Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!


## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

# SL3ICS1002/1202

## UCODE G2XM and G2XL

Rev. 3.8 — 11 November 2013
139038

Product data sheet
COMPANY PUBLIC

## 1. General description

The UHF EPCglobal Generation 2 standard allows the commercialized provision of mass adoption of UHF RFID technology for passive smart tags and labels. Main fields of applications are supply chain management and logistics for worldwide use with special consideration of European, US and Chinese frequencies to ensure that operating distances of several meters can be realized.

The G2X is a dedicated chip for passive, intelligent tags and labels supporting the EPCglobal Class 1 Generation 2 UHF RFID standard. It is especially suited for applications where operating distances of several meters and high anti-collision rates are required.

The G2X is a product out of the NXP Semiconductors UCODE product family. The entire UCODE product family offers anti-collision and collision arbitration functionality. This allows a reader to simultaneously operate multiple labels / tags within its antenna field. A UCODE G2X based label/ tag requires no external power supply.

Its contact-less interface generates the power supply via the antenna circuit by propagative energy transmission from the interrogator (reader), while the system clock is generated by an on-chip oscillator. Data transmitted from interrogator to label/tag is demodulated by the interface, and it also modulates the interrogator's electromagnetic 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.

In addition to the EPC specifications the G2X offers an integrated EAS (Electronic Article Surveillance) feature and read protection of the memory content. On top of the specification of the G2XL the G2XM offers 512-bit of user memory.

# 2. Features and benefits

## 2.1 Key features

- 512-bit user memory (G2XM only)
- 240-bit of EPC memory
- 64-bit tag identifier (TID) including 32-bit unique serial number
- Memory read protection
- EAS (Electronic Article Surveillance) command
- Calibrate command
- 32-bit kill password to permanently disable the tag
- 32-bit access password to allow a transition into the secured transmission state
- Broad international operating frequency: from 840 MHz to 960 MHz
- Long read/write ranges due to extremely low power design
- Reliable operation of multiple tags due to advanced anti-collision
- Forward link: 40-160 kbit/s
- Return link: 40-640 kbit/s

## 2.2 Key benefits

- High sensitivity provides long read range
- Low Q-factor for consistent performance on different materials
- Improved interference suppression for reliable operation in multi-reader environment
- Large input capacitance for ease of assembly and high assembly yield
- Highly advanced anti-collision resulting in highest identification speed
- Reliable and robust RFID technology suitable for dense reader and noisy environments

## 2.3 Custom commands

- EAS Alarm
  Enables the UHF RFID tag to be used as EAS tag without the need for a backend data base.
- Read Protect
  Protects all memory content including CRC16 from unauthorized reading.
- Calibrate
  Activates permanent back-scatter in order to evaluate the tag-to-reader performance.

## 3. Applications

- Supply chain management
- Item level tagging
- Asset management
- Container identification
- Pallet and case tracking
- Product authentication

Outside above mentioned applications, please contact NXP Semiconductors for support.

## 4. Ordering information

**Table 1. Ordering information G2XM**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| SL3ICS1002FUG/V7AF | Wafer | Bumped die on sawn wafer | - |
| SL3S1002FTB1 | XSON3 | plastic extremely thin small outline package;3 terminals; body 1 x 1.45 x 0,5 mm | SOT1122 |

**Table 2. Ordering information G2XL**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| SL3ICS1202FUG/V7AF | Wafer | Bumped die on sawn wafer | - |
| SL3S1202FTB1 | XSON3 | plastic extremely thin small outline package;3 terminals; body 1 x 1.45 x 0,5 mm | SOT1122 |

## 5. Block diagram

The SL3ICS1002/1202 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.

