



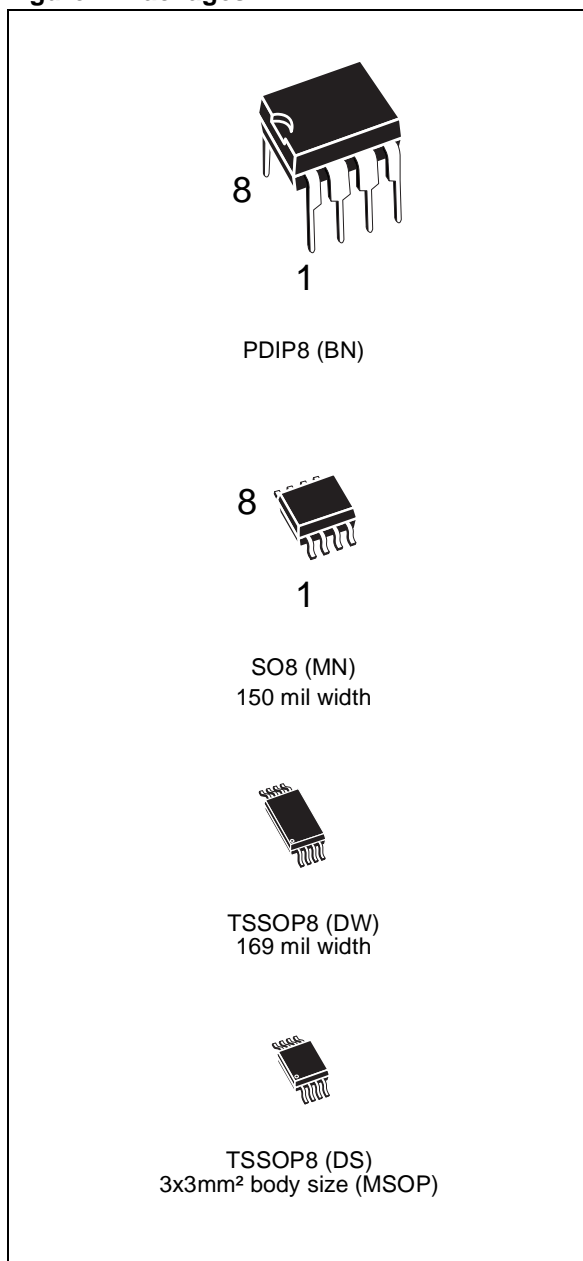
# M24C16, M24C08 M24C04, M24C02, M24C01

16Kbit, 8Kbit, 4Kbit, 2Kbit and 1Kbit Serial I<sup>2</sup>C Bus EEPROM

## FEATURES SUMMARY

- Two Wire I<sup>2</sup>C Serial Interface  
Supports 400 kHz Protocol
- Single Supply Voltage:
  - 4.5V to 5.5V for M24Cxx
  - 2.5V to 5.5V for M24Cxx-W
  - 2.2V to 5.5V for M24Cxx-L
  - 1.8V to 5.5V for M24Cxx-R
- Write Control Input
- BYTE and PAGE WRITE (up to 16 Bytes)
- RANDOM and SEQUENTIAL READ Modes
- Self-Timed Programming Cycle
- Automatic Address Incrementing
- Enhanced ESD/Latch-Up Behavior
- More than 1 Million Erase/Write Cycles
- More than 40 Year Data Retention

Figure 1. Packages



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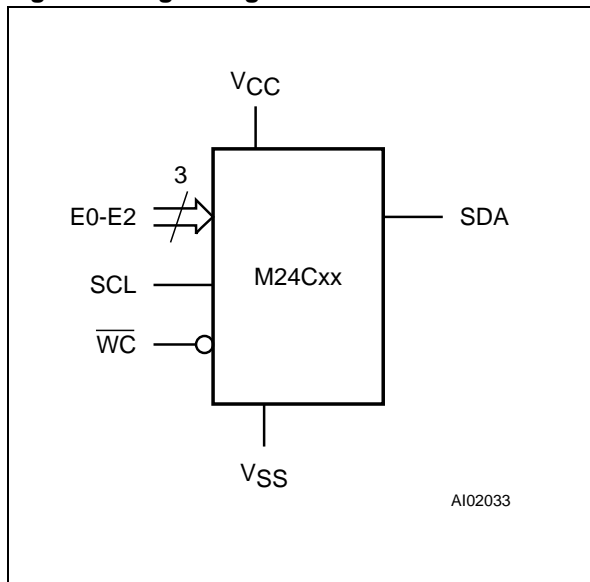
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**SUMMARY DESCRIPTION**

These I<sup>2</sup>C-compatible electrically erasable programmable memory (EEPROM) devices are organized as 2048/1024/512/256/128 x 8 (M24C16, M24C08, M24C04, M24C02, M24C01).

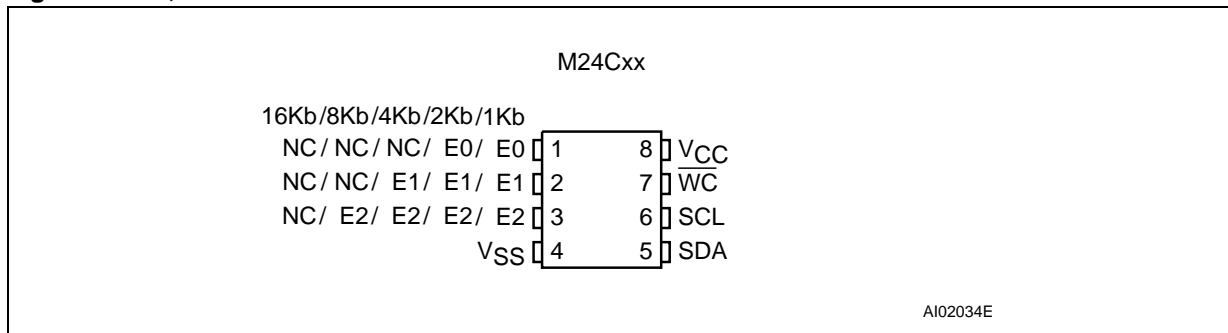
**Figure 2. Logic Diagram**



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 master. The Start condition is followed by a Device Select Code and RW bit (as described in Table 2), terminated by an acknowledge bit.

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



- Note: 1. NC = Not Connected  
 2. See page 22 (onwards) for package dimensions, and how to identify pin-1.

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.

**Table 1. Signal Names**

E0, E1, E2	Chip Enable
SDA	Serial Data
SCL	Serial Clock
WC	Write Control
VCC	Supply Voltage
VSS	Ground

**Power On Reset: VCC Lock-Out Write Protect**

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 internal reset is held active until VCC has reached the POR threshold value, and all operations are disabled – the device will not respond to any command. In the same way, when VCC drops from the operating voltage, below the POR threshold value, all operations are disabled and the device will not respond to any command.

A stable and valid VCC (as defined in Tables 7 and 10) must be applied before applying any logic signal.



## 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 can 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.

**Write Control ( $\overline{WC}$ ).** 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 ( $\overline{WC}$ ) is driven High. When unconnected, the signal is internally read as  $V_{IL}$ , and Write operations are allowed.

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

Figure 4. Maximum  $R_L$  Value versus Bus Capacitance ( $C_{BUS}$ ) for an I<sup>2</sup>C Bus

