



## 512 Kbit Serial I<sup>2</sup>C Bus EEPROM

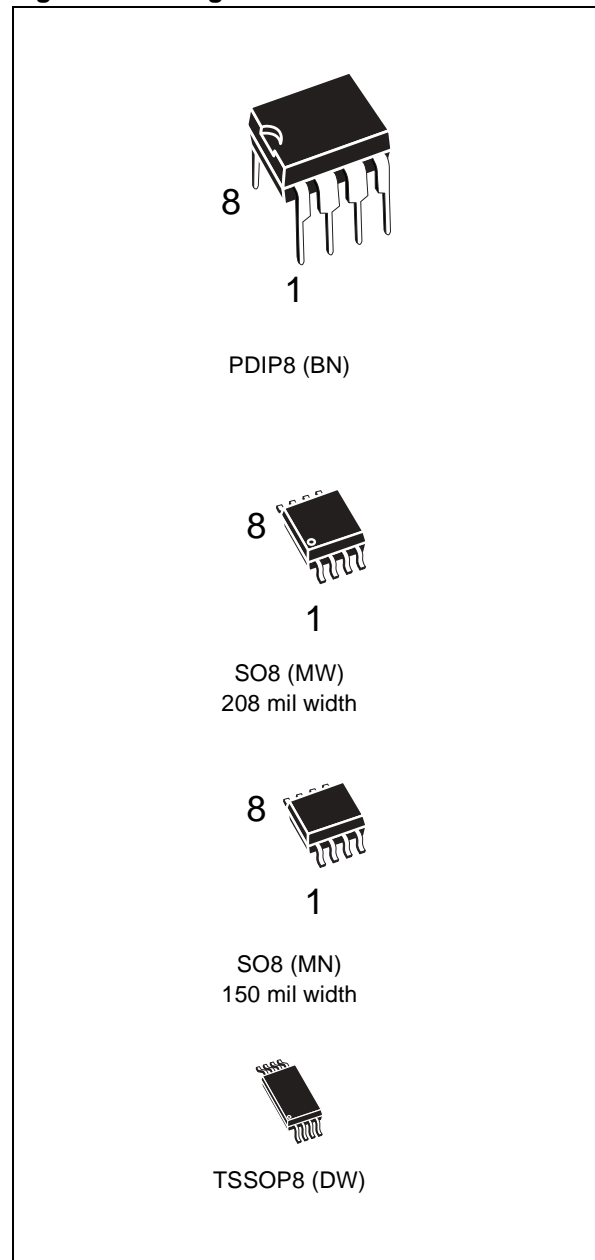
### FEATURES SUMMARY

- Two-Wire I<sup>2</sup>C Serial Interface  
Supports 400 kHz Protocol
- Supply Voltage Ranges:
  - 1.8V to 5.5V (M24512 – R)
  - 2.5V to 5.5V (M24512 – W)
- Write Control Input
- BYTE and PAGE WRITE (up to 128 Bytes)
- RANDOM and SEQUENTIAL READ Modes
- Self-Timed Programming Cycle
- Automatic Address Incrementing
- Enhanced ESD/Latch-Up Protection
- More than 100,000 Erase/Write Cycles
- More than 40-Year Data Retention

Table 1. M24512 devices

| Reference | Part Number |
|-----------|-------------|
| M24512    | M24512 – W  |
|           | M24512 – R  |

Figure 1. Packages



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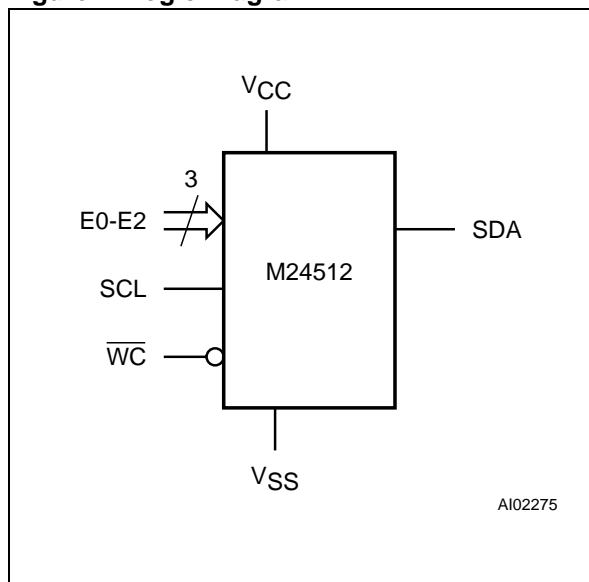
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## SUMMARY DESCRIPTION

These I<sup>2</sup>C-compatible electrically erasable programmable memory (EEPROM) devices are organized as 64K x 8 bits.

**Figure 2. Logic Diagram**



**Table 2. Signal Names**

|                 |                |
|-----------------|----------------|
| E0, E1, E2      | Chip Enable    |
| SDA             | Serial Data    |
| SCL             | Serial Clock   |
| $\overline{WC}$ | Write Control  |
| VCC             | Supply Voltage |
| VSS             | Ground         |

I<sup>2</sup>C uses a two-wire serial interface, comprising a bi-directional data line and a clock line. The devices carry a built-in 4-bit Device Type Identifier code (1010) in accordance with the I<sup>2</sup>C bus definition.

The device behaves as a slave in the I<sup>2</sup>C protocol, with all memory operations synchronized by the serial clock. Read and Write operations are initiated by a Start condition, generated by the bus mas-

ter. The Start condition is followed by a Device Select Code and Read/Write bit (RW) (as described in Table 3.), terminated by an acknowledge bit.

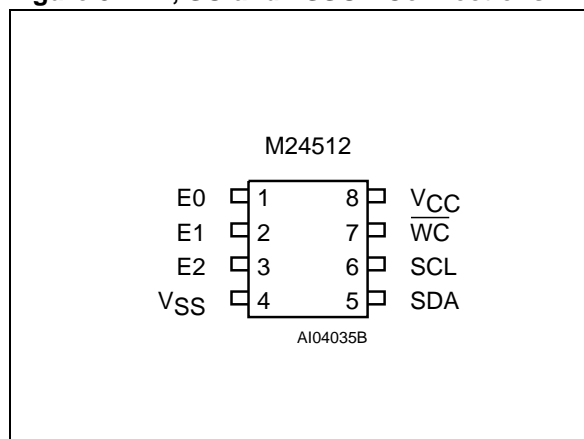
When writing data to the memory, the device inserts an acknowledge bit during the 9<sup>th</sup> bit time, following the bus master's 8-bit transmission. When data is read by the bus master, the bus master acknowledges the receipt of the data byte in the same way. Data transfers are terminated by a Stop condition after an Ack for Write, and after a NoAck for Read.

### Power On Reset

In order to prevent data corruption and inadvertent Write operations during Power-up, a Power On Reset (POR) circuit is included. At Power-up, the device will not respond to any command until VCC has reached the Power On Reset threshold voltage (this threshold is lower than the VCC min operating voltage defined in Tables 8 and 9). In the same way, as soon as VCC drops from the normal operating voltage, below the Power On Reset threshold voltage, the device stops to respond to any command.

Prior to selecting and issuing commands to the memory, a valid and stable VCC voltage must be applied. This voltage must remain stable and valid until the end of the transmission of the command and, for a Write instruction, until the completion of the internal write cycle (t<sub>W</sub>).

**Figure 3. DIP, SO and TSSOP Connections**



Note: See PACKAGE MECHANICAL section for package dimensions, and how to identify pin-1.

## SIGNAL DESCRIPTION

**Serial Clock (SCL).** This input signal is used to strobe all data in and out of the device. In applications where this signal is used by slave devices to synchronize the bus to a slower clock, the bus master must have an open drain output, and a pull-up resistor must be connected from Serial Clock (SCL) to  $V_{CC}$ . (Figure 4. indicates how the value of the pull-up resistor can be calculated). In most applications, though, this method of synchronization is not employed, and so the pull-up resistor is not necessary, provided that the bus master has a push-pull (rather than open drain) output.

**Serial Data (SDA).** This bi-directional signal is used to transfer data in or out of the device. It is an open drain output that may be wire-OR'ed with other open drain or open collector signals on the bus. A pull up resistor must be connected from Serial Data (SDA) to  $V_{CC}$ . (Figure 4. indicates how the value of the pull-up resistor can be calculated).

**Chip Enable (E0, E1, E2).** These input signals are used to set the value that is to be looked for on the three least significant bits (b3, b2, b1) of the 7-bit Device Select Code. These inputs must be tied to  $V_{CC}$  or  $V_{SS}$ , to establish the Device Select Code. When not connected (left floating), these inputs are read as Low (0,0,0).

**Write Control (WC).** This input signal is useful for protecting the entire contents of the memory from inadvertent write operations. Write operations are disabled to the entire memory array when Write Control (WC) is driven High. When unconnected, the signal is internally read as  $V_{IL}$ , and Write operations are allowed.

When Write Control (WC) is driven High, Device Select and Address bytes are acknowledged, Data bytes are not acknowledged.

