

Features

- Low-voltage and Standard-voltage Operation, $V_{CC} = 2.7V$ to $5.5V$
- Internally Organized $16,384 \times 8$ and $32,768 \times 8$
- 2-wire Serial Interface
- Schmitt Trigger, Filtered Inputs for Noise Suppression
- Bi-directional Data Transfer Protocol
- 1 MHz (5V) and 400 kHz (2.7V) Compatibility
- 64-byte Page Write Mode (Partial Page Writes Allowed)
- Self-timed Write Cycle (5 ms Typical)
- High Reliability
 - Endurance: 1 Million Write Cycles
 - Data Retention: 40 Years
 - ESD Protection: > 4000V

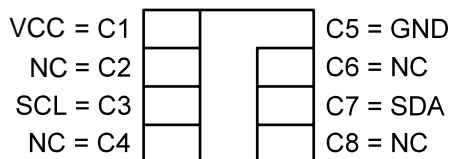
Description

The AT24C128SC/256SC provides 131,072/262,144 bits of serial electrically erasable and programmable read only memory (EEPROM) organized as 16,384/32,768 words of 8 bits each. The devices are optimized for use in smart card applications where low-power and low-voltage operation may be essential. The devices are available in several standard ISO 7816 smart card modules (see Ordering Information). All devices are functionally equivalent to Atmel Serial EEPROM products offered in standard IC packages (PDIP, SOIC, TSSOP, dBGAs), with the exception of the slave address and Write Protect functions which are not required for smart card applications.

Table 1. Pin Configurations

Pad Name	Description	ISO Module Contact
VCC	Power Supply Voltage	C1
GND	Ground	C5
SCL	Serial Clock Input	C3
SDA	Serial Data Input/Output	C7
NC	No Connect	C2, C4, C6, C8

