

Cinterion[®] Connect Shield

User Guide

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Contents

0	Document History	4
1	Introduction	5
1.1	Package Content	5
1.2	Feature Overview.....	5
1.3	Safety Precaution Notes	6
1.4	Regulatory Compliance Information.....	6
2	Interfaces	7
2.1	Overview	7
2.2	Application / Arduino UNO Interface	8
2.2.1	Pin Outline	8
2.2.2	UART	10
2.2.3	USB.....	10
2.2.4	IO Reference Setup	10
2.2.5	I2C	11
2.2.5.1	I2C Temperature Sensor	11
2.2.5.2	I2C Ambient Light Sensor	11
2.2.5.3	I2C Port Extender.....	11
2.2.5.4	I2C Quick Access via Module I ² C.....	12
2.2.6	Controlling the Modem ON/OFF State.....	13
2.3	Buttons.....	13
2.3.1	ON/OFF Button	13
2.3.2	Freely Programmable Button	13
3	RF Interference.....	14
4	Characteristics	15
4.1	Limits.....	15
4.2	Recommended Operating Conditions	15
4.3	Static Characteristics	15
5	Appendix – Schematics.....	16
5.1	Placement.....	18

0 Document History

Preceding document: "Cinterion® Connect Shield User Guide" v01

New document: "Cinterion® Connect Shield User Guide" **v02**

Chapter	What is new
Throughout document	Updates for hardware revision 2 - marked "B1" at Connect Shield's bottom side. New features are: <ul style="list-style-type: none">• IOREF signal now serving as input/output voltage level reference.• Freely programmable button now connected on D7 to GND, equivalent to an open drain output.

New document: "Cinterion® Connect Shield User Guide" v01

Chapter	What is new
---	Initial document setup.

1 Introduction

The Cinterion® Connect Shield is designed as a platform for the Internet of Things (IoT).

Programmers looking for wireless connectivity for their sensors and other actors can mount the Connect Shield to their existing Arduino stacks. No hardware expertise is required in most of these cases.

This User Guide describes the Connect Shield's interface capabilities and specifications.

1.1 Package Content

Depending on its configuration, your Connect Shield package includes:

- Cinterion® Connect Shield
- Wideband PCB antenna 700MHz...2.8GHz
- RF cable with U.FL terminations
- SMA to U.FL adaptor
- Quick start guide

For further information and resources like the Gemalto Webstore, documents, drivers, libraries, and example code, please also refer to <https://developer.gemalto.com/>.

1.2 Feature Overview

The Connect Shield provides basic features required for wireless communication







- Technology depending on the ordered Connect Shield configuration: 2G/3G/4G/NB-IoT
- On board I²C temperature and ambient light sensor as well as 4-bit I²C extender with 3 LED's connected
- On board micro-SIM card holder
- ON/OFF button plus additional programmable arbitrary button
- Power supply for the Connect Shield through Arduino 5V interface and/or an additional micro-USB on board allowing flexible powering distribution
- The Cinterion® Connect Shield with its module operates as a slave in an Arduino stack. To use the module with its Java features as a master in an Arduino environment there is a further device called the Cinterion® Concept Board. For more information on the Concept Board, please see <http://www.gemalto.com/m2m/development/cinterion-concept-board>.

1.3 Safety Precaution Notes

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The common safety precautions that apply to mobile phones must also be observed at all times when using this Connect Shield. Failure to comply with these precautions violates safety standards. Gemalto M2M assumes no liability for customer's failure to comply with these precautions.

The following is a non-extensive list of the mobile phone and Connect Shield usage restrictions:

	Pacemaker patients are advised to keep their hand-held mobile away from the pacemaker while it is on.
	Mobile phones must be switched off before boarding an aircraft.
	Mobile phones may not be operated in the presence of flammable gases or fumes
	Interference can occur if mobile phones are used close to TV sets, radios, computers or inadequately shielded equipment
	Do not use your mobile while driving a vehicle
	You should never rely solely upon any wireless device for essential communications, for example for emergency calls

The power supply connected to the Connect Shield shall be in compliance with the SELV requirements defined in EN 60950-1.

1.4 Regulatory Compliance Information

The Cinterion® Connect Shield is intended for evaluation and development purposes only, and should therefore only be used in a (laboratory) test environment. The device is not CE approved, and has not been authorized as required by the rules of the FCC. All persons handling the Cinterion® Connect Shield must be properly trained in electronics and observe good engineering practice standards.

