

Features

- Serial Peripheral Interface (SPI) Compatible
- Supports SPI Modes 0 (0,0) and 3 (1,1)
- 2.1 MHz Clock Rate
- 128-byte Page Mode Only for Write Operations
- Low-voltage and Standard-voltage Operation
 - 2.7 ($V_{CC} = 2.7V$ to 5.5V)
- Block Write Protection
 - Protect 1/4, 1/2, or Entire Array
- Write Protect (\overline{WP}) Pin and Write Disable Instructions for Both Hardware and Software Data Protection
- Self-Timed Write Cycle (5 ms Typical)
- High Reliability
 - Endurance: 100,000 Write Cycles
 - Data Retention: >40 Years
- 20-lead JEDEC SOIC and 8-lead Leadless Array Package

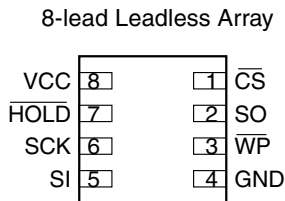
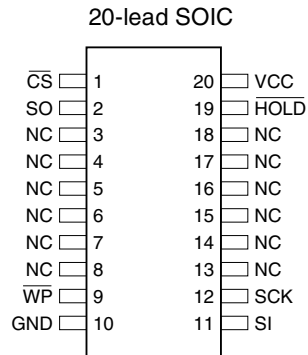
Description

The AT25P1024 provides 1,048,576 bits of serial electrically erasable programmable read only memory (EEPROM) organized as 131,072 words of 8 bits each. The device is optimized for use in many industrial and commercial applications where low power and low voltage operation are essential. The AT25P1024 is available in space saving 20-lead JEDEC SOIC and 8-lead LAP packages.

(continued)

Pin Configurations

| Pin Name | Function |
|-------------------|-----------------------|
| \overline{CS} | Chip Select |
| SCK | Serial Data Clock |
| SI | Serial Data Input |
| SO | Serial Data Output |
| GND | Ground |
| VCC | Power Supply |
| \overline{WP} | Write Protect |
| \overline{HOLD} | Suspends Serial Input |
| NC | No Connect |



Bottom View



SPI Serial EEPROMs

1M (131,072 x 8)

AT25P1024



The AT25P1024 is enabled through the Chip Select pin (\overline{CS}) and accessed via a 3-wire interface consisting of Serial Data Input (SI), Serial Data Output (SO), and Serial Clock (SCK). All programming cycles are completely self-timed, and no separate ERASE cycle is required before WRITE.

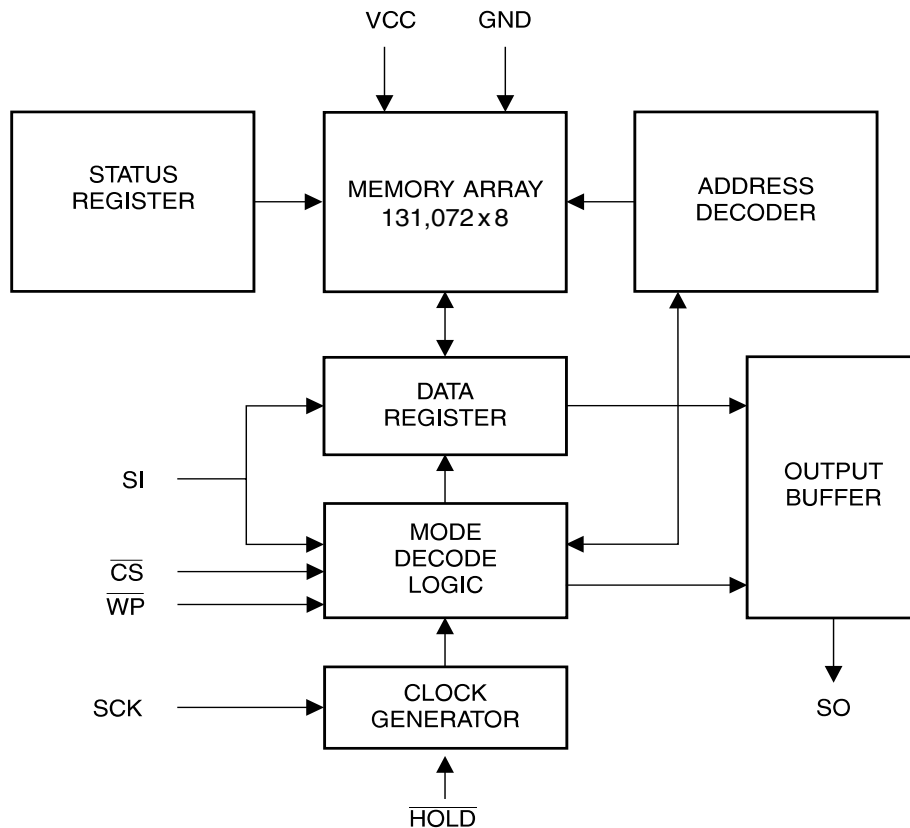
BLOCK WRITE protection is enabled by programming the status register with top $\frac{1}{4}$, top $\frac{1}{2}$ or entire array of write protection. Separate program enable and program disable instructions are provided for additional data protection. Hardware data protection is provided via the \overline{WP} pin to protect against inadvertent write attempts to the status register. The \overline{HOLD} pin may be used to suspend any serial communication without resetting the serial sequence.

