Atmel AT24C512C

I²C-Compatiable (2-wire) Serial EEPROM
512-Kbit (65,536 x 8)

DATASHEET

Features

- Low-voltage and standard-voltage operation
  - 1.7V (V_{CC} = 1.7V to 3.6V)
  - 2.5V (V_{CC} = 2.5V to 5.5V)
- Internally organized as 65,536 x 8
- 2-wire serial interface
- Schmitt Triggers, filtered inputs for noise suppression
- Bidirectional data transfer protocol
- 400kHz (1.7V) and 1MHz (2.5V, 5.5V) compatibility
- Write Protect pin for hardware data protection
- 128-byte page write mode
  - partial page writes allowed
- Random and sequential read modes
- Self-timed write cycle (5ms max)
- High reliability
  - Endurance: 1,000,000 write cycles
  - Data retention: 40 years
- Green package options (Pb/Halide-free/RoHS Compliant)
  - 8-lead JEDEC SOIC, 8-lead EIAJ SOIC, 8-lead TSSOP, 8-pad UDFN, and 8-ball VFBGA packages
- Die sale options: wafer form and tape and reel available

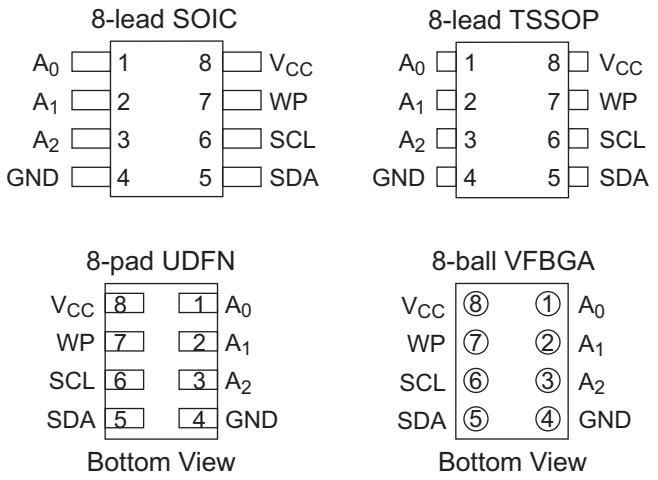
Description

The Atmel® AT24C512C provides 524,288 bits of Serial Electrically Erasable and Programmable Read-Only Memory (EEPROM) organized as 65,536 words of eight bits each. The cascadable feature of the device allows up to eight devices to share a common 2-wire bus. The device is optimized for use in many industrial and commercial applications where low-power and low-voltage operation are essential. The devices are available in space-saving 8-lead JEDEC SOIC, 8-lead EIAJ SOIC, 8-lead TSSOP, 8-pad UDFN, and 8-ball VFBGA packages. In addition, the entire family is available in 1.7V (1.7V to 3.6V) and 2.5V (2.5V to 5.5V) versions.

1. Pin Configurations and Pinouts

Figure 1. Pin Configurations

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

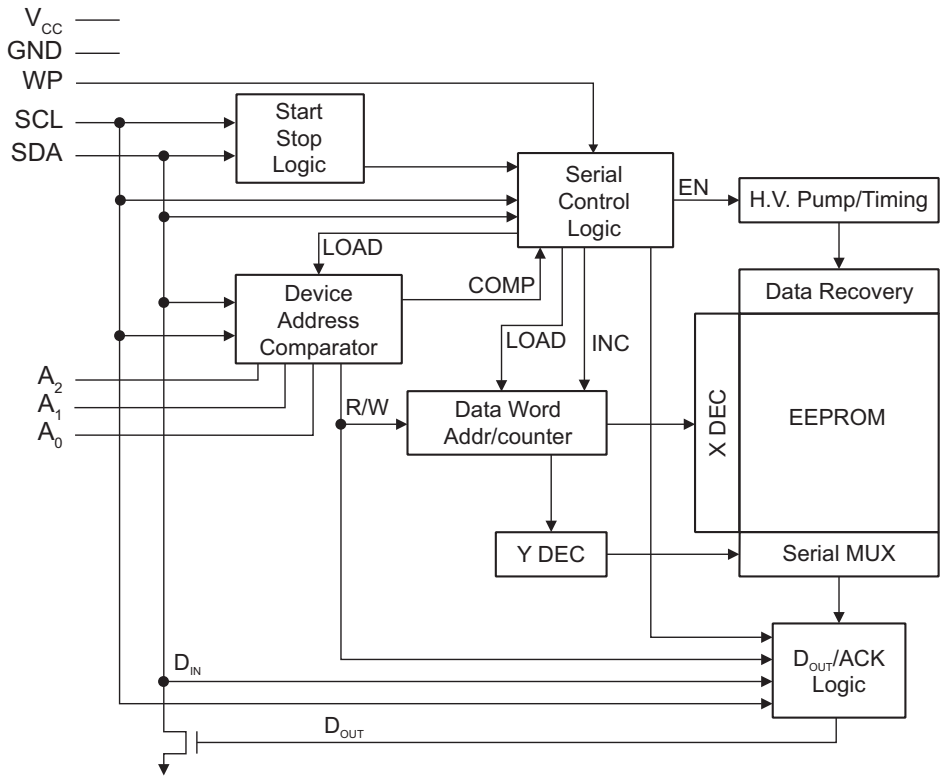


2. Absolute Maximum Ratings*

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 Descriptions

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 hardwired or left not connected for compatibility with other Atmel AT24Cxx devices. When the pins are hardwired, as many as eight 512K devices may be addressed on a single bus system (see Section 7. “Device Addressing” on page 9 for more details). If these pins are left floating, the A_2, A_1, and A_0 pins will be internally pulled down to GND. However, due to capacitive coupling that may appear during customer applications, Atmel recommends always connecting the address pins to a known state. When using a pull-up resistor, Atmel recommends using 10kΩ or less.

Write Protect (WP) — The Write Protect input, when connected to GND, allows normal write operations. When WP pin is connected directly to V_{CC}, all write operations to the memory are inhibited. If the pin is left floating, the WP pin will be internally pulled down to GND; however, due to capacitive coupling that may appear during customer applications, Atmel recommends always connecting the WP pin to a known state. When using a pull-up resistor, Atmel recommends using 10kΩ or less.

