Atmel AT24HC02C

I^2C-Compatible (2-wire) Serial EEPROM

2-Kbit (256 x 8)

DATASHEET

Features

- Write Protect pin for hardware data protection
  - Utilizes different array protection compared to the AT24C02C
- Low-voltage operation
  - V_{CC} = 1.7V to 5.5V
- Internally organized as 128 x 8 (1K) or 256 x 8 (2K)
- I^2C compatible (2-wire) serial interface
- Schmitt Trigger, filtered inputs for noise suppression
- Bidirectional data transfer protocol
- 400kHz (1.7V) and 1MHz (2.5V, 2.7V, 5.0V) compatibility
- 8-byte Page Write mode
  - Partial Page Writes allowed
- Self-timed write cycle (5ms max)
- High-reliability
  - Endurance: 1,000,000 write cycles
  - Data retention: 100 years
- Green package options (Pb/Halide-free/RoHS-compliant)
  - 8-lead PDIP, 8-lead JEDEC SOIC, and 8-lead TSSOP
- Die sale options: wafer form and tape and reel available

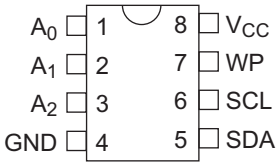
Description

The Atmel® AT24HC02C provides 2048-bits of Serial Electrically Erasable and Programmable Read-Only Memory (EEPROM) organized as 256 words of eight bits each. The device include a cascading feature that allows up to eight devices to share a common 2-wire bus. These devices are optimized for use in many industrial and commercial applications where low power and low voltage operation are essential. The AT24HC02C are available in space saving 8-lead PDIP, 8-lead JEDEC SOIC, and 8-lead TSSOP packages. In addition, the product operates from 1.7V to 5.5V V_{CC}.

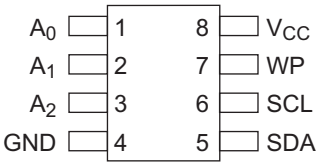
1. Pin Configurations and Pinouts

Pin Name	Function
A_0 - A_2	Address Inputs
SDA	Serial Data
SCL	Serial Clock Input
WP	Write Protect
GND	Ground
V_{CC}	Power Supply

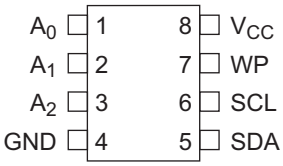
8-lead PDIP



8-lead SOIC



8-lead TSSOP

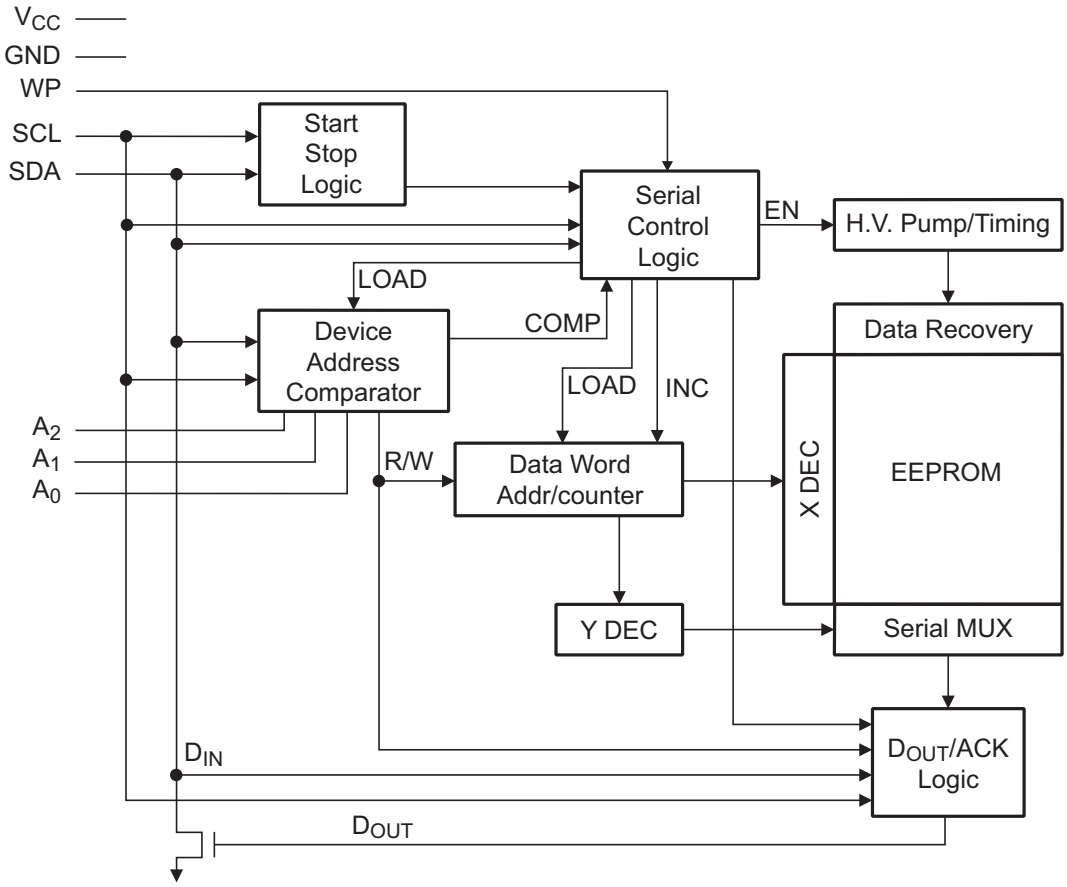


2. Absolute Maximum Ratings

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	5.0mA

*Notice: Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and 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.

