A1006

Secure Authenticator IC

Rev. 1 — 25 July 2018 Product short data sheet

1. Introduction

The A1006 Secure Authenticator IC is a secure, easy to use authentication IC for use in electronic accessories such as AC/DC adapters, cables, keyboards, docking stations, batteries, digital headsets, electronic cigarettes etc., for authentication and anti-counterfeiting purposes.

NXP Semiconductors has a long track record and extensive portfolio of security ICs. NXP security ICs have been used in many high security applications including bank cards, health insurance cards, and electronic passports. They are also being used as embedded secure elements in mobile phones.

The A1006 secure authentication IC extends this portfolio for applications requiring tamper-resistant, secure, one-way authentication.

The A1006 authentication IC is a secure solution built with many tamper resistant features and security countermeasures to deter common invasive and non-invasive attacks.

2. General description

The A1006 Secure Authenticator Solution is a complete embedded security platform for electronic accessories, mobile phones, portable devices, computing and consumer electronic devices, and embedded systems where a strong security infrastructure is required for authentication and counterfeit detection and prevention. The A1006 provides an outstanding level of security, while overcoming the challenges of performance, power consumption and solution footprint.

The A1006 security solution is based on industry standard asymmetric cryptographic challenge-response protocols, using NIST approved elliptic curves, Elliptic Curve Diffie-Hellman challenge response (ECDH), and customizable X.509 certificates signed using the Elliptic Curve Digital Signature Algorithm (ECDSA). Advanced anti-tampering countermeasures are incorporated into the A1006 to prevent various attacks and minimize the scalability of any attempts to clone the A1006.

The A1006 is offered as a turnkey solution that provides customers easy integration into their end products. A 400 kbps I^2C-bus interface along with a one-wire interface provide simple options for interfacing to most embedded systems. A reference host library is provided to simplify host code implementation, and keys and certificates can be programmed in NXP's secure manufacturing facilities, eliminating the need for creating and managing private key insertion and certificate signing in the system designer's supply chain.

3. Features and benefits

- Advanced security using unique asymmetrical public/private key based Diffie-Hellman authentication protocol based on ECC (Elliptic Curve Cryptography) with a NIST B-163 bit strong binary field curve
- Authentication time (on-chip calculations) < 50 milliseconds
- Each A1006 is provisioned with a fixed unique Private Key and a corresponding Public Key in a certificate that contains the Public Key and additional information including a unique identifier and the customizable product-specific fields.
- A1006 certificates are digitally signed using ECDSA (Elliptic Curve Digital Signature Algorithm) based on the NIST P-224 curve and the SHA-224 digest hash, with the customer's desired certificate authority key
- Non-Volatile Memory (NVM) for storage of device behavior, usage data, logistic information or any other arbitrary data
- Protection against Simple Power Analysis (SPA), Differential Power Analysis (DPA) and fault attacks
- One-Wire Interface (OWI) at 125 kbps, with ability to support bus-powered operation
- 400 Kbps I^2C Fast-mode interface
- Power consumption: Maximum of 550 µA active
- Deep Sleep mode with very low power consumption of less than 3.3 µA at 3.3 V and < 1 µA at 1.8 V
- Entry to and exit from the Deep Sleep mode through I^2C/OWI interface[1]
- ESD protection 8kV IEC61000-4-2 contact discharge (on OWI pin)
- EEPROM sections (4 Kbit total)
  - 2 Kbit certificates (2 × 1 Kbit)
  - 1 Kbit user memory
  - 1 Kbit system memory
- Minimum 10 years memory retention at 85 °C
- 500,000 write/erase endurance
- Multiple Package options available
  - HXSON6: Plastic thermal enhanced extremely thin small outline package, no leads
  - WLCSP4: 4 bump Wafer Level Chip Scale Package
- Maximum height 0.5 mm
- Operating temperature range –40 °C to 85 °C

3.1 Trust provisioning service

The A1006 can be delivered with pre-programmed, device-specific keys and certificates that are generated and programmed in a secure NXP internal environment with master keys securely stored in HSMs (Hardware Secure Modules).

