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DELIVERABLE

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Abstract:	This Deliverable Report provides detailed information of the design and implementation of the main electronic board integrated inside the PhasmaFOOD sensing device. The hardware and layout designs of the main electronic board are included. The driving boards of each sensing component, i.e., UV-VIS spectrometer, NIR spectrometer, and camera, are described at hardware level providing details on the implementation of the communication interfaces between the main electronic board and the sensing components.

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Executive Summary

The PhasmaFOOD project targets the design and implementation of a smart system for food analysis. The end-users will be able to use the PhasmaFOOD solution in order to scan food samples and access a fast and safe decision on whether they should consume them or not based on the level of mycotoxins, spoilage or adulteration they feature (D1.1). The architecture of the PhasmaFOOD system comprises three main parts: the sensing device, the end-user's mobile device with the PhasmaFOOD application installed on it, and the cloud platform and database. The PhasmaFOOD sensing device integrates a sensing node, which includes an Ultraviolet-Visible (UV-VIS) spectrometer[1], a Near-Infrared (NIR) spectrometer, a camera, and Ultraviolet (UV), white and NIR illumination sources, in order to conduct the sensory measurements on the food samples and an electronic subsystem, which supports the operation of the sensing node by controlling the sensing measurements, collecting the sensory data, partially processing them and sending them to the end-user's mobile device.

In the current Deliverable Report, we provide a brief presentation of the components and functionalities integrated at the electronic boards that drive the individual sensors, and the main supporting electronic board of the sensing device. In addition, we report any changes that have occurred in the hardware design (D2.2 and D2.3) and functional requirements (D1.2) of the PhasmaFOOD sensing device. Furthermore, a description of the electronic boards' implementation, layout design, manufacturing and assembly is provided. Each of the requirements is handled separately and the comments that follow it, refer to the progress we have made so far on implementing and fulfilling it. In the context of the implementation of the electronic boards, we provide information on different aspects of the layout design and on the subsequent manufacturing and assembly procedures. The current Deliverable Report stands as the primary source of information towards the integration of the PhasmaFOOD sensing device in conjunction with D5.1 and D5.3.

[1] In the context of the PhasmaFOOD project, the Ultraviolet-Visible (UV-VIS) spectrometer is used to detect only the fluorescence and visible spectra. However, throughout the current Deliverable Report, we refer to this spectrometer as the "UV-VIS" spectrometer because we refer to it as a hardware component regardless of its usage.

Table of Contents

Document History			
Version	**Date**	**Contributor(s)**	**Description**
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Table of Figures

List of Tables

Definitions, Acronyms and Abbreviations

Acronym	Title
ADC	Analog – to – Digital Converter
API	Application Programming Interface
BLE	Bluetooth Low Energy
BoM	Bill of Materials
CMOS	Complementary Metal-Oxide Semiconductor
DC	Direct Current
DDR	Double Data Rate
Dx	Deliverable (where x defines the deliverable identification number)
EEPROM	Electrically Erasable Programmable Read-Only Memory
eMMC	Embedded Multi-Media Card
ESD	Electro-Static Discharge
GPIO	General Purpose Input Output
HW	HardWare
IC	Integrated Circuit
I2C	Inter-Integrated Circuit
IMU	Inertial Measurement Unit
JSON	JavaScript Object Notation
LDO	Low Drop-Out
LED	Light Emitting Diode
MEMS	Micro-Electro-Mechanical Systems
microSD	micro Secure Digital
MOSFET	Metal-Oxide-Semiconductor Field-Effect Transistor
MSPS	Million Samples Per Second
MSx	project Milestone (where x defines a project milestone)
Mx	Month (where x defines a project month)
NIR	Near-Infrared
PCB	Printed Circuit Board
PHY	PHYsical
PMIC	Power Management Integrated Circuit
PRU-ICSS	Programmable Real-time Unit - Industrial Communication Subsystem
RAM	Random Access Memory
RISC	Reduced Instruction Set Computing
ROM	Read-Only Memory
RTC	Real-Time Clock
SDRAM	Synchronous Dynamic Random-Access Memory
SIMD	Single-Instruction Multiple-Data
SMD	Surface Mount Device
SMT	Surface Mount Technology

SoC	System-on-Chip
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
UART	Universal Asynchronous Receiver-Transceiver
USB	Universal Serial Bus
UV	Ultraviolet
UV-VIS	Ultraviolet-Visible
WP	Work Package

1 Overview of the PhasmaFOOD sensing device

Figure 1 illustrates the PhasmaFOOD system architecture, which comprises three main parts: (a) the PhasmaFOOD sensing device, (b) the PhasmaFOOD mobile application on the end-user's mobile device, and (c) the PhasmaFOOD cloud platform. The PhasmaFOOD sensing device is essentially built from the sensing subsystem and the main electronic subsystem.

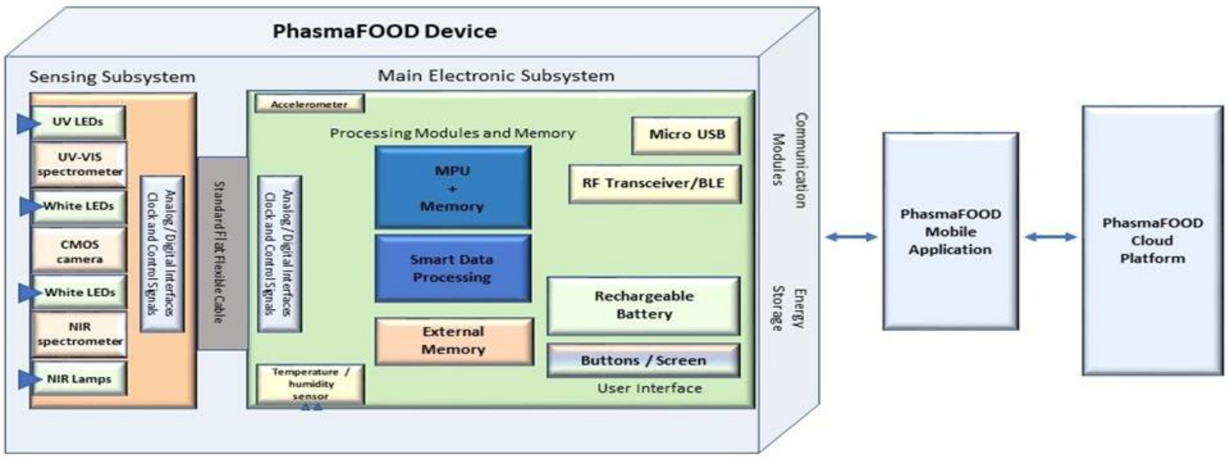

Figure 1 - The PhasmaFOOD system architecture.

1.1 Sensing subsystem

The sensing subsystem performs all the measurements required for food analysis using the sensing components and lighting sources integrated inside it. The configuration values for all sensing and lighting modules derive from the use case that the end-user has selected (i.e., the food sample and a selection between mycotoxins, adulteration or fraud detection analysis) [1] via the PhasmaFOOD mobile application on their mobile devices. The main electronic board receives these configuration values via wireless communication with the end-user's mobile device and, then, communicates them to the sensing subsystem. A number of measurements are conducted and the main electronic board receives back all the requested sensory data.

