AK93C46 Series

1024-BIT SERIAL (5V ONLY) CMOS ELECTRICALY ERASABLE PROGRAMMABLE MEMORY

FEATURES

■ADVANCED CMOS E²PROM TECHNOLOGY
■READ/WRITE NON-VOLATILE MEMORY
 —Single 5V supply operation
 —1024 bits, 64×16 organization
 —Easy to use yet versatile serial data interface
■LOW POWER CONSUMPTION
 —3mA Max Active
 —1mA Max Standby, TTL interface
 —100μA Max Standby, CMOS interface
■SPECIAL FEATURES
 —Automatic write cycle time-out
 —Ready/Busy status signal
 —Software controlled write protection
■LOW VOLTAGE READ OPERATION
 —Vccr=2.8Vmin (AK93C46M/MF)

■IDEAL FOR LOW DENSITY DATA STORAGE
 —Low cost, space saving, 8-pin package
 —Interfaces with popular microcontrollers
  and standard microprocessors
■APPLICATION VERSATILITY
 —Alarm Devices, Electronic Locks, Appliances,
  Terminals, Smart Cards, Satellite Receivers,
 Robotics, Meters, Telephones, Tuners, etc.
■SUPER-SET COMPATIBILITY
 —National : NMC9306/COP494, NMC9346/COP495
 —General Instrument : ER59256, ER5911
 —NCR : 59306, 5930B

GENERAL DESCRIPTION

The AK93C46 is a 1024-bit, 5V-only, serial, read/write, non-volatile memory device fabricated using an advanced CMOS E²PROM technology. Its 1024 bits of memory are organized into 64 registers of 16 bits each. Each register is individually addressable for serial read or write operations. A versatile serial interface, consisting of chip select, clock, data-in and data-out, can easily be controlled by popular microcontrollers or standard microprocessors.

Low power consumption, low cost, and space efficiency make the AK93C46 an ideal candidate for high volume, low density, data storage applications. Special features of the AK93C46 include : automatic write time-out, ready/busy status signal, software controlled write protection and ultra-low standby power mode when deselected (CS low). Additionally AK93C46 offers functional compatibility with existing NMOS serial E²PROMs. AK93C46M/MF functions down to 2.8V (Vccr) in the read mode.

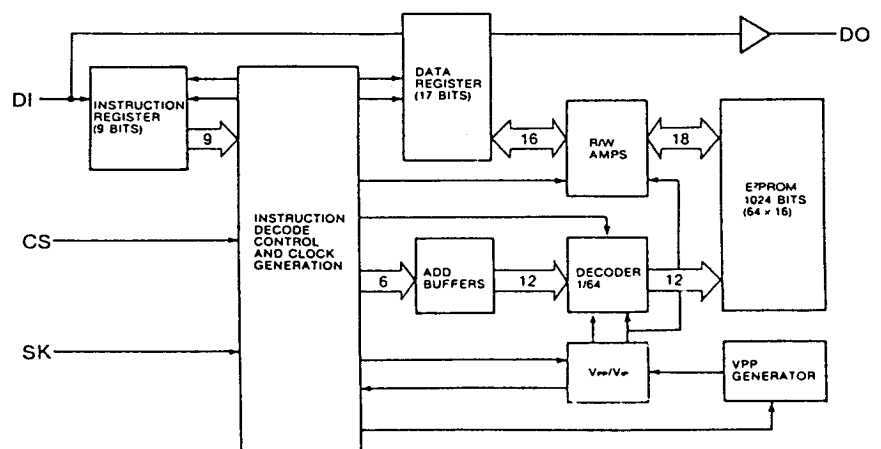### Pin Configuration

Block Diagram

(TOP VIEW)
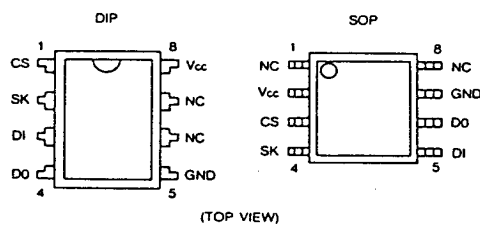
Pin Names

CS	Chip Select
SK	Serial Data Clock
DI	Serial Data Input
DO	Serial Data Output
Vcc	Power Supply
GND	Ground
NC	Not Connected

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FUNCTIONAL DESCRIPTION

Device Operation[1,2,3]

The AK93C46 is a serial 1024 bit peripheral memory device intended for use in non-volatile data storage applications. Its memory organization consists of 64 registers, each 16-bits wide. Each register is independently addressable for read or write operations. Six 9-bit serial instructions are used to control the operation of the AK93C46. These instructions are serially clocked into the DI input as controlled by the CS and SK inputs.