Absolute Maximum Ratings*

| | |
|---|-----------------|
| Operating Temperature..... | -55°C to +125°C |
| Storage Temperature..... | -65°C to +150°C |
| Voltage on Any Pin with Respect to Ground..... | -1.0V to +7.0V |
| Maximum Operating Voltage..... | 6.25V |
| DC Output Current..... | 5.0 mA |

*NOTICE: Stresses beyond 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 beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Block Diagram



Pin Capacitance⁽¹⁾

Applicable over recommended operating range from $T_A = 25^\circ\text{C}$, $f = 1.0\text{ MHz}$, $V_{CC} = +5.0\text{V}$ (unless otherwise noted).

| Symbol | Test Conditions | Max | Units | Conditions |
|-----------|--|-----|-------|-----------------------|
| C_{OUT} | Output Capacitance (SO) | 8 | pF | $V_{OUT} = 0\text{V}$ |
| C_{IN} | Input Capacitance (\overline{CS} , SCK, SI, \overline{WP} , \overline{HOLD}) | 6 | pF | $V_{IN} = 0\text{V}$ |

Note: 1. This parameter is characterized and is not 100% tested.

DC Characteristics

Applicable over recommended operating range from: $T_{AI} = -40^\circ\text{C}$ to $+85^\circ\text{C}$, $V_{CC} = +2.7\text{V}$ to $+5.5\text{V}$, $T_{AC} = 0^\circ\text{C}$ to $+70^\circ\text{C}$, $V_{CC} = +2.7\text{V}$ to $+5.5\text{V}$ (unless otherwise noted).

| Symbol | Parameter | Test Condition | Min | Typ | Max | Units |
|----------------|---------------------|---|--------------------------|-----|---------------------|---------------|
| V_{CC1} | Supply Voltage | | 2.7 | | 5.5 | V |
| V_{CC2} | Supply Voltage | | 4.5 | | 5.5 | V |
| I_{CC1} | Supply Current | $V_{CC} = 5.0\text{V}$ at 1 MHz, SO = Open Read | | 2.0 | 5.0 | mA |
| I_{CC2} | Supply Current | $V_{CC} = 5.0\text{V}$ at 2 MHz, SO = Open Write | | 4.0 | 7.0 | mA |
| I_{SB1} | Standby Current | $V_{CC} = 2.7\text{V}$, $\overline{CS} = V_{CC}$ | | 0.2 | 3.0 | μA |
| I_{SB2} | Standby Current | $V_{CC} = 5.0\text{V}$, $\overline{CS} = V_{CC}$ | | 2.0 | 7.0 | μA |
| I_{IL} | Input Leakage | $V_{IN} = 0\text{V}$ to V_{CC} | -3.0 | | 3.0 | μA |
| I_{OL} | Output Leakage | $V_{IN} = 0\text{V}$ to V_{CC} , $T_{AC} = 0^\circ\text{C}$ to 70°C | -3.0 | | 3.0 | μA |
| $V_{IL}^{(1)}$ | Input Low Voltage | | -0.6 | | $V_{CC} \times 0.3$ | V |
| $V_{IH}^{(1)}$ | Input High Voltage | | $V_{CC} \times 0.7$ | | $V_{CC} + 0.5$ | V |
| V_{OL1} | Output Low Voltage | $4.5\text{V} \leq V_{CC} \leq 5.5\text{V}$ | | | 0.4 | V |
| V_{OH1} | Output High Voltage | | $I_{OL} = 3.0\text{ mA}$ | | | V |
| | | | | | | V |
| | | | $V_{CC} - 0.8$ | | | V |

Note: 1. V_{IL} and V_{IH} max are reference only and are not tested.

AC Characteristics

Applicable over recommended operating range from $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$, $V_{CC} = \text{As Specified}$, $C_L = 1$ TTL Gate and 100 pF (unless otherwise noted).

| Symbol | Parameter | Voltage | Min | Max | Units |
|--------------------------|---|------------------------|------------|------------|---------------|
| f_{SCK} | SCK Clock Frequency | 4.5 - 5.5 2.7 - 5.5 | 0 0 | 2.1 1.0 | MHz |
| t_{RI} | Input Rise Time | 4.5 - 5.5 2.7 - 5.5 | | 2 2 | μs |
| t_{FI} | Input Fall Time | 4.5 - 5.5 2.7 - 5.5 | | 2 2 | μs |
| t_{WH} | SCK High Time | 4.5 - 5.5 2.7 - 5.5 | 200 400 | | ns |
| t_{WL} | SCK Low Time | 4.5 - 5.5 2.7 - 5.5 | 200 400 | | ns |
| t_{CS} | $\overline{\text{CS}}$ High Time | 4.5 - 5.5 2.7 - 5.5 | 250 500 | | ns |
| t_{CSS} | $\overline{\text{CS}}$ Setup Time | 4.5 - 5.5 2.7 - 5.5 | 100 250 | | ns |
| t_{CSH} | $\overline{\text{CS}}$ Hold Time | 4.5 - 5.5 2.7 - 5.5 | 150 250 | | ns |
| t_{SU} | Data In Setup Time | 4.5 - 5.5 2.7 - 5.5 | 30 50 | | ns |
| t_{H} | Data In Hold Time | 4.5 - 5.5 2.7 - 5.5 | 50 50 | | ns |
| t_{HD} | $\overline{\text{Hold}}$ Setup Time | 4.5 - 5.5 2.7 - 5.5 | 100 100 | | ns |
| t_{CD} | $\overline{\text{Hold}}$ Hold Time | 4.5 - 5.5 2.7 - 5.5 | 200 300 | | ns |
| t_{V} | Output Valid | 4.5 - 5.5 2.7 - 5.5 | 0 0 | 200 400 | ns |
| t_{HO} | Output Hold Time | 4.5 - 5.5 2.7 - 5.5 | 0 0 | | ns |
| t_{LZ} | $\overline{\text{Hold}}$ to Output Low Z | 4.5 - 5.5 2.7 - 5.5 | 0 0 | 100 200 | ns |
| t_{HZ} | $\overline{\text{Hold}}$ to Output High Z | 4.5 - 5.5 2.7 - 5.5 | | 100 200 | ns |
| t_{DIS} | Output Disable Time | 4.5 - 5.5 2.7 - 5.5 | | 200 250 | ns |
| t_{WC} | Write Cycle Time | 4.5 - 5.5 2.7 - 5.5 | | 5 10 | ms |
| Endurance ⁽¹⁾ | 5.0V, 25°C, Page Mode | 4.5 - 5.5 2.7 - 5.5 | 100K | | Write Cycles |

