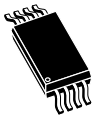
M24C32-R M24C32-F M24C32-DF
M24C32-X M24C32-W

Datasheet

32-Kbit serial I²C bus EEPROM

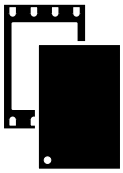
SO8N (MN)

150 mil width



TSSOP8 (DW)

169 mil width



UFDFPN8 (MC)

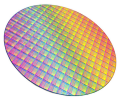
DFN8

2 x 3 mm

UFDFPN5 (MH)

DFN5

1.7 x 1.4 mm



Unsawn wafer

Product status
M24C32-R
M24C32-F
M24C32-DF
M24C32-X
M24C32-W

Product label

Features

I²C interface

- Compatible with the following I²C bus modes:
  - 1 MHz (fast mode plus)
  - 400 kHz (fast mode)
  - 100 kHz (standard mode)

Memory

- 32 Kbit (4 Kbyte) of EEPROM
- Page size: 32 bytes
- Additional 32-byte identification page for M24C32-D only

Power supply

- Wide voltage range:
  - From 1.7 V to 5.5 V over -40 °C to +85 °C
  - From 1.6 V to 5.5 V under temperature constraint

Temperature

- Operating temperature range: From -40 °C up to +85 °C

Fast write cycle time

- Byte and page write within 5 ms (3.2 ms typical)

Performance

- Enhanced ESD/latch-up protection
- More than 4 million write cycles
- More than 200-year data retention

Advanced features

- Hardware write protection of the whole memory array
- Random and sequential read modes

Package

- SO8N, TSSOP8, UFDFPN8, and UFDFPN5 (ECOPACK2)
- Unsawn wafer (each die is tested)

1 Description

The M24C32-xx is a 32-Kbit I2C-compatible EEPROM (electrically erasable programmable memory) organized as 4 K × 8 bits.

The M24C32-W can operate with a supply voltage from 2.5 V to 5.5 V, the M24C32-R can operate with a supply voltage from 1.8 V to 5.5 V, and the M24C32-F and M24C32-DF can operate with a supply voltage from 1.7 V to 5.5 V, over an ambient temperature range of -40 °C / +85 °C; while the M24C32-X can operate with a supply voltage from 1.6 V to 5.5 V over an ambient temperature range of -20 °C / +85 °C.

The M24C32-DF offers an additional page, named the identification page (32 bytes). The identification page can be used to store sensitive application parameters, which can be (later) permanently locked in read-only mode.

Figure 1. Logic diagram

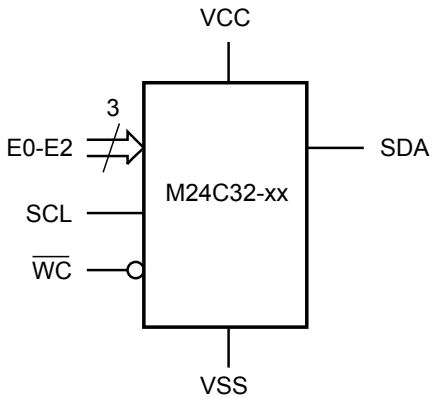


Table 1. Signal names

Signal name	Function	Direction
E2, E1, E0	Chip enable	Input
SDA	Serial data	I/O
SCL	Serial clock	Input
$\overline{WC}$	Write control	Input
V_{CC}	Supply voltage	-
V_{SS}	Ground	-

Figure 2. 8-pin package connections, top view

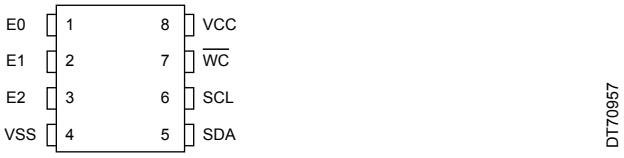
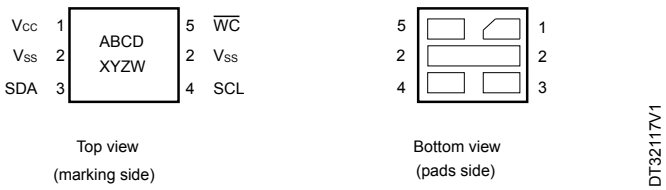


Figure 3. UFDFPN5 (DFN5) package connections



1. *Inputs E2, E1, E0 are not connected, therefore read as (000). Refer to Section 2.3 for further explanations.*

2 Signal description

2.1 Serial clock (SCL)

The signal applied on the SCL input is used to strobe the data available on SDA(in) and to output the data on SDA(out).

2.2 Serial data (SDA)

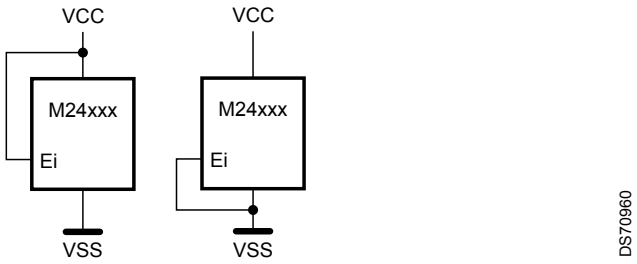
SDA is an input/output used to transfer data in or data out of the device. SDA(out) is an open drain output that may be wired-AND with other open drain or open collector signals on the bus. A pull-up resistor must be connected from serial data (SDA) to V_{CC} (Figure 14 and Figure 15 indicate how to calculate the value of the pull-up resistor).

2.3 Chip enable (E2, E1, E0)

(E2, E1, E0) 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 (see Table 2). These inputs must be tied to V_{CC} or V_{SS}, as shown in Figure 4. When not connected (left floating), these inputs are read as low (0).

For the UFDFPN5 package, the (E2, E1, E0) inputs are not connected, therefore read as (0,0,0).

Figure 4. Chip enable inputs connection



2.4 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. Write operations are enabled when write control ($\overline{WC}$) is either driven low or left floating.

When write control ($\overline{WC}$) is driven high, device select and address bytes are acknowledged, data bytes are not acknowledged.

2.5 V_{SS} (ground)

V_{SS} is the reference for the V_{CC} supply voltage.

2.6 Supply voltage (V_{CC})

2.6.1 Operating supply voltage (V_{CC})

Before selecting the memory and issuing instructions to it, a valid and stable V_{CC} voltage within the specified [V_{CC}(min), V_{CC}(max)] range must be applied (see operating conditions in Section 8: DC and AC parameters).

To secure a stable DC supply voltage, it is recommended to decouple the V_{CC} line with a suitable capacitor (usually from 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).

2.6.2 Power-up conditions

The V_{CC} voltage has to rise continuously from 0 V up to the minimum V_{CC} operating voltage (see operating conditions in Section 8: DC and AC parameters).

2.6.3 Device reset

To prevent inadvertent write operations during power-up, a power-on reset (POR) circuit is included.

At power-up, the device does not respond to any instruction until V_{CC} has reached the internal reset threshold voltage. This threshold is lower than the minimum V_{CC} operating voltage (see operating conditions in Section 8: DC and AC parameters). When V_{CC} passes over the POR threshold, the device is reset and enters the standby power mode. The device must not be accessed until V_{CC} reaches a valid and stable DC voltage within the specified [V_{CC}(min), V_{CC}(max)] range (see operating conditions in Section 8: DC and AC parameters).

Similarly, during power-down, when the V_{CC} decreases, the device must not be accessed once V_{CC} drops below V_{CC}(min). When V_{CC} drops below the power-on-reset threshold voltage, the device stops responding to any instruction sent to it.

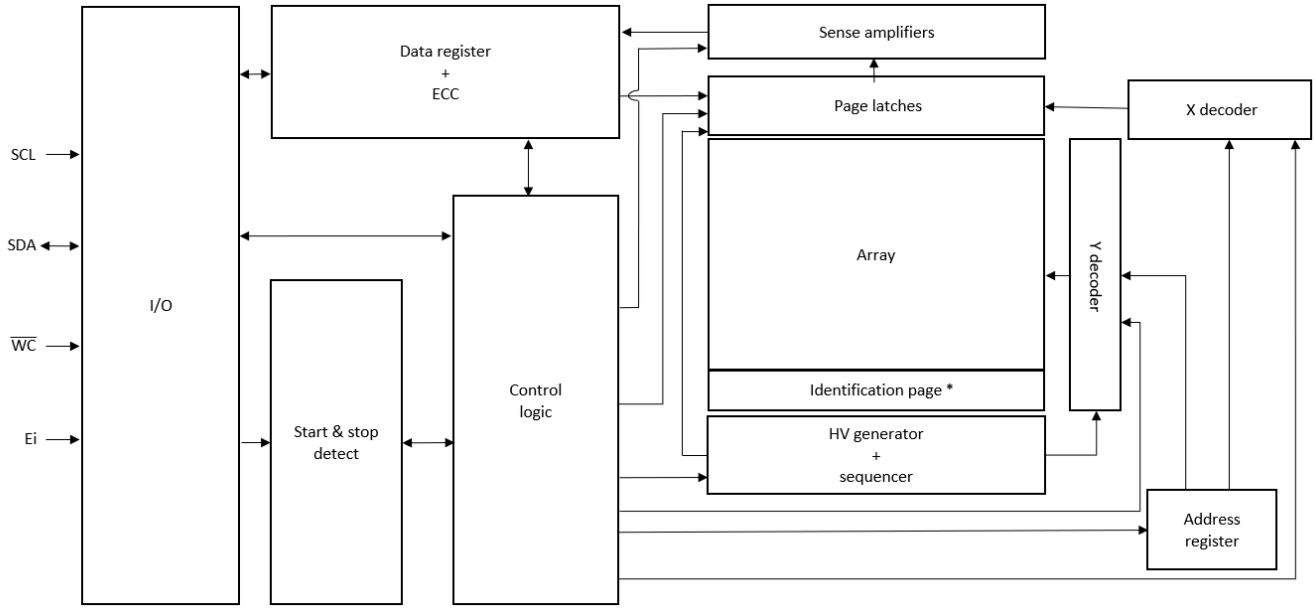
2.6.4 Power-down conditions

During power-down (continuous decrease in V_{CC}), the device must be in the standby power mode (mode reached after decoding a stop condition, assuming that there is no internal write cycle in progress).

3 Memory organization

The memory is organized as shown below.