3. Block Diagram



4. 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.

Device Addresses (A_2, A_1, A_0): The A_2, A_1, and A_0 pins are device address inputs that are hard wired for the AT24HC02C. As many as eight 2-Kbit devices may be addressed on a single bus system. See Section 7. “Device Addressing” on page 9 for more details.

Write Protect (WP): The AT24HC02C have a Write Protect pin that provides hardware data protection. The Write Protect pin allows normal read/write operations when connected to ground (GND). When the Write Protect pin is connected to V_{CC}, the write protection feature is enabled and operates as shown below in Table 4-1.

Table 4-1. Write Protect

WP Pin Status	Part of the Array Protected
	Atmel AT24HC02C
At V_{CC}	Upper Half (1K) of Array
At GND	Normal Read/Write Operations

5. Memory Organization

Atmel AT24HC02C, 2K Serial EEPROM: Internally organized with 32 pages of 8-bytes each, the 2K requires an 8-bit data word address for random word addressing.

Table 5-1. Pin Capacitance[1]

Applicable over recommended operating range from T_A = 25°C, f = 1.0MHz, V_{CC} = 1.7V to 5.5V

Symbol	Test Condition	Max	Units	Conditions
$C_{I/O}$	Input/Output Capacitance (SDA)	8	pF	$V_{I/O}$ = 0V
C_{IN}	Input Capacitance (A_0, A_1, A_2, SCL)	6	pF	V_{IN} = 0V

Note: 1. This parameter is characterized and is not 100% tested.

Table 5-2. DC Characteristics

Applicable over recommended operating range from: T_{AI} = –40°C to +85°C, V_{CC} = 1.7V to 5.5V (unless otherwise noted)

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
V_{CC1}	Supply Voltage		1.7		5.5	V
V_{CC2}	Supply Voltage		2.5		5.5	V
V_{CC3}	Supply Voltage		4.5		5.5	V
I_{CC1}	Supply Current V_{CC} = 5.0V	Read at 400kHz		0.4	1.0	mA
I_{CC2}	Supply Current V_{CC} = 5.0V	Write at 400kHz		2.0	3.0	mA
I_{SB1}	Standby Current V_{CC} = 1.7V	V_{IN} = V_{CC} or V_{SS}			1.0	µA
I_{SB2}	Standby Current V_{CC} = 2.5V	V_{IN} = V_{CC} or V_{SS}			2.0	µA
I_{SB3}	Standby Current V_{CC} = 5.5V	V_{IN} = V_{CC} or V_{SS}			6.0	µA
I_{LI}	Input Leakage Current	V_{IN} = V_{CC} or V_{SS}		0.10	3.0	µA
I_{LO}	Output Leakage Current	V_{OUT} = V_{CC} or V_{SS}		0.05	3.0	µA
V_{IL}	Input Low Level[1]		–0.6		V_{CC} x 0.3	V
V_{IH}	Input High Level[1]		V_{CC} x 0.7		V_{CC} + 0.5	V
V_{OL1}	Output Low Level V_{CC} = 1.7V	I_{OL} = 0.15mA			0.2	V
V_{OL2}	Output Low Level V_{CC} = 3.0V	I_{OL} = 2.1mA			0.4	V

Note: 1. V_{IL} min and V_{IH} max are reference only and are not tested.

Table 5-3. AC Characteristics

Applicable over recommended operating range from T_{AI} = –40°C to +85°C, V_{CC} = 1.7V to 5.5V, CL = 1TTL Gate and 100pF (unless otherwise noted). Test conditions are listed in Note 2.

Symbol	Parameter	1.7V		2.5V,5.0V		Units
		Min	Max	Min	Max	
f_{SCL}	Clock Frequency, SCL		400		1000	kHz
t_{LOW}	Clock Pulse Width Low	1.2		0.4		µs
t_{HIGH}	Clock Pulse Width High	0.6		0.4		µs
t_I	Noise Suppression Time		100		50	ns
t_{AA}	Clock Low to Data Out Valid	0.1	0.9	0.05	0.55	µs
t_{BUF}	Time the bus must be free before a new transmission can start.	1.2		0.5		µs
$t_{HD.STA}$	Start Hold Time	0.6		0.25		µs
$t_{SU.STA}$	Start Setup Time	0.6		0.25		µs
$t_{HD.DAT}$	Data In Hold Time	0		0		µs
$t_{SU.DAT}$	Data In Setup Time	100		100		ns
t_R	Inputs Rise Time(1)		0.3		0.3	µs
t_F	Inputs Fall Time(1)		300		100	ns
$t_{SU.STO}$	Stop Setup Time	0.6		.25		µs
t_{DH}	Data Out Hold Time	50		50		ns
t_{WR}	Write Cycle Time		5		5	ms
Endurance(1)	25°C, Page Mode, 3.3V	1,000,000				Write Cycles

Note: 1. This parameter is ensured by characterization only.

2. AC measurement conditions:
   - R_L (connects to V_{CC}): 1.3 kΩ (2.5V, 5V), 10 kΩ (1.7V)
   - Input pulse voltages: 0.3 V_{CC} to 0.7 V_{CC}
   - Input rise and fall times: ≤ 50ns
   - Input and output timing reference voltages: 0.5 V_{CC}

6. 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 (see Figure 6-4 on page 8). 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 (see Figure 6-5 on page 8).

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 (see Figure 6-5 on page 8).

