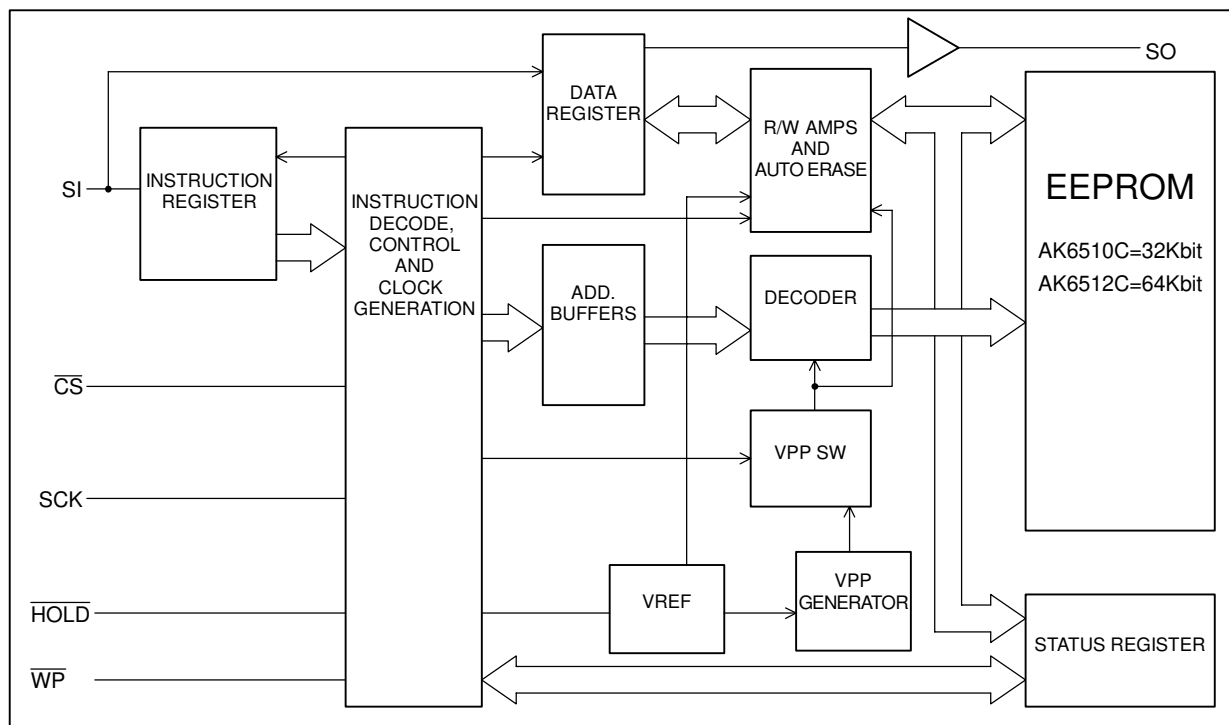


# AK6510C / 12C

## SPI bus 32K/64Kbit Serial CMOS EEPROM

### Features

- Advanced CMOS EEPROM Technology
- Single Voltage Supply: 1.8V to 5.5V
- AK6510C: 32Kbits; 4096 x 8 organization  
AK6512C: 64Kbits; 8192 x 8 organization
- SPI Serial Interface Compatible
- Low Power Consumption  
0.8μA Max. (Standby mode)
- High Reliability  
Endurance: 1000K E/W cycles / Address  
Data Retention: 10 Years
- Special Features  
32 byte Page Write Mode  
Block Write Protection (Protect 1/4, 1/2 or Entire Array)  
Automatic write cycle time-out with auto-ERASE
- Software and Hardware controlled Write Protection
- Self timed Programming Cycle: 5msec. Max.
- Ideal for Low Density Data Storage  
Low cost, space saving, 8-pin SSOP/SONW package



Block Diagram

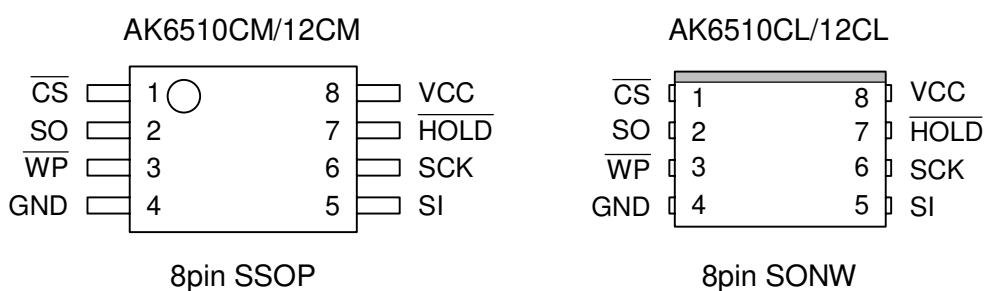
General Description

The AK6510C/12C is a 32768/65536-bit, serial, read/write, non-volatile memory device fabricated using an advanced CMOS EEPROM technology. The AK6510C/12C has 32768-bits/65536-bits of memory organized as 4096/8192 registers of 8 bits each. The AK6510C/12C can operate all function under wide operating voltage range: 1.8V to 5.5V. The charge up circuit for high voltage generation needed for write operations is integrated.

The AK6510C/12C serial interface is compatible to a SPI bus. The AK6510C/12C has 6 instructions: READ, WRITE, WREN (write enable), WRDI (write disable), RDSR (read status register), and WRSR (write status register).

Each instruction is organized by an op-code (8bits), address (16bits), and data (8bits). When input level of  $\overline{CS}$  pin changed from high level to low level, AK6510C/12C can receive instructions.