**Figure 4. Maximum  $R_p$  Value versus Bus Parasitic Capacitance (C) for an I<sup>2</sup>C Bus**

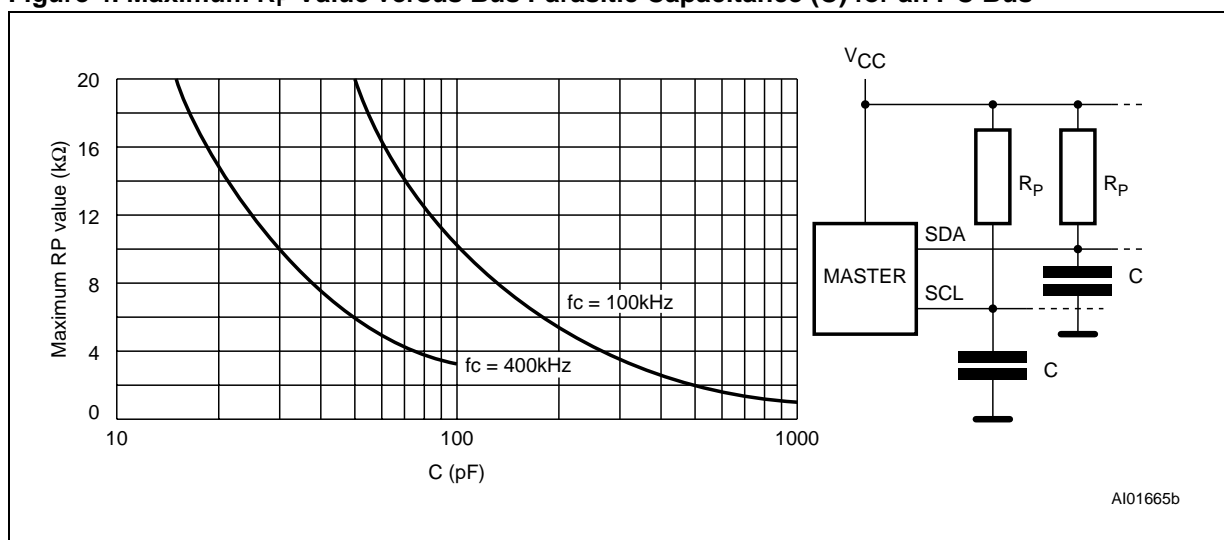


Figure 5. I<sup>2</sup>C Bus Protocol

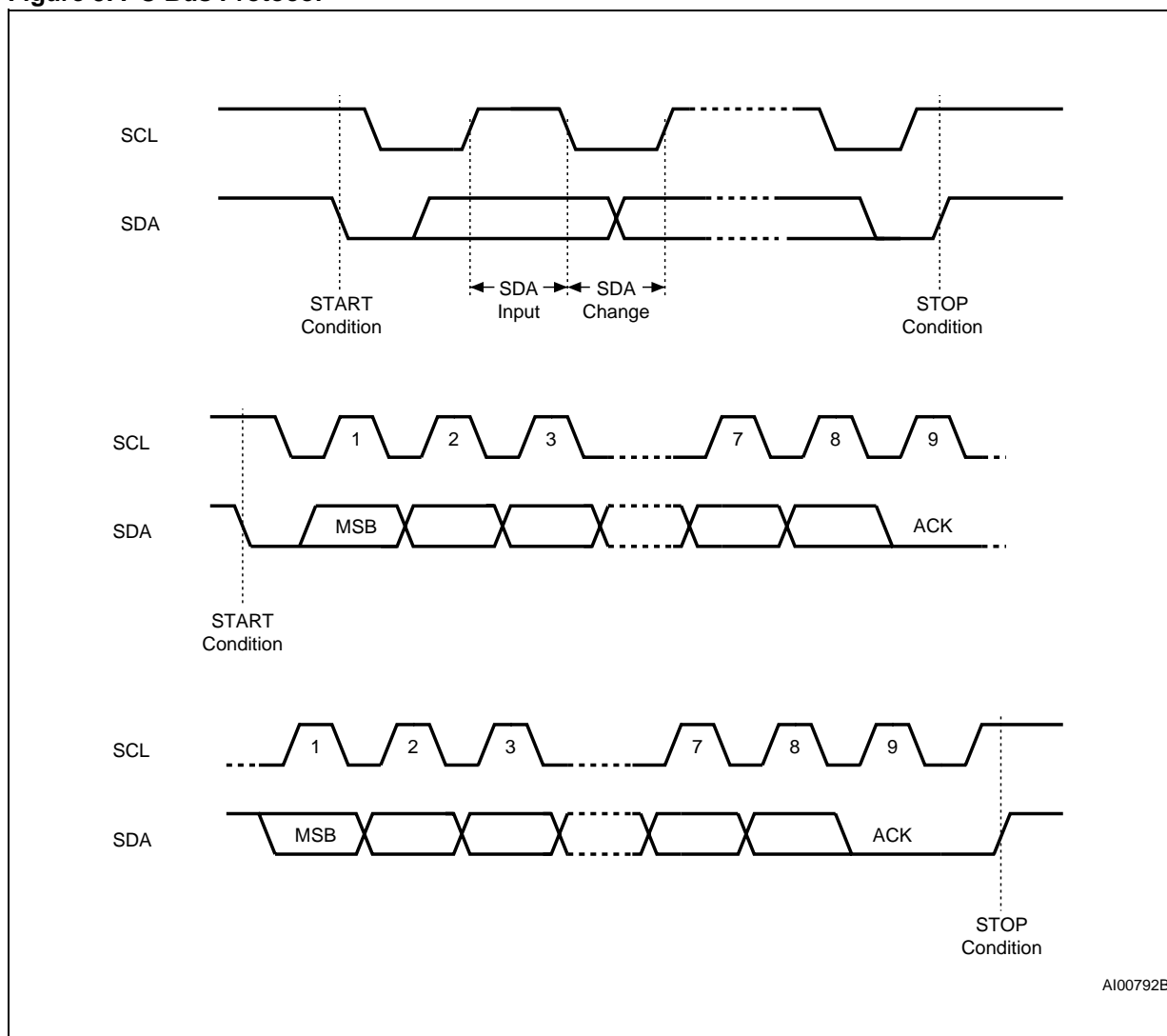


Table 3. Device Select Code

|                    | Device Type Identifier <sup>1</sup> |    |    |    | Chip Enable Address <sup>2</sup> |    |    | R $\bar{W}$ |
|--------------------|-------------------------------------|----|----|----|----------------------------------|----|----|-------------|
|                    | b7                                  | b6 | b5 | b4 | b3                               | b2 | b1 | b0          |
| Device Select Code | 1                                   | 0  | 1  | 0  | E2                               | E1 | E0 | R $\bar{W}$ |

Note: 1. The most significant bit, b7, is sent first.

2. E0, E1 and E2 are compared against the respective external pins on the memory device.

Table 4. Most Significant Byte

|     |     |     |     |     |     |    |    |
|-----|-----|-----|-----|-----|-----|----|----|
| b15 | b14 | b13 | b12 | b11 | b10 | b9 | b8 |
|-----|-----|-----|-----|-----|-----|----|----|

Table 5. Least Significant Byte

|    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|
| b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 |
|----|----|----|----|----|----|----|----|

## DEVICE OPERATION

The device supports the I<sup>2</sup>C protocol. This is summarized in [Figure 5](#). Any device that sends data on to the bus is defined to be a transmitter, and any device that reads the data to be a receiver. The device that controls the data transfer is known as the bus master, and the other as the slave device. A data transfer can only be initiated by the bus master, which will also provide the serial clock for synchronization. The M24512 device is always a slave in all communication.

### Start Condition

Start is identified by a falling edge of Serial Data (SDA) while Serial Clock (SCL) is stable in the High state. A Start condition must precede any data transfer command. The device continuously monitors (except during a Write cycle) Serial Data (SDA) and Serial Clock (SCL) for a Start condition, and will not respond unless one is given.

### Stop Condition

Stop is identified by a rising edge of Serial Data (SDA) while Serial Clock (SCL) is stable and driven High. A Stop condition terminates communication between the device and the bus master. A Read command that is followed by NoAck can be followed by a Stop condition to force the device into the Stand-by mode. A Stop condition at the end of a Write command triggers the internal Write cycle.

### Acknowledge Bit (ACK)

The acknowledge bit is used to indicate a successful byte transfer. The bus transmitter, whether it be bus master or slave device, releases Serial Data (SDA) after sending eight bits of data. During the 9<sup>th</sup> clock pulse period, the receiver pulls Serial

Data (SDA) Low to acknowledge the receipt of the eight data bits.

### Data Input

During data input, the device samples Serial Data (SDA) on the rising edge of Serial Clock (SCL). For correct device operation, Serial Data (SDA) must be stable during the rising edge of Serial Clock (SCL), and the Serial Data (SDA) signal must change *only* when Serial Clock (SCL) is driven Low.

### Memory Addressing

To start communication between the bus master and the slave device, the bus master must initiate a Start condition. Following this, the bus master sends the Device Select Code, shown in [Table 3](#). (on Serial Data (SDA), most significant bit first).

The Device Select Code consists of a 4-bit Device Type Identifier, and a 3-bit Chip Enable "Address" (E2, E1, E0). To address the memory array, the 4-bit Device Type Identifier is 1010b.

Up to eight memory devices can be connected on a single I<sup>2</sup>C bus. Each one is given a unique 3-bit code on the Chip Enable (E0, E1, E2) inputs. When the Device Select Code is received, the device only responds if the Chip Enable Address is the same as the value on the Chip Enable (E0, E1, E2) inputs.

The 8<sup>th</sup> bit is the Read/Write bit ( $\overline{RW}$ ). This bit is set to 1 for Read and 0 for Write operations.