The sensing subsystem was thoroughly analyzed in Deliverable Reports D2.2 [2] and D2.3 [3]. It integrates an Ultraviolet-Visible (UV-VIS) spectrometer[2] [4], a Near-Infrared (NIR) spectrometer designed, developed and fabricated by Fraunhofer Institute for Photonic Microsystems (IPMS), a Complementary Metal-Oxide Semiconductor (CMOS) camera [5] and all the lighting sources, which ensure the right operation of the aforementioned sensing components. These sources include Ultraviolet (UV) Light Emitting Diodes (LEDs), white LEDs and NIR micro-lamps. Each of the sensing and lighting components of the sensing subsystem is properly mounted on an electronic driving board. These electronic boards are either developed specifically for the

[2] In the context of the PhasmaFOOD project, the Ultraviolet-Visible (UV-VIS) spectrometer is used to detect only the fluorescence and visible spectra. However, throughout the current Deliverable Report, we refer to this spectrometer as the "UV-VIS" spectrometer because we refer to it as a hardware component regardless of its usage.

component they drive (e.g., for the UV-VIS and NIR spectrometers) or purchased as ready to be used from the companies that provide the components (e.g., camera, lighting sources). The communication between the electronic driving boards of each of the sensing and lighting components and the main electronic subsystem is established in a wired manner. All the electronic driving boards inside the sensing subsystem integrate the appropriate connectors in order that they exchange data and control information with the main electronic subsystem. The electronic boards, which drive the sensing components of the sensing subsystem, are also described in Section 2 of the current Deliverable Report.

1.2 Main electronic subsystem

The main electronic subsystem resides between the sensing node and the end-user's mobile device. The latter stands as the main user interface to the PhasmaFOOD system. The end-user selects the desired food sample to be analyzed along with the analysis they would like to be performed (i.e., mycotoxins, adulteration or fraud detection). A set of configuration values are wirelessly communicated to the main electronic board based on the end-user's selections and, then, the main electronic subsystem forwards these values to the sensing node. The requested sensory data are collected by the main electronic board and stored on it in order for some pre-processing functionalities to be performed on them, e.g., image compression, noise filtering, data compression, data normalization, feature extraction. The pre-processed sensory data are wirelessly transmitted to the mobile device for potential further processing before ending up at the cloud platform for analysis and decision making on the quality of the selected food sample.

The main electronic subsystem essentially supports the operation of the sensing subsystem by integrating all the necessary processing and memory components for driving the sensing subsystem, collecting the sensory data, executing some pre-processing algorithms on them and wirelessly communicating them, properly formatted, to the end-user's mobile device.

A microprocessor environment with on-chip memory is integrated on the main electronic subsystem. External memory components, i.e., a Double Data Rate (DDR) Synchronous Dynamic Random-Access Memory (SDRAM), a micro Secure Digital (microSD) connector, an embedded Multi-Media Card (eMMC), and an Electrically Erasable Programmable Read-Only Memory (EEPROM), support the operation of the processing component and provide the required space for data storage and intermediate manipulations. A rechargeable battery is integrated on the main electronic subsystem and provides all the energy required for the operation of the PhasmaFOOD sensing device. A Power Management Integrated Circuit (PMIC) and some voltage regulators, all powered by the rechargeable battery, produce all the voltage levels required for the PhasmaFOOD sensing device operation.

The pre-processed sensory data are transmitted to the end-user's mobile device using a Wi-Fi/Bluetooth/Bluetooth Low Energy (BLE) component and, then, the PhasmaFOOD mobile application manages their forwarding to the cloud platform. A microUSB connection is also integrated on the main electronic subsystem as an alternative way of communication with the end-user's mobile device. All data and control information exchanges with the sensing subsystem are handled through the appropriate connectors integrated on the main electronic subsystem.

The PhasmaFOOD sensing device interfaces with the end-user with some buttons and potentially a screen connected with the main electronic board. The end-users are informed through notifications and messages on the screen about the current state of the sensing device.

An Inertial Measurement Unit (IMU), which includes an accelerometer, and a temperature sensor are integrated at the main electronics subsystem targeting to ensure a stable and appropriate environment for the operation of the PhasmaFOOD sensing device and the conduction of the sensing measurements.

The design of the main electronic subsystem was thoroughly described and analyzed in Section 2.2 of the Deliverable Report D2.3 [3] including the complete schematic design for the main electronic board at Section 8 of the same Deliverable Report. In the current Deliverable Report, we summarize some key features of the main electronic subsystem (Section 3) and provide the layout design for the main electronic board (Section 5).

2 Sensor-near electronics inside the sensing subsystem

2.1 Driving board of the UV-VIS spectrometer

2.1.1 Hardware design of the driving board for the UV-VIS spectrometer

Regarding the driving board of the UV-VIS spectrometer, the latter is not directly mounted on the board. The UV-VIS spectrometer is connected on a 115-47-314-41-003000 socket [6] targeting modularity and flexibility increase, i.e., easy replacement of the spectrometer. The digital clock and control signals of the spectrometer are driven to and from it through a digital buffer [7] following the recommendations of the Hamamatsu company [8]. Also, an operational amplifier [9] for the analog video output of the spectrometer is integrated on the electronic board for the same reason.

A header of 10 pins [10] is mounted on the UV-VIS driving board comprising the following pins:

- Two pins provide voltage and ground supply from the main electronic board.
- Four pins are dedicated for driving the clock and control signals (digital signals) to and from the spectrometer.
- Four pins are dedicated to the Serial Peripheral Interface (SPI) [11] for the communication of the sensory data to the main electronic board. The SPI is a 4-wire interface integrated at the on-board Analog-to-Digital Converter (ADC).

The ADC [12] initially processes the analog output of the spectrometer before any further processing on the main electronic board. The output of the operational amplifier is driven to the input of the ADC, which handles its conversion to an equivalent digital signal. The sampling frequency of the ADC is 2 Million Samples Per Second (MSPS) and its precision is 16 bits. The ADC integrates a SPI in order that the microprocessor of the main electronic board can control its operation and its digital output can be transferred to the main electronic board.

An additional low noise Low Drop-Out (LDO) linear voltage regulator [13] is incorporated on the UV-VIS driving board in order to provide the 1.8 V power supply for the operation of the ADC.

For further information on the components of the driving board for the UV-VIS spectrometer, please refer to Section 2.1.1.2 of the Deliverable Report D2.3 [3]. Here, in Table 1, we report only the changes regarding the components of the driving board for the UV-VIS spectrometer compared to Table 1 of the Deliverable Report D2.3 [3]. The schematic design for the driving board of the UV-VIS spectrometer was developed using the Autodesk Eagle Printed Circuit Board (PCB) design tool [14]. The reader can access a detailed view of the schematic design in Section 8.1 of the current Deliverable Report.

Table 1 - Table reporting the changes regarding the components of the driving board for the UV-VIS spectrometer compared to Table 1 of the Deliverable Report D2.3.