1. Separate wakeup pin to wake up from deep sleep state in HXSON6 package

3.2 Security features

The A1006 secure authentication IC incorporates an extensive set of security measures from NXP Semiconductor's portfolio of such measures. The countermeasures against invasive and non-invasive attacks provide a high level of attack resilience. The A1006 countermeasures, including glue logic, active and passive shielding, memory scrambling and encryption, and other security features provide a unique level of security for this class of authentication devices.

The A1006 includes dedicated HW to protect against reverse engineering attacks, fault attacks and leakage attacks.

The A1006 incorporates many security countermeasures, including:

- Mathematically proven design that offers protection against logical and messaging attacks
- Use of active and passive shielding to protect against probe attacks
- EEPROM data encryption and address scrambling with random data placement
- Simple Power Analysis (SPA)/ Differential Power Analysis (DPA) protected calculation of ECC point multiplication
- Proprietary glue logic to thwart circuit analysis
- Enhanced security sensors
  - Low and high supply voltage sensors

4. Applications

- Embedded Security
- Counterfeit protection of hardware and software
  - Anti-cloning
  - Brand integrity of original goods
  - Accessories like speakers, docking stations, batteries, chargers, printer cartridges, e-cigarettes and other high value disposables
- Profile of service
  - Conditional access to software, content and features
  - Secure access to online services
- Secure Device identity

5. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DD}	Supply Voltage		1.62[1]	1.8	3.6	V
EEPROM						
t_{ret}	retention time	T_{amb} = +85 °C	10	-	-	years
$N_{endu(W)}$	write endurance	under all operating conditions	5×10^5	-	-	cycles

[1] minimum supply voltage related to the pull-up resistor values. In case of a single A1006 device, this is in the 200 to 500 Ohm range.

6. Ordering information

6.1 A1006 naming conventions

The following table explains the naming conventions of the commercial product name of the A1006 products. Every A1006 product gets assigned such a commercial name, which includes also customer and application specific data.

The A1006 commercial names have the following format.

A1006pp

The ‘A1006’ is a constant, all other letters are variables, which are explained in Table 2.

Table 2. A1006 commercial type name format

Variable	Meaning	Values	Description
pp	package type code	see Table 4	

The following table explains the naming conventions used for A1006 products.

A1006pp/mvsrr

The 'A1006' is the base device part number. The variable letters and digits are explained in Table 3.

Table 3. Naming conventions

Variable	Meaning	Values
pp	package type code	see Table 4
m	manufacturing site code	T
v	silicon version code	A
s	silicon subversion code	1
rr	Fabkey number	Refer to Fabkey chapter for more details

Table 4. Base product types

Type number	Package		
	Name	Description	Version
A1006TL	HXSON6	plastic, thermal enhanced extremely thin small outline package; no leads; 6 terminals; body 2.0 x 2.0 x 0.5 mm	SOT1348-1
A1006UK	WLCSP4	wafer level chip-scale package; 4 bumps; 1.03 x 0.94 x 0.5 mm	SOT1375-4

6.2 Ordering options

Table 5. Ordering options

Type number	Orderable part number	Package	Packing method	Minimum order quantity	Temperature
A1006TL	A1006TL/TA1NXZ[1]	HXSON6	7-inch reel	4000	T_{amb} = −40 °C to +85 °C
A1006TL	A1006TL/TA1rrZ[2]	HXSON6	13-inch reel	75000	T_{amb} = −40 °C to +85 °C
A1006UK	A1006UK/TA1NXZ[1]	WLCSP4	7-inch reel	4000	T_{amb} = −40 °C to +85 °C
A1006UK	A1006UK/TA1rrZ[2]	WLCSP4	13-inch reel	75000	T_{amb} = −40 °C to +85 °C

[1] NX (fixed) - standard certificate

[2] Variable, <>NX - custom certificate, code assigned after certificate verification

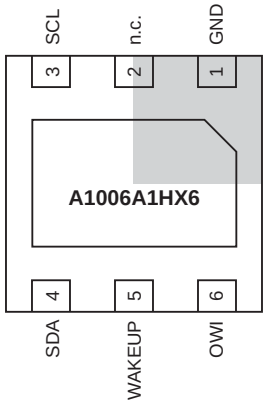
7. Marking

Table 6. Marking codes

Type number	Marking code
A1006UK/TA1…	Line A: .(DOT)A1 (A1 Product Family) Line B: ddd (Last 3 digits of diffusion #) Line C: d|| (d – last 1 digit of diffusion # || - Wafer ID)
A1006TL/TA1....	Line A: A 1 6 Line B: XXY XX = ASID Y: weekly rotating 1-5