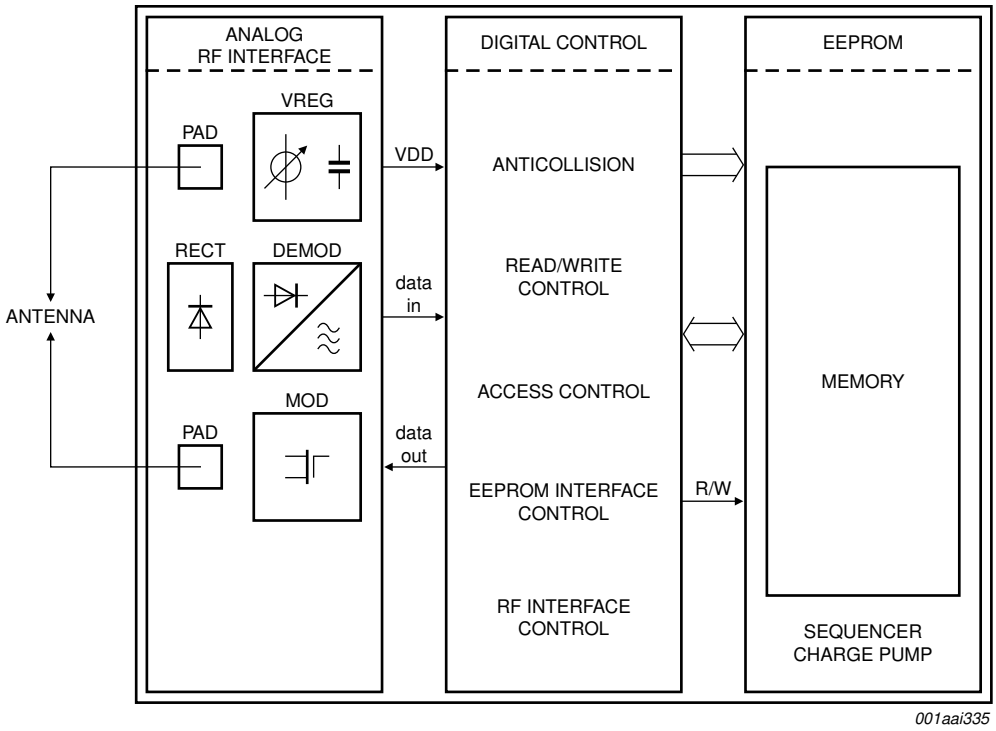
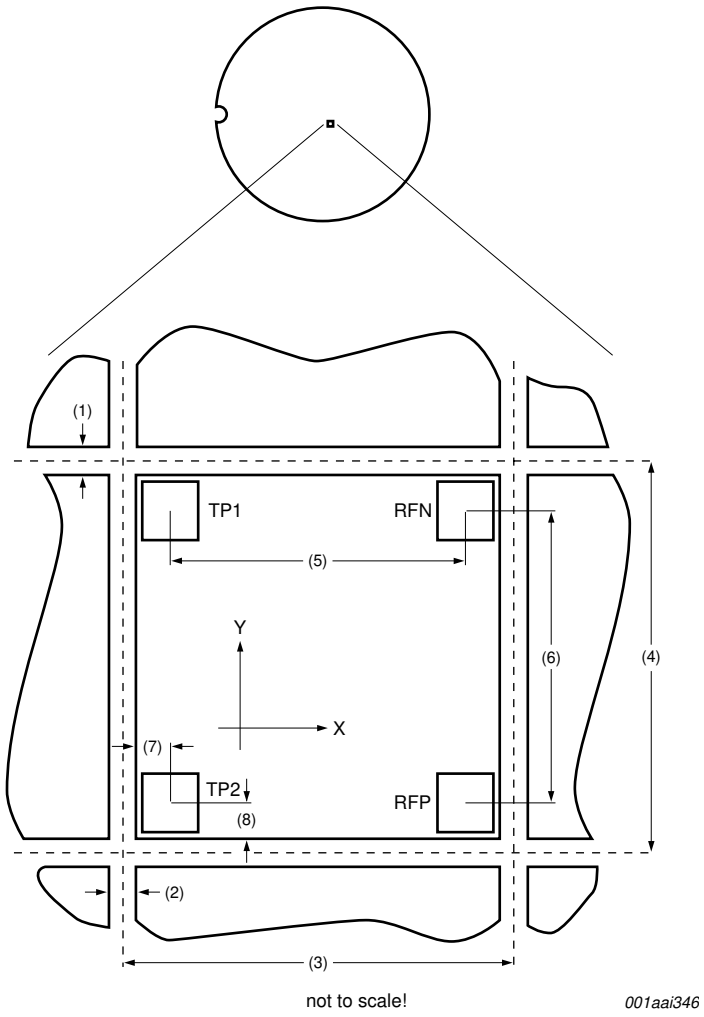



**Fig 1. Block diagram of G2X IC**

# 6. Wafer layout and pinning information

## 6.1 Wafer layout

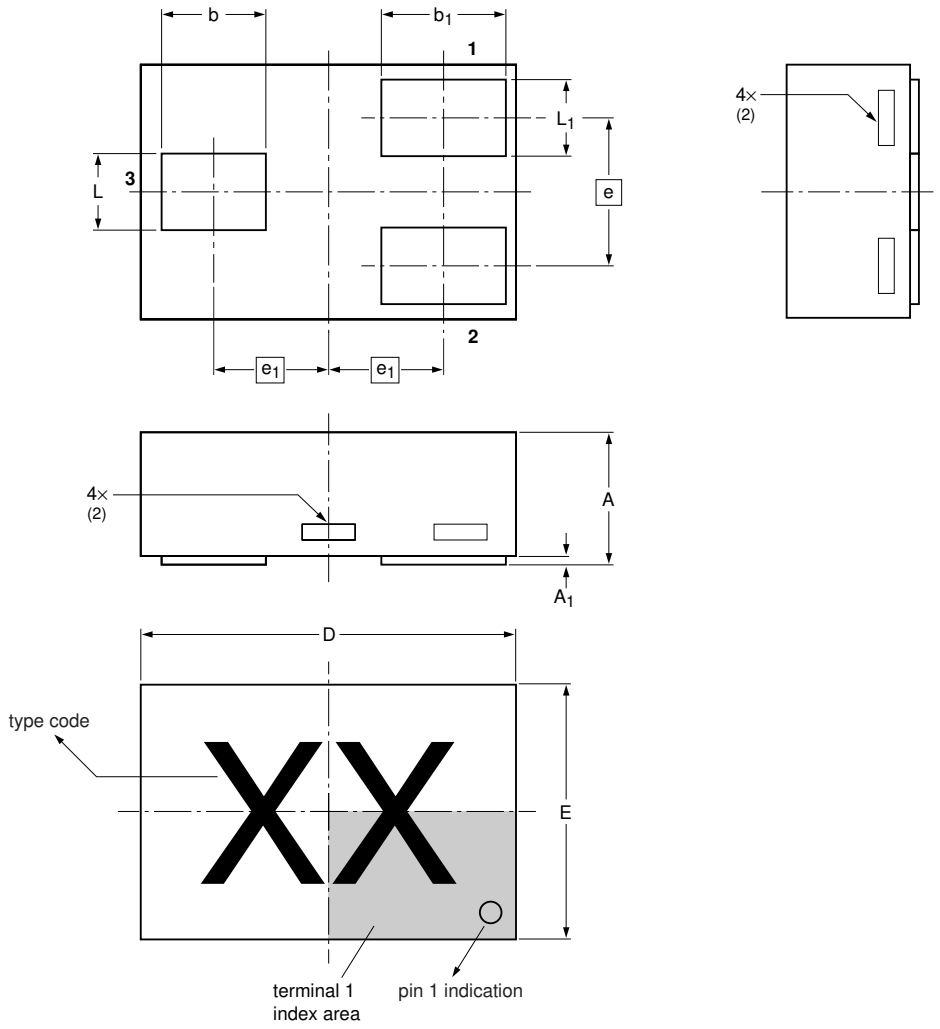



(1) X-scribe line width: 56.4 μm
(2) Y-scribe line width: 56.4 μm
(3) Chip step, x-length: 488.0 μm
(4) Chip step, y-length: 470,0 μm
(5) Bump to bump distance X (TP1 - RFN): 351,0 μm
(6) Bump to bump distance Y (RFN - RFP): 333,0 μm
(7) Distance bump to metal sealring X: 40,3 μm
(8) Distance bump to metal sealring Y: 40,3 μm
Bump size X x Y: 60 μm x 60 μm

