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UCODE G2iM+ demo board documentation

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Application note
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Abstract	Description of the functionality of the UCODE G2iM+ demo board

Revision history

Rev	Date	Description
1.2	20130527	Update bill of material
1.1	20120716	Major modification to describe G2iM+ demo board
1.0	20100531	Internal version

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1. Introduction

This application note describes the functionality of the UCODE G2iM+ demo board.

Fig 1 shows a picture of the demo board.

Fig 1. UCODE G2iM+ demo board

The UCODE G2iM+ IC has the most extensive feature set of all products in the UCODE G2i family. All UCODE G2i products contain the basic functionality of the EPC Gen2 standard [1]. In addition G2iL and G2iM have some additional features that are described in [1] and [3] resp. G2iM+ contains a superset of all G2i features. The G2iM+ demo board can therefore be used to get hands-on experience with all the features of the UCODE G2i family. In addition to the "standard" EPC Gen2 functionality (including User Memory) it shows the functionality of the following features:

Command	G2iL	G2iL+	G2iM	G2iM+
Read Protection (bankwise)	x	x	x	x
PSF (Built-in Product Status Flag)	x	x	x	x
Backscatter strength reduction	x	x	x	x
BlockWrite (32 Bit)	x	x	x	x
BlockPermalock	-	-	x	x
Tag Tamper Alarm	-	x	-	x
Digital switch	-	x	-	x
External supply mode	-	x	-	x
Data Transfer	-	x	-	x
Real Read Range Reduction	-	x	-	x
Conditional Read Range Reduction	-	-	-	x
Segmented user memory (open, protected, private)	-	-	-	x
Additional user memory for private memory	-	-	-	x
EPC size selectable (448 Bit max)	-	-	-	x

Fig 2. Features of UCODE G2i family

The demo board consists of a UCODE G2iM+ mounted on a PCB with an integrated slot antenna for the RFID functionality. It has 2 jumpers; one to activate the on-board battery for external supply voltage and the other to enable or disable the tamper alarm.

All details of the UCODE G2iL and UCODE G2iM products are described in the datasheets [1] and [3]. NXP also offers a document with frequently asked questions [4].

2. Functional description

2.1 Basic functionality

The demo board consists of a UCODE G2iM+ (SL3S1013FTB0) in a SOT886 package, mounted on a standard PCB with one copper layer and an integrated slot antenna for the RFID functionality. The slot antenna has the functionality of a dipole antenna.

The board contains a 3V battery that is connected to a voltage regulator to ensure that the supply voltage remains independent from the load. The battery can be used to extend the read range and to provide power for the LED that can be illuminated via the OUT pin. The OUT pin is connected to a FET [5] that is well suited due to a low internal capacitance value and a suitable threshold voltage.

Note: A low capacitance value is important to minimize coupling effects. If the slot antenna is in an RF field, voltage might couple into VDD and OUT pin and could restrict the performance of the IC.

Also additional inductors are used to limit coupling effects on the OUT and VDD pin.