8. Pinning information

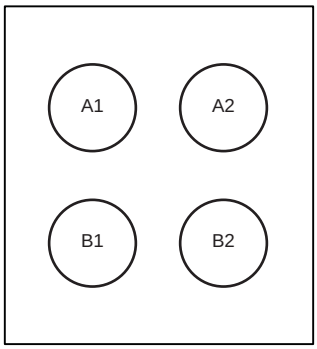
8.1 Pinning



aaa-022289

(1) The center pad is attached internally to the substrate using non-conductive die attach material. It can be externally connected to ground or treated as a no connect.

Fig 1. Pin configuration for HXSON6 (top view)



aaa-022290

Fig 2. Ball layout for WLCSP4 (top view)

8.2 Pin description

Table 7. Pin description

Symbol	Pin		Description
	HXSON6	WLCSP4	
GND	1	A2	ground (0 V)
n.c.	2	-	connect to ground
SCL	3	B2	I^2C clock
SDA	4	B1	I^2C data
WAKEUP	5	-	wakeup from Deep-sleep mode
OWI	6	A1	One-Wire Interface. Power pin as well as communication channel if OWI mode is used; I^2C VDD supply voltage if I^2C-bus interface is used

9. Functional description

9.1 External interfaces

The A1006 supports both an I^2C and an OWI. After boot phase, both the interfaces are active. The first valid command at any interface decides which interface will stay active. With the SoftReset command, it is possible to activate both interfaces again.

9.2 OWI

The A1006 Secure Authenticator IC implements the proprietary OWI protocol of NXP. This interface provides both data and power, eliminating the need for an extra supply pin and no external components except pull-up (like a cap). The A1006 implements a half duplex master/slave communication protocol that can easily be controlled via a microcontroller's GPIO. The OWI is capable of up to 125 kbps data transmission.

9.3 I^2C-bus interface

The A1006 supports the I^2C-bus protocol at a data rate of up to 400 kbps. Any device that sends data to the bus is defined to be a transmitter, and any device that reads the data to be a receiver. The device that controls the data transfer is known as the bus master and the other as the slave device. A data transfer can only be initiated by the bus master, which also provides the serial clock for synchronization. The A1006 is always a slave in all communications. In the following description, the Master device refers to the host, and the slave device refers to the A1006.

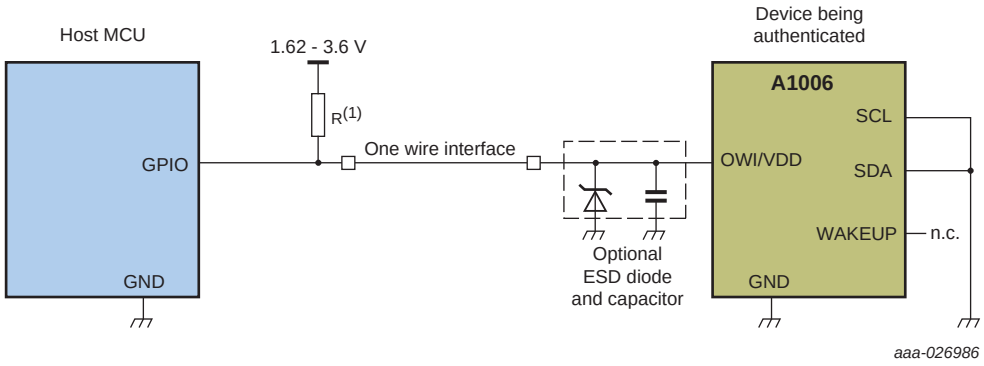
9.4 Deep-sleep mode

The A1006 supports a deep sleep mode where it consumes extremely low power but it can also be woken up in case further operations with the IC are necessary.

10. Application information

10.1 One Wire Interface

Figure 3 shows A1006 powered by a host microcontroller using the OWI interface to communicate with A1006.

