



# A71CH

## Plug & Trust Secure Element

Rev. 1.2 — 27 September 2018  
449312

Data sheet  
COMPANY PUBLIC

## 1. Introduction

The A71CH is a ready-to-use solution providing a root of trust at the IC level and proven, chip-to-cloud security right out of the box. It is a platform capable of securely storing and provisioning credentials, securely connecting IoT devices to cloud services and performing cryptographic node authentication.

The A71CH solution provides basic security measures protecting the IC against many physical and logical attacks. It can be used with various host platforms and host operating systems to secure a broad range of applications. It is complemented by a comprehensive product support package, offering easy design-in with plug & play host application code, easy to use development kits, reference designs, and extensive documentation for product evaluation.



Fig 1. A71CH block diagram

## 2. General description

### 2.1 A71CH naming conventions

The following table explains the naming conventions of the commercial product name of the A71CH products. Every A71CH product gets assigned such a commercial name, which includes also customer and application specific data.

The A71CH commercial names have the following format.

**A71CHxagpp(p)/mvsrrff**

The 'A71CH' is a constant, all other letters are variables, which are explained in [Table 1](#).

**Table 1. A71CH commercial name format**

Variable	Meaning	Values	Description
x	IC hardware specification code	1	standard operational ambient temperature: -25 °C to +85 °C I <sup>2</sup> C interface supported
		2	standard operational ambient temperature: -40 °C to +90 °C I <sup>2</sup> C interface supported
a	embedded operating system code	C	Java card operating system
g	embedded application firmware (applet) code	H	H is a fixed value = IoT security applet pre installed
pp(p)	package type code dd(d)= Delivery Type, TK2= HVSON8 (4x4), UK= WLCSP12		
m	Manufacturing Site Code	T	
v	Silicon Version Code	0	
s	Silicon Version Subcode	B	
rr	ROM Code ID		
ff	FabKey ID		

### 2.2 I<sup>2</sup>C interface

The A71CH has an I<sup>2</sup>C interface in slave mode, supporting data rates up to 400 kbit/s operating in Fast-Mode (FM). The I<sup>2</sup>C interface is using the Smartcard I<sup>2</sup>C protocol as defined in [Ref. 3](#) which is based on SMBus.

### 2.3 Security licensing

NXP Semiconductors has obtained a patent license for SPA and DPA countermeasures from Cryptography Research Incorporated (CRI). This license covers both hardware and software countermeasures. It is important to customers that countermeasures within the operation system are covered under this license agreement with CRI. Further details can be obtained on request.

## 3. Features and benefits

### 3.1 Key benefits

- Secure, zero-touch connectivity
- End-to-end security, from chip to edge to cloud
- Secure credential injection for IC-level root of trust
- Fast design-in with complete product support package
- Easy to integrate with different MCU platforms

### 3.2 Security features

The A71CH security concepts includes many security measures to protect the chip.

The A71CH operates fully autonomously based on an integrated Javacard operating system and applet. Direct memory access is possible by the fixed functionalities of the applet only. With that, the content from the memory is fully isolated from the host system.

Attack protection by integrated design measures in the chip layout, the logic and the functional blocks.

### 3.3 Cryptography features

The A71CH Secure Element provides the following functionality:

- Protected Access storage, generation, insertion or deletion of 4 key pairs (ECC NIST P-256)
- Systematic enforced authentication
- Secure key management
- Protected Access storage, insertion or deletion of 3 public keys
- Signature generation and verification (ECDSA)
- Shared secret calculation for Key Agreement (ECDH or ECDH-E)
- Protected Access storage and use of 2 monotonic counters (32 bits each)
- Protected Access storage, insertion or deletion of symmetric secrets (8x 128 bits); longer keys can be used by using a ConstructedSecret type
- Content protected access to keys
- A unique chip ID (18 bytes)
- HKDF key derivation using the symmetric secrets as key, Extract & Expand or Expand only modes
- HMAC SHA256 calculation in one shot or sequential
- Freezing of credentials (= OTP behavior)
- Secure channel SCPO3 GP support
- (Optional) trust provisioning of key pairs, public keys, symmetric secrets, etc.
- Possibility to lock the A71CH module as transport lock mechanism

ECC keys and operations support the following ECC curve:

- NIST P-256



Fig 2. Protected key storage & provisioning of credentials

### 3.4 Functional features

- Dedicated MX51 security CPU
- 400 kbit/s I<sup>2</sup>C Fast-mode interface
- -40 °C to +90 °C operational ambient temperature (A7102)
- On-chip Javacard operating system
- 40 µA typical sleep mode current with I<sup>2</sup>C pads in tristate mode
- 10 µA max deep sleep mode current with I<sup>2</sup>C pads in tristate mode
- High-performance Public Key Infrastructure (PKI)
- EEPROM with min 500,000 cycles endurance and min 25 years retention time
- HVSON8 package and small WLCSP available

## 4. Applications

---

### 4.1 Use Cases and target applications

- A710xCH EXAMPLE USE CASES
  - ◆ Secure connection to public/private clouds, edge computing platforms, infrastructure
  - ◆ Secure Amazon Web Services-compliant connectivity
  - ◆ Secure commissioning
  - ◆ Device-to-device authentication
  - ◆ Proof of origin / anti-counterfeiting
  - ◆ Key storage and data protection
  - ◆ Secure provisioning of credentials
  - ◆ Ecosystem protection
- A710xCH TARGET APPLICATIONS
  - ◆ Connected industrial devices
  - ◆ Sensor networks
  - ◆ IP cameras
  - ◆ Home gateways
  - ◆ Home appliances

## 5. Ordering information

### 5.1 Ordering options

**Table 2. Ordering information**

Type number <sup>[1]</sup>	Package		
	Name	Description	Version
A7101agTK2/... A7102agTK2/...	HVSON-8	plastic thermal enhanced very thin small outline package; no leads; 8 terminals; body 4 x 4 x 0.85 mm	SOT909-1
A7101agUK/... A7102agUK/...	WLCSP12	wafer level chip scale package, 12 bumping, 0.5 mm ball pitch	not applicable

[1] a = A or C, g = G, C or A, according to the A71CH type classification see [Section 2.1 "A71CH naming conventions"](#)

**Table 3. A71CH type table**

12NC	Type number	Product	Configuration	Package	Orderable part no
9353 68 097118	A7101CHTK2/T0BC2V6	A71(01)CH	customer programmable	HVSON8	A7101CHTK2/T0BC2VJ
9353 635 15118	A7102CHTK2/T0BC2A5	A71(02)CH	customer programmable	HVSON8	A7102CHTK2/T0BC2AJ
9353 694 82023	A7101CHUK/T0BC2HA	A71(01)CH	customer programmable	WLCSP	A7101CHUK/T0BC2HAZ
9353 695 02023	A7102CHUK/T0BC2VA	A71(02)CH	customer programmable	WLCSP	A7102CHUK/T0BC2VAZ
9353 737 63118	A7101CHTK2/T0BC2BM	A71(01)CH	Provisioned & Programmable 'Ready for IBM Watson IoT'	HVSON8	A7101CHTK2/T0BC2BJ
9353 741 46118	A7102CHTK2/T0BC2CH	A71(02)CH	Provisioned & Programmable 'Ready for IBM Watson IoT'	HVSON8	A7102CHTK2/T0BC2CJ

**Table 4. A71CH development tools type table**

12NC	Type number	Development kit	Description
935368997598	OM3710/A71CHARD	OM3710/A71CHARD	Arduino compatible development kit
935369302598	OM3710/A71CHPCB	OM3710/A71CHPCB	Mini PCB

[Table 5](#) gives an overview of available A71CH product types.