Figure 5. Block diagram

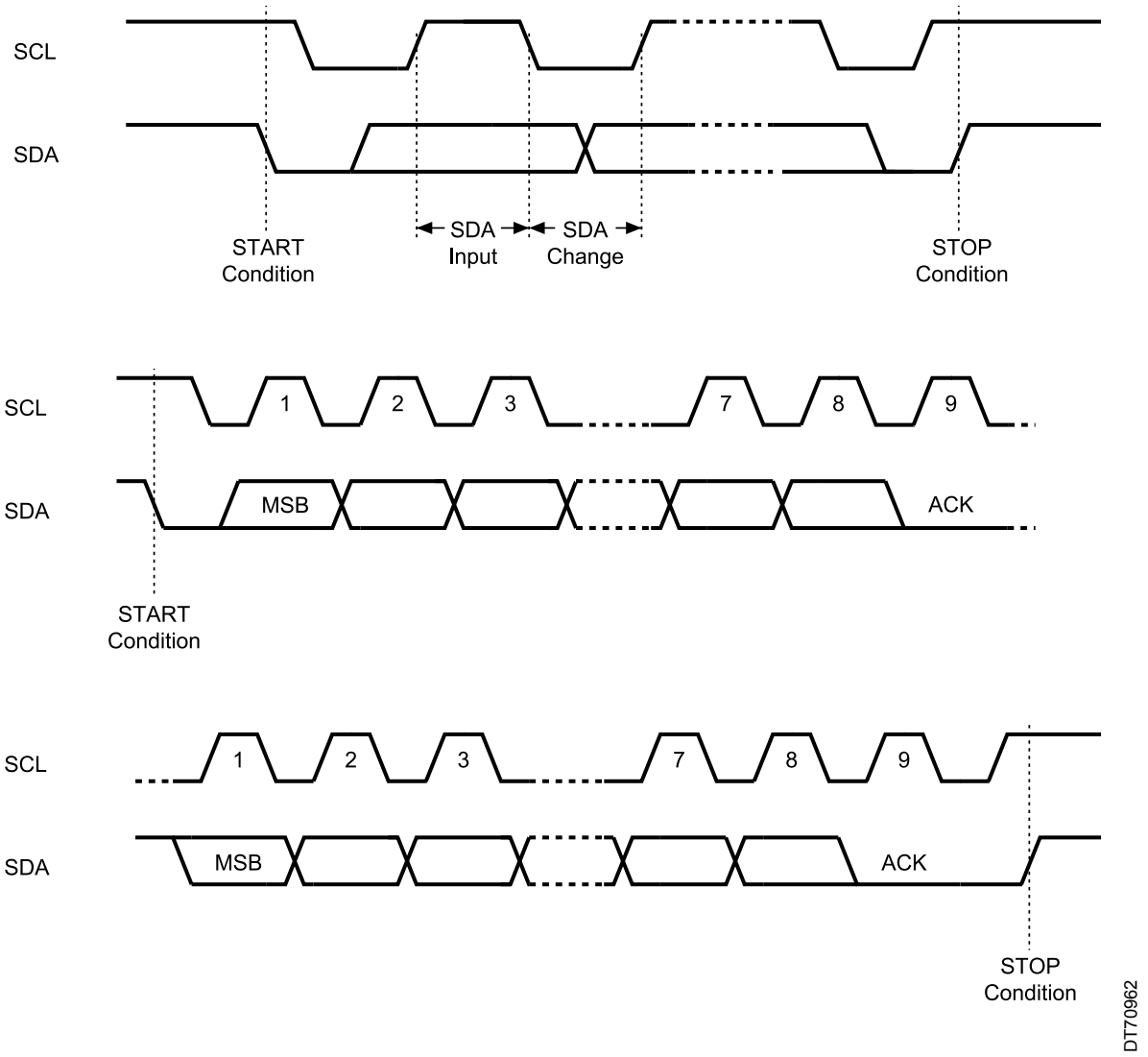


*: For M24C32-DF only

4 Device operation

The device supports the I²C protocol. This is summarized in Figure 6. 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 controller, and the other as the target device. A data transfer can only be initiated by the bus controller, which also provides the serial clock for synchronization. The device is always a target in all communications.

Figure 6. I²C bus protocol



4.1 Start condition

Start is identified by a falling edge of serial data (SDA) while the serial clock (SCL) is stable in the high state. A start condition must precede any data transfer instruction. The device continuously monitors (except during a write cycle) serial data (SDA) and serial clock (SCL) for a start condition.

4.2 Stop condition

Stop is identified by a rising edge of serial data (SDA) while the serial clock (SCL) is stable in the high state. A stop condition terminates communication between the device and the bus controller. A read instruction that is followed by NoAck can be followed by a stop condition to force the device into the standby mode.

A stop condition at the end of a write instruction triggers the internal write cycle.

4.3 Data input

During data input, the device samples serial data (SDA) on the rising edge of the serial clock (SCL). For correct device operation, serial data (SDA) must be stable during the rising edge of the serial clock (SCL), and the serial data (SDA) signal must change only when the serial clock (SCL) is driven low.

4.4 Acknowledge bit (ACK)

The acknowledge bit is used to indicate a successful byte transfer. The bus transmitter, whether it be a bus controller or target device, releases serial data (SDA) after sending eight bits of data. During the 9^{th} clock pulse period, the receiver pulls serial data (SDA) low to acknowledge the receipt of the eight data bits.

4.5 Device addressing

To start communication between the bus controller and the target device, the bus controller must initiate a Start condition. Following this, the bus controller sends the device select code and byte address as specified in Table 2, Table 3, and Table 4.

When the device select code is received, the device only responds if the chip enable address is the same as the value on its chip enable E2, E1, E0 inputs.

The 8^{th} bit is the read/write bit (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^{th} bit time. If the device does not match the device select code, the device deselects itself from the bus, and goes into standby mode.

Table 2. Device select code

Features	Device type identifier bits				Chip enable address (1)			R/W
	Bit 7(2)	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0 (3)
Memory	1	0	1	0	E2	E1	E0	R/W
Identification page	1	0	1	1	E2	E1	E0	R/W
Identification page lock	1	0	1	1	E2	E1	E0	R/W

1. *E0, E1, and E2 are compared with the value read on input pins E0, E1, and E2.*
2. *MSB is sent first.*
3. *LSB*

Table 3. First byte address

Features	Bit 7(1)	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Memory	X	X	X	X	A11	A10	A9	A8
Identification page	X	X	X	X	X	0	X	X
Identification page lock	X	X	X	X	X	1	X	X

1. *MSB is sent first.*

Note: X = Don't care.

Table 4. Second byte address

Features	Bit 7(1)	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Memory	A7	A6	A5	A4	A3	A2	A1	A0
Identification page	X	X	X	A4	A3	A2	A1	A0
Identification page lock	X	X	X	X	X	X	X	X

1. *MSB is sent first.*

Note: X = Don't care.

5 Instructions

5.1 Write operations

Following a start condition the bus controller sends a device select code with the R/W bit (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. See in Section 4.5: Device addressing (Table 2, Table 3, and Table 4) how to address the memory and the identification page.

When the bus controller generates a stop condition immediately after a data byte ack bit (in the "10^{th} bit" time slot), either at the end of a byte write or a page write, the internal write cycle tW is triggered. A stop condition at any other time slot does not trigger the internal write cycle.

After the stop condition and the successful completion of an internal write cycle (t_W), the device internal address counter is automatically incremented to point to the next byte after the last modified byte.

During the internal write cycle, serial data (SDA) is disabled internally, and the device does not respond to any requests.

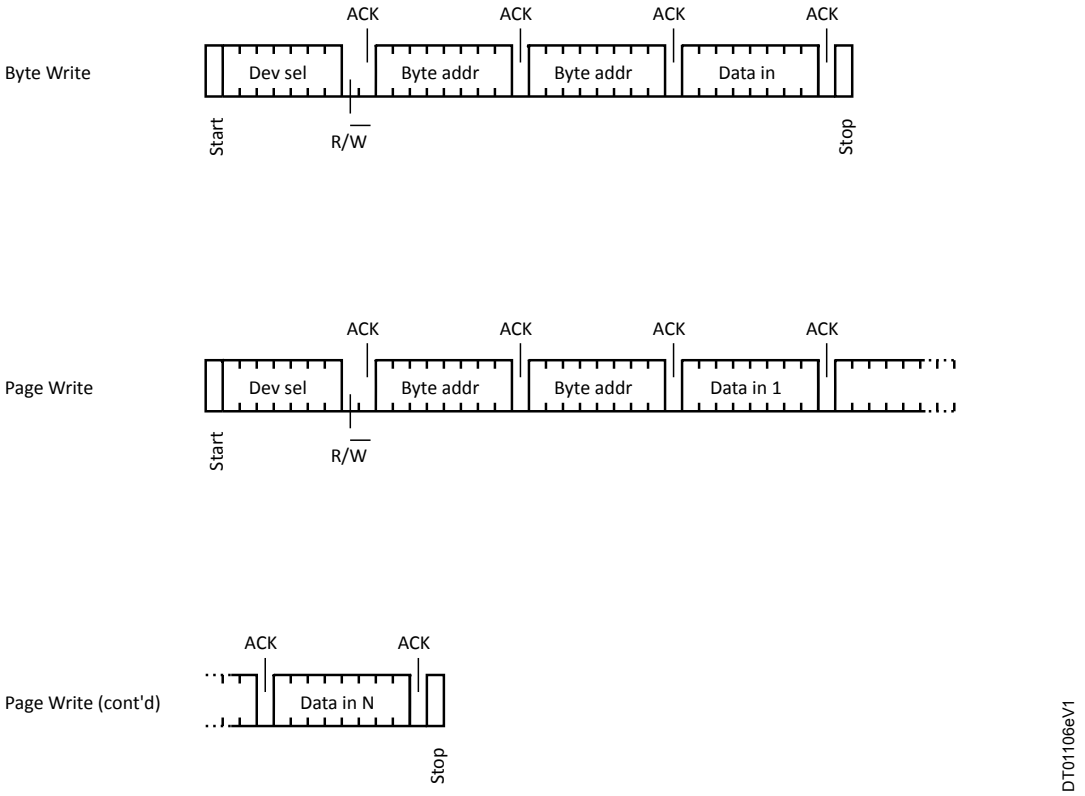
If the write control input ($\overline{WC}$) is driven high, the write instruction is not executed and the accompanying data bytes are not acknowledged, as shown in Figure 8.

5.1.1 Byte write

After the device select code and the address bytes, the bus controller sends one data byte.