The instructions include read, write, erase, erase/write enable, erase/write disable and erase all registers. The format of each instruction has a logical "1" as a start bit, two bits as an op code, and six bits of address. During read operations the DO output is valid as data out after the address is entered. After a write/erase instruction, the DO output serves as a ready/busy status indicator signaling when the operation is complete allowing further read or write access. The ready/busy status indicator is only valid when CS is active (high), when CS is low, the DO output goes into a high impedance state. After a new instruction is initiated, the DO output also goes to high impedance.

Read

The read instruction is the only instruction which outputs serial data on the DO pin. After a read instruction is received, the instruction and address are decoded, followed by data transfer from the memory register into a 16-bit serial-out-shift register. A dummy bit (logical "0") precedes the 16-bit data output string.

The output data changes during the high states of the system clock.

Erase/Write Enable and Disable

When Vcc is applied to the part it powers up in the programming disable (EWDS) state, programming must be preceded by a programming enable (EWEN) instruction. Programming remains enabled until a programming disable (EWDS) instruction is executed or Vcc is removed from the part. The programming disable instruction is provided to protect against accidental data disturb.

Execution of a read instruction is independent of both EWEN and EWDS instructions.

Erase

Like most EEPROMs, the register must first be erased (all bits set to logical "1") before the register can be written (certain bits set to logical "0"). After an erase instruction is input, CS is dropped low. This falling edge of CS determines the start of the self-timed programming cycle. If CS is brought high subsequently (after observing the Tcs specification), the DO pin will indicate the ready/busy status of the chip. The DO pin will go low if the chip is still programming. The DO pin will go high when all bits of the register at the address specified in the instruction have been set to a logical "1". The part is now ready for the next instruction sequence.

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 data in (DI) pin, CS must be brought low before the next rising edge of the SK clock. This falling edge of CS initiates the self-timed programming cycle. Like all programming modes, DO indicates the ready/busy status of the chip if CS is brought high after a minimum of $1\mu s$ (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 data pattern specified in the instruction and the part is ready for another instruction. The register to be written into must have been previously erased.

Chip Erase

Entire chip erasing is provided for ease of programming. Erasing the chip means that all registers in the memory array each bit set to a logical "1". Each register is then ready for write instruction. The chip erase cycle is identical to the erase cycle except for the different op code.

Instruction Set For 93C46

Instruction	Start Bit	Opcode	Address	Data	Comments
READ	01	10	A5A4A3A2A1A0		READ register A5A4A3A2A1A0
WRITE	01	01	A5A4A3A2A1A0	$D_{15}-D_0$	WRITE register A5A4A3A2A1A0
ERASE	01	11	A5A4A3A2A1A0		ERASE register A5A4A3A2A1A0
EWEN	01	00	11XXXX		ERASE/WRITE enable
EWDS	01	00	00XXXX		ERASE/WRITE disable
ERAL	01	00	10XXXX		Erase all registers
WRAL	01	00	01XXXX	$D_{15}-D_0$	Write all registers[4]

AK93C46 has 7 instructions as shown. Note that the Most Significant Bit of any given instruction is a "1" and is viewed as a start bit in the interface sequence. The next 8 bits carry the op code and the 6-bit address for 1 of 64, 16-bit registers.

Notes

[1] CS must be brought low for a minimum of $1\mu s$ (Tcs) between consecutive instruction cycles.

[2] During a programming mode (write, erase, chip erase), SK clock is only needed while the actual instruction, i.e. start bit, op code address and data is being input. It can remain deactivated during the self-timed programming cycle and status check.