2 Interfaces

2.1 Overview

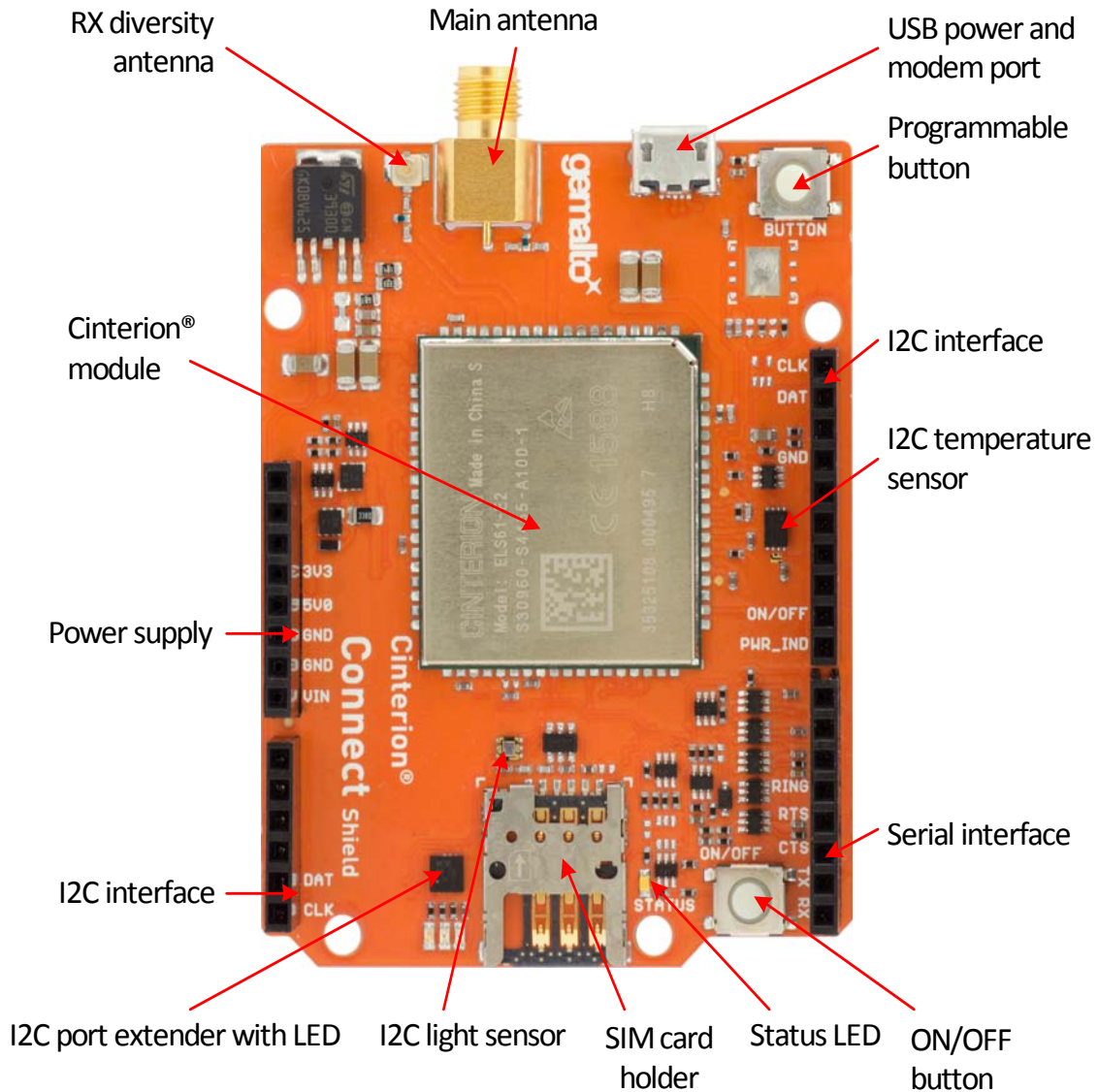


Figure 1: Connect Shield interfaces

Table 1: Connect Shield's Arduino UNO interface pin and signal description

Name	Modem Reference	Dir	Description	Properties
NC	-		NC ¹	
IOREF	-	I ²	Reference	Reference level 3V3 / 5V for IO Pins. 1MΩ PU to 5V, 470kΩ//1μF PD
RESET	-	-	NC	
3.3V	-	I	Shield supply	I ² C sensor supply
5V	-	I	Shield supply	Modem supply via voltage regulator
GND	-		Main Ground	
Vin	-	-	NC	
A0	-	-	NC	
A1	-	-	NC	
A2	-	-	NC	
A3	-	-	NC	
SDA	SDA	IO	I2C data signal	5V compliant, Rpu=4.7kΩ, connected to modem via level shifter
SCL	SCL	O	I2C clock signal	5V compliant, Rpu=4.7kΩ, connected to modem via level shifter
SCL	SCL	O	I2C clock signal	5V compliant, Rpu=4.7kΩ, connected to modem via level shifter
SDA	SDA	IO	I2C data signal	5V compliant, Rpu=4.7kΩ, connected to modem via level shifter
AREF	-	-	NC	
SCK	-	-	NC	
MISO	-	-	NC	
MOSI	-	-	NC	
CS	-	-	NC	
D9	ON	I	ON/OFF	A falling edge triggers the modem ON signal. A low level (>3s) switches off the modem power supply. Note: After the falling edge this signal should be released within 1s in order to keep the modem running.
D8	PWR_IND	O	PWR_IND	Low level open collector output, Rout=100Ω, indicating the modem has been started
D7	-	I ²	Button	Input for free push button, operating as open drain.
D6	-	-	NC	
D5	-	-	NC	
D4	RING	O	Host wake up	5V compliant, Rout=1kΩ, wake host from sleep for incoming message
D3	RTS	I	Flow control	5V compliant, Iinmax=+-2μA, Modem wake up, can be configured as not used
D2	CTS	O	Flow control	5V compliant, Rout=1kΩ, can be configured as not used
TX	RxD0	O	Serial out	5V compliant, Push pull; Io=+-50mA
RX	TxD0	I	Serial in	5V compliant, Iinmax=+-2μA

¹. NC = Not Connected

². Not supported with hardware revision 1.

2.2.2 UART

The Connect Shield interface supports a UART (RxD/TxD) connection with up to 921kbit/s. By default the speed is set to 115kbit/s. It is mandatory to use the modem's flow control RTS in case the modem is configured for SLEEP mode (i.e., power saving). In SLEEP mode - please refer to the modem's AT Command Set for possible SLEEP mode settings - the modem awakes by a falling RTS signal and retrieves UART data. On incoming messages the RING toggles to awake the host from sleep, this line should be interrupt able on host side.

