

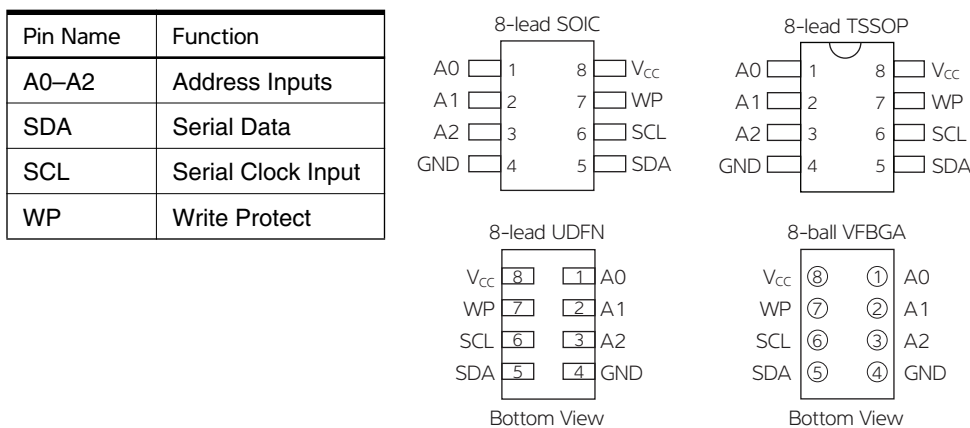
Features

- Low-voltage and standard-voltage operation
 - M for V_{CC} from 1.7V to 3.6V
 - D for V_{CC} from 2.5V to 5.5V
- Internally organized 65,536 x 8
- Two-wire serial interface
- Schmitt triggers, filtered inputs for noise suppression
- Bidirectional data transfer protocol
- 1MHz (2.5V, 5.5V), 400kHz (1.7V) compatibility
- Write protect pin for hardware and software data protection
- 128-byte page write mode (partial page writes allowed)
- Self-timed write cycle (5ms max)
- High reliability
 - Endurance: 1,000,000 write cycles
 - Data retention: 40 years
- Lead-free/halogen-free devices
- 8-lead JEDEC SOIC, 8-lead EIAJ SOIC, 8-lead TSSOP, 8-lead UDFN, and 8-ball VFBGA packages
- Die sales: wafer form, waaffle pack and bumped die

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 device's cascadable feature allows up to eight devices to share a common two-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-lead UDFN, and 8-ball VFBGA packages. The M voltage range devices operate from 1.7V to 3.6V. The D voltage range devices operate from 2.5V to 5.5V.

Figure 0-1. Pin Configurations



Two-wire Serial,
Electrically
Erasable and
Programmable
Read-only Memory
512K (65,536 x 8)

Atmel AT24C512C
with Three Device
Address Inputs

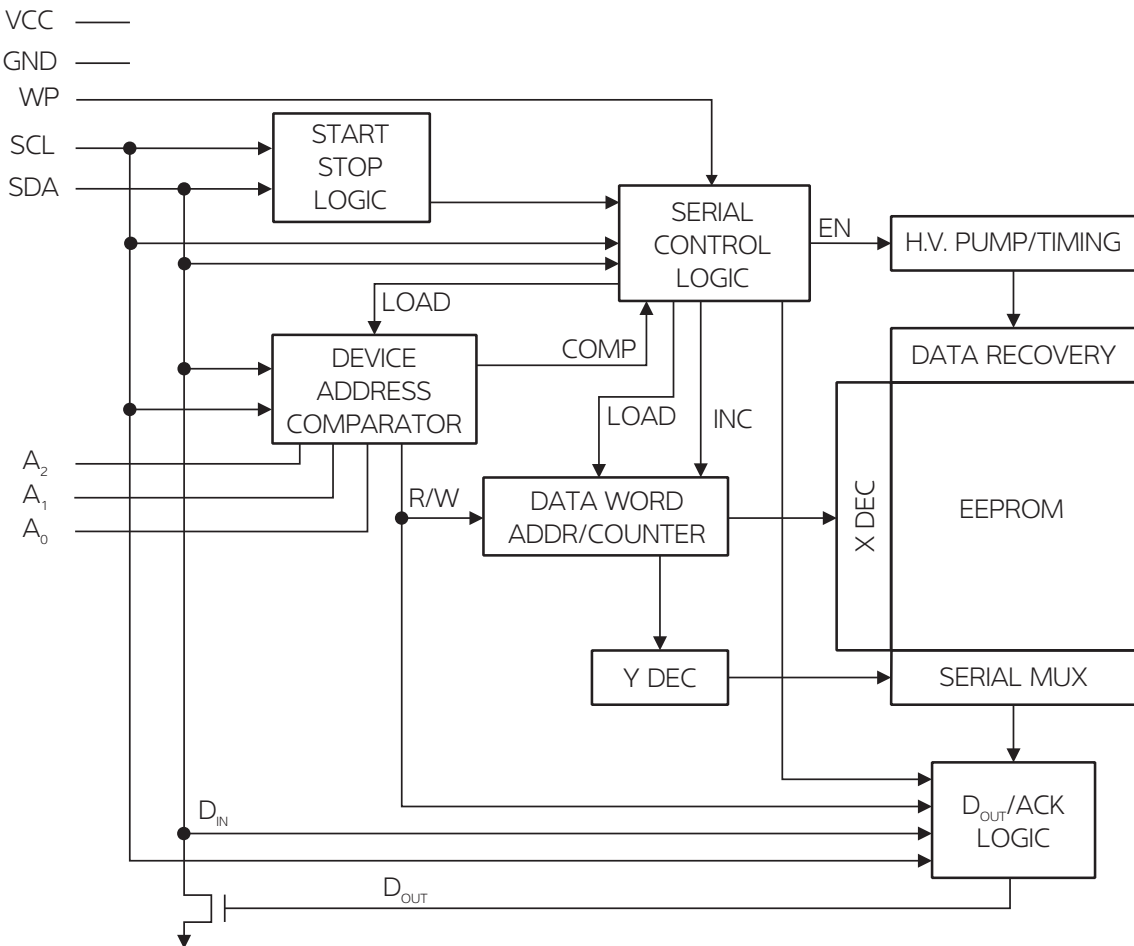


1. Absolute Maximum Ratings*

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.

Figure 1-1. Block Diagram



2. 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/PAGE ADDRESSES (A2, A1, A0): The A2, A1, and A0 pins are device address inputs that are hardwired (directly to GND or to Vcc) 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. (Device addressing is discussed in detail under "Device Addressing," [page 8](#).) A device is selected when a corresponding hardware and software match is true. If these pins are left floating, the A2, A1, and A0 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 10k Ω or less.

WRITE PROTECT (WP): The write protect input, when connected to GND, allows normal write operations. When WP is connected directly to Vcc, 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 pins to a known state. When using a pull-up resistor, Atmel recommends using 10k Ω or less.

