

# SL2S1412; SL2S1512; SL2S1612

ICODE ILT-M

Rev. 3.0 — 2 May 2012  
230330

Product short data sheet  
COMPANY PUBLIC

## 1. General description

---

The ISO 18000-3 mode 3/EPC Class-1 HF standard allows the commercialized provision of mass adoption of HF RFID technology for passive smart tags and labels. Main fields of applications are supply chain management and logistics for worldwide use.

The ICODE ILT-M is a dedicated chip for passive, intelligent tags and labels supporting the ISO 18000-3 mode 3 RFID standard. It is especially suited for applications where reliable identification and high anti-collision rates are required.

The ICODE ILT-M is a product out of the NXP Semiconductors ICODE product family. The entire ICODE product family offers anti-collision functionality. This allows a reader to simultaneously operate multiple labels/tags within its antenna field. A ICODE ILT-M based label/tag requires no external power supply.

Its contactless interface generates the power supply via the antenna circuit by inductive energy transmission from the interrogator (reader), while the system clock is extracted from the magnetic field. Data transmitted from interrogator to label/tag is demodulated by the interface, and it also modulates the interrogator's magnetic field for data transmission from label/tag to interrogator. A label/tag can be operated without the need for line of sight or battery, as long as it is connected to a dedicated antenna for the targeted frequency range. When the label/tag is within the interrogator's operating range, the high-speed wireless interface allows data transmission in both directions.

## 2. Features and benefits

---

### 2.1 Key features

- 512-bit user memory
- Up to 240-bit of EPC memory
- 96-bit tag identifier (TID) including 48-bit unique serial number
- EAS (Electronic Article Surveillance) functionality
- Recommissioning feature (privacy) with 32-bit kill password
- 32-bit access password to allow a transition into the secured state
- Long read/write ranges due to extremely low-power design
- Reliable operation of multiple tags due to advanced anti-collision (up to 800 tags/s)
- Fast initialization (write EPC)
- Forward link: 25 kbit/s to 100 kbit/s
- Return link: 53 kbit/s to 848 kbit/s



## 2.2 Key benefits

- High sensitivity provides long read range
- Highly advanced anti-collision resulting in highest identification speed
- Reliable and robust RFID technology suitable noisy environments and dense label populations

## 2.3 Custom features

- EAS  
Enables the HF RFID tag to be used as EAS tag without the need for a backend data base.

## 3. Applications

- Healthcare and pharmaceutical supply chain
- Medical lab automation
- Document tracking
- Casino chips
- Laundry automation

## 4. Quick reference data

**Table 1. Quick reference data**

Typical ratings are not guaranteed. The values listed are at room temperature.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$t_{ret}$	retention time	$T_{amb} \leq 55\text{ }^{\circ}\text{C}$	50	-	-	year
$N_{endu(W)}$	write endurance		100000	-	-	cycle
$f_i$	input frequency		[1] 13.553	13.56	13.567	MHz
$V_{i(RMS)min}$	minimum RMS input voltage	operating read/write	1.5	-	1.7	V
$P_{i(min)}$	minimum input power	operating	[2] -	40	-	$\mu\text{W}$
$C_i$	input capacitance	between LA and LB	[3]			
		SL2S1412FUD	-	-	-	pF
		SL2S1512FUD	22.3	23.5	24.7	pF
		SL2S1612FUD	92	97	102	pF

[1] Bandwidth limitation ( $\pm 7$  kHz) according to ISM band regulations.

[2] Including losses in the resonant capacitor and rectifier.

[3] Measured with an HP4285A LCR meter at 13.56 MHz and 2 V RMS.