Note: 1. This parameter is characterized and is not 100% tested.

Serial Interface Description

MASTER: The device that generates the serial clock.

SLAVE: Because the Serial Clock pin (SCK) is always an input, the AT25P1024 always operates as a slave.

TRANSMITTER/RECEIVER: The AT25P1024 has separate pins designated for data transmission (SO) and reception (SI).

MSB: The Most Significant Bit (MSB) is the first bit transmitted and received.

SERIAL OP-CODE: After the device is selected with \overline{CS} going low, the first byte will be received. This byte contains the op-code that defines the operations to be performed.

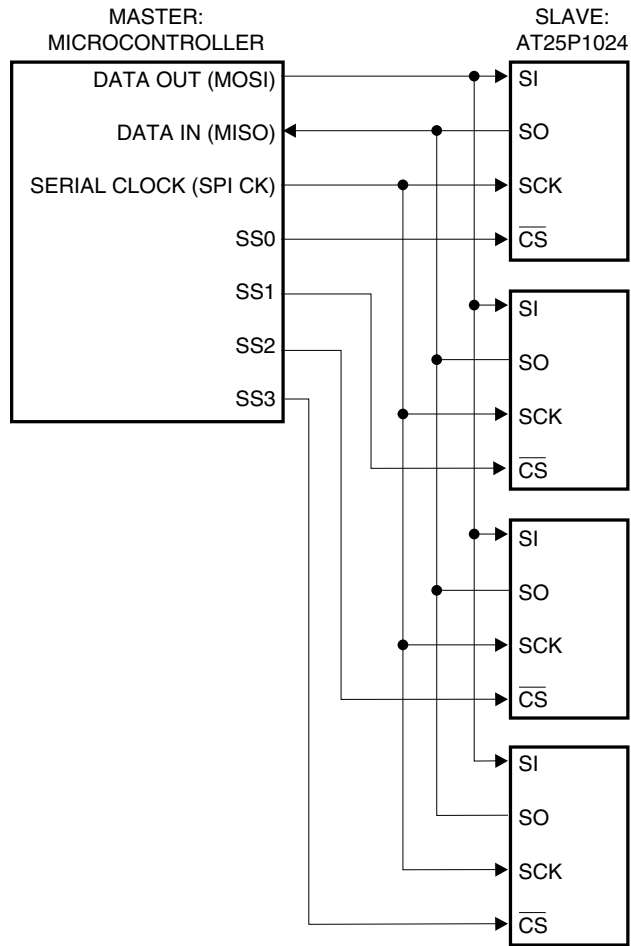
INVALID OP-CODE: If an invalid op-code is received, no data will be shifted into the AT25P1024, and the serial output pin (SO) will remain in a high impedance state until the falling edge of \overline{CS} is detected again. This will reinitialize the serial communication.

CHIP SELECT: The AT25P1024 is selected when the \overline{CS} pin is low. When the device is not selected, data will not be accepted via the SI pin, and the serial output pin (SO) will remain in a high impedance state.

HOLD: The \overline{HOLD} pin is used in conjunction with the \overline{CS} pin to select the AT25P1024. When the device is selected and a serial sequence is underway, \overline{HOLD} can be used to pause the serial communication with the master device without resetting the serial sequence. To pause, the \overline{HOLD} pin must be brought low while the SCK pin is low. To resume serial communication, the \overline{HOLD} pin is brought high while the SCK pin is low (SCK may still toggle during \overline{HOLD}). Inputs to the SI pin will be ignored while the SO pin is in the high impedance state.

WRITE PROTECT: The write protect pin (\overline{WP}) will allow normal read/write operations when held high. When the \overline{WP} pin is brought low and WPEN bit is "1", all write operations to the status register are inhibited. \overline{WP} going low while \overline{CS} is still low will interrupt a write to the status register. If the internal write cycle has already been initiated, \overline{WP} going low will have no effect on any write operation to the status register. The \overline{WP} pin function is blocked when the WPEN bit in the status register is "0". This will allow the user to install the AT25P1024 in a system with the \overline{WP} pin tied to ground and still be able to write to the status register. All \overline{WP} pin functions are enabled when the WPEN bit is set to "1".

SPI Serial Interface



Functional Description

The AT25P1024 is designed to interface directly with the synchronous serial peripheral interface (SPI) of the 6800 type series of microcontrollers.

The AT25P1024 utilizes an 8-bit instruction register. The list of instructions and their operation codes are contained in Table 1. All instructions, addresses, and data are transferred with the MSB first and start with a high-to-low transition.