Table 4-1. Write Protect

WP Pin Status	Part of the Array Protected
	Atmel AT24C512C
At V_{CC}	Full Array
At GND	Normal Read/Write Operations

5. Memory Organization

Atmel AT24C512C, 512-Kbit Serial EEPROM: The 512K is internally organized as 512 pages of 128 bytes each. Random word addressing requires a 16-bit data word address.

Table 5-1. Pin Capacitance[1]

Applicable over recommended operating range from T_A = 25°C, f = 1.0MHz, V_{CC} = 1.7V to 3.6V or 2.5V 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 3.6V or 2.5V to 5.5V (unless otherwise noted)

Symbol	Parameter	Test Condition		Min	Typ	Max	Units
V_{CC1}	Supply Voltage			1.7		3.6	V
V_{CC2}	Supply Voltage			2.5		5.5	V
I_{CC1}	Supply Current	V_{CC} = 5.0V	Read at 400kHz			2.0	mA
I_{CC2}	Supply Current	V_{CC} = 5.0V	Write at 400kHz			3.0	mA
I_{SB1}	Standby Current	V_{CC} = 1.7V	V_{IN} = V_{CC} or V_{SS}			1.0	µA
		V_{CC} = 3.6V				3.0	µA
I_{SB2}	Standby Current	V_{CC} = 2.5V	V_{IN} = V_{CC} or V_{SS}			2.0	µA
		V_{CC} = 5.5V				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 3.6V or 2.5V to 5.5V (where applicable), CL = 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	1.3		0.4		µs
t_{HIGH}	Clock Pulse Width High	0.6		0.4		µs
t_I	Noise Suppression Time(1)		100		50	ns
t_{AA}	Clock Low to Data Out Valid	0.05	0.9	0.05	0.55	µs
t_{BUF}	Time the bus must be free before a new transmission can start(1)	1.3		0.5		µs
$t_{HD.STA}$	Start Hold Time	0.6		0.25		µs
$t_{SU.STA}$	Start Set-up Time	0.6		0.25		µs
$t_{HD.DAT}$	Data In Hold Time	0		0		µs
$t_{SU.DAT}$	Data In Set-up 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 Set-up Time	0.6		0.25		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

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

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

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 during the ninth clock cycle to acknowledge that it has received each word.

Standby Mode: The AT24C512C features a low-power standby mode, which is enabled:

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

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

1. Create a Start condition
2. Clock nine cycles
3. Create another Start condition followed by a Stop condition, as shown in Figure 6-1 below.