Component Name (Component Version)	Reference Designator[3]	Description
929 [10] (929850-01-10-30)	J1	Header, Vertical, 10 Positions, 1 Row, Through Hole, 2.54 mm Pitch

2.1.2 Layout design of the driving board for the UV-VIS spectrometer

The layout design for the driving board of the UV-VIS spectrometer was developed using the Autodesk Eagle PCB design tool [14] based on the schematic design described in Section 2.1.1 and provided in Section 8.1. The size of the electronic board is 30 mm by 30 mm with two of its edges (the ones close to the UV-VIS spectrometer) trimmed in order to fit inside the sensing subunit. In the following sections, we provide some figures targeting to present different aspects of the layout design for the driving board of the UV-VIS spectrometer. Section 2.1.2.1 presents the four layers of copper, which comprise the electronic board. The layer No.2 is dedicated to ground, while the layer No.3 is dedicated to 5 V voltage supply. Between each two layers of the electronic board, insulation material resides. Section 2.1.2.2 presents the solder mask for both the top and bottom layers of the UV-VIS spectrometer's driving board. Solder mask is a protective layer of liquid photo image able lacquer applied on the top and bottom side of a PCB [15]. Section 2.1.2.3 reports on the areas of applying solder paste for both the top and bottom layers of the electronic board. Finally, Section 2.1.2.4 presents the silkscreen for both the top and bottom layers of the driving board of the UV-VIS spectrometer.

[3] The reference designator refers to the part name of the component in the schematic of the UV-VIS driving board (Section 8.1).

2.1.2.1 Copper layers of the driving board for the UV-VIS spectrometer

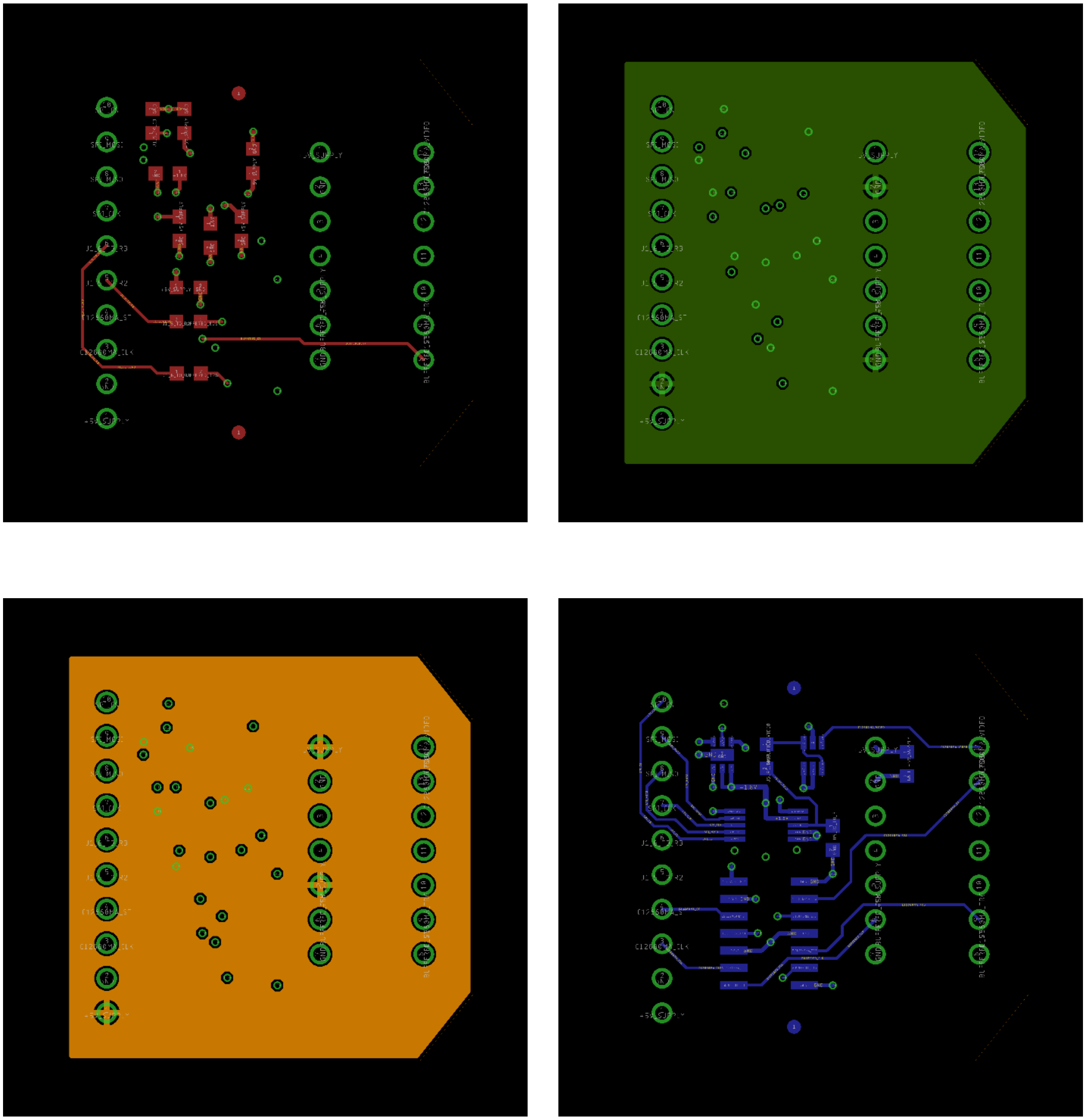

Figure 2 - The copper layers of the driving board for the UV-VIS spectrometer including all vias and pads. Top left: Top copper layer (layer No.1); Top right: Copper layer No.2 (Ground layer); Bottom left: Copper layer No.3 (5 V layer); Bottom right: Bottom copper layer (layer No.4).

2.1.2.2 Solder mask of the driving board for the UV-VIS spectrometer

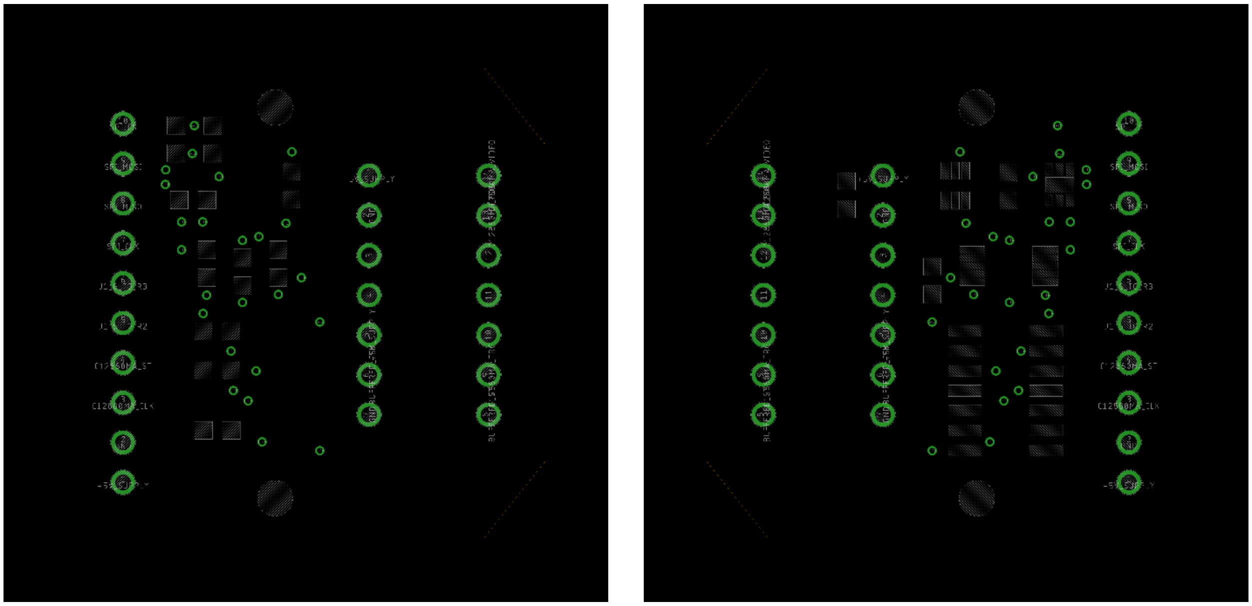

Figure 3 - Top and bottom layer solder mask of the driving board for the UV-VIS spectrometer including all vias and pads.