**Table 5. A71CH feature table**

Product type <sup>[1]</sup>	Operational ambient temperature	Interface option
A7101Cgpp(p)	-25 °C to +85 °C	I <sup>2</sup> C
A7102Cgpp(p)	-40 °C to +90 °C	

[1] g = G, C, or A; pp(p) = UA or HN1, according the A71CH type classification see [Section 2.1 "A71CH naming conventions"](#)

#### 5.1.1 Samples and final products

[Section 5.1.2](#), gives details of how to order samples and final products.

### 5.1.2 Ordering A71CH samples

Samples can be ordered from NXP Semiconductors via [nxp.com](http://nxp.com) using the "Buy Direct" button.

Note that NXP Semiconductors can provide up to 5 pieces free of charge. Larger quantities have to be ordered separately.

## 5.2 Configuration

The A71CH is available in configurations as specified in [Table 3](#). The Configuration defines the default memory and key contents. The table below describes the default configuration "customer programmable". Other configurations will be described in addenda to this data sheet.

**Table 6. A71CH type table**

Credential/ State	Amount	Description
Asymmetric Key Pairs	4 x ECDSA NIST P-256 private + public key	Not set, not locked
Asymmetric Public Keys	3 x ECDSA NIST P-256 public keys	Not set, not locked
Config Keys	3 x AES128	Not set, cannot be locked
Symmetric Secret	8 x 128 bit key data	Not set, cannot be locked
Monotonic Counter	2 x upcounting counter with 32 bit	Counter set to 0, cannot be locked
SCP channel	SCP03 keyset with 3 AES128 keys	Keys not set, SCP03 not active
GP Data	128 segments of 32 bytes each	All bytes set to 0x00
Plain Injection Mode		Plain secrets can be inserted
Debug Mode		Debug Mode is active
TransportLock		Module can be set to "LOCKED"

## 6. Marking

**Table 7. Marking codes**

Type number	Marking code
A710x..TK2/...	Line A: 710* (* = '1' for A7101, '2' for A7102, '3' for A7103) Line B: **** (**** = 4 digit Batch code <sup>[1]</sup> ) Line C: ZnD***0 (** = 3 digit Date code <sup>[2]</sup> ) Z: diffusion center, SSMC Systems on Silicon Manufacturing (SSMC), Singapore n: assembly center D: code to indicate conformance to RHF-2006 O: Mask version code

- [1] Batch code: 5 digits available, 2 for DBSN, 2 for ASID: mark "YY ZZ" or 4 digits available, 2 for DBSN, 2 for ASID: mark "YYZZ"

The Assembly Sequence ID (ASID) is a 2-digit indicator that counts the number of assembly batches (transport lots) within one diffusion batch id and one weekly date code. The week start and end dates are defined by the assembly center algorithm. The ASID is assigned sequentially starting with 01 and ranging through 99, then each digit ranges upper case alphabet letters in combination with numeric, then numeric in combination with upper case alphabet letters, then upper case alphabet letters in combination with upper case alphabet letters providing 1175 possible values within a week-code. The numeric zero '0' is only allowed within the sequence of 01 to 99. The alphabet letter 'O' is not allowed to avoid confusion with numeric '0'.

The Diffusion Batch Sequence Number (DBSN) is a 2-digit indicator that counts the number of diffusion batches (DBID) within one Package Type (i.e. HVSON8) and one weekly date code. The DBSN is assigned sequentially starting with 01 and ranging through 99, then each digit ranges upper case alphabet letters in combination with numeric, then numeric in combination with upper case alphabet letters, then upper case alphabet letters in combination with upper case alphabet letters providing 1175 possible values within a week-code. The numeric zero '0' is only allowed within the sequence of 01 to 99. The alphabet letter 'O' is not allowed to avoid confusion with numeric '0'.

- [2] 3 digit Date code: "YWW"

"Y" is a code indicating the year in which the IC is assembled. Examples: for year 1999 is Y = 9, for year 2000 is Y = 0, for year 2001 is Y = 1. "WW" is a code indicating the week in which the IC is assembled. It is determined from the date the assembly transport lot is created or alternately the date die is issued from die stores to assembly start or the date die attach (Diebond) occurs or the date encapsulation occurs.

Examples: for week 01 is WW = 01, for week 52 is WW = 52, for week 53 is WW = 53.

In the case of bumped die (WL-CSP) the code indicates the week in which the IC was bumped.



## 7. Functional description

### 7.1 Functional diagram



Fig 3. A71CH functional diagram - example Open SSL

The A71CH uses I<sup>2</sup>C as communication interface as described in the following section. The A71CH commands are wrapped using the Smartcard I<sup>2</sup> protocol (SCI2C). The detailed documentation for the A71CH commands [ref to APDU Spec] and SCI2C encapsulation (Ref. 3) is available in NXP docstore.”

In order to simplify the product usage a host library was created which takes care for the A71CH commands and SCI2C protocol encapsulation. The host library for various platforms is available for download with complete sources on the A71CH website.

### 7.2 Credential Storage & Memory

The I<sup>2</sup>C interface of the A71CH is supporting a Smart Card I<sup>2</sup>C (SCIIC) Protocol using an Inter-IC (I<sup>2</sup>C) based physical interface and data link layer using Fast-mode (FM) up to 400 kBit/s, a SMBus based network layer and bus protocol as well as a mapping layer to convey [ISO/IEC 7816-4] based communication. This protocol is specified in [Ref to SCI<sup>2</sup>C].