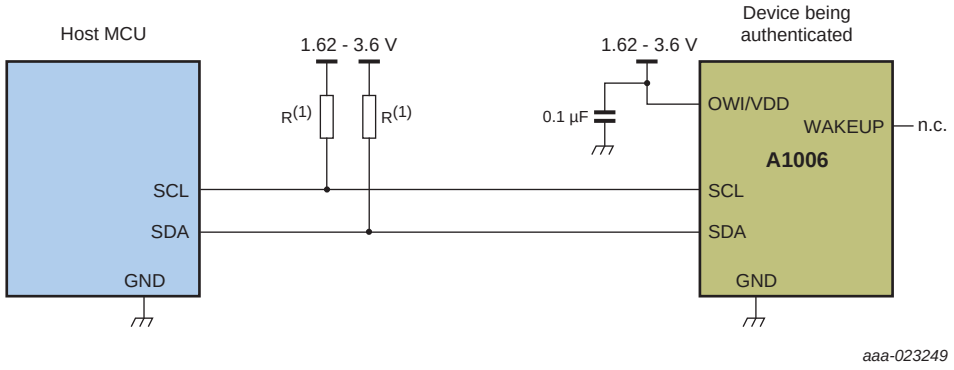


(1) 200Ω to 500Ω recommended for VDD = 1.8 V. Higher values up to 1.2kΩ may be used with VDD = 3.3 V.

Fig 3. Application diagram for OWI

10.2 I²C interface

Figure 4 shows A1006 connected to a host microcontroller via I²C interface.



(1) Typically 900Ω for VDD = 1.8 V and 1.1kΩ for 3.3 V

Fig 4. Application diagram for using I²C-bus interface

10.3 Authentication

Figure 5 shows authentication flow at a high level. Please refer to A1006 user guide for details.

