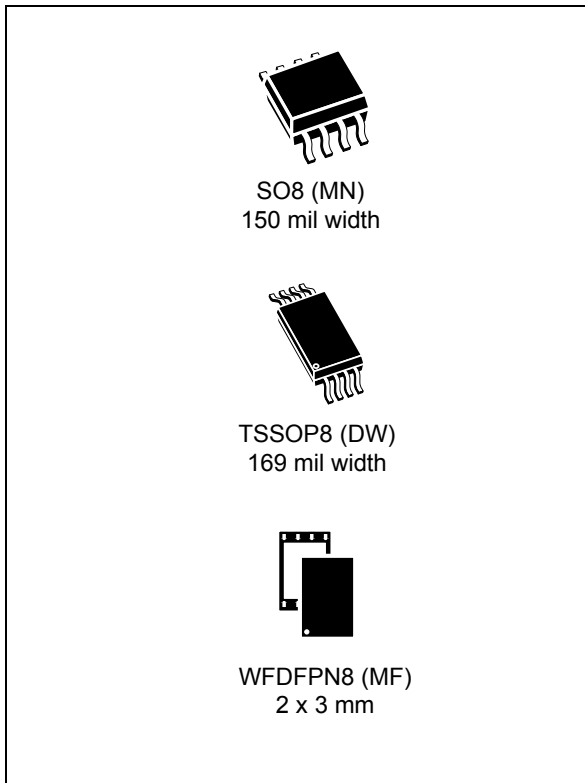


## Automotive 16-Kbit, 8-Kbit, 4-Kbit, 2-Kbit and 1-Kbit (8-bit or 16-bit wide) MICROWIRE serial EEPROM

Datasheet - production data



### Features

- Industry standard MICROWIRE™ bus
- Memory array: 1 Kb, 2 Kb, 4 Kb, 8 Kb or 16 Kb
- Dual organization: by word (x16) or by byte (x8)
- Write
  - Byte within 4 ms
  - Word within 4 ms
- READY/BUSY signal during programming
- 2 MHz clock rate
- Sequential read operation
- Single supply voltage: 1.8 V to 5.5 V
- Operating temperature range: -40 °C up to 125 °C
- Enhanced ESD protection
- Write cycle endurance
  - 4 million Write cycles at 25 °C
  - 1.2 million Write cycles at 85 °C
  - 600 k Write cycles at 125 °C
- Data retention
  - 50 years at 125 °C
  - more than 100 years at 25 °C
- Packages
  - RoHS-compliant and Halogen-free (ECOPACK®)

**Table 1. Device summary**

| Reference   | Part number |
|-------------|-------------|
| M93Cx6-A125 | M93C46-A125 |
|             | M93C56-A125 |
|             | M93C66-A125 |
|             | M93C76-A125 |
|             | M93C86-A125 |

# Contents

- 1 Description ..... 6**
- 2 Connecting to the serial bus ..... 8**
- 3 Operating features ..... 9**
  - 3.1 Supply voltage ( $V_{CC}$ ) ..... 9
    - 3.1.1 Operating supply voltage ( $V_{CC}$ ) ..... 9
    - 3.1.2 Power-up conditions ..... 9
    - 3.1.3 Power-up and device reset ..... 9
    - 3.1.4 Power-down ..... 9
- 4 Memory organization ..... 10**
- 5 Instructions ..... 11**
  - 5.1 Read Data from Memory ..... 13
  - 5.2 Erase and Write data ..... 13
    - 5.2.1 Write Enable and Write Disable ..... 13
    - 5.2.2 Write ..... 13
    - 5.2.3 Write All ..... 15
    - 5.2.4 ECC (Error Correction Code) and Write cycling ..... 15
    - 5.2.5 Erase Byte or Word ..... 16
    - 5.2.6 Erase All ..... 16
- 6  $\overline{\text{READY}}/\overline{\text{BUSY}}$  status ..... 17**
- 7 Initial delivery state ..... 17**
- 8 Common I/O operation ..... 17**
- 9 Clock pulse counter ..... 18**
- 10 Maximum ratings ..... 19**
- 11 DC and AC parameters ..... 20**



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|    |                               |    |
|----|-------------------------------|----|
| 12 | Package mechanical data ..... | 24 |
| 13 | Part numbering .....          | 29 |
| 14 | Revision history .....        | 30 |

## List of tables

|           |  |    |
|-----------|--|----|
| Table 1.  | Device summary . . . . .   | 1  |
| Table 2.  | Memory size versus organization . . . . .  | 6  |
| Table 3.  | Signal names . . . . .   | 6  |
| Table 4.  | Instruction set for the M93Cx6-A125 . . . . .  | 7  |
| Table 5.  | Instruction set for the M93C46 . . . . .   | 11 |
| Table 6.  | Instruction set for the M93C56 and M93C66 . . . . .  | 12 |
| Table 7.  | Instruction set for the M93C76 and M93C86 . . . . .  | 12 |
| Table 8.  | Absolute maximum ratings . . . . .   | 19 |
| Table 9.  | Operating conditions (M93Cx6-A125) . . . . .   | 20 |
| Table 10. | AC measurement conditions. . . . .   | 20 |
| Table 11. | Input and output capacitance . . . . .   | 20 |
| Table 12. | Cycling performance by byte . . . . .  | 20 |
| Table 13. | DC characteristics. . . . .  | 21 |
| Table 14. | AC characteristics . . . . .   | 22 |
| Table 15. | SO8 narrow – 8 lead plastic small outline, 150 mils body width, package data . . . . .                   | 25 |
| Table 16. | TSSOP8 – 8-lead thin shrink small outline, package mechanical data. . . . .                              | 26 |
| Table 17. | WFDFPN8 (MLP8) – 8-lead thin fine pitch dual flat package no lead 2 x 3 mm,<br>mechanical data . . . . . | 28 |
| Table 18. | Ordering information scheme . . . . .  | 29 |
| Table 19. | Document revision history . . . . .  | 30 |

## List of figures

|            |  |    |
|------------|--|----|
| Figure 1.  | Logic diagram . . . . .  | 6  |
| Figure 2.  | 8-pin package connections (top view) . . . . .   | 7  |
| Figure 3.  | Bus master and memory devices on the serial bus . . . . .  | 8  |
| Figure 4.  | M93Cx6-A125 ORG input connection . . . . .   | 10 |
| Figure 5.  | READ, WRITE, WEN, WDS sequences . . . . .  | 14 |
| Figure 6.  | WRAL sequence . . . . .  | 15 |
| Figure 7.  | ERASE, ERAL sequences . . . . .  | 16 |
| Figure 8.  | Write sequence with one clock glitch . . . . .   | 18 |
| Figure 9.  | AC testing input output waveforms . . . . .  | 20 |
| Figure 10. | Synchronous timing (Start and op-code input) . . . . .   | 23 |
| Figure 11. | Synchronous timing (Read) . . . . .  | 23 |
| Figure 12. | Synchronous timing (Write) . . . . .   | 23 |
| Figure 13. | SO8 narrow – 8 lead plastic small outline, 150 mils body width, package outline . . . . .                | 25 |
| Figure 14. | TSSOP8 – 8 lead thin shrink small outline, package outline . . . . .                                     | 26 |
| Figure 15. | WFDFPN8 (MLP8) – 8-lead thin fine pitch dual flat package no lead<br>2 x 3 mm, package outline . . . . . | 27 |

# 1 Description

The M93C46 (1 Kbit), M93C56 (2 Kbit), M93C66 (4 Kbit), M93C76 (8 Kbit) and M93C86 (16 Kbit) are Electrically Erasable PROgrammable Memory (EEPROM) devices accessed through the MICROWIRE bus protocol. The memory array can be configured either in bytes (x8b) or in words (x16b).

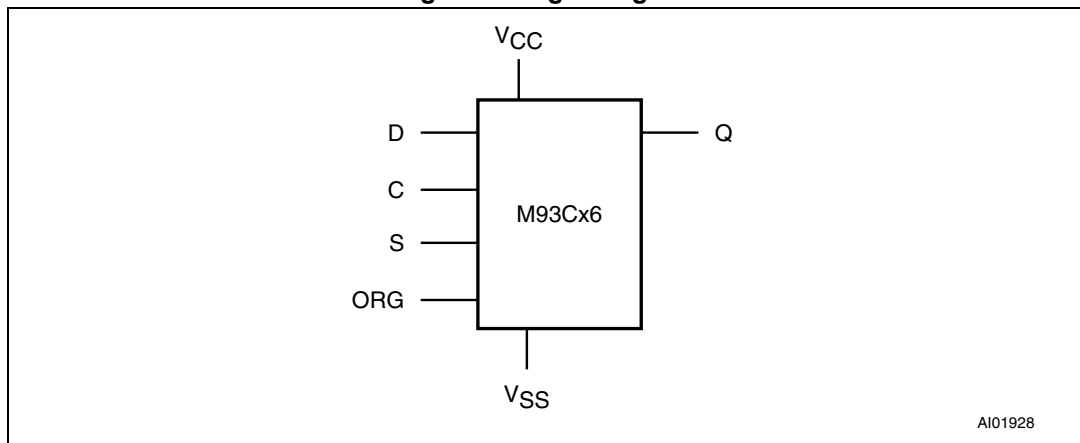
The M93Cx6-A125 devices operate within a voltage supply range from 1.8 V to 5.5 V

The M93Cx6-A125 devices are guaranteed over the -40 °C/+125 °C temperature range and are compliant with the Automotive standard AEC-Q100 Grade 1.