2.1.2.3 Solder paste of the driving board for the UV-VIS spectrometer

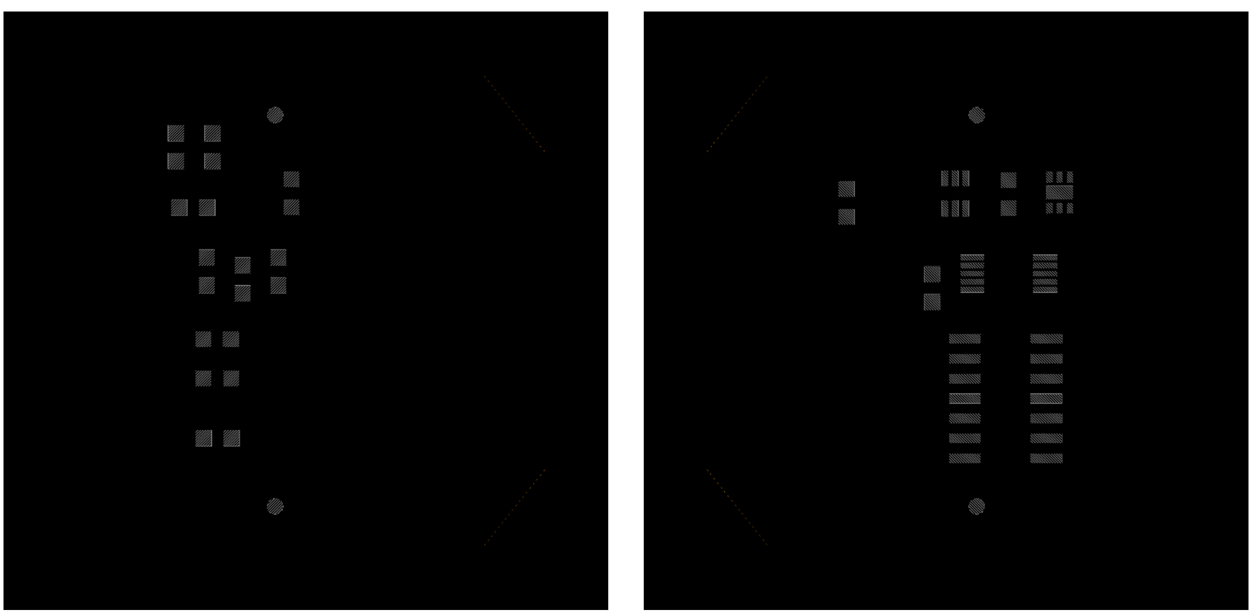

Figure 4 - Top and bottom layer solder paste of the driving board for the UV-VIS spectrometer.

2.1.2.4 Silkscreen of the driving board for the UV-VIS spectrometer

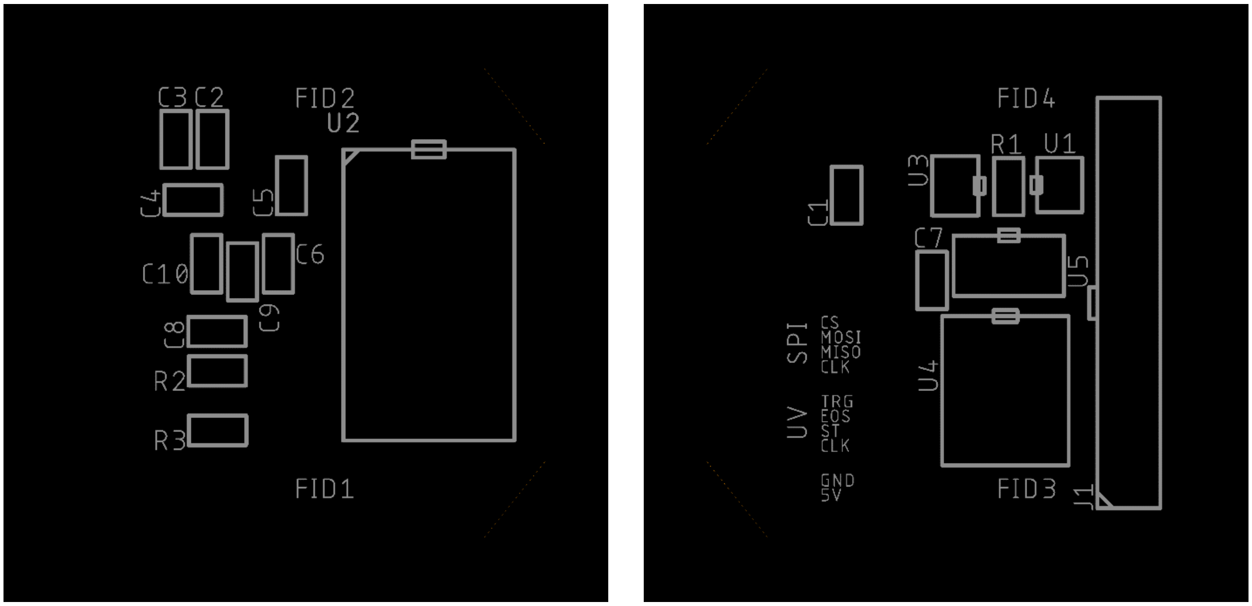

Figure 5 - Top and bottom layer silkscreen of the driving board for the UV-VIS spectrometer.

2.1.3 Bill of Materials (BoM) list for the driving board of the UV-VIS spectrometer

Table 2 reports the complete BoM list, which includes all the components mounted on the driving board of the UV-VIS spectrometer. This list was delivered to the company chosen for manufacturing and assembly of the UV-VIS spectrometer's electronic driving board. Any changes, which occurred due to the lack of ability of the aforementioned company to find and purchase any of the BoM list's components, are not reported here. The components, which finally replaced the ones being out of stock, feature the same characteristics with the initially chosen ones listed in the BoM list of Table 2.

Table 2 - Complete BoM list with all the components mounted on the driving board of the UV-VIS spectrometer.