3. Memory Organization

Atmel AT24C512C, 512K 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 3-1. Pin Capacitance⁽¹⁾

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, SCL)	6	pF	$V_{IN} = 0V$

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

Table 3-2. DC Characteristics

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_{CC}	Supply Current	$V_{CC} = 5.0V$	READ at 400kHz			2.0	mA
I_{CC}	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	$V_{IN} = V_{CC}$ or V_{SS}			0.05	3.0	μA
V_{IL}	Input Low Level ⁽¹⁾			-0.6		$V_{CC} \times 0.3$	V
V_{IH}	Input High Level ⁽¹⁾			$V_{CC} \times 0.7$		$V_{CC} + 0.5$	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 3-3. AC Characteristics (Industrial Temperature)

Symbol	Parameter	1.7V		2.5-5.0V		Units
		Min	Max	Min	Max	
f_{SCL}	Clock Frequency, SCL		400		1000	kHz
t_{LOW}	Clock Pulse Width Low	1.3		0.4		μ s
t_{HIGH}	Clock Pulse Width High	0.6		0.4		μ s
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	μ s
t_{BUF}	Time the bus must be free before a new transmission can start ⁽¹⁾	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 ⁽¹⁾		0.3		0.3	μ s
t_F	Inputs Fall Time ⁽¹⁾		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 ⁽¹⁾	25°C, Page Mode, 3.3V	1,000,000				Write Cycles

- Notes:
- This parameter is ensured by characterization only
 - AC measurement conditions:
 - R_L (connects to V_{CC}): 1.3k Ω (2.5V, 5V), 10 k Ω (1.7V)
 - Input pulse voltages: 0.3 V_{CC} to 0.7 V_{CC}
 - Input rise and fall times: \leq 50ns
 - Input and output timing reference voltages: 0.5 V_{CC}

4. 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 4-4 on page 7). 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 4-5 on page 7).

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 4-5 on page 7).

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 Atmel® AT24C512C 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.

SOFTWARE RESET: After an interruption in protocol, power loss or system reset, any two-wire part can be protocol reset by following these steps: (a) Create a start condition, (b) clock nine cycles, (c) create another start condition followed by a stop condition, as shown below. The device is ready for the next communication after the above steps have been completed.

Figure 4-1. Protocol Reset Condition

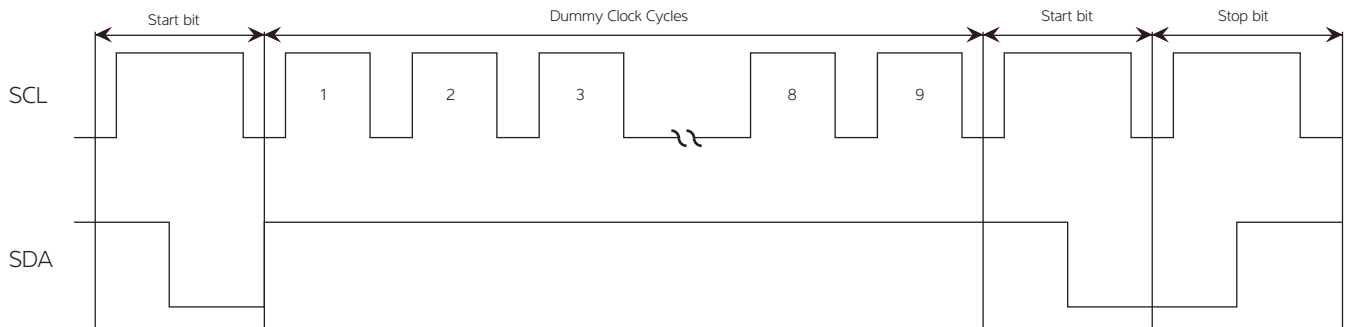


Figure 4-2. Bus Timing (SCL: Serial Clock, SDA: Serial Data I/O)

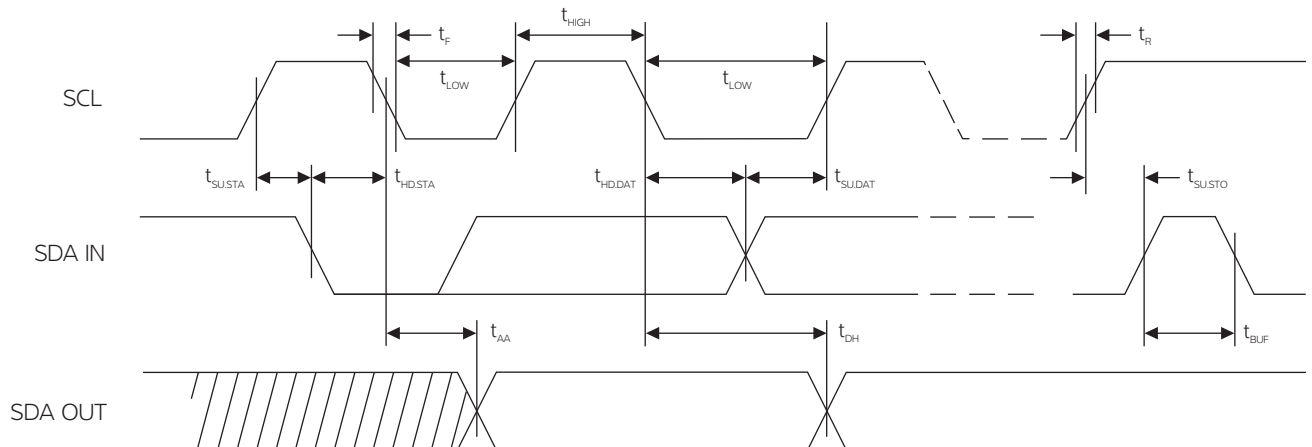
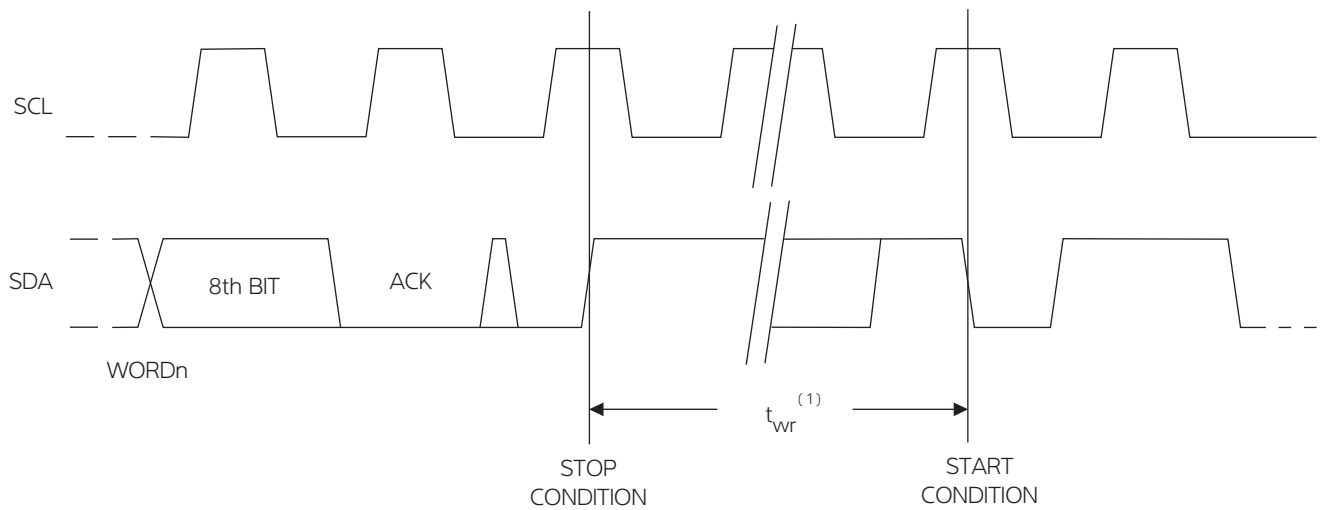