**Fig 2. Wafer layout and pinning information**

# 7. Package outline

**XSON3: plastic extremely thin small outline package; no leads; 3 terminals; body 1 x 1.45 x 0.5 mm** **SOT1122**




Dimensions

| Unit | | A(1) | A1 | b | b1 | D | E | e | e1 | L | L1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | max | 0.50 | 0.04 | 0.45 | 0.55 | 1.50 | 1.05 | | | 0.35 | 0.30 |
| mm | nom | | | 0.40 | 0.50 | 1.45 | 1.00 | 0.55 | 0.425 | 0.30 | 0.25 |
| | min | | | 0.37 | 0.47 | 1.40 | 0.95 | | | 0.27 | 0.22 |

Notes
1. Dimension A is including plating thickness.
2. Can be visible in some manufacturing processes.

*sot1122_po*

| Outline version | References | | | | European projection | Issue date |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT1122 | | MO-252 | | | | 09-10-09 |

**Fig 3. Package outline SOT1122**

**Table 3. Pin description of SOT1122**

| Symbol | Pin | Description |
|---|---|---|
| RFP | 1 | Ungrounded antenna connector |
| RFN | 2 | Grounded antenna connector |
| n.c. | 3 | not connected |

**Table 4. SOT1122 Marking**

| Type | Type code (Marking) | Comment |
|---|---|---|
| SL3S1202FTB1 | UL | UCODE G2XL |
| SL3S1002FTB1 | UM | UCODE G2XM |

# 8. Mechanical specification

## 8.1 Wafer specification

See Ref. 20 “Data sheet - Delivery type description – General specification for 8” wafer on UV-tape with electronic fail die marking, BL-ID document number: 1093**”.

### 8.1.1 Wafer

- Designation: each wafer is scribed with batch number and wafer number
- Diameter: 200 mm (8”)
- Thickness: 150 µm ± 15 µm
- Number of pads 4
- Pad location: non diagonal/ placed in chip corners
- Distance pad to pad RFN-RFP 333.0 µm
- Distance pad to pad TP1-RFN: 351.0 µm
- Process: CMOS 0.14 µm
- Batch size: 25 wafers
- Dies per wafer: 120.000

### 8.1.2 Wafer backside

- Material: Si
- Treatment: ground and stress release
- Roughness: $R_a$ max. 0.5 µm, $R_t$ max. 5 µm

### 8.1.3 Chip dimensions

- Die size without scribe: 0.414 mm x 0.432 mm = 0.178 $mm^2$
- Scribe line width:
  x-dimension:56.4 µm (width is measured on top metal layer)
  y-dimension:56.4 µm (width is measured on top metal layer)

### 8.1.4 Passivation on front

- Type Sandwich structure
- Material: PE-Nitride (on top)
- Thickness: 1.75 µm total thickness of passivation

### 8.1.5 Au bump

- Bump material: > 99.9% pure Au
- Bump hardness: 35 – 80 HV 0.005
- Bump shear strength: > 70 MPa
- Bump height: 18 μm
- Bump height uniformity:
  - within a die: ± 2 μm
  - within a wafer: ± 3 μm
  - wafer to wafer: ± 4 μm
- Bump flatness: ± 1.5 μm
- Bump size:
  - RFP, RFN 60 x 60 μm
  - TP1, TP2 60 x 60 μm
  - Bump size variation: ± 5 μm
- Under bump metallization: sputtered TiW

### 8.1.6 Fail die identification

No inkdots are applied to the wafer.

Electronic wafer mapping (SECS II format) covers the electrical test results and additionally the results of mechanical/visual inspection.

See Ref. 20 “Data sheet - Delivery type description – General specification for 8” wafer on UV-tape with electronic fail die marking, BL-ID document number: 1093**”

### 8.1.7 Map file distribution

See Ref. 20 “Data sheet - Delivery type description – General specification for 8” wafer on UV-tape with electronic fail die marking, BL-ID document number: 1093**”

# 9. Limiting values

**Table 5. Limiting values[1][2]**

*In accordance with the Absolute Maximum Rating System (IEC 60134)*
*Voltages are referenced to RFN*

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| **Die** | | | | | |
| $T_{stg}$ | storage temperature range | | -55 | +125 | °C |
| $T_{oper}$ | operating temperature | | -40 | +85 | °C |
| $V_{ESD}$ | electrostatic discharge voltage | Human body model [3] | - | ± 2 | kV |
| **SOT1122** | | | | | |
| $T_{stg}$ | storage temperature range | | -55 | +125 | °C |
| $P_{tot}$ | total power dissipation | | - | 30 | mW |
| $T_{oper}$ | operating temperature | | -40 | +85 | °C |
| $V_{ESD}$ | electrostatic discharge voltage | Human body model | - | ± 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 section 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] For ESD measurement, the die chip has been mounted into a CDIP20 package.