**Table 2. Memory size versus organization**

| Device | Number of bits | Number of 8-bit bytes | Number of 16-bit words |
|--------|----------------|-----------------------|------------------------|
| M93C86 | 16384          | 2048                  | 1024                   |
| M93C76 | 8192           | 1024                  | 512                    |
| M93C66 | 4096           | 512                   | 256                    |
| M93C56 | 2048           | 256                   | 128                    |
| M93C46 | 1024           | 128                   | 64                     |

**Figure 1. Logic diagram**



**Table 3. Signal names**

| Signal name     | Function            | Direction |
|-----------------|---------------------|-----------|
| S               | Chip Select         | Input     |
| D               | Serial Data input   | Input     |
| Q               | Serial Data output  | Output    |
| C               | Serial Clock        | Input     |
| ORG             | Organization Select | Input     |
| V <sub>CC</sub> | Supply voltage      |           |
| V <sub>SS</sub> | Ground              |           |

The M93Cx6-A125 is accessed by a set of instructions, as summarized in [Table 4](#), and in more detail in [Table 5: Instruction set for the M93C46](#) to [Table 7: Instruction set for the M93C76 and M93C86](#)).

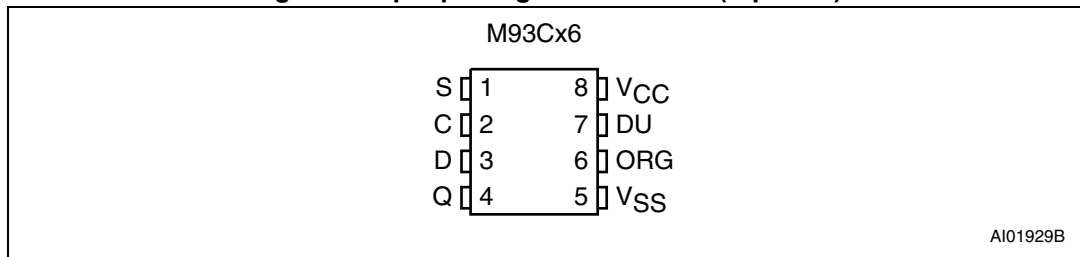
**Table 4. Instruction set for the M93Cx6-A125**

| Instruction | Description                     | Data         |
|-------------|---------------------------------|--------------|
| READ        | Read Data from Memory           | Byte or Word |
| WRITE       | Write Data to Memory            | Byte or Word |
| WEN         | Write Enable                    | -            |
| WDS         | Write Disable                   | -            |
| ERASE       | Erase Byte or Word              | Byte or Word |
| ERAL        | Erase All Memory                | -            |
| WRAL        | Write All Memory with same Data | -            |

A Read Data from Memory (READ) instruction loads the address of the first byte or word to be read in an internal address register. The data at this address is then clocked out serially. The address register is automatically incremented after the data is output and, if Chip Select Input (S) is held High, the M93Cx6-A125 can output a sequential stream of data bytes or words. In this way, the memory can be read as a data stream from eight to 16384 bits long (in the case of the M93C86), or continuously (the address counter automatically rolls over to 00h when the highest address is reached).

Programming is internally self-timed (the external clock signal on Serial Clock (C) may be stopped or left running after the start of a Write cycle) and does not require an Erase cycle prior to the Write instruction. The Write instruction writes 8 or 16 bits at a time into one of the byte or word locations of the M93Cx6-A125. After the start of the programming cycle, a Busy/Ready signal is available on Serial Data Output (Q) when Chip Select Input (S) is driven High. An internal Power-on Data Protection mechanism in the M93Cx6-A125 inhibits the device when the supply is too low.

**Figure 2. 8-pin package connections (top view)**



1. See [Section 12: Package mechanical data](#) for package dimensions, and how to identify pin-1.
2. DU = Don't Use. The DU (do not use) pin does not contribute to the normal operation of the device. It is reserved for use by STMicroelectronics during test sequences. The pin may be left unconnected or may be connected to V<sub>CC</sub> or V<sub>SS</sub>.

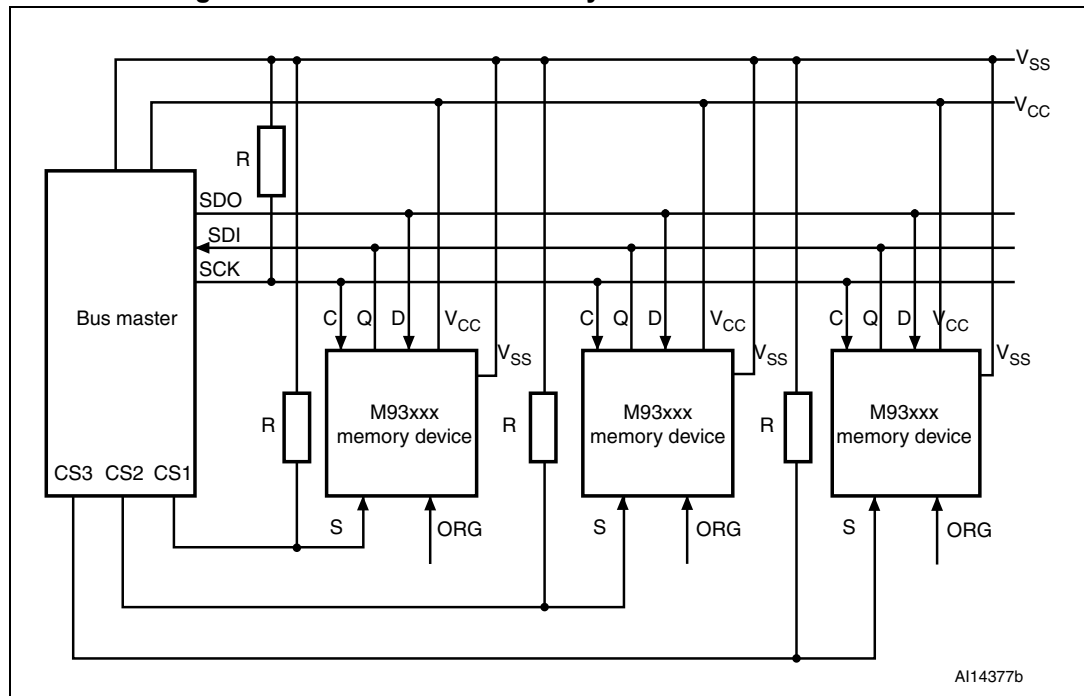
## 2 Connecting to the serial bus

Figure 3 shows an example of three memory devices connected to an MCU, on a serial bus. Only one device is selected at a time, so only one device drives the Serial Data output (Q) line at a time, the other devices are high impedance.

The pull-down resistor R (represented in Figure 3) ensures that no device is selected if the bus master leaves the S line in the high impedance state.

In applications where the bus master may be in a state where all inputs/outputs are high impedance at the same time (for example, if the bus master is reset during the transmission of an instruction), the clock line (C) must be connected to an external pull-down resistor so that, if all inputs/outputs become high impedance, the C line is pulled low (while the S line is pulled low): this ensures that C does not become high at the same time as S goes low, and so, that the  $t_{SLCH}$  requirement is met. The typical value of R is 100 kΩ

Figure 3. Bus master and memory devices on the serial bus





## 3 Operating features

### 3.1 Supply voltage ( $V_{CC}$ )

#### 3.1.1 Operating supply voltage ( $V_{CC}$ )

Prior to selecting the memory and issuing instructions to it, a valid and stable  $V_{CC}$  voltage within the specified [ $V_{CC}(\text{min})$ ,  $V_{CC}(\text{max})$ ] range must be applied. In order to secure a stable DC supply voltage, it is recommended to decouple the  $V_{CC}$  line with a suitable capacitor (usually of the order of 10 nF to 100 nF) close to the  $V_{CC}/V_{SS}$  package pins.

This voltage must remain stable and valid until the end of the transmission of the instruction and, for a Write instruction, until the completion of the internal write cycle ( $t_W$ ).

#### 3.1.2 Power-up conditions

When the power supply is turned on,  $V_{CC}$  rises from  $V_{SS}$  to  $V_{CC}$ . During this time, the Chip Select (S) line is not allowed to float and should be driven to  $V_{SS}$ , it is therefore recommended to connect the S line to  $V_{SS}$  via a suitable pull-down resistor.

The  $V_{CC}$  rise time must not vary faster than 1 V/ $\mu\text{s}$ .

#### 3.1.3 Power-up and device reset

In order to prevent inadvertent Write operations during power-up, a power on reset (POR) circuit is included. At power-up (continuous rise of  $V_{CC}$ ), the device does not respond to any instruction until  $V_{CC}$  has reached the power on reset threshold voltage (this threshold is lower than the minimum  $V_{CC}$  operating voltage defined in Operating conditions, in [Section 11: DC and AC parameters](#)).

When  $V_{CC}$  passes the POR threshold, the device is reset and is in the following state:

- Standby Power mode
- deselected (assuming that there is a pull-down resistor on the S line)

#### 3.1.4 Power-down

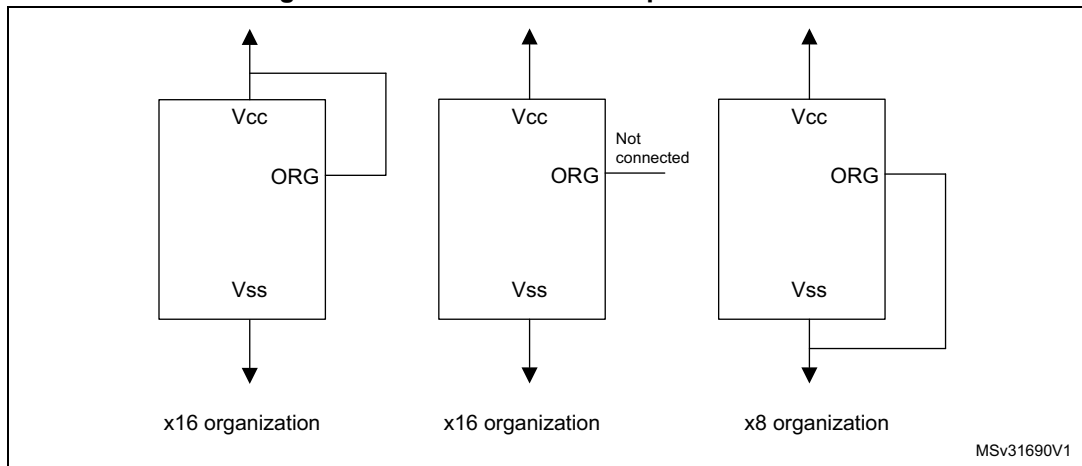
At power-down (continuous decrease in  $V_{CC}$ ), as soon as  $V_{CC}$  drops from the normal operating voltage to below the power on reset threshold voltage, the device stops responding to any instruction sent to it.

