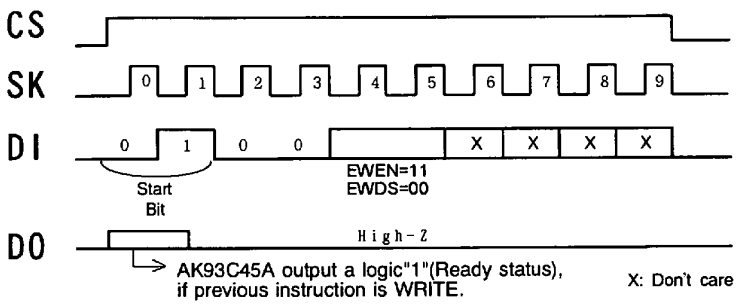
READ (AK93C55A/65A)



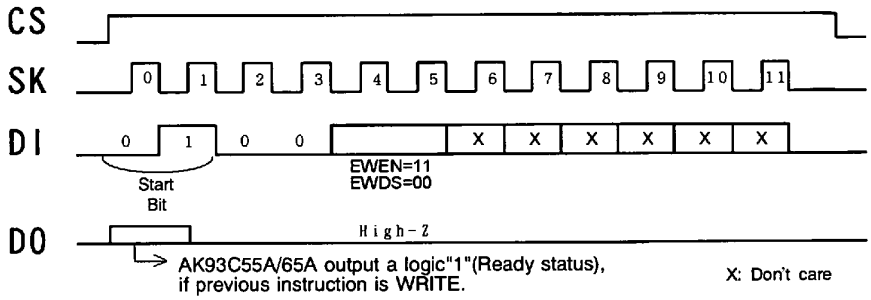
READ (AK93C75A)

EWEN / EWDS

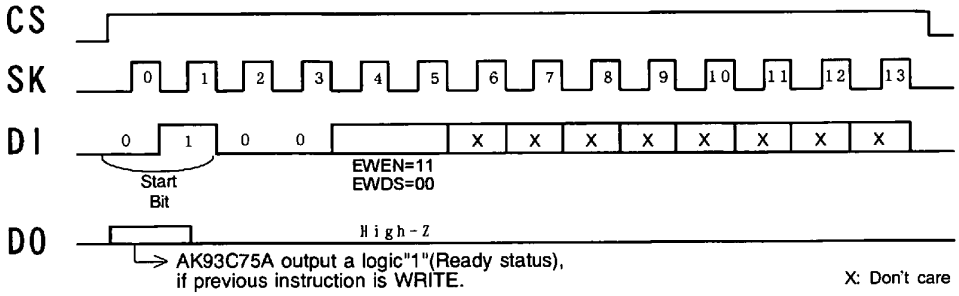
When Vcc is applied to the part, the part automatically powers up in the ERASE/WRITE Disable state. In the ERASE/WRITE disable state, execution of WRITE instruction is disable. Before WRITE instruction is executed, EWEN instruction must be executed. The ERASE/WRITE enable state continues until EWDS instruction is executed or Vcc is removed from the part.
Execution of a read instruction is independent of both EWEN and EWDS instructions.



EWEN/EWDS (AK93C45A)



EWEN/EWDS (AK93C55A/65A)



EWEN/EWDS (AK93C75A)

Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Unit
Power Supply	VCC	-0.6	+7.0	V
All Input Voltages with Respect to Ground	VIO	-0.6	VCC+0.6	V
Ambient storage temperature	Tst	-65	+150	°C

Stress above 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 these or any other conditions above those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum conditions for extended periods may affect device reliability.

Recommended Operating Condition

Parameter	Symbol	Min	Max	Unit
Power Supply	VCC	1.8	5.5	V
Ambient Operating Temperature	Ta	-40	+85	°C

Electrical Characteristics

(1) D.C. ELECTRICAL CHARACTERISTICS

✧ AK93C45A/55A/65A

(1.8V≤Vcc≤5.5V, -40°C≤Ta≤85°C, unless otherwise specified)

Parameter	Symbol	Condition		Min.	Max.	Unit
Current Dissipation (WRITE)	ICC1	VCC=5.5V, tSKP=1us, *1			4.0	mA
	ICC2	VCC=1.8V, tSK=4us,*1	93C45A		1.5	mA
			93C55A/65A		2.0	mA
Current Dissipation (READ,EWEN,EWDS)	ICC3	VCC=5.5V, tSKP=1us, *1			0.5	mA
	ICC4	VCC=2.5V, tSKP=2us, *1			0.2	mA
	ICC5	VCC=1.8V, tSKP=4us, *1			0.1	mA
Current Dissipation (Standby)	ICC_{SB}	VCC=5.5V *2			0.8	uA
Input High Voltage	VIH1	VCC=5V±10%		2.0	VCC+0.5	V
	VIH2	2.5V≤VCC≤5.5V		0.8 × VCC	VCC+0.5	V
	VIH3	1.8V≤VCC<2.5V		0.8 × VCC	VCC+0.5	V
Input Low Voltage	VIL1	VCC=5V±10%		-0.1	0.8	V
	VIL2	2.5V≤VCC≤5.5V		-0.1	0.15 × VCC	V
	VIL3	1.8V≤VCC<2.5V		-0.1	0.2 × VCC	V
Output High Voltage	VOH1	VCC=5V±10% IOH=-0.4mA		2.2		V
	VOH2	2.5V≤VCC≤5.5V IOH=-0.1mA		0.8 × VCC		V
	VOH3	1.8V≤VCC<2.5V IOH=-0.1mA		0.8 × VCC		V
Output Low Voltage	VOL1	VCC=5V±10% IOL=2.1mA			0.4	V
	VOL2	2.5V≤VCC≤5.5V IOL=1.0mA			0.4	V
	VOL3	1.8V≤VCC<2.5V IOL=0.1mA			0.4	V
Input Leakage	ILI	VCC=5.5V,VIN=5.5V *3			±1.0	uA
Output Leakage	ILO	VCC=5.5V VOUT=5.5V,CS=GND			±1.0	uA