# 10. Characteristics

## 10.1 Wafer characteristics

**Table 6. Wafer characteristics**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Memory characteristics** | | | | | | | |
| $t_{RET}$ | EEPROM data retention | $T_{amb} \leq 55$ °C | | 50 | - | - | year |
| $N_{WE}$ | EEPROM write endurance | $T_{amb} \leq 55$ °C | | 100000 | - | - | cycle |
| **Interface characteristics** | | | | | | | |
| $P_{tot}$ | total power dissipation | | | | - | 30 | mW |
| $f_{oper}$ | operating frequency | | | 840 | - | 960 | MHz |
| $P_{min}$ | minimum operating power supply | | [1][2] | - | -15 | - | dBm |
| $C_i$ | input capacitance (parallel) | | [3] | - | 0.88 | - | pF |
| Q | quality factor (Im ($Z_{chip}$) / Re ($Z_{chip}$)) | | [3] | - | 9 | - | - |
| Z | impedance (915 MHz) | | | - | 22 - j195 | - | Ω |
| - | modulated jammer suppression ≥1.0 MHz | | [4] | - | - 4 | - | dB |
| - | unmodulated jammer suppression ≥1.0 MHz | | [4] | - | - 4 | - | dB |

[1] Power to process a Query command

[2] Measured with a 50 Ω source impedance

[3] At minimum operating power

[4] Values measured for a 40 kHz phase reserval command under matched conditions

## 10.2 Package characteristics

**Table 7. Package interface characteristics**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Interface characteristics SOT1122** | | | | | | | |
| $C_i$ | input capacitance (parallel) | | [1] | - | 1.02 | - | pF |
| Z | SOT1122 impedance (915 MHz) | | | - | 18.6 - j171.2 | - | Ω |

[1] Measured with network analyzer at 915 MHz; values at 0.5 dBm after $peak_{max}$ of on-set of die, measured in the center of the pads.

# 11. Packing information

## 11.1 Wafer

See Ref. 20 “Data sheet - Delivery type description – General specification for 8” wafer on UV-tape with electronic fail die marking, BL-ID document number: 1093**”.

## 11.2 SOT1122

Part orientation T1. For details please refer to http://www.standardics.nxp.com/packaging/packing/pdf/sot886.t1.t4.pdf.

# 12. Functional description

## 12.1 Power transfer

The interrogator provides an RF field that powers the tag, equipped with a UCODE G2X. The antenna transforms the impedance of free space to the chip input impedance in order to get the maximum possible power for the G2X on the tag.

The RF field, which is oscillating on the operating frequency provided by the interrogator, is rectified to provide a smoothed DC voltage to the analog and digital modules of the IC.

The antenna that is attached to the chip may use a DC connection between the two antenna pads. Therefore the G2X also enables loop antenna design. Possible examples of supported antenna structures can be found in the reference antenna design guide.

## 12.2 Data transfer

### 12.2.1 Reader to G2X Link

An interrogator transmits information to the UCODE G2X by modulating an RF signal in the 840 MHz - 960 MHz frequency range. The G2X 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 G2X by modulating an RF carrier using DSB-ASK, SSB-ASK or PR-ASK with PIE encoding.

For further details refer to Section 17, Ref. 1, section 6.3.1.2. Interrogator-to-tag (R=>T) communications.

### 12.2.2 G2X to reader Link

An interrogator receives information from the UCODE G2X by transmitting a continuous-wave RF signal to the tag; the G2X responds by modulating the reflection coefficient of its antenna, thereby generating modulated sidebands used to backscatter an information signal to the interrogator. The system is a reader talks first (RTF) system, meaning that a G2X modulates its antenna reflection coefficient with an information signal only after being directed by the interrogator.

G2X backscatter is a combination of ASK and PSK modulation depending on the tuning and bias point. The backscattered data is either modulated with FM0 baseband or Miller sub carrier.

For further details refer to Section 17, Ref. 1, section 6.3.1.3. tag-to-interrogator (T=>R) communications.

## 12.3 Operating distances

RFID tags based on the UCODE G2X silicon may achieve maximum operating distances according the following formula:

(1)

$$P_{tag} = EIRP \cdot G_{tag}\left(\frac{\lambda}{4\pi R}\right)^2 \cdot \eta$$

(2)

$$R_{max} = \sqrt{\frac{EIRP \cdot G_{tag} \cdot \lambda^2}{(4\pi)^2 P_{tag}} \cdot \eta}$$

**Table 8. Symbol description**

| Symbol | Description | Unit |
|---|---|---|
| $P_{tag}$ | minimum required RF power for the tag | W |
| $G_{tag}$ | gain of the tag antenna | - |
| EIRP | transmitted RF power | m |
| $\lambda$ | wavelength | m |
| $R_{max}$ | maximum achieved operating distance for a $\lambda/2$-dipole | m |
| $\eta$ | loss factor assumed to be 0.5 considering matching and package losses | - |
| R | distance | m |

**Table 9. Operating distances for UCODE G2X based tags and labels in released frequency bands**

| Frequency range | Region | Available power | Calculated read distance single antenna [4] | Unit |
|---|---|---|---|---|
| 868.4 to 868.65 MHz (UHF) | Europe [1] | 0.5 W ERP | 3.6 | m |
| 865.5 to 867.6 MHz (UHF) | Europe [2] | 2 W ERP | 7.1 | m |
| 902 to 928 MHz (UHF) | America [3] | 4 W EIRP | 7.5 | m |

[1] CEPT/ETSI regulations [CEPT1], [ETSI1].

[2] New CEPT/ETSI regulations. [ETSI3].

[3] FCC 47 part 15 regulation [FCC1].

[4] These read distances are maximum values for general tags and labels. Practical usable values may be lower due to damping by object materials and environmental conditions. A special tag antenna design can help achieve higher values.