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

Standby Mode: The AT24HC02C features a low power standby mode which is enabled:

- Upon power-up
- After the receipt of the stop bit and the completion of any internal operations

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

1. Create a start bit condition
2. Clock nine cycles
3. Create another start bit followed by stop bit condition as shown in Figure 6-1.

The device is ready for the next communication after above steps have been completed.

Figure 6-1. Software reset

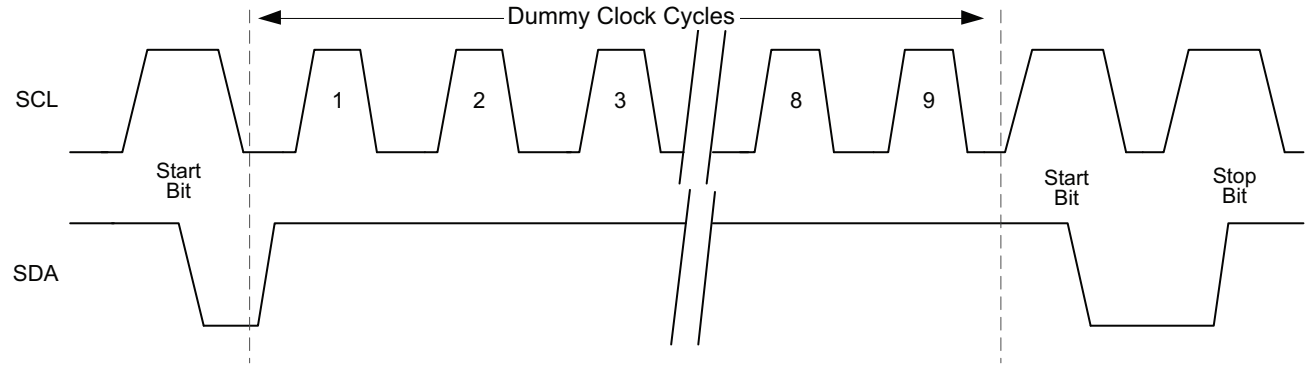


Figure 6-2. Bus Timing

SCL: Serial Clock, SDA: Serial Data I/O

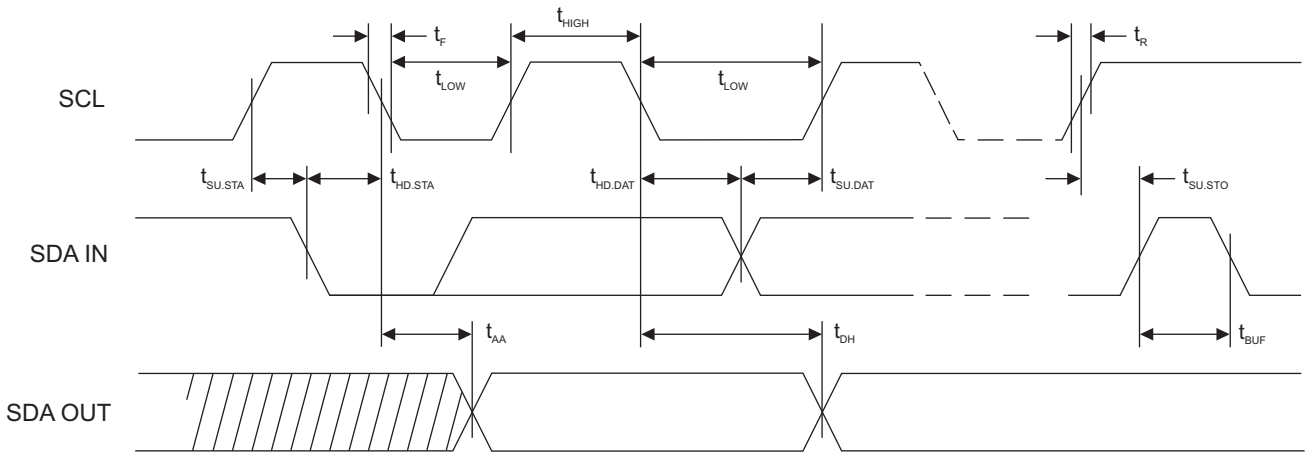
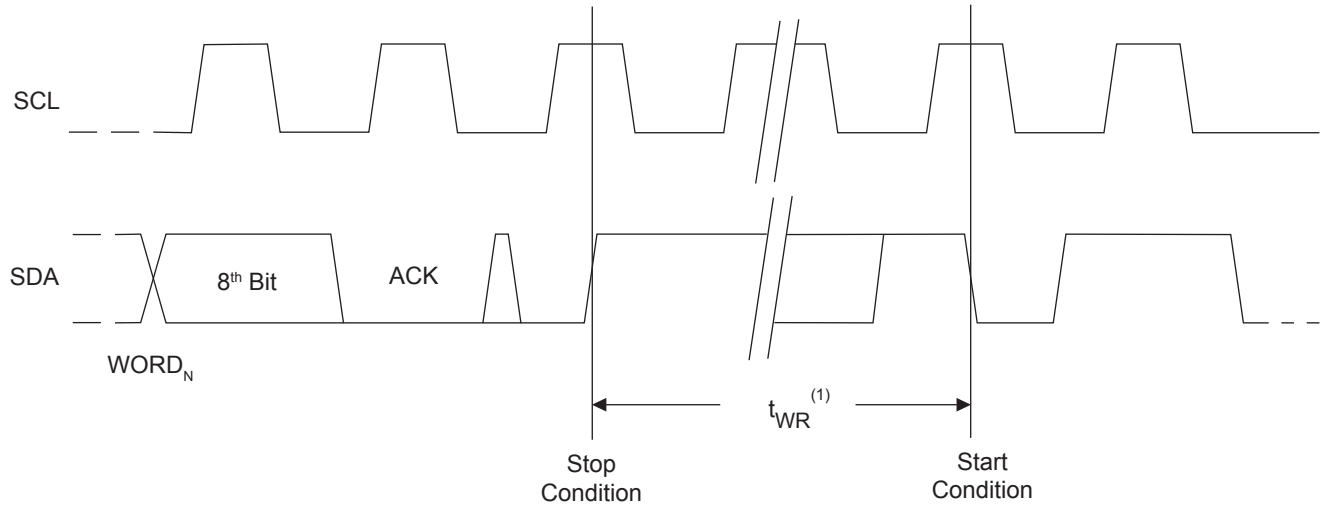