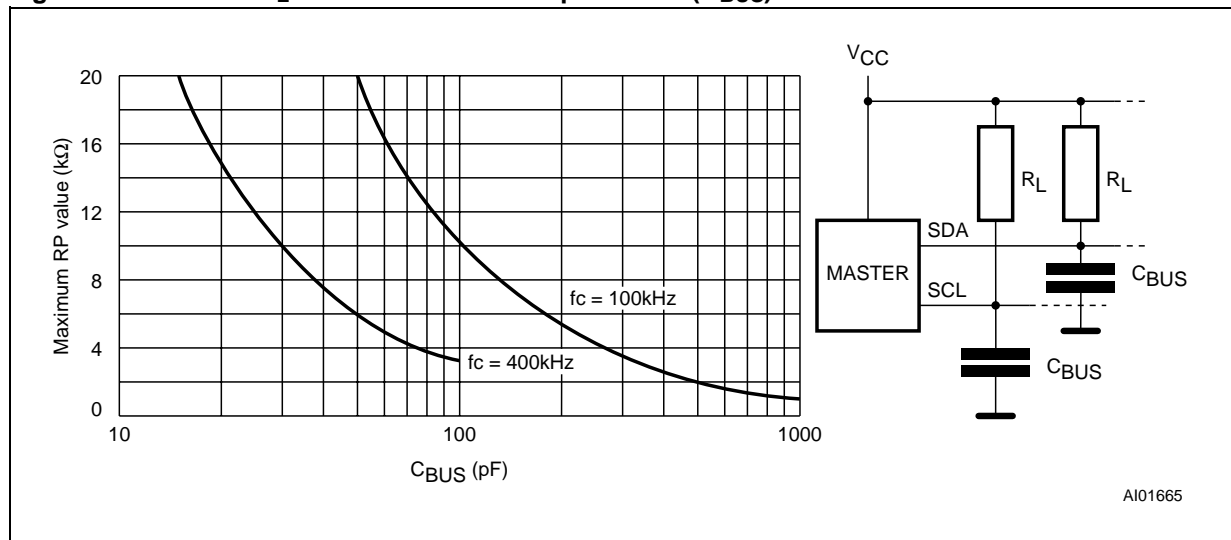


Figure 5. I<sup>2</sup>C Bus Protocol

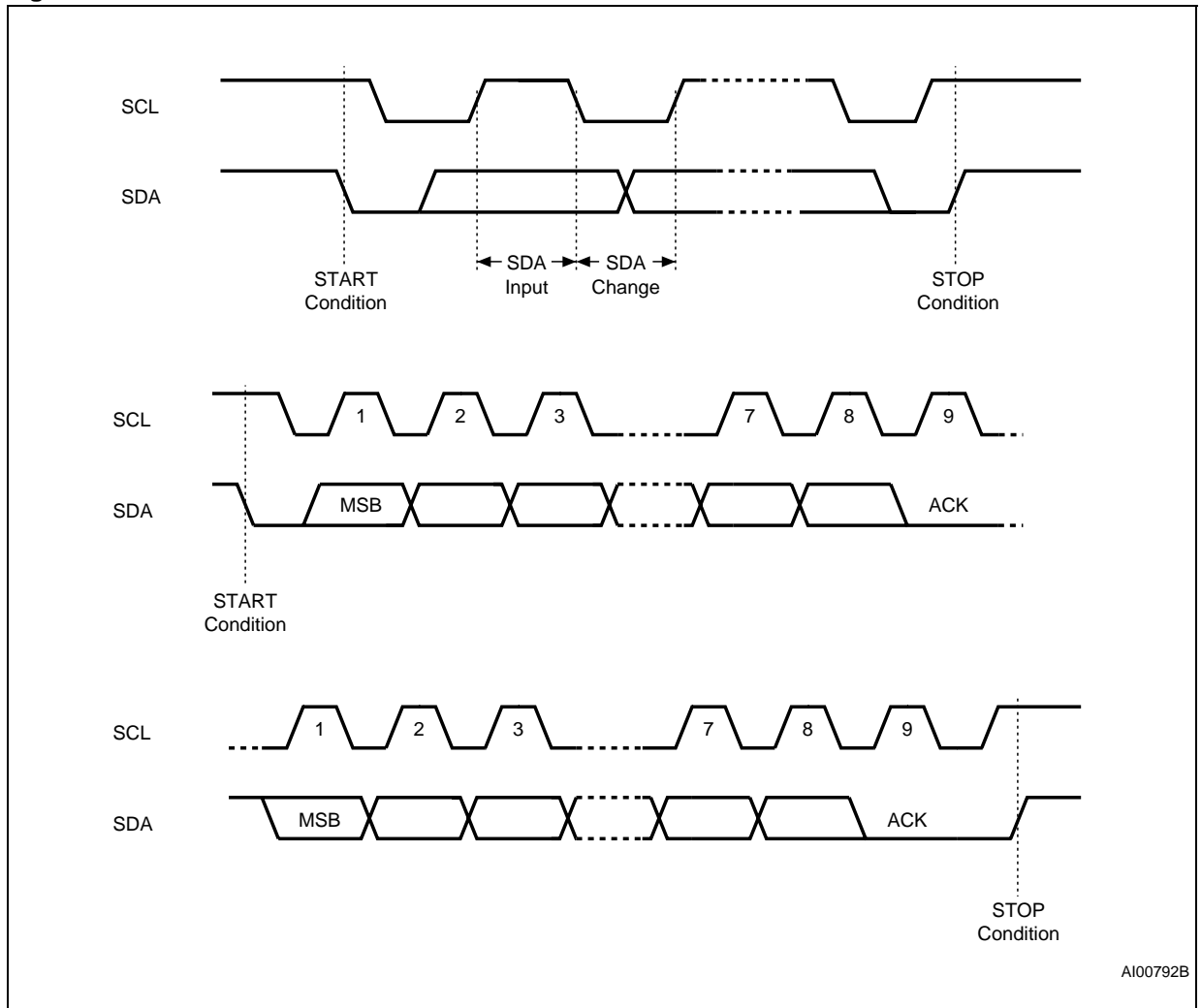


Table 2. Device Select Code

	Device Type Identifier <sup>1</sup>				Chip Enable <sup>2,3</sup>			R $\bar{W}$
	b7	b6	b5	b4	b3	b2	b1	b0
M24C01 Select Code	1	0	1	0	E2	E1	E0	R $\bar{W}$
M24C02 Select Code	1	0	1	0	E2	E1	E0	R $\bar{W}$
M24C04 Select Code	1	0	1	0	E2	E1	A8	R $\bar{W}$
M24C08 Select Code	1	0	1	0	E2	A9	A8	R $\bar{W}$
M24C16 Select Code	1	0	1	0	A10	A9	A8	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.

3. A10, A9 and A8 represent most significant bits of the address.

## 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 M24Cxx 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 EEPROM 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 2 (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.

Each device 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. However, those devices with larger memory capacities (the M24C16, M24C08 and M24C04) need more address bits. E0 is not available for use on devices that need to use address line A8; E1 is not available for devices that need to use address line A9, and E2 is not available for devices that need to use address line A10 (see Figure 3 and Table 2 for details). Using the E0, E1 and E2 inputs, up to eight M24C02 (or M24C01), four M24C04, two M24C08 or one M24C16 devices can be connected to one I<sup>2</sup>C bus. In each case, and in the hybrid cases, this gives a total memory capacity of 16 Kbits, 2 KBytes (except where M24C01 devices are used).

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.

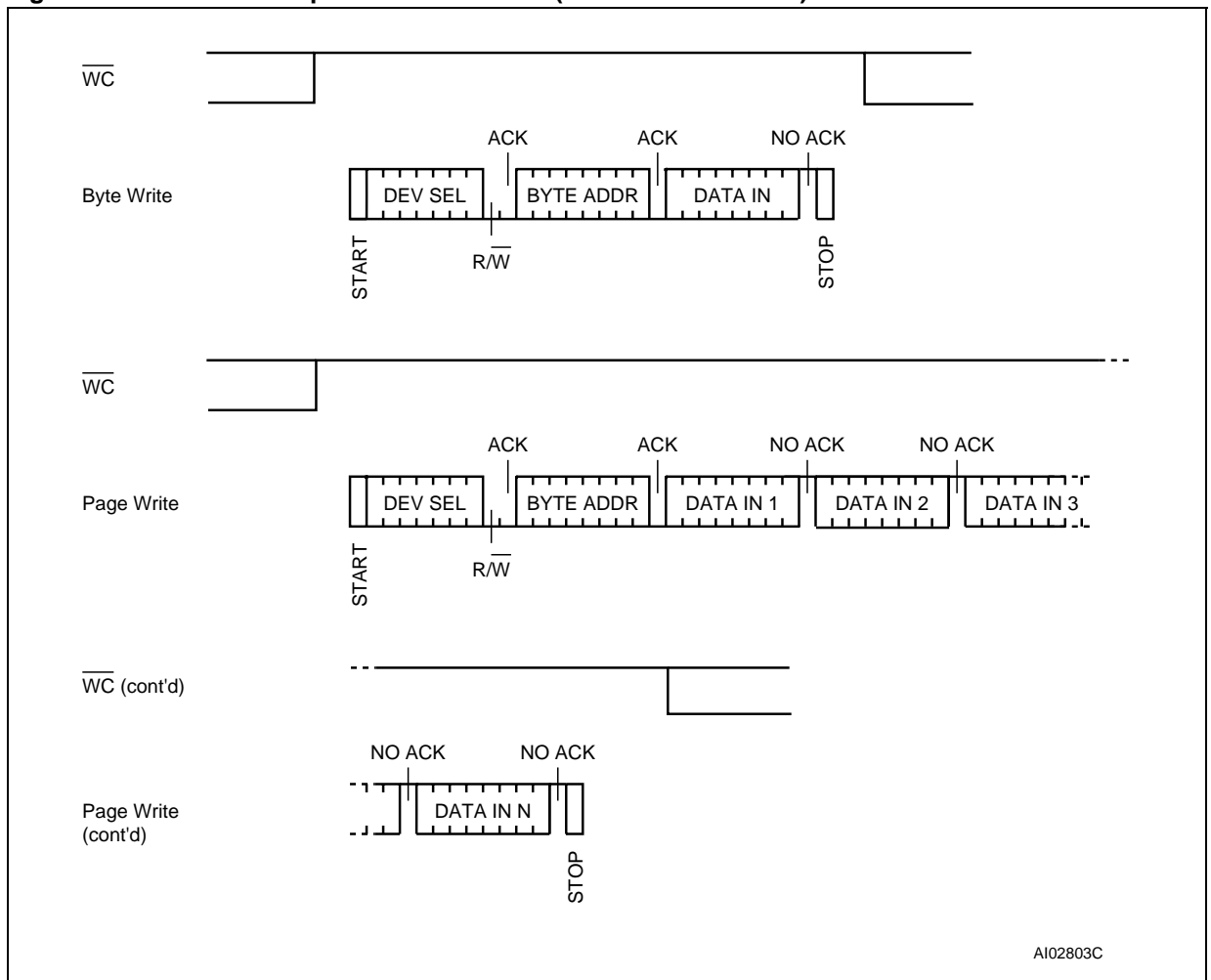
If a match occurs on the Device Select code, the corresponding device gives an acknowledgment on Serial Data (SDA) during the 9<sup>th</sup> bit time. If the device does not match the Device Select code, it deselects itself from the bus, and goes into Stand-by mode.