The typical write range is > 50% of the read range.

## 12.4 Air interface standards

The G2X is certified according EPCglobal 1.0.9 and fully supports all parts of the "Specification for RFID Air Interface EPCglobal, EPCTM Radio-Frequency Identity Protocols, Class-1 Generation-2 UHF RFID, Protocol for Communications at 860 MHz - 960 MHz, Version 1.1.0".


EPCglobal compliance and interoperability certification

# 13. Physical layer and signaling

## 13.1 Reader to G2X communication

### 13.1.1 Physical layer

For interrogator-to-G2X link modulation refer to Section 17, Ref. 1, annex H.1 Baseband waveforms, modulated RF, and detected waveforms.

### 13.1.2 Modulation

An interrogator sends information to one or more G2X by modulating an RF carrier using double-sideband amplitude shift keying (DSB-ASK), single-sideband amplitude shift keying (SSB-ASK) or phase-reversal amplitude shift keying (PR-ASK) using a pulse-interval encoding (PIE) format. The G2X receives the operating energy from this same modulated RF carrier.

Section 17, Ref. 1: Annex H, as well as chapter 6.3.1.2.2.

The G2X is capable of demodulating all three modulation types.

### 13.1.3 Data encoding

The R=>T link is using PIE. For the definition of the therefore relevant reference time interval for interrogator-to-chip signaling (Tari) refer to Section 17, Ref. 1, chapter 6.3.1.2.3. The Tari is specified as the duration of a data-0.

### 13.1.4 Data rates

Interrogators shall communicate using Tari values between 6.25 μs and 25 μs, inclusive. For interrogator compliance evaluation the preferred Tari values of 6.25 μs, 12.5 μs or 25 μs should be used. For further details refer to Section 17, Ref. 1, chapter 6.3.1.2.4.

### 13.1.5 RF envelope for R=>T

A specification of the relevant RF envelope parameters can be found in Section 17, Ref. 1, chapter 6.3.1.2.5.

### 13.1.6 Interrogator power-up/down waveform

For a specification of the interrogator power-up and power-down RF envelope and waveform parameters refer to Section 17, Ref. 1, chapters 6.3.1.2.6 and 6.3.1.2.7.

### 13.1.7 Preamble and frame-sync

An interrogator shall begin all R=>T signaling with either a preamble or a frame-sync. A preamble shall precede a Query command and denotes the start of an inventory round. For a definition and explanation of the relevant R=>T preamble and frame-sync refer to Section 17, Ref. 1, chapter 6.3.1.2.8.

## 13.2 G2X to reader communication

An interrogator receives information from a G2X by transmitting an unmodulated RF carrier and listening for a backscattered reply. The G2X backscatters by switching the reflection coefficient of its antenna between two states in accordance with the data being sent. For further details refer to Section 17, Ref. 1, chapter 6.3.1.3.

### 13.2.1 Modulation

The UCODE G2X communicates information by backscatter-modulating the amplitude and/or phase of the RF carrier. Interrogators shall be capable of demodulating either demodulation type.

### 13.2.2 Data encoding

The encoding format, selected in response to interrogator commands, is either FM0 baseband or Miller-modulated subaltern. The interrogator commands the encoding choice

#### 13.2.2.1 FM0 baseband

FM0 inverts the baseband phase at every symbol boundary; a data-0 has an additional mid-symbol phase inversion. For details on FM0 and generator state diagram, FM0 symbols and sequences and how FM0 transmissions should be terminated refer to Section 17, Ref. 1, chapter 6.3.1.3.

#### 13.2.2.2 FM0 Preamble

T=>R FM0 signaling begin with one of two defined preambles, depending on the value of the TRext bit specified in the Query command that initiated the inventory round. For further details refer to Section 17, Ref. 1, chapter 6.3.1.3.

#### 13.2.2.3 Miller-modulated sub carrier

Baseband Miller inverts its phase between two data-0s in sequence. Baseband Miller also places a phase inversion in the middle of a data-1 symbol. For details on Miller-modulated sub carrier, generator state diagram, sub carrier sequences and terminating sub carrier transmissions refer to Section 17, Ref. 1, chapter 6.3.1.3.

#### 13.2.2.4 Miller sub carrier preamble

T=>R sub carrier signaling begins with one of the two defined preambles. The choice depends on the value of the TRext bit specified in the Query command that initiated the inventory round. For further details refer to Section 17, Ref. 1, chapter 6.3.1.3.

### 13.2.3 Data rates

The G2X IC supports tag to interrogator data rates and link frequencies as specified in Section 17, Ref. 1, chapter 6.3.1.3.

## 13.3 Link timing

For the interrogator interacting with a UCODE G2X equipped tag population exact link and response timing requirements must be fulfilled, which can be found in Section 17, Ref. 1, chapter 6.3.1.6.

### 13.3.1 Regeneration time

The regeneration time is the time required if a G2X is to demodulate the interrogator signal, measured from the last falling edge of the last bit of the G2X response to the first falling edge of the interrogator transmission. This time is referred to as T2 and can vary between 3.0 Tpri and 20 Tpri. For a more detailed description refer to Section 17, Ref. 1, chapter 6.3.1.6.

### 13.3.2 Start-up time

For a detailed description refer to Section 17, Ref. 1, chapter 6.3.1.3.4.

### 13.3.3 Persistence time

An interrogator chooses one of four sessions and inventories tags within that session (denoted S0, S1, S2, and S3). The interrogator and associated UCODE G2X population operate in one and only one session for the duration of an inventory round (defined above). For each session, a corresponding inventoried flag is maintained. Sessions allow tags to keep track of their inventoried status separately for each of four possible time-interleaved inventory processes, using an independent inventoried flag for each process. Two or more interrogators can use sessions to independently inventory a common UCODE G2X chip population.