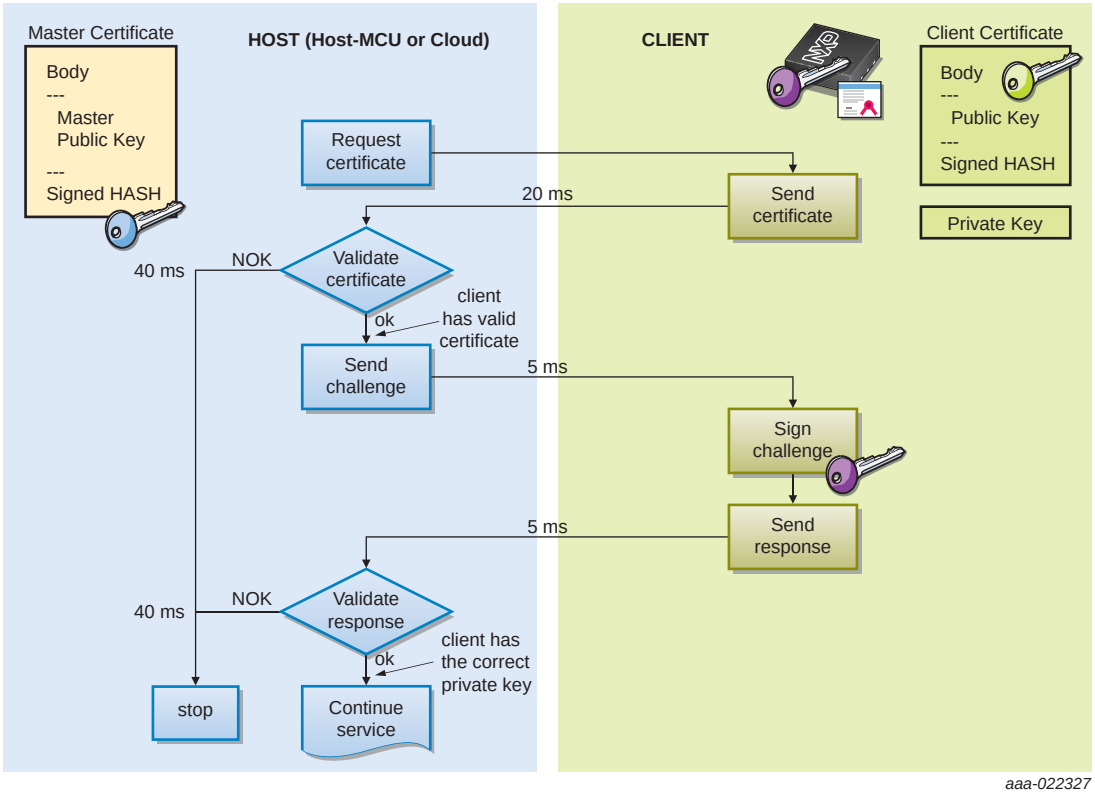


Fig 5. Authentication flow

To prove its authenticity the A1006 supports a public/private key Diffie-Hellman authentication protocol based on ECC (Elliptic Curve Cryptography) with a 163 bit strong binary field curve. The implementation uses a standard curve NIST B-163.

The protocol is a two-pass challenge-response protocol where the host can verify the authenticity of the A1006. The host chooses random number r, multiplies “basepoint” G by this random number to get point rG. The host sends the point rG to the A1006. The A1006 stores a private key q and public key Q (=qG). This public key Q is embedded in a certificate cert(Q) and stored in the A1006. The A1006 computes q(rG) and returns the result to the host. The host verifies that cert(Q) is valid, extracts the public key Q from the certificate and verifies that q(rG) received from the A1006 equals rQ (i.e. r(qG)).

If both checks are valid, the A1006 has proven its authenticity.

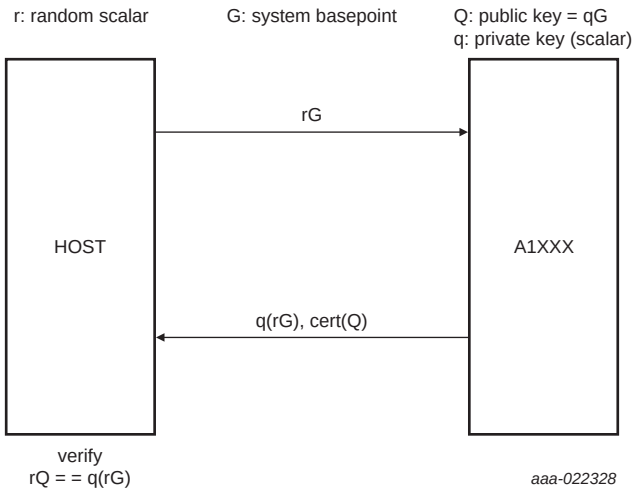


Fig 6. Authentication protocol

11. Limiting values

Table 8. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).
Voltages are referenced to V_{SS} (ground = 0 V).

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DD,OWI}$	supply voltage		−0.5	+4.6	V
V_I	I/O voltage	on pins SCL, SDA, WAKEUP	−0.5	+4.6	V
I_{IL}	latch-up current	$V_I < 0$ V or $V_I > V_{OWI}$	-	100	mA
V_{esd}	electrostatic discharge voltage	[1]	-	8.0	kV
P_{tot}	total power dissipation	[2]	-	2.0	mW
T_{stg}	storage temperature		−65	+150	°C
T_J	junction temperature		−40	+85	°C
t_{ret}	retention time	T_{amb} = +85 °C	10	-	years
$N_{endu(W)}$	write endurance	under all operating conditions	5×10^5	-	cycles

