



**THE DATASHEET OF  
ATAES132A-SHEQ-T**



## 32K AES Serial EEPROM Specification

## SUMMARY DATASHEET

## CryptoAuthentication

Ensures Things and Code are Real, Untampered, and Confidential



**Secure Download and Boot**  
Authentication and Protect Code In-transit

**Ecosystem Control**  
Ensure Only OEM/Licensed Nodes and Accessories Work

**Anti-cloning**  
Prevent Building with Identical BOM or Stolen Code

**Message Security**  
Authentication, Message Integrity, and Confidentiality of Network Nodes (IoT)

## Features

- Crypto Element Device with Secure Hardware-based Key Storage
- 32Kb Standard Serial EEPROM Memory
  - Compatible with the Atmel® AT24C32D and the Atmel AT25320B
  - 16 User Zones of 2Kb Each
- High-security Features
  - AES Algorithm with 128-bit Keys
  - AES-CCM for Authentication
  - Message Authentication Code (MAC) Capability
  - Guaranteed Unique Die Serial Number
  - Secure Storage for up to Sixteen 128-bit Keys
  - Encrypted User Memory Read and Write
  - Internal High-quality FIPS Random Number Generator (RNG)
  - 16 High-Endurance Monotonic EEPROM Counters
- Flexible User Configured Security
  - User Zone Access Rights Independently Configured
  - Authentication Prior to Zone Access
- Read/Write, Encrypted, or Read-only User Zone Options
- High-speed Serial Interface Options
  - 10MHz SPI (Mode 0 and 3)
  - 1MHz Standard I<sup>2</sup>C Interface
- 2.5V to 5.5V Supply Voltage Range
- <250nA Sleep Current
- 8-pad UDFN and 8-lead SOIC Package Options
- Temperature Range: -40°C to +85°C

## Benefits

- Easily Add Security by Replacing Existing Serial EEPROM
- Authenticate Consumables, Components, and Network Access
- Protect Sensitive Firmware
- Securely Store Sensitive Data and Enable Paid-for Features
- Prevent Contract Manufacturers from Overbuilding
- Manage Warranty Claims
- Securely Store Identity Data (i.e. Fingerprints and Pictures)

This is a summary document.  
The complete document is available on the Atmel website at [www.atmel.com](http://www.atmel.com).

## Description

The Atmel ATAES132A is a high-security, Serial Electrically-Erasable and Programmable Read-Only Memory (EEPROM) providing both authentication and confidential nonvolatile data storage capabilities. Access restrictions for the 16 user zones are independently configured, and any key can be used with any zone. In addition, keys can be used for standalone authentication. This flexibility permits the ATAES132A to be used in a wide range of applications.

The AES-128 cryptographic engine operates in AES-CCM mode to provide authentication, stored data encryption/decryption, and Message Authentication Codes. Data encryption/decryption can be performed for internally stored data or for small external data packets, depending upon the configuration. Data encrypted by one ATAES132A device can be decrypted by another, and vice versa.

The ATAES132A pinout is compatible with standard SPI and I<sup>2</sup>C Serial EEPROMs to allow placement on existing PC boards. The SPI and I<sup>2</sup>C instruction sets are identical to the Atmel Serial EEPROMs. The extended security functions are accessed by sending command packets to the ATAES132A using standard write instructions, and reading responses using standard read instructions. The ATAES132A secure Serial EEPROM architecture allows it to be inserted into existing applications.

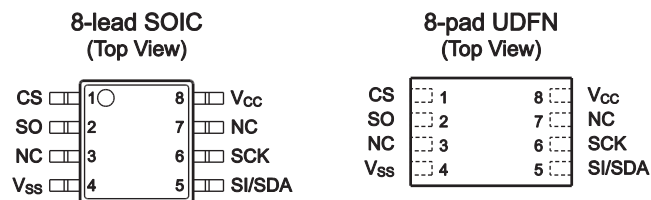
The ATAES132A device incorporates multiple physical security mechanisms to prevent the release of the internally stored secrets. Secure personalization features are provided to facilitate third-party product manufacturing.