- A71CH is compliant to [Ref. 3](#) and implements the following SCIIC protocol options:
  - Usage of the optional error detection code supported
  - CDBMS\_MAX of 255 and a CDBSM\_MAX of 252
  - Default Frame Waiting Time is 320 ms
  - Protocol binding selection is not supported (not needed as only 7816-4 APDU mapping is supported)
  - The I2C address is 90h (8-bit address) equals 48h (7-bit address) and optional 92h (8-bit address) which equals 49h (7-bit address)

### 7.3 I<sup>2</sup>C Interface

The A71CH has an I<sup>2</sup>C interface in slave mode, supporting data rates up to 400 kbit/s operating in Fast-Mode (FM). The I<sup>2</sup>C interface is using the Smartcard I<sup>2</sup>C protocol as defined in [Ref. 3](#) which is based on SMBus. The default I<sup>2</sup>C address after power-on-reset depends on the bootup condition as shown in [Table 8](#).

### 7.4 Automatic Communication Mode detection at Power on

The IC configures its interface according to the pin state as shown in the table below. The host system must keep the voltage levels stable at these pins for at least 500  $\mu$ s after power-on-reset.

**Table 8.** I<sup>2</sup>C address

IF0	Value at startup			I <sup>2</sup> C address	
	IF1	I2C_SCL	I2C_SDA	Write	Read
0	x	0	0	n.a.	n.a.
1	0	1	1	0x90	0x91
1	1	1	1	0x92	0x93

### 7.5 Power-saving modes

The device provides two power-saving operation modes, the SLEEP mode and the DEEP SLEEP mode. These modes are activated via pad RST\_N (DEEP SLEEP mode) or by the device.

#### 7.5.1 SLEEP mode

The SLEEP mode has the following properties:

- all internal clocks are frozen,
- CPU enters power saving mode with program execution being stopped,
- CPU registers keep their contents,
- RAM keeps its contents,

The A71CH enters automatically into SLEEP mode after 312 ms of inactivity on the I<sup>2</sup>C lines and also wakes up automatically from SLEEP mode. In SLEEP mode, all internal clocks are stopped. The IOs hold the logical states they had at the time IDLE was activated. During SLEEP mode security sensors HVS, LVS, LTS, HTS, Light Sensors, Glitch Sensors and Active Shielding are disabled.

There are two ways to exit from the SLEEP mode:

- A reset signal on RST\_N
- An External Interrupt edge triggered by a falling edge on I2C\_SDA

### 7.5.2 DEEP SLEEP mode

The A71CHx provides a special sleep mode offering maximum power saving. It is reached by pulling RST\_N to a logic zero level for more than 500  $\mu$ s.

While in deep sleep mode the internal power is completely switched off and only the IO pads stay supplied. All digital pads will stay in high-Z mode.

To leave the DEEP SLEEP mode RST\_N has to be released and set to a logic „1“ level.

## 8. Pinning information

### 8.1 Pinning

#### 8.1.1 Pinning HVSON8

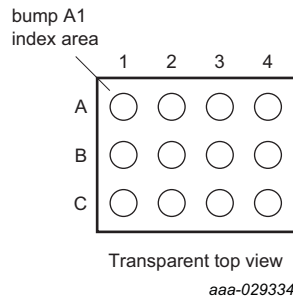


**Table 9. Pin description HVSON8**

Symbol	Pin	Description
I2C_SCL	1	I <sup>2</sup> C clock
VSS	2	ground
IF0	3	interface activation, apply high on startup
n.c.	4	not connected
IF1	5	I <sup>2</sup> C address selection
RST_N	6	reset input, active LOW
VCC	7	power supply voltage input
I2C_SDA	8	I <sup>2</sup> C data

The center pad of the IC is not connected, although it is recommended to connect it to ground for thermal reasons.

8.1.2 Pinning WLCSP



	1	2	3	4
A	n.c.	VSS	I2C_SCL	I2C_SDA
B	n.c.	VCC	n.c.	IF1
C	n.c.	i.c.	RST_N	IF0

Transparent top view aaa-029335

Fig 5. Pin configuration for WLCSP12

Fig 6. Ball mapping for WLCSP12

Table 10. Pin description WLCSP

Symbol	Pin	Description
n.c.	A1	not connected
VSS	A2	ground
I2C_SCL	A3	I <sup>2</sup> C Clock
I2C_SDA	A4	I <sup>2</sup> C Data
n.c.	B1	not connected
VCC	B2	Power supply voltage input
n.c.	B3	not connected
IF1	B4	I <sup>2</sup> C address selection
n.c.	C1	not connected
i.c.	C2	internally connected; connect to ground
RST_N	C3	Reset input, active LOW
IF0	C4	interface activation, apply high on startup

The pins/balls A1, B1, C1, and B3 are not connected internally. These pins/balls can be used for routing to connect to B2 (VCC) in order to have an easier PCB layout.