■ Pin Configurations



| Pin name          | Functions           |
|-------------------|---------------------|
| $\overline{CS}$   | Chip Select input   |
| SCK               | Serial Clock input  |
| SI                | Serial Data input   |
| SO                | Serial Data output  |
| $\overline{WP}$   | Write Protect input |
| $\overline{HOLD}$ | Hold input          |
| VCC               | Power Supply        |
| GND               | Ground              |

■ Type of Products

| Model    | Memory size | Temp. Range    | VCC          | Package           |
|----------|-------------|----------------|--------------|-------------------|
| AK6510CM | 32K bits    | -40°C to +85°C | 1.8V to 5.5V | 8pin Plastic SSOP |
| AK6510CL |             | -40°C to +85°C | 1.8V to 5.5V | 8pin Plastic SONW |
| AK6512CM | 64K bits    | -40°C to +85°C | 1.8V to 5.5V | 8pin Plastic SSOP |
| AK6512CL |             | -40°C to +85°C | 1.8V to 5.5V | 8pin Plastic SONW |

**■ Data Transfer**

An IC that outputs the clock is called "MASTER", an IC that receives the clock is called "SLAVE". The AK6510C/12C operates as a SLAVE. Data is written to the SI pin and read from SO pin. The MSB is transmitted first.

After  $\overline{CS}$  pin changes hi level to low level, AK6510C/12C receives the first data bit on the SI pin synchronously with the rising edge of the input pulse of serial clock. While  $\overline{CS}$  pin is high level, the data input to the SI pin is don't care and SO pin indicates Hi-Z.

All the functions are organized 8 bits of op-code, address, and data. If there is an invalid op-code, the AK6510C/12C ignores the address and data information and SO pin indicates Hi-Z. In order to input new op-code,  $\overline{CS}$  pin should be toggled.

**■ Hold**

AK6510C/12C has a  $\overline{HOLD}$  pin that can hold the data transfer. When  $\overline{HOLD}$  changes high to low while SCK is low, the data transfer stops. After the  $\overline{HOLD}$  pin changes low to High while SCK is low, the data transfer starts again. While the data transfer is paused, AK6510C/12C ignores the clock on the SCK line.

**■ Write Protect**

AK6510C/12C has status registers. When the WPEN bit in the status registers is "1", Write Protect function is enabled. When WPEN bit is "1" and  $\overline{WP}$  pin is low level, the status register is protected from write function. When  $\overline{WP}$  pin becomes low level while the WRITE to the status register instruction is written, the AK6510C/12C doesn't accept the instruction. When the  $\overline{WP}$  pin changes low level while the internal programming, the programming function continues.

When the WPEN bit is "0",  $\overline{WP}$  pin function is disabled. Even if  $\overline{WP}$  pin is fixed to low level, the WRITE function to the status register can be done. When the  $\overline{WP}$  pin is high level, AK6510C/12C can accept all of READ and WRITE functions.

|                 |
|-----------------|
| Pin Description |
|-----------------|

 **$\overline{\text{CS}}$**  (Chip Select Input)

When  $\overline{\text{CS}}$  changes high level to low level, the AK6510C/12C can receive the instructions.

$\overline{\text{CS}}$  should be kept low level while receiving op-code, address and data, and while outputting data.

When  $\overline{\text{CS}}$  is high level, SO indicate Hi-Z.

**SCK** (Serial Clock Input)

The SCK clock pin is the synchronous clock input for input/output data.

**SI** (Serial Data Input)

The op-code, address, and data are written to the SI pin.

**SO** (Serial Data Output)

The SO pin outputs the data from memory array and status register.

 **$\overline{\text{WP}}$**  (Write Protect Input)

The  $\overline{\text{WP}}$  pin controls the write function to the status register.

When the WPEN bit in the status register is "0", the function of  $\overline{\text{WP}}$  pin becomes disable. Then the status register can be programmable when the WEN bit in the status register is "1". And it does not depend on the status of  $\overline{\text{WP}}$  pin.

When the WPEN bit is "1", the function of  $\overline{\text{WP}}$  is enabled. Then the status register can not be programmable when the WEN bit is "1" and the status of  $\overline{\text{WP}}$  pin is low.

When the WPEN bit is "1",  $\overline{\text{WP}}$  pin is high and WEN bit is "1", AK6510C/12C can accept the WRITE instruction to the status registers.

During the instruction input,  $\overline{\text{WP}}$  pin should keep high or low level.

 **$\overline{\text{HOLD}}$**  (Hold Input)

The HOLD pin can hold the data transfer. When the  $\overline{\text{HOLD}}$  pin changes hi to low while the SCK is low, the data transfer is held. And the transfer starts when the  $\overline{\text{HOLD}}$  pin changes low to high while the SCK is low. While the holding the data transfer, AK6510C/12C ignores the clock signal on SCK pin.

Function Description

AK6510C/12C has six instructions. The instruction can be input after the  $\overline{CS}$  pin changes high to low. All the instructions are MSB first.