Table 1. Instruction Set for the AT25P1024

| Instruction Name | Instruction Format | Operation |
|------------------|--------------------|-----------------------------|
| WREN | 0000 X110 | Set Write Enable Latch |
| WRDI | 0000 X100 | Reset Write Enable Latch |
| RDSR | 0000 X101 | Read Status Register |
| WRSR | 0000 X001 | Write Status Register |
| READ | 0000 X011 | Read Data from Memory Array |
| WRITE | 0000 X010 | Write Data to Memory Array |

WRITE ENABLE (WREN): The device will power up in the write disable state when V_{CC} is applied. All programming instructions must therefore be preceded by a Write Enable instruction.

WRITE DISABLE (WRDI): To protect the device against inadvertent writes, the Write Disable instruction disables all programming modes. The WRDI instruction is independent of the status of the \overline{WP} pin.

READ STATUS REGISTER (RDSR): The Read Status Register instruction provides access to the status register. The READY/BUSY and Write Enable status of the device can be determined by the RDSR instruction. Similarly, the Block Write Protection bits indicate the extent of protection employed. These bits are set by using the WRSR instruction.

Table 2. Status Register Format

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|-------|-------|-------|-------|-------|-------|-------|------------------|
| WPEN | X | X | X | BP1 | BP0 | WEN | \overline{RDY} |

Table 3. Read Status Register Bit Definition

| Bit | Definition |
|--|--|
| Bit 0 ($\overline{\text{RDY}}$) | Bit 0 = 0 ($\overline{\text{RDY}}$) indicates the device is READY. Bit 0 = 1 indicates the write cycle is in progress. |
| Bit 1 (WEN) | Bit 1 = 0 indicates the device <i>is not</i> WRITE ENABLED. Bit 1 = 1 indicates the device is WRITE ENABLED. |
| Bit 2 (BP0) | See Table 4. |
| Bit 3 (BP1) | See Table 4. |
| Bits 4-6 are 0s when device is not in an internal write cycle. | |
| Bit 7 (WPEN) | See Table 5. |
| Bits 0-7 are 1s during an internal write cycle. | |

WRITE STATUS REGISTER (WRSR): The WRSR instruction allows the user to select one of four levels of protection. The AT25P1024 is divided into four array segments. Top quarter (1/4), top half (1/2), or all of the memory segments can be protected. Any of the data within any selected segment will therefore be READ only. The block write protection levels and corresponding status register control bits are shown in Table 4.

The three bits, BP0, BP1, and WPEN are nonvolatile cells that have the same properties and functions as the regular memory cells (e.g. WREN, t_{WC} , RDSR).

Table 4. Block Write Protect Bits

| Level | Status Register Bits | | Array Addresses Protected |
|--------|----------------------|-----|---------------------------|
| | BP1 | BP0 | AT25P1024 |
| 0 | 0 | 0 | None |
| 1(1/4) | 0 | 1 | 01800 - 01FFFF |
| 2(1/2) | 1 | 0 | 010000 - 01FFFF |
| 3(All) | 1 | 1 | 0000 - 01FFFF |

The WRSR instruction also allows the user to enable or disable the write protect ($\overline{\text{WP}}$) pin through the use of the Write Protect Enable (WPEN) bit. Hardware write protection is enabled when the $\overline{\text{WP}}$ pin is low and the WPEN bit is “1”. Hardware write protection is disabled when *either* the $\overline{\text{WP}}$ pin is high or the WPEN bit is “0.” When the device is hardware write protected, writes to the Status Register, including the Block Protect bits and the WPEN bit, and the block-protected sections in the memory array are disabled. Writes are only allowed to sections of the memory which are not block-protected.

NOTE: When the WPEN bit is hardware write protected, it cannot be changed back to “0”, as long as the $\overline{\text{WP}}$ pin is held low.

Table 5. WPEN Operation

| WPEN | WP | WEN | ProtectedBlocks | UnprotectedBlocks | Status Register |
|------|-----|-----|-----------------|-------------------|-----------------|
| 0 | X | 0 | Protected | Protected | Protected |
| 0 | X | 1 | Protected | Writable | Writable |
| 1 | Low | 0 | Protected | Protected | Protected |

Table 5. WPEN Operation

| WPEN | WP | WEN | ProtectedBlocks | UnprotectedBlocks | Status Register |
|------|------|-----|-----------------|-------------------|-----------------|
| 1 | Low | 1 | Protected | Writable | Protected |
| X | High | 0 | Protected | Protected | Protected |
| X | High | 1 | Protected | Writable | Writable |

READ SEQUENCE (READ): Reading the AT25P1024 via the SO (Serial Output) pin requires the following sequence. After the \overline{CS} line is pulled low to select a device, the READ op-code is transmitted via the SI line followed by the byte address to be read (Refer to Table 6). Upon completion, any data on the SI line will be ignored. The data (D7-D0) at the specified address is then shifted out onto the SO line. If only one byte is to be read, the \overline{CS} line should be driven high after the data comes out. The READ sequence can be continued since the byte address is automatically incremented and data will continue to be shifted out. When the highest address is reached, the address counter will roll over to the lowest address allowing the entire memory to be read in one continuous READ cycle.

WRITE SEQUENCE (WRITE): In order to program the AT25P1024, two separate instructions must be executed. First, the device **must be write enabled** via the Write Enable (WREN) Instruction. Then a Write (WRITE) Instruction may be executed. Also, the address of the memory location(s) to be programmed must be outside the protected address field location selected by the Block Write Protection Level. During an internal write cycle, all commands will be ignored except the RDSR instruction.

A Write Instruction requires the following sequence. After the \overline{CS} line is pulled low to select the device, the WRITE op-code is transmitted via the SI line followed by the byte address and the data (D7-D0) to be programmed (Refer to Table 6). Programming will start after the \overline{CS} pin is brought high. (The LOW to High transition of the \overline{CS} pin must occur during the SCK low time immediately after clocking in the D0 (LSB) data bit.