If the addressed location is write-protected, by write control ($\overline{WC}$) being driven high, the device replies with no ACK, and the location is not modified, as shown in Figure 8. If, instead, the addressed location is not write-protected, the device replies with ACK. The bus controller terminates the transfer by generating a stop condition, as shown in the figure below:

Figure 7. Write mode sequence with data write enabled



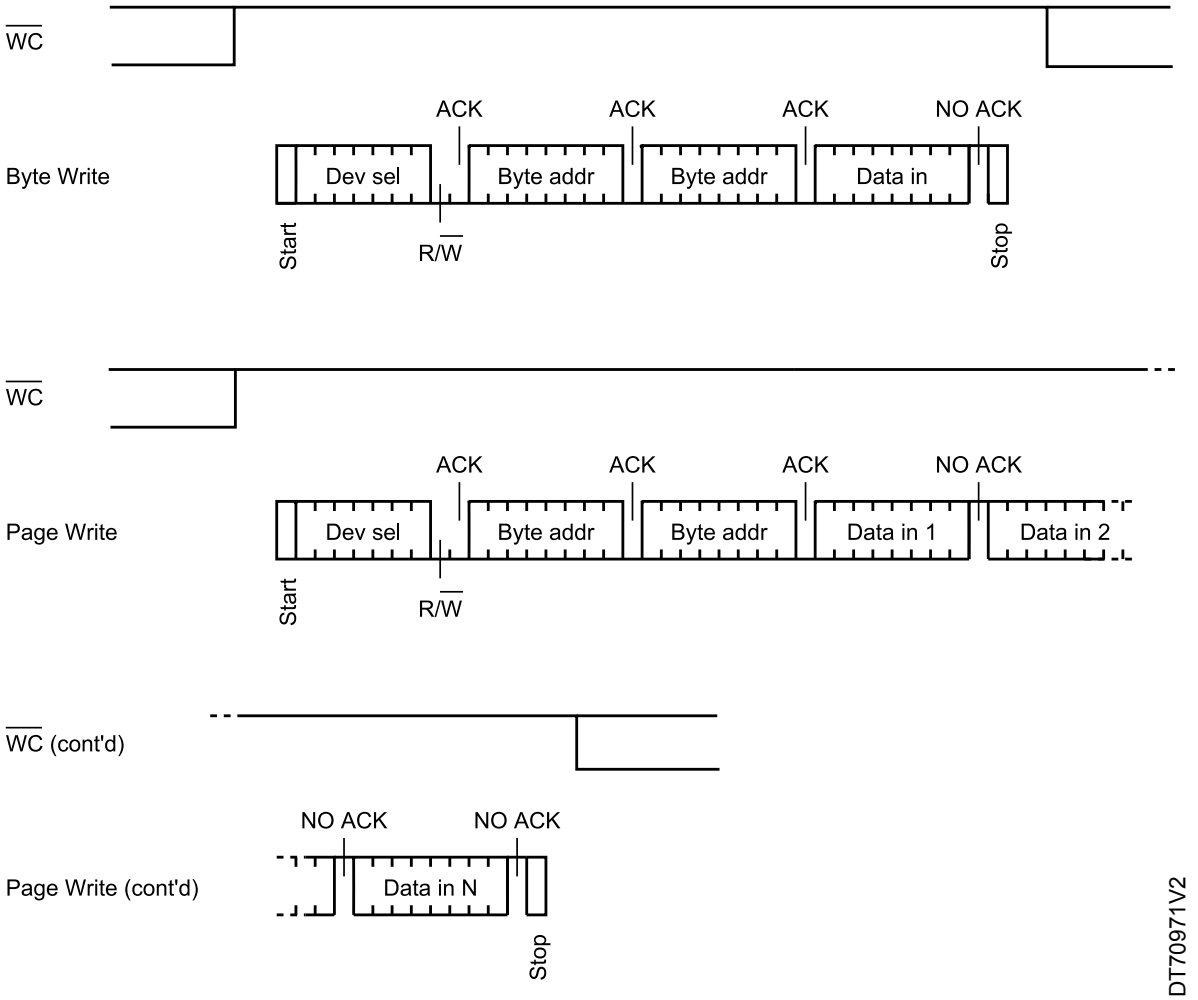
5.1.2 Page write

The page write mode allows up to 32 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, A16-A5, are the same. If more bytes are sent than fit up to the end of the page, a “roll-over” occurs, that is, the bytes exceeding the page end are written on the same page, from location 0.

The bus controller sends from 1 to 32 byte of data, each of which is acknowledged by the device if write control ($\overline{WC}$) is low. If write control ($\overline{WC}$) is high, the contents of the addressed memory location are not modified, and each data byte is followed by a NoAck, as shown in Figure 8. After each transferred byte, the internal page address counter is incremented.

The transfer is terminated by the bus controller generating a stop condition.

Figure 8. Write mode sequences with $\overline{WC}$ = 1 (data write inhibited)



5.1.3 Write identification page (M24C32-D only)

The identification page is an additional 32-byte page, which can be written and (later) permanently locked in read-only mode. It is written by issuing the write identification page instruction. This instruction uses the same protocol and format as page write (into memory array), except for the following differences:

- Device type identifier = 1011b
- MSB address bits A15 to A5 are don't care except for address bit A10, which must be ‘0’.
- LSB address bits A4 to A0 define the byte address inside the identification page.

If the identification page is locked, the data bytes transferred during the write identification page instruction are not acknowledged (NoAck).

5.1.4 Lock identification page (M24C32-D only)

The lock identification page instruction (lock ID) permanently locks the identification page in read-only mode. The lock ID instruction is similar to byte write (into memory array) with the following specific conditions:

- Device type identifier = 1011b
- Address bit A10 must be ‘1’; all other address bits are don't care
- The data byte must be equal to the binary value xxxx xx1x, where x is don't care.

5.1.5 ECC (error correction code) and write cycling

The ECC is offered only in devices identified with the process letter K, all other devices (identified with a different process letter) do not embed the ECC logic.

The error correction code (ECC) is an internal logic function, which is transparent for the I²C communication protocol.

The ECC logic is implemented on each group of four EEPROM bytes. Inside a group, if a single bit out of the four bytes happens to be erroneous during a read operation, the ECC detects this bit and replaces it with the correct value. The read reliability is therefore much improved.

Even if the ECC function is performed on groups of four bytes, a single byte can be written/cycled independently. In this case, the ECC function also writes/cycles the three other bytes located in the same group. As a consequence, the maximum cycling budget is defined at group level and the cycling can be distributed over the 4 bytes of the group: the sum of the cycles seen by byte0, byte1, byte2, and byte3 of the same group must remain below the maximum value defined Table 7.

*Note: A group of four bytes is located at addresses [4*N, 4*N+1, 4*N+2, 4*N+3], where N is an integer.*

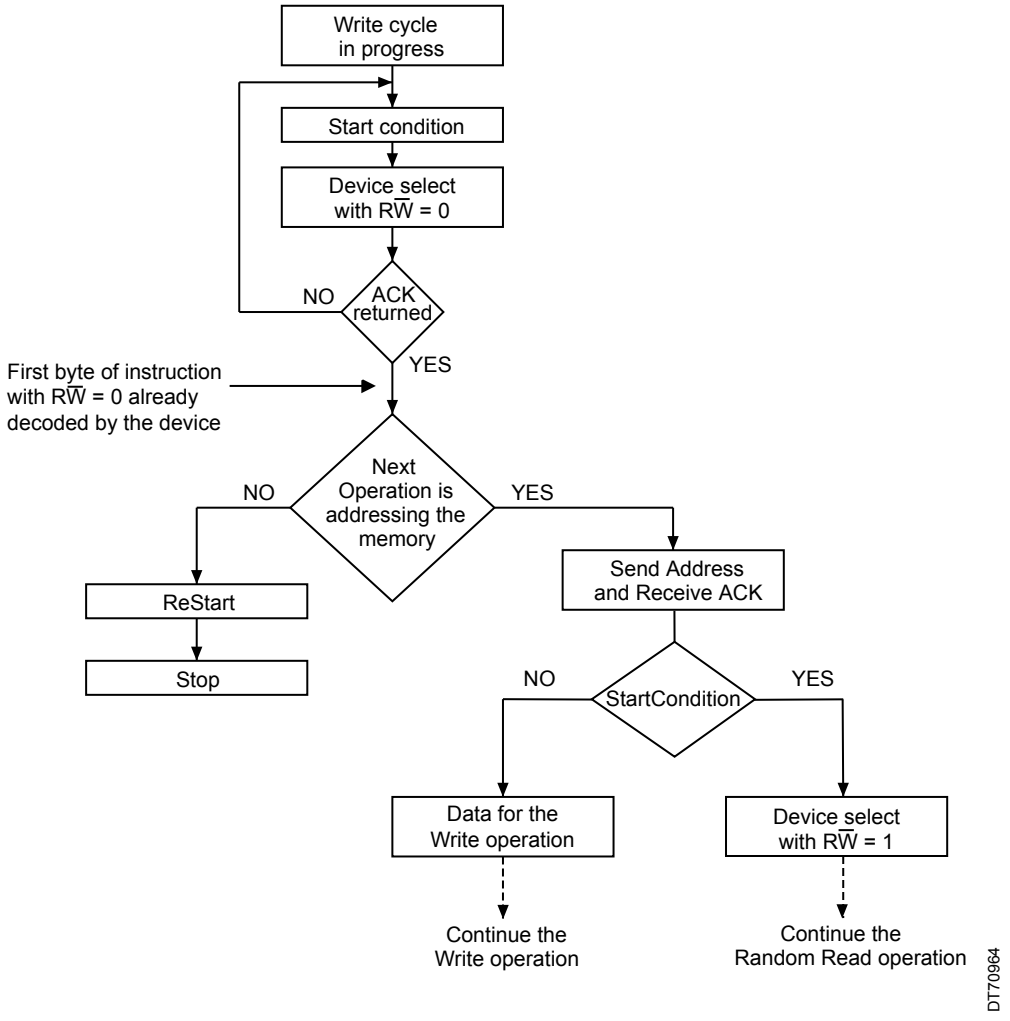
5.1.6 Minimizing write delays by polling on ACK

The maximum write time (t_W) is shown in AC characteristics tables in Section 8: DC and AC parameters, but the typical time is shorter. To use this, a polling sequence can be used by the bus controller.

The sequence, as shown in Figure 9, is:

- Initial condition: a writing cycle is in progress.
- Step 1: the bus controller 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 is returned and the bus controller 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. Write cycle polling flowchart using ACK



Note: The seven most significant bits of the device select code of a random read (bottom-right box in the figure) must be identical to the seven most significant bits of the device select code of the write (polling instruction in the figure).