9. Package outline

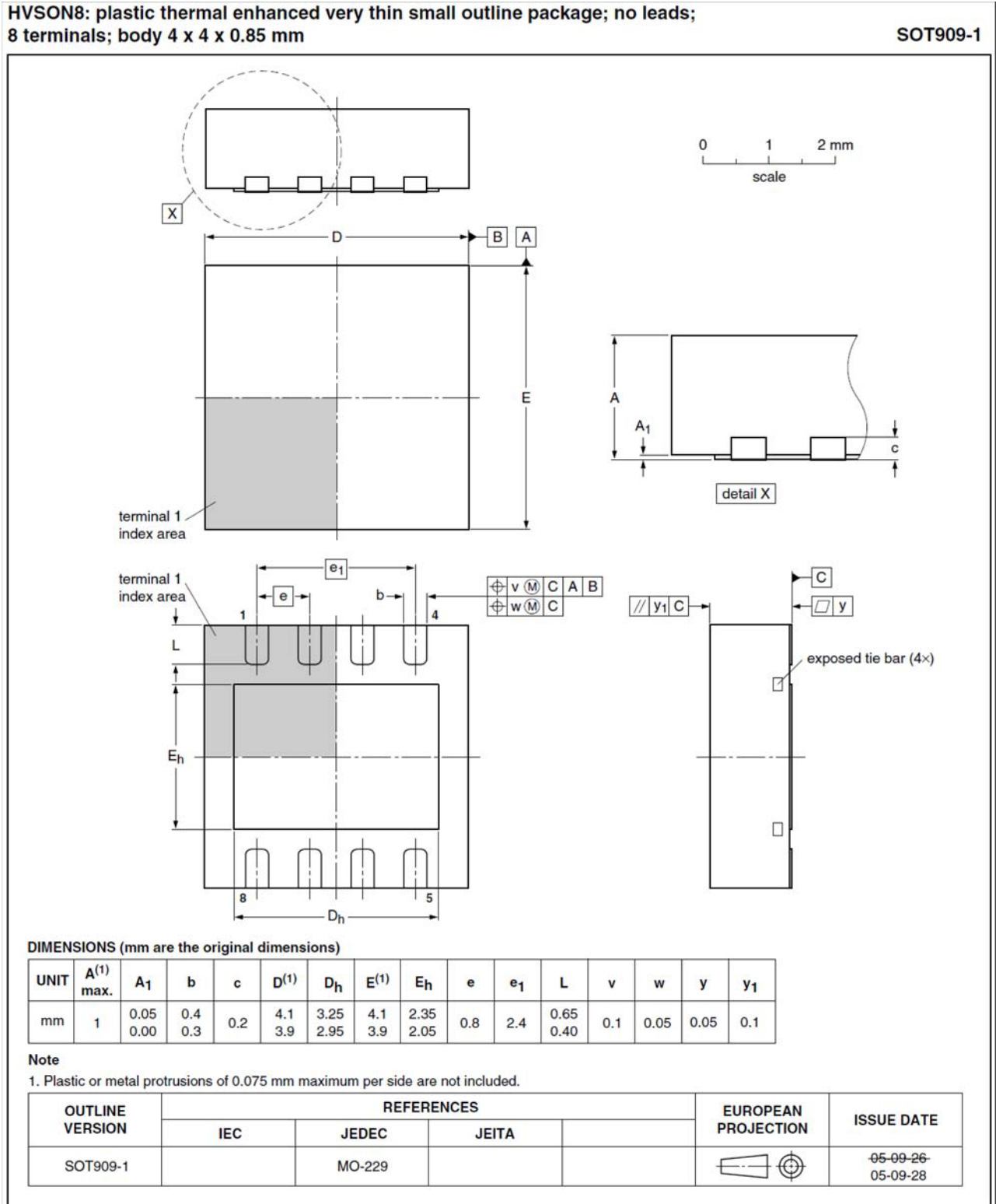


Fig 7. Package outline SOT909-1

WLCSP12 : wafer level chip-size package, 12 bumps, 2.06x2.018x0.6 mm

A7101

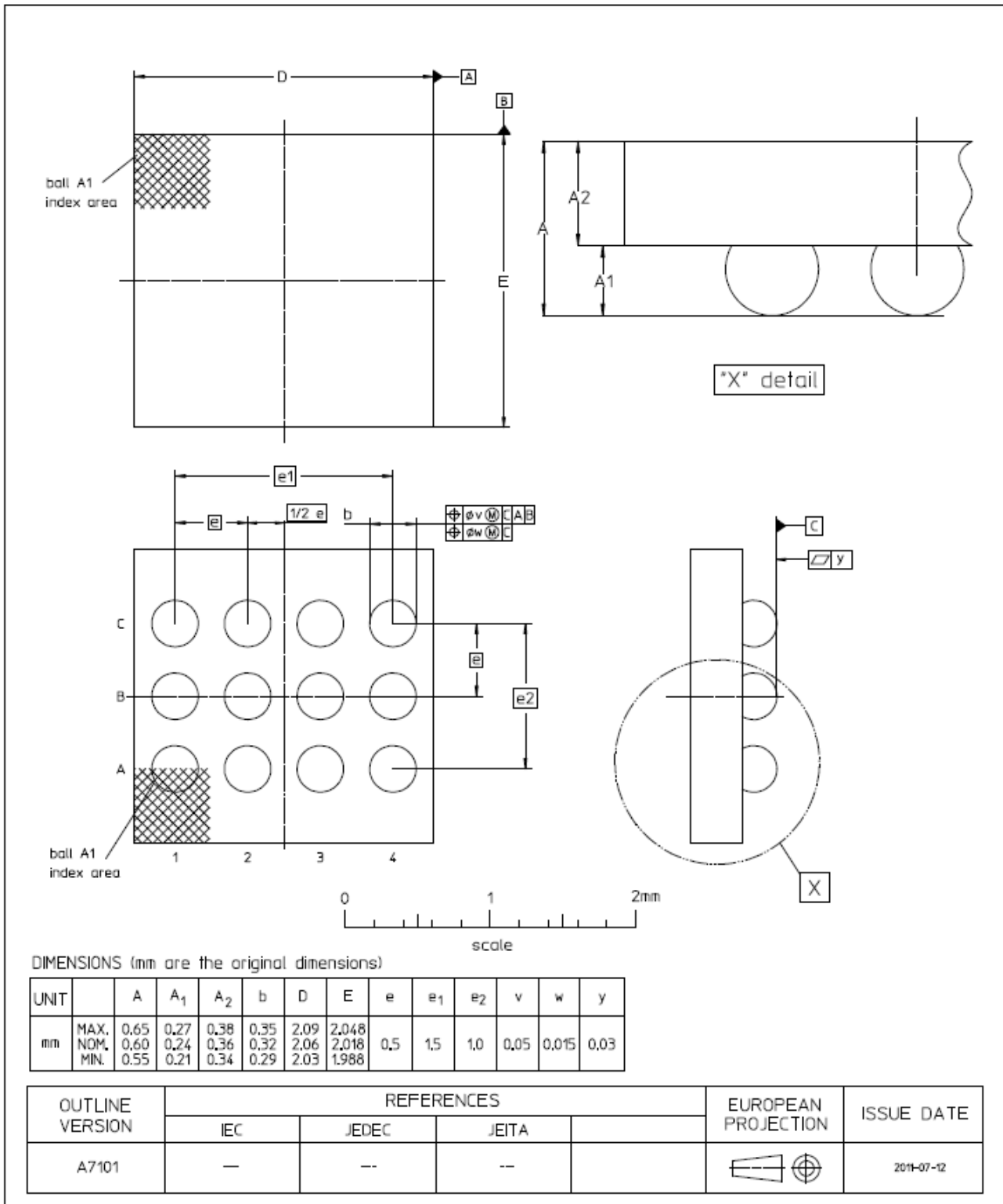


Fig 8. Package outline WLCSP12

## 10. Packing information

### 10.1 Reel packing

The A71CH product is available on 7" tape on reel and 13" tape on reel. Details are provided in [Table 11](#).

**Table 11. Reel packing options**

Package type	Reel type	Minimum packing quantity
HVSON8	7" tape on reel	1500
HVSON8	13" tape on reel <sup>[1]</sup>	6000
WLCSP12	7" tape on reel	3000

[1] For details about packing method, product orientation, tape dimensions and labeling for A71 parts in HVSON8 package having an ordering code (12NC) ending 118 refer to [Ref. 2](#).

## 11. Electrical and timing characteristics

The electrical interface characteristics of static (DC) and dynamic (AC) parameters for pads and functions used for I<sup>2</sup>C are in accordance with the NXP I<sup>2</sup>C specification (see [Ref. 1](#)).