**Table 3. 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>	≤ 16	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  $\overline{R/W}$  bit reset to 0. The device acknowledges this, as shown in Figure 7, and waits for an address byte. The device responds to the address byte with an acknowledge bit, and then waits for the data byte.

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 memory Write cycle is triggered. A Stop condition at any other time slot does not trigger the internal Write cycle.

During the internal Write cycle, Serial Data (SDA) and Serial Clock (SCL) are ignored, and the device does not respond to any requests.

### Byte Write

After the Device Select code and the address byte, the bus master sends one data byte. If the addressed location is Write-protected, by Write Control ( $\overline{WC}$ ) being driven High (during the period from

the Start condition until the end of the address byte), the device replies to the data byte with NoAck, as shown in Figure 6, and the location is not modified. If, instead, the addressed location is not Write-protected, 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 16 bytes to be written in a single Write cycle, provided that they are all located in the same page in the memory: that is, the most significant memory address bits are the same. If more bytes are sent than will fit up to the end of the page, 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 16 bytes of data, each of which is acknowledged by the device if Write Control ( $\overline{WC}$ ) is Low. If the addressed location is Write-protected, by Write Control ( $\overline{WC}$ ) being driven High (during the period from the Start



condition until the end of the address byte), the device replies to the data bytes with NoAck, as shown in Figure 6, and the locations are not modified. After each byte is transferred, the internal

byte address counter (the 4 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  $\overline{WC}=0$  (data write enabled)**

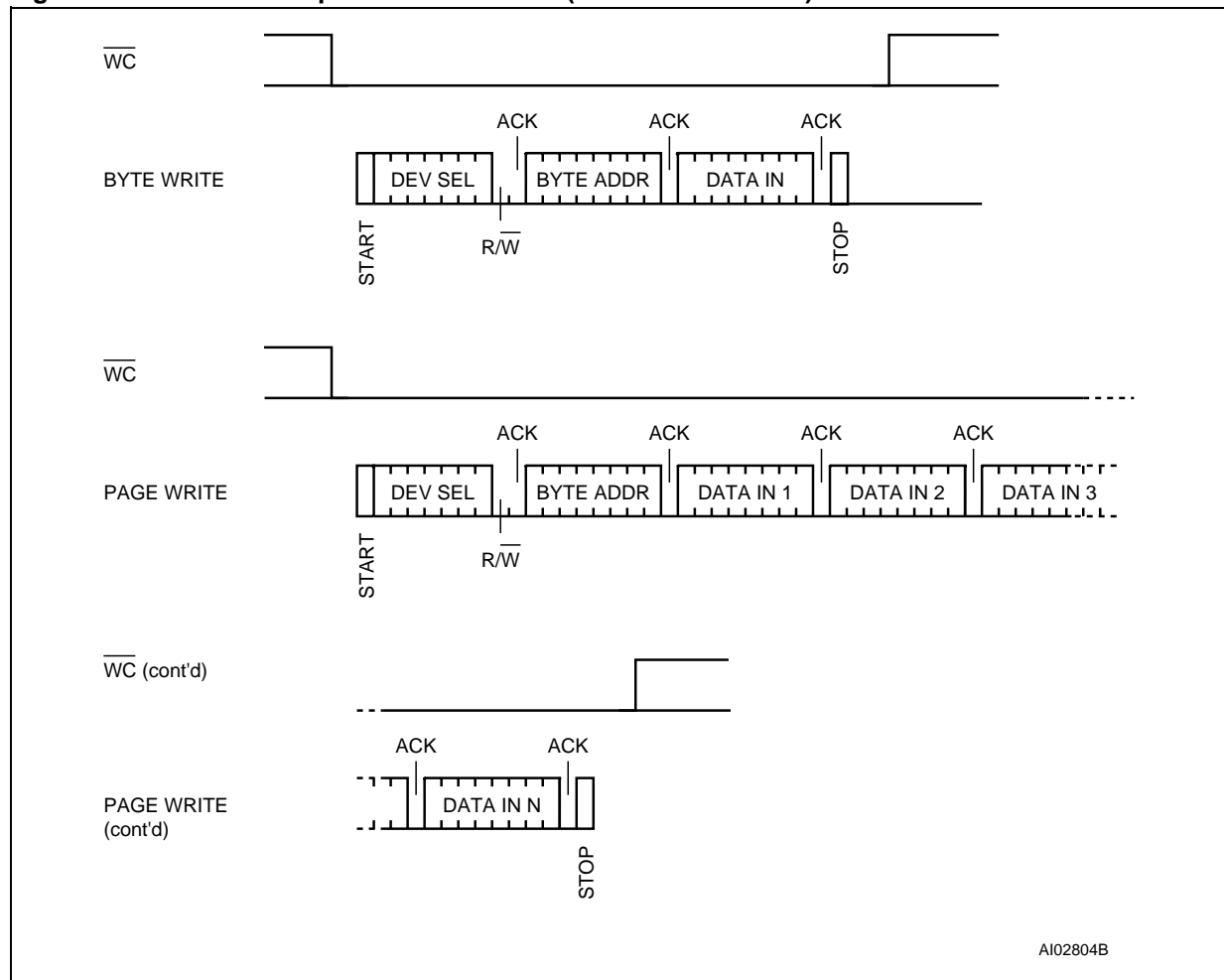
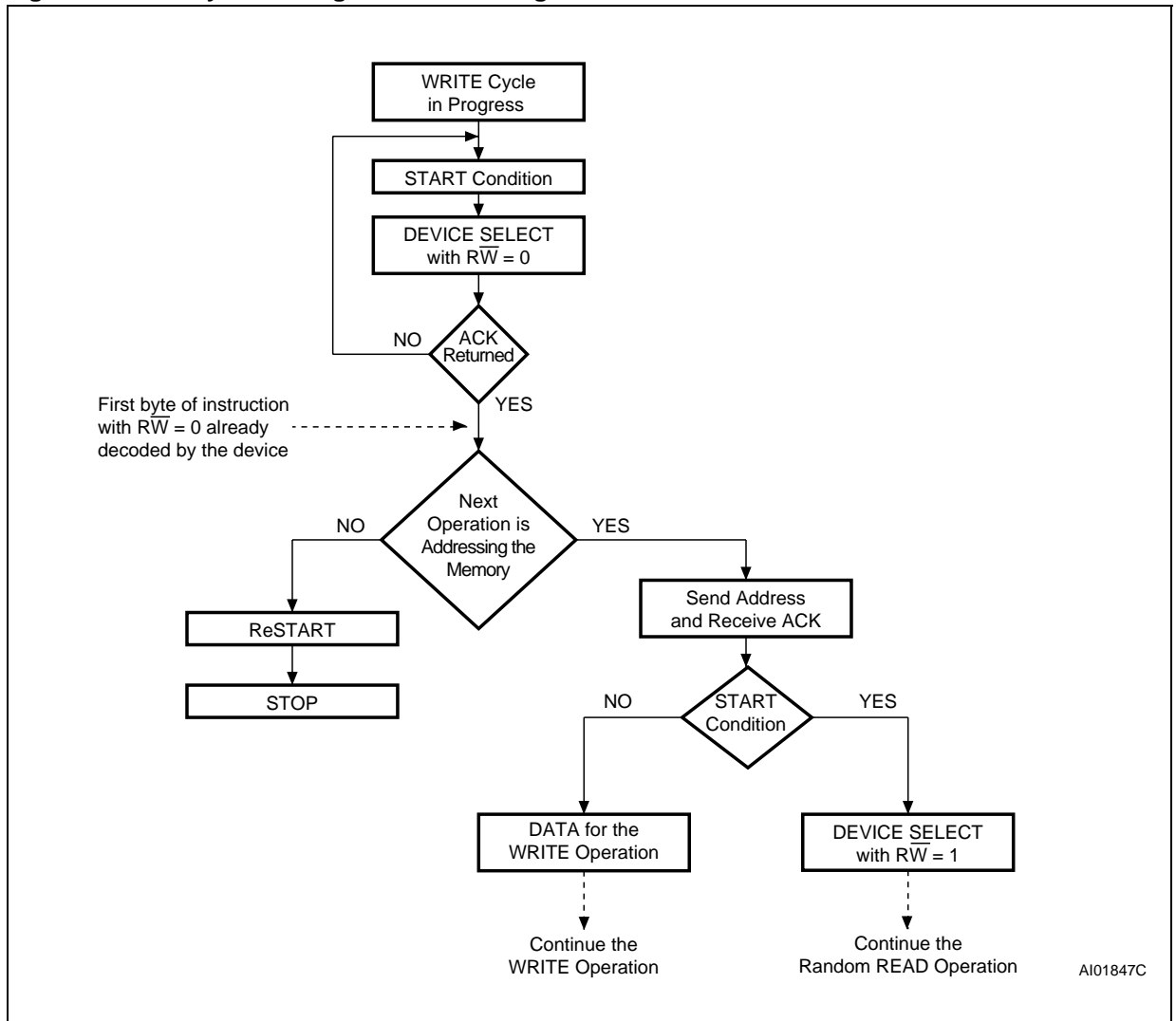