During power-down, the device must be deselected and in the Standby Power mode (that is, there should be no internal Write cycle in progress).

## 4 Memory organization

The M93Cx6-A125 memory is organized either as bytes (x8) or as words (x16). If Organization Select (ORG) is left unconnected (or connected to  $V_{CC}$ ) the x16 organization is selected; when Organization Select (ORG) is connected to Ground ( $V_{SS}$ ) the x8 organization is selected. When the M93Cx6-A125 is in Standby mode, Organization Select (ORG) should be set either to  $V_{SS}$  or  $V_{CC}$  to reach the device minimum power consumption (as any voltage between  $V_{SS}$  and  $V_{CC}$  applied to ORG input may increase the device Standby current).

Figure 4. M93Cx6-A125 ORG input connection



## 5 Instructions

The instruction set of the M93Cx6-A125 devices contains seven instructions, as summarized in [Table 5](#) to [Table 7](#). Each instruction consists of the following parts, as shown in [Figure 5: READ, WRITE, WEN, WDS sequences](#):

- Each instruction is preceded by a rising edge on Chip Select Input (S) with Serial Clock (C) being held low.
- A start bit, which is the first '1' read on Serial Data Input (D) during the rising edge of Serial Clock (C).
- Two op-code bits, read on Serial Data Input (D) during the rising edge of Serial Clock (C). (Some instructions also use the first two bits of the address to define the op-code).
- The address bits of the byte or word that is to be accessed. For the M93C46, the address is made up of 6 bits for the x16 organization or 7 bits for the x8 organization (see [Table 5](#)). For the M93C56 and M93C66, the address is made up of 8 bits for the x16 organization or 9 bits for the x8 organization (see [Table 6](#)). For the M93C76 and M93C86, the address is made up of 10 bits for the x16 organization or 11 bits for the x8 organization (see [Table 7](#)).

The M93Cx6-A125 devices are fabricated in CMOS technology and are therefore able to run as slow as 0 Hz (static input signals) or as fast as the maximum ratings specified in "AC characteristics" tables, in [Section 11: DC and AC parameters](#).

**Table 5. Instruction set for the M93C46**

| Instruction | Description                     | Start bit | Op-code | x8 origination (ORG = 0) |       |                       | x16 origination (ORG = 1) |        |                       |
|-------------|---------------------------------|-----------|---------|--------------------------|-------|-----------------------|---------------------------|--------|-----------------------|
|             |                                 |           |         | Address (1)              | Data  | Required clock cycles | Address (1)               | Data   | Required clock cycles |
| READ        | Read Data from Memory           | 1         | 10      | A6-A0                    | Q7-Q0 | -                     | A5-A0                     | Q15-Q0 | -                     |
| WRITE       | Write Data to Memory            | 1         | 01      | A6-A0                    | D7-D0 | 18                    | A5-A0                     | D15-D0 | 25                    |
| WEN         | Write Enable                    | 1         | 00      | 11X XXXX                 | -     | 10                    | 11 XXXX                   | -      | 9                     |
| WDS         | Write Disable                   | 1         | 00      | 00X XXXX                 | -     | 10                    | 00 XXXX                   | -      | 9                     |
| ERASE       | Erase Byte or Word              | 1         | 11      | A6-A0                    | -     | 10                    | A5-A0                     | -      | 9                     |
| ERAL        | Erase All Memory                | 1         | 00      | 10X XXXX                 | -     | 10                    | 10 XXXX                   | -      | 9                     |
| WRAL        | Write All Memory with same Data | 1         | 00      | 01X XXXX                 | D7-D0 | 18                    | 01 XXXX                   | D15-D0 | 25                    |

1. X = Don't Care bit.

**Table 6. Instruction set for the M93C56 and M93C66**

| Instruction | Description                     | Start bit | Op-code | x8 origination (ORG = 0) |       |                       | x16 origination (ORG = 1) |        |                       |
|-------------|---------------------------------|-----------|---------|--------------------------|-------|-----------------------|---------------------------|--------|-----------------------|
|             |                                 |           |         | Address (1) (2)          | Data  | Required clock cycles | Address (1) (3)           | Data   | Required clock cycles |
| READ        | Read Data from Memory           | 1         | 10      | A8-A0                    | Q7-Q0 | -                     | A7-A0                     | Q15-Q0 | -                     |
| WRITE       | Write Data to Memory            | 1         | 01      | A8-A0                    | D7-D0 | 20                    | A7-A0                     | D15-D0 | 27                    |
| WEN         | Write Enable                    | 1         | 00      | 1 1XXX<br>XXXX           | -     | 12                    | 11XX<br>XXXX              | -      | 11                    |
| WDS         | Write Disable                   | 1         | 00      | 0 0XXX<br>XXXX           | -     | 12                    | 00XX<br>XXXX              | -      | 11                    |
| ERASE       | Erase Byte or Word              | 1         | 11      | A8-A0                    | -     | 12                    | A7-A0                     | -      | 11                    |
| ERAL        | Erase All Memory                | 1         | 00      | 1 0XXX<br>XXXX           | -     | 12                    | 10XX<br>XXXX              | -      | 11                    |
| WRAL        | Write All Memory with same Data | 1         | 00      | 0 1XXX<br>XXXX           | D7-D0 | 20                    | 01XX<br>XXXX              | D15-D0 | 27                    |

1. X = Don't Care bit.
2. Address bit A8 is not decoded by the M93C56.
3. Address bit A7 is not decoded by the M93C56.

**Table 7. Instruction set for the M93C76 and M93C86**

| Instruction | Description                     | Start bit | Op-code | x8 Origination (ORG = 0) |       |                       | x16 Origination (ORG = 1) |        |                       |
|-------------|---------------------------------|-----------|---------|--------------------------|-------|-----------------------|---------------------------|--------|-----------------------|
|             |                                 |           |         | Address (1)(2)           | Data  | Required clock cycles | Address (1) (3)           | Data   | Required clock cycles |
| READ        | Read Data from Memory           | 1         | 10      | A10-A0                   | Q7-Q0 | -                     | A9-A0                     | Q15-Q0 | -                     |
| WRITE       | Write Data to Memory            | 1         | 01      | A10-A0                   | D7-D0 | 22                    | A9-A0                     | D15-D0 | 29                    |
| WEN         | Write Enable                    | 1         | 00      | 11X XXXX<br>XXXX         | -     | 14                    | 11 XXXX<br>XXXX           | -      | 13                    |
| WDS         | Write Disable                   | 1         | 00      | 00X XXXX<br>XXXX         | -     | 14                    | 00 XXXX<br>XXXX           | -      | 13                    |
| ERASE       | Erase Byte or Word              | 1         | 11      | A10-A0                   | -     | 14                    | A9-A0                     | -      | 13                    |
| ERAL        | Erase All Memory                | 1         | 00      | 10X XXXX<br>XXXX         | -     | 14                    | 10 XXXX<br>XXXX           | -      | 13                    |
| WRAL        | Write All Memory with same Data | 1         | 00      | 01X XXXX<br>XXXX         | D7-D0 | 22                    | 01 XXXX<br>XXXX           | D15-D0 | 29                    |

1. X = Don't Care bit.
2. Address bit A10 is not decoded by the M93C76.
3. Address bit A9 is not decoded by the M93C76.



## 5.1 Read Data from Memory

The Read Data from Memory (READ) instruction outputs data on Serial Data Output (Q). When the instruction is received, the op-code and address are decoded, and the data from the memory is transferred to an output shift register. A dummy 0 bit is output first, followed by the 8-bit byte or 16-bit word, with the most significant bit first. Output data changes are triggered by the rising edge of Serial Clock (C). The M93Cx6-A125 automatically increments the internal address register and clocks out the next byte (or word) as long as the Chip Select Input (S) is held High. In this case, the dummy 0 bit is *not* output between bytes (or words) and a continuous stream of data can be read (the address counter automatically rolls over to 00h when the highest address is reached).

## 5.2 Erase and Write data

### 5.2.1 Write Enable and Write Disable

The Write Enable (WEN) instruction enables the future execution of erase or write instructions, and the Write Disable (WDS) instruction disables it. When power is first applied, the M93Cx6-A125 initializes itself so that erase and write instructions are disabled. After a Write Enable (WEN) instruction has been executed, erasing and writing remains enabled until a Write Disable (WDS) instruction is executed, or until  $V_{CC}$  falls below the power-on reset threshold voltage. To protect the memory contents from accidental corruption, it is advisable to issue the Write Disable (WDS) instruction after every write cycle. The Read Data from Memory (READ) instruction is not affected by the Write Enable (WEN) or Write Disable (WDS) instructions.