[3] DI must be brought low during the self-timed programming cycle and status check.

[4] The write-all (WRAL) command writes all registers to a logical 0. This command is provided for device evaluation purposes only and is not meant to be used for normal operation.

[5] 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.

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ABSOLUTE MAXIMUM RATINGS[5]

Voltage relative to ground	−0.3V to +6.5V
Ambient operating temperature	−30°C to +70°C

Ambient storage temperature	−65°C to +125°C
Lead temperature (soldering 10 sec.)	+260°C

D.C. AND A.C. ELECTRICAL CHARACTERISTICS

$T_A = -30°C$ to $+70°C$, $V_{CC} = 5V + 10\%$ unless otherwise specified

| Symbol	Parameter	Conditions	MIN	MAX	UNIT
V_{CC}	Operating Voltage		4.5	5.5	V
I_{CC}	Operating Current TTL/CMOS Inputs	V_{CC}=5.5V, CS=SK=V_{IH} DO=OPEN, f=250 KHz		3	mA
I_{CCSB1}	Standby Current TTL/CMOS Inputs	V_{CC}=5.5V, CS=V_{IL} DO=OPEN		1	mA
I_{CCSB2}	Standby Current CMOS Inputs	V_{CC}=5.5V, CS=V_{IL}, DO=OPEN Inputs=V_{CC} or GND		100	μA
V_{IL}	Input Voltage Low		−0.1	0.8	V
V_{IH}	Input Voltage High		2.0	V_{CC}+1	V
V_{OL}	Output Voltage Low	I_{OL}=2.1mA		0.4	V
V_{OH}	Output Voltage High	I_{OH}=0.4mA	2.2		V
I_{LI}	Input Leakage Current	V_{IN}=5.5V		10	μA
I_{LO}	Output Leakage Current	V_{OUT}=5.5V, CS=0,		10	μA
f_{SK}	SK Frequency		0	250	kHz
	SK Duty Cycle		25	75	%
t_{CSS}	Chip Select High to Serial Clock High Delay		200		ns
t_{CSH}	Serial Clock Low to Chip Select Low Delay		0		ns
t_{DIS}	Data Setup Time (Write)		400		ns
t_{DIH}	Data Hold Time (Write)		400		ns
t_{PD1}	Serial Clock to Output Delay	C_L=100PF, V_{OL}=0.8V, V_{OH}=2.0V V_{IL}=0.45V, V_{IH}=2.4V, C_L=100PF		2	μs
t_{PD0}				2	μs
$t_{E/W}$	Self–timed Program Cycle			10	ms
t_{CS}	Min CS Low Time		1		μs
t_{SV}	CS to Status Valid	C_L=100PF		1	μs
t_{OH} t_{IH}	Falling Edge of CS to DO High Impedance			400	ns

The following characteristics apply only for the READ operation of AK93C46M/MF

Symbol	Parameter	Conditions	MIN	MAX	UNIT
V_{CCR}	Operating Voltage For Read		2.8		V
V_{ILR}	Input Voltage Low	V_{CCR}=2.8V		0.6	V
V_{IHR}	Input Voltage High		1.8		V
V_{OLR}	Output Voltage Low	V_{CCR}=2.8V I_{OL}=2.1mA		0.4	V
V_{OHR}	Output Voltage High	V_{CCR}=2.8V I_{OH}=0.1mA	1.8		V
t_{PD1R}	Serial Clock to Output Delay	V_{OL}=0.6V, V_{OH}=1.8V, V_{IL}=0.45V V_{IH}=2.0V, CL=100PF, V_{CCR}=2.8V		2	μs
t_{PD2R}				2	μs

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NON-VOLATILE CHARACTERISTICS

Symbol	Parameter	Condition	
T_{DR}	Data Retention Time	Ta=70°C	10 years (min.)
N_{ew}	Write/Erase Cycles		10^4 (typ.)