Figure 8. Write Cycle Polling Flowchart using ACK



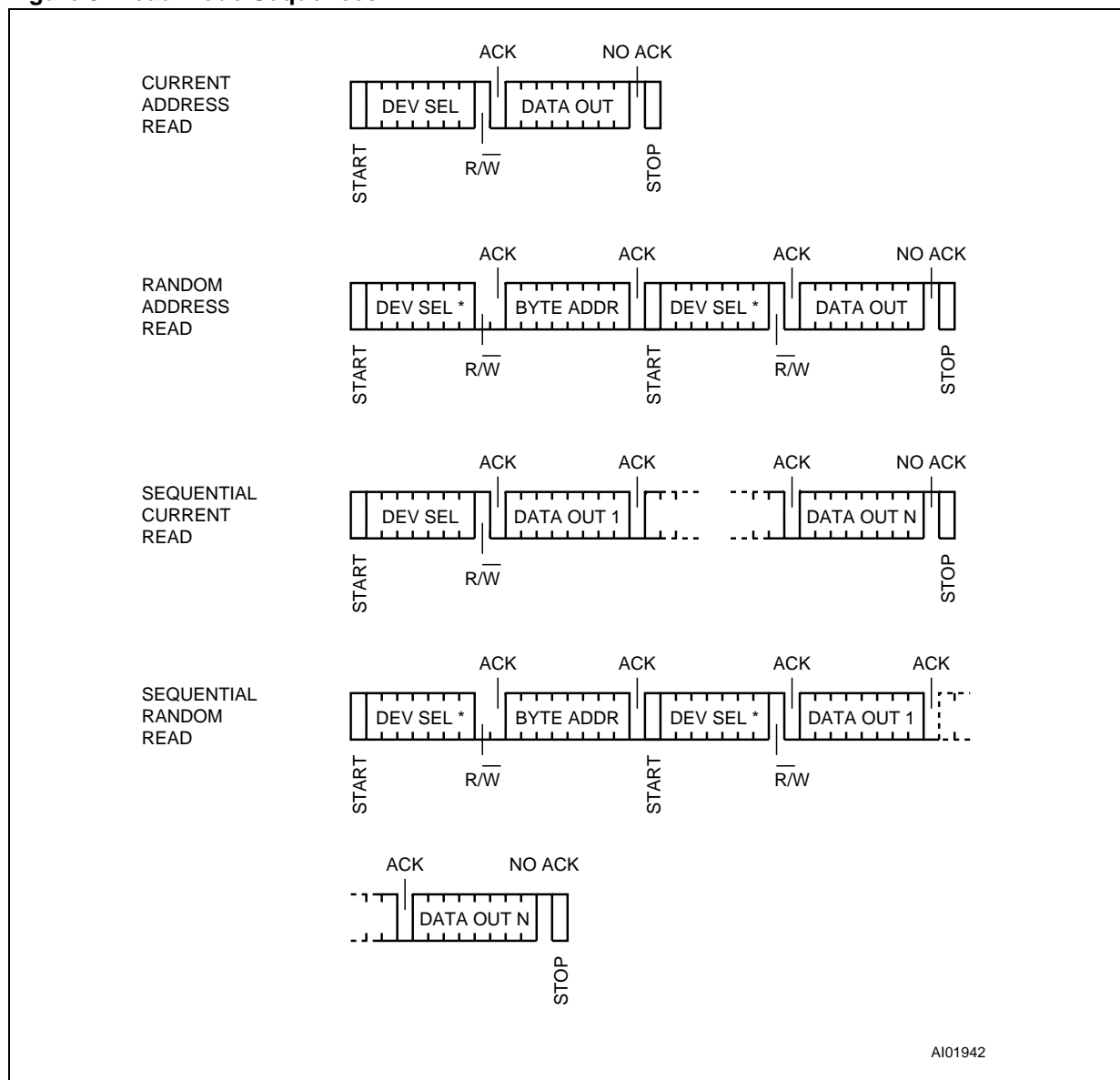
**Minimizing System Delays by Polling On ACK**

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 Tables 19 to 21, 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 3<sup>rd</sup> bytes) must be identical.

### Read Operations

Read operations are performed independently of the state of the Write Control ( $\overline{WC}$ ) signal.

The device has an internal address counter which is incremented each time a byte is read.

### 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  $\overline{RW}$  bit 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  $\overline{RW}$  bit 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 Stand-by mode.

### **INITIAL DELIVERY STATE**

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

**MAXIMUM RATING**

Stressing the device above the rating 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 above those indicated in the Operating sections of this specification is not im-

plied. 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 4. Absolute Maximum Ratings**

Symbol	Parameter	Min.	Max.	Unit
T <sub>STG</sub>	Storage Temperature	-65	150	°C
T <sub>LEAD</sub>	Lead Temperature during Soldering <sup>1</sup> PDIP SO TSSOP		260 <sup>2</sup> 260 <sup>3</sup> 260 <sup>3</sup>	°C
V <sub>IO</sub>	Input or Output range	-0.6	6.5	V
V <sub>CC</sub>	Supply Voltage	-0.3	6.5	V
V <sub>ESD</sub>	Electrostatic Discharge Voltage (Human Body model) <sup>4</sup>	-4000	4000	V

Note: 1. Compliant with the ECOPACK® 7191395 specification for lead-free soldering processes

2. No longer than 10 seconds

3. Not exceeding 250°C for more than 30 seconds, and peaking at 260°C

4. JEDEC Std JESD22-A114A (C1=100 pF, R1=1500 Ω, R2=500 Ω)

**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 5. Operating Conditions (M24Cxx-xx6)**

Symbol	Parameter	Min.	Max.	Unit
V <sub>CC</sub>	Supply Voltage	4.5	5.5	V
T <sub>A</sub>	Ambient Operating Temperature	-40	85	°C

**Table 6. Operating Conditions (M24Cxx-xx3)**

Symbol	Parameter	Min.	Max.	Unit
V <sub>CC</sub>	Supply Voltage	4.5	5.5	V
T <sub>A</sub>	Ambient Operating Temperature	-40	125	°C

**Table 7. Operating Conditions (M24Cxx-Wxx6)**

Symbol	Parameter	Min.	Max.	Unit
V <sub>CC</sub>	Supply Voltage	2.5	5.5	V
T <sub>A</sub>	Ambient Operating Temperature	-40	85	°C

**Table 8. Operating Conditions (M24Cxx-Wxx3)**

Symbol	Parameter	Min.	Max.	Unit
V <sub>CC</sub>	Supply Voltage	2.5	5.5	V
T <sub>A</sub>	Ambient Operating Temperature	-40	125	°C

**Table 9. Operating Conditions (M24Cxx-Lxx6)**

Symbol	Parameter	Min.	Max.	Unit
V <sub>CC</sub>	Supply Voltage	2.2	5.5	V
T <sub>A</sub>	Ambient Operating Temperature	-40	85	°C

**Table 10. Operating Conditions (M24Cxx-Rxx6)**

Symbol	Parameter	Min.	Max.	Unit
V <sub>CC</sub>	Supply Voltage	1.8	5.5	V
T <sub>A</sub>	Ambient Operating Temperature	-40	85	°C

Table 11. 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

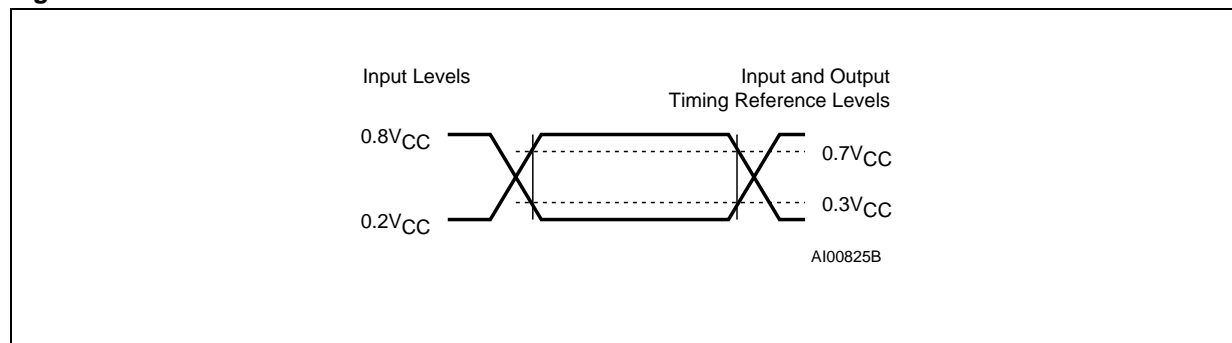


Table 12. Input Parameters

Symbol	Parameter <sup>1,2</sup>	Test Condition	Min.	Max.	Unit
$C_{IN}$	Input Capacitance (SDA)			8	pF
$C_{IN}$	Input Capacitance (other pins)			6	pF
$Z_{WCL}$	$\overline{WC}$ Input Impedance	$V_{IN} < 0.5 V$	5	70	k $\Omega$
$Z_{WCH}$	$\overline{WC}$ Input Impedance	$V_{IN} > 0.7V_{CC}$	500		k $\Omega$
$t_{NS}$	Pulse width ignored (Input Filter on SCL and SDA)	Single glitch		100	ns