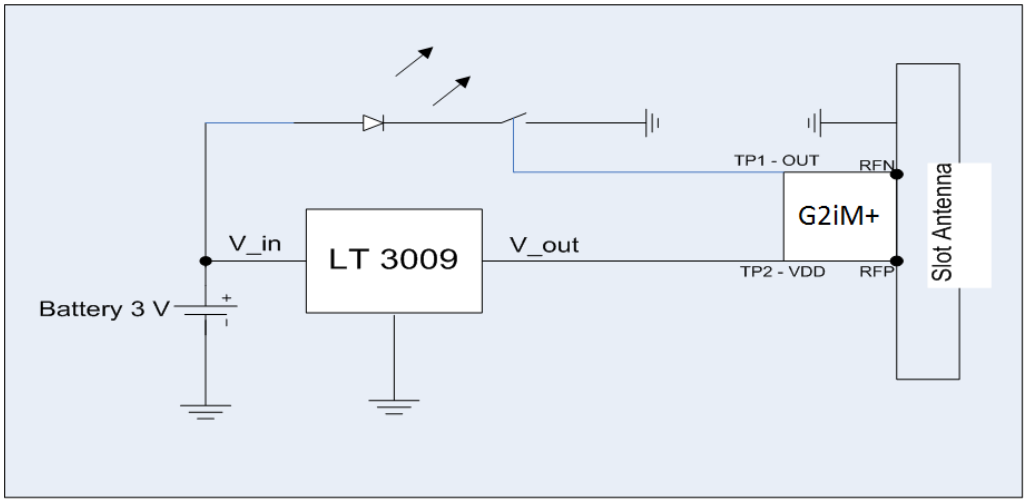

Fig 3. Basic function blocks

2.2 Layout

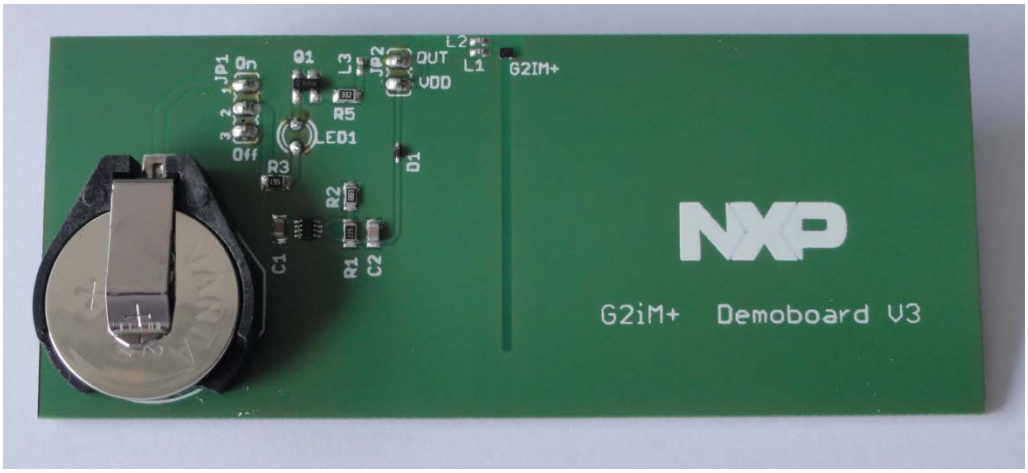

Fig 4. UCODE G2iM+ demo board- layout

The dimensions of the demo board are 100 mm x 40mm.

2.3 Schematic diagram

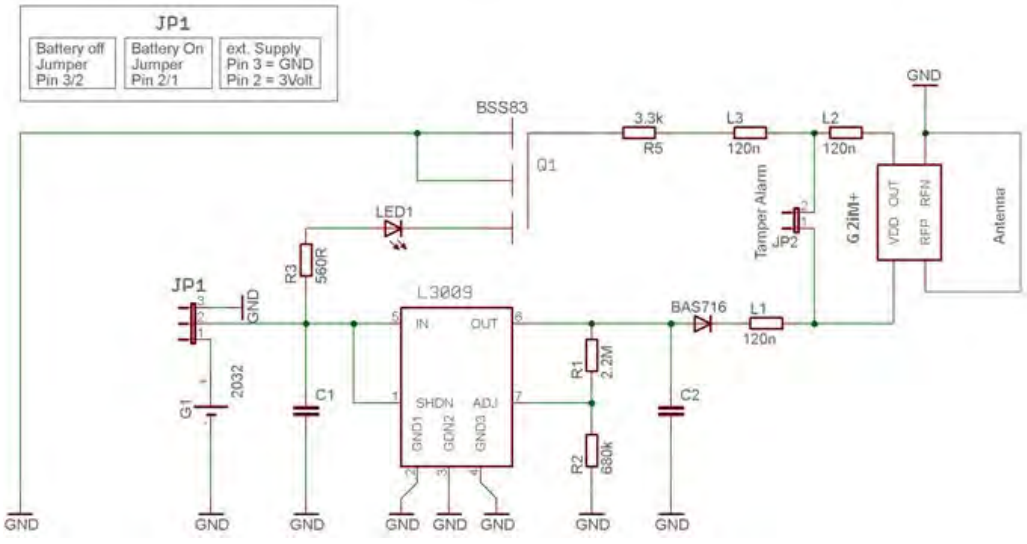

Fig 5. NXP PCB UCODE G2iM+ demo board-schematic

The demo board has 2 jumpers; JP1 and JP2

- **JP1** can be used to activate the on-board battery for extending the read range (see 3.4). It has two jumper positions; P1:1-2 and P1:2-3. A jumper on JP1:1-2

enables the on-board battery. This jumper will also extend the read range of the demo board. Pins 2-3 of JP1 can be used to connect an external power supply. If the demo board is not in use the jumper should either be removed or put on pin JP1:2-3. If it remains on pin JP1:1-2, the circuit will draw a small current that will drain the battery within the timeframe of a few weeks even when the LED is switched off

- **JP2** can be used to enable or disable the tamper alarm (see 3.2). Setting the jumper will set the “tamper alarm indicator” bit to 1.