2.2.3 USB

The Connect Shield comes with a separated micro-USB interface that is intended to

- Supply additional power in case of weak Arduino supply while transmitting data in areas with a weak network coverage
- Support additional serial interfaces for different purpose, like debugging, modem firmware upgrade or command interface

Whenever the modem switches off while transmitting data over the air, an additional USB power supply 5V/1A should be connected to resolves such power issues. Please note, this additional supply is not fed toward the Arduino base board, meaning the Arduino has to be supplied in any case.

Note: The micro-USB driver can be downloaded under developer.gemalto.com.

2.2.4 IO Reference Setup

Since the connect shield is multilevel compatible, the input signal IOREF sets the IO reference voltage for all input and output signals. See [Table 1](#) for IOREF signal properties.

When setting IOREF to GND with no 3V3 present at the same time, the Connect Shield could run into an undefined state as shown in [Table 2](#). Such a state should be avoided by releasing IOREF (i.e., NC) - which than sets the IO level to 5V.

Table 2: IO reference setup

IOREF state	Presence PWR 3V3	IO level setup
3V3	3V3	3V3
GND	3V3	3V3
5V	3V3	5V
NC	3V3	5V
3V3	Not present	5V
NC	Not present	5V
GND	Not present	Undefined

2.2.5 I²C

Arduino's I²C interface is connected to the modem as well as to a separate temperature sensor, ambient light sensor and a 4-bit port extender.

Note: The modem can be master only. For I²C commands and settings for modem controlled I²C please refer to the modem's AT Command Set. Refer to the device command description on how to setup the I²C protocol.

2.2.5.1 I²C Temperature Sensor

On board is the temperature sensor NXP PCT2075 accessible via I²C address 1110 101 (0x75).

2.2.5.2 I²C Ambient Light Sensor

On board is the ambient light sensor Vishay VEML6030 accessible via I²C address 0010 000 (0x10).

Note: Ambient light sensor needs to be powered by the 3.3V source from Arduino based board.