## Pin Descriptions and Configurations

**Table 1. Pin Descriptions**

Name	Description
$\overline{CS}$	SPI Chip Select Bar Input
SO	Serial Data Out
NC	No Connect
V <sub>SS</sub>	Ground
SI/SDA	Serial Data In
SCK	Serial Clock Input
NC	No Connect
V <sub>CC</sub>	Supply Voltage

**Table 2. Pin Configurations**



**Note:** Drawings are not to scale.

# 1. Introduction

The ATAES132A is the first device in a family of high-security Serial EEPROMs using the Advanced Encryption Standard (AES) cryptographic algorithm. The ATAES132A provides 32Kb of EEPROM user data memory, sixteen 128-bit Key Registers, sixteen high-endurance monotonic EEPROM Counters, factory unique Die Identification Numbers, and a Configuration Memory. The Configuration Memory registers control access to the User Memory, as well as the restrictions on Key and Counter functionality.

The User Memory can be accessed directly with standard SPI or I<sup>2</sup>C commands if a user zone is configured for open or read-only access. If the user zone security is activated, then the extended ATAES132A command set is used to access the contents of a user zone. The extended ATAES132A commands are executed by writing the command packet to the virtual memory using standard SPI or I<sup>2</sup>C Write commands. The response packet is retrieved by reading it from the virtual memory using standard SPI or I<sup>2</sup>C Read commands.

The ATAES132A packages are compatible with standard SPI and I<sup>2</sup>C EEPROM footprints. This allows the ATAES132A to be inserted into many existing Serial EEPROM applications.

# 2. Security Features

All ATAES132A security features are optional. Each feature is enabled or disabled by programming configuration bits in the EEPROM Configuration Memory. Each user zone, Key, and Counter is separately and independently configured.

## 2.1 Architecture

ATAES132A contains all circuitry for performing authentication, encryption, and decryption using keys stored securely in the internal EEPROM. Since the secrets are stored securely in the ATAES132A, they do not have to be exchanged prior to executing cryptographic operations.

ATAES132A has fixed cryptographic functionality; it is not a microcontroller and cannot accept customer firmware. ATAES132A contains a hardware AES cryptographic engine and has a fixed command set. Although the functionality is fixed, it is also flexible because each feature is enabled or disabled by the customer by programming registers in the EEPROM Configuration Memory. After personalization is complete, fuses lock the configuration so it cannot be changed.

### 2.1.1 AES

The ATAES132A cryptographic functions are implemented with a hardware cryptographic engine using AES in CCM mode with a 128-bit key. AES-CCM mode provides both confidentiality and integrity checking with a single key. The integrity MAC includes both the encrypted data and additional authenticate-only data bytes, as described in each command definition. Each MAC is unique due to inclusion of a Nonce and an incrementing MacCount Register in the MAC calculation.

### 2.1.2 Hardware Security Features

The ATAES132A device contains physical security features to prevent an attacker from determining the internal secrets. ATAES132A includes tamper detectors for voltage, temperature, frequency, and light, as well as an active metal shield over the circuitry, internal memory encryption, and other various features. The ATAES132A physical design and cryptographic protocol are designed to prevent or significantly complicate most algorithmic, timing, and side-channel attacks.

## 2.2 Authentication

The authentication commands utilize AES-CCM to generate or validate a MAC value computed using an internally stored key. The command set supports both one-way and mutual authentication. One ATAES132A device can generate packets for authentication of a second ATAES132A device containing the same key. The internal authentication status register remembers only the most recent authentication attempt. A user zone can be configured to require prior authentication of a designated key before access to the user zone is permitted.

### 2.2.1 Key Authentication

Individual keys can be configured to require a successful authentication prior to use. This requirement can be used to prevent some kinds of exhaustive attacks on the keys. The authentication requirement can be chained to require authentication of several keys prior to allowing a particular operation. The internal Authentication Status Registers remember only the most recent authentication attempt.

## 3. Electrical Characteristics

### 3.1 Absolute Maximum Ratings\*

Operating Temperature .....	-40°C to +85°C
Storage Temperature.....	-65°C to +150°C
Maximum Operating Voltage .....	6.0V
DC Output Current.....	5.0mA
Voltage on any pin .....	-0.7V to (V <sub>CC</sub> + 0.7V)
HBM ESD .....	3kV minimum

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

### 3.2 Reliability

The ATAES132A is fabricated with the Atmel high reliability CMOS EEPROM manufacturing technology. The reliability ratings in Table 3-1 apply to each byte of the EEPROM memory.