Figure 4-3. Write Cycle Timing (SCL: Serial Clock, SDA: Serial Data I/O)



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 4-4. Data Validity

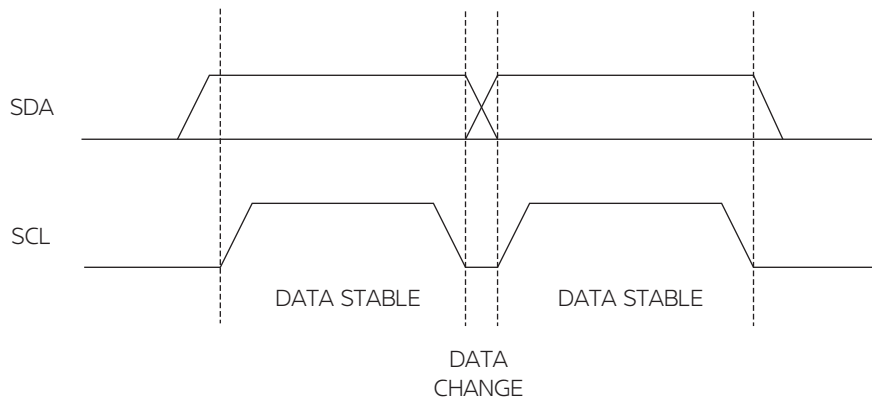


Figure 4-5. Start and Stop Definition

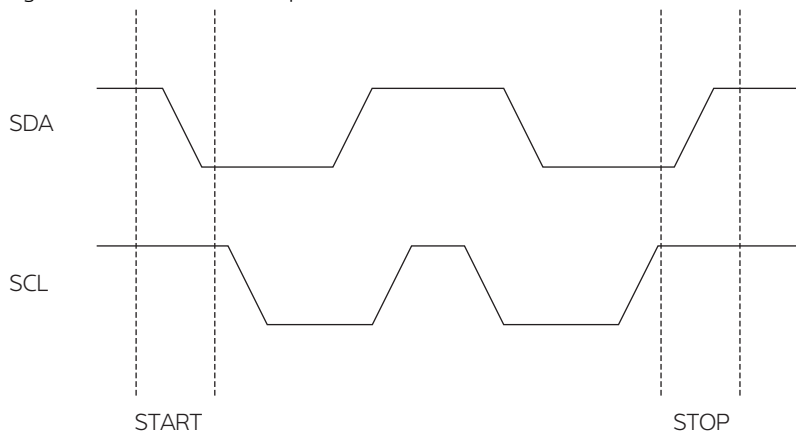
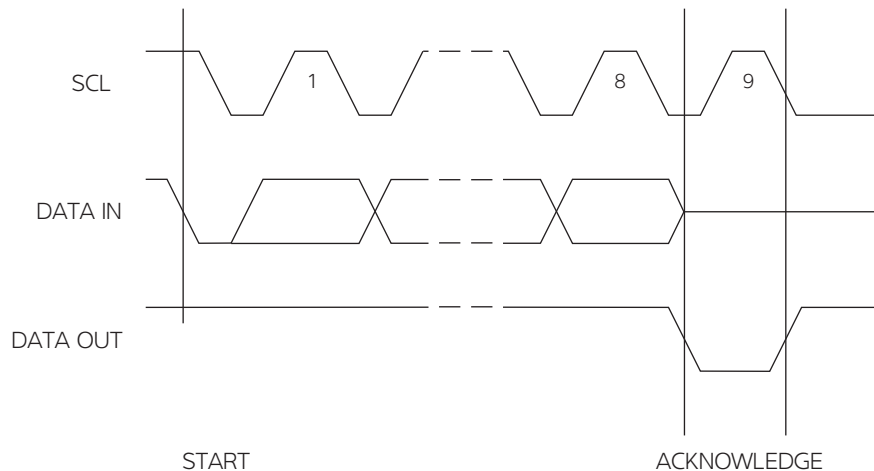


Figure 4-6. Output Acknowledge



5. 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 (see [Figure 7-1 on page 9](#)). The device address word consists of a mandatory one-zero sequence for the first four most-significant bits, as shown. This is common to all two-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 A2, A1, and A0 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 compare is not made, the device will return to a standby state.

DATA SECURITY: The Atmel® AT24C512C has a hardware data protection scheme that allows the user to write protect the whole memory when the WP pin is at V_{CC} .

6. Write Operations

BYTE WRITE: A 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 clock in the first 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 7-2 on page 10](#)).

PAGE WRITE: The 512K 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 7-3 on page 10](#)).

The data word address lower seven 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 128 data words are transmitted to the EEPROM, the data word address will “roll over” and 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 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.

7. 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 (see [Figure 7-4 on page 10](#)).

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 7-5 on page 10](#)).

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 7-6 on page 10](#)).