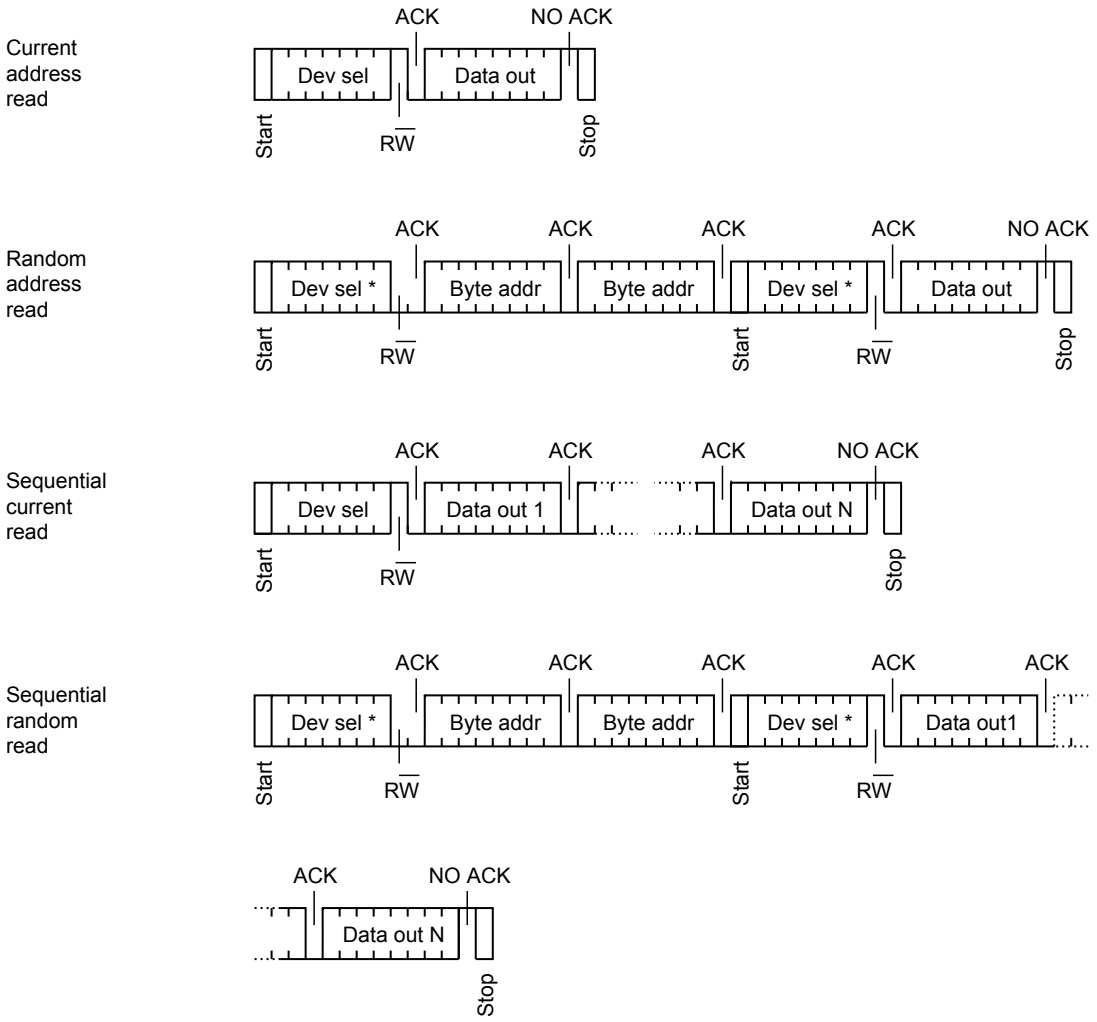
5.2 Read operations

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

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

For the read instructions, after each byte read (data out), the device waits for an acknowledgment (data in) during the 9th bit time. If the bus controller does not acknowledge during this 9th time, the device terminates the data transfer and switches to its standby mode after a stop condition.

Figure 10. Read mode sequences



5.2.1 Random address read

A dummy write is first performed to load the address into this address counter (as shown in Figure 10) but without sending a stop condition. Then, the bus controller 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 controller must not acknowledge the byte, and terminates the transfer with a stop condition.

5.2.2 Current address read

For the current address read operation, following a start condition, the bus controller 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 controller terminates the transfer with a stop condition, as shown in Figure 10, without acknowledging the byte.

Note: The address counter value is defined by instructions accessing either the memory, or the identification page. When accessing the identification page, the address counter value is loaded with the byte location, therefore the next current address read in the memory uses this new address counter value. When accessing the memory, it is safer to always use the random address read instruction (this instruction loads the address counter with the byte location to read in the memory, see Section 5.2.1: Random address read) instead of the current address read instruction.

5.2.3 Sequential read

This operation can be used after a current address read or a random address read. The bus controller 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 controller must not acknowledge the last byte, and must generate a stop condition, as shown in Figure 10.

The output data originates from consecutive addresses, with the internal address counter incrementing automatically after each byte is output. After the final memory address, the address counter rolls over, and the device outputs data starting from memory address 00h.

5.2.4 Read identification page (M24C32-D only)

The identification page is a 32-bytes additional page, which can be written and (later) permanently locked in read-only mode.

The identification page can be read by issuing a read identification page instruction. This instruction uses the same protocol and format as the random address read (from memory array) except for the following differences:

- Device type identifier = 1011b
- MSB address bits A15 to A8 are don't care
- LSB address bits A7 to A5 are don't care. Bits A4 to A0 define the byte address inside the identification page.

The number of bytes to read in the ID page must not exceed the page boundary (for example: when reading the identification page from location 10d, the number of bytes should be less than or equal to 22, as the ID page boundary is 32 bytes).

5.2.5 Read the lock status (M24C32-D only)

The locked/unlocked status of the identification page can be checked by transmitting a specific truncated command [identification page write instruction + one data byte] to the device. The device returns an acknowledge bit if the identification page is unlocked, otherwise a NoAck bit if the identification page is locked.

Right after this, it is recommended to transmit to the device a start condition followed by a stop condition, so that:

- Start: the truncated command is not executed because the start condition resets the device internal logic,
- Stop: the device is then set back into standby mode by the stop condition

Figure 11. Read lock status (identification page unlocked)

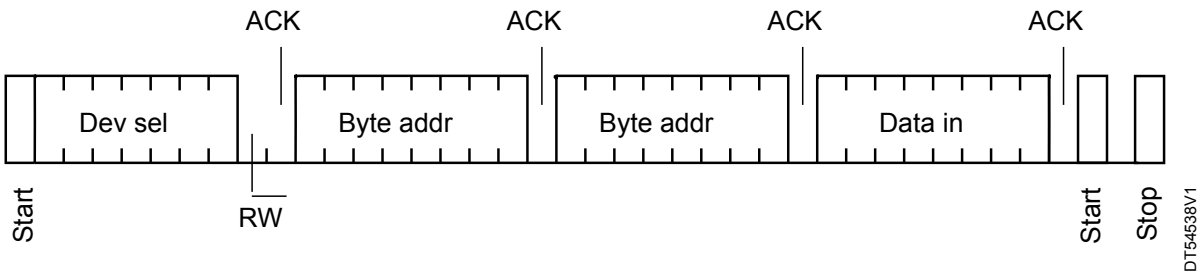
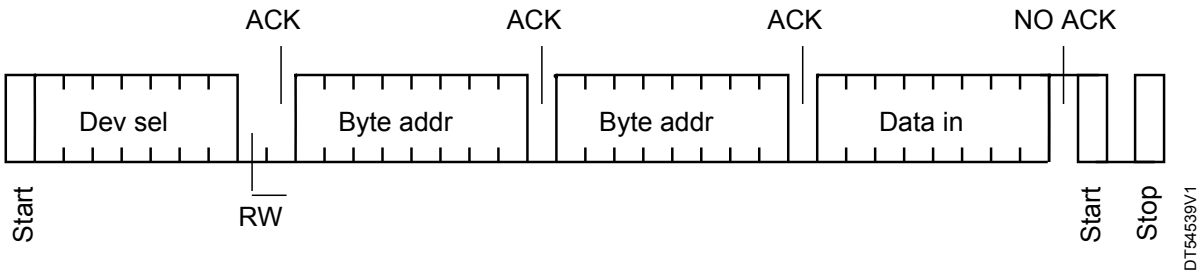


Figure 12. Read lock status (identification page locked)



6 Initial delivery state

The packaged device is delivered with:

- All the memory array bits set to 1 (each byte contains FFh)
- All the identification page bits set to 1 (each byte contains FFh)

And when delivered in unsawn wafer:

- All the memory array bits set to 1 (each byte contains FFh), except the last byte located at the address 0FFFh that is written with the value 22h.

7 Maximum rating

Stressing the device outside the ratings listed in Table 5 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 5. Absolute maximum ratings

Symbol	Parameter	Min.	Max.	Unit
-	Ambient operating temperature	-40	130	°C
T_{STG}	Storage temperature	-65	150	°C
T_{LEAD}	Lead temperature during soldering	see note (1)		°C
I_{OL}	DC output current (SDA = 0)	-	5	mA
V_{IO}	Input or output range	-0.50	6.5	V
V_{CC}	Supply voltage	-0.50	6.5	V
V_{ESD}	Electrostatic pulse (human body model) (2)	-	3000(3)	V

1. *Compliant with JEDEC standard J-STD-020 (for small body, Sn-Pb or Pb-free assembly), the ST ECOPACK 7191395 specification, and the European directive on restrictions of hazardous substances (RoHS directive 2011/65/EU of July 2011).*
2. *Positive and negative pulses applied on different combinations of pin connections, according to ANSI/ESDA/JEDEC JS-001, C1 = 100 pF, R1 = 1500 Ω, R2 = 500 Ω.*
3. *4000 V for devices identified with the process letter K.*

8 DC and AC parameters

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

Table 6. Operating conditions (voltage range W)

Symbol	Parameter	Min.	Max.	Unit
V_{CC}	Supply voltage	2.5	5.5	V
T_A	Ambient operating temperature	-40	85	°C
f_C	Operating clock frequency	-	1	MHz

Table 7. Operating conditions (voltage range R)

Symbol	Parameter	Min.	Max.	Unit
V_{CC}	Supply voltage	1.8	5.5	V
T_A	Ambient operating temperature	-40	85	°C
f_C	Operating clock frequency	-	1	MHz

Table 8. Operating conditions (voltage range F)

Symbol	Parameter	Min.		Max.	Unit
V_{CC}	Supply voltage	1.6 (1)	1.7	5.5	V
T_A	Ambient operating temperature: read	-40	-40	85	°C
	Ambient operating temperature: write	0	-40	85	°C
f_C	Operating clock frequency, $V_{CC} \geq 1.6$ V (1)	-		400	kHz
	Operating clock frequency, $V_{CC} \geq 1.7$ V	-		1000	kHz

1. *Only for devices identified with the process letter T*

Table 9. Operating conditions (voltage range X)

Symbol	Parameter	Min.	Max.	Unit
V_{CC}	Supply voltage	1.6	5.5	V
T_A	Ambient operating temperature	-20	85	°C
f_C	Operating clock frequency	-	1	MHz

Table 10. Input parameters

Symbol	Parameter	Test condition	Min.	Max.	Unit
C_{IN} (1)	Input capacitance (SDA)	-	-	8	pF
C_{IN} (1)	Input capacitance (other pins)	-	-	6	pF
Z_L	Input impedance (E2, E1, E0, $\overline{WC}$) (2)	$V_{IN} < 0.3\ V_{CC}$	30	-	kΩ
Z_H		$V_{IN} > 0.7\ V_{CC}$	500	-	kΩ

1. *Specified by design – Not tested in production*
2. *Evaluated by characterization - not tested in production. E2, E1, E0 input impedance when the memory is selected (after a Start condition).*

Table 11. AC measurement conditions

Symbol	Parameter	Min.	Max.	Unit
C_{bus}	Load capacitance	-	100	pF
-	SCL input rise/fall time, SDA input fall time	-	50	ns
-	Input levels	0.2 V_{CC} to 0.8 V_{CC}		V
-	Input and output timing reference levels	0.3 V_{CC} to 0.7 V_{CC}		V