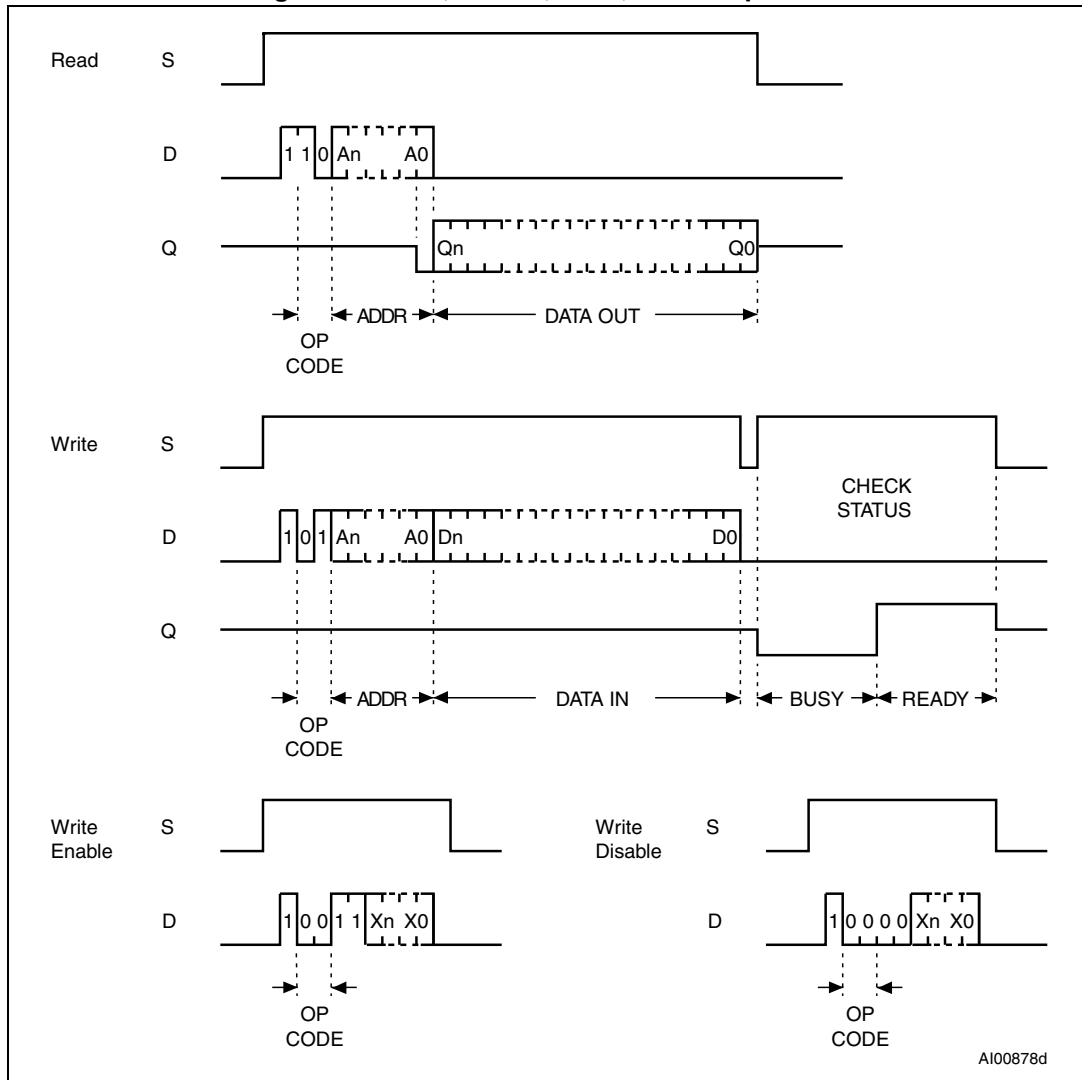
### 5.2.2 Write

For the Write Data to Memory (WRITE) instruction, 8 or 16 data bits follow the op-code and address bits. These form the byte or word that is to be written. As with the other bits, Serial Data Input (D) is sampled on the rising edge of Serial Clock (C).

After the last data bit has been sampled, the Chip Select Input (S) must be taken low before the next rising edge of Serial Clock (C). If Chip Select Input (S) is brought low before or after this specific time frame, the self-timed programming cycle will not be started, and the addressed location will *not* be programmed. The completion of the cycle can be detected by monitoring the READY/BUSY line, as described later in this document.

Once the Write cycle has been started, it is internally self-timed (the external clock signal on Serial Clock (C) may be stopped or left running after the start of a Write cycle). The Write cycle is automatically preceded by an Erase cycle, so it is unnecessary to execute an explicit erase instruction before a Write Data to Memory (WRITE) instruction.

Figure 5. READ, WRITE, WEN, WDS sequences

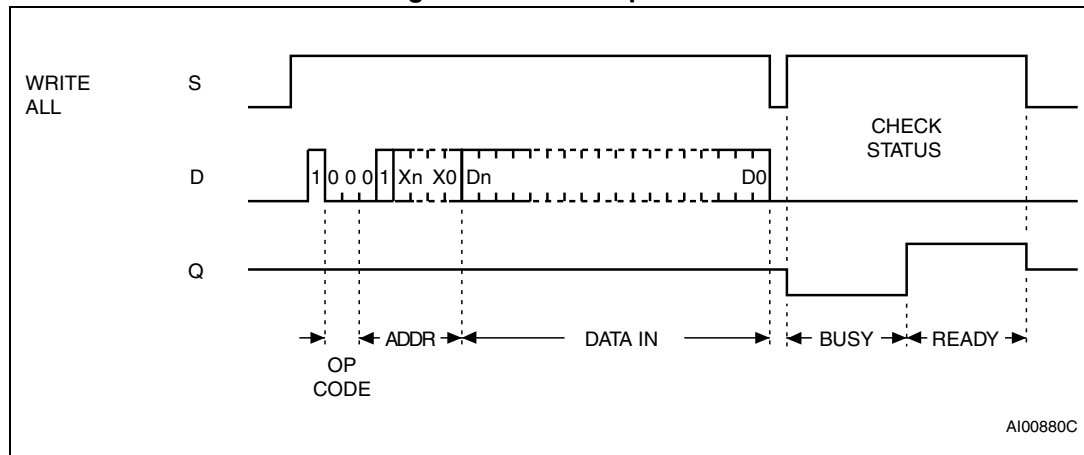


1. For the meanings of An, Xn, Qn and Dn, see [Table 5](#), [Table 6](#) and [Table 7](#).

### 5.2.3 Write All

As with the Erase All Memory (ERAL) instruction, the format of the Write All Memory with same Data (WRAL) instruction requires that a dummy address be provided. As with the Write Data to Memory (WRITE) instruction, the format of the Write All Memory with same Data (WRAL) instruction requires that an 8-bit data byte, or 16-bit data word, be provided. This value is written to all the addresses of the memory device. The completion of the cycle can be detected by monitoring the READY/ $\overline{\text{BUSY}}$  line, as described next.

Figure 6. WRAL sequence



1. For the meanings of Xn and Dn, please see [Table 5](#), [Table 6](#) and [Table 7](#).

### 5.2.4 ECC (Error Correction Code) and Write cycling

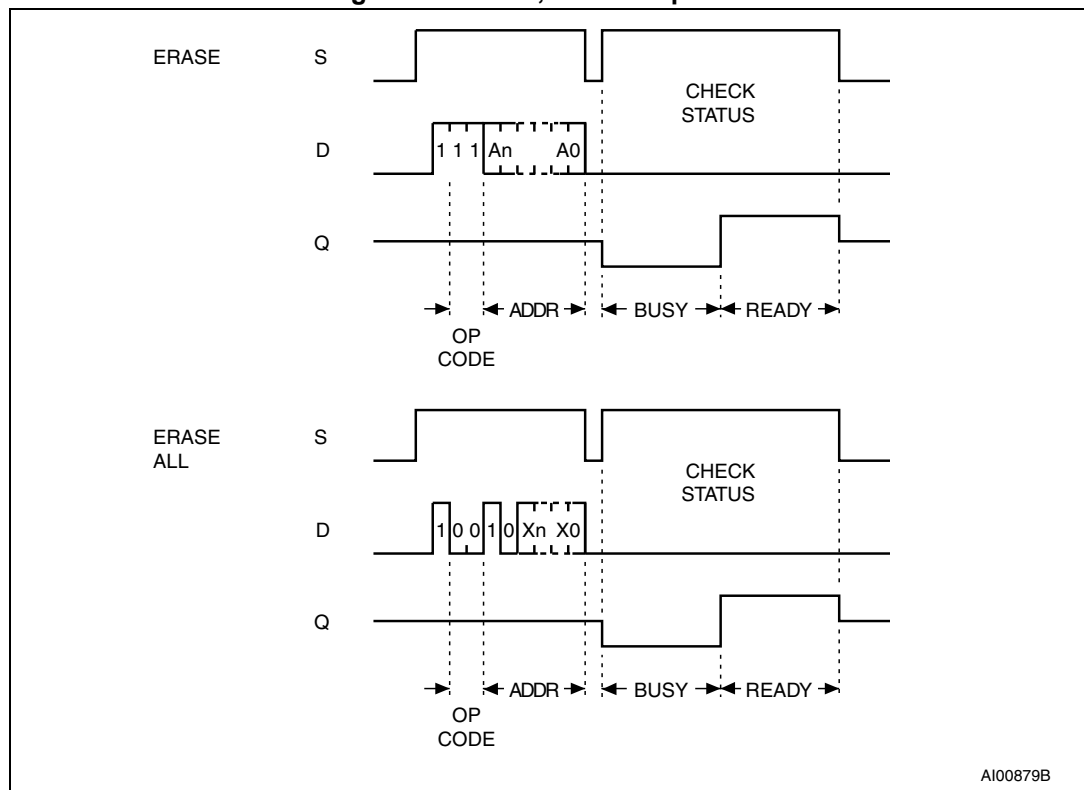
The devices identified with the Process letter “K” embed an Error Correction Code (ECC) internal logic function which is transparent for the Microwire communication protocol.