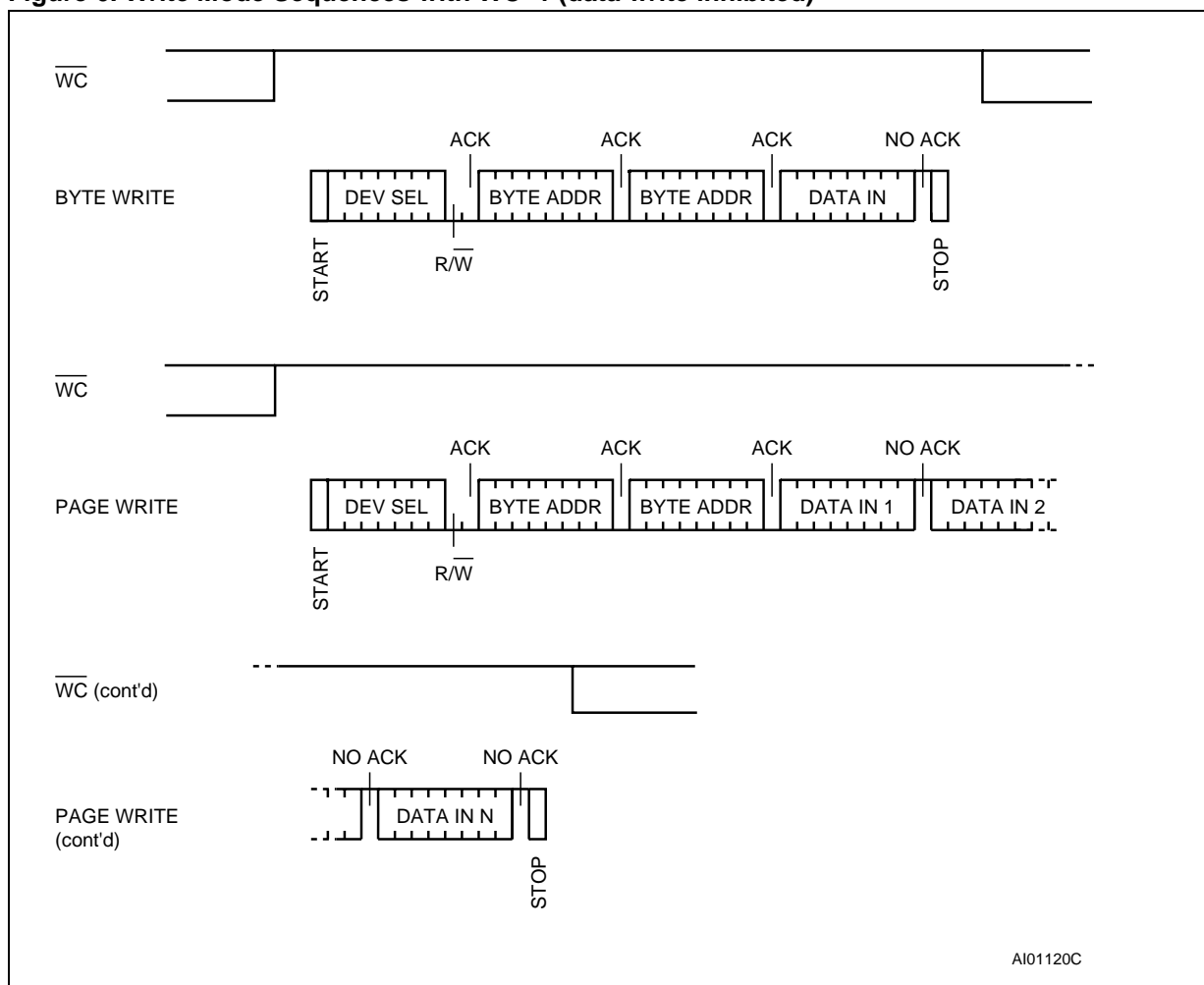
If a match occurs on the Device Select code, the corresponding device gives an acknowledgment on Serial Data (SDA) during the 9<sup>th</sup> bit time. If the device does not match the Device Select code, it deselected itself from the bus, and goes into Stand-by mode.

**Table 6. Operating Modes**

| Mode                 | $\overline{RW}$ bit | $\overline{WC}$ <sup>1</sup> | Bytes | Initial Sequence                                    |
|----------------------|---------------------|------------------------------|-------|---|
| Current Address Read | 1                   | X                            | 1     | START, Device Select, $\overline{RW} = 1$           |
| Random Address Read  | 0                   | X                            | 1     | START, Device Select, $\overline{RW} = 0$ , Address |
|                      | 1                   | X                            |       | reSTART, Device Select, $\overline{RW} = 1$         |
| Sequential Read      | 1                   | X                            | ≥ 1   | Similar to Current or Random Address Read           |
| Byte Write           | 0                   | V <sub>IL</sub>              | 1     | START, Device Select, $\overline{RW} = 0$           |
| Page Write           | 0                   | V <sub>IL</sub>              | ≤ 128 | START, Device Select, $\overline{RW} = 0$           |

Note: 1. X = V<sub>IH</sub> or V<sub>IL</sub>.

Figure 6. Write Mode Sequences with  $\overline{WC}=1$  (data write inhibited)



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**Write Operations**

Following a Start condition the bus master sends a Device Select Code with the Read/Write bit ( $\overline{RW}$ ) reset to 0. The device acknowledges this, as shown in Figure 7., and waits for two address bytes. The device responds to each address byte with an acknowledge bit, and then waits for the data byte.

Writing to the memory may be inhibited if Write Control ( $\overline{WC}$ ) is driven High. Any Write instruction with Write Control ( $\overline{WC}$ ) driven High (during a period of time from the Start condition until the end of the two address bytes) will not modify the memory contents, and the accompanying data bytes are not acknowledged, as shown in Figure 6..

Each data byte in the memory has a 16-bit (two byte wide) address. The Most Significant Byte (Table 4.) is sent first, followed by the Least Significant Byte (Table 5.). Bits b15 to b0 form the address of the byte in memory.

When the bus master generates a Stop condition immediately after the Ack bit (in the “10<sup>th</sup> bit” time slot), either at the end of a Byte Write or a Page Write, the internal Write cycle is triggered. A Stop condition at any other time slot does not trigger the internal Write cycle.

After the Stop condition, the delay  $t_{W}$ , and the successful completion of a Write operation, the device’s internal address counter is incremented automatically, to point to the next byte address after the last one that was modified.

During the internal Write cycle, Serial Data (SDA) is disabled internally, and the device does not respond to any requests.

**Byte Write**

After the Device Select code and the address bytes, the bus master sends one data byte. If the addressed location is Write-protected, by Write Control ( $\overline{WC}$ ) being driven High, the device replies with NoAck, and the location is not modified. If, instead, the addressed location is not Write-protect-



ed, the device replies with Ack. The bus master terminates the transfer by generating a Stop condition, as shown in Figure 7.

**Page Write**

The Page Write mode allows up to 128 bytes to be written in a single Write cycle, provided that they are all located in the same 'row' in the memory: that is, the most significant memory address bits (b15-b7) are the same. If more bytes are sent than will fit up to the end of the row, a condition known as 'roll-over' occurs. This should be avoided, as

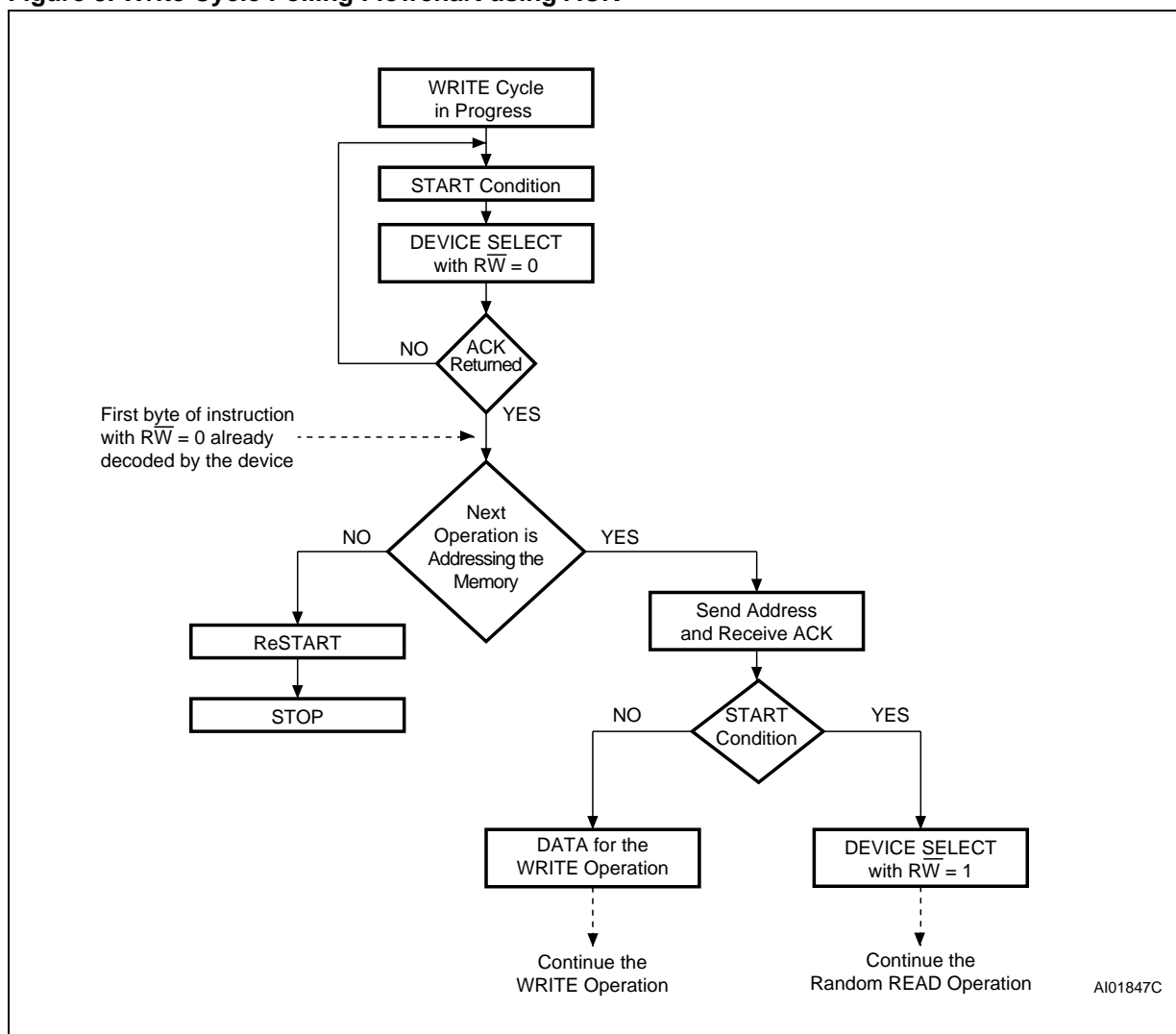
data starts to become overwritten in an implementation dependent way.