Note: 1.  $T_A = 25^\circ C$ ,  $f = 400 kHz$

2. Sampled only, not 100% tested.

**Table 13. DC Characteristics (M24Cxx-xx6)**

Symbol	Parameter	Test Condition (in addition to those in Table 5)	Min.	Max.	Unit
$I_{LI}$	Input Leakage Current (SCL, SDA)	$V_{IN} = V_{SS}$ or $V_{CC}$		$\pm 2$	$\mu A$
$I_{LO}$	Output Leakage Current	$V_{OUT} = V_{SS}$ or $V_{CC}$ , SDA in Hi-Z		$\pm 2$	$\mu A$
$I_{CC}$	Supply Current	$V_{CC}=5V$ , $f_c=400kHz$ (rise/fall time < 30ns)		2	mA
$I_{CC1}$	Stand-by Supply Current	$V_{IN} = V_{SS}$ or $V_{CC}$ , $V_{CC} = 5 V$		1	$\mu A$
$V_{IL}$	Input Low Voltage (E2, E1, E0, SCL, SDA)		-0.45	$0.3V_{CC}$	V
	Input Low Voltage ( $\overline{WC}$ )		-0.45	0.5	V
$V_{IH}$	Input High Voltage (E2, E1, E0, SCL, SDA, $\overline{WC}$ )		$0.7V_{CC}$	$V_{CC}+1$	V
$V_{OL}$	Output Low Voltage	$I_{OL} = 3 mA$ , $V_{CC} = 5 V$		0.4	V

**Table 14. DC Characteristics (M24Cxx-xx3)**

Symbol	Parameter	Test Condition (in addition to those in Table 6)	Min.	Max.	Unit
$I_{LI}$	Input Leakage Current (SCL, SDA)	$V_{IN} = V_{SS}$ or $V_{CC}$		$\pm 2$	$\mu A$
$I_{LO}$	Output Leakage Current	$V_{OUT} = V_{SS}$ or $V_{CC}$ , SDA in Hi-Z		$\pm 2$	$\mu A$
$I_{CC}$	Supply Current	$V_{CC}=5V$ , $f_c=400kHz$ (rise/fall time < 30ns)		3	mA
$I_{CC1}$	Stand-by Supply Current	$V_{IN} = V_{SS}$ or $V_{CC}$ , $V_{CC} = 5 V$		5	$\mu A$
$V_{IL}$	Input Low Voltage (E2, E1, E0, SCL, SDA)		-0.45	$0.3V_{CC}$	V
	Input Low Voltage ( $\overline{WC}$ )		-0.45	0.5	V
$V_{IH}$	Input High Voltage (E2, E1, E0, SCL, SDA, $\overline{WC}$ )		$0.7V_{CC}$	$V_{CC}+1$	V
$V_{OL}$	Output Low Voltage	$I_{OL} = 3 mA$ , $V_{CC} = 5 V$		0.4	V



Table 15. DC Characteristics (M24Cxx-Wxx6)

Symbol	Parameter	Test Condition (in addition to those in Table 7)	Min.	Max.	Unit
$I_{LI}$	Input Leakage Current (SCL, SDA)	$V_{IN} = V_{SS}$ or $V_{CC}$		$\pm 2$	$\mu A$
$I_{LO}$	Output Leakage Current	$V_{OUT} = V_{SS}$ or $V_{CC}$ , SDA in Hi-Z		$\pm 2$	$\mu A$
$I_{CC}$	Supply Current	$V_{CC} = 2.5V$ , $f_C = 400kHz$ (rise/fall time < 30ns)		1	mA
$I_{CC1}$	Stand-by Supply Current	$V_{IN} = V_{SS}$ or $V_{CC}$ , $V_{CC} = 2.5 V$		0.5	$\mu A$
$V_{IL}$	Input Low Voltage (E2, E1, E0, SCL, SDA)		-0.45	$0.3V_{CC}$	V
	Input Low Voltage ( $\overline{WC}$ )		-0.45	0.5	V
$V_{IH}$	Input High Voltage (E2, E1, E0, SCL, SDA, $\overline{WC}$ )		$0.7V_{CC}$	$V_{CC}+1$	V
$V_{OL}$	Output Low Voltage	$I_{OL} = 2.1 mA$ , $V_{CC} = 2.5 V$		0.4	V

Table 16. DC Characteristics (M24Cxx-Wxx3)

Symbol	Parameter	Test Condition (in addition to those in Table 8)	Min. <sup>1</sup>	Max. <sup>1</sup>	Unit
$I_{LI}$	Input Leakage Current (SCL, SDA)	$V_{IN} = V_{SS}$ or $V_{CC}$		$\pm 2$	$\mu A$
$I_{LO}$	Output Leakage Current	$V_{OUT} = V_{SS}$ or $V_{CC}$ , SDA in Hi-Z		$\pm 2$	$\mu A$
$I_{CC}$	Supply Current	$V_{CC} = 2.5V$ , $f_C = 400kHz$ (rise/fall time < 30ns)		3	mA
$I_{CC1}$	Stand-by Supply Current	$V_{IN} = V_{SS}$ or $V_{CC}$ , $V_{CC} = 2.5 V$		2	$\mu A$
$V_{IL}$	Input Low Voltage (E2, E1, E0, SCL, SDA)		-0.45	$0.3V_{CC}$	V
	Input Low Voltage ( $\overline{WC}$ )		-0.45	0.5	V
$V_{IH}$	Input High Voltage (E2, E1, E0, SCL, SDA, $\overline{WC}$ )		$0.7V_{CC}$	$V_{CC}+1$	V
$V_{OL}$	Output Low Voltage	$I_{OL} = 2.1 mA$ , $V_{CC} = 2.5 V$		0.4	V

Note: 1. This is preliminary data.

**Table 17. DC Characteristics (M24Cxx-Lxx6)**

Symbol	Parameter	Test Condition (in addition to those in Table 9)	Min.	Max.	Unit
$I_{LI}$	Input Leakage Current (SCL, SDA)	$V_{IN} = V_{SS} \text{ or } V_{CC}$		$\pm 2$	$\mu\text{A}$
$I_{LO}$	Output Leakage Current	$V_{OUT} = V_{SS} \text{ or } V_{CC}$ , SDA in Hi-Z		$\pm 2$	$\mu\text{A}$
$I_{CC}$	Supply Current	$V_{CC} = 2.5\text{V}$ , $f_c = 400\text{kHz}$ (rise/fall time < 30ns)		1	mA
$I_{CC1}$	Stand-by Supply Current	$V_{IN} = V_{SS} \text{ or } V_{CC}$ , $V_{CC} = 2.5 \text{ V}$		0.5	$\mu\text{A}$
$V_{IL}$	Input Low Voltage (E2, E1, E0, SCL, SDA)		-0.45	$0.3V_{CC}$	V
	Input Low Voltage ( $\overline{WC}$ )		-0.45	0.5	V
$V_{IH}$	Input High Voltage (E2, E1, E0, SCL, SDA, $\overline{WC}$ )		$0.7V_{CC}$	$V_{CC}+1$	V
$V_{OL}$	Output Low Voltage	$I_{OL} = 2.1 \text{ mA}$ , $V_{CC} = 2.2 \text{ V}$		0.4	V

**Table 18. DC Characteristics (M24Cxx-Rxx6)**

Symbol	Parameter	Test Condition (in addition to those in Table 10)	Min.	Max.	Unit
$I_{LI}$	Input Leakage Current (SCL, SDA)	$V_{IN} = V_{SS} \text{ or } V_{CC}$		$\pm 2$	$\mu\text{A}$
$I_{LO}$	Output Leakage Current	$V_{OUT} = V_{SS} \text{ or } V_{CC}$ , SDA in Hi-Z		$\pm 2$	$\mu\text{A}$
$I_{CC}$	Supply Current	$V_{CC} = 1.8\text{V}$ , $f_c = 400\text{kHz}$ (rise/fall time < 30ns)		0.8	mA
$I_{CC1}$	Stand-by Supply Current	$V_{IN} = V_{SS} \text{ or } V_{CC}$ , $V_{CC} = 1.8 \text{ V}$		0.3	$\mu\text{A}$
$V_{IL}$	Input Low Voltage (E2, E1, E0, SCL, SDA)	$2.5 \text{ V} \leq V_{CC}$	-0.45	$0.3 V_{CC}$	V
		$1.8 \text{ V} \leq V_{CC} < 2.5 \text{ V}$	-0.45	$0.25 V_{CC}$	V
	Input Low Voltage ( $\overline{WC}$ )		-0.45	0.5	V
$V_{IH}$	Input High Voltage (E2, E1, E0, SCL, SDA, $\overline{WC}$ )		$0.7V_{CC}$	$V_{CC}+1$	V
$V_{OL}$	Output Low Voltage	$I_{OL} = 0.7 \text{ mA}$ , $V_{CC} = 1.8 \text{ V}$		0.2	V