The ECC logic is implemented on each byte.

### 5.2.5 Erase Byte or Word

The Erase Byte or Word (ERASE) instruction sets the bits of the addressed memory byte (or word) to 1. Once the address has been correctly decoded, the falling edge of the Chip Select Input (S) starts the self-timed Erase cycle. The completion of the cycle can be detected by monitoring the READY/ $\overline{\text{BUSY}}$  line, as described in [Section 6: READY/BUSY status](#).

Figure 7. ERASE, ERAL sequences



1. For the meanings of  $A_n$  and  $X_n$ , please see [Table 5](#), [Table 6](#) and [Table 7](#).

### 5.2.6 Erase All

The Erase All Memory (ERAL) instruction erases the whole memory (all memory bits are set to 1). The format of the instruction requires that a dummy address be provided. The Erase cycle is conducted in the same way as the Erase instruction (ERASE). The completion of the cycle can be detected by monitoring the READY/ $\overline{\text{BUSY}}$  line, as described in [Section 6: READY/BUSY status](#).



## 6 **READY/BUSY status**

While the Write or Erase cycle is underway, for a WRITE, ERASE, WRAL or ERAL instruction, the Busy signal (Q=0) is returned whenever Chip Select input (S) is driven high. (Please note, though, that there is an initial delay, of  $t_{SLSH}$ , before this status information becomes available). In this state, the M93Cx6-A125 ignores any data on the bus. When the Write cycle is completed, and Chip Select Input (S) is driven high, the Ready signal (Q=1) indicates that the M93Cx6-A125 is ready to receive the next instruction. Serial Data Output (Q) remains set to 1 until the Chip Select Input (S) is brought low or until a new start bit is decoded.

## 7 **Initial delivery state**

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

## 8 **Common I/O operation**

Serial Data Output (Q) and Serial Data Input (D) can be connected together, through a current limiting resistor, to form a common, single-wire data bus. Some precautions must be taken when operating the memory in this way, mostly to prevent a short circuit current from flowing when the last address bit (A0) clashes with the first data bit on Serial Data Output (Q). Please see the application note AN394 for details.

## 9 Clock pulse counter

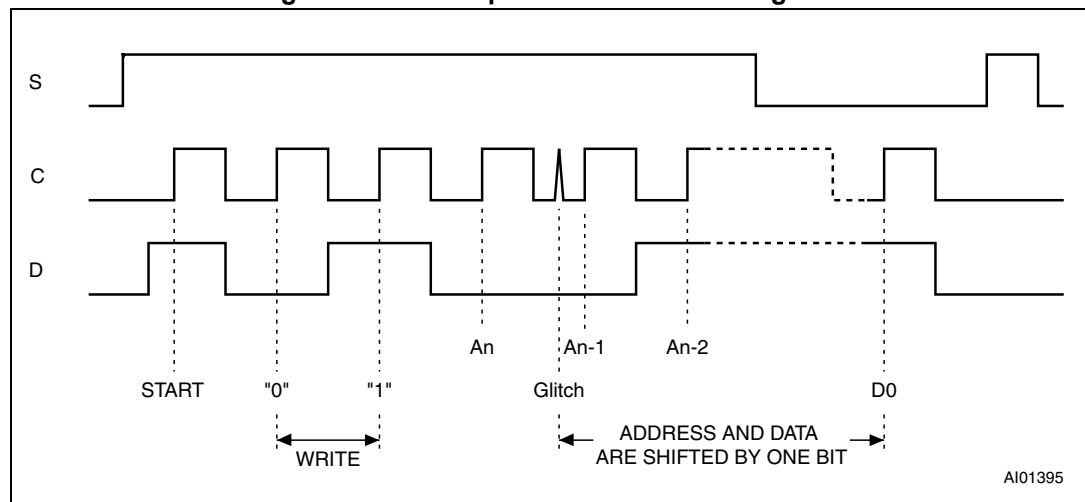
In a noisy environment, the number of pulses received on Serial Clock (C) may be greater than the number delivered by the master (the microcontroller). This can lead to a misalignment of the instruction of one or more bits (as shown in [Figure 8](#)) and may lead to the writing of erroneous data at an erroneous address.

To avoid this problem, the M93Cx6-A125 has an on-chip counter that counts the clock pulses from the start bit until the falling edge of the Chip Select Input (S). If the number of clock pulses received is not the number expected, the WRITE, ERASE, ERAL or WRAL instruction is aborted, and the contents of the memory are not modified.

The number of clock cycles expected for each instruction, and for each member of the M93Cx6-A125 family, are summarized in [Table 5: Instruction set for the M93C46](#) to [Table 7: Instruction set for the M93C76 and M93C86](#). For example, a Write Data to Memory (WRITE) instruction on the M93C56 (or M93C66) expects 20 clock cycles (for the x8 organization) from the start bit to the falling edge of Chip Select Input (S). That is:

- 1 Start bit
- + 2 Op-code bits
- + 9 Address bits
- + 8 Data bits

**Figure 8. Write sequence with one clock glitch**



## 10 Maximum ratings

Stressing the device outside the ratings listed in the Absolute maximum ratings table 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.

**Table 8. Absolute maximum ratings**

| Symbol            | Parameter   | Min.                    | Max.                 | Unit |
|-------------------|---|-------------------------|----------------------|------|
|                   | Ambient operating temperature                                     | -40                     | 130                  | °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>OUT</sub>  | Output range (Q = V <sub>OH</sub> or Hi-Z)                        | -0.50                   | V <sub>CC</sub> +0.5 | V    |
| V <sub>IN</sub>   | Input range   | -0.50                   | V <sub>CC</sub> +1   | 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                 | V    |

1. Compliant with JEDEC standard J-STD-020D (for small-body, Sn-Pb or Pb assembly), the ST ECOPACK® 7191395 specification, and the European directive on Restrictions on Hazardous Substances (RoHS directive 2011/65/EU of July 2011).
2. Positive and negative pulses applied on pin pairs, according to the AEC-Q100-002 (compliant with JEDEC Std JESD22-A114, C1 = 100 pF, R1 = 1500 Ω, R2 = 500 Ω).

# 11 DC and AC parameters

This section summarizes the operating and measurement conditions, and the DC and AC characteristics of the device.

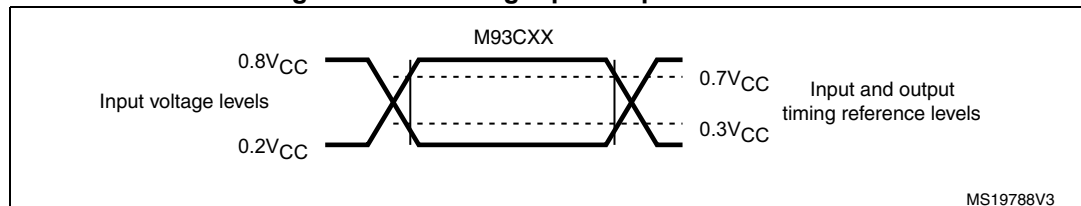
**Table 9. Operating conditions (M93Cx6-A125)**

| Symbol   | Parameter                     | Min. | Max. | Unit |
|----------|-------------------------------|------|------|------|
| $V_{CC}$ | Supply voltage                | 1.8  | 5.5  | V    |
| $T_A$    | Ambient operating temperature | -40  | 125  | °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 voltage levels             | 0.2 $V_{CC}$ to 0.8 $V_{CC}$ |      | V    |
| -      | Input timing reference voltages  | 0.3 $V_{CC}$ to 0.7 $V_{CC}$ |      | V    |
| -      | Output timing reference voltages | 0.3 $V_{CC}$ to 0.7 $V_{CC}$ |      | V    |

**Figure 9. AC testing input output waveforms**



**Table 11. Input and output capacitance**

| Symbol    | Parameter          | Test condition <sup>(1)</sup> | Min | Max | Unit |
|-----------|--------------------|-------------------------------|-----|-----|------|
| $C_{OUT}$ | Output capacitance | $V_{OUT} = 0V$                | -   | 8   | pF   |
| $C_{IN}$  | Input capacitance  | $V_{IN} = 0V$                 | -   | 6   | pF   |

1. Sampled only, not 100% tested, at  $T_A = 25\text{ °C}$  and a frequency of 1 MHz.

**Table 12. Cycling performance by byte**

| Symbol      | Parameter             | Test condition  | Min. | Max.      | Unit                       |
|-------------|-----------------------|---|------|-----------|----------------------------|
| $N_{cycle}$ | Write cycle endurance | $T_A \leq 25\text{ °C}, 1.8\text{ V} < V_{CC} < 5.5\text{ V}$ | -    | 4,000,000 | Write cycle <sup>(1)</sup> |
|             |                       | $T_A = 85\text{ °C}, 1.8\text{ V} < V_{CC} < 5.5\text{ V}$    | -    | 1,200,000 |                            |
|             |                       | $T_A = 125\text{ °C}, 1.8\text{ V} < V_{CC} < 5.5\text{ V}$   | -    | 600,000   |                            |