Figure 7-1. Device Address

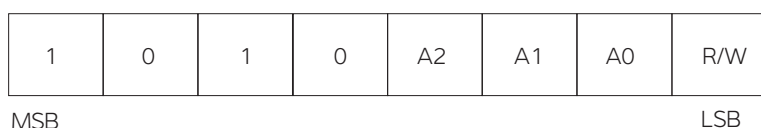


Figure 7-2. Byte Write

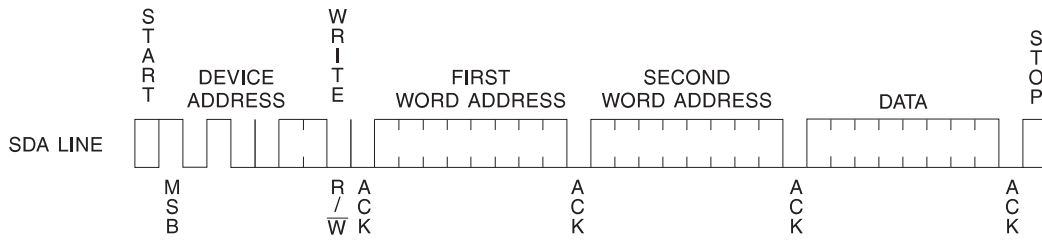


Figure 7-3. Page Write

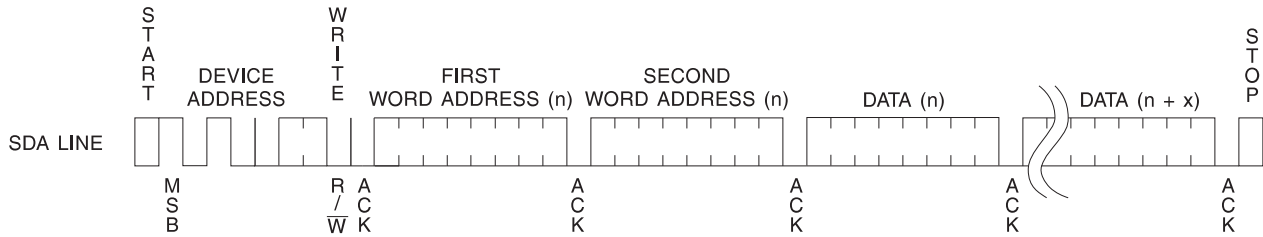


Figure 7-4. Current Address Read

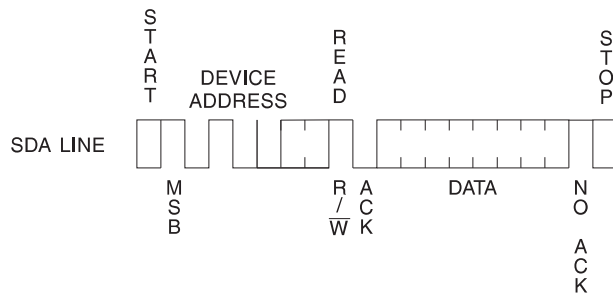


Figure 7-5. Random Read

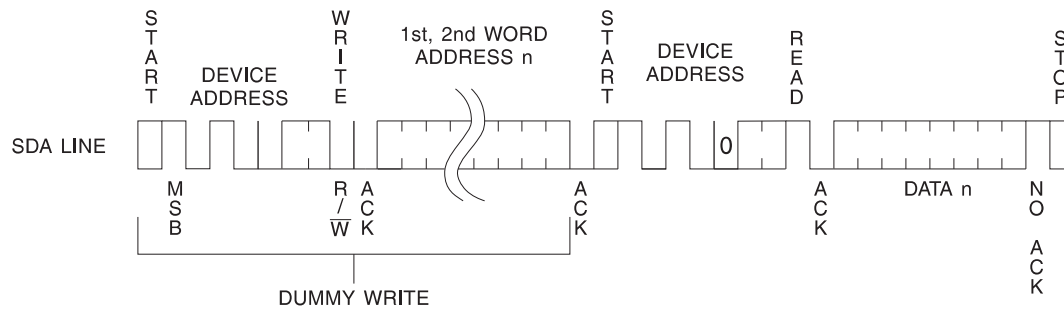
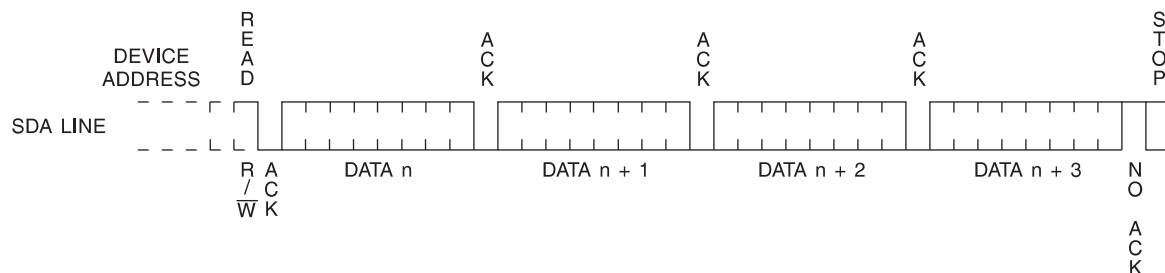
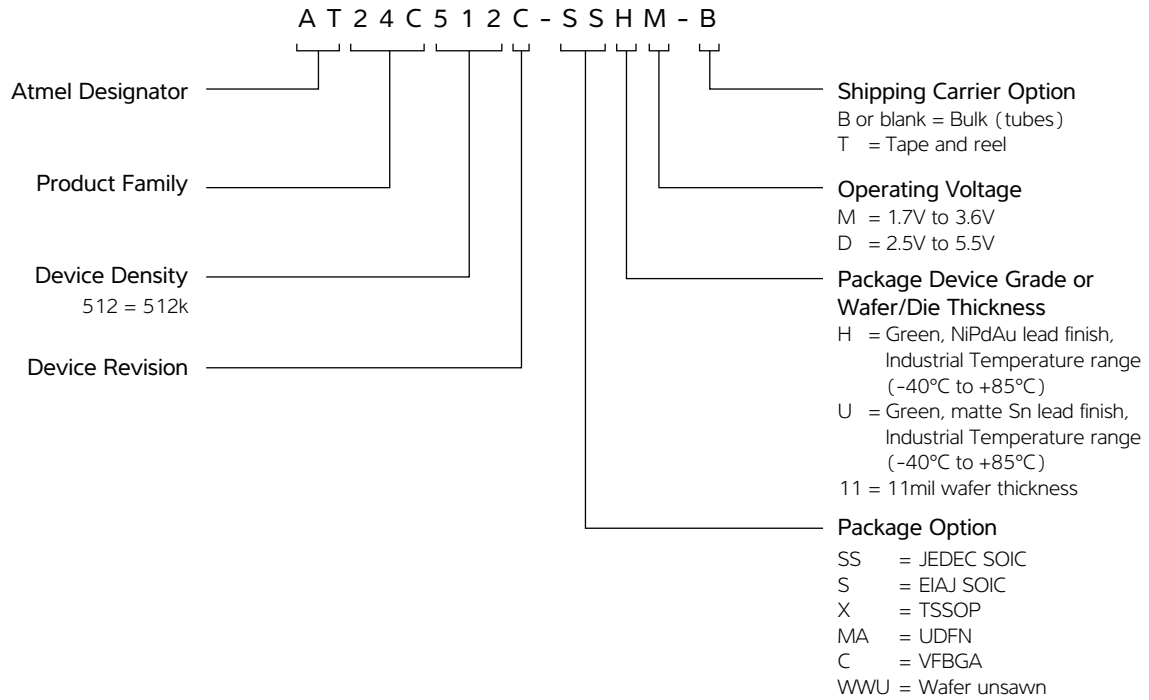


Figure 7-6. Sequential Read



8. Ordering Code Detail



9. Part Markings

Atmel AT24C512C-SSHM

Top Marking Only

```
|---|---|---|---|---|---|---|---|
  A  T  M  L  H  Y  W  W
|---|---|---|---|---|---|---|---|
  2  F  C  M                      @
|---|---|---|---|---|---|---|---|
    ATMEL LOT NUMBER
|---|---|---|---|---|---|---|---|
  |
  PIN 1 INDICATOR (DOT)
```