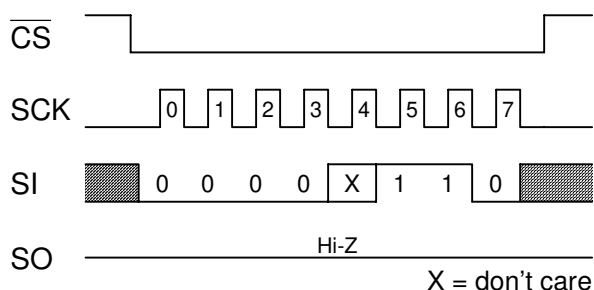
| Instruction | Op-code   | Address                 | Data        | Description            |
|-------------|-----------|-------------------------|-------------|------------------------|
| READ        | 0000 X011 | X X X A12-A8   A7-A0    | D7-D0 (out) | Read from Memory Array |
| WRITE       | 0000 X010 | X X X A12-A8   A7-A0    | D7-D0 (in)  | Write to Memory Array  |
| WREN        | 0000 X110 | -----                   | -----       | Write Enable           |
| WRDI        | 0000 X100 | -----                   | -----       | Write Disable          |
| RDSR        | 0000 X101 | Bit7-Bit0 (out)   ----- | -----       | Read Status Register   |
| WRSR        | 0000 X001 | Bit7-Bit0 (in)   -----  | -----       | Write Status Register  |

X: don't care  
AK6510C: A12 is don't care

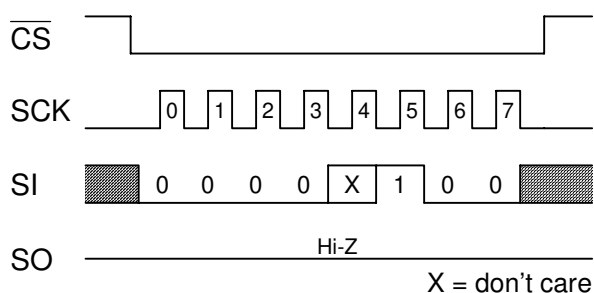
Table 1. Instruction set for AK6510C/12C

**WREN (WRITE ENABLE) / WRDI (WRITE DISABLE)**

The WRITE function can be accepted only in the status of Write Enable. After VCC is applied, AK6510C/12C is in the status of Write Disable. After the function of WRDI, AK6510C/12C cannot accept any programming function.



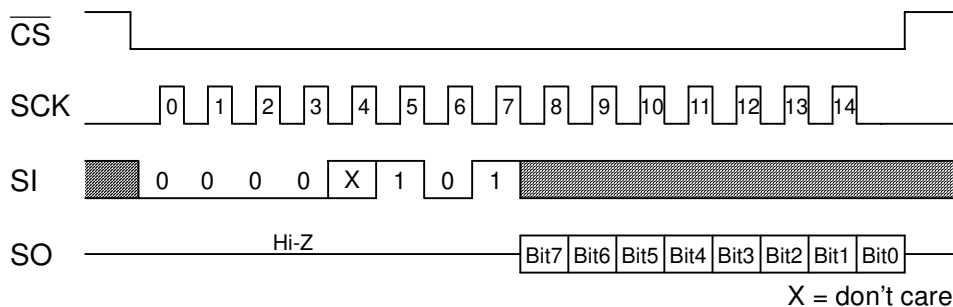
WREN



WRDI

**RDSR (READ STATUS REGISTER)**

The RDSR function is used to read the data in the STATUS register. The STATUS register has RDY bit, WEN bit, BP0/BP1 bit and WPEN bit. RDSR function can be used to read READY/BUSY status bit, WRITE ENABLE/DISABLE bit, and BLOCK PROTECT bit. These bits can be set by WRSR function.



RDSR

|      |      |      |      |      |      |      |                         |
|------|------|------|------|------|------|------|-------------------------|
| Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0                    |
| WPEN | X    | X    | X    | BP1  | BP0  | WEN  | $\overline{\text{RDY}}$ |

| Register                | Definition  |
|-------------------------|---|
| WPEN                    | $\overline{\text{WP}}$ pin set bit (programmable)<br>See Table 3.   |
| BP0 / BP1               | Block Protect bit for EEPROM memory array (programmable)<br>See Table 4.  |
| WEN                     | WRITE ENABLE / DISABLE bit (READ only)<br>This is set by WREN/WRDI function.<br>WEN=0 : WRITE DISABLE<br>WEN=1 : WRITE ENABLE |
| $\overline{\text{RDY}}$ | READY/BUSY status bit (READ only)<br>$\overline{\text{RDY}}$ =0 : READY<br>$\overline{\text{RDY}}$ =1 : BUSY                  |

Table 2. Status Register Configuration

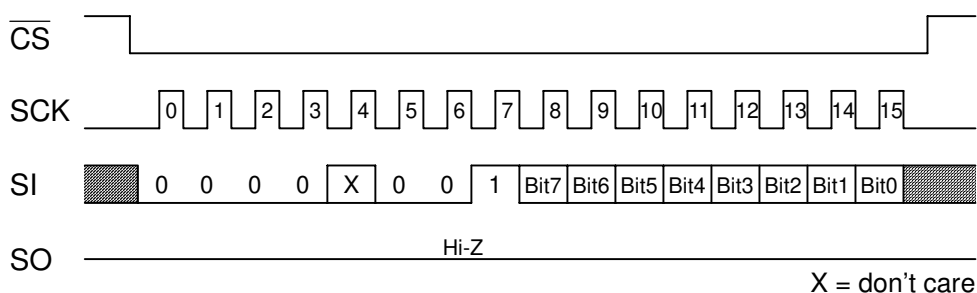
**WRSR (WRITE STATUS REGISTER)**

The WRSR instruction can set the Write Protect Block size of the memory array. AK6510C/12C has 4 Blocks of memory arrays. Write Protect Block size can be selected from 1/4, 1/2 and whole memory array. The block, which is set by Write Protect, is Read only. BP0 bit, BP1 bit, and WPEN bit are programmable with EEPROM memory cell bits. The characteristics of those bits (WREN, tE/W, RDSR) are same as the EEPROM memory array.