Figure 1. Card Module Contact



**Two-wire Serial
EEPROM Smart
Card Modules**
128K (16,384 x 8)
256 (32,768 x 8)

AT24C128SC
AT24C256SC

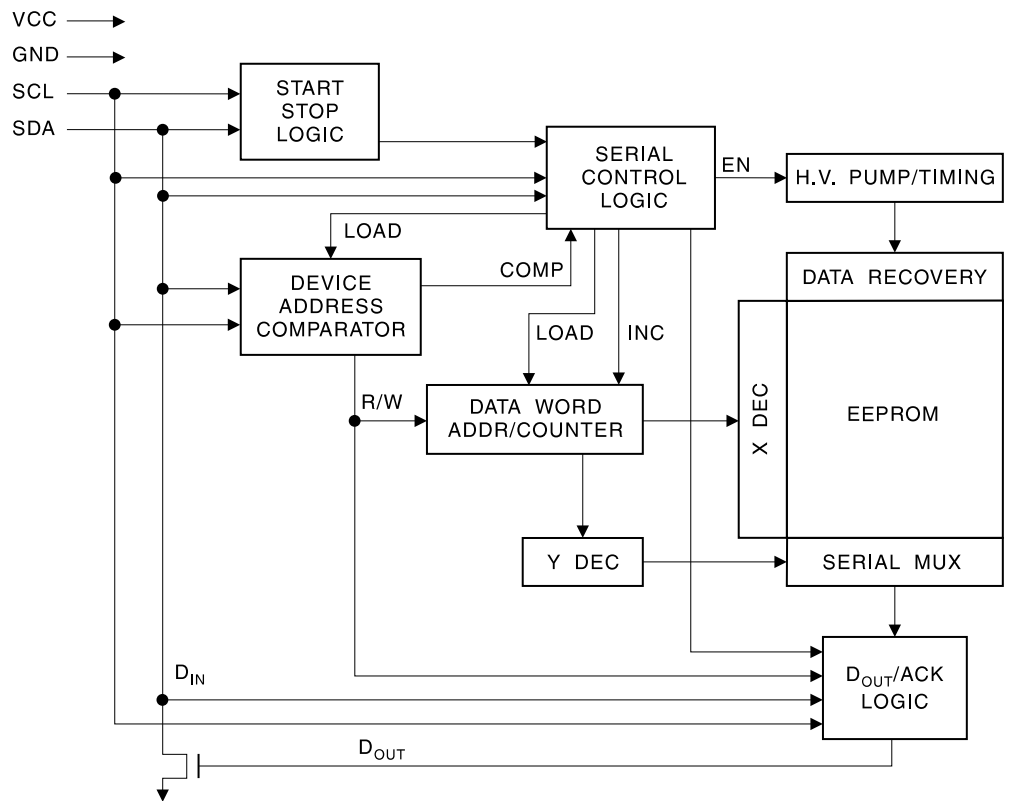


Absolute Maximum Ratings*

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

*NOTICE: Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Figure 2. Block Diagram



Pin Description

SERIAL CLOCK (SCL): The SCL input is used to positive edge clock data into each EEPROM device and negative edge clock data out of each device.

SERIAL DATA (SDA): The SDA pin is bidirectional for serial data transfer. This pin is open-drain driven and may be wire-ORed with any number of other open-drain or open-collector devices.

Memory Organization

AT24C128SC/256SC, 128K/256K SERIAL EEPROM: The 128K/256K is internally organized as 256/512 pages of 64-bytes each. Random word addressing requires a 14/15-bit data word address.

Pin Capacitance

Table 2. Pin Capacitance⁽¹⁾

Applicable over recommended operating range from $T_A = 25^\circ\text{C}$, $f = 1.0\text{ MHz}$, $V_{CC} = +2.7\text{V}$.

Symbol	Test Condition	Max	Units	Conditions
$C_{I/O}$	Input/Output Capacitance (SDA)	8	pF	$V_{I/O} = 0\text{V}$
C_{IN}	Input Capacitance (SCL)	6	pF	$V_{IN} = 0\text{V}$

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

DC Characteristics

Table 3. DC Characteristics⁽¹⁾

Symbol	Parameter	Test Condition		Min	Typ	Max	Units
V_{CC}	Supply Voltage			2.7		5.5	V
I_{CC1}	Supply Current	$V_{CC} = 5.0\text{V}$	Read at 400 kHz		1.0	2.0	mA
I_{CC2}	Supply Current	$V_{CC} = 5.0\text{V}$	Write at 400 kHz		2.0	3.0	mA
I_{SB}	Standby Current)	$V_{CC} = 2.7\text{V}$	$V_{IN} = V_{CC}$ or GND			2.0	μA
		$V_{CC} = 5.5\text{V}$				6.0	
I_{LI}	Input Leakage Current	$V_{IN} = V_{CC}$ or GND			0.10	3.0	μA
I_{LO}	Output Leakage Current	$V_{OUT} = V_{CC}$ or GND			0.05	3.0	μA
V_{IL}	Input Low Level ⁽²⁾			-0.6		$V_{CC} \times 0.3$	V
V_{IH}	Input High Level ⁽²⁾			$V_{CC} \times 0.7$		$V_{CC} + 0.5$	V
V_{OL}	Output Low Level	$V_{CC} = 3.0\text{V}$	$I_{OL} = 2.1\text{ mA}$			0.4	V

Note: 1. Applicable over recommended operating range from: $T_{AC} = 0^\circ\text{C}$ to $+70^\circ\text{C}$, $V_{CC} = +2.7\text{V}$ to $+5.5\text{V}$ (unless otherwise noted).
 2. V_{IL} min and V_{IH} max are reference only and are not tested.