## 5. Ordering information

Table 2. Ordering information

Type number	Package		Version
	Name	Description	
SL2S1412FUD	Wafer	sawn, bumped wafer, 120 $\mu\text{m}$ , on film frame carrier, - C <sub>i</sub> between LA and LB = 0 pF (typical)	
SL2S1512FUD	Wafer	sawn, bumped wafer, 120 $\mu\text{m}$ , on film frame carrier, - C <sub>i</sub> between LA and LB = 23.5 pF (typical)	
SL2S1612FUD	Wafer	sawn, bumped wafer, 120 $\mu\text{m}$ , on film frame carrier, - C <sub>i</sub> between LA and LB = 97 pF (typical)	

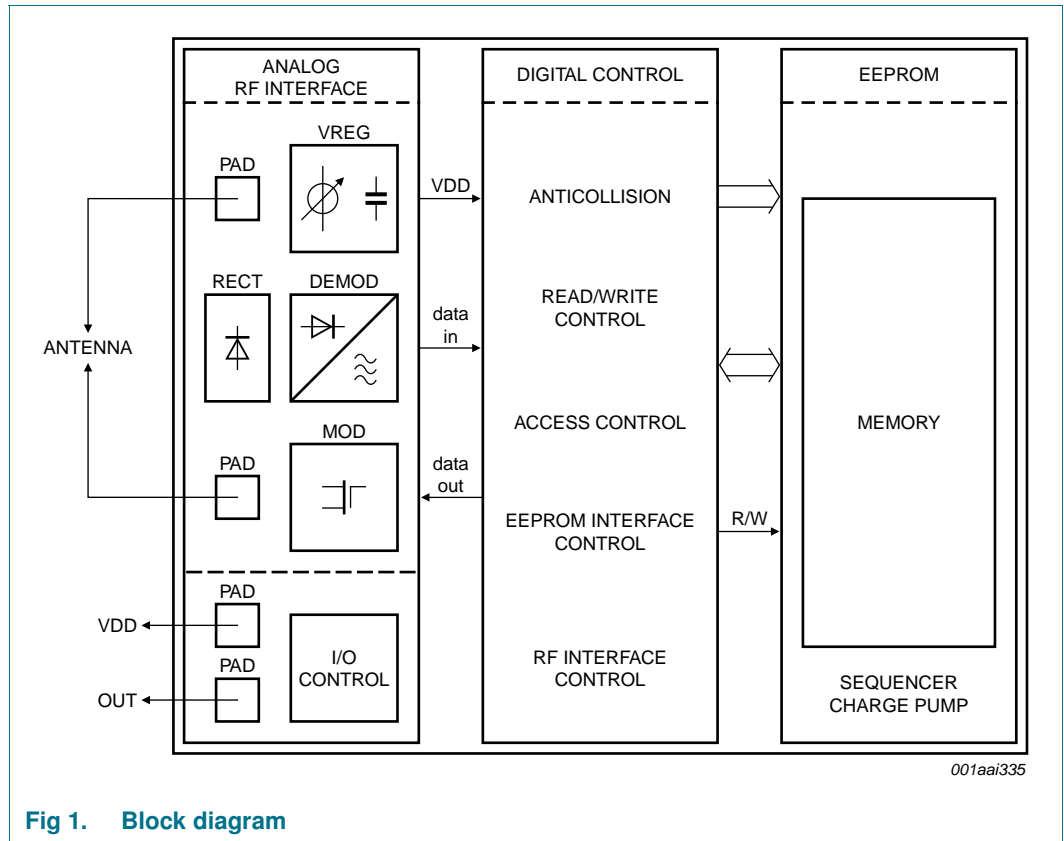
## 6. Block diagram

The SL2S1412; SL2S1512; SL2S1612 IC consists of three major blocks:

- Analog RF Interface
- Digital Controller
- EEPROM

The analog part provides stable supply voltage and demodulates data received from the reader for being processed by the digital part. Further, the modulation transistor of the analog part transmits data back to the reader.

The digital section includes the state machines, processes the protocol and handles communication with the EEPROM, which contains the EPC and the user data.



## 7. Functional description

---

### 7.1 Power transfer

Whenever connected to a very simple and cheap type of antenna (as a result of the 13.56 MHz carrier frequency) made out of a few windings printed, winded, etched or punched coil the ICODE ILT-M IC can be operated without line of sight up to a distance of 1.5 m (gate width). No battery is needed.