No	Reference	Part Number	Value	Package	Qty	Manufacturer	Comments
1	C1, C5, C8-10	C0603G104K5RACT250	0.1uF	603	5	KEMET	Multi-layer ceramic capacitor 0603, SMD
2	C2, C4, C6	GRT188R61C106KE13D	10uF	603	3	Murata	Multi-layer ceramic capacitor 0603, SMD
3	R2-3	TNPW0603100RBEEA	100R	603	2	Vishay	Resistor 0603, SMD
4	C3	06033C102KAT2A	1000pF	603	1	AVX	Multi-layer ceramic capacitor 0603, SMD
5	C7	06035C181KAT2A	180pF	603	1	AVX	Multi-layer ceramic capacitor 0603, SMD
6	R1	ERJ-PB3B2000V	200R	603	1	PANASONIC	Resistor 0603, SMD
7	U5	AD4000BRMZ		MSOP-10	1	Analog Devices Inc.	ADC, 16-Bit, 2 MSPS, SMD

8	U3	ADA4805-1AKSZ-R2		SC-70-6	1	Analog Devices Inc.	High Speed Operational Amplifier R/R AMP High Spd Ultra Low Power, SMD
9	U1	ADP7118ACPZN1.8-R7		LFCSP-6	1	Analog Devices Inc.	LDO Voltage Regulators 20V 200mA LDO, SMD
10	U4	CD74HCT125M96		SOIC-14	1	Texas Instruments	High-Speed CMOS Logic Quad Buffer, Three-State, SMD
11	U2	115-47-314-41-003000		Through-Hole	1	Mill-Max	Header Socket 2.54mm 2x7, 7.62mm row spacing, Through-Hole
12	J1	929850-01-10-30		Through-Hole	1	3M	Header Socket 2.54mm 1x10, Through-Hole

2.1.4 Manufactured and assembled driving board of the UV-VIS spectrometer

Using the Autodesk Eagle PCB tool [14], we extracted the Gerber files, which refer to the layout design of the driving board for the UV-VIS spectrometer (Section 2.1.2). The Gerber files were extracted using the RS-274X format and comprise one drill file, which shows all the drills/holes of the electronic board, one file per copper layer, i.e., four files for the driving board of the UV-VIS spectrometer (Section 2.1.2.1), one file for the solder mask of the top layer, one file for the solder mask of the bottom layer (Section 2.1.2.2), one file for the solder paste of the top layer, one file for the solder paste of the bottom layer (Section 2.1.2.3), one file for the silkscreen of the top layer, and one file for the silkscreen of the bottom layer (Section 2.1.2.4). We should mention although that the figures presented in Sections 2.1.2.1 - 2.1.2.4 depict the different aspects of the layout design at the Autodesk Eagle PCB tool [14] since limitations in the exporting features of the tool did not allow us to include the Gerber files in this deliverable. Also, we provided the chosen company for manufacturing and assembly of the electronic board with the BoM of Section 2.1.3. Figure 6 shows the top and bottom surfaces of the manufactured and assembled main electronic board.

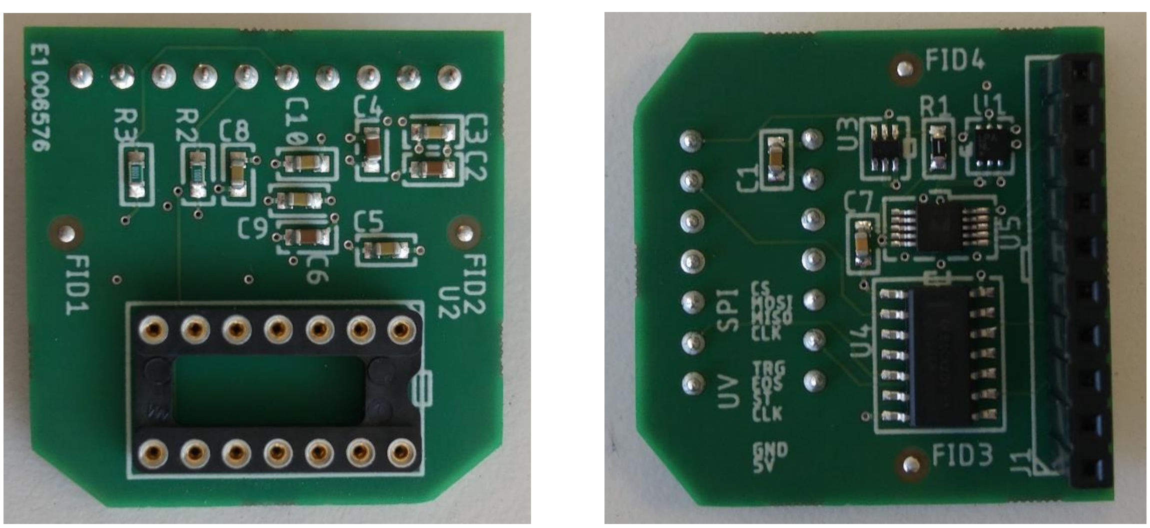

Figure 6 - The top (left figure) and bottom (right figure) of the driving board for the UV-VIS spectrometer.

2.2 Driving board of the NIR spectrometer

In order to fulfill the tight mechanical requirements of integration into the compact mechanical design of the PhasmaFOOD sensing subsystem, Fraunhofer IPMS has designed dedicated read-out and driving electronics for the Micro-Electro-Mechanical Systems (MEMS)-based NIR spectrometer. The overall concept for the NIR spectrometer is shown in Figure 7.

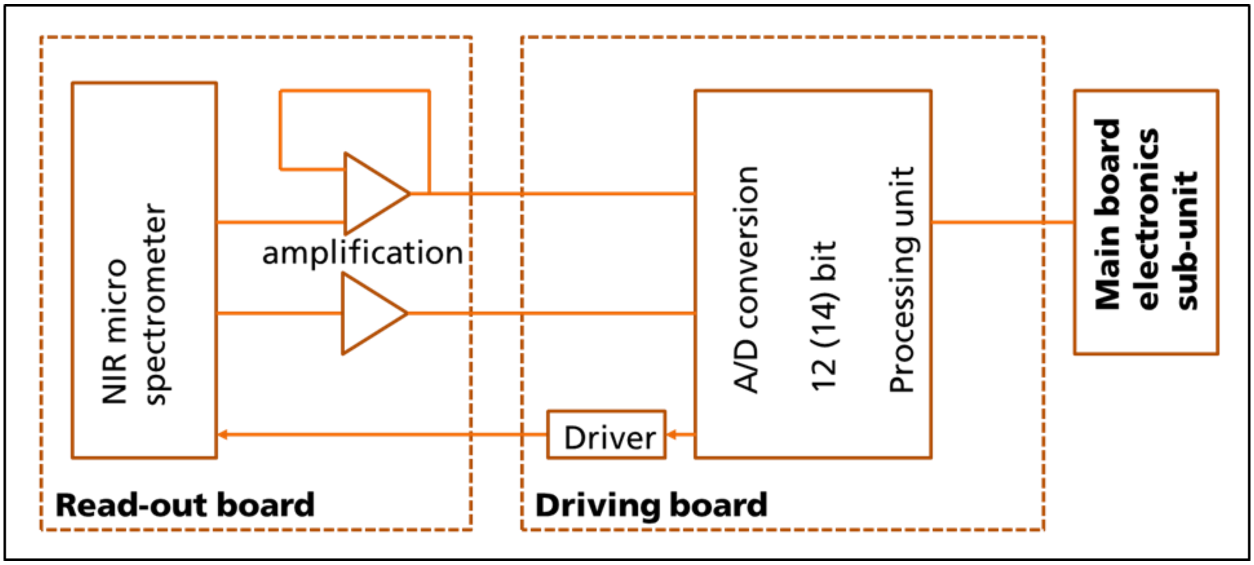

Figure 7 - Concept of the structure and functionalities of the driving board for the NIR spectrometer.