AC Characteristics

Table 4. AC Characteristics⁽¹⁾

Symbol	Parameter	2.7-volt		5.0-volt		Units
		Min	Max	Min	Max	
f_{SCL}	Clock Frequency, SCL		400		1000	kHz
t_{LOW}	Clock Pulse Width Low	1.3		0.4		μ s
t_{HIGH}	Clock Pulse Width High	0.6		0.4		μ s
t_{AA}	Clock Low to Data Out Valid	0.05	0.9	0.05	0.55	μ s
t_{BUF}	Time the bus must be free before a new transmission can start ⁽²⁾	1.3		0.5		μ s
$t_{HD,STA}$	Start Hold Time	0.6		0.25		μ s
$t_{SU,STA}$	Start Set-up Time	0.6		0.25		μ s
$t_{HD,DAT}$	Data In Hold Time	0		0		μ s
$t_{SU,DAT}$	Data In Set-up Time	100		100		ns
t_R	Inputs Rise Time ⁽²⁾		0.3		0.3	μ s
t_F	Inputs Fall Time ⁽²⁾		300		100	ns
$t_{SU,STO}$	Stop Set-up Time	0.6		0.25		μ s
t_{DH}	Data Out Hold Time	50		50		ns
t_{WR}	Write Cycle Time		5		5	ms
Endurance ⁽²⁾	25°C, Page Mode	1M		1M		Write Cycles

Notes: 1. Applicable over recommended operating range from $T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$, $V_{CC} = +2.7\text{V}$ to $+5.5\text{V}$, $CL = 100\text{ pF}$ (unless otherwise noted). Test conditions are listed in Note 3.

2. This parameter is characterized and is not 100% tested.

3. AC measurement conditions:

R_L (connects to V_{CC}): $1.3\text{ k}\Omega$ (2.7V, 5V),

Input pulse voltages: $0.3V_{CC}$ to $0.7V_{CC}$

Input rise and fall times: $\leq 50\text{ns}$

Input and output timing reference voltages: $0.5V_{CC}$

Device Operation

CLOCK AND DATA TRANSITIONS: The SDA pin is normally pulled high with an external device. Data on the SDA pin may change only during SCL low time periods (refer to Data Validity timing diagram). Data changes during SCL high periods will indicate a start or stop condition as defined below.

START CONDITION: A high-to-low transition of SDA with SCL high is a start condition which must precede any other command (refer to Start and Stop Definition timing diagram).

STOP CONDITION: A low-to-high transition of SDA with SCL high is a stop condition. After a read sequence, the stop command will place the EEPROM in a standby power mode (refer to Start and Stop Definition timing diagram).

ACKNOWLEDGE: All addresses and data words are serially transmitted to and from the EEPROM in 8-bit words. The EEPROM sends a zero during the ninth clock cycle to acknowledge that it has received each word.

STANDBY MODE: The AT24C128SC/256SC features a low power standby mode which is enabled: a) upon power-up and b) after the receipt of the STOP bit and the completion of any internal operations.

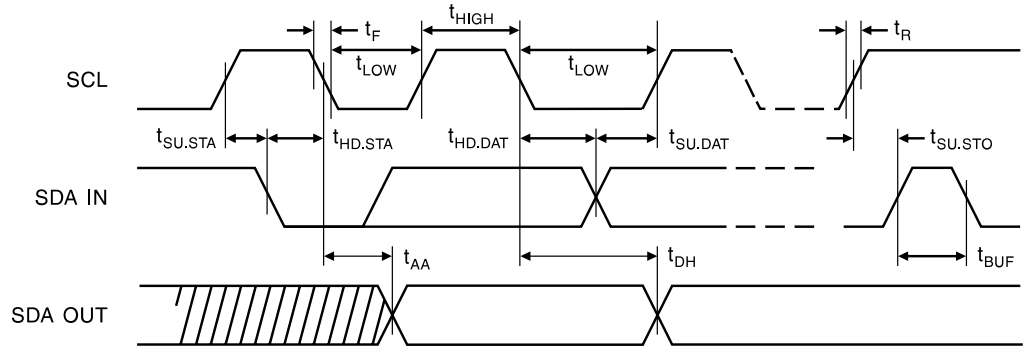
MEMORY RESET: After an interruption in protocol, power loss or system reset, any 2-wire part can be reset by following these steps:

1. Clock up to 9 cycles.
2. Look for SDA high in each cycle while SCL is high.
3. Create a start condition as SDA is high.