2.2.5.3 I²C Port Extender

On board is 4-bit port extender PCA9536TK accessible via I²C address 1000 001 (0x41). Three IO are connected to LED's as output, while one IO is free for any usage on a test point.

Table 3: I²C port extender

Hex	TP(IO3)	LED Yellow(IO2)	LED Orange(IO1)	LED Green(IO0)
0x00	low	on	on	on
0x01	low	on	on	off
0x02	low	on	off	on
0x03	low	on	off	off
0x04	low	off	on	on
0x05	low	off	on	off
0x06	low	off	off	on
0x07	low	off	off	off
0x08	high	on	on	on
0x09	high	on	on	off
0x0A	high	on	off	on
0x0B	high	on	off	off
0x0C	high	off	on	on
0x0D	high	off	on	off
0x0E	high	off	off	on
0x0F	high	off	off	off

2.2.5.4 I²C Quick Access via Module I²C

Please complete the following steps for a quick access via the module's I²C lines:

- Download the installation package from developer.gemalto.com.
- Connect the USB cable from the PC to the Connect Shield's USB socket
- Start your Connect Shield with the ON button (short press).
- Install the modem USB drivers from the ZIP file. The drivers have to be installed manually.
- Open the Windows Device Manager to check for the modem's COM Port number:
Modems > Cinterion <Modem name> Java Debug Modem USB > Properties > Modem > Port
- Open your favorite Terminal program, and connect to Connect Shield using these settings:
< COM port number>, 115200 bps, 8N1, CTS/RTS control, DTR on
- Using the Terminal program you can now start entering commands for the Connect Shield (plus CR+LF) as shown further below.

The given addresses for the sensors and the port extender are 7 bit. Adding after the address a read bit R=1 or write bit W=0 changes the length to 8bit.

PCT2075 temperature sensor	PCA9536TK port extender	VEML6030 ambient light sensor
0x75 + W = 0xEA	0x41 + W = 0x82	0x10 + W = 0x20
0x75 + R = 0xEB	0x41 + R = 0x83	0x10 + R = 0x21

Example for reading the PCT2075 temperature sensor:

To read the temperature via module I²C you need to open the I²C bus:

AT^SSPI=	(Wait for "CONNECT") (EA=0x75+W, 00=temperature pointer byte)
<aEA00>	(Answer: {a+}) (EB=0x75+R, 0002=16bit which needs to be parsed)
<aEB0002>	(Answer: {a+1A20}) (Close the I ² C bus)
#	(Answer: "OK")

The returned answer is for example $1A20_{\text{hex}} \Rightarrow 0001.1010.0010.0000_{\text{bit}}$

The first 7 MSB should be used $\Rightarrow 0001.1010.0010.0000$

$0001.1010.001_{\text{bit}} = 209_{\text{dec}}$

$209 \times 0,125^{\circ}\text{C} = 26^{\circ}\text{C}$

Example for reading the PCA9536 port extender:

To set the port extender via module I²C you need to open the I²C bus:

```

AT^SSPI=                (Wait for "CONNECT")
                        (82=0x41+W, 0x03=Configuration Register, 0xF0=sets Q0 to Q3 to output)

<a8203F0>                (Answer: {a+})
                        (82=0x41+W, 0x01=Output Port Register, 0xF0= turns all 3 LEDs on and
                        test point to low)

<a8201F0>                (Answer: {a+})
                        (Close the I2C bus)

#                          (Answer: "OK")

```

2.2.6 Controlling the Modem ON/OFF State

The modem can be started with a falling edge at the ON signal (high to low transition). To keep the modem running the ON signal must then be released again within 1s. Holding the ON signal low for more than 3s, the modem is switched off again, i.e., the power supply is disconnected from the module. Thus the ON signal behaves like the ON/OFF button.

Note: An Arduino may come with a default low level at the ON signal that causes the Connect Shield's power supply to be permanently disabled. Such a case is indicated by the LED remaining off when stacked up. In this case the ON signal must be programmed on the Arduino to be an open drain.

2.3 Buttons**2.3.1 ON/OFF Button**

Pressing the ON/OFF button shortly starts the modem - indicated by the LED lighting up.

Pressing the ON/OFF button for more than 3s switches off the modem's power supply, i.e., powers off the modem, which is indicated by the LED going off.

2.3.2 Freely Programmable Button

A further button is freely programmable, and might be polled by the modem or Arduino.