Figure 6-3. Write Cycle Timing

SCL: Serial Clock, SDA: Serial Data I/O



Notes: 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.

Figure 6-4. Data Validity

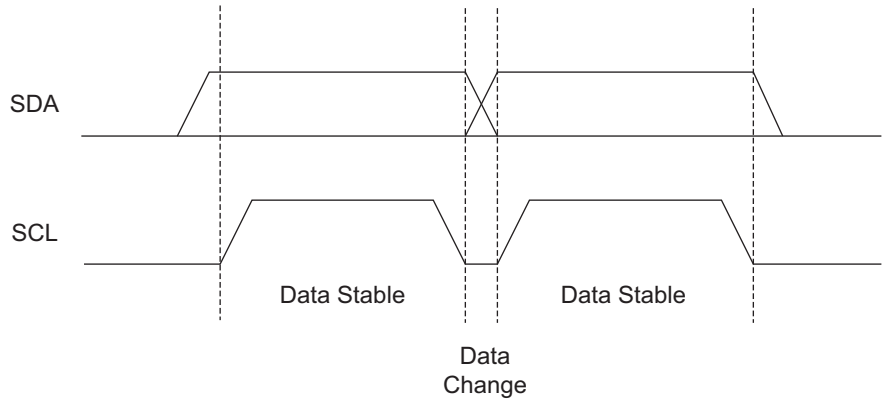


Figure 6-5. Start and Stop Definition

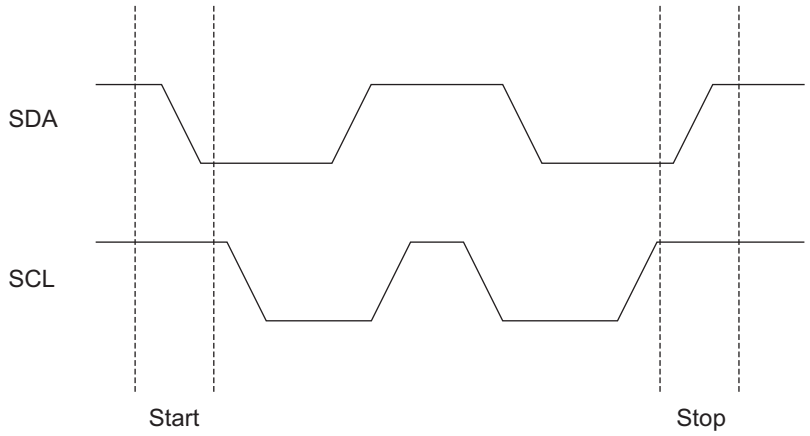
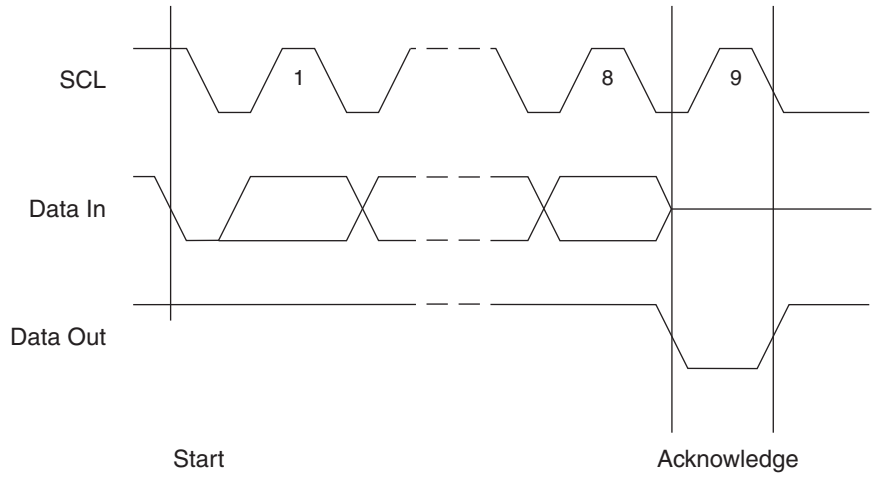


Figure 6-6. Output Acknowledge



7. Device Addressing

The 2-Kbit EEPROM device requires an 8-bit device address word following a start condition to enable the chip for a Read or Write operation.

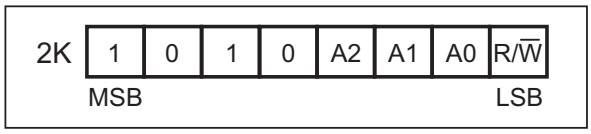
The device address word consists of a mandatory '1010' (Ah) sequence for the first four most significant bits as shown in Figure 7-1. This is common to all Serial EEPROM devices.