The READY/BUSY status of the device can be determined by initiating a READ STATUS REGISTER (RDSR) Instruction. If Bit 0 = 1, the WRITE cycle is still in progress. If Bit 0 = 0, the WRITE cycle has ended. Only the READ STATUS REGISTER instruction is enabled during the WRITE programming cycle.

The AT25P1024 is capable of a 128-byte PAGE WRITE operation ONLY. Content of the page in the array will not be guaranteed if less than 128 bytes of data is received (byte operation is not supported). After each byte of data is received, the seven low order address bits are internally incremented by one; the high order bits of the address will remain constant. If more than 128 bytes of data are transmitted, the address counter will roll over and the previously written data will be overwritten. The AT25P1024 is automatically returned to the write disable state at the completion of a WRITE cycle.

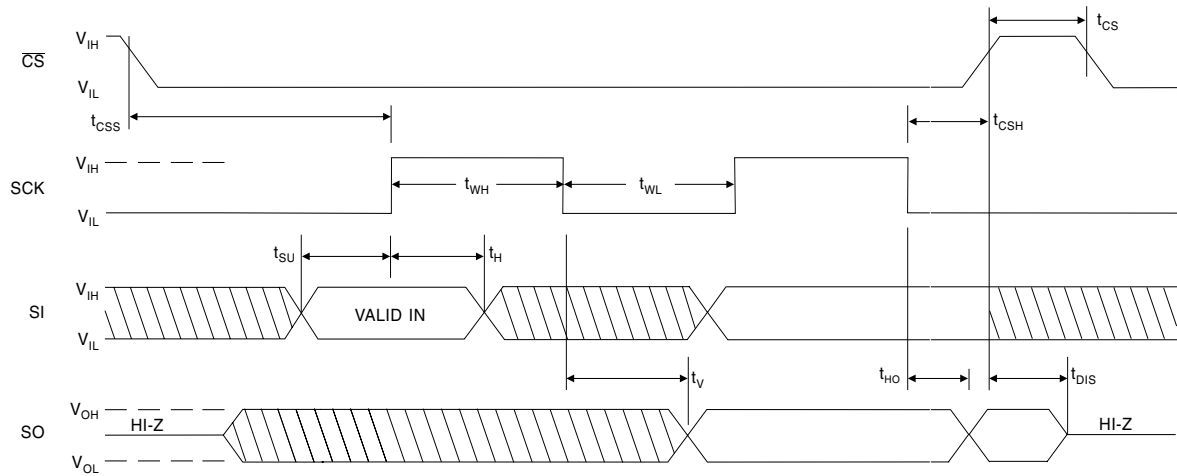
NOTE: If the device is not Write enabled (WREN), the device will ignore the Write instruction and will return to the standby state, when \overline{CS} is brought high. A new CS falling edge is required to re-initiate the serial communication.

Table 6. Address Key

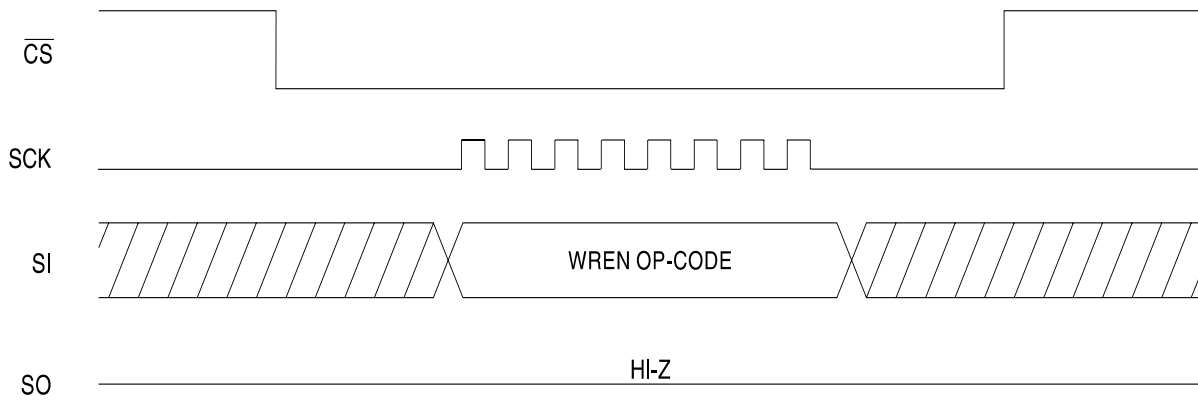
| Address | AT25P1024 |
|-----------------|-------------------|
| A_N | $A_{16} - A_0$ |
| Don't Care Bits | $A_{23} - A_{17}$ |

Timing Diagrams (for SPI Mode 0 (0, 0))