## 12. Limiting values

**Table 12. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to VSS (ground = 0 V).*

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>DD</sub>	supply voltage		-0.3	+4.6	V
V <sub>I</sub>	input voltage	any signal pad	-0.3	+4.6	V
I <sub>I</sub>	input current	pad I2C_SDA, I2C_SCL	-	10	mA
I <sub>O</sub>	output current	pad I2C_SDA, I2C_SCL	-	10	mA
I <sub>lu</sub>	latch-up current	V <sub>I</sub> < 0 V or V <sub>I</sub> > V <sub>DD</sub>	-	100	mA
V <sub>esd_hbm</sub>	electrostatic discharge voltage (Human Body Model)	pads VCC, VSS, RST_N, I2C_SDA, I2C_SCL	<sup>[1]</sup>	± 2.0	kV
V <sub>esd_cdm</sub>	electrostatic discharge voltage (Charge Device Model)	pads VCC, VSS, RST_N, I2C_SDA, I2C_SCL	<sup>[3]</sup>	± 500	V
P <sub>tot</sub>	Total power dissipation		<sup>[2]</sup>	1	W
T <sub>stg</sub>	Storage temperature		-55	+125	°C

[1] MIL Standard 883-D method 3015; human body model; C = 100 pF, R = 1.5 kΩ; T<sub>amb</sub> = -25 °C to +85 °C.

[2] Depending on appropriate thermal resistance of the package.

[3] JESD22-C101, JEDEC Standard Field induced charge device model test method.



### 13. Recommended operating conditions

The A71CH offers two operation modes, the so-called 1V8 mode and the 3V3 mode targeted for battery supplied applications.

**Table 13. Recommended operating conditions**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>DD</sub>	supply voltage range	3V3 mode range CPU in free runing mode	2.50	3.3	3.6	V
		1V8 mode	1.62	1.8	1.98	V
V <sub>I</sub>	DC input voltage on digital I/O pads I2C_SCL, I2C_SDA	3V3 mode	0		3.6	V
		1V8 mode	0		3.6	V
V <sub>I</sub>	DC input voltage on digital input pad RST_N	3V3 mode	0		3.6	V
		1V8 mode	0		3.6	V
T <sub>amb</sub>	Operating ambient temperature	A7101	-25		+85	°C
		A7102	-40		+90	°C



## 14. Characteristics

### 14.1 DC characteristics

#### Measurement conventions

Testing measurements are performed at the contact pads of the device under test. All voltages are defined with respect to the ground contact pad VSS. All currents flowing into the device are considered positive.

#### 14.1.1 General and I<sup>2</sup>C I/O interface

Table 14. Electrical DC characteristics of I2C\_SCL, I2C\_SDA and RST\_N

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Input/Output: I2C_SCL, I2C_SDA in push-pull mode</b>						
V <sub>IH</sub>	HIGH level input voltage		0.7 V <sub>DD</sub>		V <sub>Imax</sub> <sup>[1]</sup>	V
V <sub>IL</sub>	LOW level input voltage		-0.5		0.3 V <sub>DD</sub>	V
I <sub>IH</sub>	HIGH level input current in input mode	V <sub>IHmin</sub> < V <sub>I</sub> < V <sub>IHmax</sub>			± 10	μA
I <sub>IL</sub>	LOW level input current	V <sub>ILmin</sub> < V <sub>I</sub> < V <sub>ILmax</sub>			± 10	μA
V <sub>OH</sub>	HIGH level output voltage	I <sub>OH</sub> = -3.0 mA; 3V3 mode	<sup>[2]</sup>	0.7 V <sub>DD</sub>		V
		I <sub>OH</sub> = -3.0 mA; 1V8 mode	<sup>[2]</sup>	0.7 V <sub>DD</sub>		V
V <sub>OL</sub>	LOW level output voltage	I <sub>OL</sub> = 3.0 mA 3V3 mode			0.4	V
		I <sub>OL</sub> = 2.0 mA 1V8 mode			0.2 V <sub>DD</sub>	V
<b>Input/Output: I2C_SCL, I2C_SDA in open-drain mode</b>						
V <sub>IH</sub>	HIGH level input voltage		0.7 V <sub>DD</sub>		V <sub>Imax</sub> <sup>[1]</sup>	V
V <sub>IL</sub>	LOW level input voltage		-0.5		0.3 V <sub>DD</sub>	V
I <sub>IH</sub>	HIGH level input current in input mode	V <sub>IHmin</sub> < V <sub>I</sub> < V <sub>IHmax</sub>			± 10	μA
I <sub>IL</sub>	LOW level input current	V <sub>ILmin</sub> < V <sub>I</sub> < V <sub>ILmax</sub>			± 10	μA
V <sub>OL</sub>	LOW level output voltage	I <sub>OL</sub> = 3.0 mA 3V3 mode			0.4	V
		I <sub>OL</sub> = 2.0 mA 1V8 mode			0.2 V <sub>DD</sub>	V
<b>Input: RST_N</b>						
V <sub>IH1</sub>	HIGH level input voltage		0.7 V <sub>DD</sub>		V <sub>Imax</sub> <sup>[1]</sup>	V
V <sub>IL1</sub>	LOW level input voltage		-0.3		0.3 V <sub>DD</sub>	V
I <sub>IH1</sub>	HIGH level RST_N input current	V <sub>IH1min</sub> ≤ V <sub>I</sub> ≤ V <sub>DD</sub>	<sup>[3]</sup>		± 20	μA
I <sub>IL1</sub>	LOW level RST_N input current	0 V ≤ V <sub>I</sub> ≤ V <sub>IL1max</sub>	<sup>[3]</sup>		± 20	μA

[1] Maximum value according to [Table 13 "Recommended operating conditions"](#)

- [2] : External pull-up resistor 20 kΩ to VDD. The worst case test condition for parameter  $V_{OH}$  is present at minimum  $V_{DD}$ . For class A supply voltage conditions  $V_{DD} = 4.5\text{ V}$  is the worst case with respect to the fix specification limit  $V_{OHmin} = 3.8\text{ V}$  ( $0.844 V_{DD}$ ). The supply voltage related limit “ $0.7 V_{DD}$ ” is a stricter requirement than the fix value 3.8 V at high  $V_{DD}$  ( $0.7 V_{DD} = 3.85\text{ V}$  at  $V_{DD} = 5.5\text{ V}$ ). So, in the  $V_{DD}$  range 4.5 V to 5.5 V,  $V_{OHmin}$  is specified as “the larger value of  $0.7 V_{DD}$  and 3.8 V, respectively”.
- [3] The active low RST\_N input internally has a resistive pull-down device to VSS. Accordingly a current is flowing into the pad voltages above 0 V. [Figure 10](#) shows the RST\_N input characteristic.