Note: The Connect Shield hardware revision 1 does not support the button being controlled by the Arduino.

3 RF Interference

When stacking up the Connect Shield with other shields as well the Arduino together with the PCB antenna, high power RF radiation from the high efficiency PCB antenna may interfere with other shields or the Arduino, especially in 2G mode with up to +33dBm output power. This interference may result in signal distortion caused by RF demodulation. In such cases it is recommended to separate the antenna from the shield and increase the distance.

4 Characteristics

4.1 Limits

Table 4: Absolute maximum ratings

Parameter	Min	Max	Unit
Supply voltage on USB ports	-0.3	5.5	V
Voltage at 3.3V application supply interface (Arduino)	-0.3	3.6	V
Voltage at 5V application supply interface (Arduino)	-0.3	5.25	V
Voltage at application signal interface (Arduino)	-0.3	6	V
Environmental temperature	0	35	°C

Note: Violation of these limits may cause permanent damages to the Connect Shield.

4.2 Recommended Operating Conditions

Table 5: Recommended operating conditions

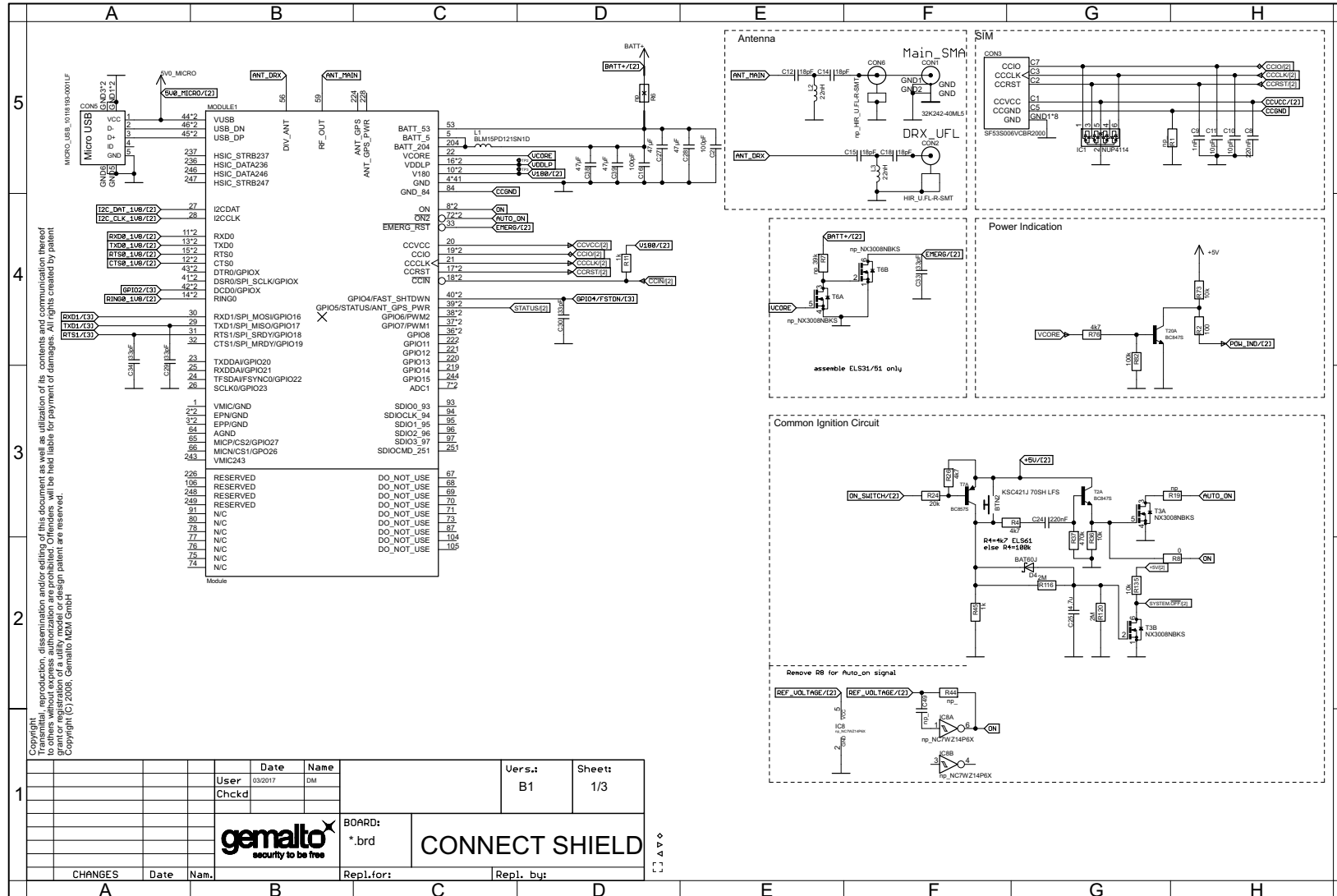
Parameter	Min	Max	Unit
Supply voltage on USB port and 5V power	4.75	5.25	V