Timing Diagrams

Bus Timing

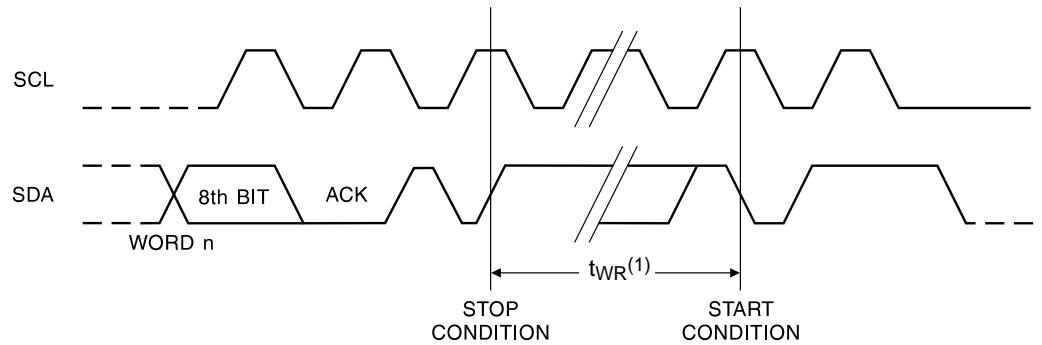
Figure 3. Bus Timing



Note: SCL: Serial Clock; SDA: Serial Data I/O

Write Cycle Timing

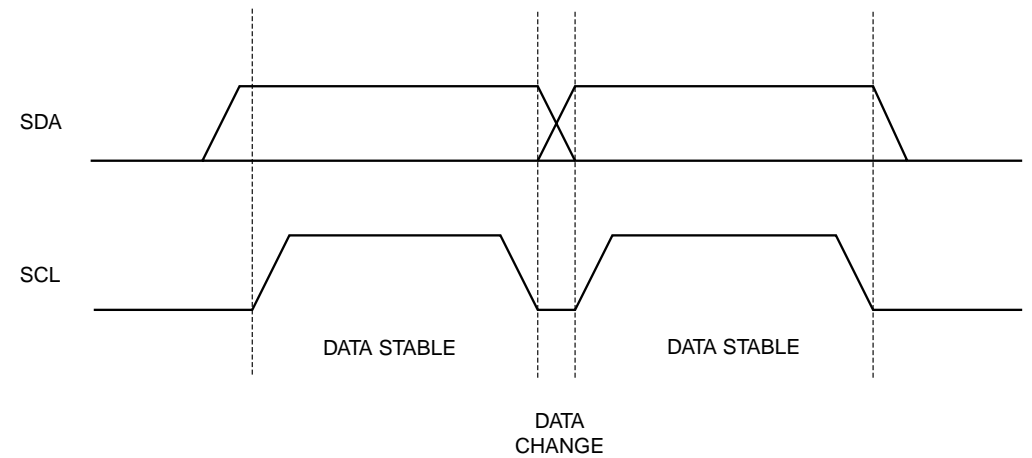
Figure 4. Write Cycle Timing



Note: 1. The write cycle time t_{WR} is the time from a valid stop condition of a write sequence to the end of the internal clear/write cycle.
SCL: Serial Clock; SDA: Serial Data I/O