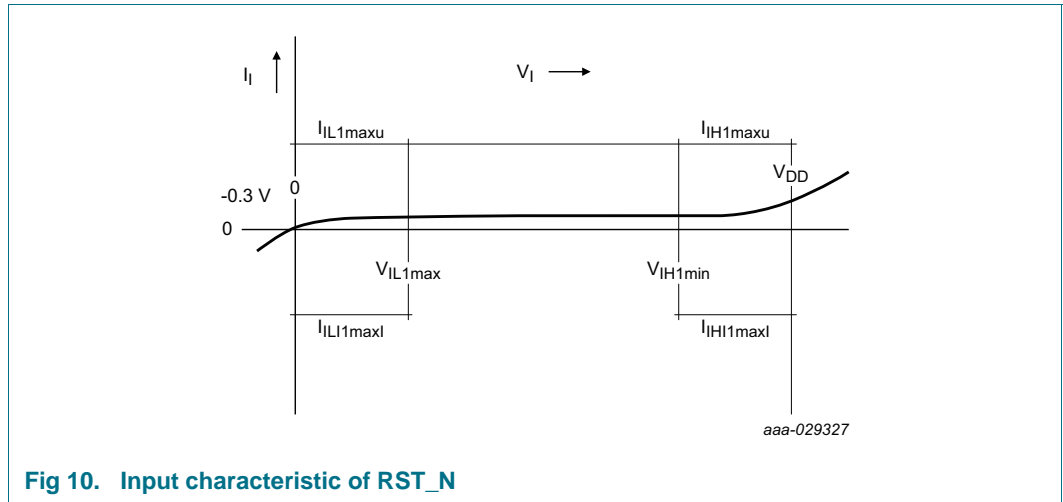


Fig 10. Input characteristic of RST\_N

14.1.2 I<sup>2</sup>C interface at 3V3 mode operation<sup>[1]</sup>Table 15. Electrical characteristics of IC supply voltage V<sub>DD</sub>; V<sub>SS</sub> = 0 V; T<sub>amb</sub> = -40 to +90 °C

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Supply</b>						
V <sub>DD</sub>	supply voltage range	3V3 mode range CPU in free running mode	2.50	3.3	3.6	V
I <sub>DD</sub>	no coprocessor active	CPU in free running mode		6.3	7.0	mA
	EPROM programming in progress	CPU in free running mode		7.3	8.0	mA
	AES coprocessor active	CPU in free running mode		9.3	10.3	mA
	ECC coprocessor active	CPU in free running mode		13.7	15.1	mA
I <sub>DD(SLP)</sub>	supply current SLEEP mode	T <sub>amb</sub> = 25 °C		45	150	μA
I <sub>DD(DSLP)</sub>	supply current deep sleep mode	RST_N at 0V, T <sub>amb</sub> = 25 °C			10	μA
		RST_N at 0V, T <sub>amb</sub> = 90 °C			10	μA

[1] All appropriately marked values are typical values and only referenced for information. They are subject to change without notice.

### 14.1.3 I<sup>2</sup>C interface at 1V8 mode operation<sup>[1]</sup>

**Table 16. Electrical characteristics of IC supply voltage V<sub>DD</sub>; V<sub>SS</sub> = 0 V; T<sub>amb</sub> = -40 to +90 °C**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Supply</b>						
V <sub>DD</sub>	supply voltage range	1V8 mode range	1.62	1.8	1.98	V
I <sub>DD</sub>	no coprocessor active	CPU in free running mode		2.45		mA
	AES coprocessor active	CPU in free running mode		2.7		mA
	ECC coprocessor active	CPU in free running mode		7.5		mA
I <sub>DD(SLP)</sub>	supply current SLEEP mode	T <sub>amb</sub> = 25 °C		40	80	µA
I <sub>DD(DSLP)</sub>	supply current deep sleep mode	RST_N at 0V, T <sub>amb</sub> = 25 °C			10	µA
		RST_N at 0V, T <sub>amb</sub> = 90 °C			10	µA

[1] All appropriately marked values are typical values and only referenced for information. They are subject to change without notice.

## 14.2 AC characteristics

**Table 17. Non-volatile memory timing characteristics; V<sub>DD</sub> = 1.8 V ± 10% or 3 V ± 10% V; V<sub>SS</sub> = 0 V; T<sub>amb</sub> = -40 to 90 °C**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t <sub>EEP</sub>	EEPROM erase + program time			2.7		ms
t <sub>EEE</sub>	EEPROM erase time			1.7		ms
t <sub>EEW</sub>	EEPROM program time			1.0		ms
t <sub>EEER</sub>	EEPROM data retention time	T <sub>amb</sub> = +55 °C	25			years
N <sub>EEC</sub>	EEPROM endurance (number of programming cycles)		5 × 10 <sup>5</sup>			cycles

**Table 18. Electrical AC characteristics of I2C\_SDA, I2C\_SCL, and RST\_N<sup>[1]</sup>; V<sub>DD</sub> = 1.8 V ± 10% or 3 V ± 10% V; V<sub>SS</sub> = 0 V; T<sub>amb</sub> = -40 to 90 °C**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Input/Output: I2C_SDA, I2C_SCL in open-drain mode</b>						
t <sub>rIO</sub>	I/O Input rise time	Input/reception mode <sup>[4]</sup>			1	µs
t <sub>fIO</sub>	I/O Input fall time	Input/reception mode <sup>[4]</sup>			1	µs
t <sub>fOIO</sub>	I/O Output fall time	Output/transmission mode; C <sub>L</sub> = 30 pF <sup>[4]</sup>			0.3	µs
f <sub>CLK</sub>	External clock frequency in I <sup>2</sup> C applications	t <sub>CLKW</sub> , T <sub>amb</sub> and V <sub>DD</sub> in their spec'd limits	-		400	kHz
t <sub>CLKW</sub>	Clock pulse width i.r.t. clock period (positive pulse duty cycle of CLK)	<sup>[3]</sup>	40		60	%
<b>Inputs: RST_N</b>						
t <sub>RW</sub>	Reset pulse width (RST_N low) without entering deep sleep mode		40		400	µs
t <sub>RDSLP</sub>	Reset pulse width (RST_N low) to enter deep sleep mode		500			µs
t <sub>WKP</sub>	Wake-up time from SLEEP mode	f <sub>CLKmin</sub> < f <sub>CLK</sub> < f <sub>CLKmax</sub>	-	8	10	µs