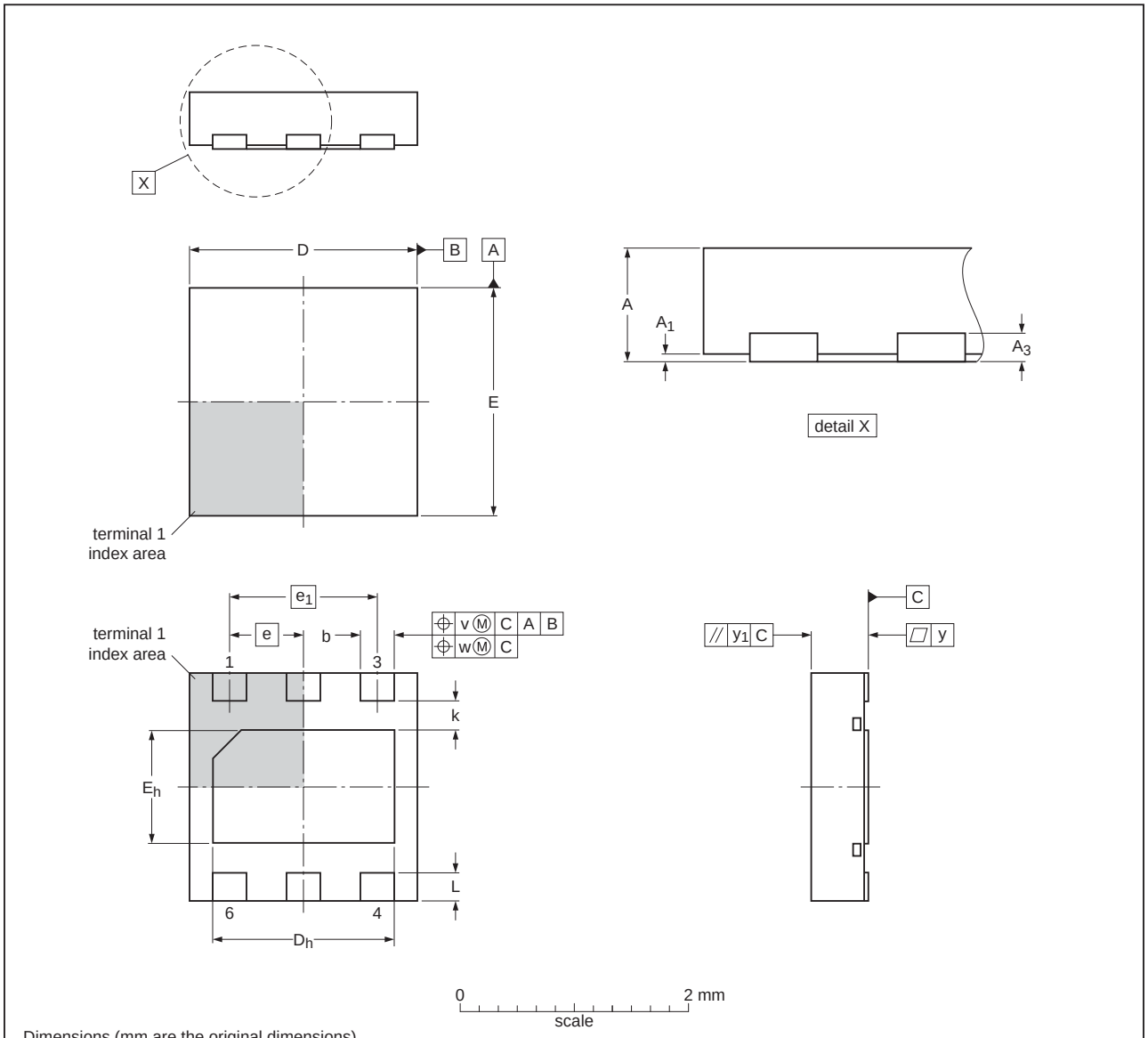
[1] IEC61000-4-2; contact discharge only on the OWI pin, all other pins support 2 kV HBM

[2] Depending on appropriate thermal resistance of the package

12. Package outline

HXSON6: plastic, thermal enhanced extremely thin small outline package; no leads; 6 terminals; body 2.0 x 2.0 x 0.5 mm

SOT1348-1



Dimensions (mm are the original dimensions)

Unit		A	A_1	A_3	b	$D^{(1)}$	D_h	$E^{(1)}$	E_h	e	e_1	k	L	v	w	y	y_1
mm	max	0.5	0.05		0.35	2.1	1.7	2.1	1.1				0.30				
	nom			0.127	0.30	2.0	1.6	2.0	1.0	0.65	1.3		0.25	0.1	0.05	0.05	0.05
	min		0.00		0.25	1.9	1.5	1.9	0.9			0.2	0.20				