Table 19. AC Characteristics (M24Cxx-xx6, M24Cxx-Wxx3)

Test conditions specified in Table 11 and Table 5 or 8					
Symbol	Alt.	Parameter	Min. <sup>4</sup>	Max. <sup>4</sup>	Unit
f <sub>C</sub>	f <sub>SCL</sub>	Clock Frequency		400	kHz
t <sub>CHCL</sub>	t <sub>HIGH</sub>	Clock Pulse Width High	600		ns
t <sub>CLCH</sub>	t <sub>LOW</sub>	Clock Pulse Width Low	1300		ns
t <sub>DL1DL2</sub> <sup>2</sup>	t <sub>F</sub>	SDA Fall Time	20	300	ns
t <sub>DXCX</sub>	t <sub>SU:DAT</sub>	Data In Set Up Time	100		ns
t <sub>CLDX</sub>	t <sub>HD:DAT</sub>	Data In Hold Time	0		ns
t <sub>CLQX</sub>	t <sub>DH</sub>	Data Out Hold Time	200		ns
t <sub>CLQV</sub> <sup>3</sup>	t <sub>AA</sub>	Clock Low to Next Data Valid (Access Time)	200	900	ns
t <sub>CHDX</sub> <sup>1</sup>	t <sub>SU:STA</sub>	Start Condition Set Up Time	600		ns
t <sub>DLCL</sub>	t <sub>HD:STA</sub>	Start Condition Hold Time	600		ns
t <sub>CHDH</sub>	t <sub>SU:STO</sub>	Stop Condition Set Up Time	600		ns
t <sub>DHDL</sub>	t <sub>BUF</sub>	Time between Stop Condition and Next Start Condition	1300		ns
t <sub>W</sub>	t <sub>WR</sub>	Write Time		5	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. This is preliminary data for M24Cxx-Wxx3.

Table 20. AC Characteristics (M24Cxx-xx3, M24Cxx-Wxx6, M24Cxx-Lxx6)

Test conditions specified in Table 11 and Table 6 or 7 or 9					
Symbol	Alt.	Parameter	Min.	Max.	Unit
f <sub>C</sub>	f <sub>SCL</sub>	Clock Frequency		400	kHz
t <sub>CHCL</sub>	t <sub>HIGH</sub>	Clock Pulse Width High	600		ns
t <sub>CLCH</sub>	t <sub>LOW</sub>	Clock Pulse Width Low	1300		ns
t <sub>DL1DL2</sub> <sup>2</sup>	t <sub>F</sub>	SDA Fall Time	20	300	ns
t <sub>DXCX</sub>	t <sub>SU:DAT</sub>	Data In Set Up Time	100		ns
t <sub>CLDX</sub>	t <sub>HD:DAT</sub>	Data In Hold Time	0		ns
t <sub>CLQX</sub>	t <sub>DH</sub>	Data Out Hold Time	200		ns
t <sub>CLQV</sub> <sup>3</sup>	t <sub>AA</sub>	Clock Low to Next Data Valid (Access Time)	200	900	ns
t <sub>CHDX</sub> <sup>1</sup>	t <sub>SU:STA</sub>	Start Condition Set Up Time	600		ns
t <sub>DLCL</sub>	t <sub>HD:STA</sub>	Start Condition Hold Time	600		ns
t <sub>CHDH</sub>	t <sub>SU:STO</sub>	Stop Condition Set Up Time	600		ns
t <sub>DHDL</sub>	t <sub>BUF</sub>	Time between Stop Condition and Next Start Condition	1300		ns
t <sub>W</sub>	t <sub>WR</sub>	Write Time		10 or <sup>4</sup> 5	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. 10ms write time is offered on the standard device. 5ms write time is offered on new products bearing the Process Identification letter "W" on the package, as described in Table 27.

Table 21. AC Characteristics (M24Cxx-Rxx6)

Test conditions specified in Table 11 and Table 10							
Symbol	Alt.	Parameter	Min.	Max.	Min. <sup>4</sup>	Max. <sup>4</sup>	Unit
$f_C$	$f_{SCL}$	Clock Frequency		100		400	kHz
$t_{CHCL}$	$t_{HIGH}$	Clock Pulse Width High	4000		600		ns
$t_{CLCH}$	$t_{LOW}$	Clock Pulse Width Low	4700		1300		ns
$t_{DL1DL2}^2$	$t_F$	SDA Fall Time	20	300	20	300	ns
$t_{DXCX}$	$t_{SU:DAT}$	Data In Set Up Time	250		100		ns
$t_{CLDX}$	$t_{HD:DAT}$	Data In Hold Time	0		0		ns
$t_{CLQX}$	$t_{DH}$	Data Out Hold Time	200		200		ns
$t_{CLQV}^3$	$t_{AA}$	Clock Low to Next Data Valid (Access Time)	200	3500	200	900	ns
$t_{CHDX}^1$	$t_{SU:STA}$	Start Condition Set Up Time	4700		600		ns
$t_{DLCL}$	$t_{HD:STA}$	Start Condition Hold Time	4000		600		ns
$t_{CHDH}$	$t_{SU:STO}$	Stop Condition Set Up Time	4000		600		ns
$t_{DHDL}$	$t_{BUF}$	Time between Stop Condition and Next Start Condition	4700		1300		ns
$t_W$	$t_{WR}$	Write Time		10		10	ms

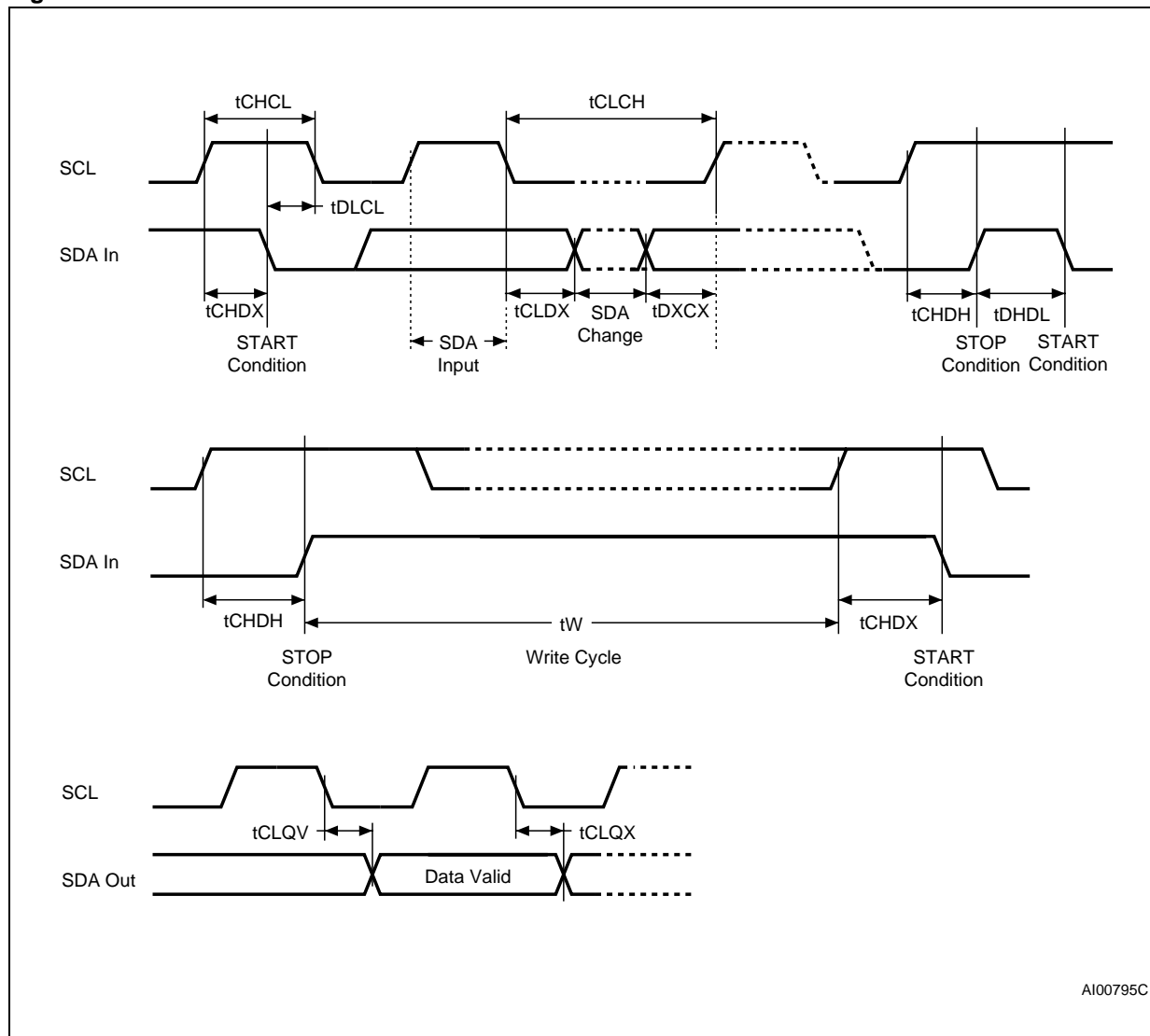
Note: 1. For a reSTART condition, or following a Write cycle.