**Table 18. Electrical AC characteristics of I2C\_SDA, I2C\_SCL, and RST\_N<sup>[1]</sup>;**  
 $V_{DD} = 1.8\text{ V} \pm 10\%$  or  $3\text{ V} \pm 10\%$  V;  $V_{SS} = 0\text{ V}$ ;  $T_{amb} = -40\text{ to }90\text{ }^{\circ}\text{C}$

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$t_{WKPIO}$	Pad LOW time for wake-up from SLEEP mode	level triggered ext.int.	-	8	10	$\mu\text{s}$
		edge triggered ext.int.	-	8	10	$\mu\text{s}$
$t_{WKPRST}$	RST_N LOW time for wake-up from SLEEP mode		40		-	$\mu\text{s}$
$t_{WKWT}$	Time from SLEEP mode wake/up event to I2C_SDA valid			50	100	ns
$C_{PIN}$	Pin capacitances RST_N, I2C_SDA, /I2C_SCL	Test frequency = 1 MHz; $T_{amb} = 25\text{ }^{\circ}\text{C}$	-		10	pF

- [1] All appropriately marked values are typical values and only referenced for information. They are subject to change without notice.
- [2]  $t_r$  is defined as rise time between 20% and 80% of the signal amplitude.  
 $t_f$  is defined as fall time between 80% and 20% of the signal amplitude.
- [3] During AC testing the inputs RST\_N, I2C\_SDA, I2C\_SCL are driven at 0 V to +0.3 V for a LOW input level and at  $V_{DD} - 0.3\text{ V}$  to  $V_{DD}$  for a HIGH input level. Clock period and signal pulse (duty cycle) timing is measured at 50% of  $V_{DD}$ .
- [4]  $t_r$  is defined as rise time between 30% and 70% of the signal amplitude.  
 $t_f$  is defined as fall time between 70% and 30% of the signal amplitude.



### 14.3 EMC/EMI

EMC and EMI resistance according to IEC 61967-4.

## 15. Abbreviations

**Table 19. Abbreviations**

<b>Acronym</b>	<b>Description</b>
AES	Advanced Encryption Standard
CRC	Cyclic Redundancy Check
DES	Digital Encryption Standard
DPA	Differential Power Analysis
DSS	Digital Signature Standard
ECC	Elliptic Curve Cryptography
EEPROM	Electrically Erasable Programmable Read-Only Memory
I/O	Input/Output
MAC	Message Authentication Code
OS	Operating System
PKI	Public Key Infrastructure
SFI	Single Fault Injection
SHA	Secure Hash Algorithm

## 16. References

---

- [1] I<sup>2</sup>C-bus specification and user manual, Rev. 3.0 — June-19-2007, NXP Semiconductors
- [2] SOT909-1; HVSON8; Reel pack; Ordering code (12NC) ending 118; Packing Information; Rev. 2 — 19 April 2013
- [3] Application note SCIIC Protocol Specification, Application note, Rev 1.x, AN12207 (document number an19501x)



## 17. Revision history

**Table 20. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
449312	20180927	Data sheet		449311
Modifications:				
			<ul style="list-style-type: none"> <li>• <a href="#">Table 1 "A71CH commercial name format"</a>: Added WLCSP</li> <li>• <a href="#">Table 3 "A71CH type table"</a>: Updated</li> <li>• <a href="#">Section 3.4 "Functional features"</a>: Added WLCSP</li> <li>• <a href="#">Section 8.1.1 "Pinning HVSON8"</a>: Added paragraph</li> <li>• <a href="#">Section 8.1.2 "Pinning WLCSP"</a>: Added section</li> <li>• <a href="#">Figure 5 "Pin configuration for WLCSP12"</a>: Added pin configuration</li> <li>• <a href="#">Figure 6 "Ball mapping for WLCSP12"</a>: Updated</li> <li>• <a href="#">Table 10 "Pin description WLCSP"</a>: Updated</li> <li>• <a href="#">Table 11 "Reel packing options"</a>: Added WLCSP</li> </ul>	
449311	20180801	Data sheet		449310
449310	20180221	Objective short data sheet		
Modifications:				
			<ul style="list-style-type: none"> <li>• Initial version</li> </ul>	

## 18. Legal information

### 18.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

### 18.2 Definitions

**Draft** — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

**Short data sheet** — A short data sheet is an extract from a full data sheet with the same product type number(s) and title. A short data sheet is intended for quick reference only and should not be relied upon to contain detailed and full information. For detailed and full information see the relevant full data sheet, which is available on request via the local NXP Semiconductors sales office. In case of any inconsistency or conflict with the short data sheet, the full data sheet shall prevail.

**Product specification** — The information and data provided in a Product data sheet shall define the specification of the product as agreed between NXP Semiconductors and its customer, unless NXP Semiconductors and customer have explicitly agreed otherwise in writing. In no event however, shall an agreement be valid in which the NXP Semiconductors product is deemed to offer functions and qualities beyond those described in the Product data sheet.

### 18.3 Disclaimers

**Limited warranty and liability** — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of NXP Semiconductors.

**Right to make changes** — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

**Suitability for use** — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

**Applications** — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

**Limiting values** — Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and (proper) operation of the device at these or any other conditions above those given in the Recommended operating conditions section (if present) or the Characteristics sections of this document is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

**Terms and conditions of commercial sale** — NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at <http://www.nxp.com/profile/terms>, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

**No offer to sell or license** — Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

**Export control** — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

**Quick reference data** — The Quick reference data is an extract of the product data given in the Limiting values and Characteristics sections of this document, and as such is not complete, exhaustive or legally binding.

**Non-automotive qualified products** — Unless this data sheet expressly states that this specific NXP Semiconductors product is automotive qualified, the product is not suitable for automotive use. It is neither qualified nor tested in accordance with automotive testing or application requirements. NXP Semiconductors accepts no liability for inclusion and/or use of non-automotive qualified products in automotive equipment or applications.

In the event that customer uses the product for design-in and use in automotive applications to automotive specifications and standards, customer (a) shall use the product without NXP Semiconductors' warranty of the product for such automotive applications, use and specifications, and (b) whenever customer uses the product for automotive applications beyond NXP Semiconductors' specifications such use shall be solely at customer's own risk, and (c) customer fully indemnifies NXP Semiconductors for any liability, damages or failed product claims resulting from customer design and use of the product for automotive applications beyond NXP Semiconductors' standard warranty and NXP Semiconductors' product specifications.

**Translations** — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

## 18.4 Licenses

### ICs with DPA Countermeasures functionality



NXP ICs containing functionality implementing countermeasures to Differential Power Analysis and Simple Power Analysis are produced and sold under applicable license from Cryptography Research, Inc.