Figure 13. AC measurement I/O waveform

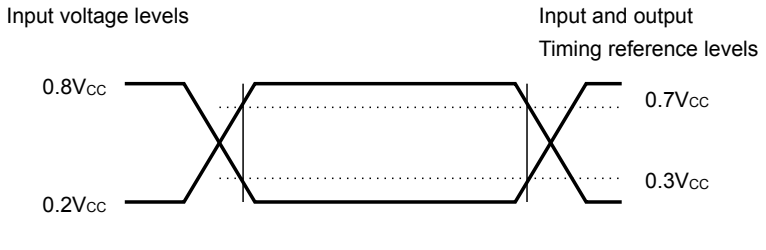


Table 12. Cycling performance

Symbol	Parameter	Test condition	Max.	Unit
Ncycle	Write cycle endurance(1)	$T_A \leq 25$ °C, $V_{CC}(min) < V_{CC} < V_{CC}(max)$	4,000,000	Write cycle(2)
		$T_A = 85$ °C, $V_{CC}(min) < V_{CC} < V_{CC}(max)$	1,200,000	

1. *The write cycle endurance is defined by characterization and qualification. For devices embedding the ECC functionality (see Section 5.1.5), the write cycle endurance is defined for group of four bytes located at addresses [4*N, 4*N+1, 4*N+2, 4*N+3] where N is an integer.*
2. *A write cycle is executed when either a page write, a byte write, a write identification page or a lock identification page instruction is decoded. When using the byte write, the page write, or the write identification page, refer also to Section 5.1.5.*

Table 13. Memory cell data retention

Parameter	Test condition	Min.	Unit
Data retention(1)	$T_A = 55$ °C	200	Year

1. *The data retention behavior is checked in production, while the data retention limit defined in this table is extracted from characterization and qualification results.*

Table 14. DC characteristics (M24C32-W)

Symbol	Parameter	Test conditions (in addition to those in Table 6)	Min.	Max.	Unit
I_{LI}	Input leakage current (SCL, SDA, E_i)	$V_{IN} = V_{SS}$ or V_{CC} device in standby mode	-	± 2	µA
I_{LO}	Output leakage current	SDA in high-Z, external voltage applied on SDA: V_{SS} or V_{CC}	-	± 2	µA
I_{CC}	Supply current (Read)	2.5 V < V_{CC} < 5.5 V, f_C = 400 kHz	-	2	mA
		2.5 V < V_{CC} < 5.5 V, f_C = 1 MHz	-	2.5	mA
I_{CC0}	Supply current (Write)	During t_W, 2.5 V ≤ V_{CC} ≤ 5.5 V	-	5 (1)	mA
I_{CC1}	Standby supply current	Device not selected (2) $V_{IN} = V_{SS}$ or V_{CC}, V_{CC} = 2.5 V	-	2	µA
		Device not selected (2), $V_{IN} = V_{SS}$ or V_{CC}, V_{CC} = 5.5 V	-	3	µA
V_{IL}	Input low voltage (SCL, SDA, $\overline{WC}$, E_i)(3)	-	-0.45	0.3 V_{CC}	V
V_{IH}	Input high voltage (SCL, SDA)	-	0.7 V_{CC}	6.5	V
	Input high voltage ($\overline{WC}$, E_i)(4)	-	0.7 V_{CC}	V_{CC}+1	V
V_{OL}	Output low voltage	I_{OL} = 2.1 mA, V_{CC} = 2.5 V or I_{OL} = 3 mA, V_{CC} = 5.5 V	-	0.4	V

1. *Evaluated by characterization – not tested in production.*
2. *The device is not selected after power-up, after a read instruction (after the stop condition), or after the completion of the internal write cycle t_W (t_W is triggered by the correct decoding of a write instruction).*
3. *E_i inputs should be tied to V_{SS} (see Section 2.3).*
4. *E_i inputs should be tied to V_{CC} (see Section 2.3).*

Table 15. DC characteristics (M24C32-R)

Symbol	Parameter	Test conditions[1] (in addition to those in Table 7)	Min.	Max.	Unit
I_{LI}	Input leakage current (SCL, SDA, E_i)	$V_{IN} = V_{SS}$ or V_{CC} device in standby mode	-	± 2	µA
I_{LO}	Output leakage current	SDA in high-Z, external voltage applied on SDA: V_{SS} or V_{CC}	-	± 2	µA
I_{CC}	Supply current (Read)	V_{CC} = 1.8 V, f_C = 400 kHz	-	0.8	mA
		f_C = 1 MHz	-	2.5	mA
I_{CC0}	Supply current (write)	During t_W, 1.8 V ≤ V_{CC} ≤ 2.5 V	-	3[2]	mA
I_{CC1}	Standby supply current	Device not selected[3] $V_{IN} = V_{SS}$ or V_{CC}, V_{CC} = 1.8 V	-	1	µA
V_{IL}	Input low voltage (SCL, SDA, $\overline{WC}$, E_i)[4]	1.8 V ≤ V_{CC} < 2.5 V	-0.45	0.25 V_{CC}	V
V_{IH}	Input high voltage (SCL, SDA)	1.8 V ≤ V_{CC} < 2.5 V	0.75 V_{CC}	6.5	V
	Input high voltage ($\overline{WC}$, E_i)[5]	1.8 V ≤ V_{CC} < 2.5 V	0.75 V_{CC}	V_{CC}+1	V
V_{OL}	Output low voltage	I_{OL} = 1 mA, V_{CC} = 1.8 V	-	0.2	V

1. *If the application uses the voltage range R device with 2.5 V < V_{CC} < 5.5 V and -40 °C < T_A < +85 °C, refer to Table 14 instead of this table.*
2. *Evaluated by characterization – not tested in production.*
3. *The device is not selected after power-up, after a read instruction (after the stop condition), or after the completion of the internal write cycle t_W (t_W is triggered by the correct decoding of a write instruction).*
4. *E_i inputs should be tied to V_{SS} (see Section 2.3).*
5. *E_i inputs should be tied to V_{CC} (see Section 2.3).*

Table 16. DC characteristics (M24C32-F)

Symbol	Parameter	Test conditions[1] (in addition to those in Table 8)	Min.	Max.	Unit
I_{LI}	Input leakage current (SCL, SDA, E_i)	V_{IN} = V_{SS} or V_{CC} device in standby mode	-	± 2	µA
I_{LO}	Output leakage current	SDA in high-Z, external voltage applied on SDA: V_{SS} or V_{CC}	-	± 2	µA
I_{CC}	Supply current (Read)	V_{CC} = 1.6 V or 1.7 V, f_C = 400 kHz	-	0.8	mA
		f_C = 1 MHz	-	2.5	mA
I_{CC0}	Supply current (write)	During t_W, V_{CC} < 2.5 V	-	3[2]	mA
I_{CC1}	Standby supply current	Device not selected[3] V_{IN} = V_{SS} or V_{CC}, V_{CC} = 1.6 V or 1.7 V	-	1	µA
V_{IL}	Input low voltage (SCL, SDA, $\overline{WC}$, E_i)[4]	V_{CC} < 2.5 V	-0.45	0.25 V_{CC}	V
V_{IH}	Input high voltage (SCL, SDA)	V_{CC} < 2.5 V	0.75 V_{CC}	6.5	V
	Input high voltage ($\overline{WC}$, E_i)[5]	V_{CC} < 2.5 V	0.75 V_{CC}	V_{CC}+1	V
V_{OL}	Output low voltage	I_{OL} = 1 mA, V_{CC} = 1.6 V or 1.7 V	-	0.2	V

1. *If the application uses the voltage range F device with 2.5 V < V_{CC} < 5.5 V and -40 °C < T_A < +85 °C, refer to Table 14 instead of this table.*
2. *Evaluated by characterization – not tested in production.*
3. *The device is not selected after power-up, after a read instruction (after the stop condition), or after the completion of the internal write cycle t_W (t_W is triggered by the correct decoding of a write instruction).*
4. *E_i inputs should be tied to V_{SS} (see Section 2.3).*
5. *E_i inputs should be tied to V_{CC} (see Section 2.3).*

Table 17. DC characteristics (M24C32-X)

Symbol	Parameter	Test conditions(1) (in addition to those in Table 9)	Min.	Max.	Unit
I_{LI}	Input leakage current (SCL, SDA, E_i)	$V_{IN} = V_{SS}$ or V_{CC} device in standby mode	-	± 2	µA
I_{LO}	Output leakage current	SDA in high-Z, external voltage applied on SDA: V_{SS} or V_{CC}	-	± 2	µA
I_{CC}	Supply current (Read)	V_{CC} = 1.6 V, f_C = 400 kHz	-	0.8	mA
		f_C = 1 MHz	-	2.5	mA
I_{CC0}	Supply current (write)	During t_W, 1.6 V ≤ V_{CC} < 2.5 V	-	3(2)	mA
I_{CC1}	Standby supply current	Device not selected(3) $V_{IN} = V_{SS}$ or V_{CC}, V_{CC} = 1.6 V	-	1	µA
V_{IL}	Input low voltage (SCL, SDA, $\overline{WC}$, E_i)(4)	1.6 V ≤ V_{CC} < 2.5 V	-0.45	0.25 V_{CC}	V
V_{IH}	Input high voltage (SCL, SDA)	1.6 V ≤ V_{CC} < 2.5 V	0.75 V_{CC}	6.5	V
	Input high voltage ($\overline{WC}$, E_i)(5)	1.6 V ≤ V_{CC} < 2.5 V	0.75 V_{CC}	V_{CC}+0.6	V
V_{OL}	Output low voltage	I_{OL} = 1 mA, V_{CC} = 1.6 V	-	0.2	V

1. *If the application uses the device with 2.5 V < V_{CC} < 5.5 V and -20 °C < T_A < +85 °C, refer to Table 14 instead of this table.*
2. *Evaluated by characterization – not tested in production.*
3. *The device is not selected after power-up, after a read instruction (after the stop condition), or after the completion of the internal write cycle t_W (t_W is triggered by the correct decoding of a write instruction).*
4. *E_i inputs should be tied to V_{SS} (see Section 2.3).*
5. *E_i inputs should be tied to V_{CC} (see Section 2.3).*

Table 18. AC characteristics (Fast mode)

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_{QL1QL2}(1)	t_F	SDA (out) fall time	20(2)	300	ns
t_{XH1XH2}	t_R	Input signal rise time	(3)	(3)	ns
t_{XL1XL2}	t_F	Input signal fall time	(3)	(3)	ns
t_{DXCH}	$t_{SU:DAT}$	Data in setup time	100	-	ns
t_{CLDX}	$t_{HD:DAT}$	Data in hold time	0	-	ns
t_{CLQX}(4)	t_{DH}	Data out hold time	100	-	ns
t_{CLQV}(5)	t_{AA}	Clock low to next data valid (access time)	-	900	ns
t_{CHDL}	$t_{SU:STA}$	Start condition setup time	600	-	ns
t_{DLCL}	$t_{HD:STA}$	Start condition hold time	600	-	ns
t_{CHDH}	$t_{SU:STO}$	Stop condition setup time	600	-	ns
t_{DHDL}	t_{BUF}	Time between Stop condition and next Start condition	1300	-	ns
t_{WLDL}(1)(6)	$t_{SU:WC}$	$\overline{WC}$ setup time (before the start condition)	0	-	µs
t_{DHWH}(1)(7)	$t_{HD:WC}$	$\overline{WC}$ hold time (after the stop condition)	1	-	µs
t_W	t_{WR}	Internal Write cycle duration	-	5(8)	ms
t_{NS}(1)	-	Pulse width ignored (input filter on SCL and SDA) - single glitch	-	80	ns