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

Figure 6-1. Software Reset

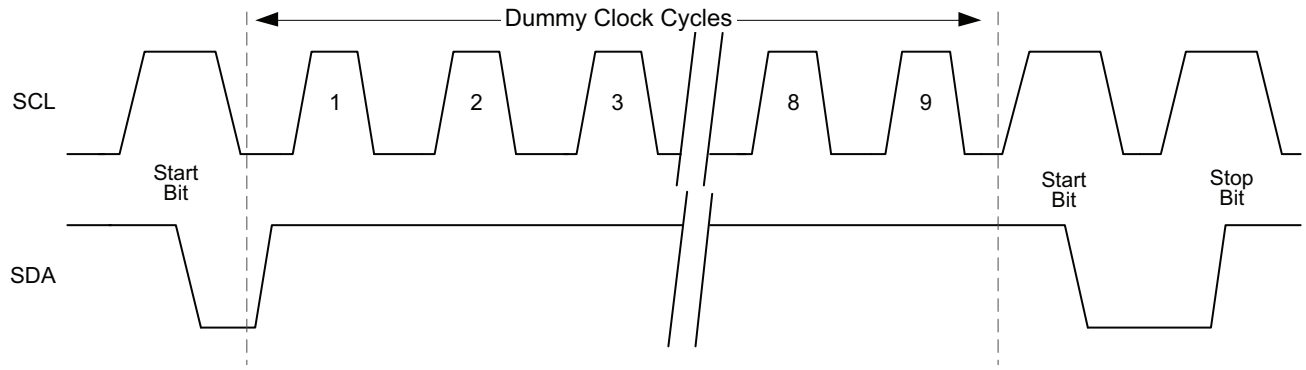


Figure 6-2. Bus Timing

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

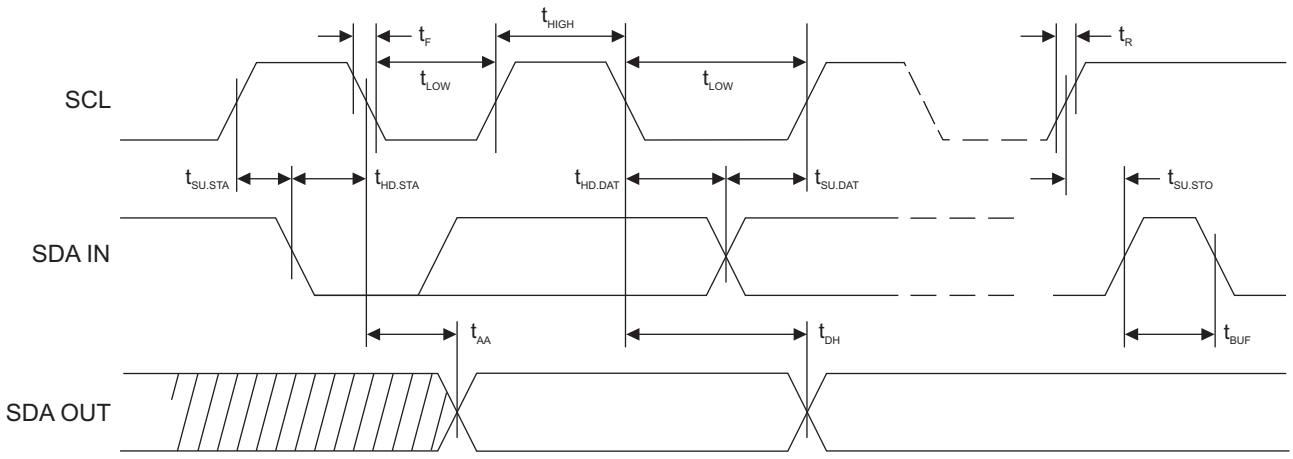
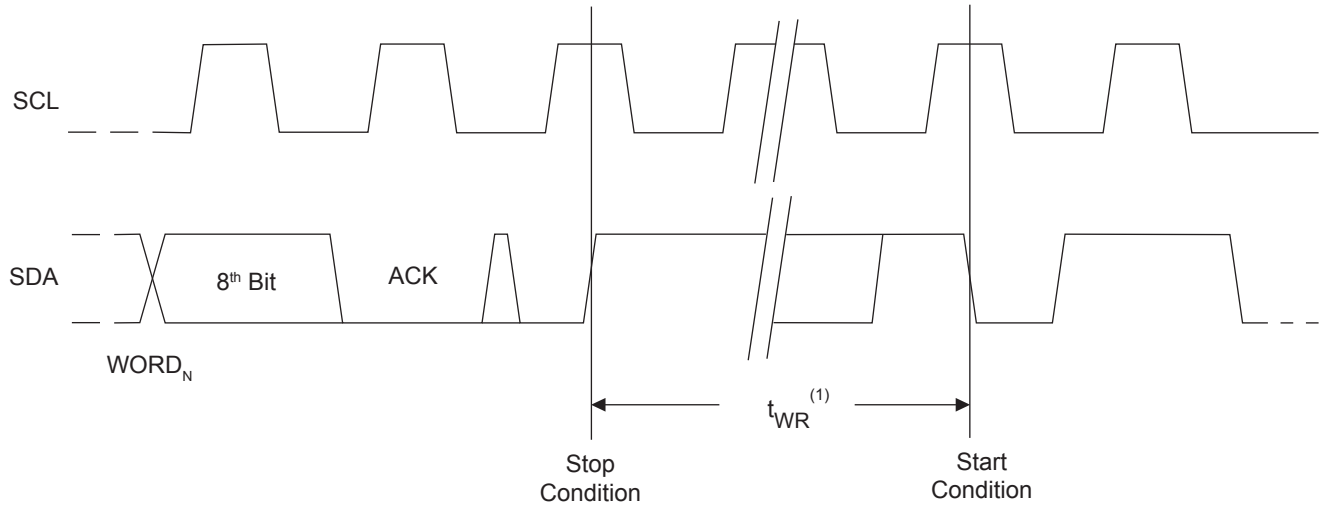


Figure 6-3. Write Cycle Timing

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

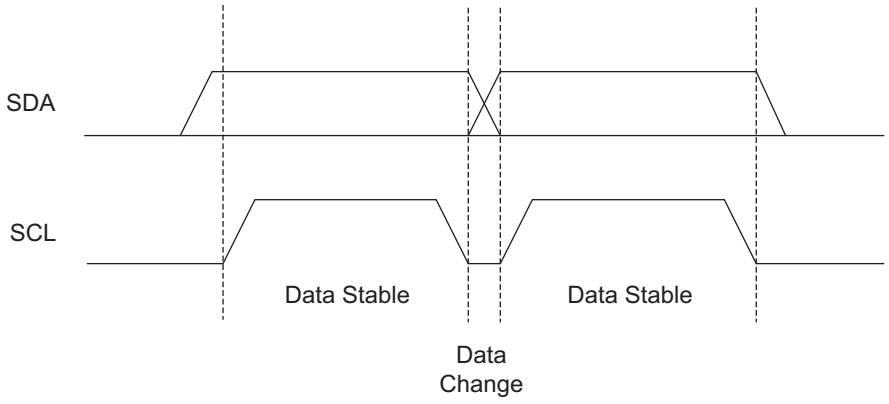


Figure 6-5. Start and Stop Definition

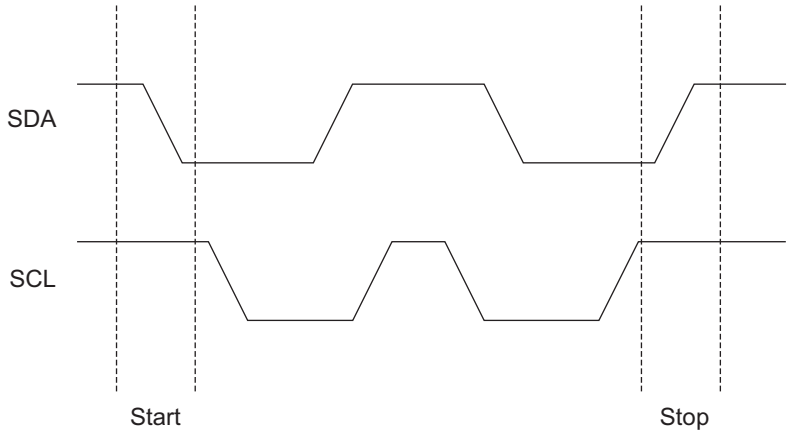
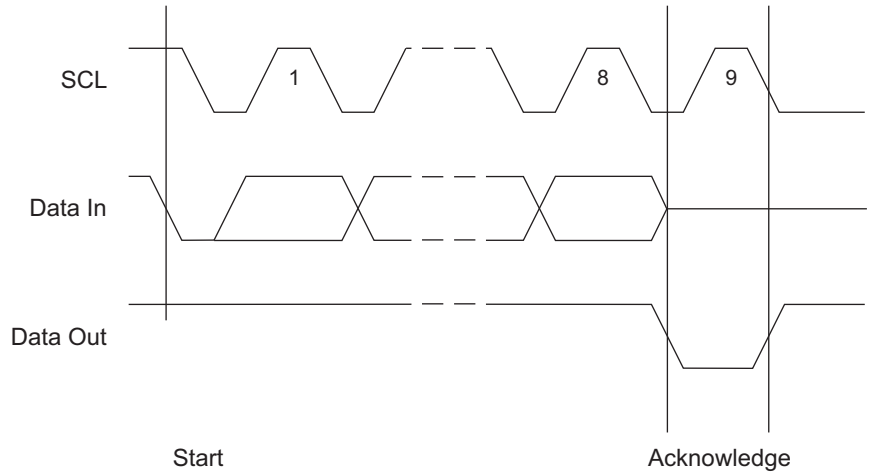


Figure 6-6. Output Acknowledge



7. Device Addressing

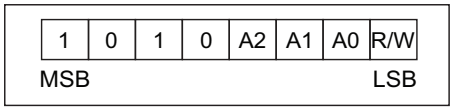
The 512K EEPROM requires an 8-bit device address word following a Start condition to enable the chip for a read or write operation. The device address word consists of a mandatory '1010' sequence for the first four most-significant bits (see Figure 7-1 below). This is common to all 2-wire EEPROM devices.