## 18.5 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

**FabKey** — is a trademark of NXP B.V.

**I<sup>2</sup>C-bus** — logo is a trademark of NXP B.V.

## 19. Contact information

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

**20. Tables**

Table 1. A71CH commercial name format . . . . .	2	I2C_SDA and RST_N . . . . .	18
Table 2. Ordering information . . . . .	6	Table 15. Electrical characteristics of IC supply voltage $V_{DD}$ ; $V_{SS} = 0\text{ V}$ ; $T_{amb} = -40\text{ to }+90\text{ }^{\circ}\text{C}$ . . . . .	20
Table 3. A71CH type table . . . . .	6	Table 16. Electrical characteristics of IC supply voltage $V_{DD}$ ; $V_{SS} = 0\text{ V}$ ; $T_{amb} = -40\text{ to }+90\text{ }^{\circ}\text{C}$ . . . . .	21
Table 4. A71CH development tools type table . . . . .	6	Table 17. Non-volatile memory timing characteristics; $V_{DD} = 1.8\text{ V} \pm 10\%$ or $3\text{ V} \pm 10\%$ ; $V_{SS} = 0\text{ V}$ ; $T_{amb} = -40\text{ to }90\text{ }^{\circ}\text{C}$ . . . . .	21
Table 5. A71CH feature table . . . . .	6	Table 18. Electrical AC characteristics of I2C_SDA, I2C_SCL, and RST_N[1]; $V_{DD} = 1.8\text{ V} \pm 10\%$ or $3\text{ V} \pm 10\%$ ; $V_{SS} = 0\text{ V}$ ; $T_{amb} = -40\text{ to }90\text{ }^{\circ}\text{C}$ . . . . .	21
Table 6. A71CH type table . . . . .	7	Table 19. Abbreviations . . . . .	23
Table 7. Marking codes . . . . .	8	Table 20. Revision history . . . . .	25
Table 8. I <sup>2</sup> C address . . . . .	10		
Table 9. Pin description HVSON8 . . . . .	12		
Table 10. Pin description WLCSP . . . . .	13		
Table 11. Reel packing options . . . . .	16		
Table 12. Limiting values . . . . .	16		
Table 13. Recommended operating conditions . . . . .	17		
Table 14. Electrical DC characteristics of I2C_SCL,			

**21. Figures**

Fig 1. A71CH block diagram . . . . .	1	Fig 8. Package outline WLCSP12 . . . . .	15
Fig 2. Protected key storage & provisioning of credentials 4		Fig 9. Recommended operating conditions over voltage range . . . . .	17
Fig 3. A71CH functional diagram - example Open SSL . . . . .	9	Fig 10. Input characteristic of RST_N . . . . .	19
Fig 4. Pin configuration for HVSON-8 (SOT909-1) . . . . .	12	Fig 11. External clock drive and AC test timing reference points of I2C_SDA, I2C_SCL, and RST_N (see <a href="#">Table note [3]</a> and <a href="#">Table note [4]</a> ) in open drain mode . . . . .	22
Fig 5. Pin configuration for WLCSP12 . . . . .	13		
Fig 6. Ball mapping for WLCSP12 . . . . .	13		
Fig 7. Package outline SOT909-1 . . . . .	14		

**22. Contents**

<b>1</b>	<b>Introduction . . . . .</b>	<b>1</b>	<b>6</b>	<b>Marking . . . . .</b>	<b>8</b>
<b>2</b>	<b>General description . . . . .</b>	<b>2</b>	<b>7</b>	<b>Functional description . . . . .</b>	<b>9</b>
2.1	A71CH naming conventions . . . . .	2	7.1	Functional diagram . . . . .	9
2.2	I <sup>2</sup> C interface . . . . .	2	7.2	Credential Storage & Memory . . . . .	9
2.3	Security licensing . . . . .	2	7.3	I <sup>2</sup> C Interface . . . . .	10
<b>3</b>	<b>Features and benefits . . . . .</b>	<b>3</b>	7.4	Automatic Communication Mode detection at Power on . . . . .	10
3.1	Key benefits . . . . .	3	7.5	Power-saving modes . . . . .	10
3.2	Security features . . . . .	3	7.5.1	SLEEP mode . . . . .	10
3.3	Cryptography features . . . . .	3	7.5.2	DEEP SLEEP mode . . . . .	11
3.4	Functional features . . . . .	4	<b>8</b>	<b>Pinning information . . . . .</b>	<b>12</b>
<b>4</b>	<b>Applications . . . . .</b>	<b>5</b>	8.1	Pinning . . . . .	12
4.1	Use Cases and target applications . . . . .	5	8.1.1	Pinning HVSON8 . . . . .	12
<b>5</b>	<b>Ordering information . . . . .</b>	<b>6</b>	8.1.2	Pinning WLCSP . . . . .	13
5.1	Ordering options . . . . .	6	<b>9</b>	<b>Package outline . . . . .</b>	<b>14</b>
5.1.1	Samples and final products . . . . .	6	<b>10</b>	<b>Packing information . . . . .</b>	<b>16</b>
5.1.2	Ordering A71CH samples . . . . .	7	10.1	Reel packing . . . . .	16
5.2	Configuration . . . . .	7			

continued >>

<b>11</b>	<b>Electrical and timing characteristics . . . . .</b>	<b>16</b>
<b>12</b>	<b>Limiting values . . . . .</b>	<b>16</b>
<b>13</b>	<b>Recommended operating conditions . . . . .</b>	<b>17</b>
<b>14</b>	<b>Characteristics . . . . .</b>	<b>18</b>
14.1	DC characteristics . . . . .	18
14.1.1	General and I2C I/O interface . . . . .	18
14.1.2	I2C interface at 3V3 mode operation <sup>[1]</sup> . . . . .	20
14.1.3	I2C interface at 1V8 mode operation <sup>[1]</sup> . . . . .	21
14.2	AC characteristics . . . . .	21
14.3	EMC/EMI . . . . .	22
<b>15</b>	<b>Abbreviations . . . . .</b>	<b>23</b>
<b>16</b>	<b>References . . . . .</b>	<b>24</b>
<b>17</b>	<b>Revision history . . . . .</b>	<b>25</b>
<b>18</b>	<b>Legal information . . . . .</b>	<b>26</b>
18.1	Data sheet status . . . . .	26
18.2	Definitions . . . . .	26
18.3	Disclaimers . . . . .	26
18.4	Licenses . . . . .	27
18.5	Trademarks . . . . .	27
<b>19</b>	<b>Contact information . . . . .</b>	<b>27</b>
<b>20</b>	<b>Tables . . . . .</b>	<b>28</b>
<b>21</b>	<b>Figures . . . . .</b>	<b>28</b>
<b>22</b>	<b>Contents . . . . .</b>	<b>28</b>

---

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

---

© NXP B.V. 2018.

All rights reserved.

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

Date of release: 27 September 2018

449312