ASME Lion

User Guide

Ver 1.3

www.axelelettronica.it

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Revision Sheet

Release No.	Date	Revision Description
Ver 1.0	14/12/2016	First Release
Ver 1.1	14/01/2017	PDF error conversion fixed & General review
Ver 1.2	31/01/2017	Fig. 2 and Fig. 5 changed
Ver1.3	11/02/2017	MCU pin column added to table 4; Tables 5,6,7 added

Table 1: Document History

TABLE OF CONTENTS

Tables Index

Illustrations Index

Chapter 1 Introduction

This document describes **ASME Lion** SoM (System On Module) based on Atmel D21 Ultra low-power microcontroller using the 32-bit ARM® Cortex®-M0+ processor.

The **ASME Lion** Board provides the following peripherals or modules:

- Crypto Authentication chipset
- LoRa Module
- GPS Module with Embedded Antenna
- Bluetooth Low Energy (BLE) Interface

The **ASME Lion** Board is supported by the Arduino IDE for a fast and easy software development cycle (https://www.arduino.cc/en/Main/Software).

The software can also be developed using the Atmel Studio IDE commonly preferred by professional software engineers (http://www.atmel.com/Microsite/atmel-studio/).

1.1 Board Specifications

Characteristics	Value
CPU Clock speed	48MHz
Flash Memory	256K
SRAM	32K
Connector	1 Power Jack 1 USB 1 Lora antenna 1 Li-Po Battery 1 SWD Debugger Arduino compatible PinOut
Board supply voltage	6V – 24V CC
Operative Voltage	3.3V
Temperature	-40°C to +85°C
Dimensions	68x30 mm
RoHS status	Compliant

Table 2: Board Specifications

Chapter 2 Hardware

2.1 External View

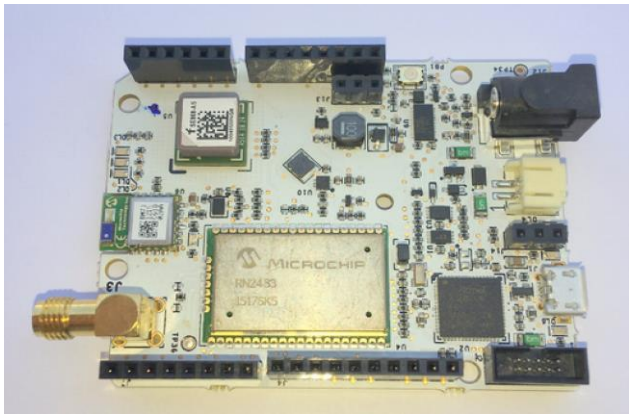


Figure 1: Front View

2.2 ASME Lion Block Diagram

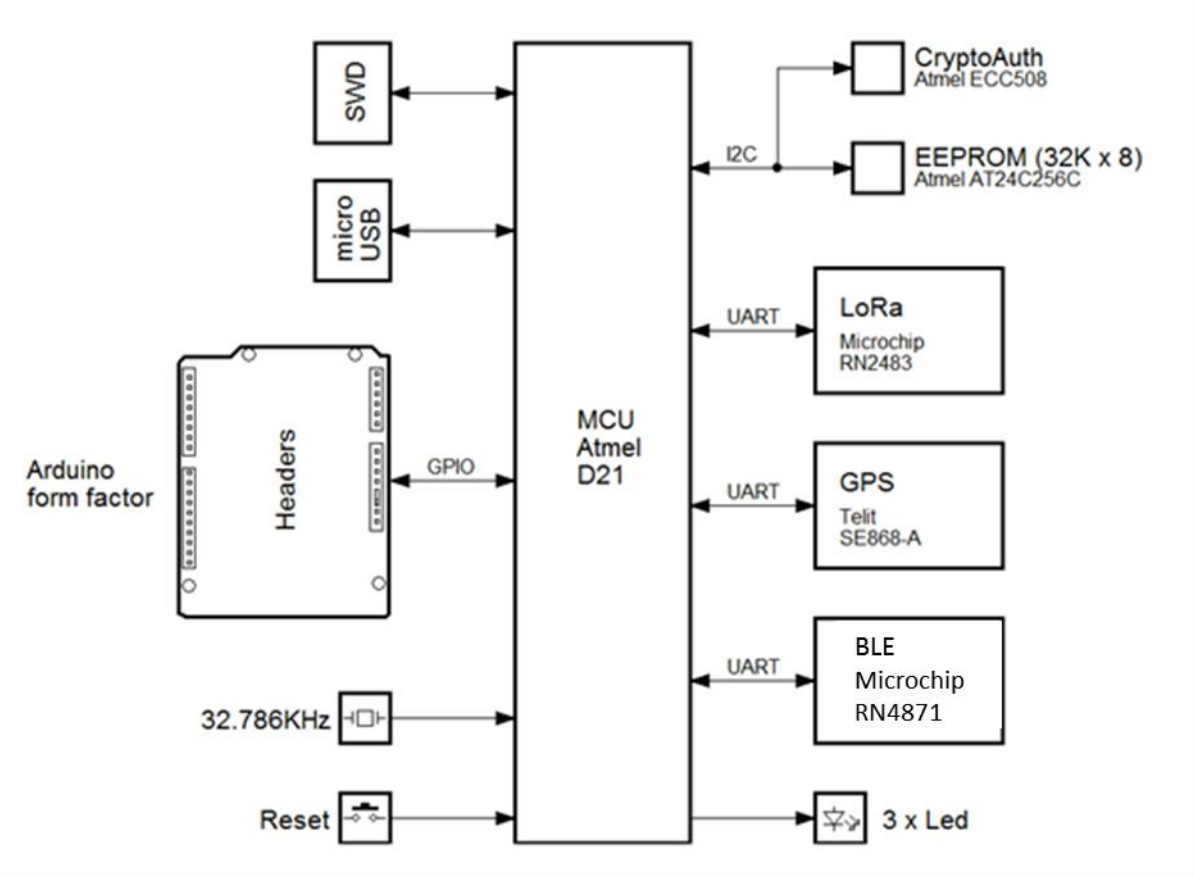


Figure 2: SmartEverything Block Diagram

2.3 ATMEL SAMD21Ultra low-power ARM® Cortex®-M0+ MCU

Atmel SAMD21 Ultra low-power microcontroller using the 32-bit ARM® Cortex®-M0+ processor is the core of the entire board.