$\overline{WP}$  pin function can be set by WPEN (WRITE PROTECT ENABLE) bit which is defined by WRSR function. When  $\overline{WP}$  pin is low level and WPEN bit is "1", the WRITE function to Status register, which has WPEN bit and BP0/BP1 bit, and to Write Disable Block is not performed. Then WRITE function is performed only to the Write enable block.

When  $\overline{WP}$  pin is "1" or WPEN bit is "0", then the function of  $\overline{WP}$  pin is disabled and WRITE function to the Status Register is performed.

WREN function should be done before WRSR function. And after the Programming function, AK6510C/12C becomes Write Disable status automatically.



WRSR

| WPEN Bit | $\overline{WP}$ Pin | WEN Bit | Write Protected Block | Not Protected Block | Status Register |
|----------|---------------------|---------|-----------------------|---------------------|-----------------|
| 0        | X                   | 0       | WRITE Disable         | WRITE Disable       | WRITE Disable   |
| 0        | X                   | 1       | WRITE Disable         | WRITE Enable        | WRITE Enable    |
| 1        | Low                 | 0       | WRITE Disable         | WRITE Disable       | WRITE Disable   |
| 1        | Low                 | 1       | WRITE Disable         | WRITE Enable        | WRITE Disable   |
| X        | High                | 0       | WRITE Disable         | WRITE Disable       | WRITE Disable   |
| X        | High                | 1       | WRITE Disable         | WRITE Enable        | WRITE Enable    |

Table 3. WPEN function

| Status Register bits |     | Write Protected Block |               |
|----------------------|-----|-----------------------|---------------|
| BP1                  | BP0 | AK6510C               | AK6512C       |
| 0                    | 0   | none                  | none          |
| 0                    | 1   | C00h - FFFh           | 1800h - 1FFFh |
| 1                    | 0   | 800h - FFFh           | 1000h - 1FFFh |
| 1                    | 1   | 000h - FFFh           | 0000h - 1FFFh |

Table 4. Write Protected Block Size

**WRITE (WRITE SEQUENCE)**

WRITE instruction can start the WRITE function to the memory cell array.

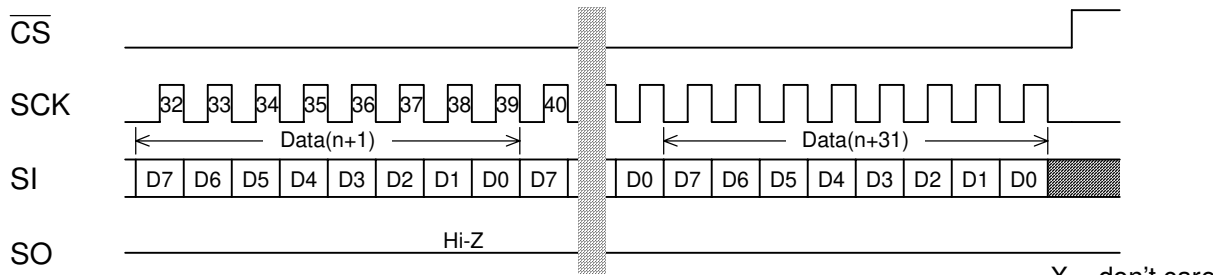
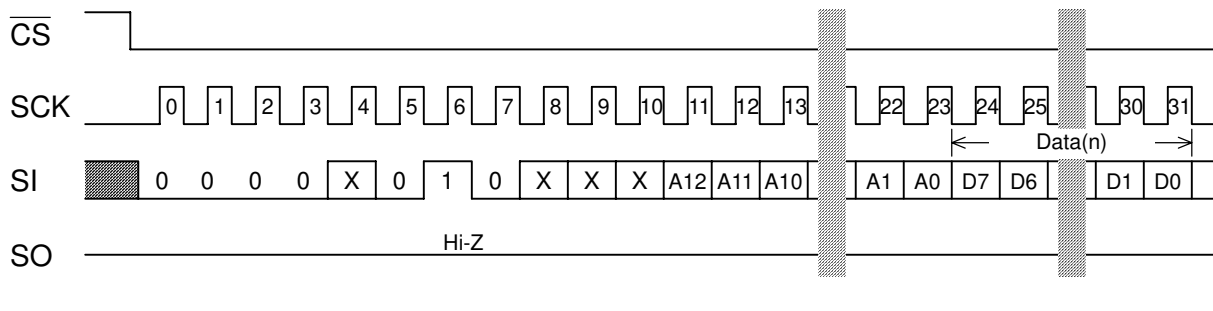
After  $\overline{CS}$  pin changes high to low, op-code, address and data are input from SI pin. After the instruction input, the internal programming cycle starts when  $\overline{CS}$  pin changes low to high. After the instructions are inputted,  $\overline{CS}$  pin should change low to high after the last data bit (D0) inputs and before next SCK clock rises. Write function can start only at this timing.

AK6510C/12C can indicate the BUSY status by using RDSR instruction and  $\overline{RDY}$  bit (Bit0) in the status register.  $\overline{RDY}$  is "1" indicates AK6510C/12C is in the programming cycle, and  $\overline{RDY}$  is "0" indicates AK6510C/12C is in the READY status. AK6510C/12C outputs the "FF" when RDSR instruction executes during the programming cycle. Only RDSR instruction can be accepted during programming cycle.

AK6510C/12C has Page Write mode, which can write the data within 32 bytes with one programming cycle. The input data sent to the shift register within 32 bytes. If the number of bytes exceeded 32, the address counter rolls over to the first address of the page. Internal programming cycle starts after  $\overline{CS}$  pin changes low to high.