The 512K uses the three device address bits, A2, A1, and A0, to allow as many as eight devices on the same bus. These bits must compare to their corresponding hardwired input pins. The A_2, A_1, and A_0 pins use an internal proprietary circuit that biases them to a logic low condition if the pins are allowed to float.

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 compare of the device address, the EEPROM will output a zero. If a valid compare is not made, the device will return to a standby state.

Figure 7-1. Device Address



8. Write Operations

Byte Write: A Byte Write operation requires two 8-bit data word addresses following the device address word and acknowledgment. Upon receipt of this address, the EEPROM will again respond with a zero, and then the part is to receive an 8-bit data word. Following receipt of the 8-bit data word, the EEPROM will output a zero. The addressing device, such as a microcontroller, then 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 512-Kbit EEPROM is capable of 128-byte page writes.

A Page Write is initiated the same way 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 127 more 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) and the internally timed write cycle will begin.

The lower seven bits of the data word address 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 128 data words are transmitted to the EEPROM, the data word address will roll-over, and the previous data will be overwritten. The address roll over during write is from the last byte of the current page to the first byte of the same page.

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 select 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: AT24C512C has a hardware data protection scheme that allows the user to write protect the entire memory 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 types of 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 on the SDA line. 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 an initial byte write sequence to load in the data word address. This is known as a “dummy write” operation. 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