4.3 Static Characteristics

Table 6: Static characteristics

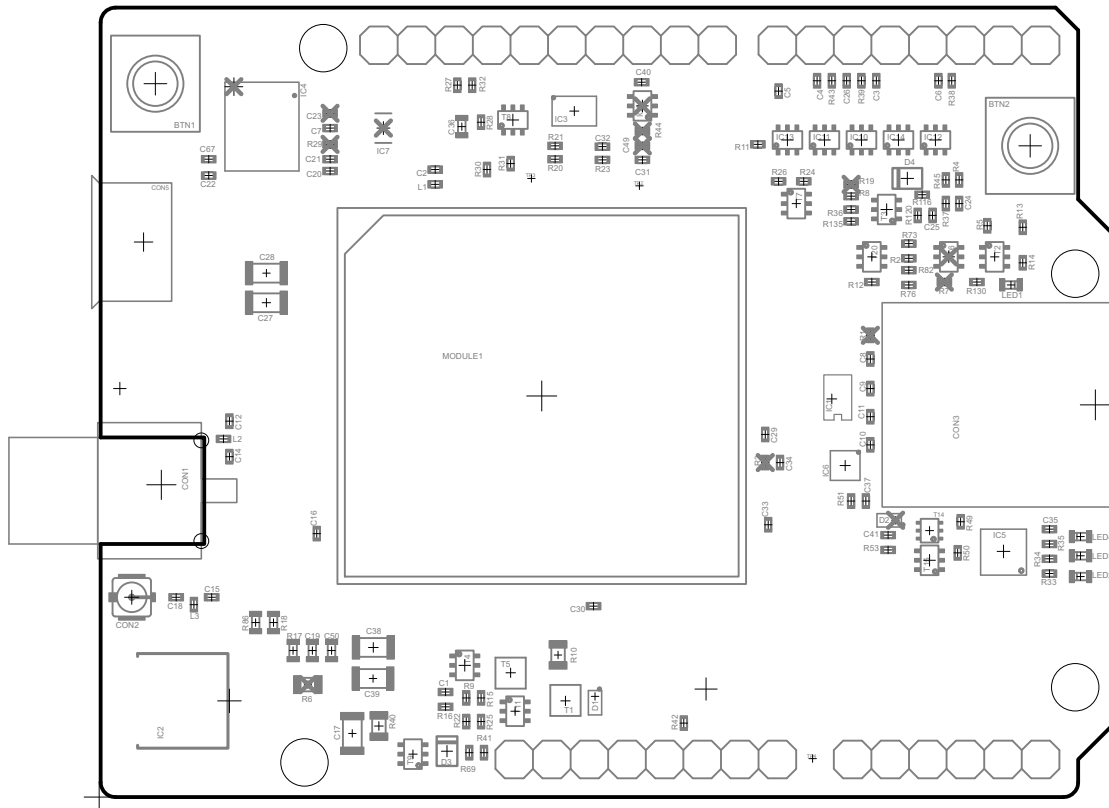
Parameter	Max value	Unit
High level input voltage on application interface	3.36	V
Low level input voltage on application interface	1.44	V
High level output voltage on application interface @ $V_{usb}=5V$; $I_o=-32mA$	TBD.	V
Low level output voltage on application interface @ $V_{usb}=5V$; $I_o=32mA$	TBD.	V

5 Appendix – Schematics



5.1 Placement

5.1 Placement



x = Not populated

About Gemalto

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We are at the heart of the rapidly evolving digital society. Billions of people worldwide increasingly want the freedom to communicate, travel, shop, bank, entertain and work - anytime, everywhere - in ways that are enjoyable and safe. Gemalto delivers on their expanding needs for personal mobile services, payment security, authenticated cloud access, identity and privacy protection, eHealthcare and eGovernment efficiency, convenient ticketing and dependable machine-to-machine (M2M) applications.

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