Table 3-1. EEPROM Reliability<sup>(1)</sup>

Parameter	Min	Typical	Max	Units
Write Endurance (each byte)	100,000			Write Cycles
Data Retention (at 55°C)	10			Years
Data Retention (at 35°C)	30	50		Years
Read Endurance	Unlimited			Read Cycles

Note: 1. These specifications apply to every byte of the User Memory, Configuration Memory, and Key Memory. The Write Endurance specification also applies to the RNG EEPROM Seed Register.

## 3.3 DC Characteristics

### 3.3.1 Supply Characteristics

**Table 3-2. Supply Voltage and Current Characteristics**

Applicable over recommended operating range from  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = +2.5\text{V}$  to  $+5.5\text{V}$  (unless otherwise noted).<sup>(1)</sup>

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
$V_{CC}^{(1)}$	Supply Voltage		2.50		5.50	V
$I_{CC1}$	Supply Current	$V_{CC} = 3.3\text{V}$ at $f_{\max}^{(4)}$ $SO = \text{Open}^{(3)}$ , Read, Write, or AES operation.			6	mA
$I_{CC2}$	Supply Current	$V_{CC} = 5.5\text{V}$ at $f_{\max}^{(4)}$ $SO = \text{Open}^{(3)}$ , Read, Write, or AES operation.			10	mA
$I_{CC3}$	Idle Current	$V_{CC} = 3.3\text{V}$ or $5.5\text{V}$ at $f_{\max}^{(4)}$ $SO = \text{Open}^{(3)}$ , Waiting for a command.		600	800	$\mu\text{A}$
$I_{SL1}$	Sleep Current	$V_{CC} = 3.3\text{V}$ ; $\overline{CS} = V_{CC}^{(3)}$ , Sleep State		0.10	0.25	$\mu\text{A}$
$I_{SL2}$	Sleep Current	$V_{CC} = 5.5\text{V}$ ; $\overline{CS} = V_{CC}^{(3)}$ , Sleep State		0.25	0.50	$\mu\text{A}$
$I_{SB1}$	Standby Current	$V_{CC} = 3.3\text{V}$ ; $\overline{CS} = V_{CC}^{(3)}$ , Standby State		15	30	$\mu\text{A}$
$I_{SB2}$	Standby Current	$V_{CC} = 5.5\text{V}$ ; $\overline{CS} = V_{CC}^{(3)}$ , Standby State		20	40	$\mu\text{A}$

- Notes:
1. Typical values are at  $25^{\circ}\text{C}$ , and are for reference only. Typical values are not tested or guaranteed.
  2. On power-up,  $V_{CC}$  must rise continuously from  $V_{SS}$  to the operating voltage, with a rise time no faster than  $1\text{V}/\mu\text{s}$ .
  3. All input pins must be held at either  $V_{SS}$  or  $V_{CC}$  during this measurement. In SPI interface mode, the  $\overline{CS}$  pin must be at  $V_{CC}$ . In  $I^2C$  interface mode, the  $\overline{CS}$  pin may be in either state.
  4. Measurement is performed at the maximum serial clock frequency. In the  $I^2C$  interface mode,  $f_{\max}$  is 1MHz. In the SPI interface mode,  $f_{\max}$  is 10MHz.
  5. The ATAES132A does not support hot swapping or hot plugging. Connecting or disconnecting this device to a system while power is energized can cause permanent damage to the ATAES132A.

### 3.3.2 I/O Characteristics

**Table 3-3. DC Characteristics**

Applicable over recommended operating range from  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = +2.5\text{V}$  to  $+5.5\text{V}$  (unless otherwise noted).