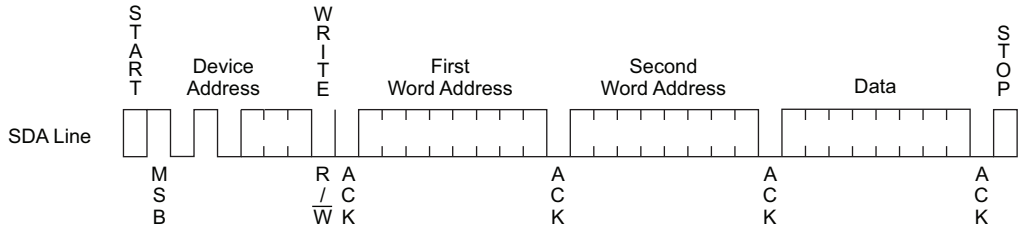


Figure 9-2. Page Write

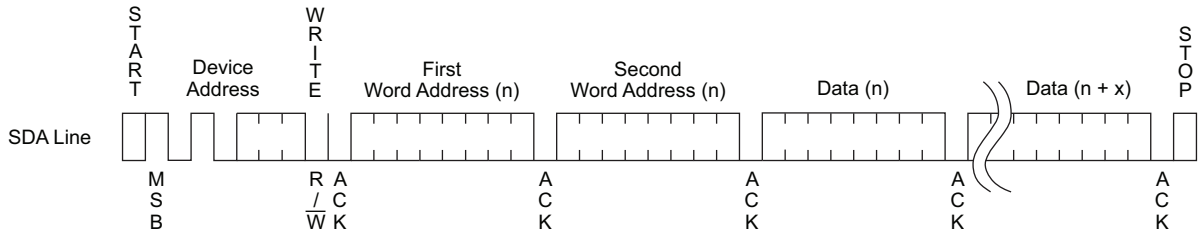


Figure 9-3. Current Address Read

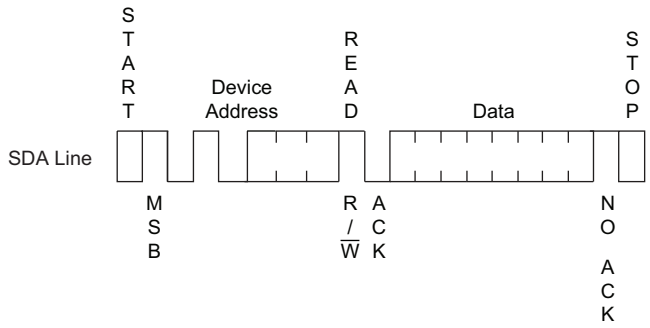


Figure 9-4. Random Read

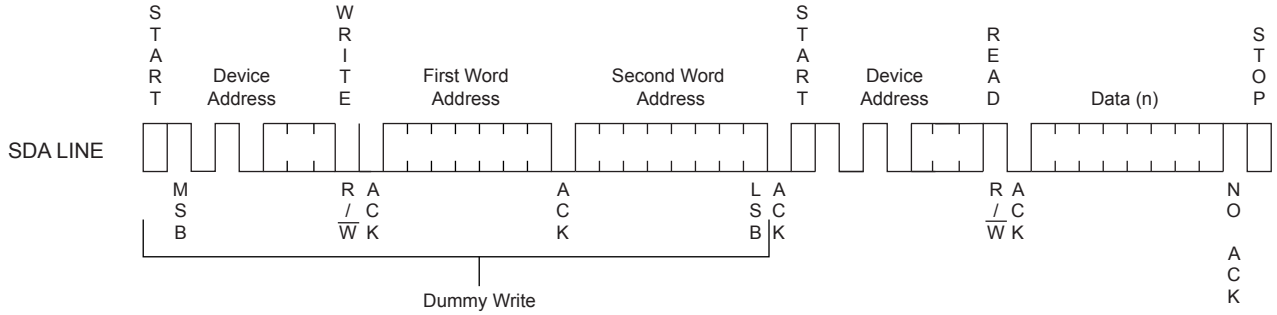
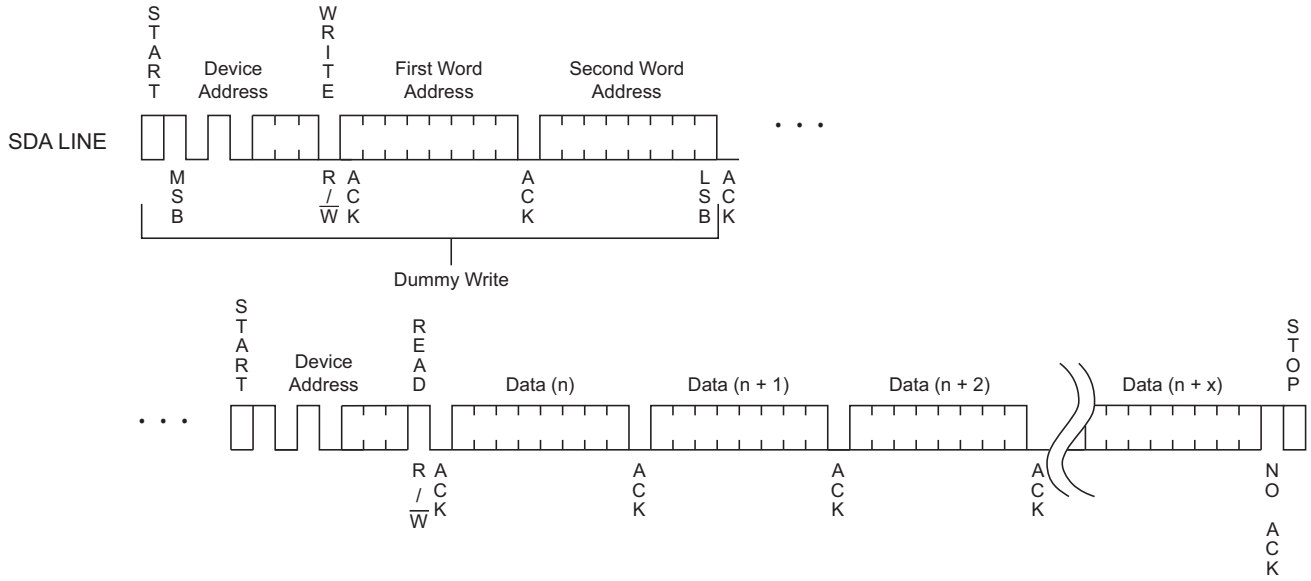
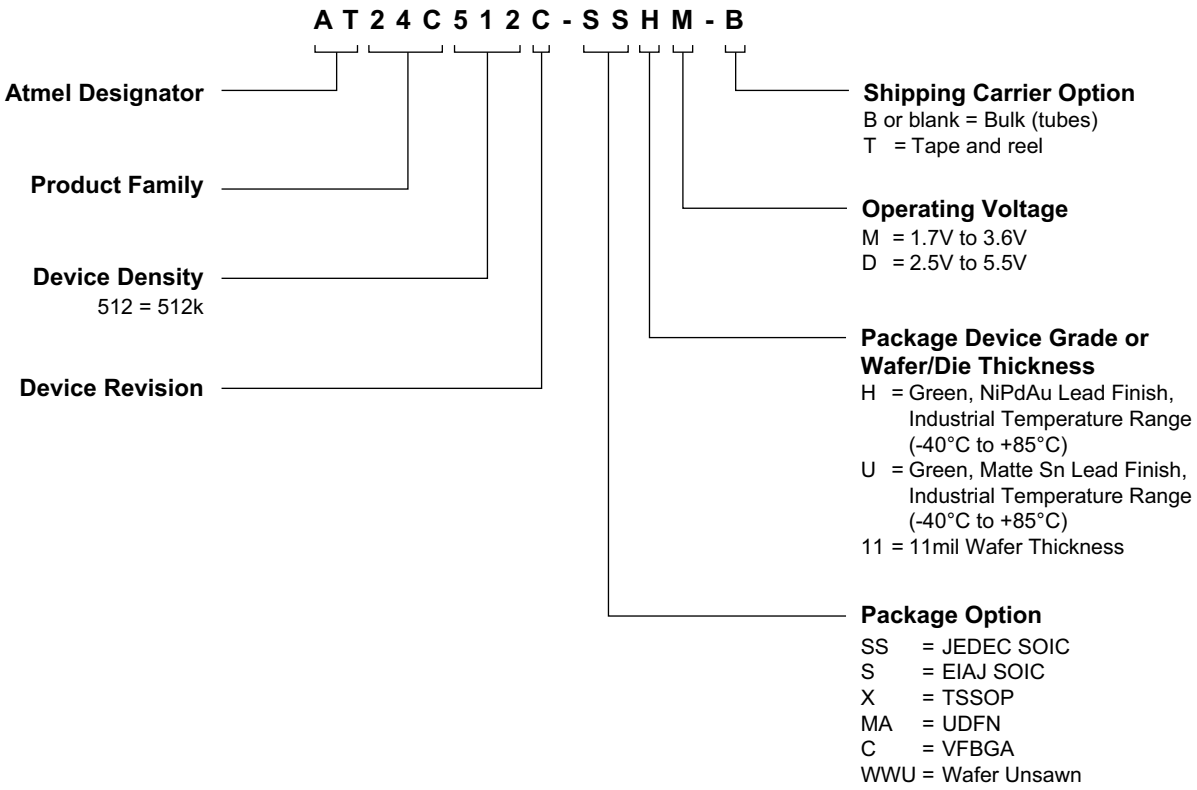


Figure 9-5. Sequential Read

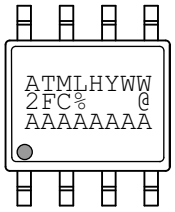
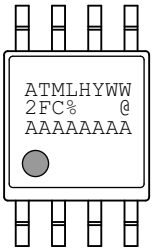
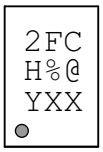
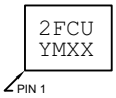