2.4 Bill of material

Table 1. UCODE G2iM+ demo board – Bill of Material

Part	Value	Package	Type
C1	100nF	C0805	Capacitance
C2	100nF	C0805	Capacitance
D1	BAS716	SOD523	Diode
G2iM+_SOT886	-	SOT886	NXP – IC
JP1	-	-	Jumper
JP2	-	-	Jumper
L1	120n	R0402	Inductance
L2	120n	R0402	Inductance
L3	120n	R0402	Inductance
L3009	L3009	SC70	linear technology
LED1		LED3MM	Led
BSS83	BSS83_N	SOT143_N	NXP – FET
R1	2.2 M	R0805	Resistor
R2	680k	R0805	Resistor
R3	560	R0805	Resistor
R5	3.3k	R0805	Resistor
U$1	CR2032H_SMD_SMALL	CR2032H_SMD_SMALL	Battery

3. Configuration of the demo board

3.1 ConfigWord

The demo board can be configured by setting the ConfigWord at addresses 200_h-$20F_h$ in EPC memory (Bank 01).

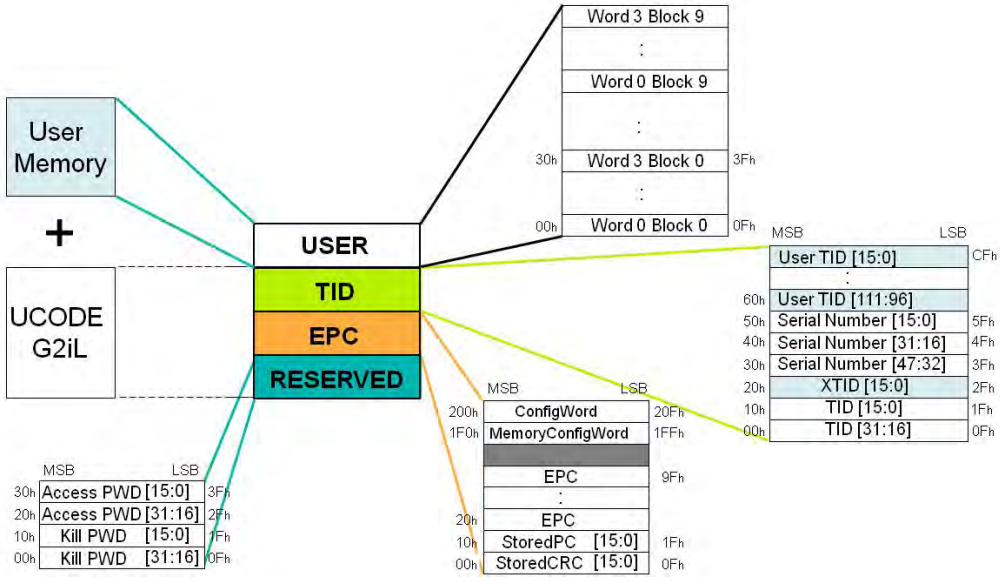

Fig 6. Memory structure of UCODE G2i family

The ConfigWord is described in Fig 7.

In order to address this word, the memory bank 1 (= EPC memory) needs to be chosen, and the word address (32d or 20h).

Address 200h - 207h

Indicator bits				Temporary bits			Permanent bits
Tamper indicator	External supply indicator	RFU	RFU	invert Digital Output	Transparent mode on/off	Data mode data/raw	Conditional Read Range Reduction ON/OFF
0	1	2	3	4	5	6	7

Address 208h - 20Fh

Permanent bits							
Conditional Read Range Reduction open/short	max backscatter strength	Digital output	Read Range Reduction	Read Protect USER Memory	Read Protect EPC	Read Protect TID	PSF Alarm Bit
8	9	10	11	12	13	14	15

Fig 7. Setup of ConfigWord EPC memory bank, address 200h – 20Fh

The factory setting of ConfigWord is 0040_h

There are three categories of bits:

- **Indicator Bits:** cannot be changed by command.
  (Value is determined by the jumper settings)
- **Temporary Bits:** reset at power up
- **Permanent Bits:** Can be changed by reader commands. Bits are permanently stored in the memory. They maintain their value, also when the tag leaves the RF-field.