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. 100kHz clock frequency is offered on the standard device. 400kHz clock frequency is offered on new products bearing the Process Identification letter "W" on the package, as described in Table 27.

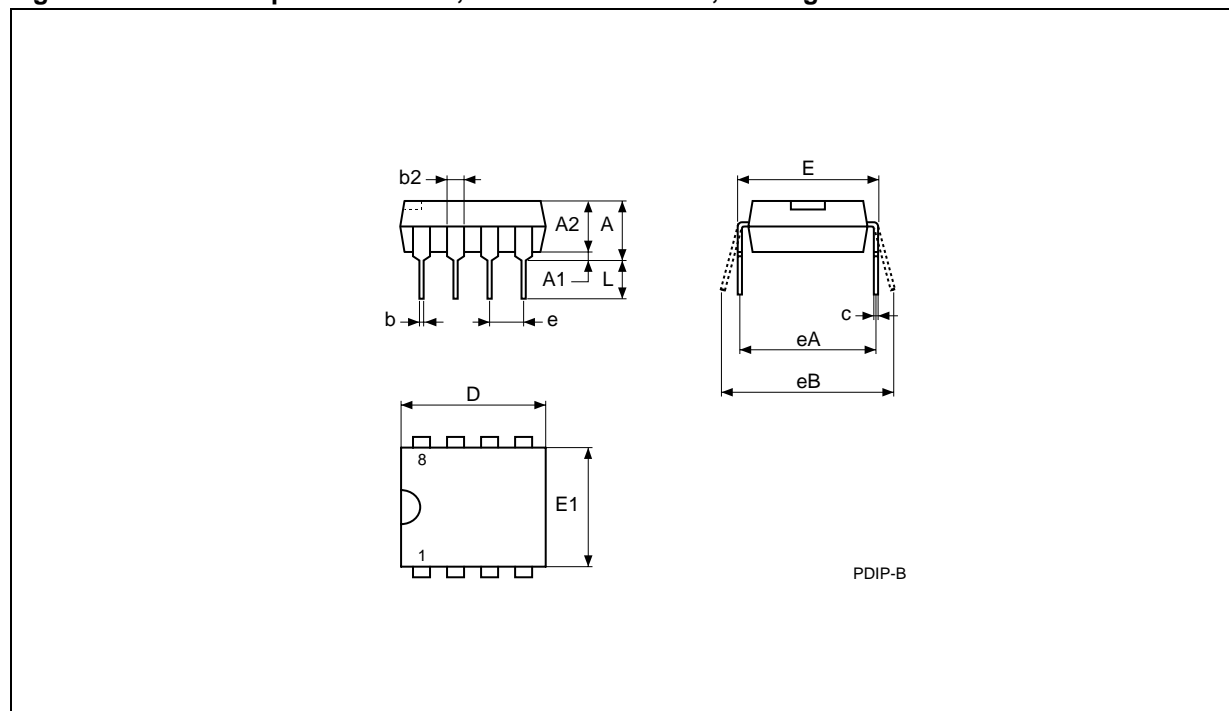
Figure 11. AC Waveforms



AI00795C

PACKAGE MECHANICAL

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

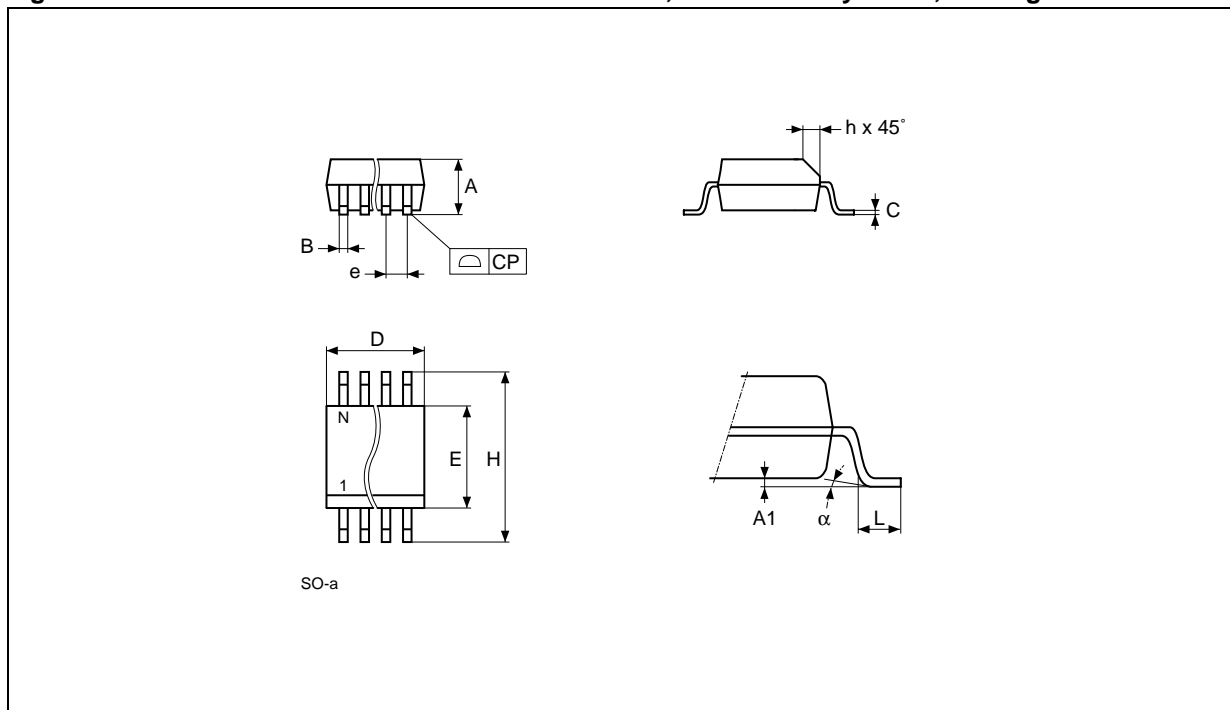


Notes: 1. Drawing is not to scale.

Table 22. PDIP8 – 8 pin Plastic DIP, 0.25mm lead frame, Package Mechanical Data

Symb.	mm			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. SO8 narrow – 8 lead Plastic Small Outline, 150 mils body width, Package Outline

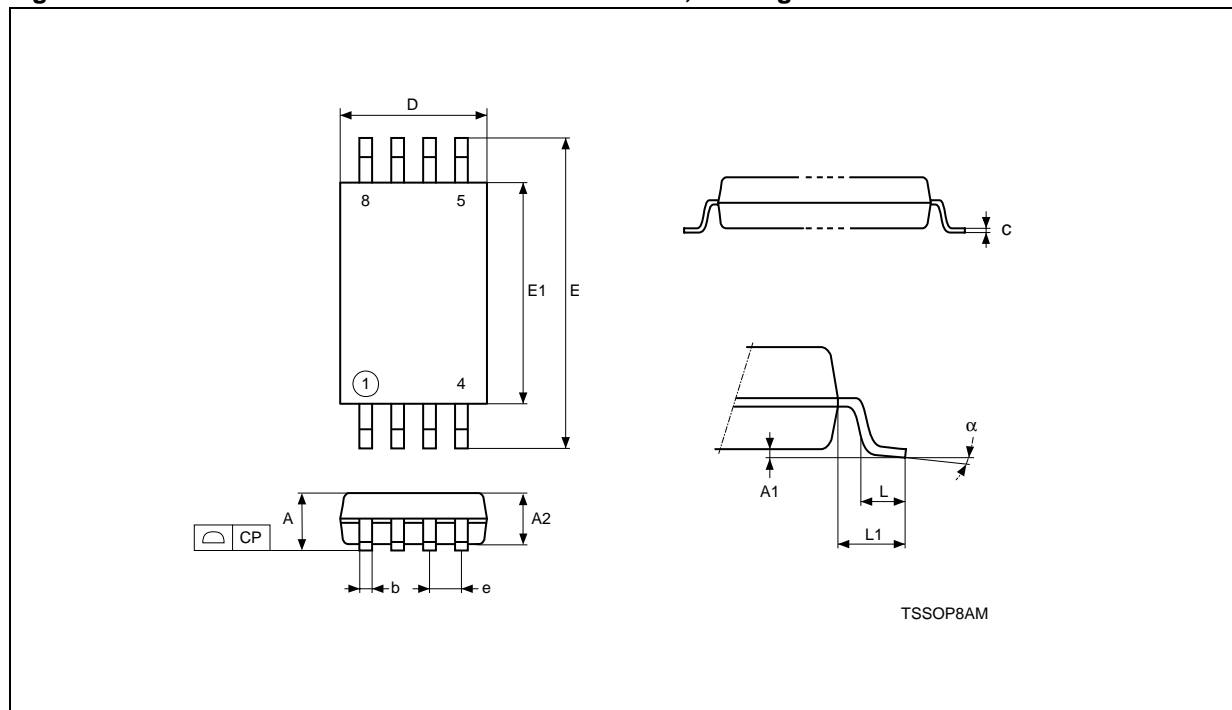


Note: Drawing is not to scale.