After WRITE instruction, AK6510C/12C changes to Write Disable status automatically. AK6510C/12C needs WREN instruction before every WRITE instruction. When WRITE instruction is done while AK6510C/12C is in Write Disable status, WRITE instructions are ignored and AK6510C/12C becomes standby status after  $\overline{CS}$  changes to high. AK6510C/12C can accept the next instruction after  $\overline{CS}$  becomes low.

WRITE instruction cannot write the data into the address of the protected block.



X = don't care  
AK6510C: A12 is don't care

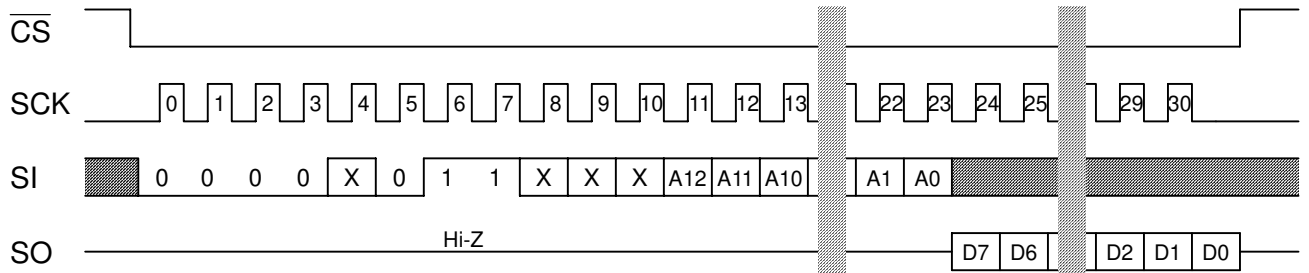
**WRITE**



**READ (READ SEQUENCE)**

After  $\overline{CS}$  changes high to low, the op-code and address are sent on SI pin and the data (D7-D0) read from SO pin.

After 1 byte of data output, internal address register is incremented, and the next byte of data is outputted. After READ the data in the highest address, the address register rolls over to the lowest address. After the last bit of the address shift into the register, the input data on SI pin is ignored.



X = don't care  
AK6510C: A12 is don't care

READ

|                          |
|--------------------------|
| Absolute Maximum Ratings |
|--------------------------|

| Parameter                                    | Symbol | Min  | Max     | Unit |
|--|--------|------|---------|------|
| Power Supply                                 | VCC    | -0.6 | +6.5    | V    |
| All Input Voltages<br>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

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

| Parameter  | Symbol | Condition                       | Min.    | Max.    | Unit |
|--|--------|---------------------------------|---------|---------|------|
| Current Dissipation<br>(WRITE)                     | ICC1   | VCC=5.5V, fSCK=5.0MHz, *1       |         | 2.0     | mA   |
|  | ICC2   | VCC=2.5V, fSCK=2.5MHz, *1       |         | 1.5     | mA   |
|  | ICC3   | VCC=1.8V, fSCK=1.0MHz, *1       |         | 1.0     | mA   |
| Current Dissipation<br>(READ)                      | ICC4   | VCC=5.5V, fSCK=5.0MHz, *1       |         | 1.0     | mA   |
|  | ICC5   | VCC=2.5V, fSCK=2.5MHz, *1       |         | 0.2     | mA   |
|  | ICC6   | VCC=1.8V, fSCK=1.0MHz, *1       |         | 0.1     | mA   |
| Current Dissipation<br>(Standby)                   | ICCS   | VCC=5.5V *2                     |         | 0.8     | μA   |
| Input High Voltage                                 | VIH1   | 2.5V ≤ VCC ≤ 5.5V               | 0.7xVCC | VCC+0.5 | V    |
|  | VIH2   | 1.8V ≤ VCC < 2.5V               | 0.8xVCC | VCC+0.5 | V    |
| Input Low Voltage                                  | VIL1   | 2.5V ≤ VCC ≤ 5.5V               | -0.3    | 0.3xVCC | V    |
|  | VIL2   | 1.8V ≤ VCC < 2.5V               | -0.3    | 0.2xVCC | V    |
| Output High Voltage                                | VOH1   | 4.5V ≤ VCC ≤ 5.5V<br>IOH=-2mA   | VCC-0.5 |         | V    |
|  | VOH2   | 2.5V ≤ VCC < 4.5V<br>IOH=-0.4mA | VCC-0.2 |         | V    |
|  | VOH3   | 1.8V ≤ VCC < 2.5V<br>IOH=-0.1mA | VCC-0.2 |         | V    |
| Output Low Voltage                                 | VOL1   | 4.5V ≤ VCC ≤ 5.5V<br>IOL=3.0mA  |         | 0.4     | V    |
|  | VOL2   | 2.5V ≤ VCC < 4.5V<br>IOL=1.6mA  |         | 0.4     | V    |
|  | VOL3   | 2.5V ≤ VCC < 4.5V<br>IOL=1.0mA  |         | 0.2     | V    |
|  | VOL4   | 1.8V ≤ VCC < 2.5V<br>IOL=1.0mA  |         | 0.2     | V    |
| Input Leakage<br>CS, SCK, DI pins<br>WP, HOLD pins | ILI    | VCC=5.5V, VIN=VCC/GND           |         | ±1.0    | μA   |
| Output Leakage<br>SO pin                           | ILO    | VCC=5.5V,<br>VOUT=VCC/GND       |         | ±1.0    | μA   |

\*1: VIN=VIH/VIL, SO=open

\*2: CS=VCC, VIN=VCC/GND, WP,HOLD=VCC, SO=open

## (2) CAPACITANCE

(Ta=25°C, fSCK=1MHz, VCC=5.0V)

| Parameter                             | Symbol | Condition | Min. | Max. | Unit |
|---------------------------------------|--------|-----------|------|------|------|
| Output Capacitance<br>SO pin          | CO     | VO=0V     |      | 8.0  | pF   |
| Input Capacitance<br>CS, SCK, SI pins | CIN    | VIN=0V    |      | 6.0  | pF   |

Note: These parameters are not 100% tested. These are the sample value.