Memory

- 256KB in-system self-programmable Flash
- 8KB Flash Read-While-Write section
- 32KB SRAM Main Memory
- 8KB SRAM Low power Memory

Clock Frequency

- 32.768kHz crystal oscillator (XOSC32K)

Arduino compliance

- Digital i/o Pins : 20
- PWM Pins: all but 2 and 7
- USART: 2 (USB and TTL Digital)
- Analog Input Pins: 6, 12-bit DAC
- Analog Output Pins: 1, 10-bit DAC
- External Interrupts: All pins except pin 4

More information can be found on the ATMEL SAMD21 Data Sheet (See the link in Chapter 6)

2.4 Power Supply Circuitry

The board can be powered by three different power supply sources:

- External Li-Po Battery
- A 6V to 24V input
- A 5V Mini USB connector

WARNING:
Li-Po batteries are charged at 4,2V with a current that is usually half of the nominal capacity (C/2). This board has a specialized chip that has a preset charging current of 350mAh. This means that the MINIMUM capacity of the Li-Po battery shall be 700 mAh. Smaller cells will be damaged by this current and may overheat, develop internal gasses and explode, setting the surroundings on fire.

All the components can work with the voltage range provided by the batteries, with the exception of the GPS module that requires at least 2.8V. For this reason it is recommended to use an appropriate battery pack for a prolonged use of the GPS.

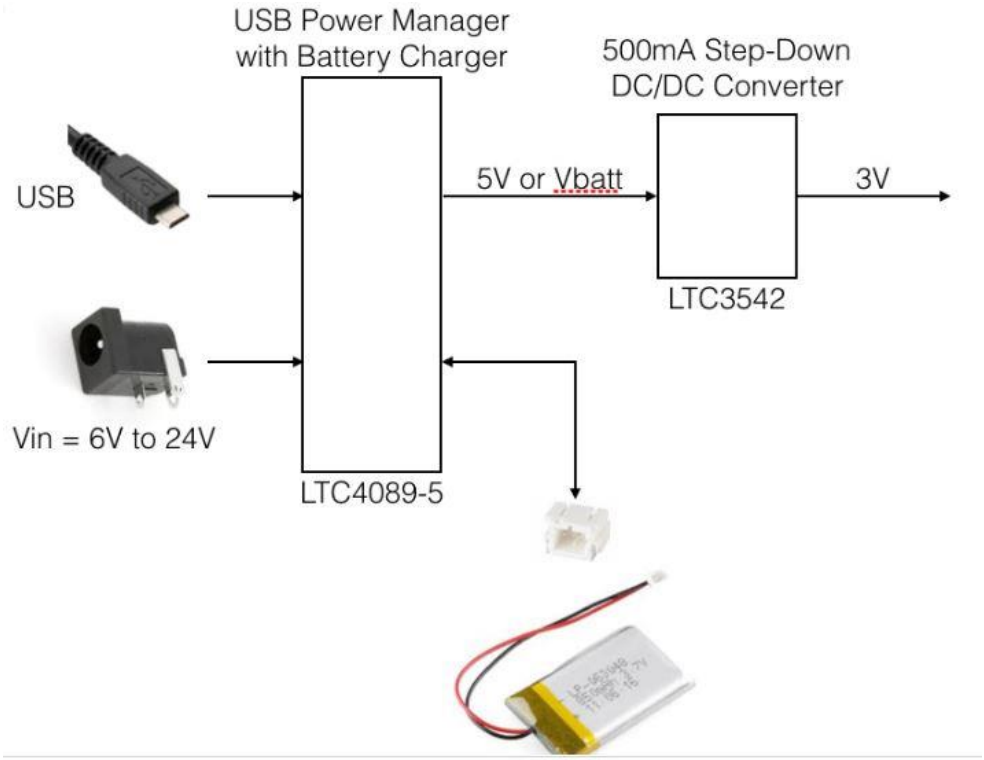


Figure 3: Power Supply block diagram

Name	Nominal	Description	Range
J10	3 V	Battery Power Supply	1.4V to 3.2V
J12	6V to 24V	External Power Supply	6V to 24V
USB	5V	USB Port	5V

Table 3: Power Supply Connectors and ranges

Use Li-Ion battery Vnom = 3.7V, Vchrg = 4.2V Capacity >= 700 mAh

2.5 Microchip LoRa Module (RN2483)

The Microchip RN2483 is a **Low-Power Long Range LoRa® Technology Transceiver Module,** providing a low-power solution for long range wireless data transmission.

The RN2483 module complies with the LoRaWAN Class A protocol specifications. It integrates RF, a baseband controller and a command Application Programming Interface (API) processor. More information can be found on relevant Data Sheet (See the link in Chapter 6)

2.5.1 Main Features

On-board LoRaWAN™ protocol stack:

- ASCII command interface over UART
- Environmentally friendly, RoHS compliant
- European R&TTE Directive Assessed Radio Module

RF/Analog Features

- Low-Power Long-range Transceiver operating in the 433 MHz and 868 MHz frequency bands
- High Receiver Sensitivity: down to -146 dBm
- TX Power: adjustable up to +14 dBm high efficiency PA
- Up to15km coverage at suburban and up to 5km coverage at urban area

2.6 Crypto Authentication Chip (ATMEL ATECC508A)

The ATECC508A is a member of the Atmel Crypto Authentication™ family of high-security hardware authentication devices. It has a flexible command set that allows to use it in many applications, including the following, among others:

- Anti-counterfeiting
- Protecting Firmware or Media
- Exchanging Session Keys
- Storing Data Securely
- Checking User Passwords

2.6.1 Device Features

The ATECC508A device includes an Electrically Erasable Programmable Read-Only Memory (EEPROM) array that can be used for key storage, miscellaneous read/write data, read-only, secret data, consumption logging, and security configuration.