Table 23. SO8 narrow – 8 lead Plastic Small Outline, 150 mils body width, Package Mechanical Data

Symb.	mm			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
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
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
$\alpha$		0°	8°		0°	8°
N		8			8	
CP			0.10			0.004

Figure 14. TSSOP8 – 8 lead Thin Shrink Small Outline, Package Outline

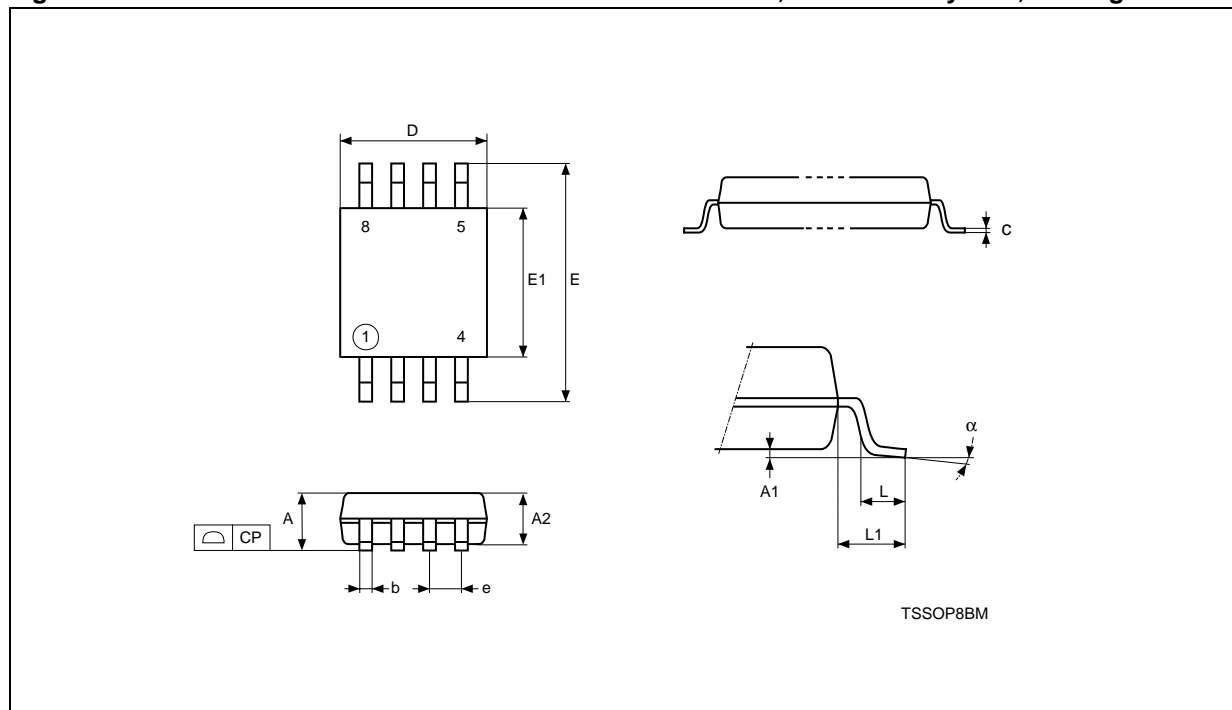


Notes: 1. Drawing is not to scale.

Table 24. TSSOP8 – 8 lead Thin Shrink Small Outline, Package Mechanical Data

Symbol	mm			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		
α		0°	8°		0°	8°



Figure 15. TSSOP8 3x3mm<sup>2</sup> – 8 lead Thin Shrink Small Outline, 3x3mm<sup>2</sup> body size, Package Outline

Notes: 1. Drawing is not to scale.

Table 25. TSSOP8 3x3mm<sup>2</sup> – 8 lead Thin Shrink Small Outline, 3x3mm<sup>2</sup> body size, Package Mechanical Data

Symbol	mm			inches		
	Typ.	Min.	Max.	Typ.	Min.	Max.
A			1.100			0.0433
A1		0.050	0.150		0.0020	0.0059
A2	0.850	0.750	0.950	0.0335	0.0295	0.0374
b		0.250	0.400		0.0098	0.0157
c		0.130	0.230		0.0051	0.0091
D	3.000	2.900	3.100	0.1181	0.1142	0.1220
E	4.900	4.650	5.150	0.1929	0.1831	0.2028
E1	3.000	2.900	3.100	0.1181	0.1142	0.1220
e	0.650	–	–	0.0256	–	–
CP			0.100			0.0039
L	0.550	0.400	0.700	0.0217	0.0157	0.0276
L1	0.950			0.0374		
α		0°	6°		0°	6°

**PART NUMBERING**

**Table 26. Ordering Information Scheme**

Example:	M24C08	-	W	DW	6	T	P	/W
<b>Device Type</b>								
M24 = I <sup>2</sup> C serial access EEPROM								
<b>Device Function</b>								
16 = 16 Kbit (2048 x 8)								
08 = 8 Kbit (1024 x 8)								
04 = 4 Kbit (512 x 8)								
02 = 2 Kbit (256 x 8)								
01 = 1 Kbit (128 x 8)								
<b>Operating Voltage</b>								
blank = V <sub>CC</sub> = 4.5 to 5.5V (400kHz)								
W <sup>1</sup> = V <sub>CC</sub> = 2.5 to 5.5V (400kHz)								
L = V <sub>CC</sub> = 2.2 to 5.5V (400kHz)								
R = V <sub>CC</sub> = 1.8 to 5.5V (400kHz)								
<b>Package</b>								
BN = PDIP8								
MN = SO8 (150 mil width)								
DW = TSSOP8 (169 mil width)								
DS = TSSOP8 (3x3mm <sup>2</sup> body size, MSOP8)								
<b>Temperature Range</b>								
6 = -40 to 85 °C								
3 = -40 to 125 °C								
<b>Option</b>								
T = Tape & Reel Packing								
<b>Plating Technology<sup>2</sup></b>								
blank = Standard SnPb plating								
P = Pb-free plating								
G = Green pack								
<b>Process<sup>2</sup></b>								
blank = F6SP20%								
/W = F6SP36%								

Note: 1. 2.5 to 5.5V devices bearing the process letter "W" in the package marking (on the top side of the package, on the right side, see Table 27, below), guarantee a maximum write time of 5ms, instead of the standard 10ms. For more information about these devices, and their device identification, please ask your ST Sales Office for Process Change Notices PCN MPG/EE/0061 and 0062 (PCEE0061 and PCEE0062).  
 2. Used only for M24Cxx-xx3

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.

**Table 27. How to Identify Current and New Products by the Process Identification Letter**

<b>Markings on Current Products<sup>1</sup></b>	<b>Markings on New Products<sup>1</sup></b>
24CxxW6 ST xxxxL	24CxxW6 ST xxxxW

Note: 1. This example comes from the S08 package. Other packages have similar information. For further information, please ask your ST Sales Office for Process Change Notices PCN MPG/EE/0061 and 0062 (PCEE0061 and PCEE0062).

## REVISION HISTORY

Table 28. Document Revision History

Date	Version	Description of Revision
10-Dec-1999	2.4	TSSOP8 Turned-Die package removed (p 2 and order information) Lead temperature added for TSSOP8 in table 2
18-Apr-2000	2.5	Labelling change to Fig-2D, correction of values for 'E' and main caption for Tab-13
05-May-2000	2.6	Extra labelling to Fig-2D
23-Nov-2000	3.0	SBGA package information removed to an annex document -R range changed to being the -S range, and the new -R range added
19-Feb-2001	3.1	SBGA package information put back in this document Lead Soldering Temperature in the Absolute Maximum Ratings table amended Write Cycle Polling Flow Chart using ACK illustration updated References to PSDIP changed to PDIP and Package Mechanical data updated Wording brought in to line with standard glossary
20-Apr-2001	3.2	Revision of DC and AC characteristics for the -S series
08-Oct-2001	3.3	Ball numbers added to the SBGA connections and package mechanical illustrations
09-Nov-2001	3.4	Specification of Test Condition for Leakage Currents in the DC Characteristics table improved
30-Jul-2002	3.5	Document reformatted using new template. SBGA5 package removed TSSOP8 (3x3mm <sup>2</sup> body size) package (MSOP8) added. -L voltage range added
04-Feb-2003	3.6	Document title spelt out more fully. "W"-marked devices with $t_w=5\text{ms}$ added.
05-May-2003	3.7	-R voltage range upgraded to 400kHz working, and no longer preliminary data. 5V voltage range at temperature range 3 (-xx3) no longer preliminary data. -S voltage range removed. -Wxx3 voltage+temp ranged added as preliminary data.
07-Oct-2003	4.0	Table of contents, and Pb-free options added. Minor wording changes in Summary Description, Power-On Reset, Memory Addressing, Read Operations. $V_{IL}(\text{min})$ improved to -0.45V. $t_W(\text{max})$ value for -R voltage range corrected.

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