10. Ordering Code Detail



11. Part Markings

AT24C512C: Package Marking Information

8-lead SOIC	8-lead EIAJ	8-lead TSSOP
		
8-lead UDFN	**8-ball VFBGA**	
2.0 x 3.0 mm Body	1.5 x 2.0 mm Body	
		

Note 1: ● designates pin 1

Note 2: Package drawings are not to scale

Catalog Number Truncation			
AT24C512C		Truncation Code: 2FC	
Date Codes			**Voltages**
Y = Year	M = Month	WW = Work Week of Assembly	% = Minimum Voltage
2: 2012 6: 2016 3: 2013 7: 2017 4: 2014 8: 2018 5: 2015 9: 2019	A: January B: February ... L: December	02: Week 2 04: Week 4 ... 52: Week 52	D: 2.5V min M: 1.7V min
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

7/11/12

Atmel Package Mark Contact: DL-CSO-Assy_eng@atmel.com	TITLE	DRAWING NO.	REV.
	24C512CSM, AT24C512C Package Marking Information	24C512CSM	D

12. Ordering Codes

Atmel AT24C512C Ordering Information

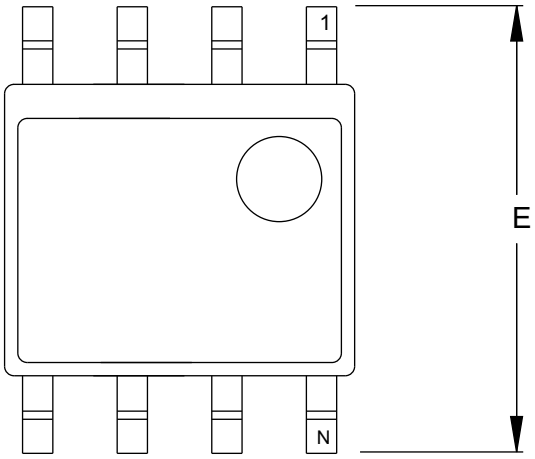
Ordering Code		Voltage	Package	Operation Range
AT24C512C-SSHM-B[1]	(NiPdAu Lead Finish)	1.7V to 3.6V	8S1	Lead-free/Halogen-free/ Industrial Temperature (–40 to 85°C)
AT24C512C-SSHM-T[2]	(NiPdAu Lead Finish)	1.7V to 3.6V	8S1	
AT24C512C-SSHD-B[1]	(NiPdAu Lead Finish)	2.5V to 5.5V	8S1	
AT24C512C-SSHD-T[2]	(NiPdAu Lead Finish)	2.5V to 5.5V	8S1	
AT24C512C-SHM-B[1]	(NiPdAu Lead Finish)	1.7V to 3.6V	8S2	
AT24C512C-SHM-T[2]	(NiPdAu Lead Finish)	1.7V to 3.6V	8S2	
AT24C512C-SHD-B[1]	(NiPdAu Lead Finish)	2.5V to 5.5V	8S2	
AT24C512C-SHD-T[2]	(NiPdAu Lead Finish)	2.5V to 5.5V	8S2	
AT24C512C-XHM-B[1]	(NiPdAu Lead Finish)	1.7V to 3.6V	8X	
AT24C512C-XHM-T[2]	(NiPdAu Lead Finish)	1.7V to 3.6V	8X	
AT24C512C-XHD-B[1]	(NiPdAu Lead Finish)	2.5V to 5.5V	8X	
AT24C512C-XHD-T[2]	(NiPdAu Lead Finish)	2.5V to 5.5V	8X	
AT24C512C-MAHM-T[2]	(NiPdAu Lead Finish)	1.7V to 3.6V	8MA2	
AT24C512C-CUM-T[2]		1.7V to 3.6V	8U2-1	
AT24C512C-WWU11M[3]		1.7V to 3.6V	Die Sale	Industrial Temperature (–40 to 85°C)

Notes:
1. B = Bulk
2. T = Tape and reel
   - SOIC = 4K per reel,
   - TSSOP, UDFN, and VFBGA = 5K per reel
3. For wafer sales, please contact Atmel sales.

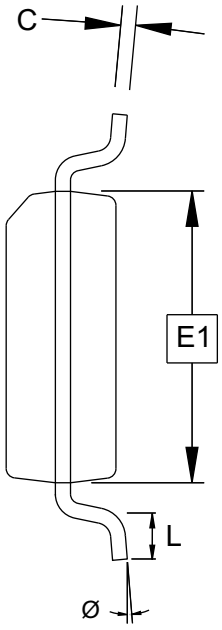
Package Type	
8S1	8-lead, 0.150” wide, Plastic Gull Wing, Small Outline (JEDEC SOIC)
8S2	8-lead, 0.208” wide, Plastic Gull Wing, Small Outline (EIAJ SOIC)
8X	8-lead, 4.4mm body, Plastic Thin Shrink Small Outline (TSSOP)
8MA2	8-pad, 2.00mm x 3.00mm body, 0.50mm Pitch, Ultra Thin Dual No Lead (UDFN)
8U2-1	8-ball, 2.35 x 3.73mm body, 0.75mm pitch, Small Die Ball Grid Array (VFBGA)

13. Package Information

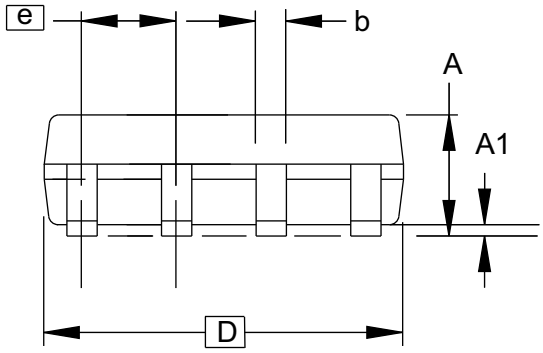
13.1 8S1 — 8-lead JEDEC SOIC



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.