## (3) A.C. ELECTRICAL CHARACTERISTICS 1

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

| Parameter               | Symbol | Condition         | Min. | Max. | Unit |
|-------------------------|--------|-------------------|------|------|------|
| SCK Frequency           | fSCK1  | 4.5V ≤ VCC ≤ 5.5V |      | 5.0  | MHz  |
|                         | fSCK2  | 2.5V ≤ VCC < 4.5V |      | 2.5  | MHz  |
|                         | fSCK3  | 1.8V ≤ VCC < 2.5V |      | 1.0  | MHz  |
| SCK Setup Time          | tSKSH1 | 4.5V ≤ VCC ≤ 5.5V | 50   |      | ns   |
|                         | tSKSH2 | 2.5V ≤ VCC < 4.5V | 50   |      | ns   |
|                         | tSKSH3 | 1.8V ≤ VCC < 2.5V | 50   |      | ns   |
| CS Setup Time           | tCSS1  | 4.5V ≤ VCC ≤ 5.5V | 90   |      | ns   |
|                         | tCSS2  | 2.5V ≤ VCC < 4.5V | 200  |      | ns   |
|                         | tCSS3  | 1.8V ≤ VCC < 2.5V | 400  |      | ns   |
| SCK Pulse Width         | tSKW1  | 4.5V ≤ VCC ≤ 5.5V | 90   |      | ns   |
|                         | tSKW2  | 2.5V ≤ VCC < 4.5V | 200  |      | ns   |
|                         | tSKW3  | 1.8V ≤ VCC < 2.5V | 400  |      | ns   |
| SCK Rise Time           | *3 tRC |                   |      | 2    | μs   |
| SCK Fall Time           | *3 tFC |                   |      | 2    | μs   |
| Data Setup Time         | tDIS1  | 4.5V ≤ VCC ≤ 5.5V | 20   |      | ns   |
|                         | tDIS2  | 2.5V ≤ VCC < 4.5V | 40   |      | ns   |
|                         | tDIS3  | 1.8V ≤ VCC < 2.5V | 60   |      | ns   |
| Data Hold Time          | tDIH1  | 4.5V ≤ VCC ≤ 5.5V | 30   |      | ns   |
|                         | tDIH2  | 2.5V ≤ VCC < 4.5V | 50   |      | ns   |
|                         | tDIH3  | 1.8V ≤ VCC < 2.5V | 100  |      | ns   |
| Data Rise Time          | *3 tRD |                   |      | 2    | μs   |
| Data Fall Time          | *3 tFD |                   |      | 2    | μs   |
| SO pin Output Delay     | tPD1   | 4.5V ≤ VCC ≤ 5.5V |      | 60   | ns   |
|                         | tPD2   | 2.5V ≤ VCC < 4.5V |      | 150  | ns   |
|                         | tPD3   | 1.8V ≤ VCC < 2.5V |      | 340  | ns   |
| SO pin Hi-Z Time        | tOZ1   | 4.5V ≤ VCC ≤ 5.5V |      | 100  | ns   |
|                         | tOZ2   | 2.5V ≤ VCC < 4.5V |      | 240  | ns   |
|                         | tOZ3   | 1.8V ≤ VCC < 2.5V |      | 500  | ns   |
| SO pin Output Hold Time | tOHD   |                   | 0    |      | ns   |
| CS Hold Time            | tCSH1  | 4.5V ≤ VCC ≤ 5.5V | 90   |      | ns   |
|                         | tCSH2  | 2.5V ≤ VCC < 4.5V | 200  |      | ns   |
|                         | tCSH3  | 1.8V ≤ VCC < 2.5V | 400  |      | ns   |
| SCK Hold Time           | tSKH1  | 4.5V ≤ VCC ≤ 5.5V | 50   |      | ns   |
|                         | tSKH2  | 2.5V ≤ VCC < 4.5V | 50   |      | ns   |
|                         | tSKH3  | 1.8V ≤ VCC < 2.5V | 50   |      | ns   |
| CS High Time            | tCS1   | 4.5V ≤ VCC ≤ 5.5V | 100  |      | ns   |
|                         | tCS2   | 2.5V ≤ VCC < 4.5V | 200  |      | ns   |
|                         | tCS3   | 1.8V ≤ VCC < 2.5V | 300  |      | ns   |

\*3: These parameters are not 100% tested. These are the sample value.