### 7.2 Data transfer

#### 7.2.1 Reader to tag Link

An interrogator transmits information to the ICODE ILT-M by modulating an RF signal in the 13.56 MHz frequency. The ICODE ILT-M receives both information and operating energy from this RF signal. Tags are passive, meaning that they receive all of their operating energy from the interrogator's RF waveform.

An interrogator is using a fixed modulation and data rate for the duration of at least an inventory round. It communicates to the ICODE ILT-M by modulating an RF carrier using DSB-ASK with PIE encoding.

For further details refer to [Section 11](#), [Ref. 2](#). Interrogator-to-tag (R=>T) communications.

#### 7.2.2 Tag to reader Link

An interrogator receives information from the ICODE ILT-M by transmitting a continuous-wave RF signal to the tag; the ICODE ILT-M responds by load modulation of the 13.56 MHz carrier frequency, thereby generating modulated sidebands used to transmit an information signal to the interrogator. The system is a reader talks first (RTF) system, meaning that a ICODE ILT-M only responds with an information signal after being directed by the interrogator.

ICODE ILT-M transmits information using ASK modulation. The returned data are either coded with FM0 baseband, Miller with sub carrier or Manchester with sub carrier. The interrogator can select if the ICODE ILT-M shall respond with a sub carrier frequency of 424 kHz or 848 kHz.

For further details refer to [Section 11](#), [Ref. 2](#). tag-to-interrogator (T=>R) communications.

### 7.3 Air interface standards

The ICODE ILT-M fully supports all parts of the ISO 18000-3 Mode 3 (refer to [Section 11](#), [Ref. 1](#)) and the "EPC™ Radio-Frequency Identity Protocols EPC Class-1 HF RFID Air Interface Protocol for Communications at 13.56 MHz, Version 2.0.3" (refer to [Section 11](#), [Ref. 2](#)).

## 8. Memory configuration

This section contains all information including commands by which a reader selects, inventories, and accesses a ICODE ILT-M population

An interrogator manages ICODE ILT-M equipped tag populations using three basic operations. Each of these operations comprises one or more commands. The operations are defined as follows

- Select:** The process by which an interrogator selects a tag population for inventory and access. Interrogators may use one or more Select commands to select a particular tag population prior to inventory.
- Inventory:** The process by which an interrogator identifies ICODE ILT-M equipped tags. An interrogator begins an inventory round by transmitting a BeginRound command in one of two sessions. One or more tags may reply. The interrogator detects a single tag reply and requests the PC, EPC, and CRC-16 from the chip. An inventory round operates in one and only one session at a time. For an example of an interrogator inventorying and accessing a single tag refer to [Section 11](#), [Ref. 2](#).
- Access:** The process by which an interrogator transacts with (reads from or writes to) individual tags. An individual tag must be uniquely identified prior to access. Access comprises multiple commands, some of which employ one-time-pad based cover-coding of the R=>T link.

### 8.1 Memory

For the general memory layout according to the standard [Section 11](#), [Ref. 2](#). The tag memory is logically subdivided into four distinct banks.

In accordance to the standard [Section 11](#), [Ref. 2](#). The tag memory of the ICODE ILT-M is organized in following 4 memory sections:

**Table 3. Memory sections**

Name	Size	Bank
Reserved memory (32-bit ACCESS and 32-bit KILL password)	64 bit	00b
EPC (excluding 16 bit CRC-16 and 16-bit PC)	240 bit	01b
TID (including unique 48 bit serial number)	96 bit	10b
User memory	512 bit	11b

The logical address of all memory banks begin at zero (00h).