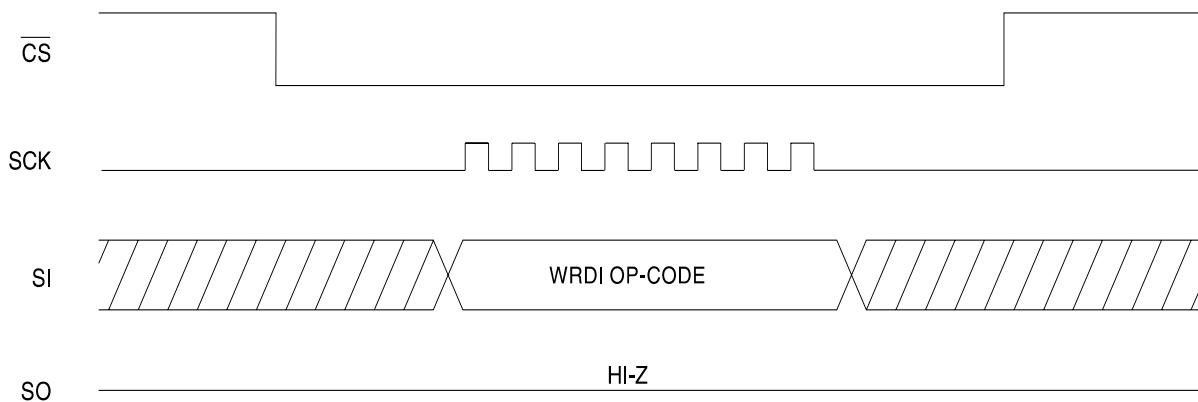
Synchronous Data Timing



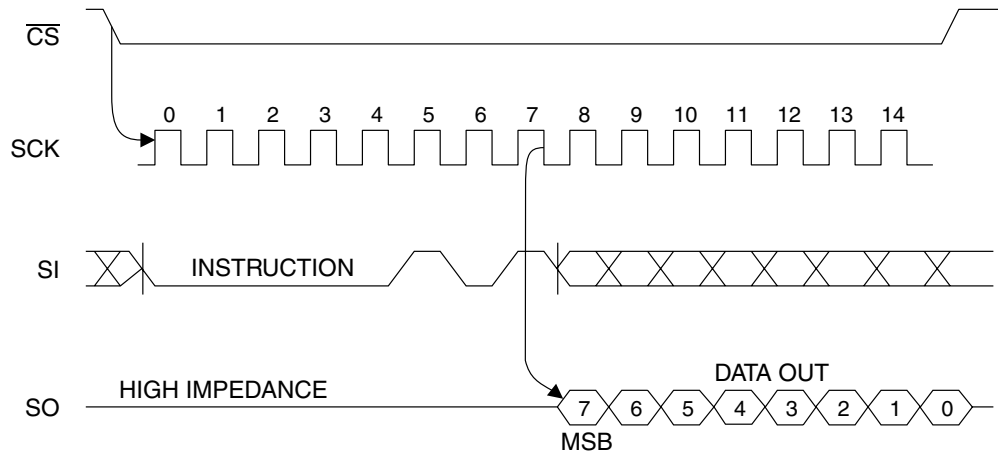
WREN Timing



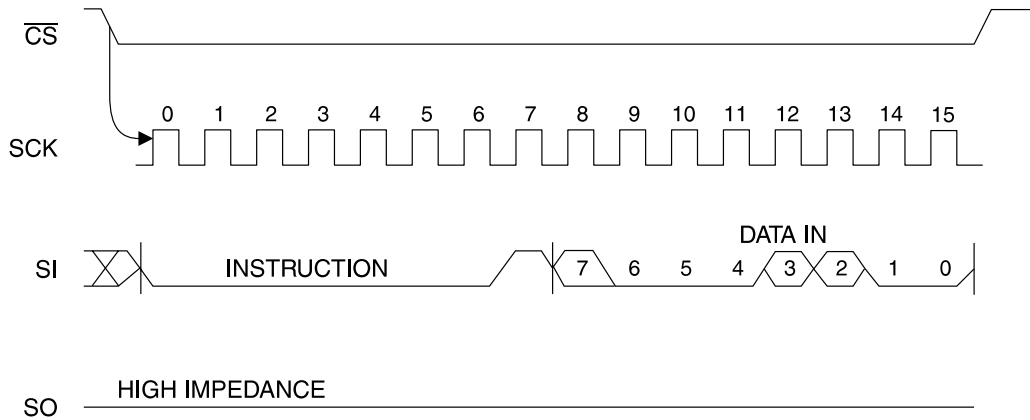
WRDI Timing



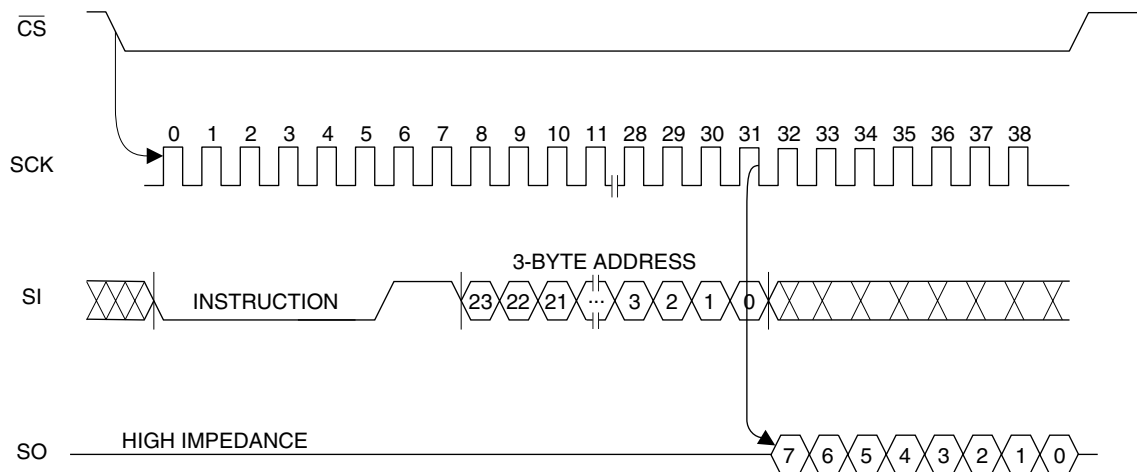
RDSR Timing



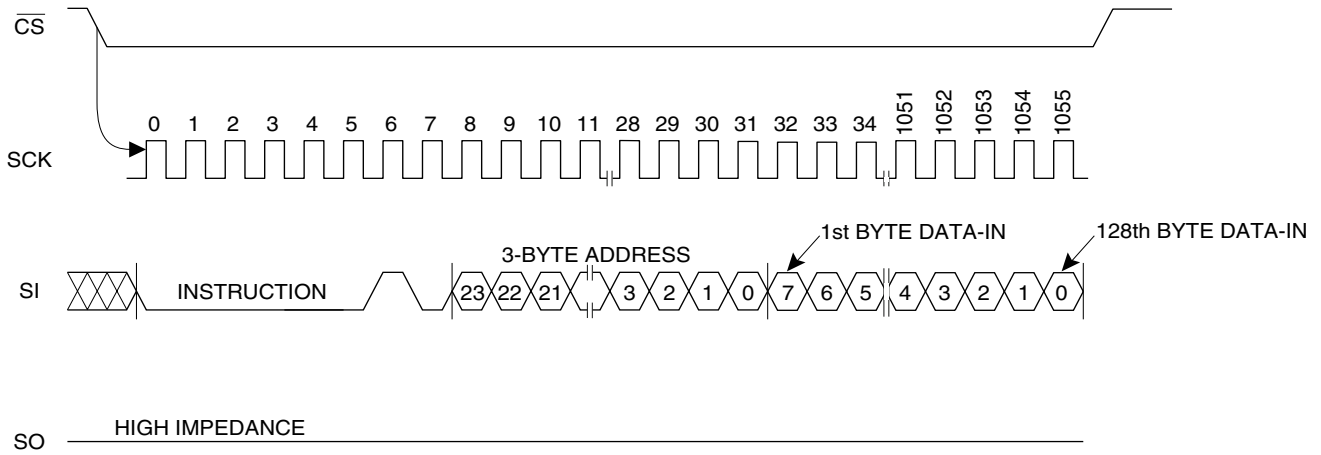
WRSR Timing



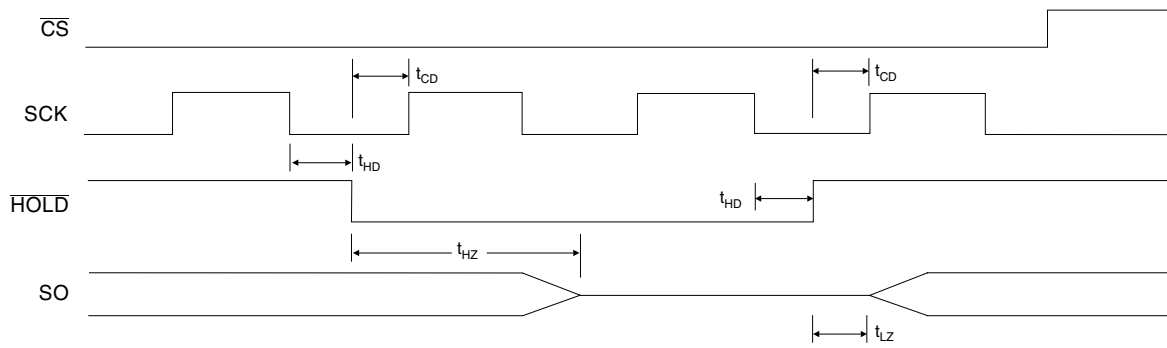