LINE 1: ATML=ATMEL H=MATERIAL SET/GRADE YWW=DATE CODE
LINE 2: 2FC=AT24C512C, M=1.7 to 3.6V, @=COUNTRY OF ASSEMBLY
LINE 3: ATMEL LOT NUMBER

No Bottom Marking

Atmel AT24C512C-SHM

Top Marking Only

```
|---|---|---|---|---|---|---|---|
  A  T  M  L  H  Y  W  W
|---|---|---|---|---|---|---|---|
  2  F  C  M                      @
|---|---|---|---|---|---|---|---|
    ATMEL LOT NUMBER
|---|---|---|---|---|---|---|---|
  |
  PIN 1 INDICATOR (DOT)
```

LINE 1: ATML=ATMEL H=MATERIAL SET/GRADE YWW=DATE CODE
LINE 2: 2FC=AT24C512C, M=1.7 to 3.6V, @=COUNTRY OF ASSEMBLY
LINE 3: ATMEL LOT NUMBER

No Bottom Marking

Atmel AT24C512C-XHM

Top Marking Only

```

PIN 1 INDICATOR (DOT)
| |---|---|---|---|---|
*  A  T  H  Y  W  W
  |---|---|---|---|---|
    2  F  C  M      @
|---|---|---|---|---|
  ATMEL LOT NUMBER
|---|---|---|---|---|

```

```

LINE 1: AT=ATMEL, H=MATERIAL SET/GRADE, YWW=DATE CODE
LINE 2: 2FC=AT24C512C, M=1.7 to 3.6V, @=COUNTRY OF ASSEMBLY
LINE 3: ATMEL LOT NUMBER

```

No Bottom Marking

Atmel AT24C512C-MAHM

Top Marking Only

```

|---|---|---|
  2  F  C
|---|---|---|
  H  M  @
|---|---|---|
  Y  X  X
|---|---|---|
*
|
PIN 1 INDICATOR (DOT)

```

```

LINE 1: 2FC=AT24C512C
LINE 2: H=MATERIAL SET/GRADE, M=1.7 to 3.6V, @=COUNTRY OF ASSEMBLY
LINE 3: Y=DATE CODE, XX=Trace Code

```

No Bottom Marking

Atmel AT24C512C-CUM

Top Marking Only

```

|---|---|---|---|---|
  2  F  C  U
|---|---|---|---|---|
  @  Y  M  X  X
|---|---|---|---|---|
*
|
PIN 1 INDICATOR (DOT)

```

```

LINE 1: 2FC=AT24C512C, U=MATERIAL SET/GRADE
LINE 2: YM=DATE CODE, XX=Trace Code

```

No Bottom Marking



Atmel AT24C512C-SSHD

Top Marking Only

```
|---|---|---|---|---|---|---|---|
  A   T   M   L   H   Y   W   W
|---|---|---|---|---|---|---|---|
  2   F   C   D                               @
|---|---|---|---|---|---|---|---|
    ATMEL LOT NUMBER
|---|---|---|---|---|---|---|---|
  |
  PIN 1 INDICATOR (DOT)
```

LINE 1: ATML=ATMEL H=MATERIAL SET/GRADE YWW=DATE CODE
LINE 2: 2FC=AT24C512C, D=2.5 to 5.5V, @=COUNTRY OF ASSEMBLY
LINE 3: ATMEL LOT NUMBER

No Bottom Marking

Atmel AT24C512C-SHD

Top Marking Only

```
|---|---|---|---|---|---|---|---|
  A   T   M   L   H   Y   W   W
|---|---|---|---|---|---|---|---|
  2   F   C   D                               @
|---|---|---|---|---|---|---|---|
    ATMEL LOT NUMBER
|---|---|---|---|---|---|---|---|
  |
  PIN 1 INDICATOR (DOT)
```

LINE 1: ATML=ATMEL H=MATERIAL SET/GRADE YWW=DATE CODE
LINE 2: 2FC=AT24C512C, D=2.5 to 5.5V, @=COUNTRY OF ASSEMBLY
LINE 3: ATMEL LOT NUMBER

No Bottom Marking

Atmel AT24C512C-XHD

Top Marking Only

```

PIN 1 INDICATOR (DOT)
| |---|---|---|---|---|
*  A  T  H  Y  W  W
  |---|---|---|---|---|
    2  F  C  D      @
|---|---|---|---|---|
  ATMEL LOT NUMBER
|---|---|---|---|---|

```

LINE 1: AT=ATMEL, H=MATERIAL SET/GRADE, YWW=DATE CODE
 LINE 2: 2FC=AT24C512C, M=2.5 to 5.5V, @=COUNTRY OF ASSEMBLY
 LINE 3: ATMEL LOT NUMBER

No Bottom Marking

Atmel AT24C512C-MAHD

Top Marking Only

```

|---|---|---|
  2  F  C
|---|---|---|
  H  D  @
|---|---|---|
  Y  X  X
|---|---|---|
  *
  |
  PIN 1 INDICATOR (DOT)

```

LINE 1: 2FC=AT24C512C
 LINE 2: H=MATERIAL SET/GRADE, D=2.5 to 5.5V, @=COUNTRY OF ASSEMBLY
 LINE 3: Y=DATE CODE, XX=Trace Code

No Bottom Marking

Atmel AT24C512C-CUD

Top Marking Only

```

|---|---|---|---|---|
  2  F  C  U
|---|---|---|---|---|
  @  Y  D  X  X
|---|---|---|---|---|
  *
  |
  PIN 1 INDICATOR (DOT)