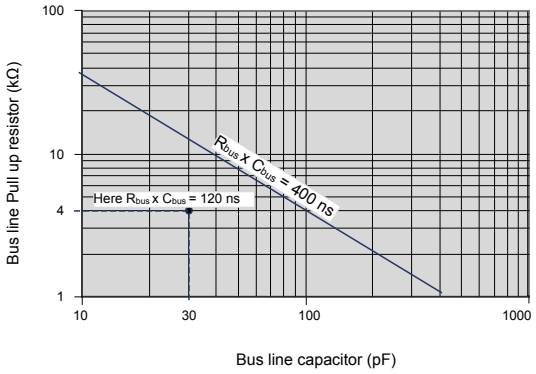
1. *Evaluated by characterization - not tested in production.*
2. *With C_L = 10 pF.*
3. *There is no min. or max. values for the input signal rise and fall times. It is however recommended by the I²C specification that the input signal rise and fall times be more than 20 ns and less than 300 ns when f_C < 400 kHz.*
4. *To avoid spurious start and stop conditions, a minimum delay is placed between SCL=1 and the falling or rising edge of SDA.*
5. *t_{CLQV} is the time (from the falling edge of SCL) required by the SDA bus line to reach either 0.3V_{CC} or 0.7V_{CC}, assuming that the R_{bus} × C_{bus} time constant is within the values specified in Figure 14*
6. *$\overline{WC}$ = 0 setup time condition to enable the execution of a write command.*
7. *$\overline{WC}$ = 0 hold time condition to enable the execution of a write command.*
8. *10 ms for the M24C32-X.*

Table 19. AC characteristics (Fast mode Plus)

Symbol	Alt.	Parameter	Min.	Max.	Unit
f_C	f_{SCL}	Clock frequency	-	1	MHz
t_{CHCL}	t_{HIGH}	Clock pulse width high	260	-	ns
t_{CLCH}	t_{LOW}	Clock pulse width low	500	-	ns
t_{XH1XH2}	t_R	Input signal rise time	(1)	(1)	ns
t_{XL1XL2}	t_F	Input signal fall time	(1)	(1)	ns
t_{QL1QL2}(2)	t_F	SDA (out) fall time	20(3)	120	ns
t_{DXCH}	$t_{SU:DAT}$	Data in setup time	50	-	ns
t_{CLDX}	$t_{HD:DAT}$	Data in hold time	0	-	ns
t_{CLQX}(4)	t_{DH}	Data out hold time	100	-	ns
t_{CLQV}(5)	t_{AA}	Clock low to next data valid (access time)	-	450	ns
t_{CHDL}	$t_{SU:STA}$	Start condition setup time	250	-	ns
t_{DLCL}	$t_{HD:STA}$	Start condition hold time	250	-	ns
t_{CHDH}	$t_{SU:STO}$	Stop condition setup time	250	-	ns
t_{DHDL}	t_{BUF}	Time between Stop condition and next Start condition	500	-	ns
t_{WLDL}(2)(6)	$t_{SU:WC}$	$\overline{WC}$ setup time (before the start condition)	0	-	µs
t_{DHWH}(2)(7)	$t_{HD:WC}$	$\overline{WC}$ hold time (after the stop condition)	1	-	µs
t_W	t_{WR}	Write cycle time	-	5(8)	ms
t_{NS}(2)	-	Pulse width ignored (input filter on SCL and SDA)	-	80	ns

1. *There is no min. or max. values for the input signal rise and fall times. It is however recommended by the I²C specification that the input signal rise and fall times be less than 120 ns when f_C < 1 MHz.*
2. *Evaluated by characterization - not tested in production.*
3. *With CL = 10 pF.*
4. *To avoid spurious Start and Stop conditions, a minimum delay is placed between SCL=1 and the falling or rising edge of SDA.*
5. *t_{CLQV} is the time (from the falling edge of SCL) required by the SDA bus line to reach either 0.3 V_{CC} or 0.7 V_{CC}, assuming that the Rbus × Cbus time constant is within the values specified in Figure 15.*
6. *$\overline{WC}$ = 0 setup time condition to enable the execution of a write command.*
7. *$\overline{WC}$ = 0 hold time condition to enable the execution of a write command.*
8. *10 ms for the M24C32-X.*

Figure 14. R_{bus} value versus bus parasitic capacitance (C_{bus}) for an I^2C_{bus} (f_C = 400 kHz)



The R_{bus} x C_{bus} time constant must be below the 400 ns time constant line displayed on the left

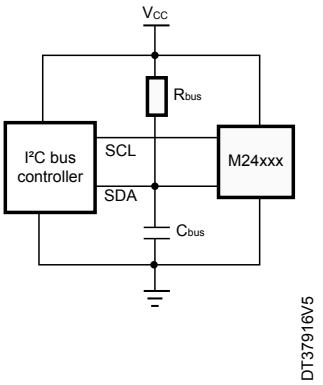


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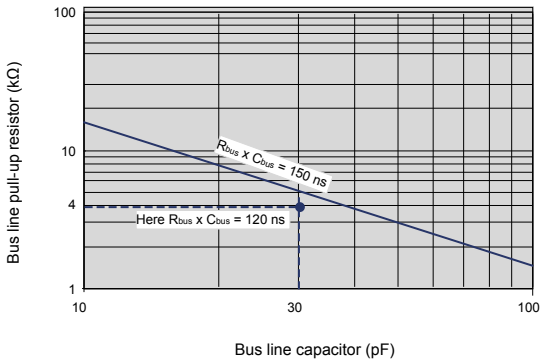
Figure 15. R_{bus} value versus bus parasitic capacitance (C_{bus}) for an I^2C bus (f_C = 1 MHz)



The R_{bus} x C_{bus} time constant must be below the 150 ns time constant line displayed on the left

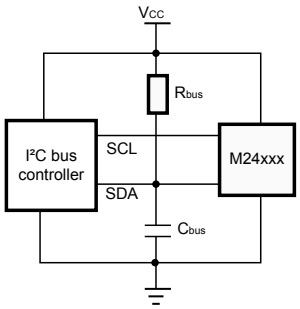


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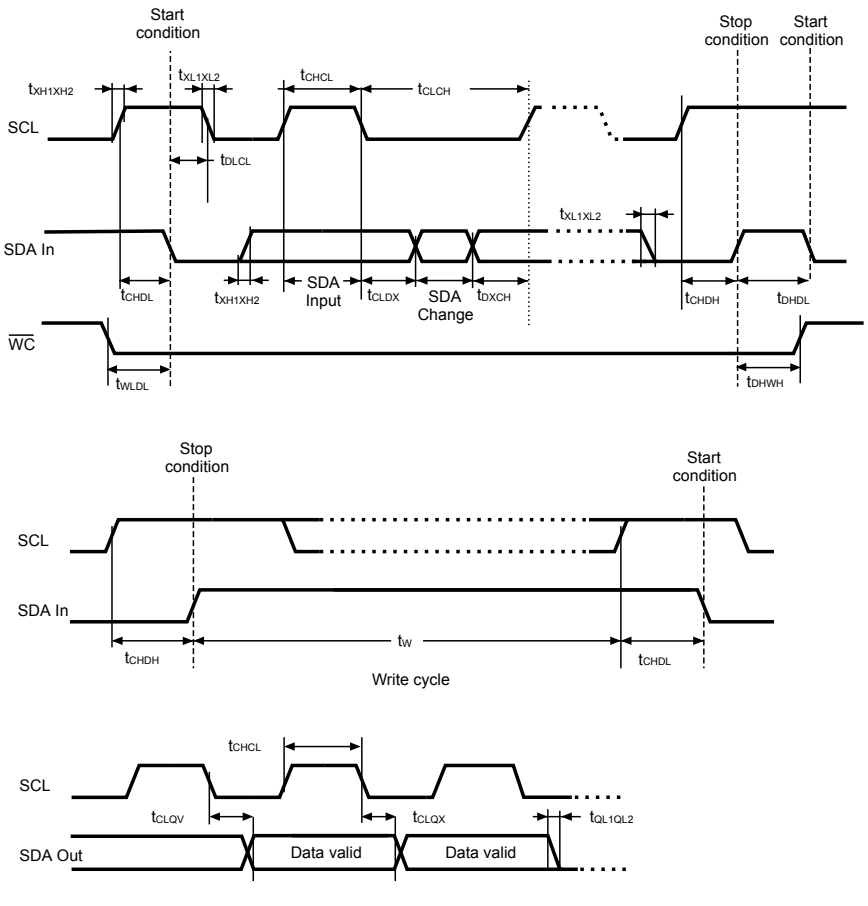
Figure 16. AC waveforms



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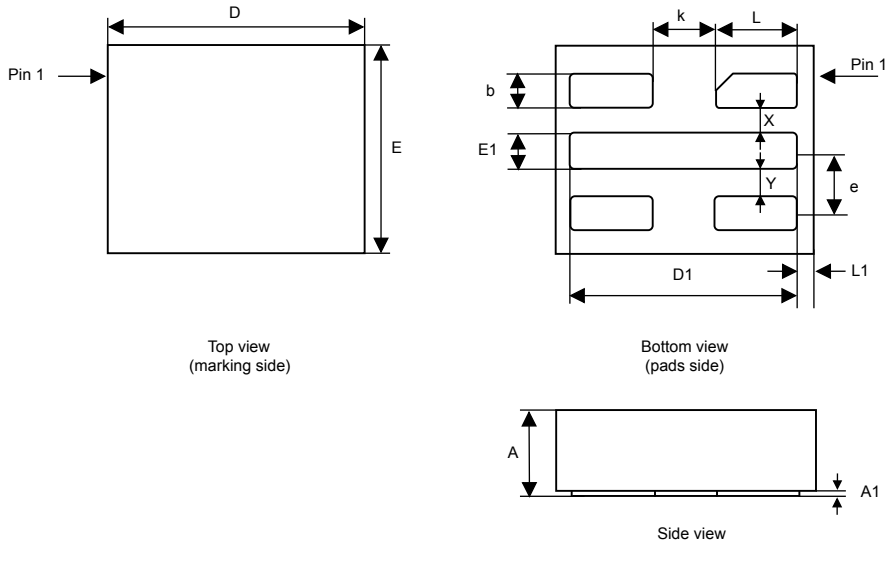
9 Package information

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. ECOPACK is an ST trademark.

9.1 UFDFPN5 (DFN5) package information

UFDFPN5 is a 5-lead, 1.7 × 1.4 mm, 0.55 mm thickness, ultrathin fine-pitch dual flat package.