READ Timing



WRITE Timing



HOLD Timing



Ordering Information

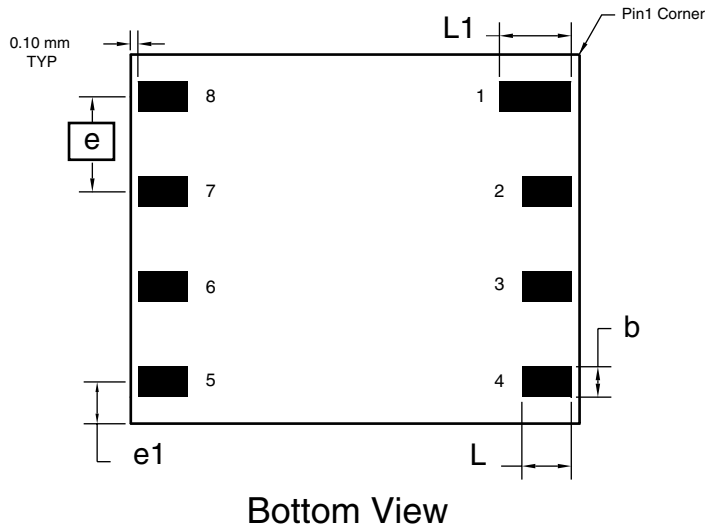
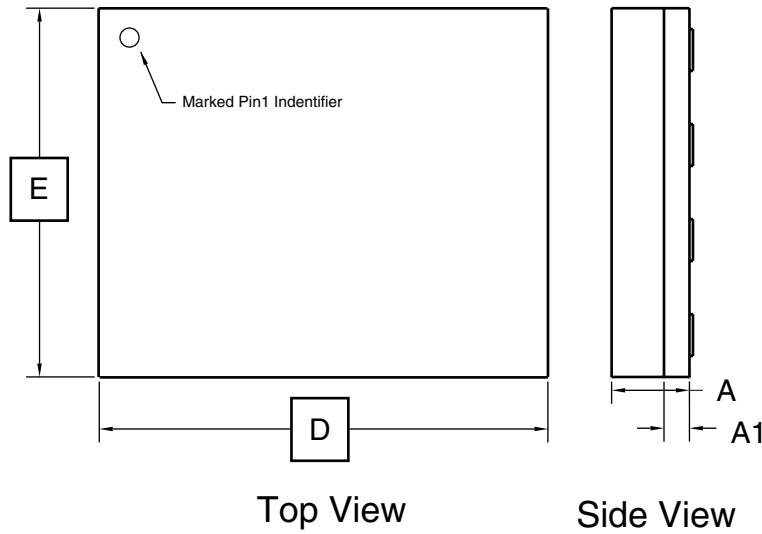
| Ordering Code | Package | Operation Range |
|----------------------|---------|-----------------|
| AT25P1024C1-10CI-2.7 | 8C1 | Industrial |
| AT25P1024W1-10SI-2.7 | 20S2 | (-40°C to 85°C) |