The value of the bits can be toggled by sending a WRITE command with the right value for the related bit:

First, check the status of a bit by sending a READ command to read the contents of the ConfigWord.
Here are some examples to assist with the interpretation of the response:

- 0020_h : Only the “Digital Output” is set to 1, all other bits of this word are zero.
- 8040_h: Tamper indicator is set (VDD and OUT have a galvanic connection), and the “Max Backscatter Strength” is set, all other bits of this word are zeros.
- 4020_h: The “external supply indicator “is set (V_{supply} is on), and the “Digital Output” bit is set, all other bits of this word are zeros.
- Second, toggle the OUT pin –if needed- by sending a WRITE command.

Example: Write “0020_h” on the address 20_h (word 32 in EPC memory), and the state of the OUT pin will change.

3.2 Tag Tamper Alarm

The tag tamper alarm is a feature that can be used to monitor the connection between the OUT and VDD pin (see Fig 5). Anytime the tag moves into READY state (see [1]), it check if the two pins are connected or not.

The tag tamper alarm can be set by jumper JP2 (see Fig 5). Setting the jumper will set the “tamper alarm indicator” bit to 1.

The tamper feature and the external supply cannot be used at the same time!

Example:

If the jumper is set, the value of the ConfigWord could be:

“8040” - Tamper indicator bit is set, max backscatter strength is set.

After removing the jumper on JP2, this will change to: “0040”

3.3 Read Range Reduction

Read range reduction can be used as a privacy feature to reduce the read range of a tag. When the UCODE G2iM+ demo board is in the privacy mode, the read range is limited to a few centimeters.

Setting the Read Range Reduction will reduce the sensitivity by ~38 dB. The sensitivity of the tag will change from -18dBm to +12dBm. Sufficient RF field power is required in order to assure a stable RF communication between reader and demo board. This means that only larger (Far field) antenna designs are working very close to the antenna.

Toggling the “privacy mode” bit on position 11, will set or reset the privacy mode.

Example:

Starting value is “8040” (Tamper indicator bit is set, max backscatter strength is set)

A WRITE command with the data “0010” will change the value to “8050”. The demo board is now in the privacy mode.

3.4 Increase read range

The read range of the demo board can be increased by using the power of the onboard battery. The battery can be activated by putting a jumper on position JP1:1-2 (see Fig 5). This will increase the sensitivity of the tag and therefore also the read range of the demo board will increase.

3.5 Digital Switch (Externally Supplied)

A jumper on position JP1:1-2 (see Fig 5) can be used to activate the onboard battery for illuminating the LED. The LED can be switched on or off by toggling the state of the “digital out” bit.

The “digital out” bit can be toggled by sending a write command with the value “0020” on the address of the ConfigWord.

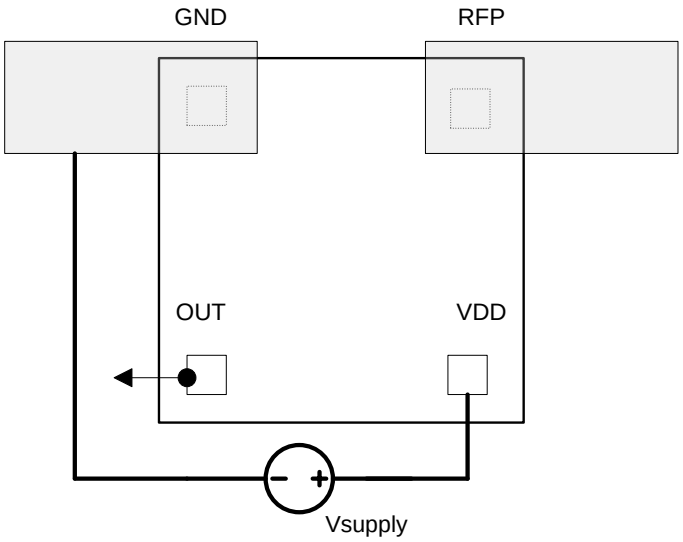

Fig 8. Digital Switch – Block Schematic

The “Digital Output” bit determines the state of the OUT pin, and can be set to 0 or 1.

The state can be toggled by performing a WRITE command on this bit:

- Example: Write “0020” on the address 20h (word 32 in EPC memory), and the state of the OUT pin will change

There are also “temporary” bits defined in the ConfigWord, such as “invert digital output”, (bit 4).