Access to the various sections of memory can be restricted in a variety of ways, and the configuration can then be locked to prevent changes.

The ATECC508A features a wide array of defense mechanisms specifically designed to prevent physical attacks against the device itself or logical attacks against data transmitted between the device and the system.

Hardware restrictions on the way keys are used or generated provide further defense

against certain styles of attack.

Access to the device is made through a standard I2C interface.

Each ATECC508A ships with a guaranteed unique 9-byte (72-bit) serial number. Using the cryptographic protocols supported by the device, a Host system or remote server can prove that the serial number is authentic and is not a copy. Serial numbers are often stored in a standard Serial EEPROM, which can be easily copied with no way for the Host to know if the serial number is authentic or if it is a clone. The entire serial number must be utilized to guarantee uniqueness.

2.6.2 Cryptographic Operation

The ATSHA204A supports a standard challenge-response protocol to simplify programming. In its most basic installation, the Host system sends a challenge (i.e. a number) to the device in the Client, which combines that challenge with a secret key by using the Message Authentication Code (MAC) command from the system and sends that response back to the system.

This basic operation can be expanded in many ways because of the flexible command set of the ATECC508A.

For a complete explanation about the possible Cryptographic Operations check the Data Sheet (See the link in Chapter 6)

2.7 GPS Module with Embedded Antenna (Telit Jupiter SE868-A)

The Telit Jupiter SE868-A is a GPS Module designed to fully support GPS, QZSS, GLONASS and it is Galileo ready. It has an embedded SMT antenna and it is able to track GPS + GLONASS (and eventually Galileo) constellations simultaneously and to provide the position through the standard serial interface (UART).

The module software can increase the position accuracy supporting:

- Ephemeris file injection (A-GPS)
- Satellite Based Augmentation System (SBAS)

More information can be found on relevant Data Sheet (See the link in Chapter 6).

2.8 Bluetooth Low Energy (Microchip RN4871)

The RN4871 is a small form factor, Bluetooth 4.2 Low-Energy module measuring just 9 x 11.5 x 2.1 mm. This fully-integrated module is designed for easy implementation into a broad range of applications. Supporting the latest Bluetooth standard, it delivers up to 2.5x throughput improvement and more secure connections vs. Bluetooth 4.1 based products. Developers can easily interface to the device via a standard UART interface, available on most Microcontrollers and Processors.

2.8.1 Characteristics

- FCC Certified Yes
- Min Temp Range -20C
- Max Temp Range +70C
- Op Voltage Min 1.9V
- Op Voltage Max 3.6V

More information can be found on relevant Data Sheet (See the link in Chapter 6).

The module on the board is equipped with the firmware able to communicate with the ATMEL SAMD21 MCU.

A suggested App for Android is
B-BLE (https://play.google.com/store/apps/details?id=com.billy.billylightblue&hl=it)

2.9 32Kx8 Bits EEProm (AT24C256C)

The Atmel® AT24C256C provides 262,144-bits of Serial Electrically Erasable and Programmable Read-Only Memory (EEPROM) organized as 32,768 words of 8 bits each.

The device's cascading feature allows up to eight devices to share a common 2-wire bus. The device is optimized for use in many industrial and commercial applications where low-power and low-voltage operation are essential.

The device operates from 1.7V to 5.5V.

More information can be found on relevant Data Sheet (See the link in Chapter 6).

2.9.1 Characteristics

- Low-voltage and Standard-voltage Operation–VCC = 1.7V to 5.5V
- 400kHz (1.7V) and 1MHz (2.5V, 2.7V, 5.0V) Compatibility
- Write Protect Pin for Hardware Protection
- 64-byte Page Write Mode–Partial Page Writes Allowed
- High Reliability–Endurance: 1,000,000 Write Cycles–Data Retention: 40 Years