Figure 17. UFDFPN5 - Outline



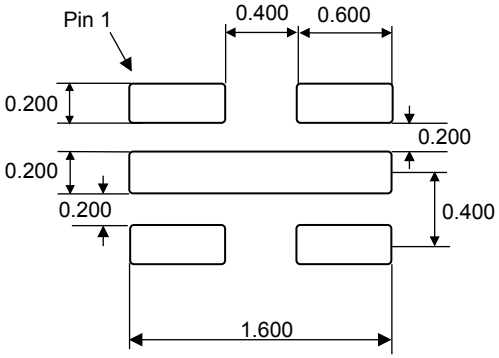
1. *The maximum package warpage is 0.05 mm.*
2. *Exposed copper is not systematic and can appear partially or totally according to the cross section.*
3. *Drawing is not to scale.*
4. *On the bottom side, pin 1 is identified by the specific pad shape and, on the top side, pin 1 is defined from the orientation of the marking. When reading the marking, pin 1 is below the upper left package corner.*

Table 20. UFDFPN5 - Mechanical data

Symbol	millimeters			inches		
	Min	Typ	Max	Min	Typ	Max
A	0.500	0.550	0.600	0.0197	0.0217	0.0236
A1	0.000	-	0.050	0.0000	-	0.0020
b (1)	0.175	0.200	0.225	0.0069	0.0079	0.0089
D	1.600	1.700	1.800	0.0630	0.0669	0.0709
D1	1.400	1.500	1.600	0.0551	0.0591	0.0630
E	1.300	1.400	1.500	0.0512	0.0551	0.0591
E1	0.175	0.200	0.225	0.0069	0.0079	0.0089
X	-	0.200	-	-	0.0079	-
Y	-	0.200	-	-	0.0079	-
e	-	0.400	-	-	0.0157	-
L	0.500	0.550	0.600	0.0197	0.0217	0.0236
L1	-	0.100	-	-	0.0039	-
k	-	0.400	-	-	0.0157	-

1. *Dimension b applies to the plated terminal and is measured between 0.15 and 0.30 mm from the terminal tip.*

Figure 18. UFDFPN5 - Footprint example

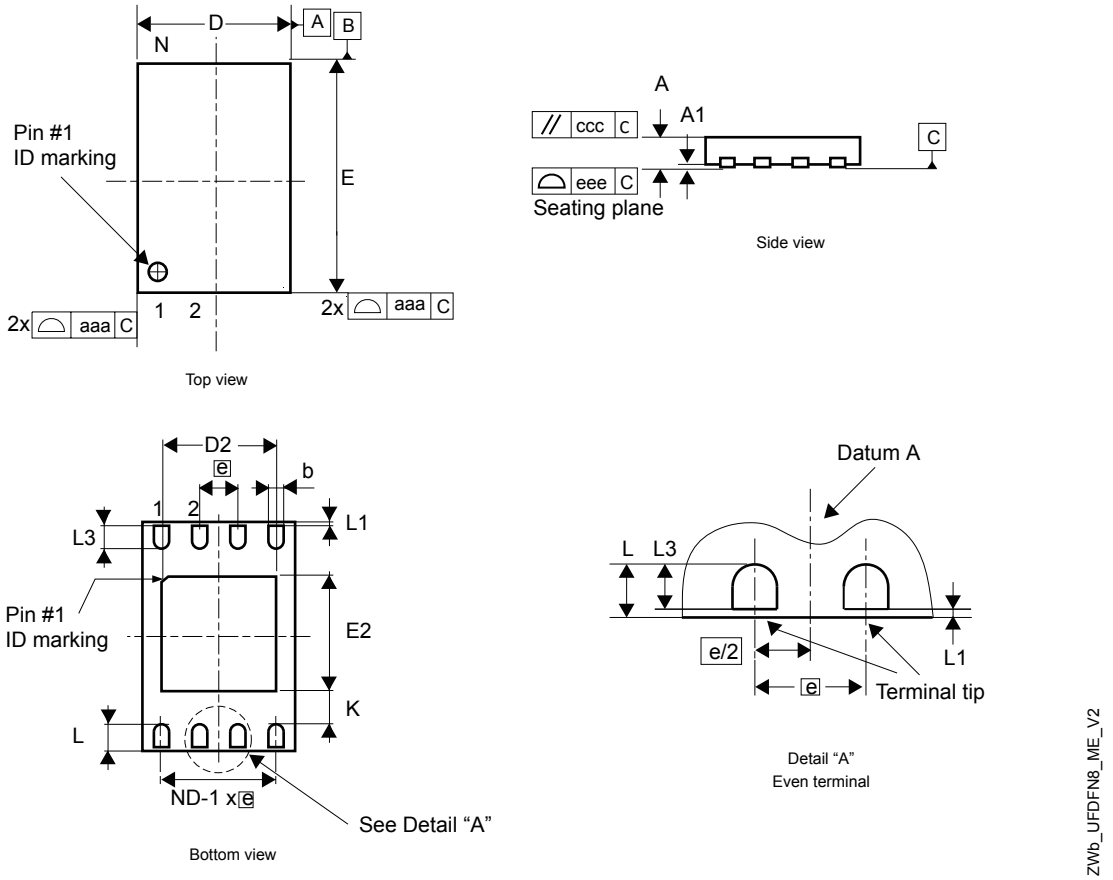


1. *Dimensions are expressed in millimeters.*

9.2 UFDFPN8 (DFN8) package information

This UFDFPN is an 8-lead, 2 x 3 mm, 0.5 mm pitch ultrathin profile fine pitch dual flat package.

Figure 19. UFDFPN8 - Outline



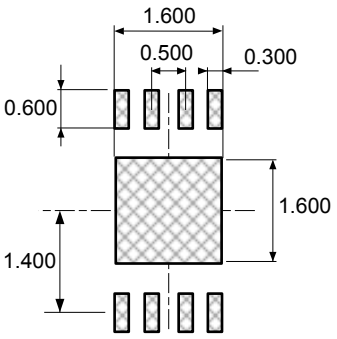
1. *The maximum package warpage is 0.05 mm.*
2. *Exposed copper is not systematic and can appear partially or totally according to the cross section.*
3. *Drawing is not to scale.*
4. *The central pad (the area E2 by D2 in the above illustration) must be either connected to V_{SS} or left floating (not connected) in the end application.*

Table 21. UFDFPN8 - Mechanical data

Symbol	millimeters			inches [1]		
	Min	Typ	Max	Min	Typ	Max
A	0.450	0.550	0.600	0.0177	0.0217	0.0236
A1	0.000	0.020	0.050	0.0000	0.0008	0.0020
b[2]	0.200	0.250	0.300	0.0079	0.0098	0.0118
D	1.900	2.000	2.100	0.0748	0.0787	0.0827
D2	1.200	-	1.600	0.0472	-	0.0630
E	2.900	3.000	3.100	0.1142	0.1181	0.1220
E2	1.200	-	1.600	0.0472	-	0.0630
e	-	0.500	-	-	0.0197	-
K	0.300	-	-	0.0118	-	-
L	0.300	-	0.500	0.0118	-	0.0197
L1	-	-	0.150	-	-	0.0059
L3	0.300	-	-	0.0118	-	-
aaa	-	-	0.150	-	-	0.0059
bbb	-	-	0.100	-	-	0.0039
ccc	-	-	0.100	-	-	0.0039
ddd	-	-	0.050	-	-	0.0020
eee[3]	-	-	0.080	-	-	0.0031

1. *Values in inches are converted from mm and rounded to four decimal digits.*
2. *Dimension b applies to the plated terminal and is measured between 0.15 and 0.30 mm from the terminal tip.*
3. *Applied for exposed die paddle and terminals. Exclude embedding part of the exposed die paddle from measuring.*

Figure 20. UFDFPN8 - Footprint example



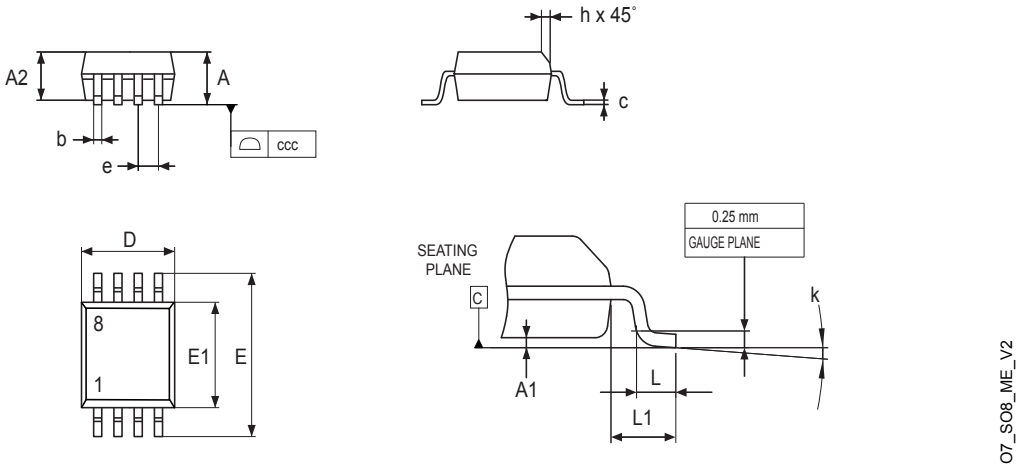
ZWb_UFDFN8_FP_V2

1. *Dimensions are expressed in millimeters.*

9.3 SO8N package information

This SO8N is an 8-lead, 4.9 x 6 mm, plastic small outline, 150 mil body width package.

Figure 21. SO8N - Outline



1. *Drawing is not to scale.*

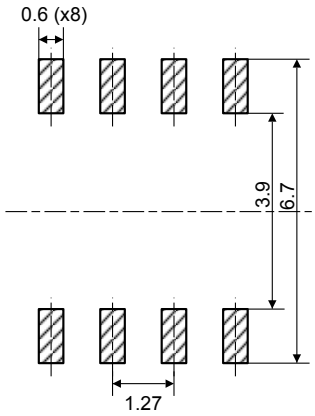
Table 22. SO8N - Mechanical data

Symbol	millimeters			inches [1]		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	-	-	1.750	-	-	0.0689
A1	0.100	-	0.250	0.0039	-	0.0098
A2	1.250	-	-	0.0492	-	-
b	0.280	-	0.480	0.0110	-	0.0189
c	0.170	-	0.230	0.0067	-	0.0091
D[2]	4.800	4.900	5.000	0.1890	0.1929	0.1969
E	5.800	6.000	6.200	0.2283	0.2362	0.2441
E1[3]	3.800	3.900	4.000	0.1496	0.1535	0.1575
e	-	1.270	-	-	0.0500	-
h	0.250	-	0.500	0.0098	-	0.0197
k	0°	-	8°	0°	-	8°
L	0.400	-	1.270	0.0157	-	0.0500
L1	-	1.040	-	-	0.0409	-
ccc	-	-	0.100	-	-	0.0039

1. *Values in inches are converted from mm and rounded to four decimal digits.*
2. *Dimension D does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side*
3. *Dimension E1 does not include interlead flash or protrusions. Interlead flash or protrusions shall not exceed 0.25 mm per side.*

Note: The package top may be smaller than the package bottom. Dimensions D and E1 are determinated at the outermost extremes of the plastic body exclusive of mold flash, tie bar burrs, gate burrs, and interleads flash, but including any mismatch between the top and bottom of the plastic body. The measurement side for mold flash, protusions, or gate burrs is the bottom side.