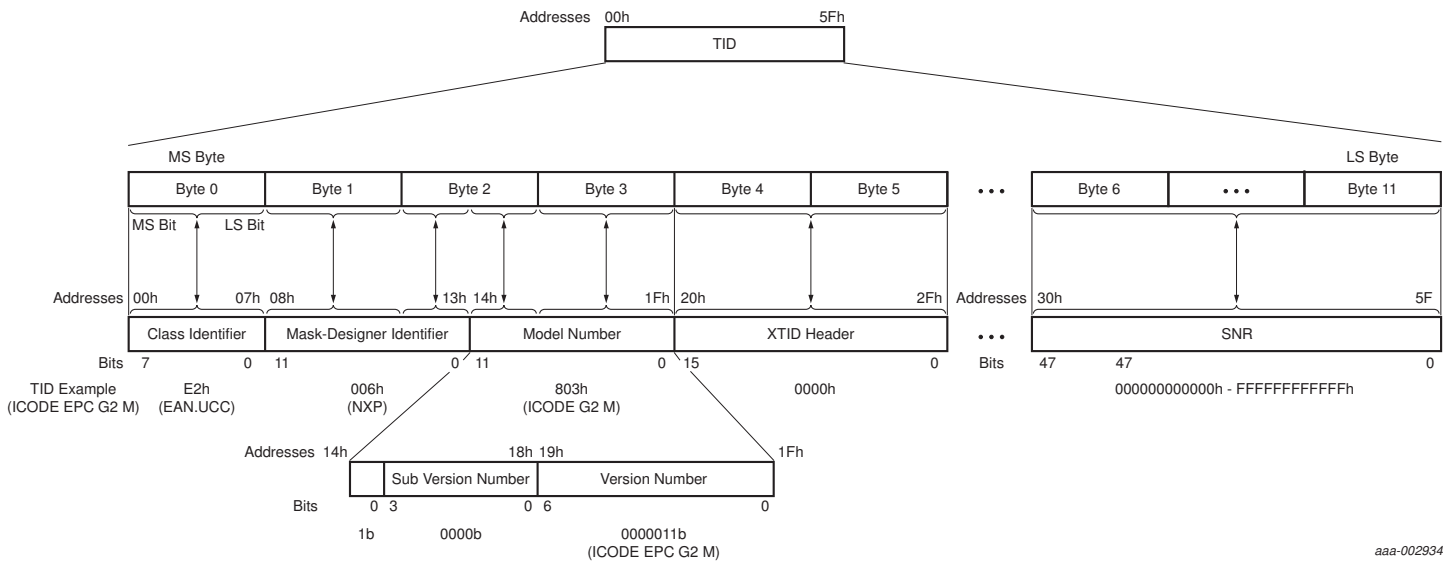


Fig 2. TID for ICODE ILT-M

Table 4. Model number

	SI (Status Indicator Bit)	Sub Version No.	Version (Silicon) No.
ICODE ILT-M	1	0000b	000011b

## 9. Limiting values

**Table 5. Limiting values (Wafer)**<sup>[1][2]</sup>

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
T <sub>stg</sub>	storage temperature		-55	+125	°C
P <sub>tot</sub>	total power dissipation		-	125	mW
T <sub>j</sub>	junction temperature		-40	+85	°C
I <sub>i(max)</sub>	maximum input current	LA to LB; peak	<a href="#">[3]</a> -	±60	mA
I <sub>I</sub>	input current	LA to LB; RMS	-	30	mA
V <sub>ESD</sub>	electrostatic discharge voltage	Human body model	<a href="#">[4]</a> -	±2	kV

- [1] Stresses above 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 conditions other than those described in the operating conditions and electrical characteristics sections of this specification is not implied.
- [2] This product includes circuitry specifically designed for the protection of its internal devices from the damaging effects of excessive static charge. Nonetheless, it is suggested that conventional precautions be taken to avoid applying greater than the rated maxima.
- [3] The voltage between LA and LB is limited by the on-chip voltage limitation circuitry (corresponding to parameter I<sub>I</sub>).
- [4] For ESD measurement, the IC was mounted in a CDIP8 package.