The next three bits are the A2, A1, and A0 device address bits for the EEPROM. These three bits must compare to their corresponding hard-wired input pins A_2, A_1, and A_0 in order for the part to acknowledge.

The eighth bit of the device address is the Read/Write operation select bit. A Read operation is initiated if this bit is high and a Write operation is initiated if this bit is low.

Upon a valid compare of the device address with hard-wired input pins A_2, A_1, and A_0, the EEPROM will output a zero. If a compare is not successfully made, the chip will return to a standby state.

Figure 7-1. Device Address



8. Write Operations

Byte Write: A write operation requires an 8-bit data word address following the device address word and acknowledgment. Upon receipt of this address, the EEPROM will again respond with a zero and then clock in the first 8-bit data word. Following receipt of the 8-bit data word, the EEPROM will output a zero and the addressing device, such as a microcontroller, must terminate the write sequence with a Stop condition. At this time, the EEPROM enters an internally timed write cycle, t_{WR}, to the nonvolatile memory. All inputs are disabled during this write cycle and the EEPROM will not respond until the write is complete (see Figure 9-1 on page 10).

Page Write: The 2-Kbit EEPROM is capable of an 8-byte Page Write.

A Page Write is initiated the same as a Byte Write, but the microcontroller does not send a Stop condition after the first data word is clocked in. Instead, after the EEPROM acknowledges receipt of the first data word, the microcontroller can transmit up to seven data words. The EEPROM will respond with a zero after each data word received. The microcontroller must terminate the page write sequence with a Stop condition (see Figure 9-2 on page 10).

The data word address lower three bits are internally incremented following the receipt of each data word. The higher data word address bits are not incremented, retaining the memory page row location. When the word address, internally generated, reaches the page boundary, the following byte is placed at the beginning of the same page. If more than eight data words are transmitted to the EEPROM, the data word address will “roll over” and previous data will be overwritten.

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.

Data Security: The Atmel AT24HC02C has a hardware data protection scheme that allows the user to write protect the upper half of the memory (00h - 7Fh) when the WP pin is at V_{CC}.

9. 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. The address “roll over” during write is from the last byte of the current page to the first byte of the same 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 zero but does generate a following Stop condition (see Figure 9-3 on page 11).

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 (see Figure 9-4 on page 11).

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 (see Figure 9-5 on page 11).