2.9.2 EEprom Address

The EEProm is mapped to the following I2C address 0x57

2.10 Board Interfaces and Connector

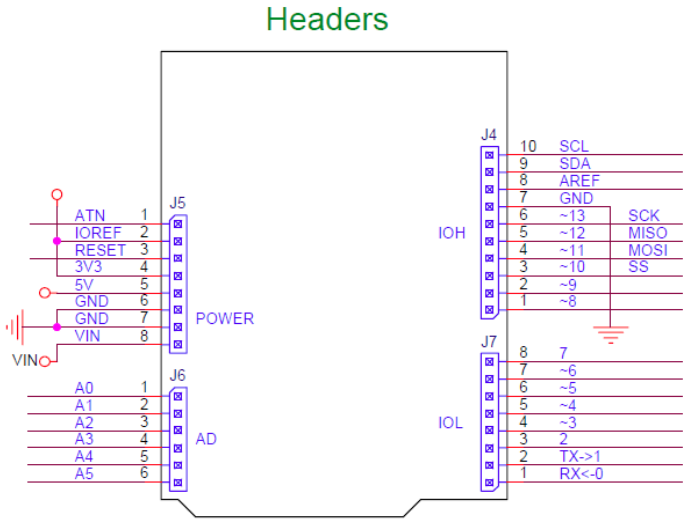


Figure 4: Headers pinout

Conn.	Pin	Description	Arduino pin label	Driven by
J4	1	Digital I/O D8 / PWM	~8	MCU Port PA06
J4	2	Digital I/O D9 / PWM	~9	MCU Port PA07
J4	3	Digital I/O D10 / PWM SS	~10	MCU Port PA18
J4	4	Digital I/O D11 / PWM MOSI	~11	MCU Port PA16
J4	5	Digital I/O D12 / PWM MISO	~12	MCU Port PA19
J4	6	Digital I/O D13 / PWM SCK	~13	MCU Port PA17
J4	7	Ground pin	GND	
J4	8	Analogue Reference (used by ADC)	AREF	MCU Port PA03
J4	9	I2C Interface SDA	SDA	MCU Port PA22
J4	10	I2C Interface SCL	SCL	MCU Port PA23
J5	1	Digital I/O ATN	ATN	MCU Port PB06
J5	2		IOREF	
J5	3	Reset	RESET	
J5	4		3.3V	
J5	5		5V	
J5	6	Ground pin	GND	
J5	7	Ground pin	GND	
J5	8	External Power Supply Input	VIN	
J6	1	Analog I/O A0	A0	MCU Port PA02
J6	2	Analog I/O A1	A1	MCU Port PB08
J6	3	Analog I/O A2	A2	MCU Port PB09
J6	4	Analog I/O A3	A3	MCU Port PA04
J6	5	Analog I/O A4	A4	MCU Port PA05
J6	6	Analog I/O A5	A5	MCU Port PB02
J7	1	Digital I/O D0 / Serial1 (RX)	RX<-0	MCU Port PA11
J7	2	Digital I/O D1 / Serial1 (TX)	TX->1	MCU Port PA10
J7	3	Digital I/O D2 / PWM	~2	MCU Port PA14
J7	4	Digital I/O D3 / PWM	~3	MCU Port PA09
J7	5	Digital I/O D4 / PWM	~4	MCU Port PA08
J7	6	Digital I/O D5 / PWM	~5	MCU Port PA15
J7	7	Digital I/O D6 / PWM	~6	MCU Port PA20
J7	8	Digital I/O D7 / PWM	~7	MCU Port PA21

Table 4: Arduino Compatible Headers

Description	Driven by
BLE TXD	MCU Port PB16
BLE RXD	MCU Port PB17
BLE RTS	MCU Port PB22
BLE CTS	MCU Port PB23
BLE P10	I/O Expander GPIO4
BLE P11	I/O Expander GPIO5
BLE P32	I/O Expander GPIO6
BLE P33	I/O Expander GPIO7
BLE RST	I/O Expander GPIO1

Table 5 BLE port description

Description	Driven by
LORA TXD	MCU Port PB12
LORA RXD	MCU Port PB13
LORA RTS	MCU Port PB14
LORA CTS	MCU Port PB15
LORA GPIO0	MCU Port PB07
LORA GPIO1	MCU Port PB10
LORA GPIO2	MCU Port PB11
LORA RST	I/O Expander GPIO0

Table 6 LORA port description

Description	Driven by
GPS TXD	MCU Port PA12
GPS RXD	MCU Port PA13
GPS RST	I/O Expander GPIO2
GPS FORCE ON	I/O Expander GPIO3

Table 7 GPS/GNSS port description

Chapter 3 Mechanical Information

3.1 Main components layout

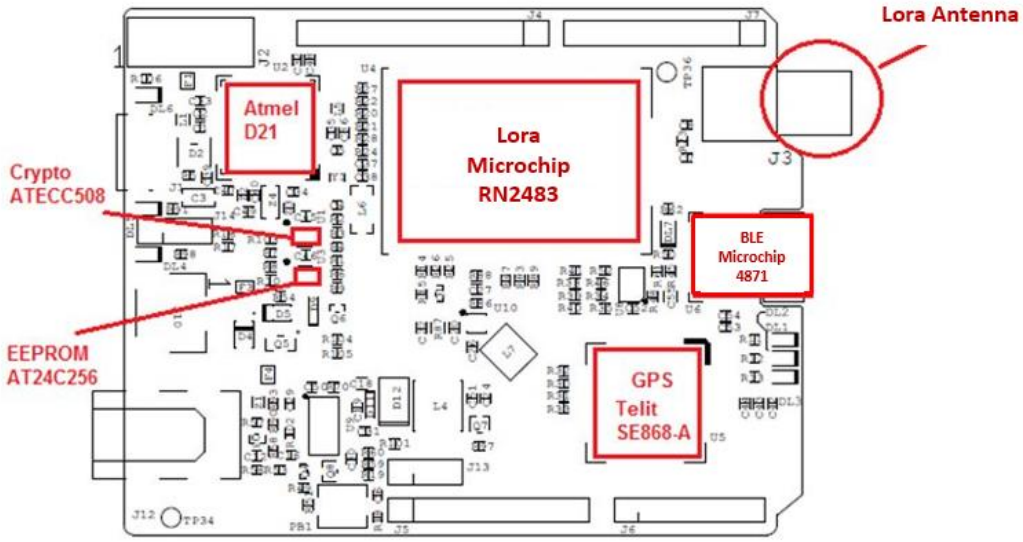


Figure 5: Main Component layout (top)

3.2 Mechanical Characteristics

The maximum length and width of the Smarteverything Lion PCB are 2.7 and 2.1 inches respectively, with the USB connectors, power jack and antenna extending beyond the former dimension.

Three screw holes allow the board to be attached to a surface or case.

Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.

This makes the SmartEverything Lion fully compatible with most shields designed for the Uno, Diecimila or Duemilanove.

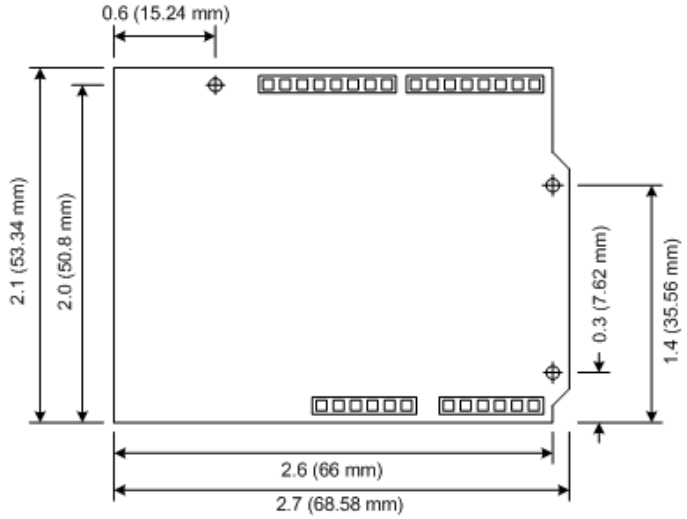


Figure 6: Dimensions

Chapter 4 Software Development

The following chapters provide an overview about how users can develop their software and run it on the ASME Lion board.

There are two main ways to develop a software, load and debug it on the card:

- Using the Arduino IDE and Sketch Projects
- Using the Atmel Studio and Standard C/C++ language

When developing a software running on a microcontroller, having some tools to easily debug the code and fix what does not work as expected is really important.