Symbol	Parameter	Test conditions	Min	Max	Units
$I_{LI}$	Input Current	$V_{IN} = 0\text{V}$ or $V_{CC}$	-3.0	3.0	$\mu\text{A}$
$I_{LO}$	Output Leakage	$V_{OUT} = 0\text{V}$ or $V_{CC}$	-3.0	3.0	$\mu\text{A}$
$V_{IL}^{(1)}$	Input Low-Voltage		-0.5	$V_{CC} \times 0.3$	V
$V_{IH}^{(1)}$	Input High-Voltage		$V_{CC} \times 0.7$	$V_{CC} + 0.5$	V
$V_{OL1}^{(2)}$	Output Low-Voltage, Except SI/SDA in I <sup>2</sup> C Mode	$I_{OL} = 3.0\text{mA}$	0	0.4	V
$V_{OH1}^{(2)}$	Output High-voltage, Except SI/SDA in I <sup>2</sup> C Mode	$I_{OH} = -3.0\text{mA}$	$V_{CC} - 0.8$	$V_{CC}$	V
$V_{OL2}$	Output Low-voltage, SI/SDA Pin in the I <sup>2</sup> C Mode <i>Only</i>	$I_{OL} = 3.0\text{mA}$	0	0.4	V

- Notes: 1.  $V_{IL}$  min and  $V_{IH}$  max are for reference only, and are not tested.  
 2. In the I<sup>2</sup>C interface mode, if Auth signaling is enabled, the SO pin functions as the AuthO output. When AuthO is high, the  $V_{OH1}$  specification applies. When AuthO is not high, the pin is in the high-impedance state; the  $V_{OL1}$  specification is not applicable.

## 3.4 AC Characteristics

**Table 3-4. AC Characteristics**

Applicable over recommended operating range from  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = +2.5\text{V}$  to  $+5.5\text{V}$ .

Symbol	Parameter	Min	Max	Units
$t_{WC1}$	User Zone Write Cycle Time <sup>(1)</sup>	6.0	9.0	ms
$t_{WC2}$	Key Zone Write Cycle Time <sup>(1)</sup>	12.0	16.0	ms
	Command Response Time			

Note: 1. The write cycle time includes the EEPROM Erase, Write, and Automatic Data Write verification operations.

### 3.4.1 Power-Up, Sleep, Standby, and Wake-Up Timing

**Table 3-5. Power-Up, Sleep, and Wake-Up Timing Characteristics<sup>(1)</sup>**

Applicable over recommended operating range from  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = +2.5\text{V}$  to  $+5.5\text{V}$ .

Symbol	Parameter	Min	Typ	Max	Units
$t_{PU.STATUS}$	Power-Up Time, Status		500	600	$\mu\text{s}$
$t_{PU.RDY}$	Power-Up Ready Time		1200	1500	$\mu\text{s}$
$t_{SB}$	Sleep Time, Entering the Standby State		65	100	$\mu\text{s}$
$t_{SL}$	Sleep Time, Entering the Sleep State		55	90	$\mu\text{s}$
$t_{WupSB.STATUS}$	Wake-Up Status Time, Standby State		50	100	$\mu\text{s}$
$t_{WupSB.RDY}$	Wake-Up Ready Time, Standby State		200	240	$\mu\text{s}$
$t_{WupSL.STATUS}$	Wake-Up Status, Sleep State		500	600	$\mu\text{s}$
$t_{WupSL.RDY}$	Wake-Up Ready Time, Sleep State		1200	1500	$\mu\text{s}$

Note: 1. All values are based on characterization and are not tested. Typical values are at  $25^{\circ}\text{C}$  and are for reference only.

### 3.4.2 I<sup>2</sup>C Interface Timing

**Table 3-6. AC Characteristics of I<sup>2</sup>C Interface**

Applicable over recommended operating range from  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = +2.5\text{V}$  to  $+5.5\text{V}$ ,  $CL = 1$  TTL Gate and  $100\text{pF}$  (unless otherwise noted).

Symbol	Parameter	Min	Max	Units
$f_{\text{SCK}}$	SCK Clock Frequency		1	MHz
	SCK Clock Duty Cycle	30	70	percent
$t_{\text{HIGH}}$	SCK High Time	400		ns
$t_{\text{LOW}}$	SCK Low Time	400		ns
$t_{\text{SU.STA}}$	Start Setup Time	250		ns
$t_{\text{HD.STA}}$	Start Hold Time	250		ns
$t_{\text{SU.STO}}$	Stop Setup Time	250		ns
$t_{\text{SU.DAT}}$	Data in Setup Time	100		ns
$t_{\text{HD.DAT}}$	Data in Hold Time	0		ns
$t_{\text{R}}$	Input Rise Time <sup>(1)</sup>		300	ns
$t_{\text{F}}$	Input Fall Time <sup>(1)</sup>		100	ns
$t_{\text{AA}}$	Clock Low to Data Out Valid	50	550	ns
$t_{\text{DH}}$	Data Out Hold Time	50		ns
$t_{\text{BUF}}$	Time bus must be free before a new transmission can start. <sup>(1)</sup>	500		ns