The bus master sends from 1 to 128 bytes of data, each of which is acknowledged by the device if Write Control (WC) is Low. If Write Control (WC) is High, the contents of the addressed memory location are not modified, and each data byte is followed by a NoAck. After each byte is transferred, the internal byte address counter (the 7 least significant address bits only) is incremented. The transfer is terminated by the bus master generating a Stop condition.

**Figure 7. Write Mode Sequences with WC=0 (data write enabled)**



Figure 8. Write Cycle Polling Flowchart using ACK



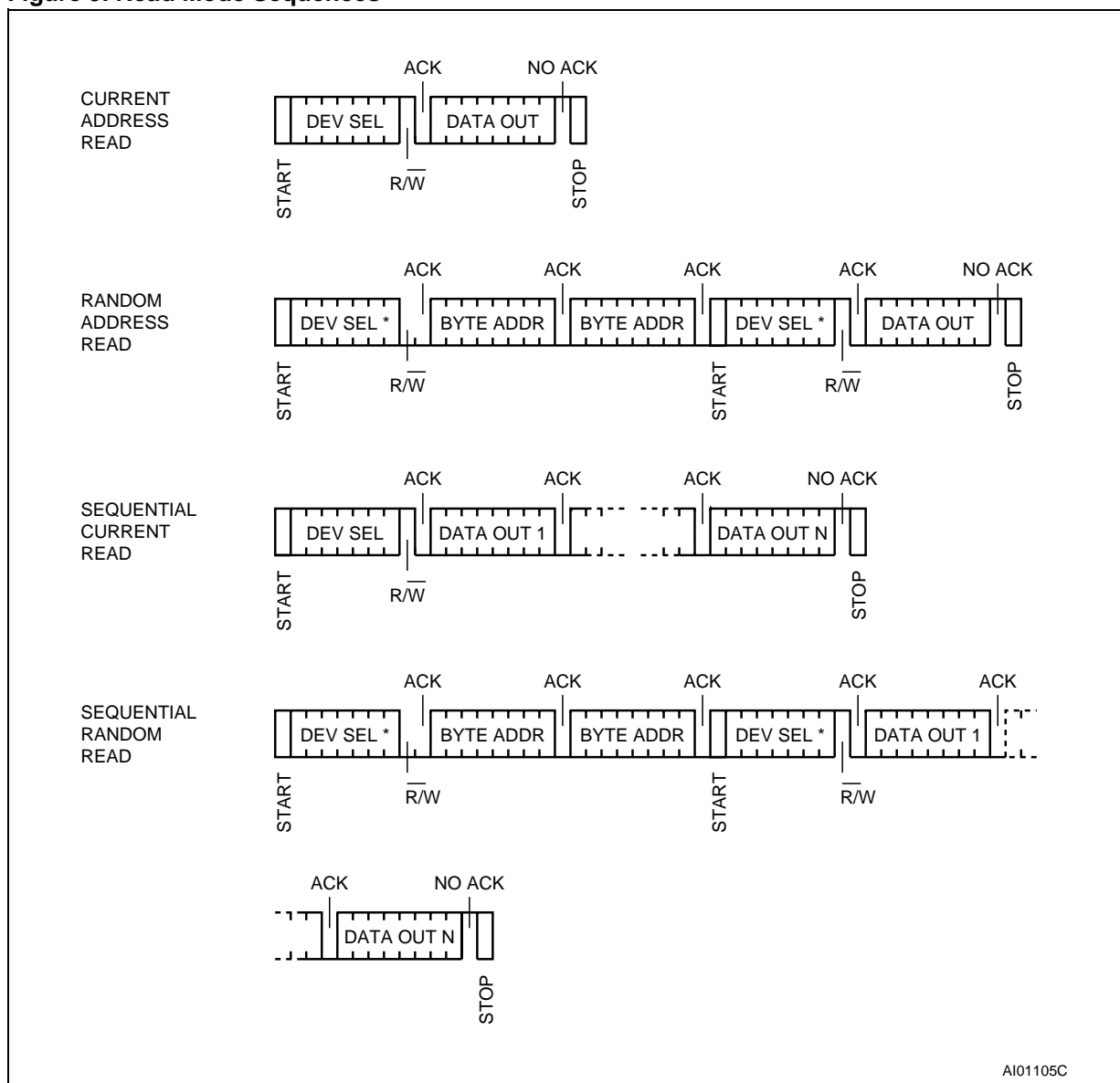
### Minimizing System Delays by Polling On ACK

During the internal Write cycle, the device disconnects itself from the bus, and writes a copy of the data from its internal latches to the memory cells. The maximum Write time ( $t_w$ ) is shown in Table 14., but the typical time is shorter. To make use of this, a polling sequence can be used by the bus master.

The sequence, as shown in Figure 8., is:

- Initial condition: a Write cycle is in progress.
- Step 1: the bus master issues a Start condition followed by a Device Select Code (the first byte of the new instruction).
- Step 2: if the device is busy with the internal Write cycle, no Ack will be returned and the bus master goes back to Step 1. If the device has terminated the internal Write cycle, it responds with an Ack, indicating that the device is ready to receive the second part of the instruction (the first byte of this instruction having been sent during Step 1).

Figure 9. Read Mode Sequences



Note: 1. The seven most significant bits of the Device Select Code of a Random Read (in the 1<sup>st</sup> and 4<sup>th</sup> bytes) must be identical.

### Read Operations

Read operations are performed independently of the state of the Write Control (WC) signal.

After the successful completion of a Read operation, the device's internal address counter is incremented by one, to point to the next byte address.

#### Random Address Read

A dummy Write is first performed to load the address into this address counter (as shown in Figure 9.) but *without* sending a Stop condition. Then, the bus master sends another Start condition, and repeats the Device Select Code, with the Read/Write bit (RW) set to 1. The device acknowledges

this, and outputs the contents of the addressed byte. The bus master must *not* acknowledge the byte, and terminates the transfer with a Stop condition.

#### Current Address Read

For the Current Address Read operation, following a Start condition, the bus master only sends a Device Select Code with the Read/Write bit (RW) set to 1. The device acknowledges this, and outputs the byte addressed by the internal address counter. The counter is then incremented. The bus master terminates the transfer with a Stop condition, as shown in Figure 9., *without* acknowledging the byte.

### Sequential Read

This operation can be used after a Current Address Read or a Random Address Read. The bus master *does* acknowledge the data byte output, and sends additional clock pulses so that the device continues to output the next byte in sequence. To terminate the stream of bytes, the bus master must *not* acknowledge the last byte, and *must* generate a Stop condition, as shown in [Figure 9](#).

The output data comes from consecutive addresses, with the internal address counter automatically incremented after each byte output. After the last memory address, the address counter 'rolls-over', and the device continues to output data from memory address 00h.

### Acknowledge in Read Mode

For all Read commands, the device waits, after each byte read, for an acknowledgment during the 9<sup>th</sup> bit time. If the bus master does not drive Serial Data (SDA) Low during this time, the device terminates the data transfer and switches to its Standby mode.

### INITIAL DELIVERY STATE

The device is delivered with all bits in the memory array set to 1 (each byte contains FFh).

## MAXIMUM RATING

Stressing the device outside the ratings listed in [Table 7](#), may cause permanent damage to the device. These are stress ratings only, and operation of the device at these, or any other conditions outside those indicated in the Operating sections of

this specification, is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Refer also to the STMicroelectronics SURE Program and other relevant quality documents.

**Table 7. Absolute Maximum Ratings**

| Symbol            | Parameter   | Min.                    | Max. | Unit |
|-------------------|---|-------------------------|------|------|
| T <sub>A</sub>    | Ambient Operating Temperature                                   | -40                     | 125  | °C   |
| T <sub>STG</sub>  | Storage Temperature   | -65                     | 150  | °C   |
| T <sub>LEAD</sub> | Lead Temperature during Soldering                               | See note <sup>(1)</sup> |      | °C   |
| V <sub>IO</sub>   | Input or Output range   | -0.50                   | 6.5  | V    |
| V <sub>CC</sub>   | Supply Voltage  | -0.50                   | 6.5  | V    |
| V <sub>ESD</sub>  | Electrostatic Discharge Voltage (Human Body model) <sup>2</sup> | -4000                   | 4000 | V    |

Note: 1. Compliant with JEDEC Std J-STD-020C (for small body, Sn-Pb or Pb assembly), the ST ECOPACK<sup>®</sup> 7191395 specification, and the European directive on Restrictions on Hazardous Substances (RoHS) 2002/95/EU

2. AEC-Q100-002 (compliant with JEDEC Std JESD22-A114A, C1=100pF, R1=1500Ω, R2=500Ω)

### DC AND AC PARAMETERS

This section summarizes the operating and measurement conditions, and the DC and AC characteristics of the device. The parameters in the DC and AC Characteristic tables that follow are derived from tests performed under the Measure-

ment Conditions summarized in the relevant tables. Designers should check that the operating conditions in their circuit match the measurement conditions when relying on the quoted parameters.