Figure 22. SO8N - Footprint example

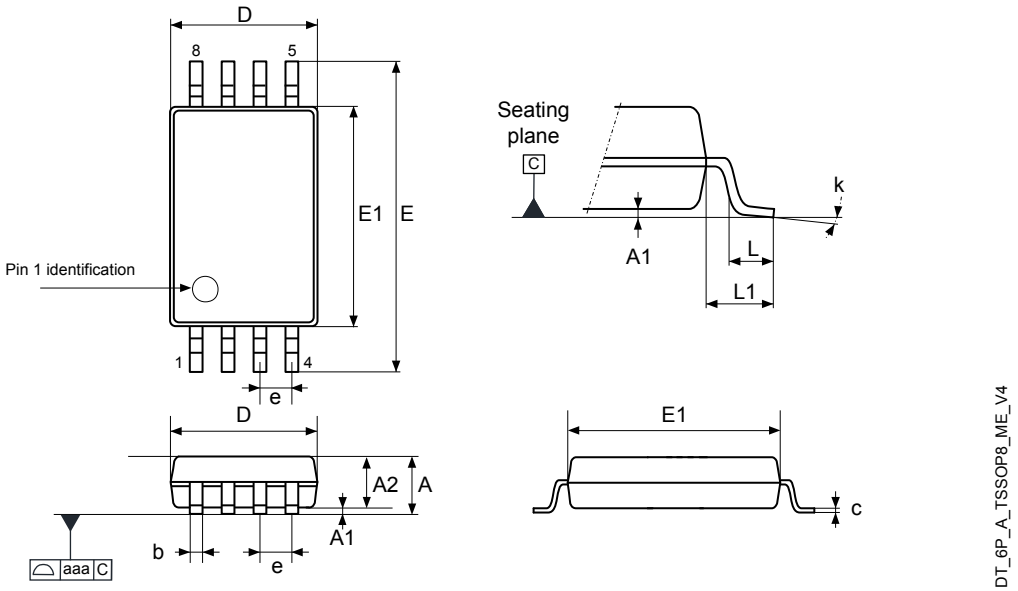


1. *Dimensions are expressed in millimeters.*

9.4 TSSOP8 package information

This TSSOP is an 8-lead, 3 x 6.4 mm, 0.65 mm pitch, thin shrink small outline package.

Figure 23. TSSOP8 – Outline



1. *Drawing is not to scale.*

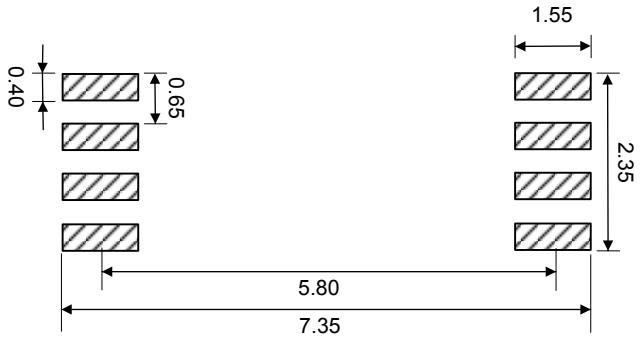
Table 23. TSSOP8 - Mechanical data

Symbol	millimeters			inches (1)		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	-	-	1.200	-	-	0.0472
A1	0.050	-	0.150	0.0020	-	0.0059
A2	0.800	1.000	1.050	0.0315	0.0394	0.0413
b	0.190	-	0.300	0.0075	-	0.0118
c	0.090	-	0.200	0.0035	-	0.0079
D(2)	2.900	3.000	3.100	0.1142	0.1181	0.1220
e	-	0.650	-	-	0.0256	-
E	6.200	6.400	6.600	0.2441	0.2520	0.2598
E1(3)	4.300	4.400	4.500	0.1693	0.1732	0.1772
L	0.450	0.600	0.750	0.0177	0.0236	0.0295
L1	-	1.000	-	-	0.0394	-
k	0°	-	8°	0°	-	8°
aaa	-	-	0.100	-	-	0.0039

1. *Values in inches are converted from mm and rounded to four decimal digits.*
2. *Dimension D does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.*
3. *Dimension E1 does not include interlead flash or protrusions. Interlead flash or protrusions shall not exceed 0.25 mm per side.*

Note: The package top may be smaller than the package bottom. Dimensions D and E1 are determinated at the outermost extremes of the plastic body exclusive of the mold flash, tie bar burrs, gate burrs, and interleads flash, but including any mismatch between the top and bottom of the plastic body. The measurement side for the mold flash, protrusions, or gate burrs is the bottom side.

Figure 24. TSSOP8 – Footprint example



1. *Dimensions are expressed in millimeters.*

10 Ordering information

Table 24. Ordering information scheme

Example:	M24	C32	- D	W	MC	6	T	P	/T

Device type

M24 = I^2C serial access EEPROM

Device function

C32 = 32 Kbit (4096 x 8 bit)

Device family

Blank = Without identification page

D = With identification page

Operating voltage

W = V_{CC} = 2.5 V to 5.5 V

R = V_{CC} = 1.8 V to 5.5 V

F = V_{CC} = 1.7 V to 5.5 V

X = V_{CC} = 1.6 V to 5.5 V

Package (1)

MN = SO8 (150 mil width)

DW = TSSOP8 (169 mil width)

MC = UFDFPN8 (DFN8)

MH = UFDFPN5 (DFN5)

Device grade

6 = Industrial: device tested with standard test flow over -40 to 85 °C

5 = Consumer: device tested with standard test flow over –20 to 85°C

Option

T = Tape and reel packing

blank = tube packing

Plating technology

P or G = ECOPACK2®

Process (2)

/K or /T= Manufacturing technology code

1. *ECOPACK2 (RoHS compliant and free of brominated, chlorinated and antimony oxide flame retardants).*
2. *These process letters appear on the device package (marking) and on the shipment box. Please contact your nearest ST Sales Office for further information.*

Note: For a list of available options (memory, package, and so on) or for further information on any aspect of this device, contact your nearest ST sales office.

Note: Parts marked as “ES” or “E” are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering samples in production. ST’s Quality department must be contacted prior to any decision to use these engineering samples to run a qualification activity.

Table 25. Ordering information scheme (unsawn wafer)

Example:	M24	C32 -	F	T	W	20	I	/90
Device type								
M24 = I^2C serial access EEPROM								
Device function								
C32 = 32 Kbit (4096 x 8 bit)								
Operating voltage								
F = V_{CC} = 1.7 V to 5.5 V								
Process								
T = F8H								
Delivery form								
W = wafer (bare die)								
Wafer thickness								
20 = Nonbacklapped wafer								
Wafer testing								
I = Inkless test								
Device grade								
90 = -40°C to 85°C								

Note: For all information concerning the M24C32 delivered in unsawn wafer, please contact your nearest ST Sales Office.

Note: Parts marked as “ES” or “E” are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering samples in production. ST’s Quality department must be contacted prior to any decision to use these engineering samples to run a qualification activity.

Revision history

Table 26. Document revision history

Date	Version	Changes
18-Mar-2011	18	Added: • M24C32-DF and all information concerning the Identification page: sections 4.9, 4.10, 4.17, 4.18 • ECC section 4.11 • AC table with clock frequency of 1 MHz (Table 18) • able 4: Device select code Updated: • Section 1: Description • Section 4.5: Memory addressing • Section 4.18: Read the lock status (M24C32-D) • Table 6: Absolute maximum ratings • AC/DC tables 13, 17 with values specific to the device identified with process letter K Deleted: • Table 2: Device select code • Table 23: Available M24C32 products (package, voltage range, temperature grade)
14-Sep-2011	19	Updated: • Figure 4: I2C Fast mode (f_C = 400 kHz): maximum Rbus value versus bus parasitic capacitance (Cbus) • Figure 5: I2C Fast mode Plus (f_C = 1 MHz): maximum Rbus value versus bus parasitic capacitance (Cbus) Added t_{WLDL} and t_{DHWH} in: • Table 17: 400 kHz AC characteristics • Table 18: 1 MHz AC characteristics • Figure 13: AC waveforms Minor text changes.
21-May-2012	20	Datasheet split into: • M24C32-DF, M24C32-W, M24C32-R,M24C32-F (this datasheet) for standard products (range 6), • M24C32-125 datasheet for automotive products (range 3).
25-Jul-2012	21	Added reference M24C32-X. Updated: • AC and DC tables in Section 8: DC and AC parameters. • Figure 56.: M24C16-FCS5TP/S WLCSP 5 bumps package outline.
19-May-2014	22	Add new package UFDFPN5, description onFigure 51 and Table 20. Updated: • Figure 30: Block diagram • VESD value on Table 14 • Icc1 values on Table 32 • Icc and Icc0 test conditions on Table 40 • VIH(max) values on Table 32, Table 33 • Icc, Icc0 ,Icc1, VIL, VOL and VIH test conditions onTable 40 • Note on Table 29, Table 31, Table 32, Table 40, Table 41 and Table 48 • Table 76 • Section numbering for Section 5.2.5 and Section 5.2.6.
28-Jul-2014	23	Updated Table 21.
02-Sept-2014	24	Updated • Section 5.1.6. • Note 1 on Table 29

Date	Version	Changes
		• Section 9, added reference to unsawn wafer availability. • note 3 on Table 76. Added: • Note 1 on Table 21 • Note 2 on Table 31 • Note 2 on Figure 58 • Table 90. Removed notes 1 and 2 on Section 5.1.6
23-Jul-2015	25	Updated: • Section 2.4 • Section 6 • Table 76 • note 2 on Table 76 Added: • WLCSP package in cover page. • Section 9.7: Ultra Thin WLCSP package information
27-Aug-2015	26	Updated: • Table 14 Added: • Note 3 in Figure 59. • Note 1 in Table 60. • Note 2 Table 76
12-Feb-2016	27	Updated Figure 17, Figure 51. Added Table 2.
05-May-2016	28	Updated Table 14: Absolute maximum ratings.
10-Jul-2017	29	Updated Section 9.6: Ultra Thin WLCSP package information.
11-Sep-2017	30	Added reference to DFN8 and DFN5 in: cover page figure, Figure 3: UFDFPN5 (DFN5) package connections, Section 9.1: UFDFPN5 (DFN5) package information, Section 9.2: UFDFPN8 (DFN8) package information and Table 28: Ordering information scheme
01-Dec-2023	31	Updated: • Section Cover images. • Section Features. • Figure 1. • Section 3: Memory organization. • Section 4.5: Device addressing. Minor text changes. New stylesheet.
23-Jun-2025	32	Updated: • Figure 10. Read mode sequences • Table footnote (1) in Table 5. Absolute maximum ratings • Table 17. DC characteristics (M24C32-X)
25-Nov-2025	33	Updated: • Section Features • Section 1: Description • Section 2.3: Chip enable (E2, E1, E0) Removed all references of WLCSP4.

Contents

List of tables

List of figures

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