- Notes: 1. Values are based on characterization, and are not tested.
2. AC measurement conditions:
- $R_L$  (connects between SDA and  $V_{CC}$ ):  $2.0\text{k}\Omega$  (for  $V_{CC} +2.5\text{V}$  to  $+5.0\text{V}$ )
  - Input pulse voltages:  $0.3V_{CC}$  to  $0.7V_{CC}$
  - Input rise and fall times:  $\leq 50\text{ns}$
  - Input and output timing reference voltage:  $0.5V_{CC}$

### 3.4.3 SPI Interface Timing

**Table 3-7. AC Characteristics of SPI Interface**

Applicable over recommended operating range from  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = +2.5\text{V}$  to  $+5.5\text{V}$ ,  $CL = 1$  TTL Gate and  $30\text{pF}$  (unless otherwise noted).

Symbol	Parameter	Min	Max	Units
$f_{\text{SCK}}$	SCK Clock Frequency	0	10	MHz
	SCK Clock Duty Cycle	30	70	percent
$t_{\text{WH}}$	SCK High Time	40		ns
$t_{\text{WL}}$	SCK Low Time	40		ns
$t_{\text{CS}}$	$\overline{\text{CS}}$ High Time	50		ns
$t_{\text{CSS}}$	$\overline{\text{CS}}$ Setup Time	50		ns
$t_{\text{CSH}}$	$\overline{\text{CS}}$ Hold Time	50		ns
$t_{\text{SU}}$	Data In Setup Time	10		ns
$t_{\text{H}}$	Data In Hold Time	10		ns
$t_{\text{RI}}$	Input Rise Time <sup>(1)</sup>		2	$\mu\text{s}$
$t_{\text{FI}}$	Input Fall Time <sup>(1)</sup>		2	$\mu\text{s}$
$t_{\text{V}}$	Output Valid	0	40	ns
$t_{\text{HO}}$	Output Hold Time	0		ns
$t_{\text{DIS}}$	Output Disable Time		50	ns

Note: 1. Values are based on characterization, and are not tested.

## 4. Ordering Information

To increase security, ATAES132A packages are not marked with the ordering code. The ATAES132A standard packages are marked with a trace code which is unique for each manufacturing lot. Contact Atmel for additional information.