The possibility to use an external debugger like the Atmel-ICE (http://www.atmel.com/tools/atatmel-ice.aspx) is available.

Chapter 5 Getting Started with Arduino IDE and Sketch Projects

5.1 Tools

The following tools are needed:

- Arduino IDE (Release 1.6.4 or newer)
- USB cable

5.2 Setup the Environment

Download and install the Arduino IDE from the Arduino web site (See the link in Chapter 6)

The first time you run the ArduinoIDE it is necessary to load the Arduino Zero & SmartEverything Core.

Click on the Tools → Boards → Boards Manager… menu entry

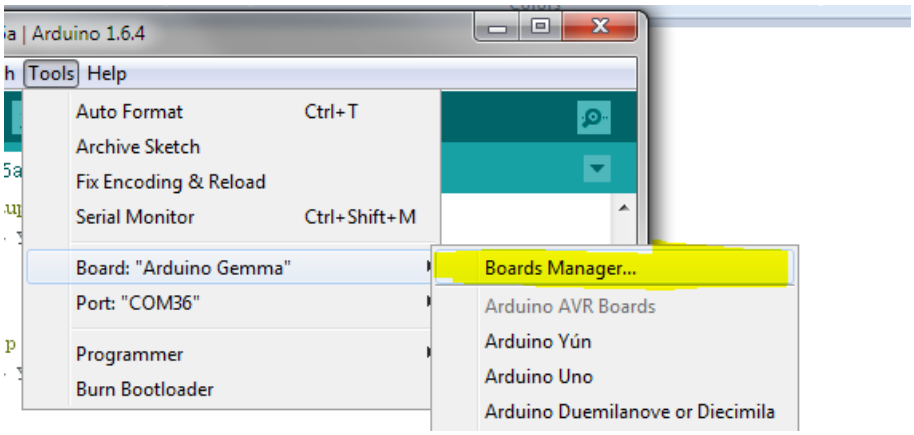


Figure 7: Launch Board Manager

The two steps of installation shall be done as follows:

1) Select from "*Type*" combo **Arduino** and choose **Arduino SAMD Boards** in order to install the core of the Arduino Zero.

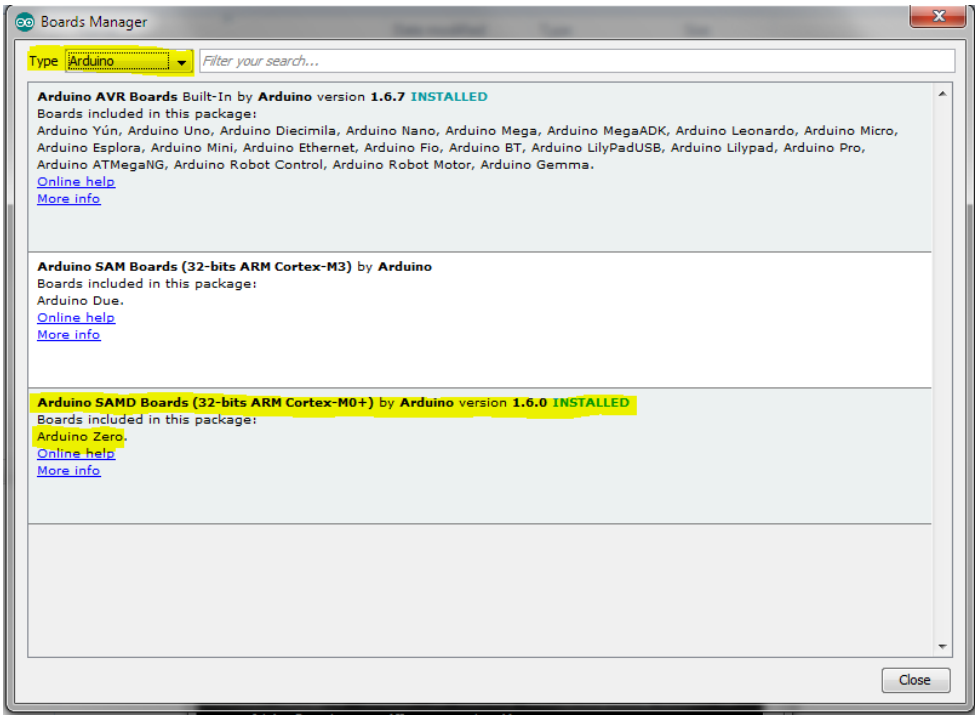


Figure 8: ArduinoZero Core Installation

2) Select from "Type" combo **Partner** and choose the **ARROW Boards** in order to install the core of the SmartEverything.