1. A Write cycle is executed when either a Write, a Write All, an Erase or an Erase All instruction is decoded.

Table 13. DC characteristics

| Symbol          | Parameter                        | Test conditions<br>(in addition to conditions specified<br>in Table 9)                             | Min.          | Max.          | Unit    |
|-----------------|----------------------------------|--|---------------|---------------|---------|
| $I_{LI}$        | Input leakage current            | $V_{IN} = V_{SS}$ or $V_{CC}$  | -             | 2             | $\mu A$ |
| $I_{LO}$        | Output leakage current           | $\bar{S} = V_{CC}$ , $V_{OUT} = V_{SS}$ or $V_{CC}$  | -             | 2             |         |
| $I_{CC}$        | Supply current (Read)            | $V_{CC} = 1.8 V$ , $C = 0.1 V_{CC}/0.9 V_{CC}$ ,<br>$Q = \text{open}$ , $f_C = 2 \text{ MHz}$      | -             | 1             | mA      |
|                 |                                  | $V_{CC} = 2.5 V$ , $C = 0.1 V_{CC}/0.9 V_{CC}$ ,<br>$Q = \text{open}$ , $f_C = 2 \text{ MHz}$      | -             | 1             |         |
|                 |                                  | $V_{CC} = 5.5 V$ , $f_C = 2 \text{ MHz}$<br>$C = 0.1 V_{CC}/0.9 V_{CC}$ , $Q = \text{open}$        | -             | 1.5           |         |
| $I_{CC0}^{(1)}$ | Supply current (Write)           | $1.8 V \leq V_{CC} < 5.5 V$ during $t_W$ ,<br>$\bar{S} = V_{CC}$                                   | -             | 1.5           | mA      |
| $I_{CC1}$       | Supply current (Standby mode)    | $t^\circ = 85^\circ C$ , $V_{CC} = 1.8 V$ ,<br>$\bar{S} = V_{CC}$ , $V_{IN} = V_{SS}$ or $V_{CC}$  | -             | 1             | $\mu A$ |
|                 |                                  | $t^\circ = 85^\circ C$ , $V_{CC} = 2.5 V$ ,<br>$\bar{S} = V_{CC}$ , $V_{IN} = V_{SS}$ or $V_{CC}$  | -             | 2             |         |
|                 |                                  | $t^\circ = 85^\circ C$ , $V_{CC} = 5.5 V$ ,<br>$\bar{S} = V_{CC}$ , $V_{IN} = V_{SS}$ or $V_{CC}$  | -             | 3             |         |
|                 |                                  | $t^\circ = 125^\circ C$ , $V_{CC} = 1.8 V$ ,<br>$\bar{S} = V_{CC}$ , $V_{IN} = V_{SS}$ or $V_{CC}$ | -             | 15            |         |
|                 |                                  | $t^\circ = 125^\circ C$ , $V_{CC} = 2.5 V$ ,<br>$\bar{S} = V_{CC}$ , $V_{IN} = V_{SS}$ or $V_{CC}$ | -             | 15            |         |
|                 |                                  | $t^\circ = 125^\circ C$ , $V_{CC} = 5.5 V$ ,<br>$\bar{S} = V_{CC}$ , $V_{IN} = V_{SS}$ or $V_{CC}$ | -             | 15            |         |
| $V_{IL}$        | Input low voltage (D, C, S)      | $1.8 V \leq V_{CC} < 2.5 V$  | -0.45         | $0.25 V_{CC}$ | V       |
|                 |                                  | $2.5 V \leq V_{CC} < 5.5 V$  | -0.45         | $0.3 V_{CC}$  |         |
| $V_{IH}$        | Input high voltage (D, C, S)     | $1.8 V \leq V_{CC} < 2.5 V$  | $0.75 V_{CC}$ | $V_{CC}+0.5$  | V       |
|                 |                                  | $2.5 V \leq V_{CC} < 5.5 V$  | $0.7 V_{CC}$  | $V_{CC}+0.5$  |         |
| $V_{OL}$        | Output low voltage               | $V_{CC} = 1.8 V$ , $I_{OL} = 1 \text{ mA}$   | -             | 0.3           | V       |
|                 |                                  | $V_{CC} \geq 2.5 V$ , $I_{OL} = 2.1 \text{ mA}$  | -             | 0.4           |         |
| $V_{OH}$        | Output high voltage              | $V_{CC} = 1.8 V$ , $I_{OH} = 1 \text{ mA}$   | $0.8 V_{CC}$  | -             | V       |
|                 |                                  | $V_{CC} \geq 2.5 V$ , $I_{OH} = -2.1 \text{ mA}$   | $0.8 V_{CC}$  | -             |         |
| $V_{RES}$       | Internal reset threshold voltage | -  | 0.5           | 1.5           | V       |

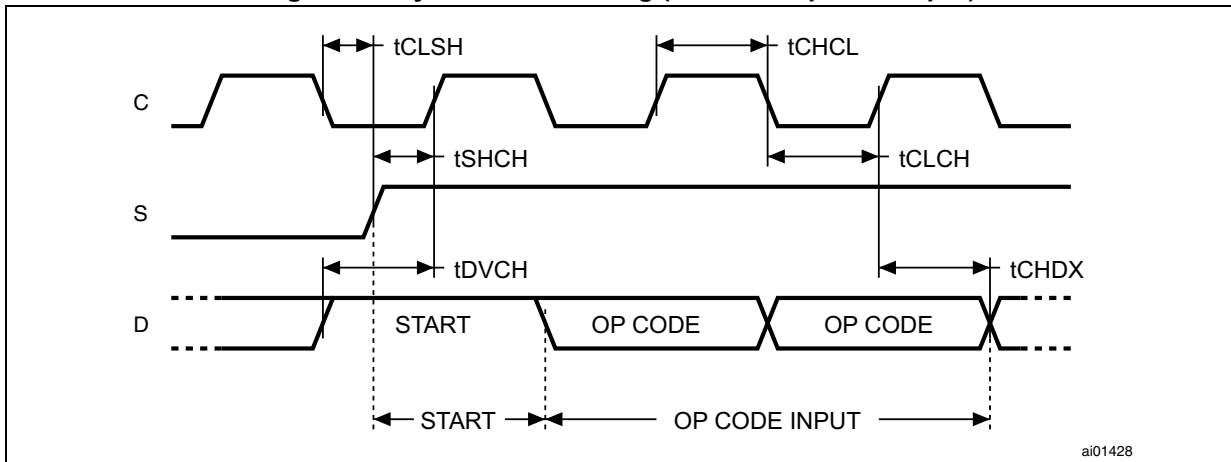
1. Average value during the Write cycle ( $t_W$ )

Table 14. AC characteristics

| Test conditions specified in <a href="#">Table 9</a> and <a href="#">Table 10</a> |           |  |      |      |      |
|---|-----------|--|------|------|------|
| Symbol  | Alt.      | Parameter  | Min. | Max. | Unit |
| $f_C$   | $f_{SK}$  | Clock frequency  | D.C. | 2    | MHz  |
| $t_{SLCH}$  |           | Chip Select low to Clock high                              | 50   | -    | ns   |
| $t_{SHCH}$  | $t_{CSS}$ | Chip Select set-up time                                    | 50   | -    | ns   |
| $t_{SLSH}^{(1)}$  | $t_{CS}$  | Chip Select low to Chip Select high                        | 200  | -    | ns   |
| $t_{CHCL}^{(2)}$  | $t_{SKH}$ | Clock high time  | 200  | -    | ns   |
| $t_{CLCH}^{(2)}$  | $t_{SKL}$ | Clock low time   | 200  | -    | ns   |
| $t_{DVCH}$  | $t_{DIS}$ | Data in set-up time  | 50   | -    | ns   |
| $t_{CHDX}$  | $t_{DIH}$ | Data in hold time  | 50   | -    | ns   |
| $t_{CLSH}$  | $t_{SKS}$ | Clock set-up time (relative to S)                          | 50   | -    | ns   |
| $t_{CLSL}$  | $t_{CSH}$ | Chip Select hold time                                      | 0    | -    | ns   |
| $t_{SHQV}$  | $t_{SV}$  | Chip Select to READY/ $\overline{\text{BUSY}}$ status      | -    | 200  | ns   |
| $t_{SLQZ}^{(3)}$  | $t_{DF}$  | Chip Select low to output Hi-Z ( $V_{CC} > 2.5\text{ V}$ ) | -    | 100  | ns   |
|   |           | Chip Select low to output Hi-Z ( $V_{CC} < 2.5\text{ V}$ ) | -    | 200  | ns   |
| $t_{CHQL}$  | $t_{PD0}$ | Delay to output low  | -    | 200  | ns   |
| $t_{CHQV}$  | $t_{PD1}$ | Delay to output valid                                      | -    | 200  | ns   |
| $t_W$   | $t_{WP}$  | Erase or Write cycle time                                  | -    | 4    | ms   |

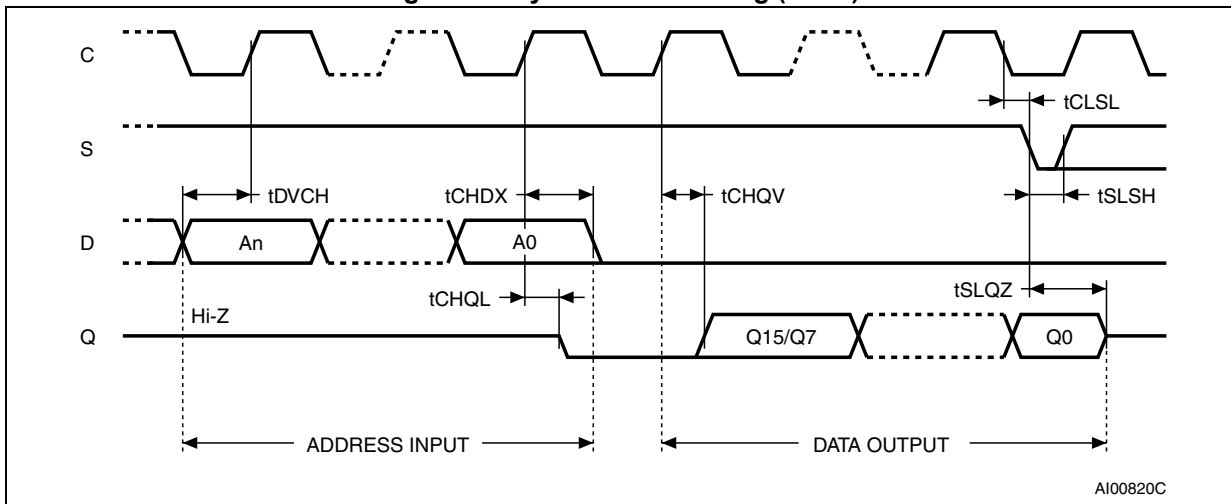
1. Chip Select Input (S) must be brought low for a minimum of  $t_{SLSH}$  between consecutive instruction cycles.
2.  $t_{CHCL} + t_{CLCH} \geq 1 / f_C$ .
3. Value defined from characterization, not tested in production.