Data acquisition and actuation of the MEMS device inside the NIR spectrometer is performed with two dedicated boards, which are connected to the main board electronics subunit. The power and connector requirements as well as the data protocol have been communicated with our project partner WINGS and have been detailed in the Deliverable Report D2.2 [2].

The MEMS device and all associated optical spectrometer components are mounted directly on the read-out board (see Figure 8). Here the analog photocurrent data are acquired, amplified and transferred to the super-ordinated driving board. Connectivity between both boards is realized via a flexible ribbon cable.

This approach follows the results from the Deliverable Report D2.2 [2].

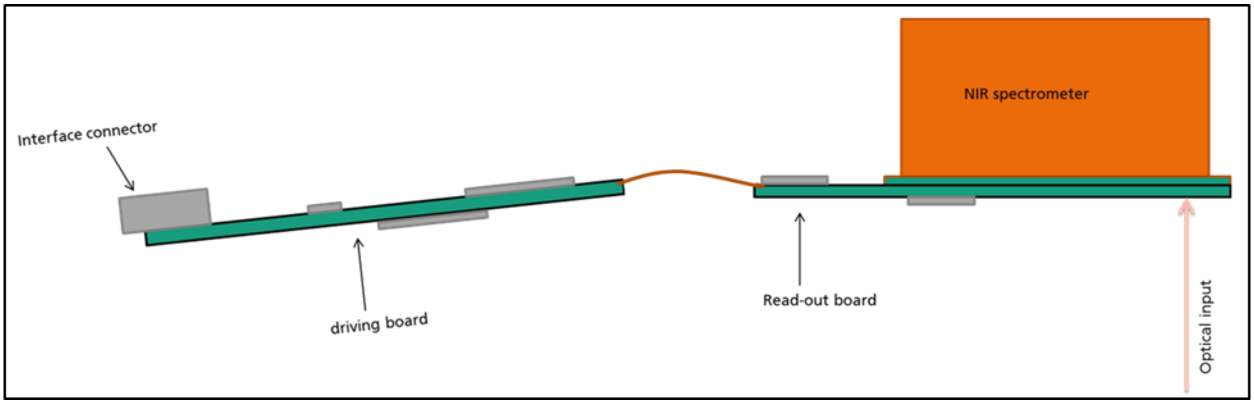

Figure 8 - Electromechanical concept of the Fraunhofer IPMS NIR spectrometer showing the assembly and relative dimensions of spectrometer and boards.

The complete NIR spectrometer module is controlled and driven by the super-ordinated driving-board, which has been designed and realized by Fraunhofer IPMS for the PhasmaFOOD device. The driving board itself includes the Analog-to-Digital converter, driver for the MEMS device and a data processing unit towards the main board electronics subunit. The assembled final PhasmaFOOD driving board can be seen in Figure 9.

Figure 9 - Super-ordinated PhasmaFOOD driving board for the IPMS NIR spectrometer module.

Concerning the aforementioned read-out board, the layout and design drawing of the NIR spectrometer on the read-out board is shown in Figure 10.

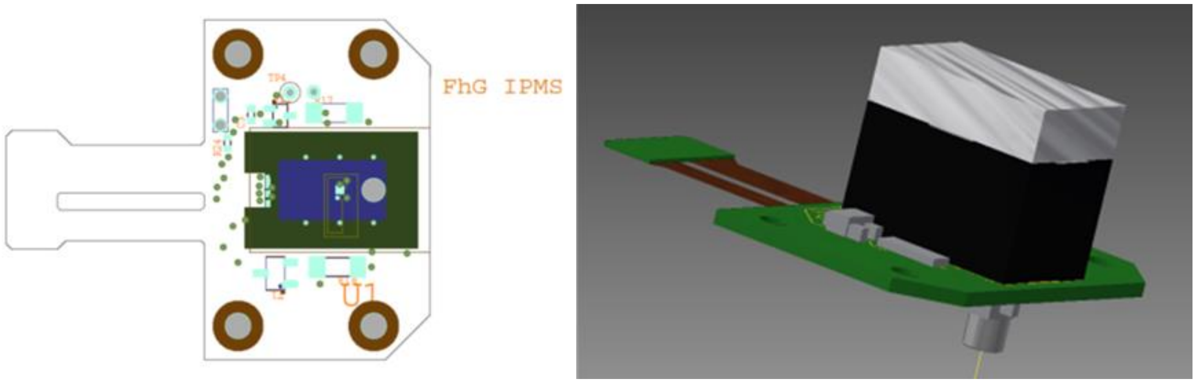

Figure 10 - Left: Sketch of NIR spectrometer mounted on the read-out board. Right: Design drawing of the spectrometer on its read-out board.

The physical realization of the read-out board for PhasmaFOOD including the NIR spectrometer body is shown in Figure 11. The read-out board itself is mounted on a lens tube for integration into the PhasmaFOOD front-end subsystem.

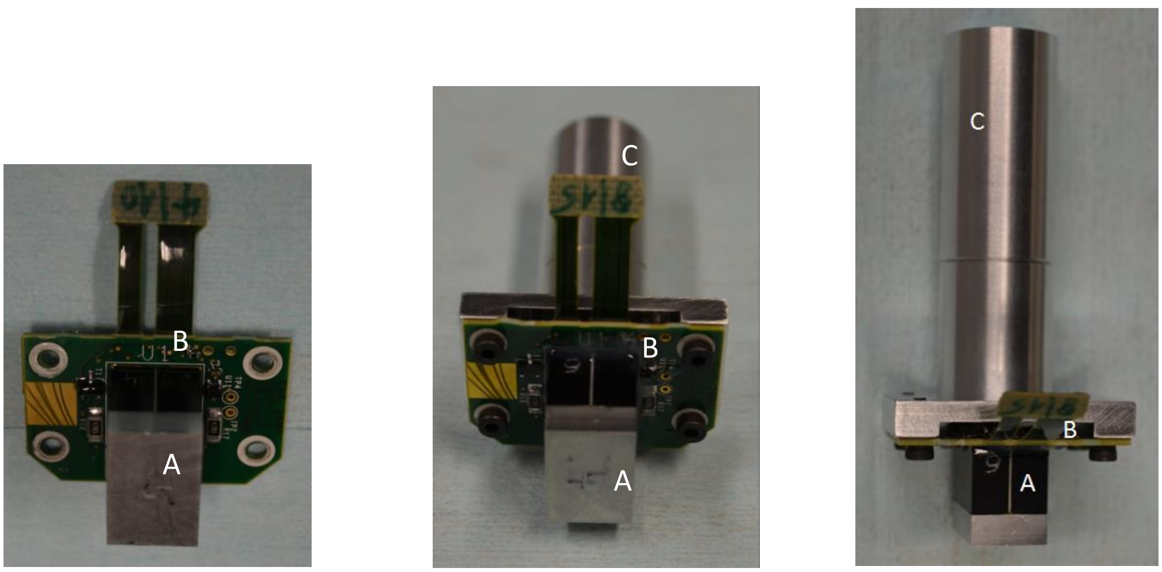

Figure 11 - IPMS NIR spectrometer module. Left: Tilted top view with NIR spectrometer body (A), read-out board for the MEMS device of the NIR spectrometer including ribbon cable (B) and Right: cylindrical mount with a lens tube (C).