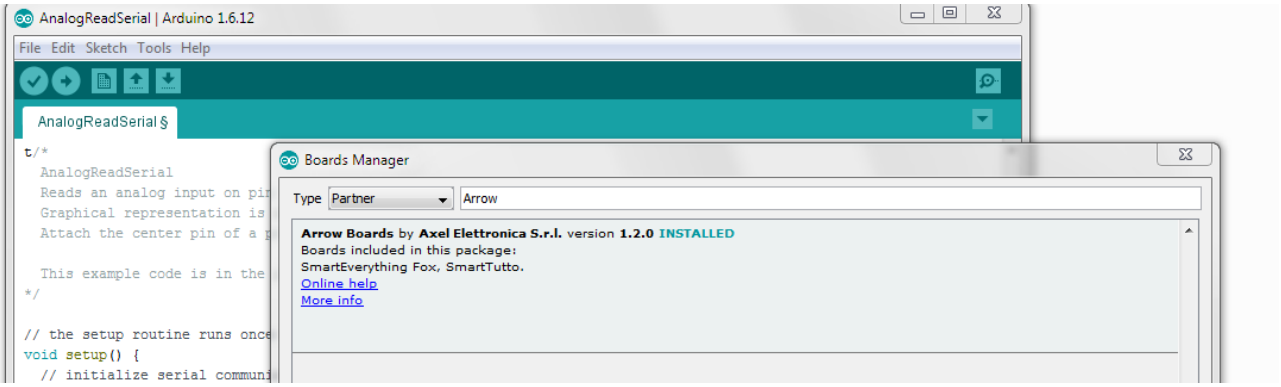


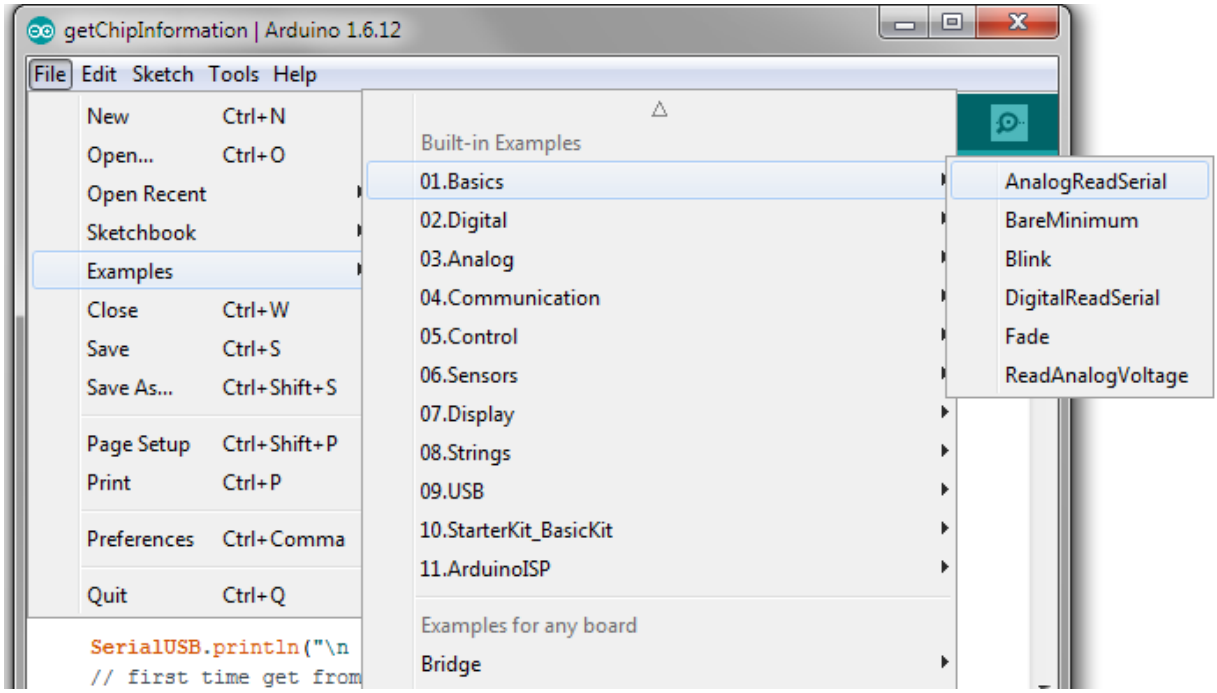
Figure 9: SmartEverything Core Installation

The installation procedure will automatically install all the necessary USB drives. Once the installation is completed, you will be able to connect the Board and start coding.
If the Driver installation process does not complete successfully, follow the steps described in Chapter 7 .

5.3 Compile the Example project

This procedure explains how to compile and download the code on the SmartEverything Lion board.

As every other Arduino board, the SmartEverything Lion has the basic examples code. To try those examples, just go to File->Examples and select one under the 01.Basics menu.



5.4 Run the software

Verify the code

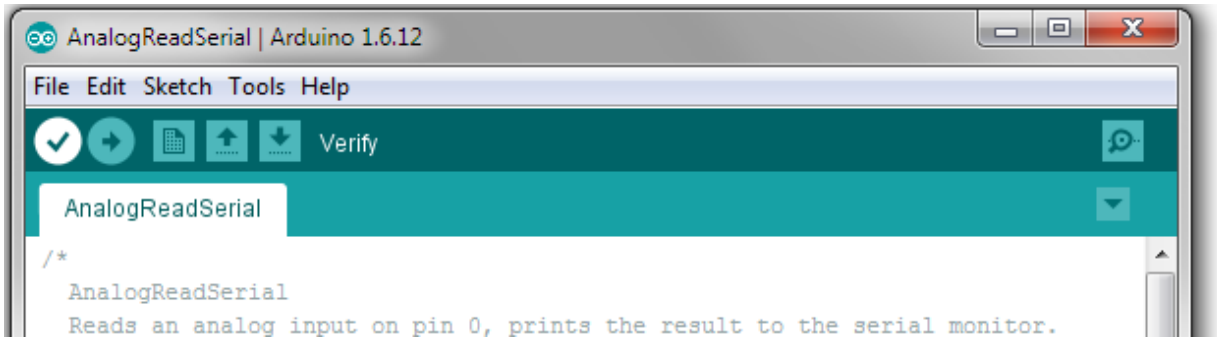


Figure 10: ArduinoIDE: Verify the code

Load the software on the Connect the SmartEverything Lion board.