TIMING DIAGRAMS
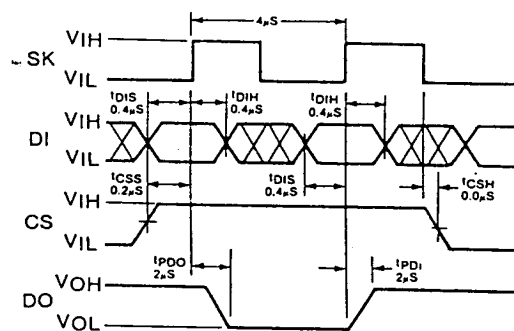
This is the minimum SK period.

Instruction Timing

READ

WRITE

EWEN
EWDS

ENABLE = 11
DISABLE = 00

4
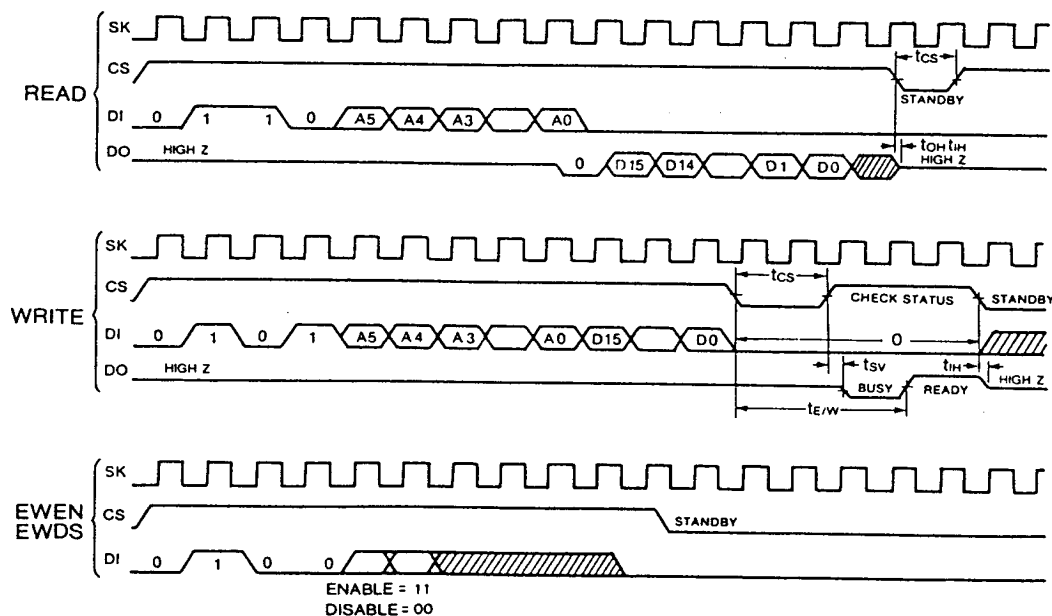
TIMING DIAGRAM (Continued)
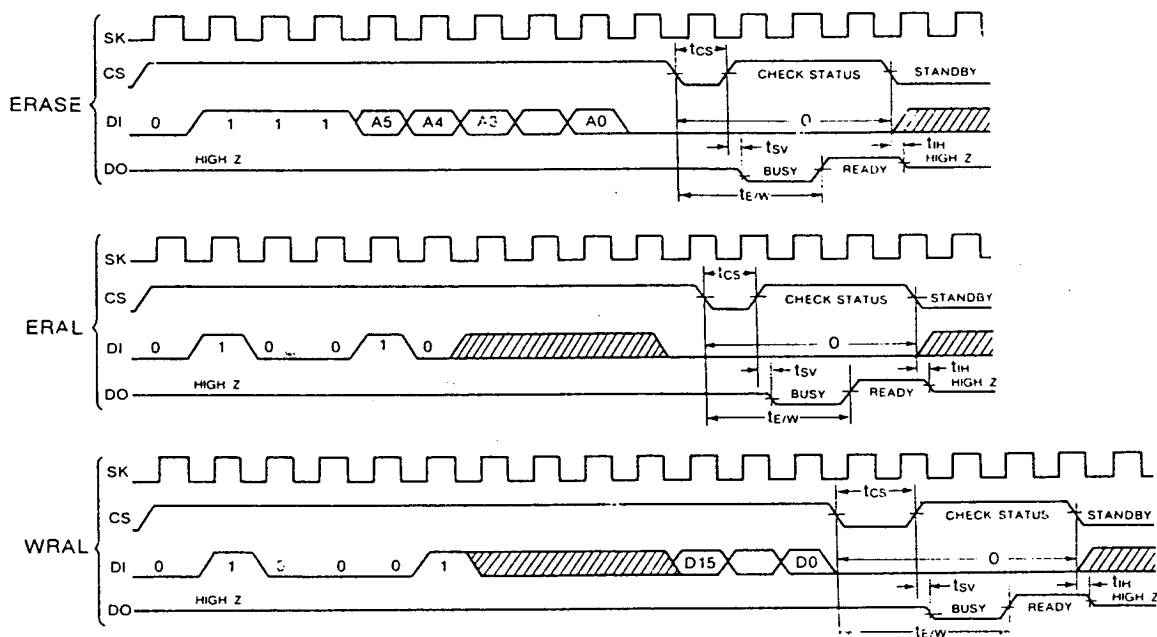
ORDER GUIDE