A session flag indicates whether a G2X may respond to an interrogator. G2X chips maintain a separate inventoried flag for each of four sessions; each flag has symmetric A and B values. Within any given session, interrogators typically inventory tags from A to B followed by a re-inventory of tags from B back to A (or vice versa).

Additionally, the G2X has implemented a selected flag, SL, which an interrogator may assert or deassert using a Select command.

For a description of Inventoried flags S0 – S3 refer to Section 17, Ref. 1 chapter 6.3.2.2 and for a description of the Selected flag refer to Section 17, Ref. 1, chapter 6.3.2.3. For tag flags and respective persistence time refer to Section 17, Ref. 1, table 6.14.

## 13.4 Bit and byte ordering

The transmission order for all R=>T and T=>R communications respects the following conventions:

- within each message, the most-significant word is transmitted first, and
- within each word, the most-significant bit (MSB) is transmitted first,

whereas one word is composed of 16 bits.

To represent memory addresses and mask lengths EBV-8 values are used. An extensible bit vector (EBV) is a data structure with an extensible data range. For a more detailed explanation refer to Section 17, Ref. 1, Annex A.

## 13.5 Data integrity

The G2X ignores invalid commands. In general, "invalid" means a command that (1) is incorrect given the current the G2X state, (2) is unsupported by the G2X, (3) has incorrect parameters, (4) has a CRC error, (5) specifies an incorrect session, or (6) is in any other way not recognized or not executable by the G2X. The actual definition of "invalid" is state-specific and defined, for each G2X state, in n Section 17, Ref. 1 Annex B and Annex C.

All UCODE G2X backscatter error codes are summarized in Section 17, Ref. 1 Error codes, Annex I. For a detailed description of the individual backscatter error situations which are command specific please refer to the Section 17, Ref. 1 individual command description section 6.3.2.10.

## 13.6 CRC

A CRC-16 is a cyclic-redundancy check that an interrogator uses when protecting certain R=>T commands, and the G2X uses when protecting certain backscattered T=>R sequences. To generate a CRC-16 an interrogator or the G2X first generates the CRC-16 precursor shown in Section 17, Ref. 1 Table 6.11, then take the ones-complement of the generated precursor to form the CRC-16. For a detailed description of the CRC-16 generation and handling rules refer to Section 17, Ref. 1, chapter 6.3.2.1.

The CRC-5 is only used to protect the Query command (out of the mandatory command set). It is calculated out of X5 + X3 + 1. For a more detailed CRC-5 description refer to Section 17, Ref. 1, table 6.12.

For exemplary schematic diagrams for CRC-5 and CRC-16 encoder/decoder refer to Section 17, Ref. 1, Annex F.

For a CRC calculation example refer to Section 15.1, Table 27 and Table 28.

# 14. TAG selection, inventory and access

This section contains all information including commands by which a reader selects, inventories, and accesses a G2X population

An interrogator manages UCODE G2X 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 UCODE G2X equipped tags. An interrogator begins an inventory round by transmitting a Query command in one of four sessions. One or more G2X may reply. The interrogator detects a single G2X 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 G2X refer to Section 17, Ref. 1, Annex E.

Access: The process by which an interrogator transacts with (reads from or writes to) individual G2X. An individual G2X 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.

## 14.1 G2X Memory

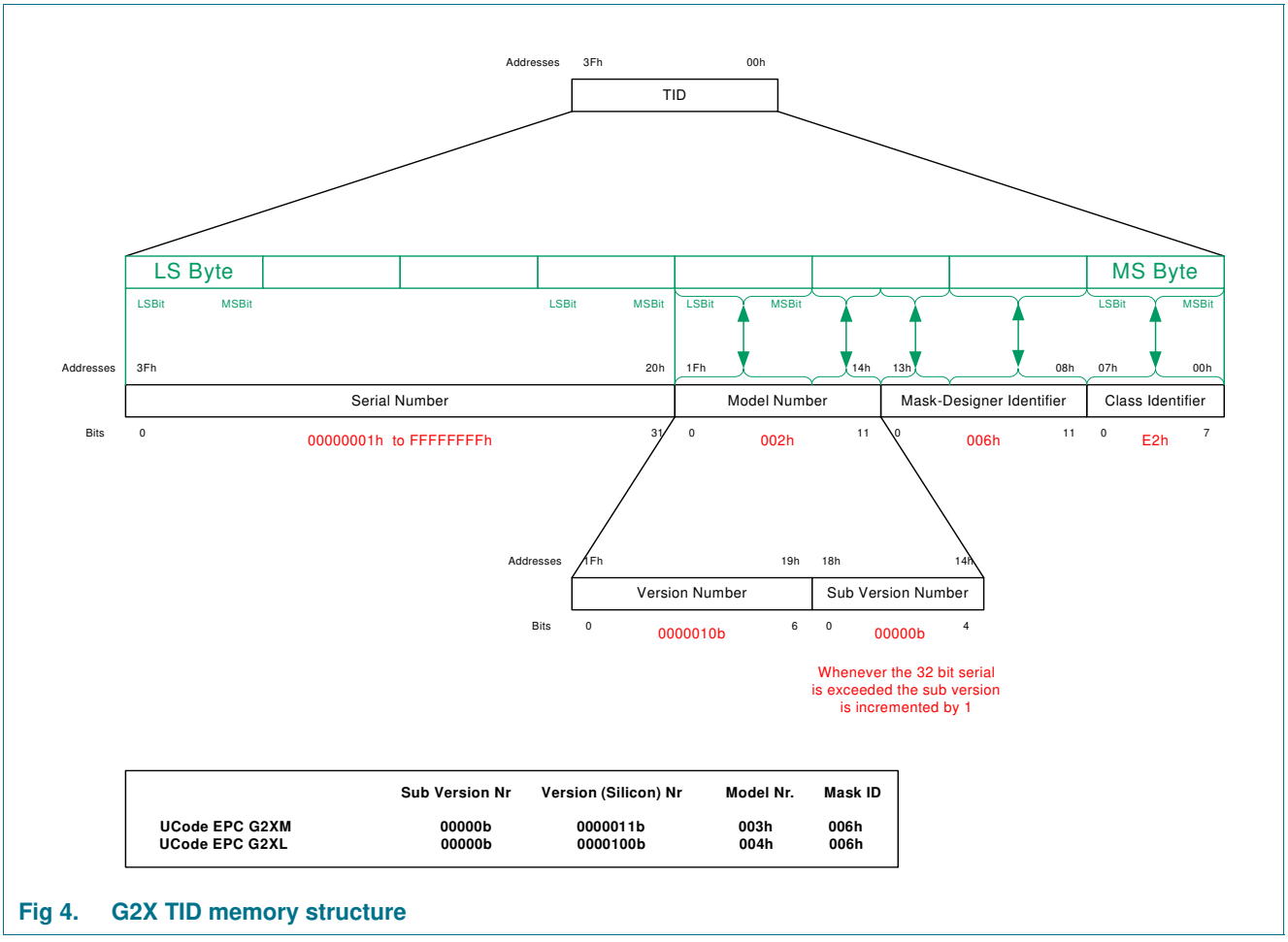
For the general memory layout according to the standard Section 17, Ref. 1, refer to Figure 6.17. The tag memory is logically subdivided into four distinct banks.