## (4) A.C. ELECTRICAL CHARACTERISTICS 2

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

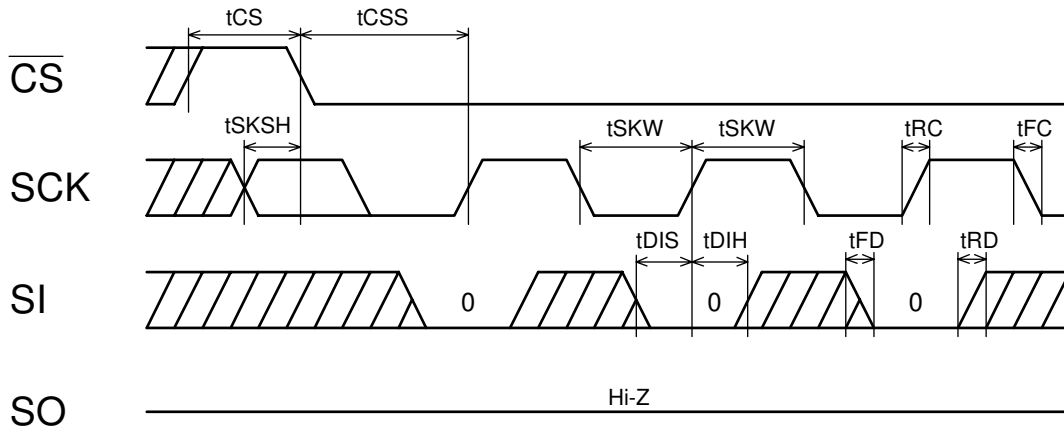
| Parameter                  | Symbol | Condition              | Min.      | Max. | Unit                 |
|----------------------------|--------|------------------------|-----------|------|----------------------|
| HOLD Setup Time 1          | tHFS1  | 4.5V ≤ VCC ≤ 5.5V      | 40        |      | ns                   |
|                            | tHFS2  | 2.5V ≤ VCC < 4.5V      | 90        |      | ns                   |
|                            | tHFS3  | 1.8V ≤ VCC < 2.5V      | 200       |      | ns                   |
| HOLD Hold Time 1           | tHFH1  | 4.5V ≤ VCC ≤ 5.5V      | 40        |      | ns                   |
|                            | tHFH2  | 2.5V ≤ VCC < 4.5V      | 90        |      | ns                   |
|                            | tHFH3  | 1.8V ≤ VCC < 2.5V      | 200       |      | ns                   |
| HOLD Setup Time 2          | tHRS1  | 4.5V ≤ VCC ≤ 5.5V      | 40        |      | ns                   |
|                            | tHRS2  | 2.5V ≤ VCC < 4.5V      | 90        |      | ns                   |
|                            | tHRS3  | 1.8V ≤ VCC < 2.5V      | 200       |      | ns                   |
| HOLD Hold Time 2           | tHRH1  | 4.5V ≤ VCC ≤ 5.5V      | 40        |      | ns                   |
|                            | tHRH2  | 2.5V ≤ VCC < 4.5V      | 90        |      | ns                   |
|                            | tHRH3  | 1.8V ≤ VCC < 2.5V      | 200       |      | ns                   |
| HOLD Low to Output Hi-Z    | tHOZ1  | 4.5V ≤ VCC ≤ 5.5V      |           | 100  | ns                   |
|                            | tHOZ2  | 2.5V ≤ VCC < 4.5V      |           | 150  | ns                   |
|                            | tHOZ3  | 1.8V ≤ VCC < 2.5V      |           | 250  | ns                   |
| HOLD High to Output Low-Z  | tHPD1  | 4.5V ≤ VCC ≤ 5.5V      |           | 100  | ns                   |
|                            | tHPD2  | 2.5V ≤ VCC < 4.5V      |           | 150  | ns                   |
|                            | tHPD3  | 1.8V ≤ VCC < 2.5V      |           | 250  | ns                   |
| Selftimed Programming Time | tWR    |                        |           | 5    | ms                   |
| Endurance                  | *4     | 5.5V, 25°C, Page Write | 1,000,000 |      | E/W cycles / Address |

\*4: These parameters are not 100% tested. These are the sample value.

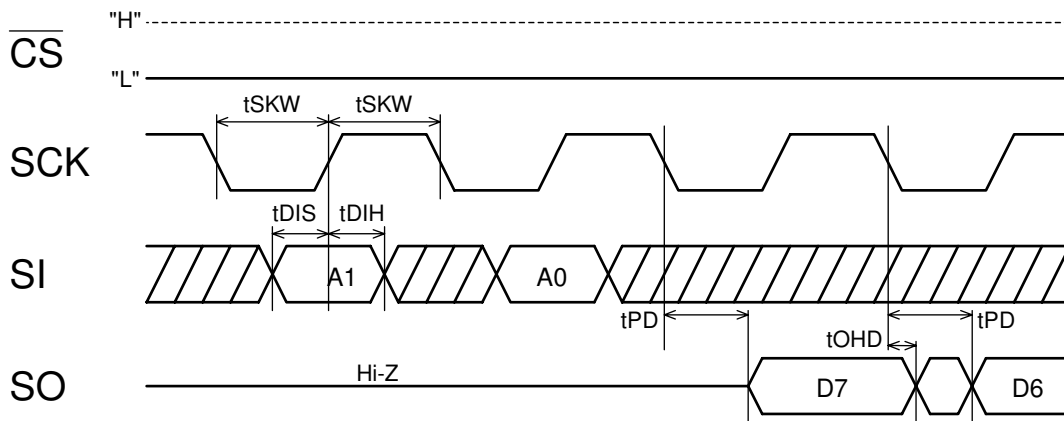
## ■ AC Measurement Condition

|                  |          |
|------------------|----------|
| Load Capacitance | CL=100pF |
|------------------|----------|