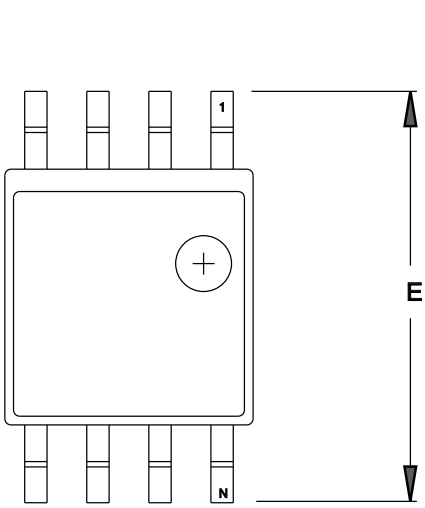
COMMON DIMENSIONS
(Unit of Measure = mm)

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°	

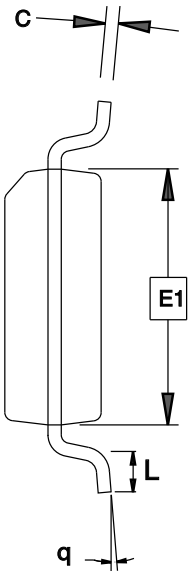
6/22/11

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

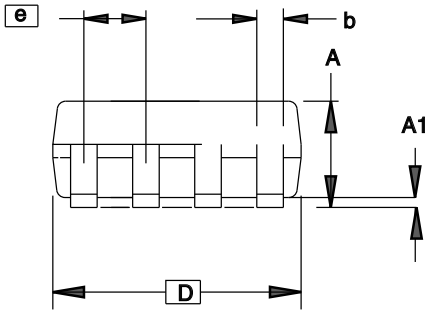
13.2 8S2 — 8-lead EIAJ SOIC



TOP VIEW



END VIEW



SIDE VIEW

COMMON DIMENSIONS
(Unit of Measure = mm)

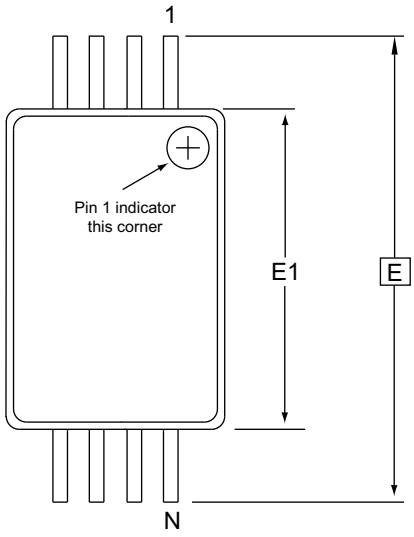
SYMBOL	MIN	NOM	MAX	NOTE
A	1.70		2.16	
A1	0.05		0.25	
b	0.35		0.48	4
C	0.15		0.35	4
D	5.13		5.35	
E1	5.18		5.40	2
E	7.70		8.26	
L	0.51		0.85	
q	0°		8°	
e	1.27 BSC			3

Notes: 1. This drawing is for general information only; refer to EIAJ Drawing EDR-7320 for additional information.
2. Mismatch of the upper and lower dies and resin burrs aren't included.
3. Determines the true geometric position.
4. Values b,C apply to plated terminal. The standard thickness of the plating layer shall measure between 0.007 to .021 mm.

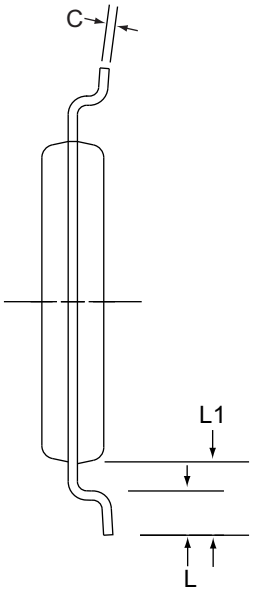
4/15/08

Atmel Package Drawing Contact: packagedrawings@atmel.com	TITLE **8S2,** 8-lead, 0.208" Body, Plastic Small Outline Package (EIAJ)	GPC STN	DRAWING NO. 8S2	REV. F

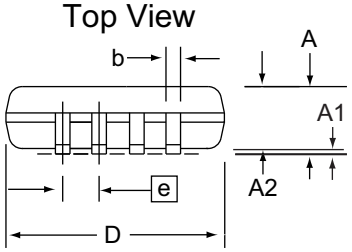
13.3 8X — 8-lead TSSOP



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.

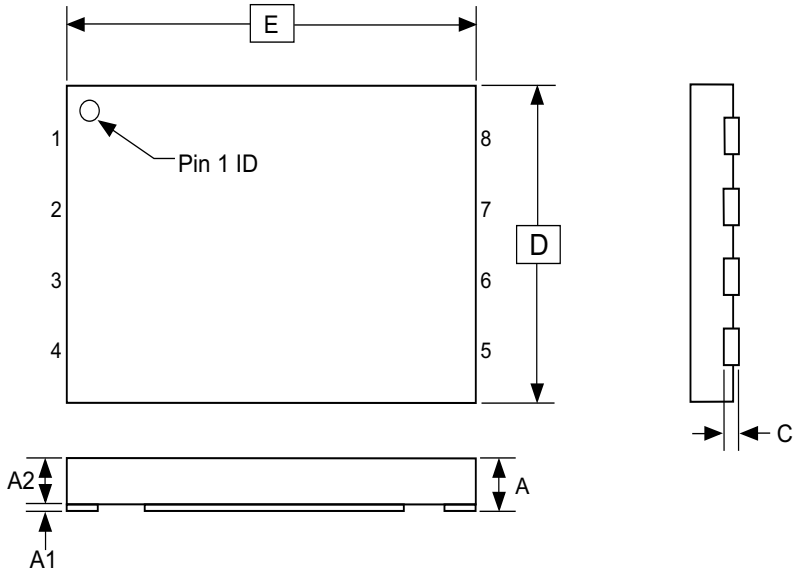
COMMON DIMENSIONS
(Unit of Measure = mm)