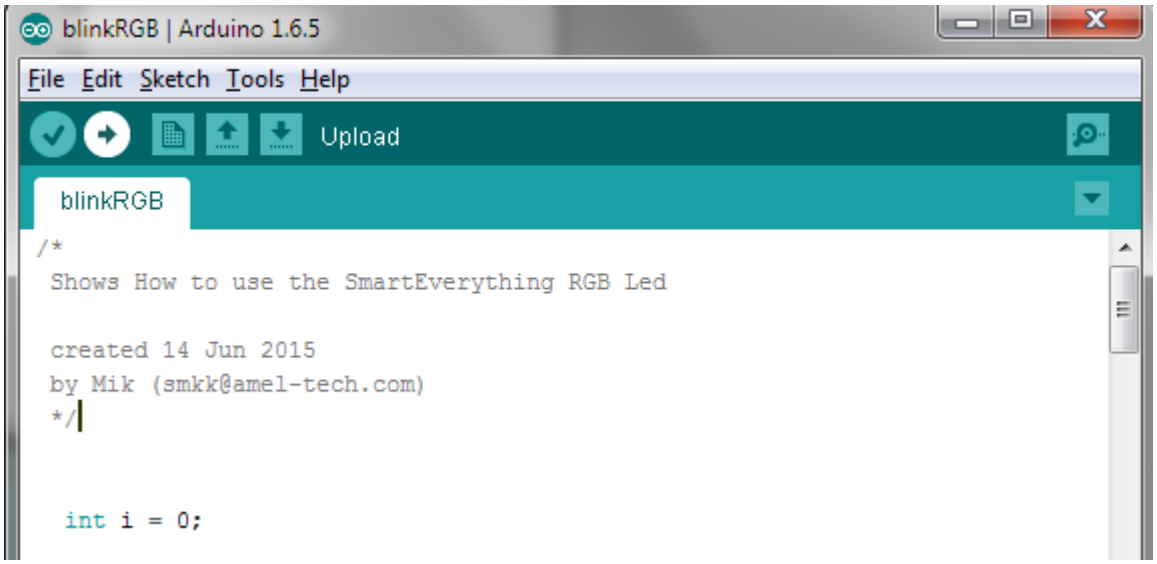


Figure 11: ArduinoIDE: Upload the code

5.5 Importing the Lora SmartEverything Board Library

The SmartEverything Lion board will provide, a few days after its release on the market, some useful libraries to interface with some of its main components.

In order to include the Smart Everything library use the menu Sketch □Include Library □ Manage Libraries.

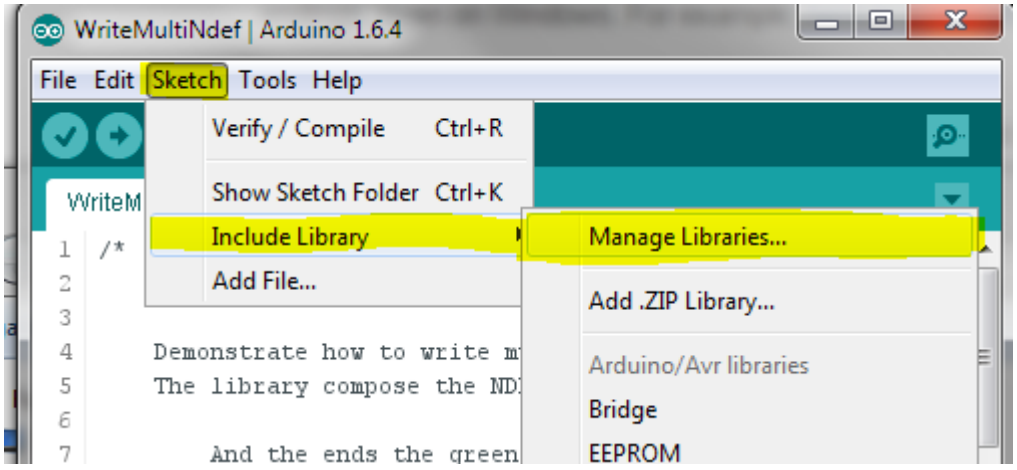


Figure 12: ArduinoIDE: Launch Manage Libraries interface

Once the Library Manager is started, you can filter the available libraries writing SmartEverything, or the name of the component, in the right top text box and then you can select the necessary library.

The procedure to download the other SmartEverything Lion libraries is identical.

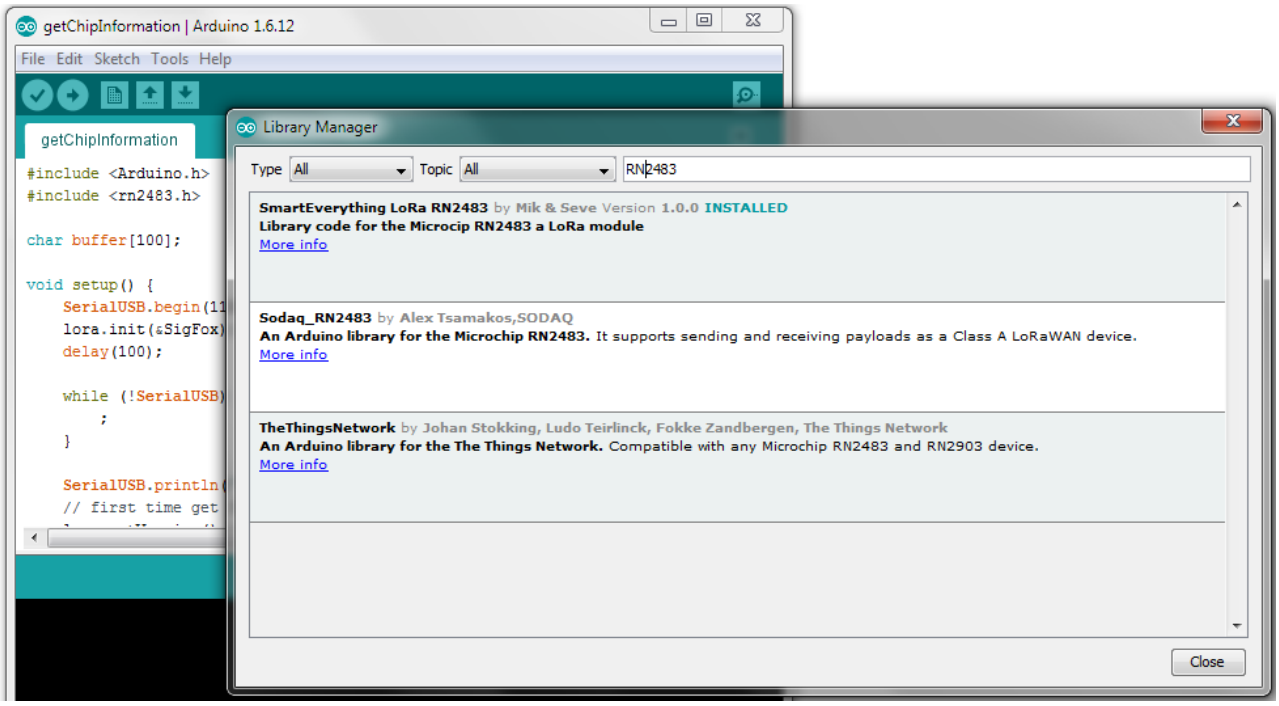
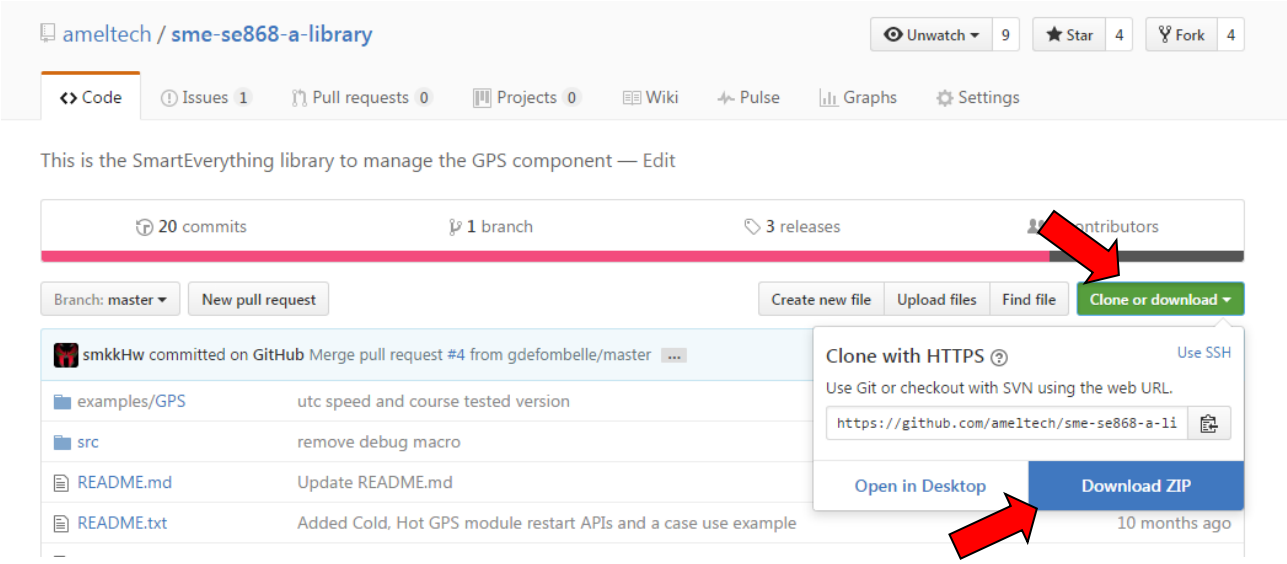