DEVICE	TEMP.RANGE	Vcc min. (Read)	Vcc min. (Write)	PACKAGE
AK93C46	−30°C ~ +70°C	+4.5V	+4.5V	8PinDIP
AK93C46F	−30°C ~ +70°C	+4.5V	+4.5V	8PinSOP
AK93C46M	−30°C ~ +70°C	+2.8V	+4.5V	8PinDIP
AK93C46MF	−30°C ~ +70°C	+2.8V	+4.5V	8PinSOP

OPERATING CONDITIONS

Temperature Range .... −30°C to +70°C

Vcc Power Supply .... Write   4.5~5.5V
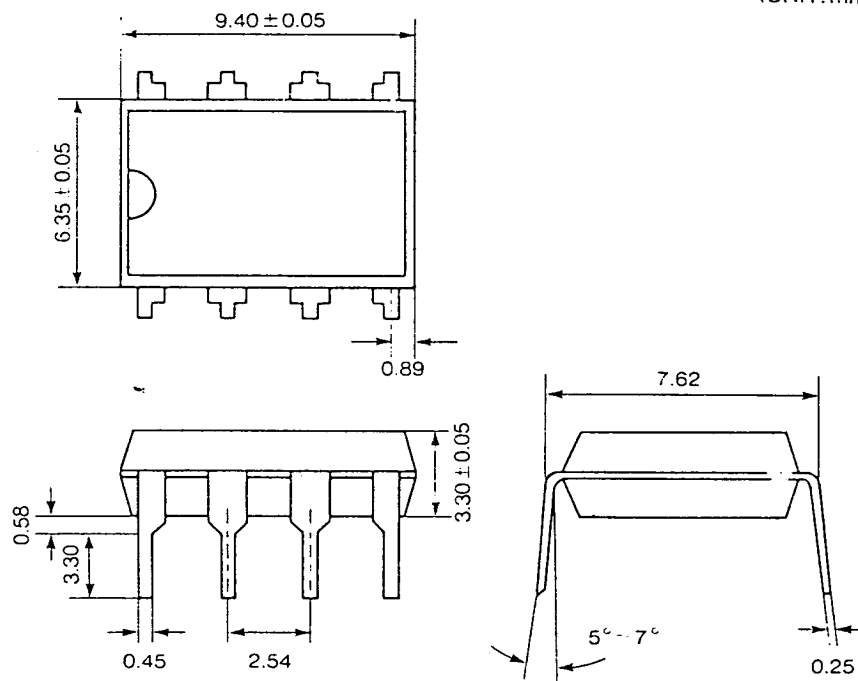
                                              Read   93C46/F   4.5~5.5V

                                                                         93C46M/MF   2.8~5.5V

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OUTLINE DIMENSIONS

AK93C46/M

(UNIT: mm)

9.40 ± 0.05

6.35 ± 0.05

0.89

3.30 ± 0.05

0.58

3.30

0.45   2.54

7.62

5° - 7°

0.25

AK93C46F/MF

4.85 ± 0.08

6.02 ± 0.17

3.94 ± 0.08

1.63 ± 0.10

0.18

0.42   1.27

0.22

0.65 ± 0.24

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