### A.1 Ordering Codes

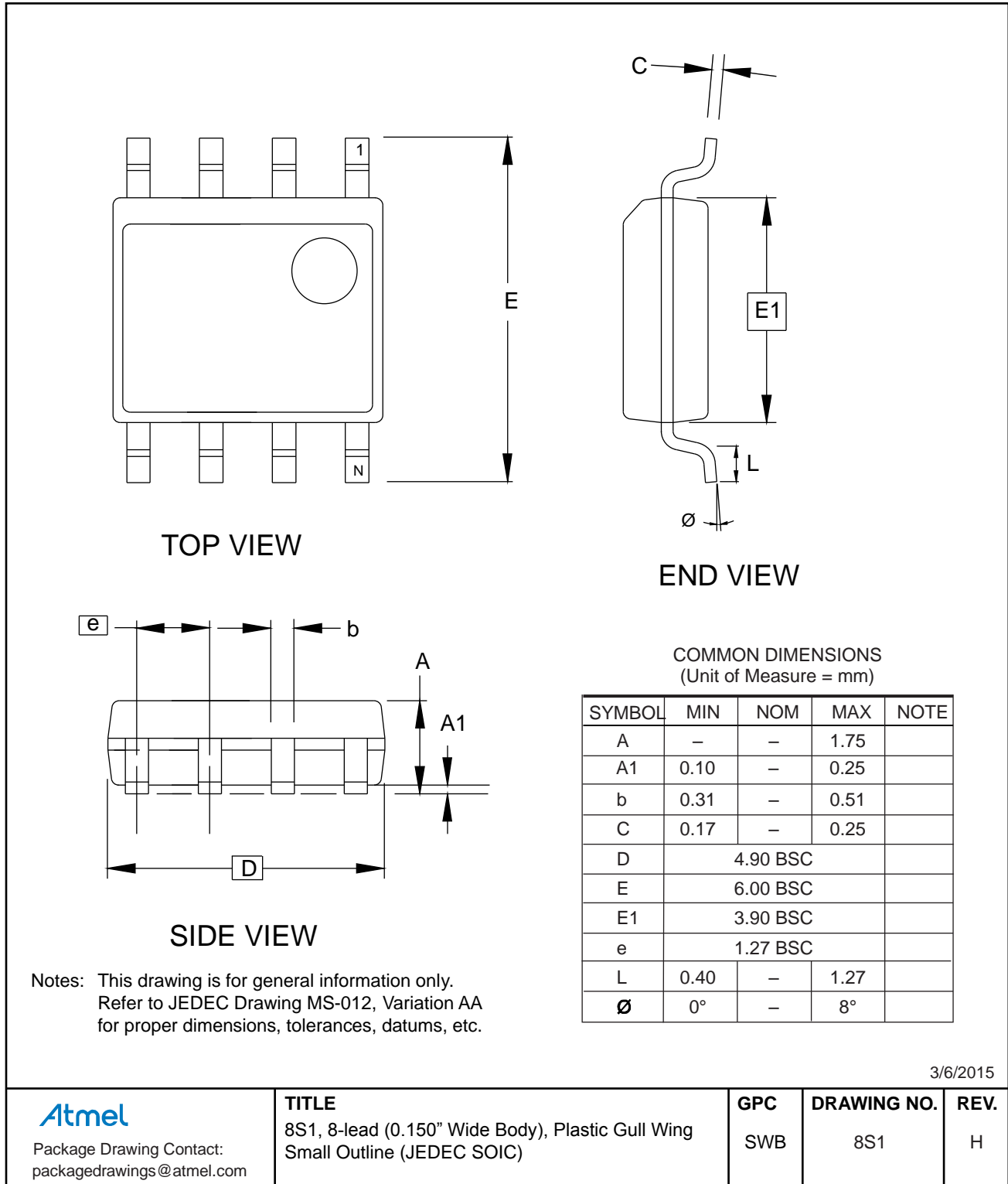
Atmel Ordering Code	Interface Configuration	Conditioning	Package	Lead Finish	Temperature Range
ATAES132A-SHEQ-B	SPI	Bulk <sup>(1)</sup>	8S1	NiPdAu Lead-free/Halogen-free (Exceeds RoHS Requirements)	Industrial Temperature (-40°C to 85°C)
ATAES132A-SHER-B	I <sup>2</sup> C				
ATAES132A-SHEQ-T	SPI	Tape and Reel <sup>(2)</sup>	8MA2		
ATAES132A-SHER-T	I <sup>2</sup> C				
ATAES132A-MAHEQ-T	SPI				
ATAES132A-MAHER-T	I <sup>2</sup> C				

- Notes: 1. -B = Bulk
- SOIC = 100 per tube.
2. -T = Tape and Reel
- SOIC = 4,000 per reel.
  - UDFN = 15,000 per reel.