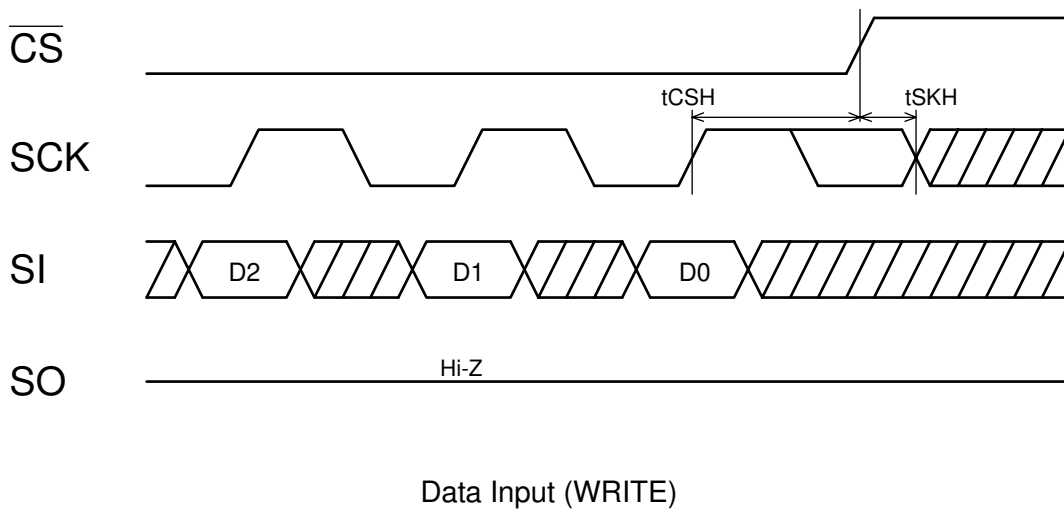
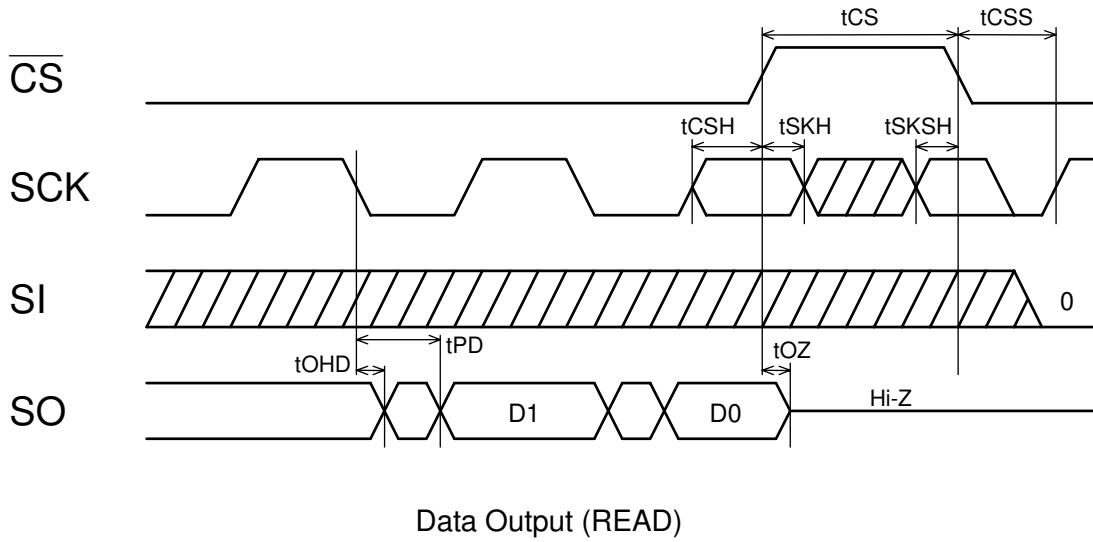
Synchronous Data Timing

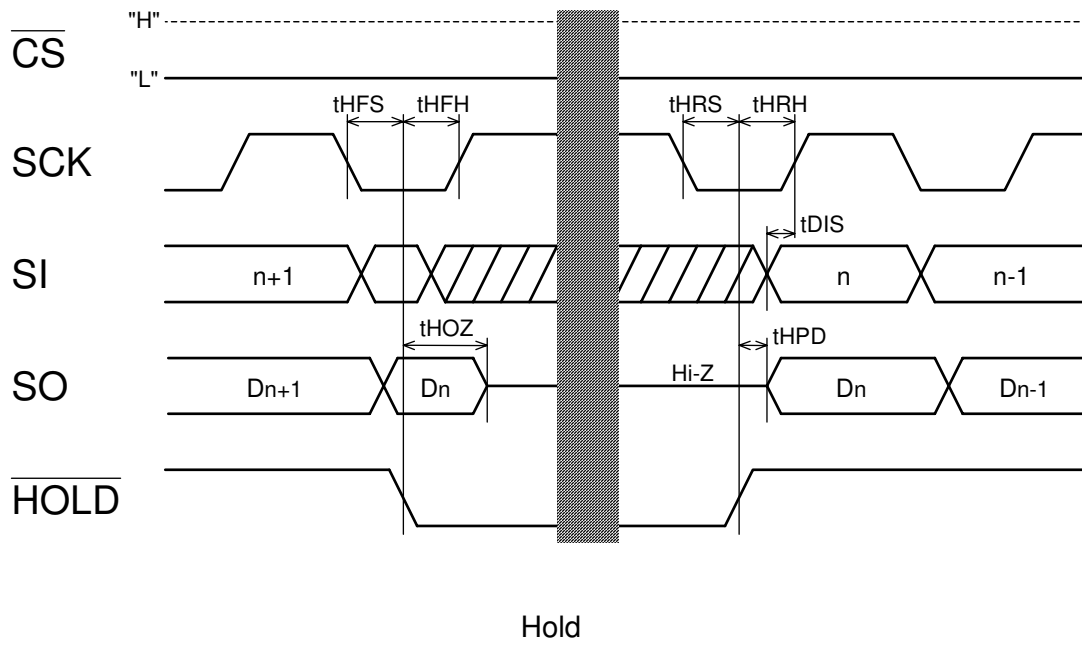


Instruction Input



Data Output (READ)







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