Figure 9-1. Byte Write

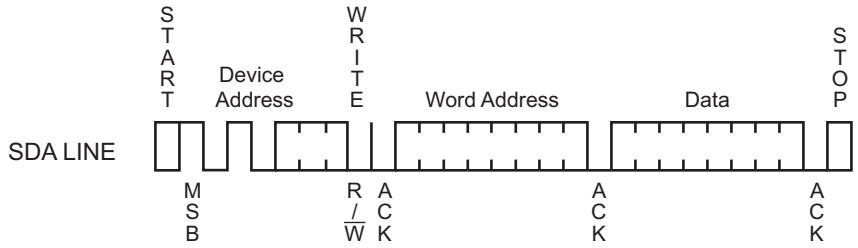


Figure 9-2. Page Write

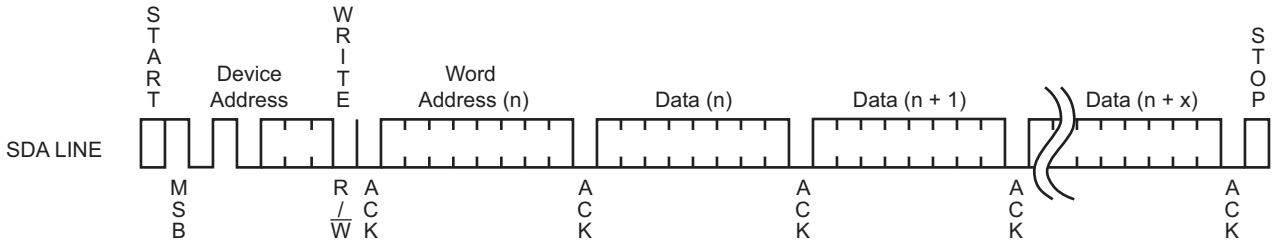


Figure 9-3. Current Address Read

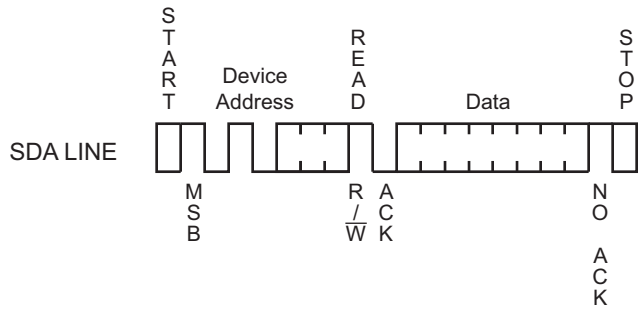


Figure 9-4. Random Read

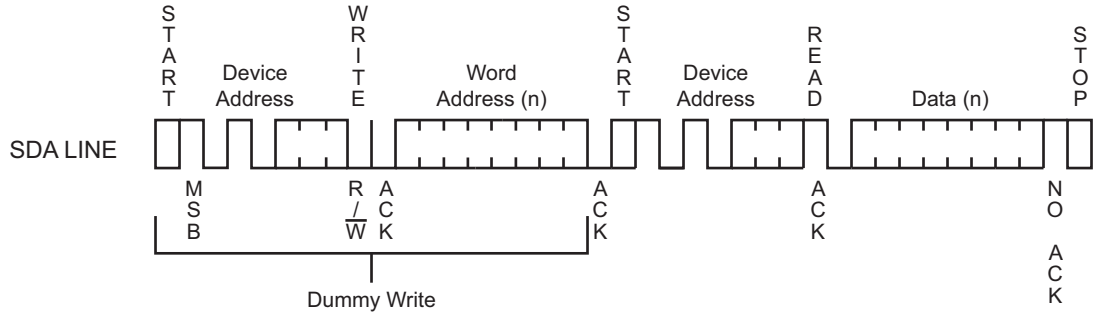
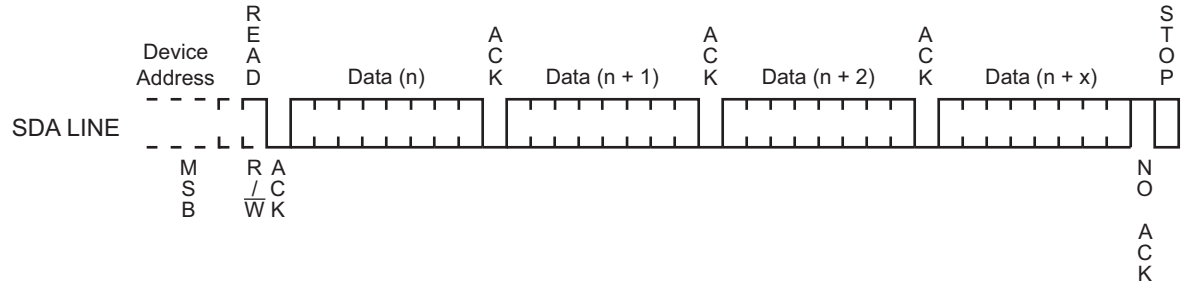
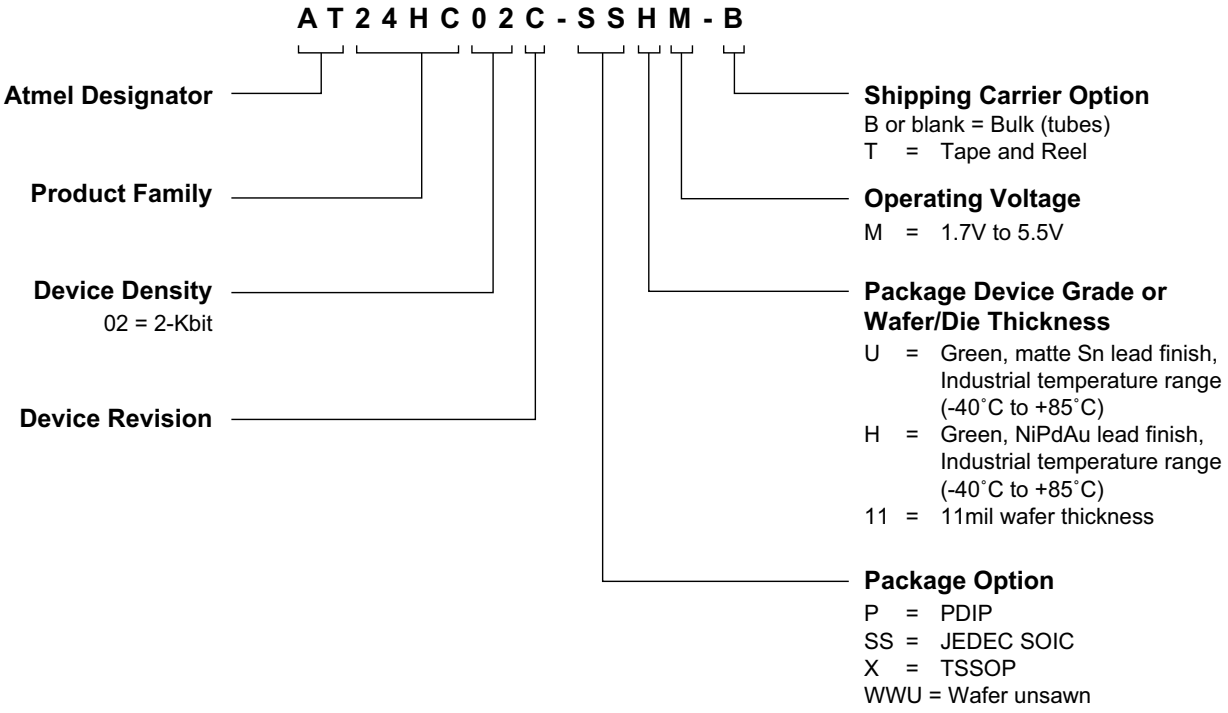


Figure 9-5. Sequential Read

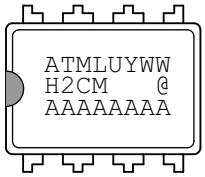
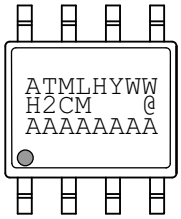
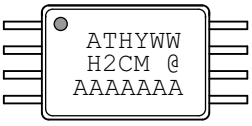