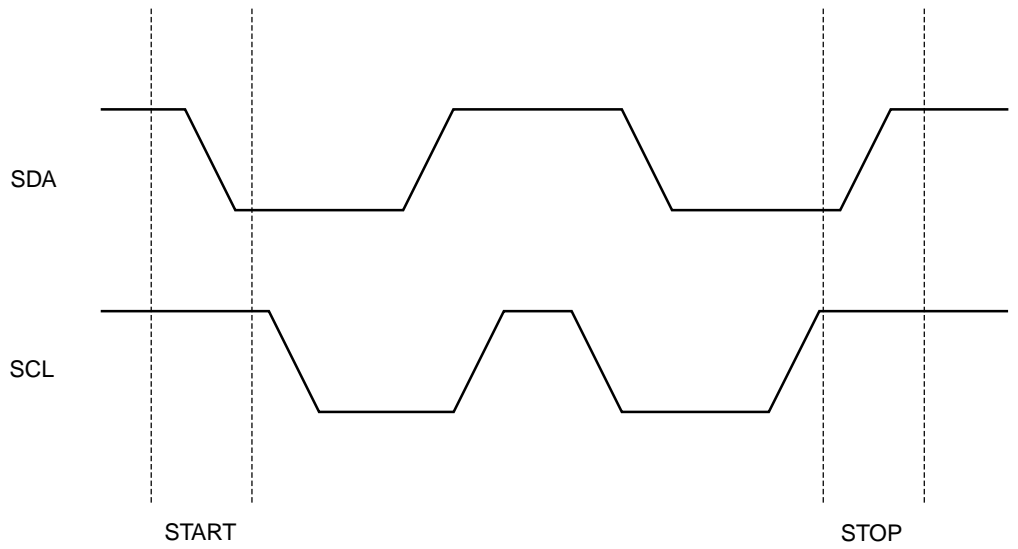
Data Validity

Figure 5. Data Validity



Start and Stop Definition

Figure 6. Start and Stop Definition



Output Acknowledge

Figure 7. Output Acknowledge

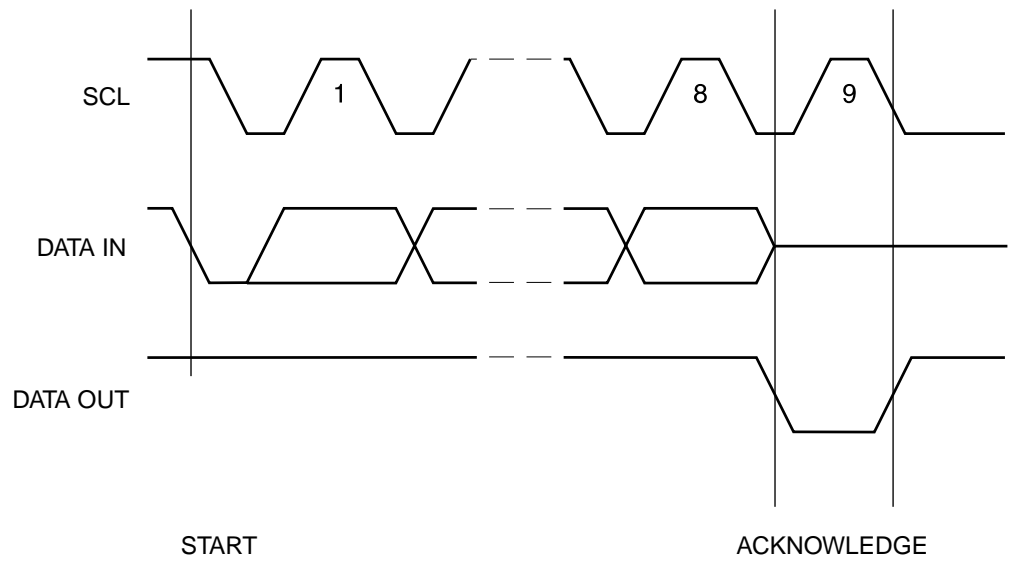
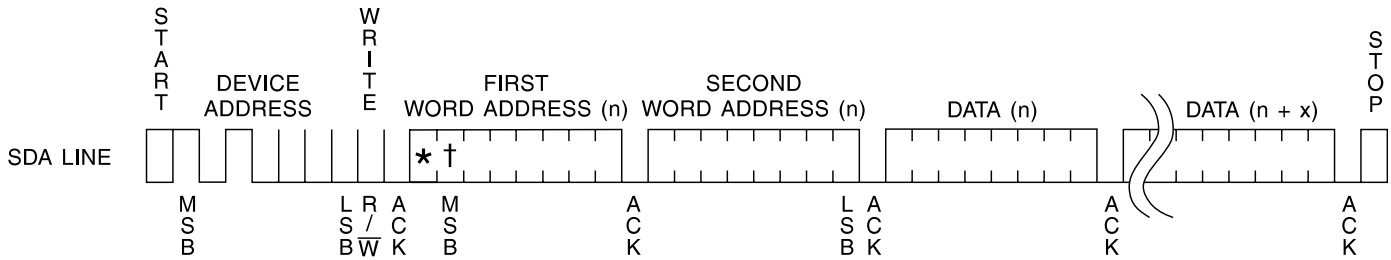