```

LINE 1: 2FC=AT24C512C, U=MATERIAL SET/GRADE
 LINE 2: YM=DATE CODE, XX=Trace Code

No Bottom Marking

10. Ordering Codes

Atmel AT24C512C Ordering Information

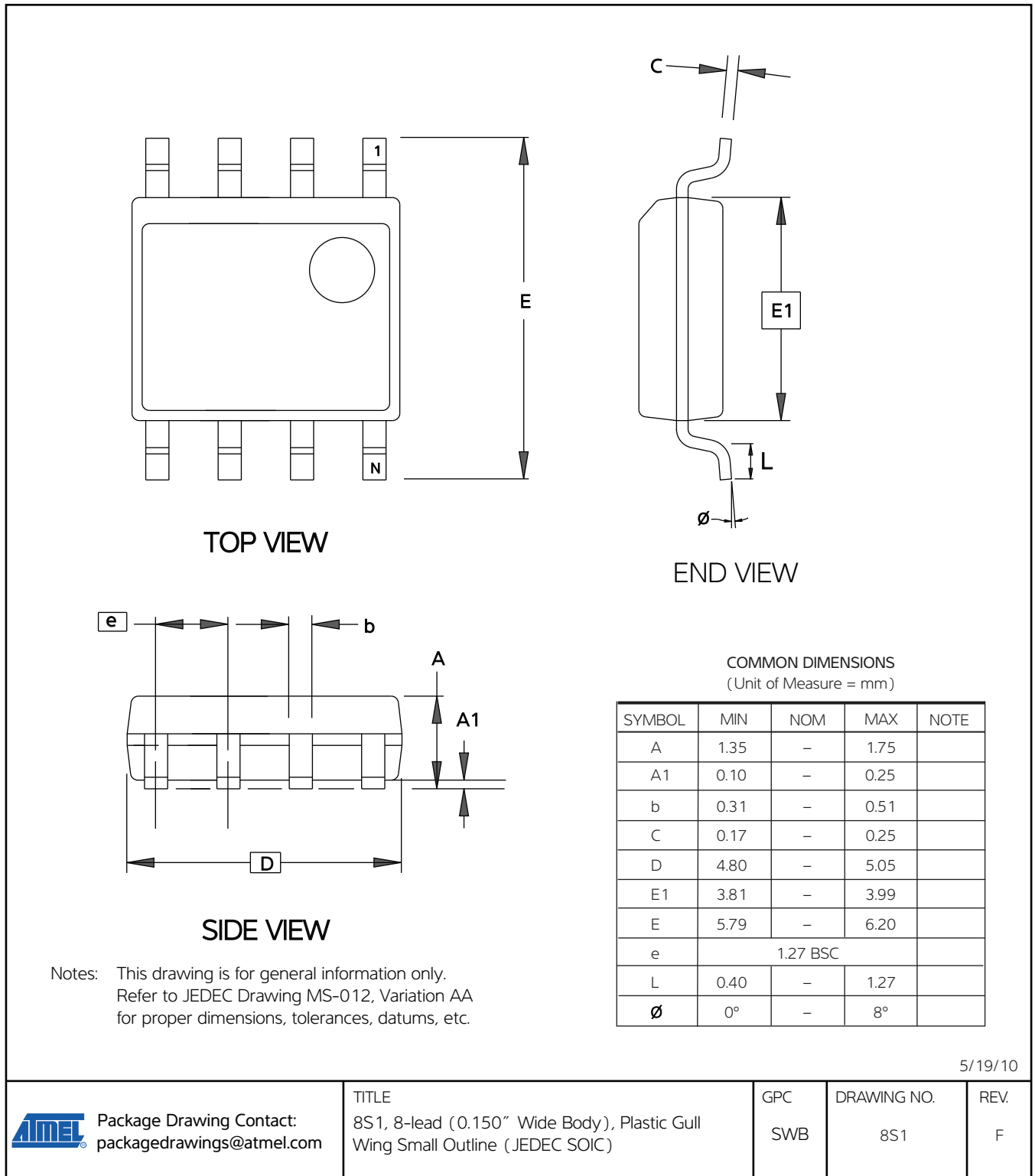
Ordering Code	Voltage	Package	Operation Range
AT24C512C-SSHM-B ⁽¹⁾ (NiPdAu Lead Finish)	1.7V to 3.6V	8S1	Lead-free/Halogen-free/ Industrial Temperature (-40 to 85°C)
AT24C512C-SSHM-T ⁽²⁾ (NiPdAu Lead Finish)	1.7V to 3.6V	8S1	
AT24C512C-SSHD-B ⁽¹⁾ (NiPdAu Lead Finish)	2.5V to 5.5V	8S1	
AT24C512C-SSHD-T ⁽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	8A2	
AT24C512C-XHM-T ⁽²⁾ (NiPdAu Lead Finish)	1.7V to 3.6V	8A2	
AT24C512C-XHD-B ⁽¹⁾ (NiPdAu Lead Finish)	2.5V to 5.5V	8A2	
AT24C512C-XHD-T ⁽²⁾ (NiPdAu Lead Finish)	2.5V to 5.5V	8A2	
AT24C512C-MAHM-T ⁽²⁾ (NiPdAu Lead Finish)	1.7V to 3.6V	8Y6	
AT24C512C-MAHD-T ⁽²⁾ (NiPdAu Lead Finish)	2.5V to 5.5V	8Y6	
AT24C512C-CUM-T ⁽²⁾ (matte Sn)	1.7V to 3.6V	8U2	
AT24C512C-CUD-T ⁽²⁾ (matte Sn)	2.5V to 5.5V	8U2	
AT24C512C-WWU11M⁽³⁾	1.7V to 3.6V	Die Sale	Industrial Temperature (-40 to 85°C)
AT24C512C-WWU11D⁽³⁾	2.5V to 5.5V		

- Note:
1. "-B" denotes bulk delivery
 2. "-T" denotes tape and reel delivery. SOIC = 4K/reel, TSSOP, UDFN, and VFBGA = 5K/reel
 3. For wafer sales, please contact Atmel Sales

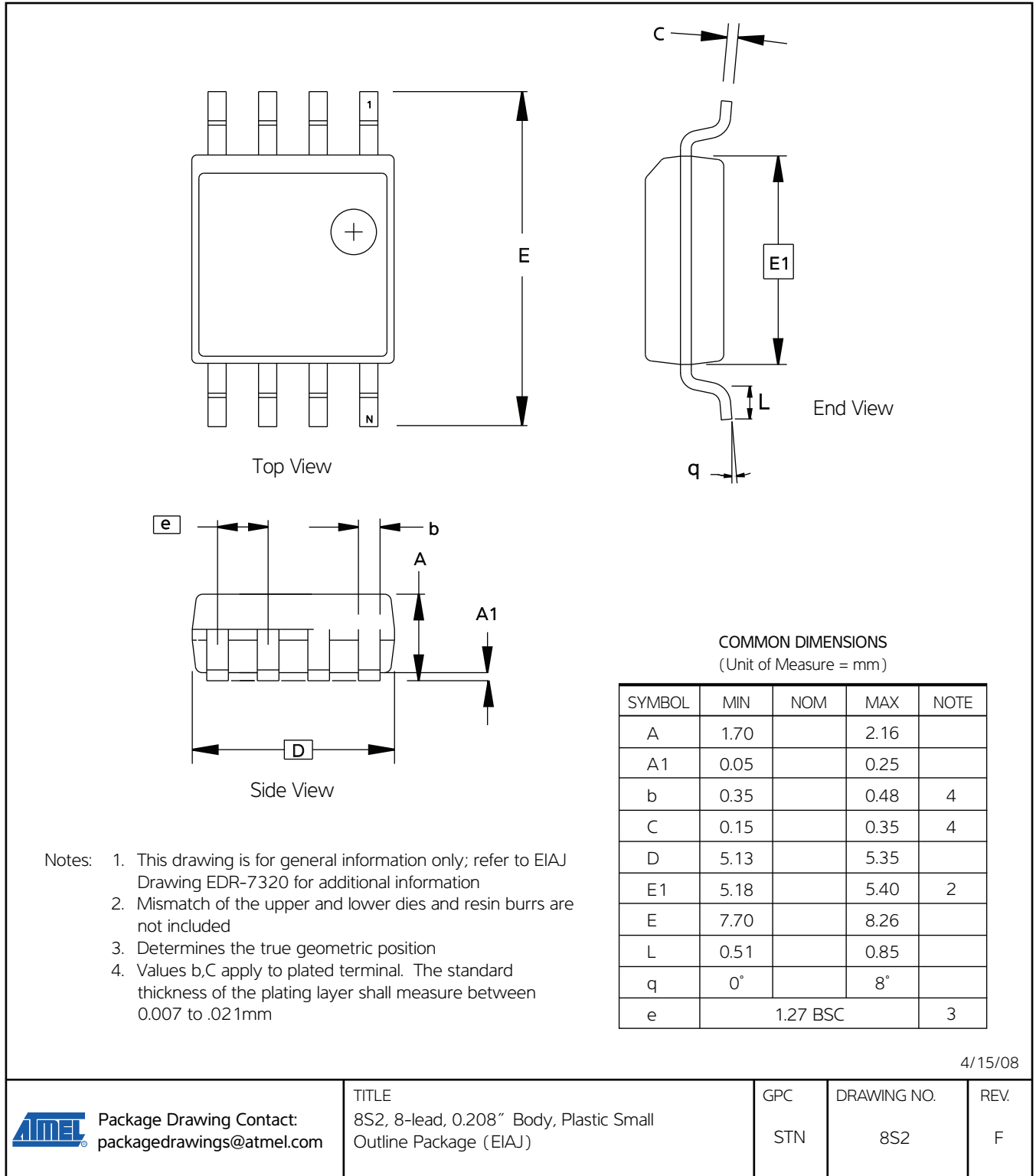
Package Type	
8S1	8-lead, 0.150" Wide, Plastic Gull Wing Small Outline Package (JEDEC SOIC)
8S2	8-lead, 0.208" Wide, Plastic Gull Wing Small Outline Package (EIAJ SOIC)
8A2	8-lead, 4.4mm Body, Plastic, Thin Shrink Small Outline Package (TSSOP)
8Y6	8-lead, 2.00mm x 3.00mm Body, 0.50mm Pitch, Ultra Thin Dual No Lead Package (UDFN)
8U2	8-ball, 2.35 x 3.73mm Body, 0.75mm Pitch, Small Die Ball Grid Array (VFBGA)