10. Ordering Code Detail



11. Part Markings

AT24HC02C: Package Marking Information

8-lead PDIP	8-lead SOIC	8-lead TSSOP
		

Note 1: ● *designates pin 1*

Note 2: Package drawings are not to scale

Catalog Number Truncation			
AT24HC02C		Truncation Code ###: H2C	
Date Codes			**Voltages**
Y = Year	M = Month	WW = Work Week of Assembly	M: 1.7V min
2: 2012 6: 2016	A: January	02: Week 2	
3: 2013 7: 2017	B: February	04: Week 4	
4: 2014 8: 2018	...	...	
5: 2015 9: 2019	L: December	52: Week 52	
Country of Assembly	**Lot Number**		**Grade/Lead Finish Material**
@ = Country of Assembly	AAA...A = Atmel Wafer Lot Number		U: Industrial/Matte Tin H: Industrial/NiPdAu
Trace Code			**Atmel Truncation**
XX = Trace Code (Atmel Lot Numbers Correspond to Code) Example: AA, AB.... YZ, ZZ			AT: Atmel ATM: Atmel ATML: Atmel

5/21/12

Atmel Package Mark Contact: DL-CSO-Assy_eng@atmel.com	TITLE	DRAWING NO.	REV.
	24HC02CSM, AT24HC02C Package Marking Information	24HC02CSM	B

12. Ordering Codes

12.1 Atmel AT24HC02C Ordering Information

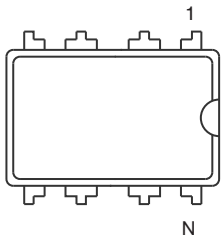
Ordering Code	Package	Voltage	Operation Range
AT24HC02C-PUM (Bulk Form Only)	8P3	1.7V to 5.5V	Lead-free/Halogen-free/ Industrial Temperature (–40°C to 85°C)
AT24HC02C-SSHM-B[1] (NiPdAu Lead Finish)	8S1		
AT24HC02C-SSHM-T[2] (NiPdAu Lead Finish)			
AT24HC02C-XHM-B[1] (NiPdAu Lead Finish)	8X		
AT24HC02C-XHM-T[2] (NiPdAu Lead Finish)			
AT24HC02C-WWU11M[3]	Wafer Sale		Industrial Temperature (–40°C to 85°C)

Notes:
1. B = Bulk (tubes)
2. T = Tape and reel
   - SOIC = 4K per reel
   - TSSOP = 5K per reel
3. For Wafer sales, please contact Atmel Sales.

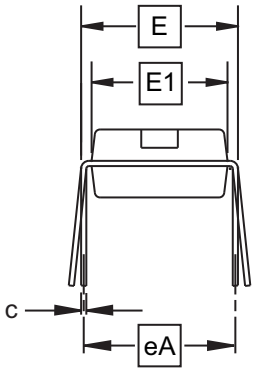
Package Type	
8P3	8-lead, 0.300" wide, Plastic Dual Inline (PDIP)
8S1	8-lead, 0.150" wide, Plastic Gull Wing Small Outline (JEDEC SOIC)
8X	8-lead, 4.4mm body, Plastic Thin Shrink Small Outline (TSSOP)

13. Packaging Information

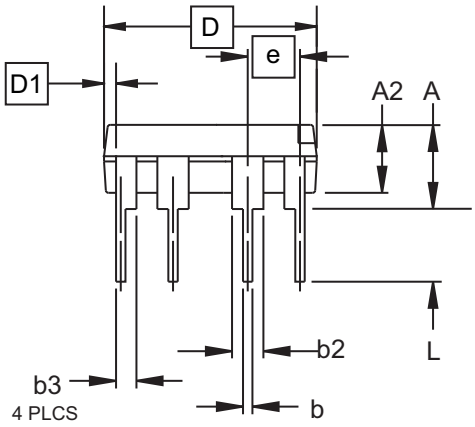
13.1 8P3 — 8-lead PDIP



Top View



End View



Side View

COMMON DIMENSIONS
(Unit of Measure = inches)

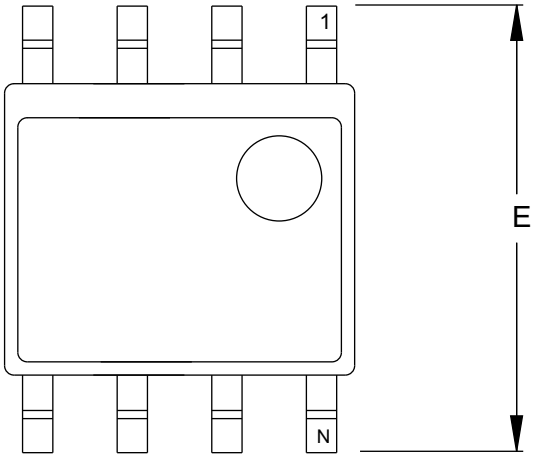
SYMBOL	MIN	NOM	MAX	NOTE
A			0.210	2
A2	0.115	0.130	0.195	
b	0.014	0.018	0.022	5
b2	0.045	0.060	0.070	6
b3	0.030	0.039	0.045	6
c	0.008	0.010	0.014	
D	0.355	0.365	0.400	3
D1	0.005			3
E	0.300	0.310	0.325	4
E1	0.240	0.250	0.280	3
e	0.100 BSC			
eA	0.300 BSC			4
L	0.115	0.130	0.150	2

Notes:
1. This drawing is for general information only; refer to JEDEC Drawing MS-001, Variation BA for additional information.
2. Dimensions A and L are measured with the package seated in JEDEC seating plane Gauge GS-3.
3. D, D1 and E1 dimensions do not include mold Flash or protrusions. Mold Flash or protrusions shall not exceed 0.010 inch.
4. E and eA measured with the leads constrained to be perpendicular to datum.
5. Pointed or rounded lead tips are preferred to ease insertion.
6. b2 and b3 maximum dimensions do not include Dambar protrusions. Dambar protrusions shall not exceed 0.010 (0.25 mm).