Figure 10. Synchronous timing (Start and op-code input)



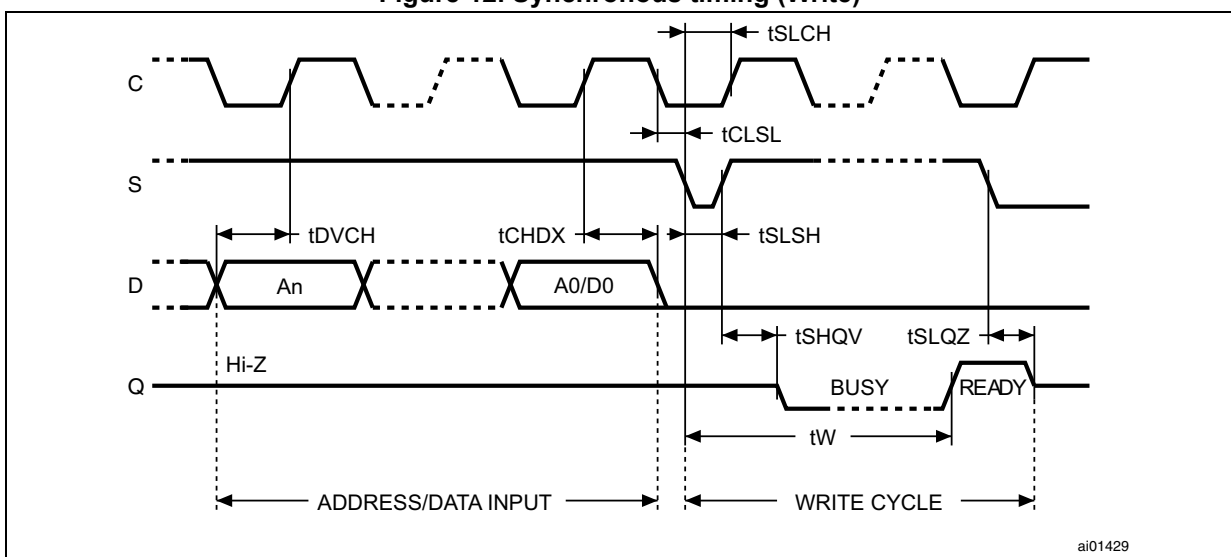
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Figure 11. Synchronous timing (Read)



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Figure 12. Synchronous timing (Write)



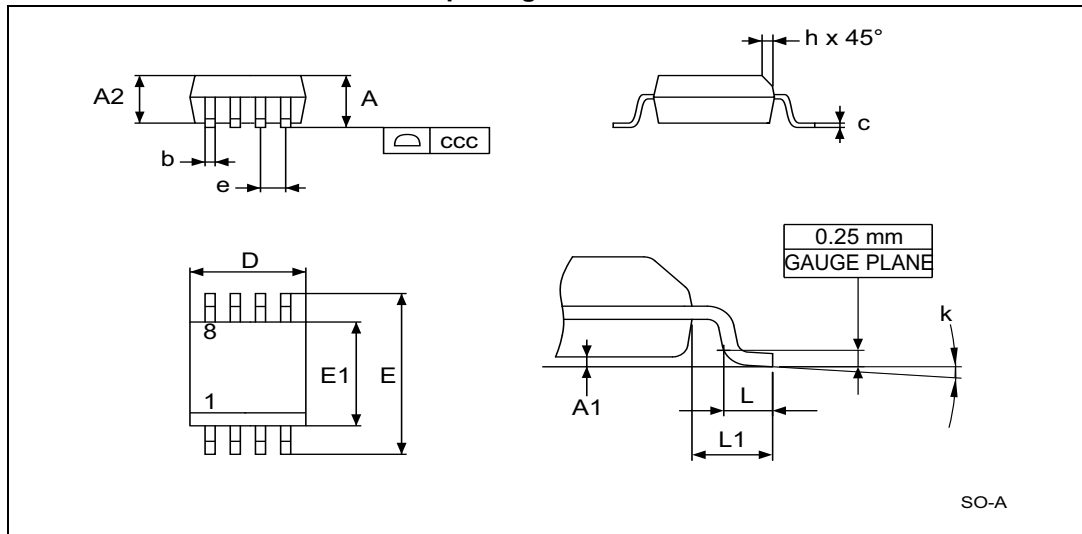
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## 12 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.



Figure 13. SO8 narrow – 8 lead plastic small outline, 150 mils body width, package outline



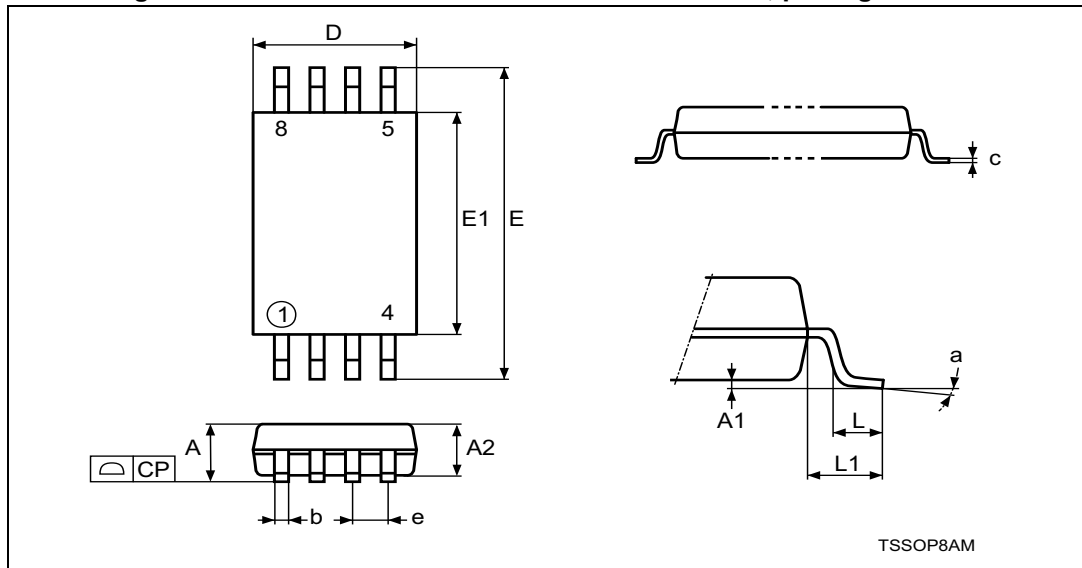
1. Drawing is not to scale.

Table 15. SO8 narrow – 8 lead plastic small outline, 150 mils body width, package data

| Symbol | millimeters |      |      | inches <sup>(1)</sup> |        |        |
|--------|-------------|------|------|-----------------------|--------|--------|
|        | Typ         | Min  | Max  | Typ                   | Min    | Max    |
| A      | -           | -    | 1.75 | -                     | -      | 0.0689 |
| A1     | -           | 0.1  | 0.25 | -                     | 0.0039 | 0.0098 |
| A2     | -           | 1.25 | -    | -                     | 0.0492 | -      |
| b      | -           | 0.28 | 0.48 | -                     | 0.011  | 0.0189 |
| c      | -           | 0.17 | 0.23 | -                     | 0.0067 | 0.0091 |
| ccc    | -           | -    | 0.1  | -                     | -      | 0.0039 |
| D      | 4.9         | 4.8  | 5    | 0.1929                | 0.189  | 0.1969 |
| E      | 6           | 5.8  | 6.2  | 0.2362                | 0.2283 | 0.2441 |
| E1     | 3.9         | 3.8  | 4    | 0.1535                | 0.1496 | 0.1575 |
| e      | 1.27        | -    | -    | 0.05                  | -      | -      |
| h      | -           | 0.25 | 0.5  | -                     | 0.0098 | 0.0197 |
| k      | -           | 0°   | 8°   | -                     | 0°     | 8°     |
| L      | -           | 0.4  | 1.27 | -                     | 0.0157 | 0.05   |
| L1     | 1.04        | -    | -    | 0.0409                | -      | -      |