## 10. Abbreviations

**Table 6. Abbreviations**

Acronym	Description
CRC	Cyclic redundancy check
EEPROM	Electrically Erasable Programmable Read Only Memory
EPC	Electronic Product Code (containing Header, Domain Manager, Object Class and Serial Number)
FM0	Bi phase space modulation
IC	Integrated Circuit
RF	Radio Frequency
RTF	Reader Talks First
HF	High Frequency

## 11. References

---

- [1] ISO 18000-3M3
- [2] EPC™ Radio-Frequency Identity Protocols EPC Class-1 HF RFID Air Interface Protocol for Communications at 13.56 MHz, Version 2.0.3
- [3] EPCglobal: EPC Tag Data Standards 1.5
- [4] ECC ERC Recommendation 70-03 Annex 9
- [5] ISO/IEC Directives, Part 2: Rules for the structure and drafting of International Standards
- [6] ISO/IEC 3309: Information technology – Telecommunications and information exchange between systems – High-level data link control (HDLC) procedures – Frame structure
- [7] ISO/IEC 15961: Information technology, Automatic identification and data capture – Radio frequency identification (RFID) for item management – Data protocol: application interface
- [8] ISO/IEC 15962: Information technology, Automatic identification and data capture techniques – Radio frequency identification (RFID) for item management – Data protocol: data encoding rules and logical memory functions
- [9] ISO/IEC 15963: Information technology — Radio frequency identification for item management — Unique identification for RF tags
- [10] ISO/IEC 18000-1: Information technology — Radio frequency identification for item management — Part 1: Reference architecture and definition of parameters to be standardized
- [11] ISO/IEC 19762: Information technology AIDC techniques – Harmonized vocabulary – Part 3: radio-frequency identification (RFID)
- [12] U.S. Code of Federal Regulations (CFR), Title 47, Chapter I, Part 15: Radio-frequency devices, U.S. Federal Communications Commission
- [13] **General specification for 8” wafer on UV-tape with electronic fail die marking** — Delivery type description – BU-ID document number: 1093\*\*1.
- [14] **Data sheet** — SL2S1412; SL2S1512; SL2S1612;– BU-ID document number: 1677\*\*

---

1. \*\* ... document version number

## 12. Revision history

Table 7. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
SL2S1412_SL2S1512_ SL2S1612 v. 3.0	20120502	Product short data sheet	-	-

## 13. Legal information

### 13.1 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>.

### 13.2 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.

### 13.3 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.

## 13.4 Trademarks

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

**ICODE and I-CODE** — are trademarks of NXP B.V.

## 14. 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)

## 15. Contents

---

<b>1</b>	<b>General description</b> .....	<b>1</b>
<b>2</b>	<b>Features and benefits</b> .....	<b>1</b>
2.1	Key features .....	1
2.2	Key benefits .....	2
2.3	Custom features .....	2
<b>3</b>	<b>Applications</b> .....	<b>2</b>
<b>4</b>	<b>Quick reference data</b> .....	<b>2</b>
<b>5</b>	<b>Ordering information</b> .....	<b>3</b>
<b>6</b>	<b>Block diagram</b> .....	<b>4</b>
<b>7</b>	<b>Functional description</b> .....	<b>5</b>
7.1	Power transfer .....	5
7.2	Data transfer .....	5
7.2.1	Reader to tag Link .....	5
7.2.2	Tag to reader Link .....	5
7.3	Air interface standards .....	5
<b>8</b>	<b>Memory configuration</b> .....	<b>6</b>
8.1	Memory .....	6
<b>9</b>	<b>Limiting values</b> .....	<b>8</b>
<b>10</b>	<b>Abbreviations</b> .....	<b>8</b>
<b>11</b>	<b>References</b> .....	<b>9</b>
<b>12</b>	<b>Revision history</b> .....	<b>10</b>
<b>13</b>	<b>Legal information</b> .....	<b>11</b>
13.1	Data sheet status .....	11
13.2	Definitions .....	11
13.3	Disclaimers .....	11
13.4	Trademarks .....	12
<b>14</b>	<b>Contact information</b> .....	<b>12</b>
<b>15</b>	<b>Contents</b> .....	<b>13</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. 2012.

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: 2 May 2012  
230330