*1:VIN=VIH/VIL,DO=Open

*2:VIN=VCC/GND,CS=GND,DO=Open

*3:CS, SK, DI pin

✧ AK93C75A

(1.8V≤Vcc≤5.5V, -40°C≤Ta≤85°C, unless otherwise specified)

Parameter	Symbol	Condition	Min.	Max.	Unit
Current Dissipation (WRITE)	ICC1	VCC=5.5V, tSKP=1us, *4		4.0	mA
	ICC2	VCC=1.8V, tSKP=4us, *4		2.0	mA
Current Dissipation (READ,EWEN,EWDS)	ICC3	VCC=5.5V, tSKP=1us, *4		0.4	mA
	ICC4	VCC=1.8V, tSKP=4us, *4		0.1	mA
Current Dissipation (Standby)	ICC_{SB}	VCC=5.5V *5		0.8	uA
Input High Voltage	VIH		0.8 × VCC	VCC+0.5	V
Input Low Voltage	VIL		-0.1	0.2 × VCC	V
Output High Voltage	VOH1	2.5V≤VCC≤5.5V IOH=-0.1mA	0.8 × VCC		V
	VOH2	1.8V≤VCC<2.5V IOH=-0.1mA	0.8 × VCC		V
Output Low Voltage	VOL1	2.5V≤VCC≤5.5V IOL=1.0mA		0.4	V
	VOL2	1.8V≤VCC<2.5V IOL=0.1mA		0.4	V
Input Leakage	ILI	VCC=5.5V, VIN=5.5V *6		±1.0	uA
Output Leakage	ILO	VCC=5.5V VOUT=5.5V, CS=GND		±1.0	uA

*4:VIN=VIH/VIL,DO=Open

*5:VIN=VCC/GND,CS=GND,DO=Open

*6:CS, SK, DI pin

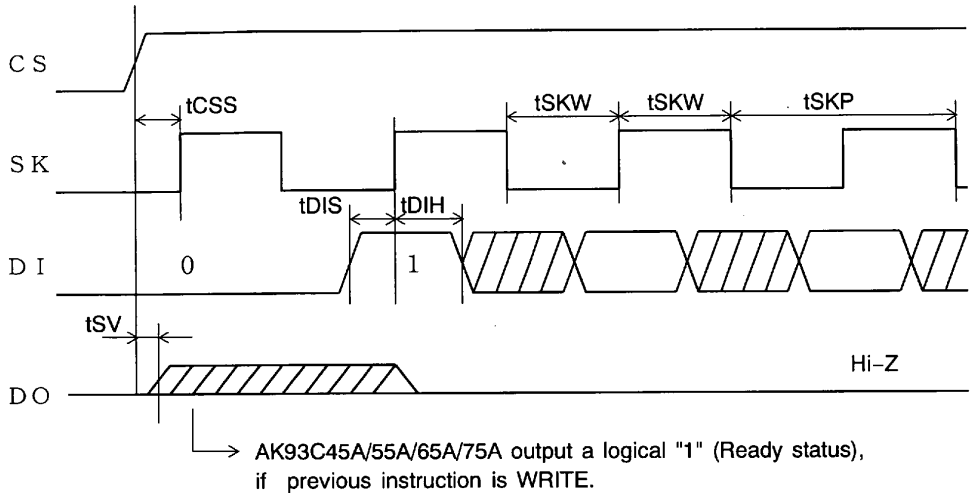
(2) A.C. ELECTRICAL CHARACTERISTICS

(1.8V≤Vcc≤5.5V, -40°C≤Ta≤85°C, unless otherwise specified)