11. Package Information

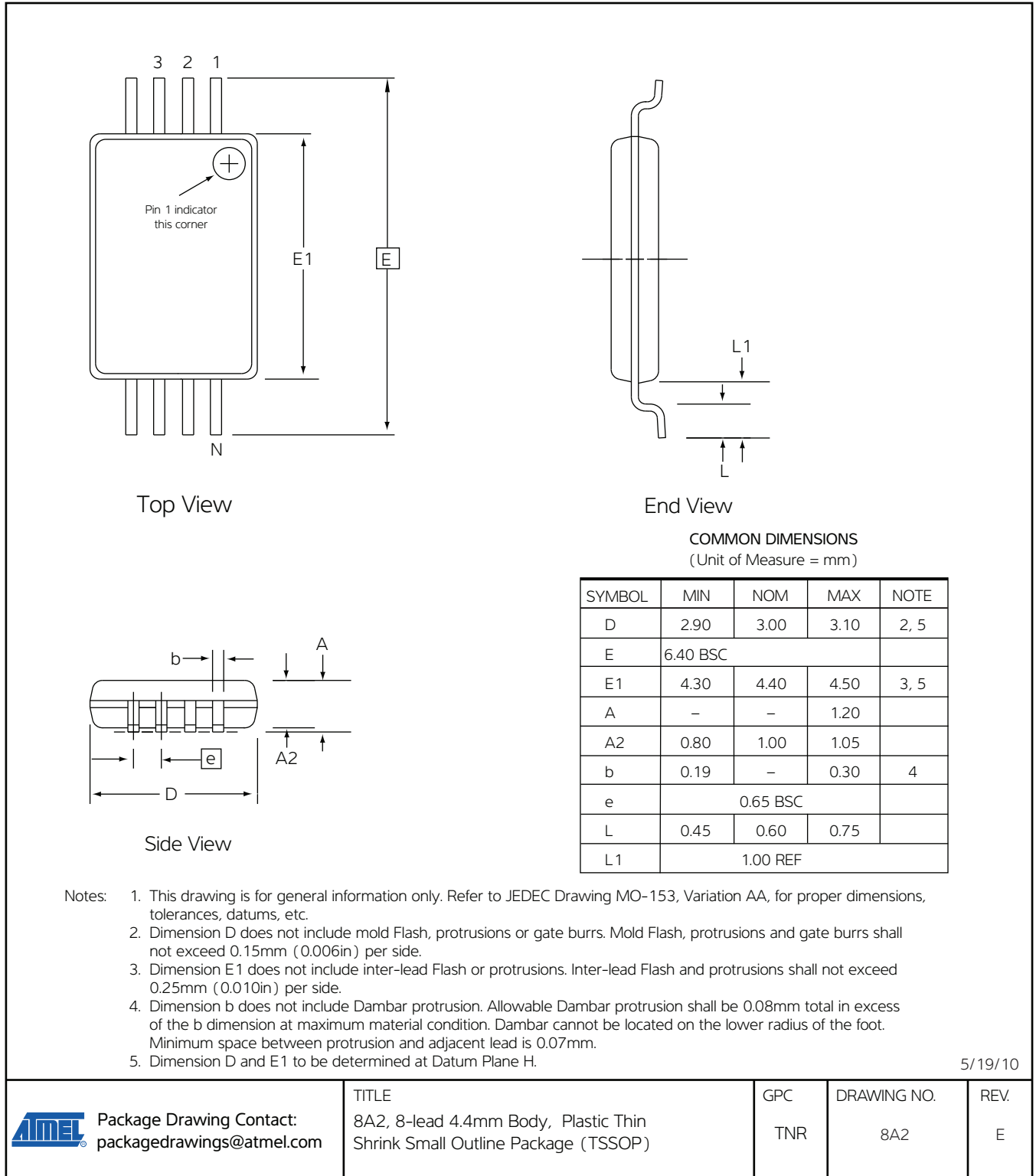
8S1 – JEDEC SOIC



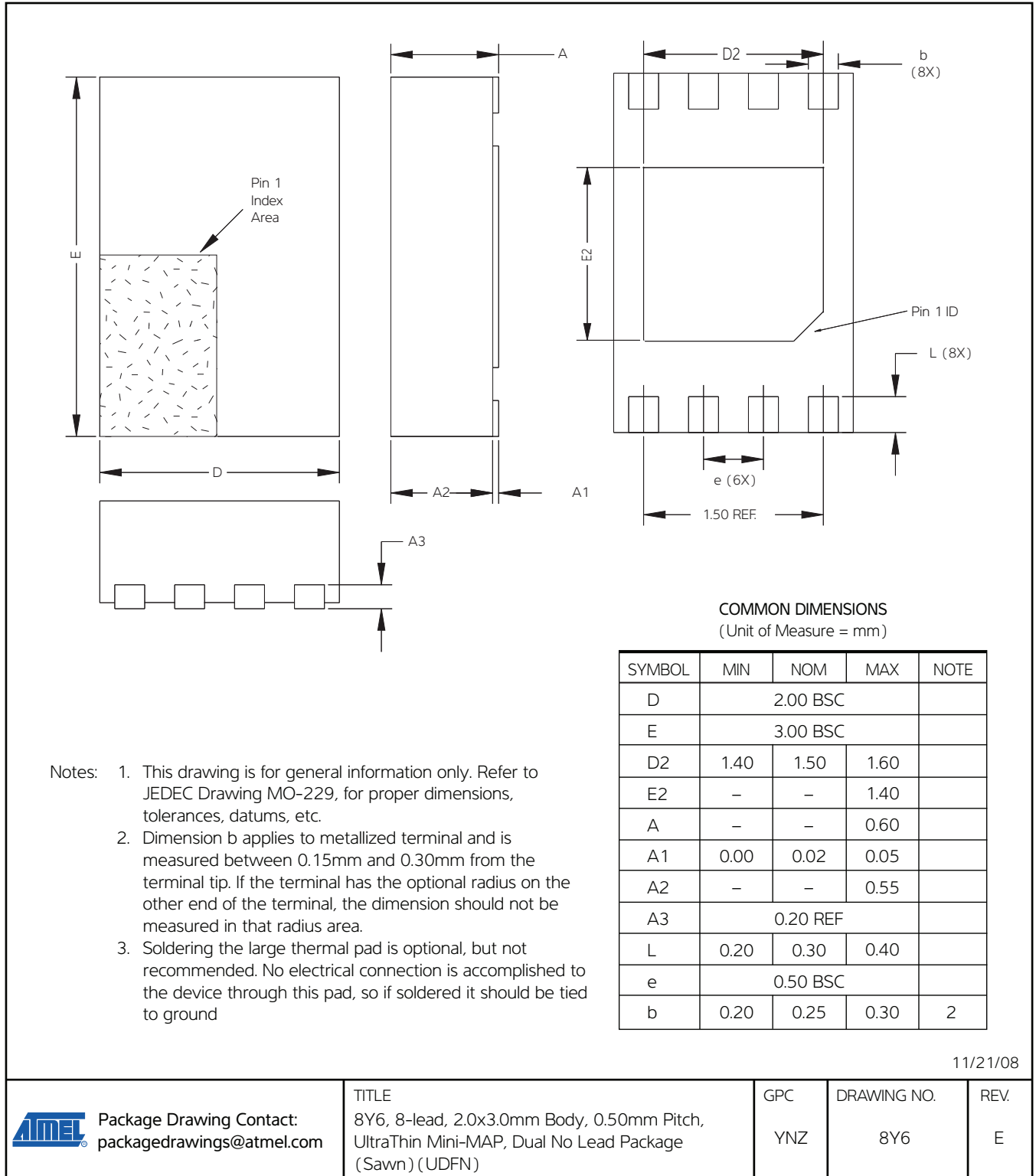
8S2 – EIAJ SOIC

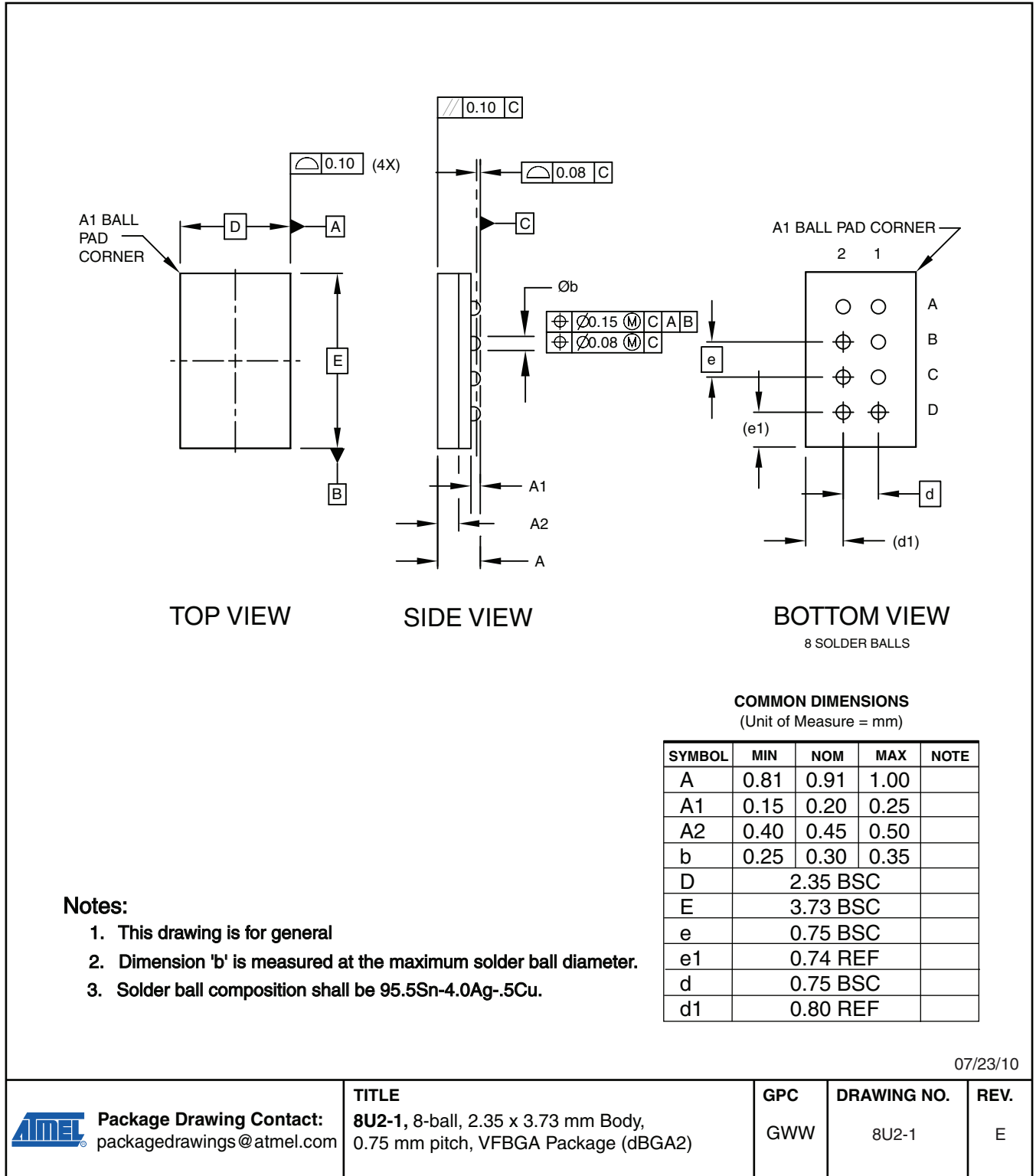


8A2 – TSSOP



8Y6 – UDFN





12. Revision History

Doc. Rev.	Date	Comments
8720A	9/2010	Initial document release

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