Figure 10. Page Write



- Note:
1. * = DON'T CARE bit
 2. † = DON'T CARE bit for the 128K

ACKNOWLEDGE POLLING: Once the internally-timed write cycle has started and the EEPROM inputs are disabled, acknowledge polling can be initiated. This involves sending a start condition followed by the device address word. The read/write bit is representative of the operation desired. Only if the internal write cycle has completed will the EEPROM respond with a zero, allowing the read or write sequence to continue.

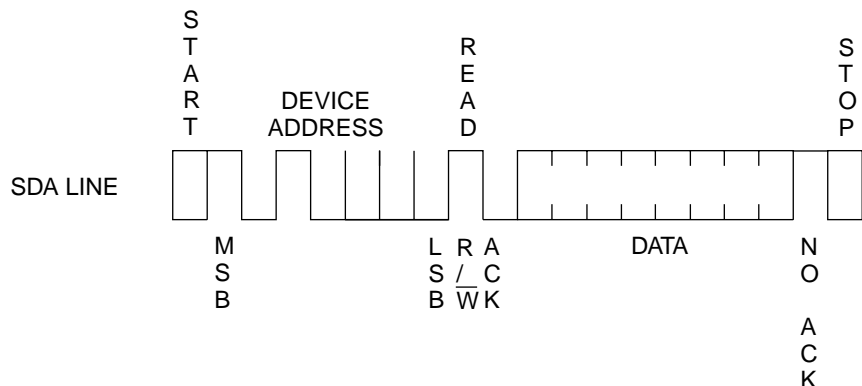
Read Operations

Read operations are initiated the same way as write operations with the exception that the read/write select bit in the device address word is set to one. There are three read operations: current address read, random address read and sequential read.

CURRENT ADDRESS READ: The internal data word address counter maintains the last address accessed during the last read or write operation, incremented by one. This address stays valid between operations as long as the chip power is maintained. The address “roll over” during read is from the last byte of the last memory page, to the first byte of the first page.

Once the device address with the read/write select bit set to one is clocked in and acknowledged by the EEPROM, the current address data word is serially clocked out. The microcontroller does not respond with an input zero but does generate a following stop condition (refer to Figure 11).

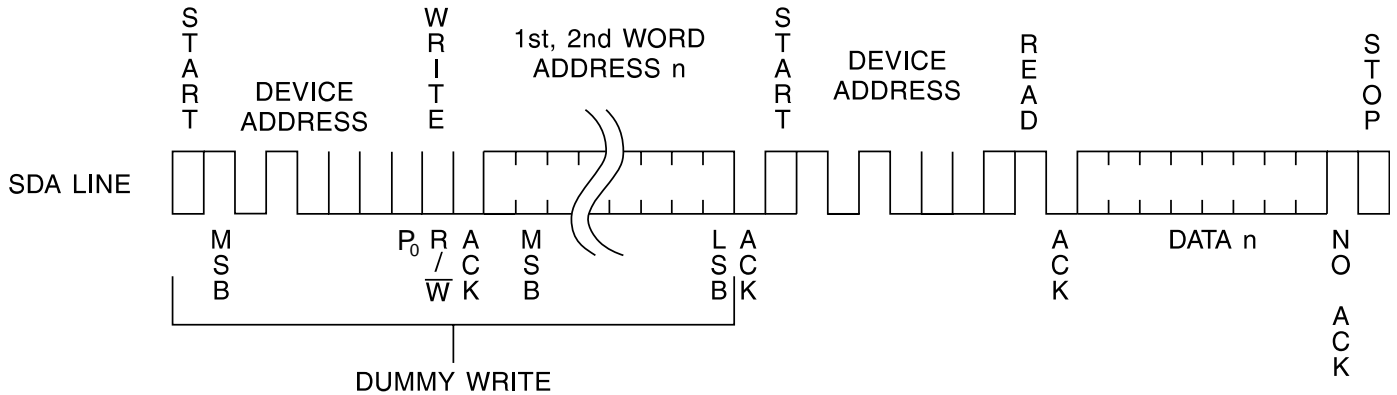
Figure 11. Current Address Read



RANDOM READ: A random read requires a “dummy” byte write sequence to load in the data word address. Once the device address word and data word address are clocked in and acknowledged by the EEPROM, the microcontroller must generate another start condition. The microcontroller now initiates a current address read by sending a device address with the read/write select bit high. The EEPROM acknowledges the device