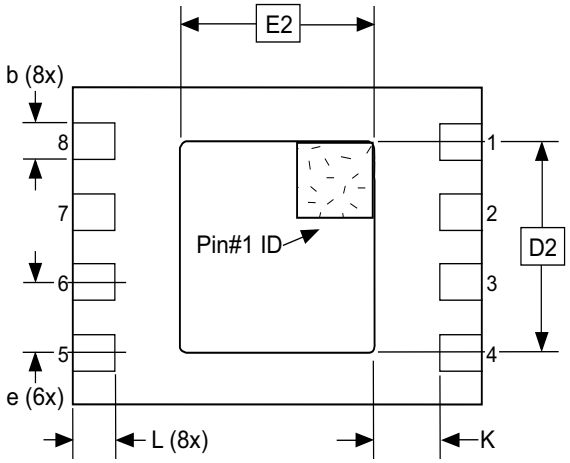
SYMBOL	MIN	NOM	MAX	NOTE
A	-	-	1.20	
A1	0.05	-	0.15	
A2	0.80	1.00	1.05	
D	2.90	3.00	3.10	2, 5
E		6.40 BSC		
E1	4.30	4.40	4.50	3, 5
b	0.19	–	0.30	4
e		0.65 BSC		
L	0.45	0.60	0.75	
L1		1.00 REF		
C		0.09	-	0.20

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

13.4 8MA2 — 8-pad UDFN





COMMON DIMENSIONS
(Unit of Measure = mm)

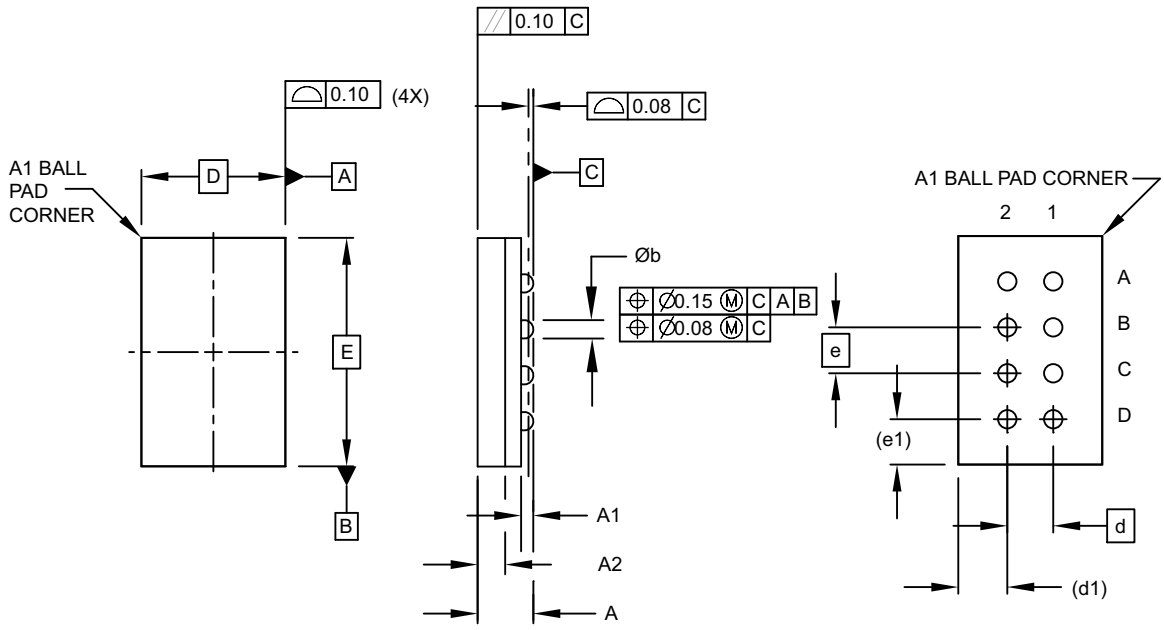
SYMBOL	MIN	NOM	MAX	NOTE
D		2.00 BSC		
E		3.00 BSC		
D2	1.40	1.50	1.60	
E2	1.20	1.30	1.40	
A	0.50	0.55	0.60	
A1	0.0	0.02	0.05	
A2	–	–	0.55	
C		0.152 REF		
L	0.30	0.35	0.40	
e		0.50 BSC		
b	0.18	0.25	0.30	3
K	0.20	–	–	

Notes:
1. This drawing is for general information only. Refer to JEDEC Drawing MO-229, for proper dimensions, tolerances, datums, etc.
2. The terminal #1 ID is a laser-marked feature.
3. Dimension b applies to metallized terminal and is measured between 0.15 mm and 0.30 mm from the terminal tip. If the terminal has the optional radius on the other end of the terminal, the dimension should not be measured in that radius area.

7/15/11

Atmel Package Drawing Contact: packagedrawings@atmel.com	**TITLE** 8MA2, 8-pad, 2 x 3 x 0.6 mm Body, Thermally Enhanced Plastic Ultra Thin Dual Flat No Lead Package (UDFN)	**GPC** YNZ	**DRAWING NO.** 8MA2	**REV.** B

13.5 8U2-1 — 8-ball VFBGA



COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	0.81	0.91	1.00	
A1	0.15	0.20	0.25	
A2	0.40	0.45	0.50	
b	0.25	0.30	0.35	
D	2.35 BSC			
E	3.73 BSC			
e	0.75 BSC			
e1	0.74 REF			
d	0.75 BSC			
d1	0.80 REF			

Notes:

1. This drawing is for general
2. Dimension 'b' is measured at the maximum solder ball diameter.
3. Solder ball composition shall be 95.5Sn-4.0Ag-.5Cu.

3/20/12

Atmel Package Drawing Contact: packagedrawings@atmel.com	TITLE 8U2-1, 8-ball, 2.35 x 3.73 mm Body, 0.75 mm pitch, VFBGA Package	GPC GWW	DRAWING NO. 8U2-1	REV. F

14. Revision History

Doc. Rev.	Date	Comments
8720C	07/2012	Update part markings. Update package drawings. Update template.
8720B	12/2010	Replace part markings with single page standard marking. Remove five ordering code variations.
8720A	09/2010	Initial document release.

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- Поставка более 17-ти миллионов наименований электронных компонентов;
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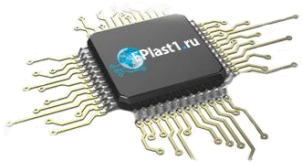
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



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