**Table 8. Operating Conditions (M24512 – W)**

| Symbol   | Parameter                     | Min. | Max. | Unit |
|----------|-------------------------------|------|------|------|
| $V_{CC}$ | Supply Voltage                | 2.5  | 5.5  | V    |
| $T_A$    | Ambient Operating Temperature | -40  | 85   | °C   |

**Table 9. Operating Conditions (M24512 – R)**

| Symbol   | Parameter                     | Min. | Max. | Unit |
|----------|-------------------------------|------|------|------|
| $V_{CC}$ | Supply Voltage                | 1.8  | 5.5  | V    |
| $T_A$    | Ambient Operating Temperature | -40  | 85   | °C   |

**Table 10. AC Measurement Conditions**

| Symbol | Parameter                                | Min.                                     | Max. | Unit |
|--------|--|--|------|------|
| $C_L$  | Load Capacitance                         | 100                                      |      | pF   |
|        | Input Rise and Fall Times                |  | 50   | ns   |
|        | Input Levels                             | 0.2V <sub>CC</sub> to 0.8V <sub>CC</sub> |      | V    |
|        | Input and Output Timing Reference Levels | 0.3V <sub>CC</sub> to 0.7V <sub>CC</sub> |      | V    |

**Figure 10. AC Measurement I/O Waveform**

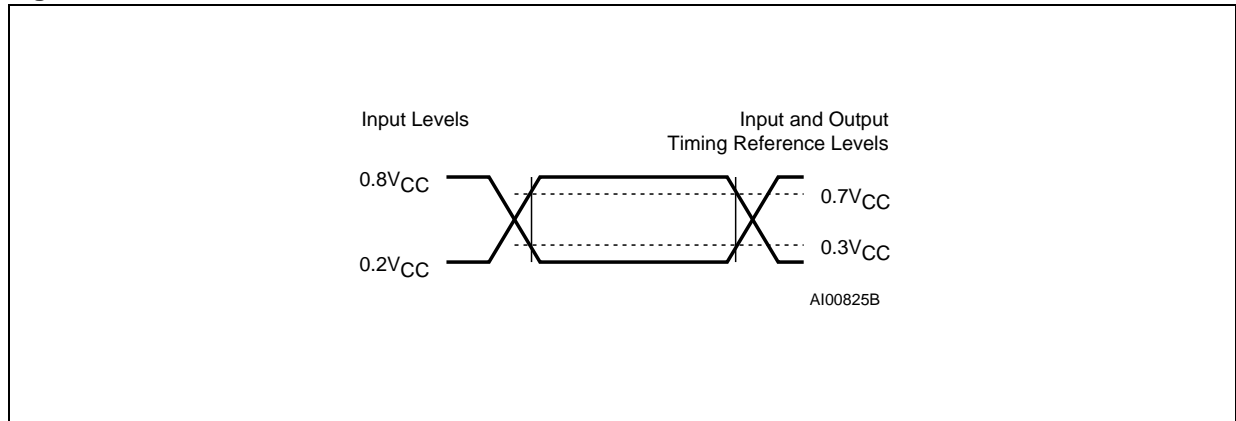


Table 11. Input Parameters

| Symbol                        | Parameter <sup>(1,2)</sup>                        | Test Condition                       | Min. | Max. | Unit |
|-------------------------------|---|--------------------------------------|------|------|------|
| C <sub>IN</sub>               | Input Capacitance (SDA)                           |                                      |      | 8    | pF   |
| C <sub>IN</sub>               | Input Capacitance (other pins)                    |                                      |      | 6    | pF   |
| Z <sub>L</sub> <sup>(3)</sup> | Input Impedance (E2, E1, E0, WC)                  | V <sub>IN</sub> < 0.3V <sub>CC</sub> | 30   |      | kΩ   |
| Z <sub>H</sub> <sup>(3)</sup> | Input Impedance (E2, E1, E0, WC)                  | V <sub>IN</sub> > 0.7V <sub>CC</sub> | 500  |      | kΩ   |
| t <sub>NS</sub>               | Pulse width ignored (Input Filter on SCL and SDA) | Single glitch                        |      | 100  | ns   |

Note: 1. T<sub>A</sub> = 25 °C, f = 400 kHz  
 2. Sampled only, not 100% tested.  
 3. E2,E1,E0: Input impedance when the memory is selected (after a Start condition).

Table 12. DC Characteristics (M24512 – W)

| Symbol           | Parameter                                    | Test Condition  | Min.               | Max.               | Unit |
|------------------|--|---|--------------------|--------------------|------|
| I <sub>LI</sub>  | Input Leakage Current (SCL, SDA, E0, E1, E2) | V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub><br>device in Standby mode <sup>(1)</sup> |                    | ± 2                | μA   |
| I <sub>LO</sub>  | Output Leakage Current                       | V <sub>OUT</sub> = V <sub>SS</sub> or V <sub>CC</sub> , SDA in Hi-Z                           |                    | ± 2                | μA   |
| I <sub>CC</sub>  | Supply Current                               | V <sub>CC</sub> = 2.5V, f <sub>c</sub> =400kHz (rise/fall time < 30ns)                        |                    | 1                  | mA   |
|                  |  | V <sub>CC</sub> = 5.5V, f <sub>c</sub> =400kHz (rise/fall time < 30ns)                        |                    | 2                  | mA   |
| I <sub>CC1</sub> | Stand-by Supply Current                      | V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub> , V <sub>CC</sub> = 2.5 V                |                    | 2                  | μA   |
|                  |  | V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub> , V <sub>CC</sub> = 5.5 V                |                    | 5                  | μA   |
| V <sub>IL</sub>  | Input Low Voltage (SCL, SDA, WC)             |   | -0.45              | 0.3V <sub>CC</sub> | V    |
| V <sub>IH</sub>  | Input High Voltage (SCL, SDA, WC)            |   | 0.7V <sub>CC</sub> | V <sub>CC</sub> +1 | V    |
| V <sub>OL</sub>  | Output Low Voltage                           | I <sub>OL</sub> = 2.1 mA, V <sub>CC</sub> = 2.5 V   |                    | 0.4                | V    |

Note: 1. When the device is selected (after a START condition), the Ei inputs have a different input impedance, as defined in Table 11.

Table 13. DC Characteristics<sup>(1)</sup> (M24512 – R)

| Symbol           | Parameter                                    | Test Condition  | Min.               | Max.                | Unit |
|------------------|--|---|--------------------|---------------------|------|
| I <sub>LI</sub>  | Input Leakage Current (SCL, SDA, E2, E1, E0) | V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub><br>device in Stand-by mode |                    | ± 2                 | μA   |
| I <sub>LO</sub>  | Output Leakage Current                       | V <sub>OUT</sub> = V <sub>SS</sub> or V <sub>CC</sub> , SDA in Hi-Z             |                    | ± 2                 | μA   |
| I <sub>CC</sub>  | Supply Current                               | V <sub>CC</sub> =1.8V, f <sub>c</sub> = 400kHz (rise/fall time < 30ns)          |                    | 1                   | mA   |
| I <sub>CC1</sub> | Standby Supply Current                       | V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub> , V <sub>CC</sub> = 1.8 V  |                    | 2                   | μA   |
| V <sub>IL</sub>  | Input Low Voltage                            |   | -0.45              | 0.3 V <sub>CC</sub> | V    |
| V <sub>IH</sub>  | Input High Voltage                           |   | 0.7V <sub>CC</sub> | V <sub>CC</sub> +1  | V    |
| V <sub>OL</sub>  | Output Low Voltage                           | I <sub>OL</sub> = 0.7 mA, V <sub>CC</sub> = 1.8 V                               |                    | 0.2                 | V    |

Note: 1. The information contained in Table 13. is related to the new M24512 (process letter "A") and is subject to change without previous notice.

Table 14. AC Characteristics (M24512 – W)

| Symbol             | Alt.         | Parameter  | Min. | Max.                   | Unit |
|--------------------|--------------|--|------|------------------------|------|
| $f_c$              | $f_{SCL}$    | Clock Frequency                                      |      | 400                    | kHz  |
| $t_{CHCL}$         | $t_{HIGH}$   | Clock Pulse Width High                               | 600  |                        | ns   |
| $t_{CLCH}$         | $t_{LOW}$    | Clock Pulse Width Low                                | 1300 |                        | ns   |
| $t_{CH1CH2}$       | $t_R$        | Clock Rise Time                                      |      | 300                    | ns   |
| $t_{CL1CL2}$       | $t_F$        | Clock Fall Time                                      |      | 300                    | ns   |
| $t_{DH1DH2}^{(2)}$ | $t_R$        | SDA Rise Time  | 20   | 300                    | ns   |
| $t_{DL1DL2}^{(2)}$ | $t_F$        | SDA Fall Time  | 20   | 300                    | ns   |
| $t_{DXCX}$         | $t_{SU:DAT}$ | Data In Set Up Time                                  | 100  |                        | ns   |
| $t_{CLDX}$         | $t_{HD:DAT}$ | Data In Hold Time                                    | 0    |                        | ns   |
| $t_{CLQX}$         | $t_{DH}$     | Data Out Hold Time                                   | 200  |                        | ns   |
| $t_{CLQV}^{(3)}$   | $t_{AA}$     | Clock Low to Next Data Valid (Access Time)           | 200  | 900                    | ns   |
| $t_{CHDX}^{(1)}$   | $t_{SU:STA}$ | Start Condition Set Up Time                          | 600  |                        | ns   |
| $t_{DLCL}$         | $t_{HD:STA}$ | Start Condition Hold Time                            | 600  |                        | ns   |
| $t_{CHDH}$         | $t_{SU:STO}$ | Stop Condition Set Up Time                           | 600  |                        | ns   |
| $t_{DHDL}$         | $t_{BUF}$    | Time between Stop Condition and Next Start Condition | 1300 |                        | ns   |
| $t_W$              | $t_{WR}$     | Write Time   |      | 5 or 10 <sup>(4)</sup> | ms   |

Note: 1. For a reSTART condition, or following a Write cycle.