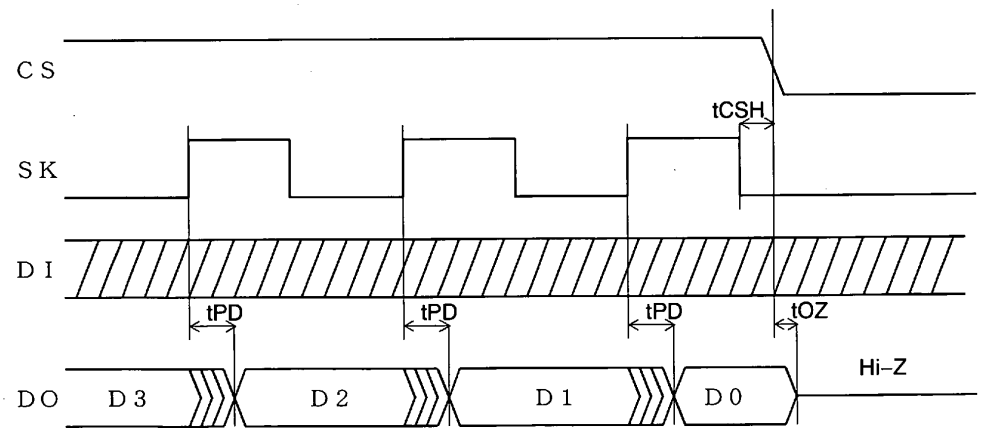
Parameter	Symbol	Condition		Min.	Max.	Unit
SK Cycle Time	tSKP1	4.5V≤VCC≤5.5V		1.0		us
	tSKP2	2.0V≤VCC<4.5V		2.0		us
	tSKP3	1.8V≤VCC<2.0V		4.0		us
SK Pulse Width	tSKW1	4.5V≤VCC≤5.5V		500		ns
	tSKW2	2.0V≤VCC<4.5V		1.0		us
	tSKW3	1.8V≤VCC<2.0V		2.0		us
CS Setup Time	tCSS			100		ns
CS Hold Time	tCSH			0		ns
Data Setup Time	tDIS			200		ns
Data Hold Time	tDIH			200		ns
Output delay *7	tPD1	4.5V≤VCC≤5.5V			500	ns
	tPD2	2.0V≤VCC<4.5V			1.0	us
	tPD3	1.8V≤VCC<2.0V			2.0	us
Selftimed Programming Time	tE/W1	93C45A/55A/65A			10	ms
	tE/W2	93C75A	4.5V≤VCC≤5.5V		8	ms
	tE/W3		1.8V≤VCC<4.5V		10	ms
Min CS Low Time	tCS			250		ns
CS to Status Valid	tSV	CL=100pF			500	ns
CS to Output High-Z	tOZ1	2.0V≤VCC≤5.5V			100	ns
	tOZ2	1.8V≤VCC<2.0V			250	ns

*7:CL=100pF

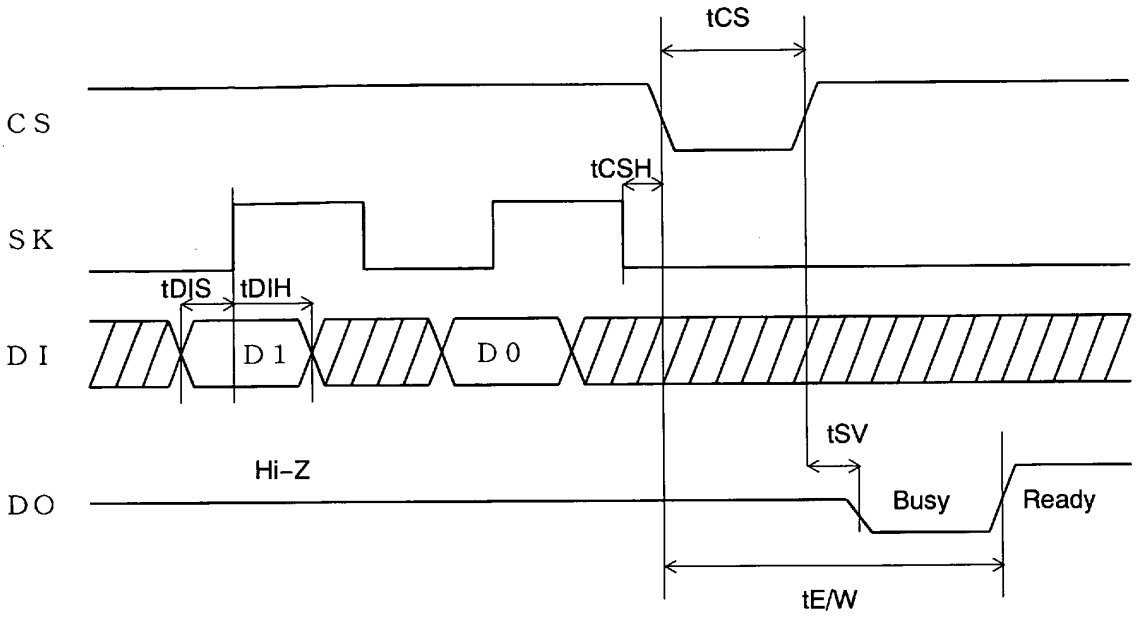
Synchronous Data Timing



The Start of Instruction



The End of Instruction



$\overline{\text{Busy}}$/Ready Signal Output

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  (b) A critical component is one whose failure to function or perform may reasonably be expected to result, whether directly or indirectly, in the loss of the safety or effectiveness of the device or system containing it, and which must therefore meet very high standards of performance and reliability.
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