Note: For 2.7V devices used in the 4.5V to 5.5V range, please refer to performance values in the AC and DC Characteristics tables.

| Package Type | |
|--------------|--|
| 8C1 | 8-pad, 0.300" Wide, Leadless Array Package (LAP) |
| 20S2 | 20-lead, 0.300" Wide, Plastic Gull Wing Small Outline Package (JEDEC SOIC) |
| Options | |
| -2.7 | Low-voltage (2.7V to 5.5V) |

Packaging Information

8C1 – LAP



COMMON DIMENSIONS
(Unit of Measure = mm)

| SYMBOL | MIN | NOM | MAX | NOTE |
|--------|----------|------|------|------|
| A | 0.94 | 1.04 | 1.14 | |
| A1 | 0.30 | 0.34 | 0.38 | |
| b | 0.36 | 0.41 | 0.46 | 1 |
| D | 7.90 | 8.00 | 8.10 | |
| E | 4.90 | 5.00 | 5.10 | |
| e | 1.27 BSC | | | |
| e1 | 0.60 REF | | | |
| L | 0.62 | 0.67 | 0.72 | 1 |
| L1 | 0.92 | 0.97 | 1.02 | 1 |

Note: 1. Metal Pad Dimensions.

11/13/01



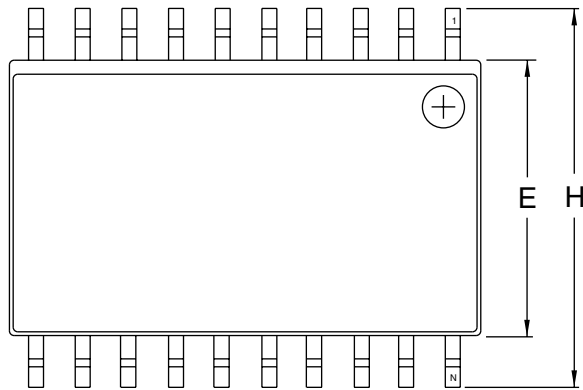
2325 Orchard Parkway
San Jose, CA 95131

TITLE
8CN1, 8-lead (8 x 5 x 1.04 mm Body), Lead Pitch 1.27 mm,
Leadless Array Package (LAP)

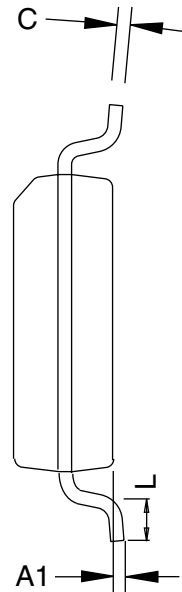
DRAWING NO.
8CN1

REV.
A

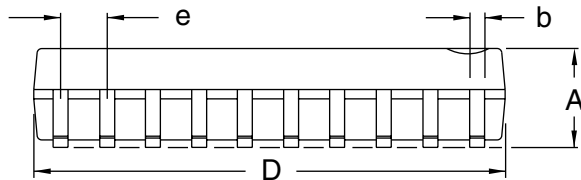
20S2 – JEDEC SOIC



Top View



End View



Side View

COMMON DIMENSIONS
(Unit of Measure = inches)

| SYMBOL | MIN | NOM | MAX | NOTE |
|--------|-----------|-----|--------|------|
| A | 0.0926 | | 0.1043 | |
| A1 | 0.0040 | | 0.0118 | |
| b | 0.0130 | | 0.0200 | 4 |
| C | 0.0091 | | 0.0125 | |
| D | 0.4961 | | 0.5118 | 1 |
| E | 0.2914 | | 0.2992 | 2 |
| H | 0.3940 | | 0.4190 | |
| L | 0.0160 | | 0.050 | 3 |
| e | 0.050 BSC | | | |

- Notes:
1. This drawing is for general information only; refer to JEDEC Drawing MS-013, Variation AC for additional information.
 2. Dimension "D" does not include mold Flash, protrusions or gate burrs. Mold Flash, protrusions and gate burrs shall not exceed 0.15 mm (0.006") per side.
 3. Dimension "E" does not include inter-lead Flash or protrusion. Inter-lead Flash and protrusions shall not exceed 0.25 mm (0.010") per side.
 4. "L" is the length of the terminal for soldering to a substrate.
 5. The lead width "b", as measured 0.36 mm (0.014") or greater above the seating plane, shall not exceed a maximum value of 0.61 mm (0.024") per side.



2325 Orchard Parkway
San Jose, CA 95131

TITLE

20S2, 20-lead, 0.300" Wide Body, Plastic Gull Wing Small Outline Package (SOIC)

DRAWING NO.

20S2

REV.

A





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