1. Values in inches are converted from mm and rounded to 4 decimal digits.

Figure 14. TSSOP8 – 8 lead thin shrink small outline, package outline



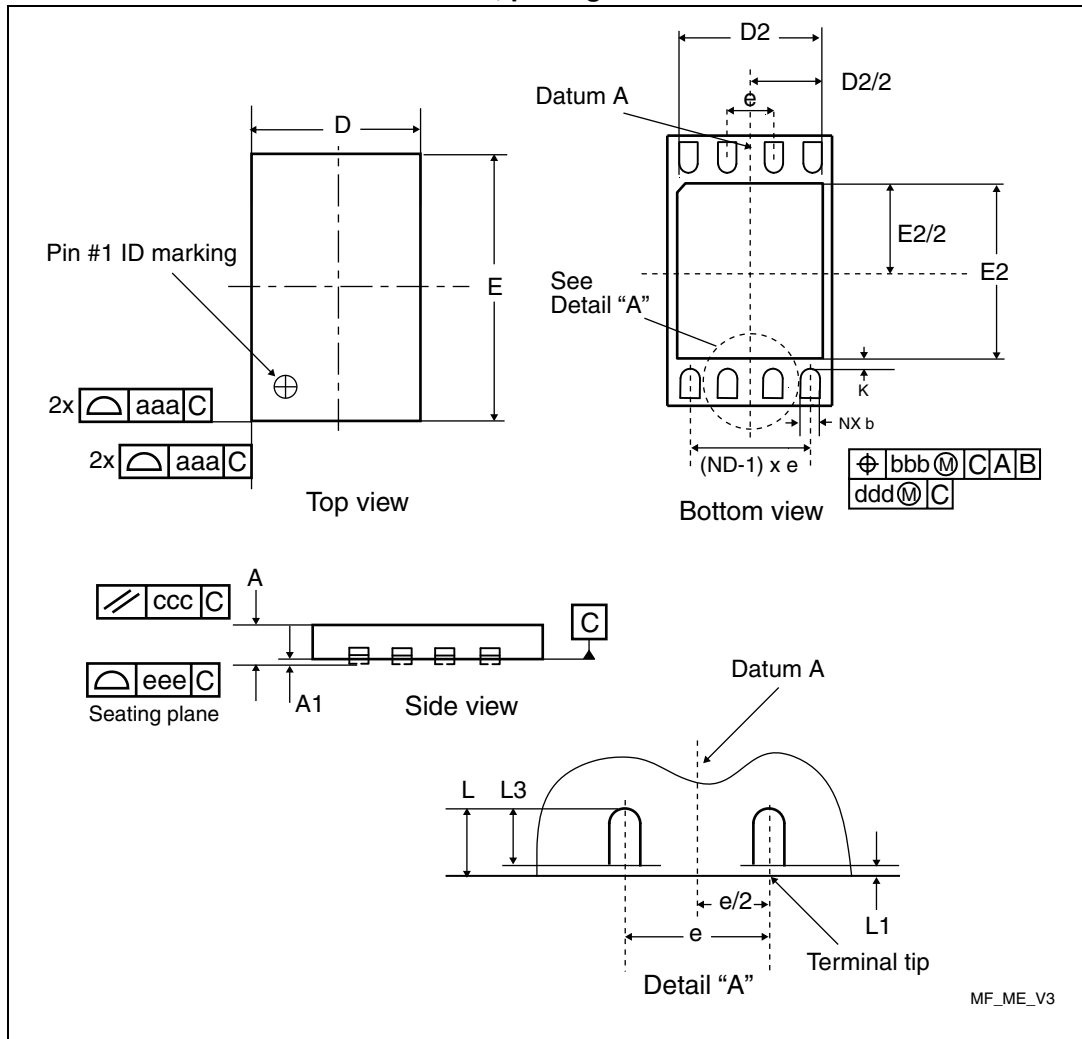
1. Drawing is not to scale.

Table 16. TSSOP8 – 8-lead thin shrink small outline, package mechanical data

| Symbol | millimeters |       |       | inches <sup>(1)</sup> |        |        |
|--------|-------------|-------|-------|-----------------------|--------|--------|
|        | 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                | -      | -      |
| α      | -           | 0°    | 8°    | -                     | 0°     | 8°     |
| N      | 8           |       |       | 8                     |        |        |

1. Values in inches are converted from mm and rounded to four decimal digits.

Figure 15. WFDFPN8 (MLP8) – 8-lead thin fine pitch dual flat package no lead  
2 x 3 mm, package outline



1. Drawing is not to scale.

**Table 17. WFDFPN8 (MLP8) – 8-lead thin fine pitch dual flat package no lead 2 x 3 mm, mechanical data**

| Symbol             | millimeters |       |       | inches <sup>(1)</sup> |        |        |
|--------------------|-------------|-------|-------|-----------------------|--------|--------|
|                    | Typ.        | Min.  | Max.  | Typ.                  | Min.   | Max.   |
| A                  | 0.750       | 0.700 | 0.800 | 0.0295                | 0.0276 | 0.0315 |
| A1                 | 0.045       | 0.025 | 0.065 | 0.0018                | 0.0010 | 0.0026 |
| b                  | 0.250       | 0.200 | 0.300 | 0.0098                | 0.0079 | 0.0118 |
| D                  | 2.000       | 1.900 | 2.100 | 0.0787                | 0.0748 | 0.0827 |
| E                  | 3.000       | 2.900 | 3.100 | 0.1181                | 0.1142 | 0.1220 |
| e                  | 0.500       |       |       | 0.0197                |        |        |
| L1                 | -           | -     | 0.150 | -                     | -      | 0.0059 |
| L3                 | -           | 0.300 | -     | -                     | 0.0118 | -      |
| NX <sup>(2)</sup>  | 8           |       |       |                       |        |        |
| ND <sup>(3)</sup>  | 4           |       |       |                       |        |        |
| aaa                | 0.150       |       |       | 0.0059                |        |        |
| bbb                | 0.100       |       |       | 0.0039                |        |        |
| ccc                | 0.100       |       |       | 0.0039                |        |        |
| ddd                | 0.050       |       |       | 0.0020                |        |        |
| eee <sup>(4)</sup> | 0.080       |       |       | 0.0031                |        |        |
| D2                 | -           | 1.050 | 1.450 | -                     | 0.0413 | 0.0571 |
| E2                 | -           | 1.050 | 1.450 | -                     | 0.0413 | 0.0571 |
| K                  | -           | 0.450 | -     | -                     | 0.0177 | -      |
| L                  | -           | 0.300 | 0.500 | -                     | 0.0118 | -      |

1. Values in inches are converted from mm and rounded to four decimal digits.
2. NX is the number of terminals.
3. ND is the number of terminals on "D" sides.
4. Applied for exposed die paddle and terminals. Exclude embedding part of exposed die paddle from measuring.



# 13 Part numbering

**Table 18. Ordering information scheme**

|   |        |   |   |    |   |   |   |    |
|---|--------|---|---|----|---|---|---|----|
| Example:  | M93C86 | - | R | MN | 3 | T | P | /K |
| <b>Device type</b>  |        |   |   |    |   |   |   |    |
| M93 = MICROWIRE serial EEPROM   |        |   |   |    |   |   |   |    |
| <b>Device function</b>  |        |   |   |    |   |   |   |    |
| 86 = 16 Kbit (2048 x 8)   |        |   |   |    |   |   |   |    |
| 76 = 8 Kbit (1024 x 8)  |        |   |   |    |   |   |   |    |
| 66 = 4 Kbit (512 x 8)   |        |   |   |    |   |   |   |    |
| 56 = 2 Kbit (256 x 8)   |        |   |   |    |   |   |   |    |
| 46 = 1 Kbit (128 x 8)   |        |   |   |    |   |   |   |    |
| <b>Operating voltage</b>  |        |   |   |    |   |   |   |    |
| R = V <sub>CC</sub> = 1.8 to 5.5 V  |        |   |   |    |   |   |   |    |
| <b>Package<sup>(1)</sup></b>  |        |   |   |    |   |   |   |    |
| MN = SO8 (150 mils width)   |        |   |   |    |   |   |   |    |
| DW = TSSOP8 (169 mils width)  |        |   |   |    |   |   |   |    |
| MF = WFDFPN8 (2 x 3 mm)   |        |   |   |    |   |   |   |    |
| <b>Device grade</b>   |        |   |   |    |   |   |   |    |
| 3 = Device tested with high reliability certified flow <sup>(2)</sup><br>Automotive temperature range (-40 to 125 °C) |        |   |   |    |   |   |   |    |
| <b>Packing</b>  |        |   |   |    |   |   |   |    |
| blank = standard packing  |        |   |   |    |   |   |   |    |
| T = tape and reel packing   |        |   |   |    |   |   |   |    |
| <b>Plating technology</b>   |        |   |   |    |   |   |   |    |
| P = ECOPACK® (RoHS compliant)   |        |   |   |    |   |   |   |    |
| <b>Process</b>  |        |   |   |    |   |   |   |    |
| /K = Manufacturing technology code  |        |   |   |    |   |   |   |    |

1. All packages are ECOPACK2® (RoHS compliant and Halogen-free).
2. The high reliability certified flow (HRCF) is described in quality note QNEE9801. Please ask your nearest ST sales office for a copy.

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.



## 14 Revision history

**Table 19. Document revision history**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 15-Nov-2013 | 15       | Removed Table 14 Cycling performance by byte   |
| 07-Aug-2013 | 1        | Initial release  |
| 02-Dec-2013 | 2        | Document status changed from "Preliminary data" to "Production data".<br>Updated: <ul style="list-style-type: none"> <li>– <a href="#">Features</a>: "data retention" bullet</li> <li>– <a href="#">Table 9: Operating conditions (M93Cx6-A125)</a></li> <li>– "T<sub>SLQZ</sub>" row in <a href="#">Table 14: AC characteristics</a></li> <li>– Note <sup>(1)</sup> under <a href="#">Table 8: Absolute maximum ratings</a></li> <li>– <a href="#">Table 13: DC characteristics</a></li> <li>– <a href="#">Figure 15: WDFPN8 (MLP8) – 8-lead thin fine pitch dual flat package no lead 2 x 3 mm, package outline.</a></li> </ul> Renamed <a href="#">Figure 11: Synchronous timing (Read)</a> and <a href="#">Figure 12: Synchronous timing (Write)</a> . |

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