Finally, the NIR spectrometer module including the read-out board is inserted into the PhasmaFOOD front-end subsystem as can be seen from Figure 12.

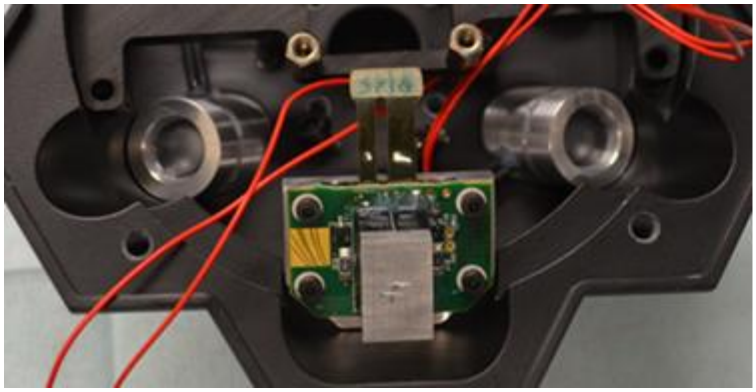

Figure 12 - Sensing front-end subsystem with inserted NIR spectrometer module mounted on the read-out board.

Besides the NIR spectrometer module, the reader can see tubular illumination units for testing the NIR spectrometer unit before integration of the UV-VIS spectrometer and the miniaturized camera. Further details are given in Deliverable Report D5.1.

2.3 Driving board of the camera

The camera, which is integrated inside the sensing subunit, is an off-the-shelf 5 Megapixels color CMOS micro camera [5], [16]. Further information on the miniaturized MU9PC-MH Ximea micro camera are provided in Deliverable Reports D2.2 [2] and D2.3 [3]. The housing of the micro camera integrates a driving electronic board. The connection to the main electronic board is achieved using a USB 2.0 interface and a USB 2.0 cable provided by the Ximea company [17].

3 Hardware design of the main electronic subsystem

3.1 Overview of the architecture of the main electronic subsystem

Figure 13 illustrates an abstract description of the architecture of the main electronic subsystem. The main electronic board comprises the following core subsystems: the microprocessor System-on-Chip (SoC) (Section 3.2), some external memory components and a memory connector (Section 3.2), the wireless communication subsystem (Section 3.3.1), the components related to the wired communication to the sensing subunit and external devices (Section 3.3.2), two auxiliary sensors (Section 3.4), some LEDs and buttons as for user interface (Section 3.4), and the power supply and management subsystem (Section 3.5).

The microprocessor SoC integrates a processing unit, a graphics processing/acceleration machine, two real-time co-processing units and on-chip Random Access Memories (RAM). The graphics machine accelerates the execution of complex and computationally intensive algorithms, e.g., algorithms related to image/video processing. Some external memories are also integrated at the main electronic subsystem. A DDR SDRAM can be used for storing the sensory data, which are collected from the sensing node, or intermediate results when complex calculations and algorithmic functionalities are processed. An EEPROM contains identification information for the main electronic board. An eMMC is used for storing the operating system. A microSD connector is integrated in order for any SD card to be connected and supplement the available storage or stand as a boot device.

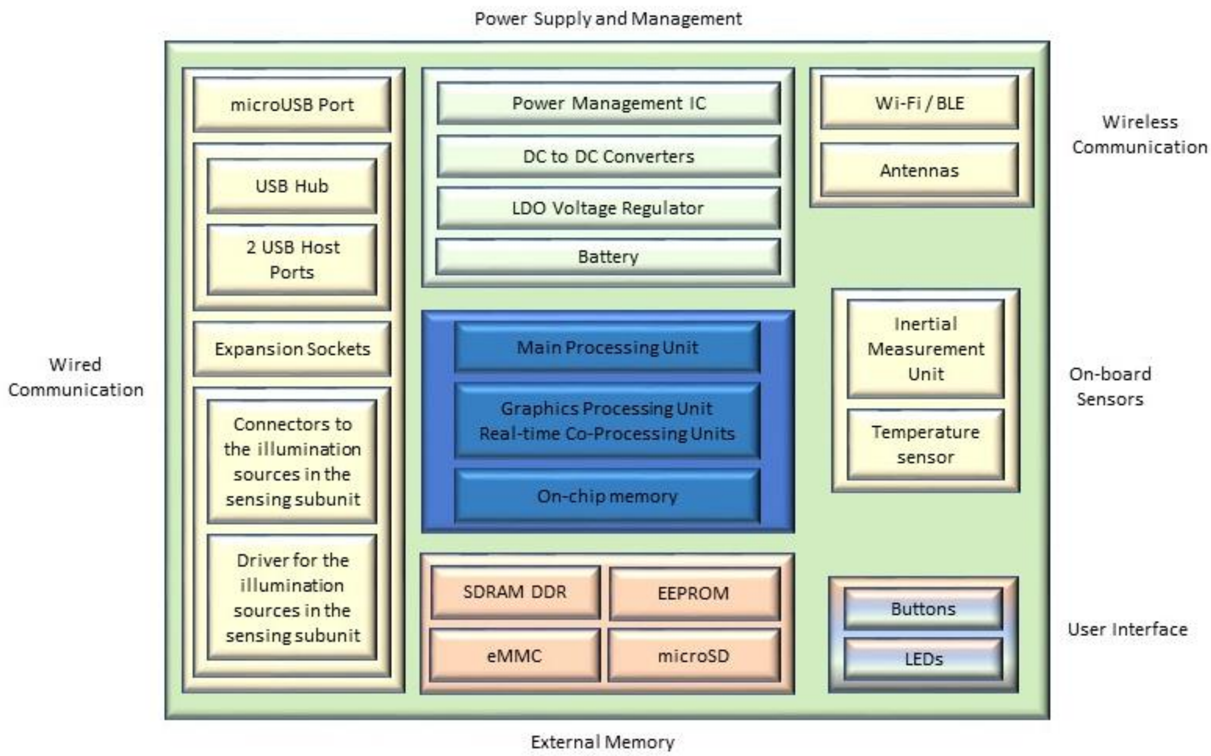

Figure 13 - An abstract description of the main electronic subsystem.

The main electronic subsystem communicates wirelessly with the end-user's mobile device using the Bluetooth/BLE protocol implemented at the Wi-Fi/Bluetooth/BLE module. A microUSB port also provides an alternative way of connection to the mobile device of the PhasmaFOOD system architecture.

The communication of the main electronic subsystem with the sensing node is achieved using wired protocols and connections. An expansion socket, which is integrated on the main electronic board, provides all the necessary wired connections with the UV-VIS driving board including the clock and control signals for the UV-VIS spectrometer, and the SPI signals for the ADC of the driving board. Both the NIR and camera driving boards require a USB connection, so, a hub is integrated at the main electronic subsystem providing two USB 2.0 high-speed host ports. Also, a LEDs driving Integrated Circuit (IC) is mounted on the main electronic board for the proper operation of the illumination sources of the sensing node. The lighting units are directly connected to the main electronic board using a number of proper connectors.