2. Sampled only, not 100% tested.

3. To avoid spurious START and STOP conditions, a minimum delay is placed between SCL=1 and the falling or rising edge of SDA.

4. For M24512 devices whose package marking shows the process letter "A"  $t_W(\max) = 5\text{ms}$  whereas for M24512 devices whose package marking shows the process letter "V"  $t_W(\max) = 10\text{ms}$

Table 15. AC Characteristics<sup>(1)</sup> (M24512 – R)

| Symbol             | Alt.         | Parameter  | Min. | Max. | Unit |
|--------------------|--------------|--|------|------|------|
| $f_c$              | $f_{SCL}$    | Clock Frequency                                      |      | 400  | kHz  |
| $t_{CHCL}$         | $t_{HIGH}$   | Clock Pulse Width High                               | 600  |      | ns   |
| $t_{CLCH}$         | $t_{LOW}$    | Clock Pulse Width Low                                | 1300 |      | ns   |
| $t_{DL1DL2}^{(3)}$ | $t_F$        | SDA Fall Time  | 20   | 300  | ns   |
| $t_{DXCX}$         | $t_{SU:DAT}$ | Data In Set Up Time                                  | 100  |      | ns   |
| $t_{CLDX}$         | $t_{HD:DAT}$ | Data In Hold Time                                    | 0    |      | ns   |
| $t_{CLQX}$         | $t_{DH}$     | Data Out Hold Time                                   | 200  |      | ns   |
| $t_{CLQV}^{(4)}$   | $t_{AA}$     | Clock Low to Next Data Valid (Access Time)           | 200  | 900  | ns   |
| $t_{CHDX}^{(2)}$   | $t_{SU:STA}$ | Start Condition Set Up Time                          | 600  |      | ns   |
| $t_{DLCL}$         | $t_{HD:STA}$ | Start Condition Hold Time                            | 600  |      | ns   |
| $t_{CHDH}$         | $t_{SU:STO}$ | Stop Condition Set Up Time                           | 600  |      | ns   |
| $t_{DHDL}$         | $t_{BUF}$    | Time between Stop Condition and Next Start Condition | 1300 |      | ns   |
| $t_W$              | $t_{WR}$     | Write Time   |      | 10   | ms   |

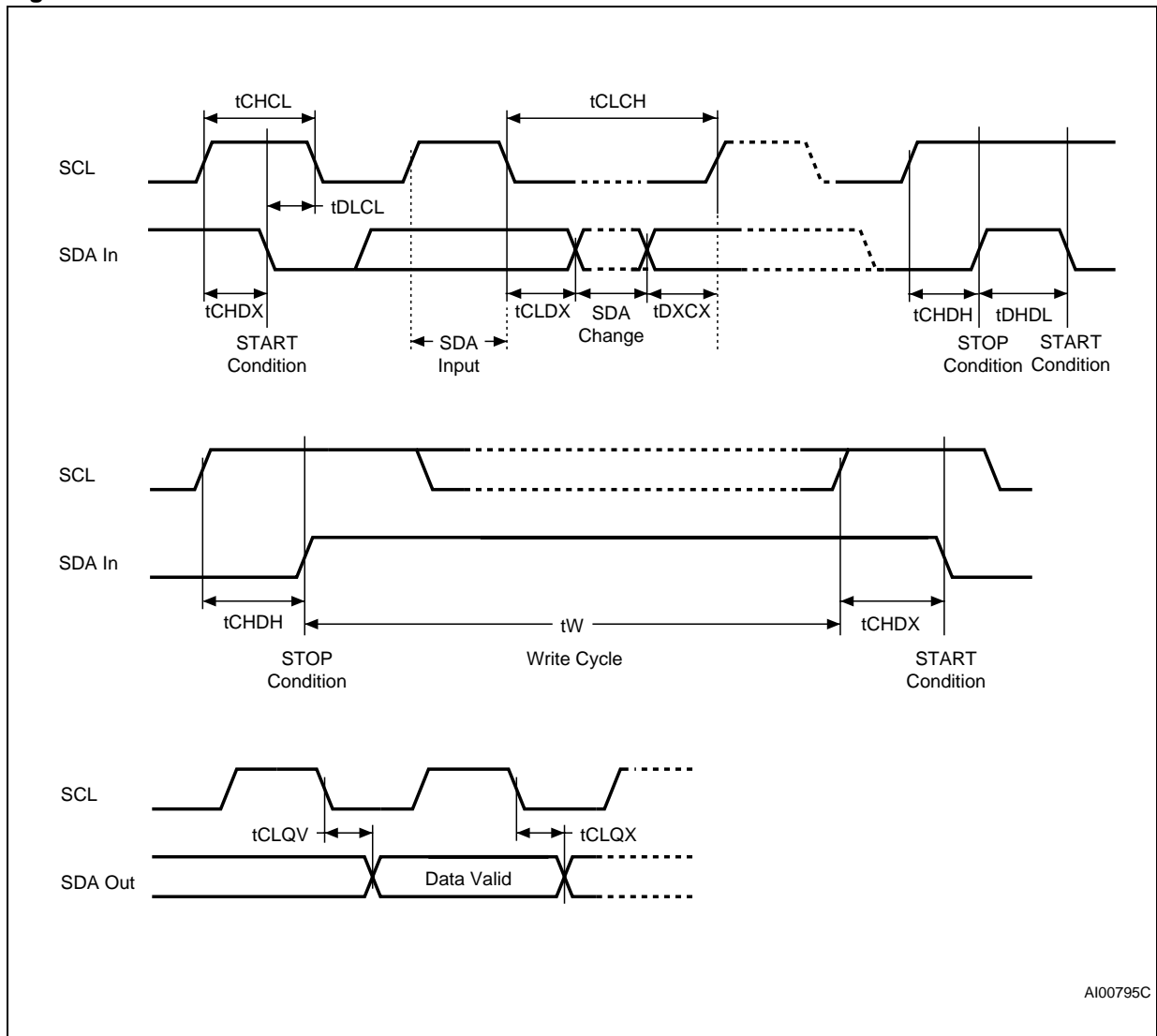
Note: 1. The information contained in Table 15. is related to the new M24512 (process letter "A") and is subject to change without previous notice.

2. For a reSTART condition, or following a Write cycle.

3. Sampled only, not 100% tested.

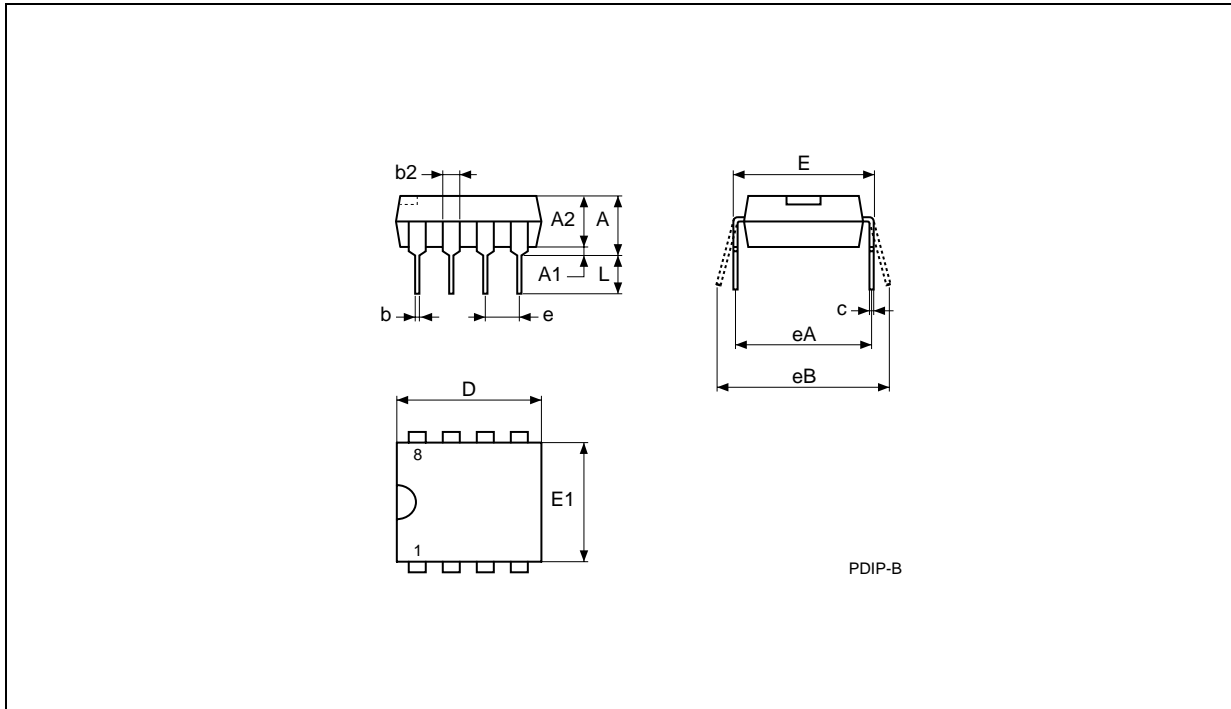
4. To avoid spurious START and STOP conditions, a minimum delay is placed between SCL=1 and the falling or rising edge of SDA.