address and serially clocks out the data word. The microcontroller does not respond with a zero but does generate a following stop condition (refer to Figure 12).

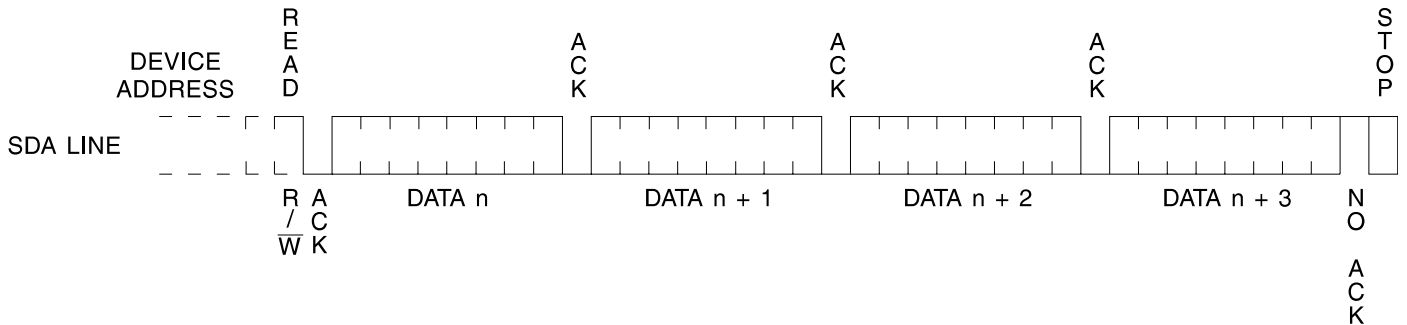
Figure 12. Random Read



- Notes:
1. * = DON'T CARE bit
 2. † = DON'T CARE bit for the 128K

SEQUENTIAL READ: Sequential reads are initiated by either a current address read or a random address read. After the microcontroller receives a data word, it responds with an acknowledge. As long as the EEPROM receives an acknowledge, it will continue to increment the data word address and serially clock out sequential data words. When the memory address limit is reached, the data word address will “roll over” and the sequential read will continue. The sequential read operation is terminated when the microcontroller does not respond with a zero but does generate a following stop condition (refer to Figure 13).

Figure 13. Sequential Read



AT24C128SC Ordering Information

Ordering Code	Package	Voltage Range	Operation Range
AT24C128SC-09AT	M2 – A Module	2.7V–5.5V	Commercial (0°C–70°C)
AT24C128SC-09BT	M2 – B Module	2.7V–5.5V	Commercial (0°C–70°C)
AT24C128SC-10WI	7 mil Wafer	2.7V–5.5V	Industrial (–40°C–85°C)

AT24C256SC Ordering Information

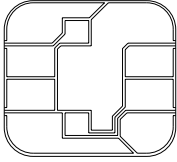
Ordering Code	Package	Voltage Range	Operation Range
AT24C256SC-09AT	M2 – A Module	2.7V–5.5V	Commercial (0°C–70°C)
AT24C256SC-09BT	M2 – B Module	2.7V–5.5V	Commercial (0°C–70°C)
AT24C256SC-10WI	7 mil Wafer	2.7V–5.5V	Industrial (–40°C–85°C)

Package Type ⁽¹⁾	Description
M2 – A Module	M2 ISO 7816 Smart Card Module
M2 – B Module	M2 ISO 7816 Smart Card Module with Atmel Logo

Note: Formal drawings may be obtained from an Atmel sales office.