Note

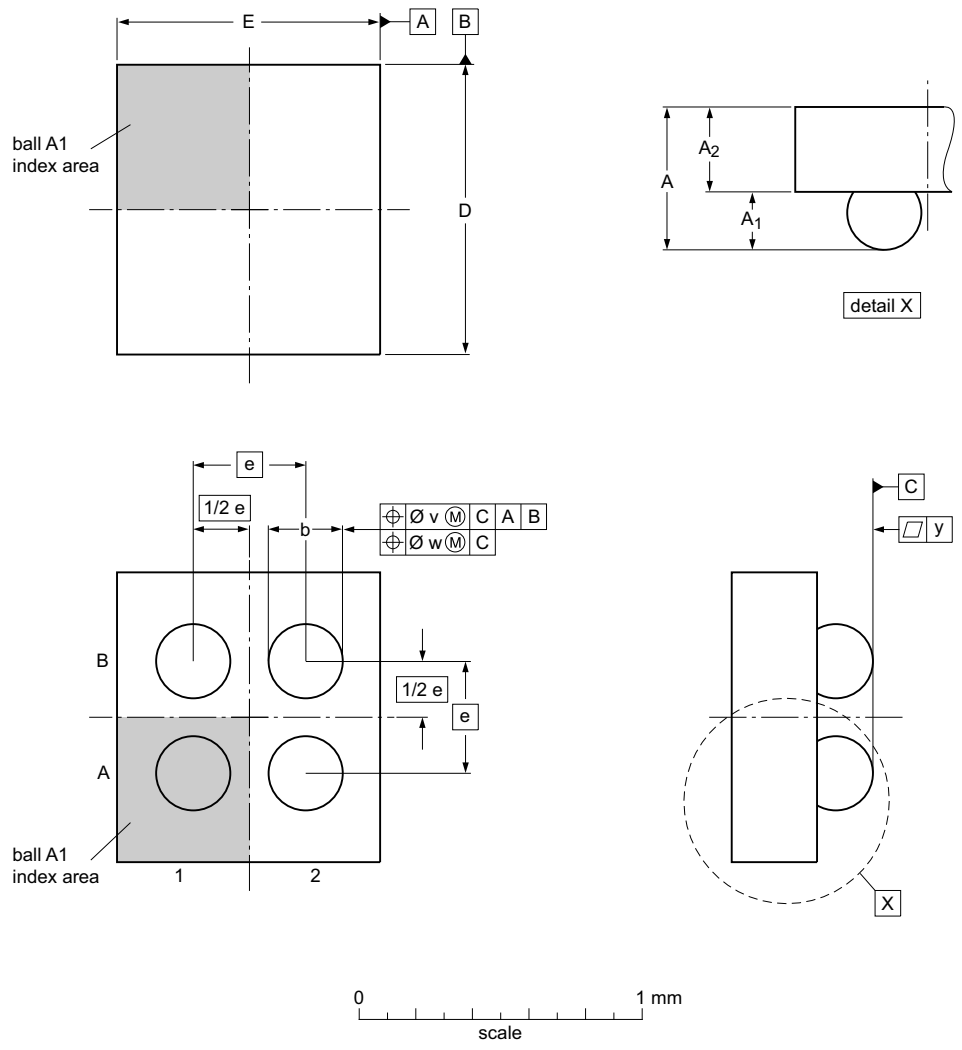
1. Plastic or metal protrusions of 0.075 mm maximum per side are not included.

sot1348-1_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1348-1	- - -	- - -	- - -			~~13-09-04~~ 15-05-08

Fig 7. Package outline SOT1348-1 (HXSON6)

WLCSP4: wafer level chip-scale package; 4 bumps; 1.03 x 0.94 x 0.5 mm **SOT1375-4**



Dimensions (mm are the original dimensions)

Unit		A	A_1	A_2	b	D	E	e	v	w	y
mm	max	0.54	0.23	0.325	0.29	1.06	0.97				
	nom	0.50	0.20	0.300	0.26	1.03	0.94	0.4	0.05	0.015	0.03
	min	0.46	0.17	0.275	0.23	1.00	0.91				

sot1375-4_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1375-4						~~16-04-06~~ 16-12-05

Fig 8. Package outline SOT1375-4 (WLCSP4)

13. Abbreviations

Table 9. Abbreviations

Acronym	Description
OWI	One-Wire Interface

14. Revision history

Table 10. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
A1006_SDS	20180725	Product short data sheet	-	-

15. Legal information

15.1 Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

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17. Contents

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Date of release: 25 July 2018
Document identifier: A1006_SDS