Figure 11. AC Waveforms



**PACKAGE MECHANICAL**

**Figure 12. PDIP8 – 8 pin Plastic DIP, 0.25mm lead frame, Package Outline**

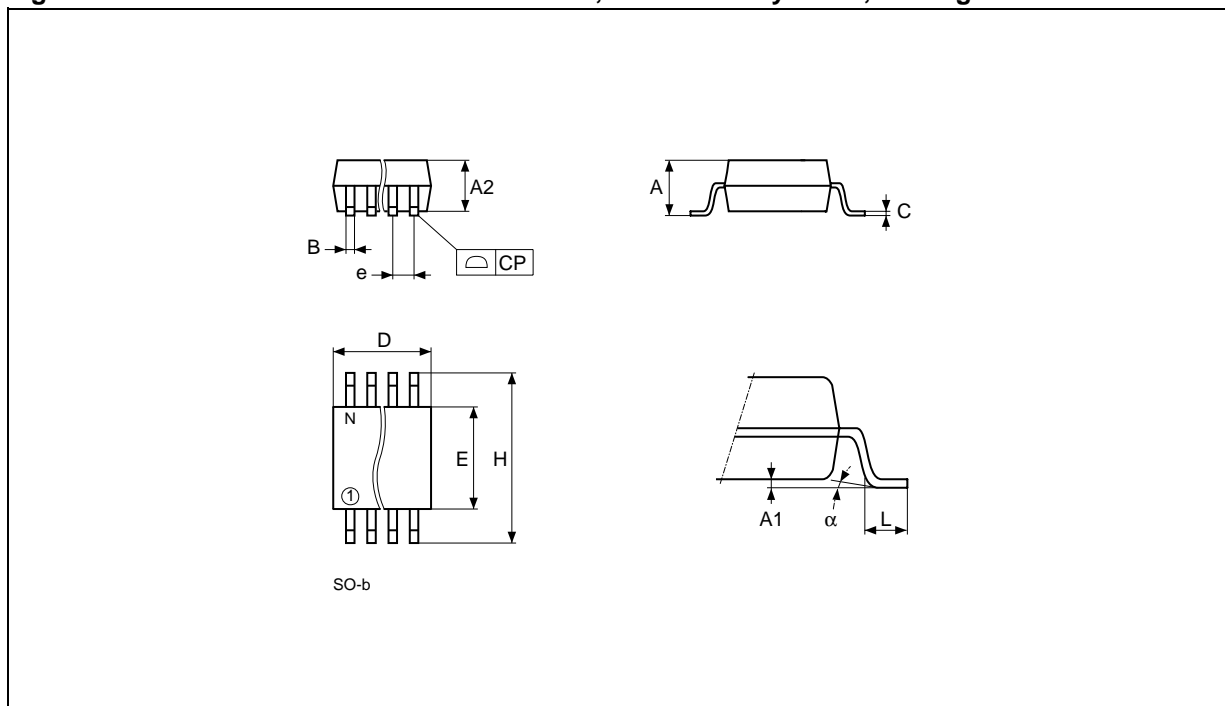


Note: Drawing is not to scale.

**Table 16. PDIP8 – 8 pin Plastic DIP, 0.25mm lead frame, Package Mechanical Data**

| Symbol | millimeters |      |       | inches |       |       |
|--------|-------------|------|-------|--------|-------|-------|
|        | Typ         | Min  | Max   | Typ    | Min   | Max   |
| A      |             |      | 5.33  |        |       | 0.210 |
| A1     |             | 0.38 |       |        | 0.015 |       |
| A2     | 3.30        | 2.92 | 4.95  | 0.130  | 0.115 | 0.195 |
| b      | 0.46        | 0.36 | 0.56  | 0.018  | 0.014 | 0.022 |
| b2     | 1.52        | 1.14 | 1.78  | 0.060  | 0.045 | 0.070 |
| c      | 0.25        | 0.20 | 0.36  | 0.010  | 0.008 | 0.014 |
| D      | 9.27        | 9.02 | 10.16 | 0.365  | 0.355 | 0.400 |
| E      | 7.87        | 7.62 | 8.26  | 0.310  | 0.300 | 0.325 |
| E1     | 6.35        | 6.10 | 7.11  | 0.250  | 0.240 | 0.280 |
| e      | 2.54        | –    | –     | 0.100  | –     | –     |
| eA     | 7.62        | –    | –     | 0.300  | –     | –     |
| eB     |             |      | 10.92 |        |       | 0.430 |
| L      | 3.30        | 2.92 | 3.81  | 0.130  | 0.115 | 0.150 |

Figure 13. SO8W – 8 lead Plastic Small Outline, 208 mils body width, Package Outline

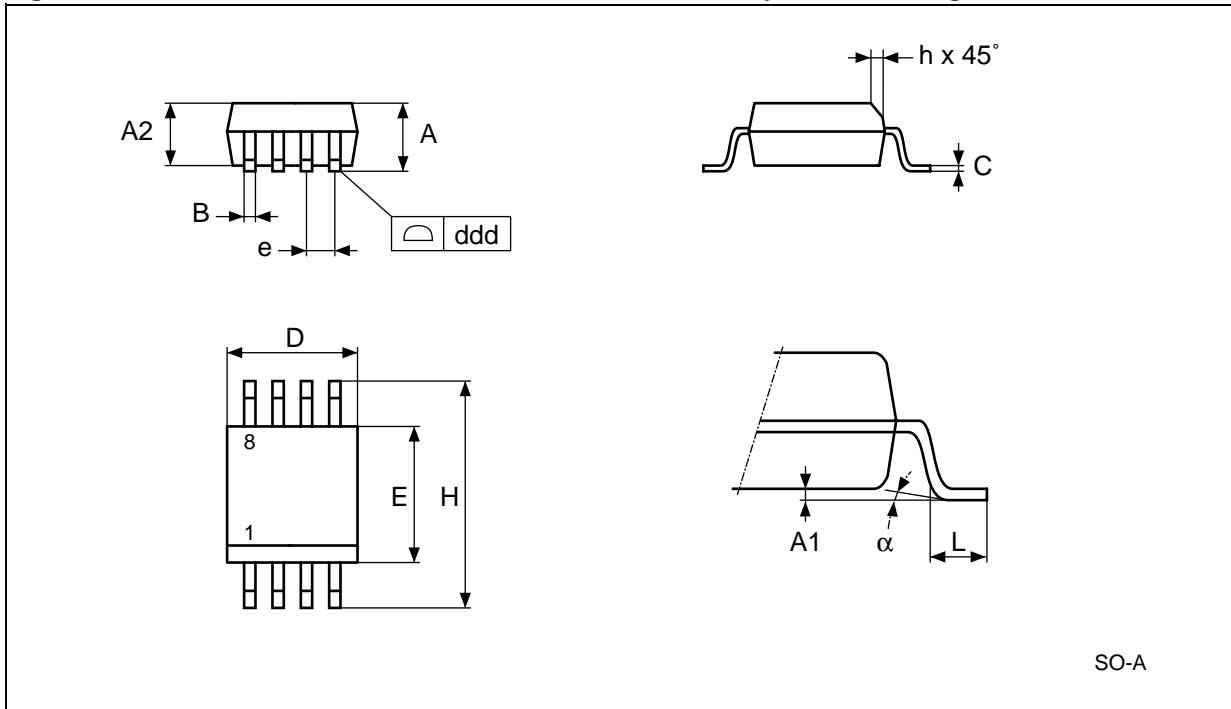


Note: Drawing is not to scale.

Table 17. SO8W – 8 lead Plastic Small Outline, 208 mils body width, Package Mechanical Data

| Symbol   | millimeters |      |      | inches |       |       |
|----------|-------------|------|------|--------|-------|-------|
|          | Typ         | Min  | Max  | Typ    | Min   | Max   |
| A        |             |      | 2.03 |        |       | 0.080 |
| A1       |             | 0.10 | 0.25 |        | 0.004 | 0.010 |
| A2       |             |      | 1.78 |        |       | 0.070 |
| B        |             | 0.35 | 0.45 |        | 0.014 | 0.018 |
| C        | 0.20        | –    | –    | 0.008  | –     | –     |
| D        |             | 5.15 | 5.35 |        | 0.203 | 0.211 |
| E        |             | 5.20 | 5.40 |        | 0.205 | 0.213 |
| e        | 1.27        | –    | –    | 0.050  | –     | –     |
| H        |             | 7.70 | 8.10 |        | 0.303 | 0.319 |
| L        |             | 0.50 | 0.80 |        | 0.020 | 0.031 |
| $\alpha$ |             | 0°   | 10°  |        | 0°    | 10°   |
| N        | 8           |      |      | 8      |       |       |
| CP       |             |      | 0.10 |        |       | 0.004 |

Figure 14. SO8N – 8 lead Plastic Small Outline, 150 mils body width, Package Outline