This can be used, if a temporary output, as long as the label is in the reader field, is needed for the application.

For example: “Digital Out” would have the value zero. Circuit is set up; power supply is connected as specified. The “invert digital out” can be set as soon as the tag is in the reader field, which is high enough to perform a WRITE operation.

Then the OUT pin will be on “high” as long as the tag is in the field, and would flip back again once it is out of the field.

3.6 Data Transfer (Externally Supplied)

The LED will be set on/off according to the transferred data stream from the reader. Instead of an LED, any device which can process an on/off data stream can be connected.

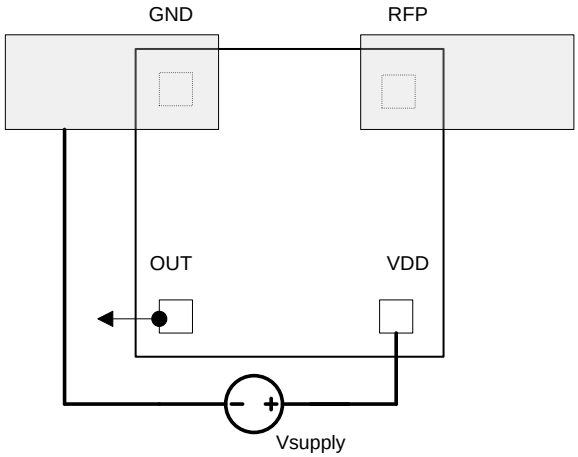

Fig 9. Data Transfer – Block Schematic

By setting the “transparent mode” in the ConfigWord, data can sent from the reader via the RF field, to the IC and then to the connected device (e.g. a microcontroller). The transparent mode can be toggled by sending a write command with the value “0400” on the address of the ConfigWord.

As long as this bit is set the data coming from the reader (e.g. a query command) will be available on the OUT pin. The bit is reset, if the battery is disconnected and then reconnected.

Fig 10 shows a screenshot of the voltage level on the OUT pin while sending a standard EPC write command from the reader to the IC.

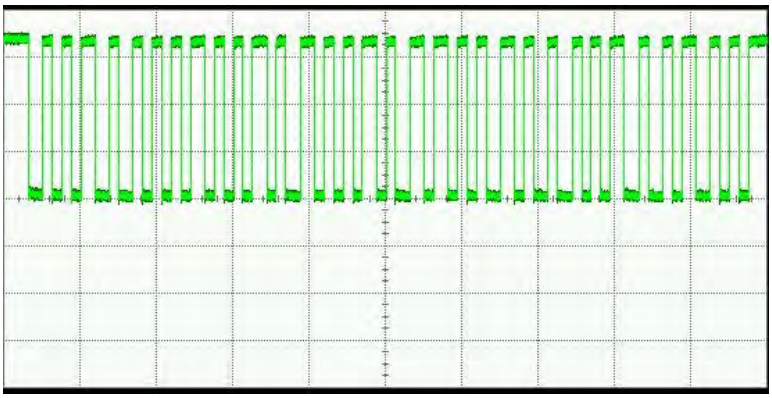

Fig 10. Screenshot of voltage level on the OUT pin. Settings: 500 mV, 200 µs /div

4. References

[1] EPC™ Radio-Frequency Identity Protocols, Class-1 Generation-2 *UHF RFID, Protocol for Communications at 860 MHz – 960 MHz, Version 1.2.0; EPCglobal™ Inc.*
http://www.nxp.com/redirect/gs1.org/gsmp/kc/epcglobal/uhfc1g2

[2] Datasheet: SL3S1203_1213; UCODE G2iL and G2iL+ (BUID doc.no. 1788**[1])
http://www.nxp.com/documents/data_sheet/SL3S1203_1213.pdf

[3] Datasheet: SL3S1003_1013; UCODE G2iM and G2iM+ (BUID doc.no. 2012**)
http://www.nxp.com/documents/data_sheet/SL3S1003_1013.pdf

[4] Application note: AN10940; Frequently asked questions and features UCODE G2i
http://www.nxp.com/restricted_documents/53420/AN10940.pdf

[5] Description of FET that is connected to OUT-pin
http://www.nxp.com/documents/data_sheet/BSS83_N.pdf

[6] NXP Application Note, AN1715 - UHF RFID PCB antenna design
http://www.nxp.com/documents/application_note/096917_UCODE_G2XM_G2XL_an.zip

1. ** … BUID document version number

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