In accordance to the standard Section 17, Ref. 1, section 6.3.2.1. The tag memory of the SL3ICS1002 G2XM is organized in following 4 memory sections:

**Table 10. G2X 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 32 bit serial number) | 64 bit | 10b |
| User memory (G2XM only) | 512 bit | 11b |

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




| | Sub Version Nr | Version (Silicon) Nr | Model Nr. | Mask ID |
|---|---|---|---|---|
| UCode EPC G2XM | 00000b | 0000011b | 003h | 006h |
| UCode EPC G2XL | 00000b | 0000100b | 004h | 006h |

**Fig 4. G2X TID memory structure**

### 14.1.1 Memory map

**Table 11. Memory map**

| Bank address | Memory address | Type | Content | Initial [1] | Remark |
|---|---|---|---|---|---|
| Bank 00 | 00h – 1Fh | Reserved | kill password: refer to Section 17, Ref. 1, chapter 6.3.2.1.1 | all 00h | unlocked memory |
| | 20h – 3Fh | Reserved | access password: refer to Section 17, Ref. 1, chapter 6.3.2.1.1 | all 00h | unlocked memory |
| Bank 01 | 00h – 0Fh | EPC | CRC-16: refer to Section 17, Ref. 1, chapter 6.3.2.1.2 | | memory mapped calculated CRC |
| | 10h – 14h | EPC | Backscatter length: refer to Section 17, Ref. 1, chapter 6.3.2.1.2 | 00110b | unlocked memory |
| | 15h | EPC | Reserved for future use: refer to Section 17, Ref. 1, chapter 6.3.2.1.2 | 0b | unlocked memory |
| | 16h | EPC | Reserved for future use: refer to Section 17, Ref. 1, chapter 6.3.2.1.2 | 0b | hardwired to 0 |
| | 17h –1Fh | EPC | Numbering system indicator: refer to Section 17, Ref. 1, chapter 6.3.2.1.2 | 00h | unlocked memory |
| | 20h - 10Fh | EPC | EPC: refer to Section 17, Ref. 1, chapter 6.3.2.1.2 | [2] | unlocked memory |
| Bank 10 | 00h – 07h | TID | allocation class identifier: refer to Section 17, Ref. 1, chapter 6.3.2.1.3 | 1110 0010b | locked memory |
| | 08h – 13h | TID | tag mask designer identifier: refer to Section 17, Ref. 1, chapter 6.3.2.1.3 | 0000 0000 0110b | locked memory |
| | 14h – 1Fh | TID | tag model number: refer to Section 17, Ref. 1, chapter 6.3.2.1.3 | TMNR | locked memory |
| | 20h – 3Fh | TID | serial number: refer to [Section 17, Ref. 1, chapter 6.3.2.1.3 | SNR | locked memory |
| Bank 11[3] | 00h – 1FFh | User | user memory: refer to [Section 17, Ref. 1, chapter 6.3.2.1.4 | undefined | unlocked memory |

[1] This is the initial memory content when delivered by NXP Semiconductors

[2] G2XL: HEX 3005 FB63 AC1F 3841 EC88 0467
G2XM: HEX 3005 FB63 AC1F 3681 EC88 0468

[3] only G2XM

#### 14.1.1.1 User memory (only G2XM)

The User Memory bank contains a sequential block of 512 bits (32 words of 16 bit) ranging from address 00h to 1Fh. The user memory can be accessed via Select, Read or Write command and it may be write locked, permanently write locked, unlocked or permanently unlocked.

In addition reading of not only of the User Memory but of the whole memory including EPC and TID can be protected by using the custom ReadProtect command.

#### 14.1.1.2 Special behavior of user memory address 1Fh

WRITE or SELECT of user memory address 1Fh will falsely set an error flag. This will affect the subsequent READ or SELECT.

**The following commands will falsely set an internal error flag (without actually causing an error):**

1) WRITE to user memory with WordPtr=1Fh

2) SELECT to user memory with compare mask ending at bitaddress 1FFh (e.g. Pointer=1FEh, length=1 or Pointer=1FDh, length=2 …)

Note: The error flag is set independent of the chip state (also chips in the e.g. Ready state are affected).