Figure 13: ArduinoIDE: Library Manager

Another way to install the Library of the supported components is going to the GitHub repository and downloading the zip file.



Once it is downloaded, go to “include Library” menu and use the “Add .ZIP Library…” item.

5.6 Official GitHub library repository

Here is the official repository where the zip file to download can be found:

- LoRa Library (https://github.com/axelelettronica/sme-rn2483-library)
- GPS Library (https://github.com/ameltech/sme-se868-a-library)
- BLE Library (https://github.com/axelelettronica/sme-rn4870-library)
- EEProm Library (https://github.com/PaoloP74/extEEPROM)

  The EEProm shall be initialized with these parameters

  new extEEPROM(kbits_256, 1, 64, 0x57);

Chapter 6 References and Useful Links

6.1 Data sheets

- ATMEL SAMD21 Ultra low-power ARM® Cortex®-M0+ MCU
  http://www.atmel.com/Images/Atmel-42181-SAM-D21_Datasheet.pdf
- Crypto Authentication Chip (ATMEL ATECC508A)
  http://www.atmel.com/devices/atecc508a.aspx
- Dynaflex 868Mhz Antenna (915/2)
- LoRa Module (Microchip RN2483)
  http://www.microchip.com/wwwproducts/en/RN2483
- GPS Module with Embedded Antenna (Telit Jupiter SE868-A)
  http://www.telit.com/products/product-service-selector/product-service-selector/show/product/jupiter-se868-a/
- BLE Microchip RN4871(specification)
  http://www.microchip.com/wwwproducts/en/RN4871
- E2Prom ATMEL (AT24C256C)
  http://www.atmel.com/images/atmel-8568-seeprom-at24c256c-datasheet.pdf

6.2 Tools

- Arduino IDE
- Atmel Studio

6.3 Web Sites

- Axel Elettronica – www.axelelettronica.it
- Arduino – www.arduino.cc
- Atmel – www.atmel.com
- Microhip - http://www.microchip.com/

Chapter 7 Troubleshooting

7.1 Driver installation problems

It can happen that the installation of the driver does not automatically complete successfully. The drivers to manage the COM Port are not properly installed and the device is reported as an Unknown Device.

If this happens, it is necessary to install the drive manually.

The correct drivers can be found on the following directory.
C:\Users\<**login name**>\AppData\Local\Arduino15\packages\Arrow\hardware\samd\<**installed Rel**>\drivers.

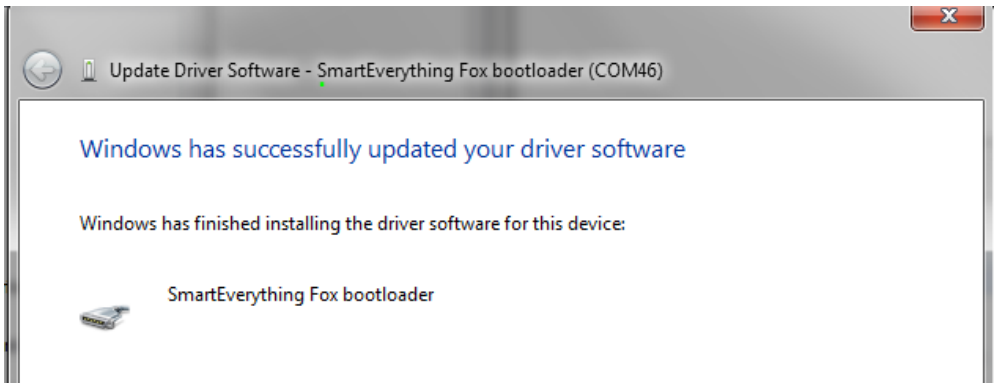


Figure 14 Correct USB Driver installation