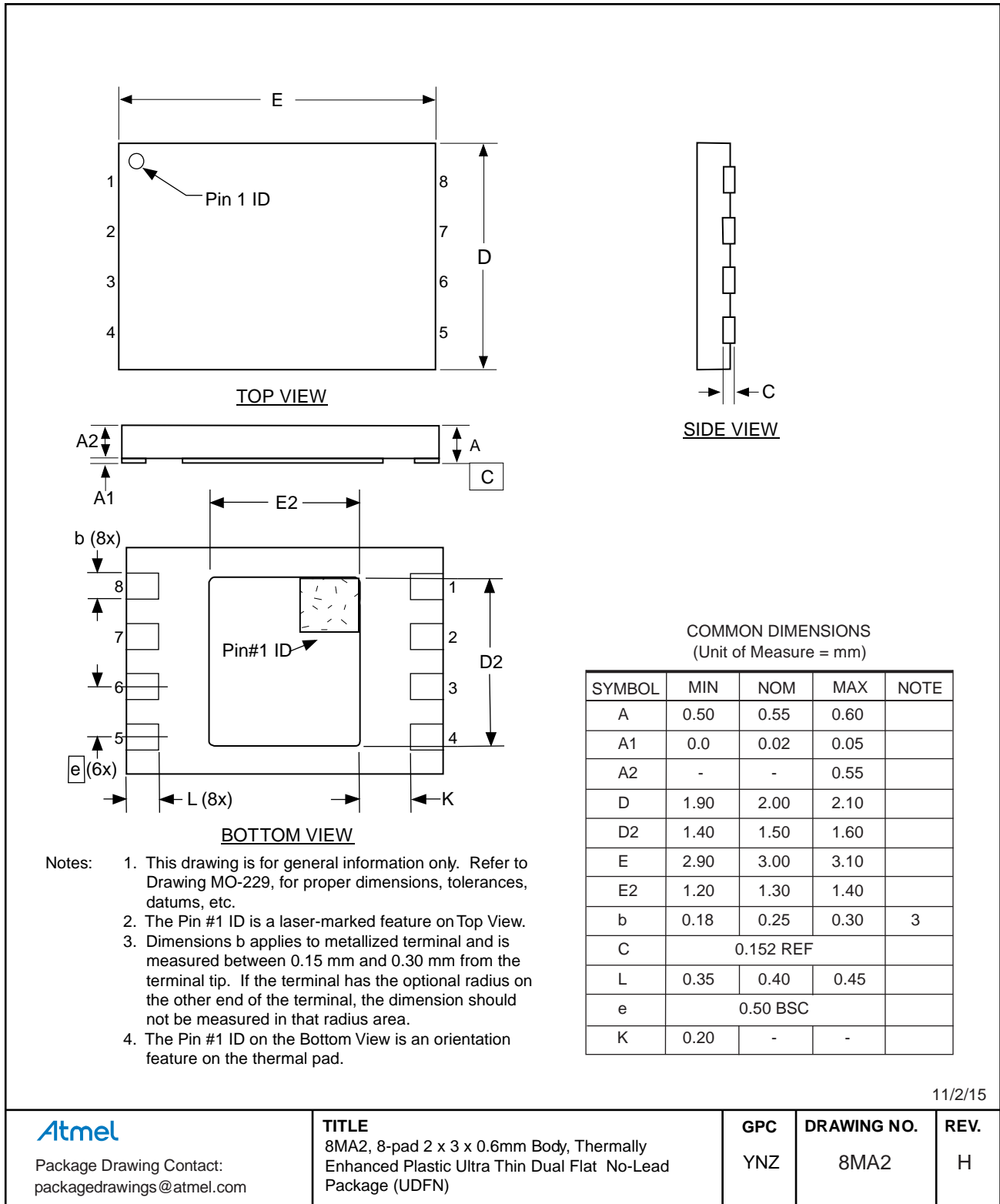
Package Type	
8S1	8-lead, 0.150" wide body, Plastic Gull Wing Small Outline, Green (JEDEC SOIC)
8MA2	8-pad, 2.0mm x 3.0mm x 0.6mm body, Thermally Enhanced Plastic Ultra Thin Dual Flat No Lead, Green (UDFN)

## A.2 Mechanical Information

### A.2.1 8S1 — 8-lead JEDEC SOIC



## A.2.2 8MA2 — 8-pad UDFN



11/2/15

**Atmel**

Package Drawing Contact:  
packagedrawings@atmel.com

**TITLE**

8MA2, 8-pad 2 x 3 x 0.6mm Body, Thermally  
Enhanced Plastic Ultra Thin Dual Flat No-Lead  
Package (UDFN)

**GPC**

YNZ

**DRAWING NO.**

8MA2

**REV.**

H

## 5. Revision History

Doc. Rev.	Date	Comments
8914BS	02/2016	Corrected ordering codes ATAES132A-SHEQ-B and ATAES132A-SHER-B by adding "-B". Updated 8MA2 package drawing. Added a high-feature bullet, "Guaranteed Unique Die Serial Number."
8914AS	03/2015	Initial summary document release.



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- ⊖ [Microchip Technology](#) Information

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- ✓ Cost Control Management
- ✓ Shortage Management
- ✓ Alternative Solution
- ✓ Excess Inventory Management