**The falsely set error flag will affect the following sub sequential commands:**

A) READ command with WordCount=0 → falsely responds with "memory overrun" error

B) SELECT command with Length<>0 → falsely assumes non existing memory location

**The behavior can be avoided with:**

- Turning off the RF carrier to reset the chip (This is what readers typically do!).
- Using the READ command with WordCount<>0.
- Sending other command prior to READ or SELECT (e.g. WRITE to address<>1Fh, ReqRN) or executing READ or SELECT two times.

**Remark:** The WRITE operation itself is not affected by this problem i.e. data is written properly! With commercially available readers this behavior is typically not observed.

#### 14.1.1.3 Supported EPC types

The EPC types are defined in the EPC Tag Standards document from EPCglobal.

These standards define completely that portion of EPC tag data that is standardized, including how that data is encoded on the EPC tag itself (i.e. the EPC Tag Encodings), as well as how it is encoded for use in the information systems layers of the EPC Systems Network (i.e. the EPC URI or Uniform Resource Identifier Encodings).

The EPC Tag Encodings include a Header field followed by one or more Value Fields. The Header field indicates the length of the Values Fields and contains a numbering system identifier (NSI). The Value Fields contain a unique EPC Identifier and optional Filter Value when the latter is judged to be important to encode on the tag itself.

## 14.2 Sessions, selected and inventoried flags

Session, Selected and Inventory Flags are according the EPCglobal standard. For a description refer to Section 17, Ref. 1, section 6.3.2.3.

### 14.2.1 G2X States and slot counter

For a description refer to Section 17, Ref. 1, section 6.3.2.4.

### 14.2.2 G2X State Diagram

The tag state are according the EPCglobal standard please refer to: Section 17, Ref. 1, section 6.3.2.4 Tag states and slot counter.

A detailed tag state diagram is shown in Section 17, Ref. 1, figure 6.19. Refer also to Section 17, Ref. 1, Annex B for the associated state-transition tables and to Section 17, Ref. 1, Annex C for the associated command-response tables.

## 14.3 Managing tag populations

For a detailed description on how to manage an UCODE G2X tag populations refer to Section 17, Ref. 1, chapter 6.3.2.6.

## 14.4 Selecting tag populations

For a detailed description of the UCODE G2X tag population selection process refer to Section 17, Ref. 1, section 6.3.2.7.

## 14.5 Inventorying tag populations

For a detailed description on accessing individual tags based on the UCODE G2X refer to Section 17, Ref. 1, section 6.3.2.8.

## 14.6 Accessing individual tags

For a detailed description on accessing individual tags based on the UCODE G2X refer to Section 17, Ref. 1, section 6.3.2.9.

An example inventory and access of a single UCODE G2X tag is shown in Section 17, Ref. 1, Annex E.1.

## 14.7 Interrogator commands and tag replies

For a detailed description refer to Section 17, Ref. 1, section 6.3.2.10.

### 14.7.1 Commands

An overview of interrogator to tag commands is located in Section 17, Ref. 1, Table 6.16.

Note that all mandatory commands are implemented on the G2X according to the standard. Additionally the optional command Access is supported by the G2X (for details refer to Section 14.11 “Optional Access Command”). Besides also custom commands are implemented on the G2X (for details refer to Section 14.12 “Custom Commands”.

### 14.7.2 State transition tables

The G2X responses to interrogator commands are defined by State Annex B transition tables in Section 17, Ref. 1. Following states are implemented on the G2X:

- Ready, for a description refer to Section 17, Ref. 1, Annex B.1.
- Arbitrate, for a description refer to Section 17, Ref. 1, Annex B.2.
- Reply, for a description refer to Section 17, Ref. 1, Annex B.3.
- Acknowledged, for a description refer to Section 17, Ref. 1, Annex B.4.
- Open, for a description refer to Section 17, Ref. 1, Annex B.5.
- Secured, for a description refer to Section 17, Ref. 1, Annex B.6.
- Killed, for a description refer to Section 17, Ref. 1, Annex B.7.

### 14.7.3 Command response tables

The G2X responses to interrogator commands are described in following Annex C sections of Section 17, Ref. 1:

- Power-up, for a description refer to Section 17, Ref. 1, Annex C.1.
- Query, for a description refer to Section 17, Ref. 1, Annex C.2.
- QueryRep, for a description refer to Section 17, Ref. 1, Annex C.3.
- QueryAdjust, for a description refer to Section 17, Ref. 1, Annex C.4.
- ACK, for a description refer to Section 17, Ref. 1, Annex C.5.
- NAK, for a description refer to Section 17, Ref. 1, Annex C.6.
- Req_RN, for a description refer to Section 17, Ref. 1, Annex C.7.
- Select, for a description refer to Section 17, Ref. 1, Annex C.8.
- Read, for a description refer to Section 17, Ref. 1, Annex C.9.
- Write, for a description refer to Section 17, Ref. 1, Annex C.10.
- Kill, for a description refer to Section 17, Ref. 1, Annex C.11.
- Lock, for a description refer to Section 17, Ref. 1, Annex C.12.
- Access, for a description refer to Section 17, Ref. 1, Annex C.13.
- T2 time-out, for a description refer to Section 17, Ref. 1, Annex C.17.
- Invalid command, for a description refer to Section 17, Ref. 1, Annex C.18.

### 14.7.4 Example data-flow exchange

For data flow-exchange examples refer to Section 17, Ref. 1, Annex K:

- K.1 Overview of the data-flow exchange
- K.2 Tag memory contents and lock-field values
- K.3 Data-flow exchange and command sequence

## 14.8 Mandatory Select Commands

Select commands select a particular UCODE G2X tag population based on user-defined criteria.