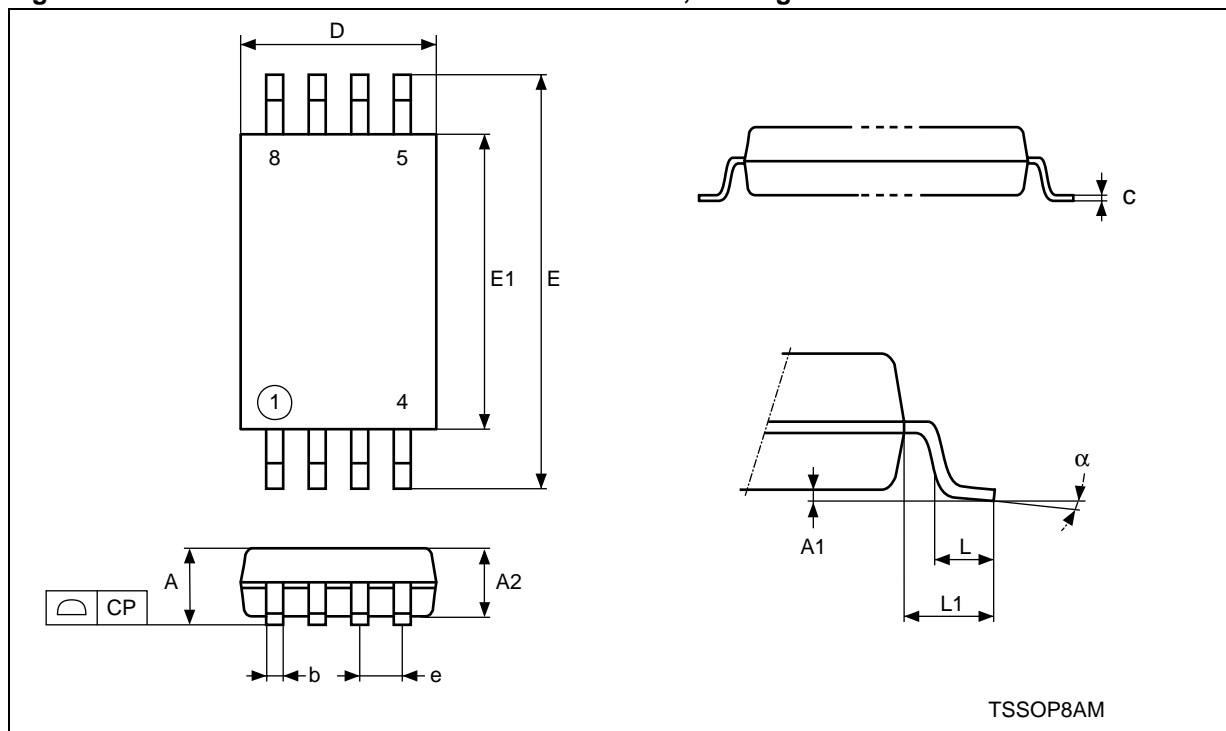


Note: Drawing is not to scale.

Table 18. SO8N – 8 lead Plastic Small Outline, 150 mils body width, Package Mechanical Data

| Symbol | millimeters |      |      | inches |       |       |
|--------|-------------|------|------|--------|-------|-------|
|        | Typ         | Min  | Max  | Typ    | Min   | Max   |
| A      |             | 1.35 | 1.75 |        | 0.053 | 0.069 |
| A1     |             | 0.10 | 0.25 |        | 0.004 | 0.010 |
| A2     |             | 1.10 | 1.65 |        | 0.043 | 0.065 |
| B      |             | 0.33 | 0.51 |        | 0.013 | 0.020 |
| C      |             | 0.19 | 0.25 |        | 0.007 | 0.010 |
| D      |             | 4.80 | 5.00 |        | 0.189 | 0.197 |
| ddd    |             |      | 0.10 |        |       | 0.004 |
| E      |             | 3.80 | 4.00 |        | 0.150 | 0.157 |
| e      | 1.27        | –    | –    | 0.050  | –     | –     |
| H      |             | 5.80 | 6.20 |        | 0.228 | 0.244 |
| h      |             | 0.25 | 0.50 |        | 0.010 | 0.020 |
| L      |             | 0.40 | 0.90 |        | 0.016 | 0.035 |
| α      |             | 0°   | 8°   |        | 0°    | 8°    |
| N      |             | 8    |      |        | 8     |       |

Figure 15. TSSOP8 – 8 lead Thin Shrink Small Outline, Package Outline



Note: Drawing is not to scale.

Table 19. TSSOP8 – 8 lead Thin Shrink Small Outline, Package Mechanical Data

| Symbol   | millimeters |       |       | inches |        |        |
|----------|-------------|-------|-------|--------|--------|--------|
|          | Typ         | Min   | Max   | Typ    | Min    | Max    |
| A        |             |       | 1.200 |        |        | 0.0472 |
| A1       |             | 0.050 | 0.150 |        | 0.0020 | 0.0059 |
| A2       | 1.000       | 0.800 | 1.050 | 0.0394 | 0.0315 | 0.0413 |
| b        |             | 0.190 | 0.300 |        | 0.0075 | 0.0118 |
| c        |             | 0.090 | 0.200 |        | 0.0035 | 0.0079 |
| CP       |             |       | 0.100 |        |        | 0.0039 |
| D        | 3.000       | 2.900 | 3.100 | 0.1181 | 0.1142 | 0.1220 |
| e        | 0.650       | –     | –     | 0.0256 | –      | –      |
| E        | 6.400       | 6.200 | 6.600 | 0.2520 | 0.2441 | 0.2598 |
| E1       | 4.400       | 4.300 | 4.500 | 0.1732 | 0.1693 | 0.1772 |
| L        | 0.600       | 0.450 | 0.750 | 0.0236 | 0.0177 | 0.0295 |
| L1       | 1.000       |       |       | 0.0394 |        |        |
| $\alpha$ |             | 0°    | 8°    |        | 0°     | 8°     |
| N        |             | 8     |       |        | 8      |        |

## PART NUMBERING

**Table 20. Ordering Information Scheme**

|   |        |   |   |    |   |   |   |
|---|--------|---|---|----|---|---|---|
| Example:  | M24512 | - | W | MW | 6 | T | P |
| <b>Device Type</b><br>M24 = I <sup>2</sup> C serial access EEPROM   |        |   |   |    |   |   |   |
| <b>Device Function</b><br>512 = 512 Kbit (64K x 8)  |        |   |   |    |   |   |   |
| <b>Operating Voltage</b><br>W = V <sub>CC</sub> = 2.5 to 5.5V<br>R = V <sub>CC</sub> = 1.8 to 5.5V              |        |   |   |    |   |   |   |
| <b>Package</b><br>BN = PDIP8<br>MW = SO8 (208 mil width)<br>MN = SO8 (150 mil body width)<br>DW = TSSOP8        |        |   |   |    |   |   |   |
| <b>Device Grade</b><br>6 = Industrial temperature range, -40 to 85 °C.<br>Device tested with standard test flow |        |   |   |    |   |   |   |
| <b>Option</b><br>blank = Standard Packing<br>T = Tape and Reel Packing  |        |   |   |    |   |   |   |
| <b>Plating Technology</b><br>blank = Standard SnPb plating<br>P or G = Lead-Free and RoHS compliant             |        |   |   |    |   |   |   |

For a list of available options (speed, package, etc.) or for further information on any aspect of this

device, please contact your nearest ST Sales Office.

## REVISION HISTORY

**Table 21. Document Revision History**

| Date        | Revision | Description of Revision  |
|-------------|----------|--|
| 29-Jan-2001 | 1.1      | Lead Soldering Temperature in the Absolute Maximum Ratings table amended<br>Write Cycle Polling Flow Chart using ACK illustration updated<br>LGA8 and SO8(wide) packages added<br>References to PSDIP8 changed to PDIP8, and Package Mechanical data updated   |
| 10-Apr-2001 | 1.2      | LGA8 Package Mechanical data and illustration updated<br>SO16 package removed  |
| 16-Jul-2001 | 1.3      | LGA8 Package given the designator "LA"   |
| 02-Oct-2001 | 1.4      | LGA8 Package mechanical data updated   |
| 13-Dec-2001 | 1.5      | Document becomes Preliminary Data<br>Test conditions for ILI, ILO, ZL and ZH made more precise<br>VIL and VIH values unified. tNS value changed  |
| 12-Jun-2001 | 1.6      | Document promoted to Full Datasheet  |
| 22-Oct-2003 | 2.0      | Table of contents, and Pb-free options added. Minor wording changes in Summary Description, Power-On Reset, Memory Addressing, Write Operations, Read Operations. V <sub>IL</sub> (min) improved to -0.45V.  |
| 02-Sep-2004 | 3.0      | LGA8 package is Not for New Design. 5V and -S supply ranges, and Device Grade 5 removed. Absolute Maximum Ratings for V <sub>IO</sub> (min) and V <sub>CC</sub> (min) changed. Soldering temperature information clarified for RoHS compliant devices. Device grade information clarified. AEC-Q100-002 compliance. V <sub>IL</sub> specification unified for SDA, SCL and WC  |
| 22-Feb-2005 | 4.0      | <b>INITIAL DELIVERY STATE</b> is FFh (not necessarily the same as Erased).<br>LGA package removed, TSSOP8 and SO8N packages added (see <b>PACKAGE MECHANICAL</b> section and <a href="#">Table 20., Ordering Information Scheme</a> ).<br>Voltage range R (1.8V to 5.5V) also offered. Minor wording changes.<br>Z <sub>L</sub> Test Conditions modified in <a href="#">Table 11., Input Parameters</a> and Note 3. added.<br>I <sub>CC</sub> and I <sub>CC1</sub> values for V <sub>CC</sub> = 5.5V added to <a href="#">Table 12., DC Characteristics (M24512 – W)</a> .<br><b>Power On Reset</b> paragraph specified.<br>t <sub>W</sub> max value modified in <a href="#">Table 14., AC Characteristics (M24512 – W)</a> and note 4 added.<br>Plating technology changed in <a href="#">Table 20., Ordering Information Scheme</a> .<br>Resistance and capacitance renamed in <a href="#">Figure 4., Maximum R<sub>p</sub> Value versus Bus Parasitic Capacitance (C) for an I<sup>2</sup>C Bus</a> . |

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