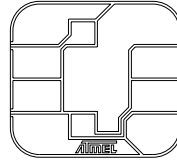
Smart Card Modules

Ordering Code: 09AT-00



Module Size: **M2**
Dimension*: 12.6 x 11.4 [mm]
Glob Top: Square: 8.6 x 8.6 [mm]
Thickness: 0.58 [mm] max
Pitch: 14.25 [mm]

Ordering Code: 09BT-00



Module Size: **M2**
Dimension*: 12.6 x 11.4 [mm]
Glob Top: Square: 8.6 x 8.6 [mm]
Thickness: 0.58 [mm] max
Pitch: 14.25 [mm]

*Note: The module dimensions listed refer to the dimensions of the exposed metal contact area. The actual dimensions of the module after excise or punching from the carrier tape are generally 0.4 mm greater in both directions (i.e., a punched M2 module will yield 13.0 x 11.8 mm).



Atmel Corporation

2325 Orchard Parkway
San Jose, CA 95131
Tel: 1(408) 441-0311
Fax: 1(408) 487-2600

Regional Headquarters

Europe

Atmel Sarl
Route des Arsenaux 41
Case Postale 80
CH-1705 Fribourg
Switzerland
Tel: (41) 26-426-5555
Fax: (41) 26-426-5500

Asia

Room 1219
Chinachem Golden Plaza
77 Mody Road Tsimshatsui
East Kowloon
Hong Kong
Tel: (852) 2721-9778
Fax: (852) 2722-1369

Japan

9F, Tonetsu Shinkawa Bldg.
1-24-8 Shinkawa
Chuo-ku, Tokyo 104-0033
Japan
Tel: (81) 3-3523-3551
Fax: (81) 3-3523-7581

Atmel Operations

Memory

2325 Orchard Parkway
San Jose, CA 95131
Tel: 1(408) 441-0311
Fax: 1(408) 436-4314

Microcontrollers

2325 Orchard Parkway
San Jose, CA 95131
Tel: 1(408) 441-0311
Fax: 1(408) 436-4314

La Chantrerie
BP 70602
44306 Nantes Cedex 3, France
Tel: (33) 2-40-18-18-18
Fax: (33) 2-40-18-19-60

ASIC/ASSP/Smart Cards

Zone Industrielle
13106 Rousset Cedex, France
Tel: (33) 4-42-53-60-00
Fax: (33) 4-42-53-60-01

1150 East Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906
Tel: 1(719) 576-3300
Fax: 1(719) 540-1759

Scottish Enterprise Technology Park
Maxwell Building
East Kilbride G75 0QR, Scotland
Tel: (44) 1355-803-000
Fax: (44) 1355-242-743

RF/Automotive

Theresienstrasse 2
Postfach 3535
74025 Heilbronn, Germany
Tel: (49) 71-31-67-0
Fax: (49) 71-31-67-2340

1150 East Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906
Tel: 1(719) 576-3300
Fax: 1(719) 540-1759

Biometrics/Imaging/Hi-Rel MPU/ High Speed Converters/RF Datacom

Avenue de Rochepleine
BP 123
38521 Saint-Egreve Cedex, France
Tel: (33) 4-76-58-30-00
Fax: (33) 4-76-58-34-80

e-mail

literature@atmel.com

Web Site

<http://www.atmel.com>

Disclaimer: Atmel Corporation makes no warranty for the use of its products, other than those expressly contained in the Company's standard warranty which is detailed in Atmel's Terms and Conditions located on the Company's web site. The Company assumes no responsibility for any errors which may appear in this document, reserves the right to change devices or specifications detailed herein at any time without notice, and does not make any commitment to update the information contained herein. No licenses to patents or other intellectual property of Atmel are granted by the Company in connection with the sale of Atmel products, expressly or by implication. Atmel's products are not authorized for use as critical components in life support devices or systems.

© Atmel Corporation 2003. All rights reserved. Atmel® and combinations thereof are registered trademarks of Atmel Corporation or its subsidiaries. Other terms and product names may be the trademarks of others.



Printed on recycled paper.

1661B-SEEPR-04/04