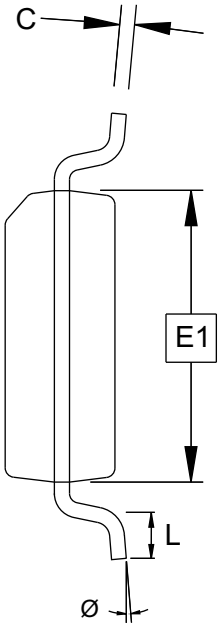
06/21/11

Atmel Package Drawing Contact: packagedrawings@atmel.com	TITLE 8P3, 8-lead, 0.300” Wide Body, Plastic Dual In-line Package (PDIP)	GPC PTC	DRAWING NO. 8P3	REV. D

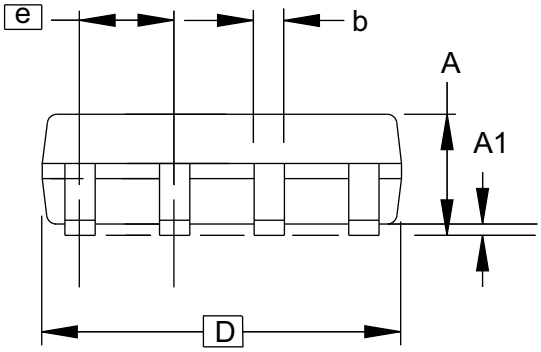
13.2 8S1 — 8-lead JEDEC SOIC



TOP VIEW



END VIEW



SIDE VIEW

Notes: This drawing is for general information only.
Refer to JEDEC Drawing MS-012, Variation AA
for proper dimensions, tolerances, datums, etc.

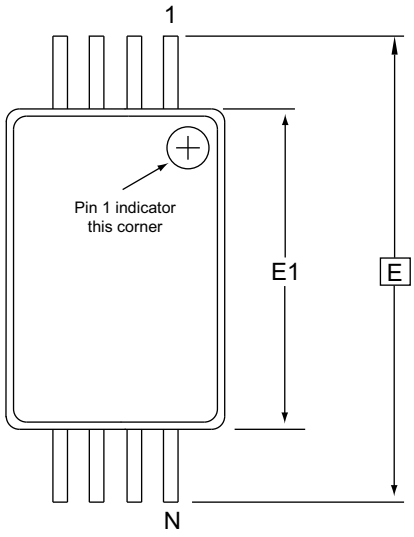
COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	1.35	–	1.75	
A1	0.10	–	0.25	
b	0.31	–	0.51	
C	0.17	–	0.25	
D	4.80	–	5.05	
E1	3.81	–	3.99	
E	5.79	–	6.20	
e	1.27 BSC			
L	0.40	–	1.27	
Ø	0°	–	8°	

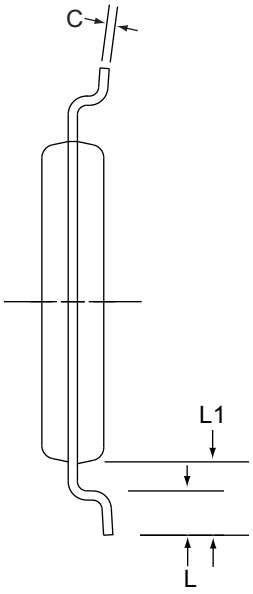
6/22/11

Atmel Package Drawing Contact: packagedrawings@atmel.com	**TITLE** 8S1, 8-lead (0.150” Wide Body), Plastic Gull Wing Small Outline (JEDEC SOIC)	**GPC** SWB	**DRAWING NO.** 8S1	**REV.** G

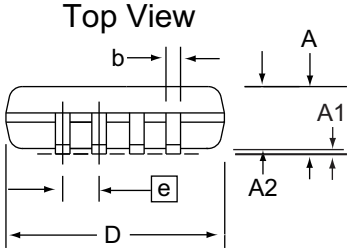
13.3 8X — 8-lead TSSOP



Top View



End View



Side View

Notes:
1. This drawing is for general information only. Refer to JEDEC Drawing MO-153, Variation AA, for proper dimensions, tolerances, datums, etc.
2. Dimension D does not include mold Flash, protrusions or gate burrs. Mold Flash, protrusions and gate burrs shall not exceed 0.15mm (0.006in) per side.
3. Dimension E1 does not include inter-lead Flash or protrusions. Inter-lead Flash and protrusions shall not exceed 0.25mm (0.010in) per side.
4. Dimension b does not include Dambar protrusion. Allowable Dambar protrusion shall be 0.08mm total in excess of the b dimension at maximum material condition. Dambar cannot be located on the lower radius of the foot. Minimum space between protrusion and adjacent lead is 0.07mm.
5. Dimension D and E1 to be determined at Datum Plane H.

COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	-	-	1.20	
A1	0.05	-	0.15	
A2	0.80	1.00	1.05	
D	2.90	3.00	3.10	2, 5
E		6.40 BSC		
E1	4.30	4.40	4.50	3, 5
b	0.19	–	0.30	4
e		0.65 BSC		
L	0.45	0.60	0.75	
L1		1.00 REF		
C		0.09	-	0.20

6/22/11

Atmel Package Drawing Contact: packagedrawings@atmel.com	**TITLE** 8X, 8-lead 4.4mm Body, Plastic Thin Shrink Small Outline Package (TSSOP)	**GPC** TNR	**DRAWING NO.** 8X	**REV.** D

14. Revision History

Doc. Rev.	Date	Comments
8779A	06/2012	Initial document release.

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