An IMU and a temperature sensor are integrated at the main electronic subsystem ensuring a stable and right environment for the operation of the sensing components inside the sensing subsystem. A number of LEDs and buttons are used as an interface to the end-user. Using an expansion socket available on the main electronic board with either the SPI or the Inter-Integrated Circuit (I2C) [18] protocol, a small character screen can be connected and provide the end-user with messages and notifications on the current status of the sensing device.

A rechargeable battery provides all the energy, which is required for the operation of the PhasmaFOOD sensing device. The microUSB port offers the potential of battery charging. A PMIC, Direct Current (DC)-to-DC voltage converters and an LDO voltage regulator form the power management subsystem on the main electronic board. They provide all the necessary and different voltage levels with the appropriate amounts of current in order that all the components of the PhasmaFOOD sensing device work properly.

The schematic design for the main electronic board of the sensing device was developed using the Autodesk Eagle PCB design tool [14]. The reader can access a detailed view of the schematic design in Section 8.1 of the current Deliverable Report. The schematic design for the main electronic board comprises ten sheets with the first one as a guideline to the subsequent sheets (sheet 1 of the main electronic board's schematic design). The aforementioned schematic design includes all the components and connections for power supply and management (sheet 2 of the main electronic board's schematic design; Section 3.5), processing and memory storage (sheets 3, 4, 5 and 6 of the main electronic board's schematic design; Section 3.2), wireless communication (sheet 7 of the main electronic board's schematic design; Section 3.3.1), wired communication and expansion (sheets 8 and 10 of the main electronic board's schematic design; Section 3.3.2), and user interface and oscillations/temperature control (sheet 9 of the main electronic board's schematic design; Section 3.4) on the main electronic board.

3.2 Processing chip and memory units

The microprocessor environment is the Texas Instruments AM3358 SoC [19] integrating a Sitara™ ARM® Cortex®-A8 32-bit Reduced Instruction Set Computing (RISC) processor with up to 1 GHz operational frequency. The processor includes a NEON™ Single-Instruction Multiple-Data (SIMD) co-processing unit, which can accelerate the execution of computationally intensive algorithms, e.g., data analysis algorithms such as data normalization, data compression, and feature extraction. The processor also includes 176 KB of on-chip boot Read-Only Memory (ROM) and 64 KB of dedicated RAM. In addition, the AM3358 SoC provides 64 KB of general purpose on-chip RAM and interfaces to external memory components, e.g., DDR SDRAM, Static Random Access Memory (SRAM), NAND flash memories. The microprocessor also integrates the PowerVR SGX™ advanced graphics acceleration engine providing the possibility of accelerating the image processing functionalities for the raw images of the CMOS camera. Finally, two real-time co-processing units, separate from the ARM core, enhance the efficiency and flexibility of the microprocessor unit as part of the programmable real-time subsystem of the microprocessor, i.e., Programmable Real-time Unit - Industrial Communication Subsystem (PRU-ICSS).

The AM3358 SoC operation is supported by two crystal oscillators, one with 24 MHz frequency [20], which is the main oscillating component, and one with 32.768 kHz frequency [21], which stands as the real-time oscillating component.

A DDR2 SDRAM AS4C128M16D2A [22] memory component, which runs at 400 MHz and provides 2 GB of storage, is also integrated on the main electronic board. The DDR2 SDRAM component can be used to temporarily store the sensory data collected from the sensing node. The sensory data may be raw or partially processed on the driving boards of the sensing components. Also, the DDR2 SDRAM component can support storing any intermediate calculations during the execution of various functionalities on the board. The SDINBDG4 [23] eMMC memory component, based on the NAND flash technology, stands as a potential storing point for any operating system that we use. A microSD connector [24] is also included in order to connect an external SD card and increase the storage availability of the main electronic board. The microSD connector was carefully chosen with a reverse on-board mounting approach. The 24LC32A [25] EEPROM, which is connected to the microprocessor using the I2C protocol, is used for storing board's identification information.

For further information on the processing and memory components, please refer to Section 2.2.2 of the Deliverable Report D2.3 [3]. Here, in Table 3, we report only the changes regarding the processing and memory components of the main electronic board compared to Table 2 of the Deliverable Report D2.3 [3]. The processing and memory components and their connections are depicted in sheets 3, 4, 5 and 6 of the main electronic board's schematic design in Section 8.1.

Table 3 - Table reporting the changes regarding the processing and memory components of the main electronic board compared to Table 2 of the Deliverable Report D2.3.

Component Name (Component Version)	Reference Designator[4]	Description
102x Resistors, 102x Capacitors, 3x Ferrite Beads		Passive Components

3.3 Communication modules and interfaces

3.3.1 Communication with mobile device (Wireless communication)

3.3.1.1 Wireless communication components

The communication between the main electronic board and the end-user's mobile device is achieved wirelessly using the WL1835MOD subsystem [26]. It is a 2.4 GHz component providing Wi-Fi and Bluetooth/BLE coexistence in a power-optimized design. The WL1835MOD component is Bluetooth 4.2 Secure Connection compliant. Two antennas can be connected to this module.

[4] The reference designator refers to the part name of the component in the schematic of the main electronic board (Section 8.1).

Thus, we have mounted two antenna connectors [27] on the main electronic board, which can host two 2.4 GHz U.FL antennas [28]. Targeting a proper communication and connection between the microprocessor and the Wi-Fi/Bluetooth/BLE module, we have also incorporated on the main electronic board two voltage level shifters [29] and a digital buffer [30].

For further information on the wireless communication components, please refer to Section 2.2.3.1 of the Deliverable Report D2.3 [3]. The wireless communication components and their connections are depicted in sheet 7 of the main electronic board's schematic design in Section 8.1.

3.3.1.2 Bluetooth Application Peripheral Interface (API)

The main electronic board establishes a wireless communication with the end-user's mobile device using the Bluetooth protocol [31]. The communication between the embedded and mobile devices should be achieved based on the BLE specification. The Deliverable Report 5.3 provides further details and information regarding the Bluetooth API and the sequence of actions that take place during the establishment and data exchange of the Bluetooth communication between the embedded and mobile devices.

The Bluetooth API employs the JavaScript Object Notation (JSON) data model for exchanging information between the embedded device and the mobile application. In Deliverable Report 5.3, more details and information are provided regarding the structure of the JSON messages, which are exchanged between the mobile application and the embedded device.

3.3.2 Communication with sensing subsystem and expansion sockets (Wired communication)

3.3.2.1 Wired communication components

The driving boards of the NIR spectrometer and the CMOS camera request a USB 2.0 interface for communication with the main electronic board. However, the microprocessor [19] provides only two USB 2.0 connections and the one of them is dedicated to a microUSB connector [32], which is targeted for powering and battery charging purposes or as an alternative way of communication with the end-user's mobile device. Thus, a two-port high-speed 480 Mbps USB 2.0 hub [33] is integrated at the main electronic board in order to provide two distinct USB 2.0 host ports [34]. The USB 2.0 host ports were chosen to be vertical in order to facilitate the mechanical design of the PhasmaFOOD sensing device. The single channel TPS2051B [35] and dual channel TPS2561 [36] components limit at 500 mA the current provided to the VBUS lines of the hub device and the two USB 2.0 host ports respectively. Also, the TPD4S012 [37] components provide Electro-Static Discharge (ESD) protection at all three USB 2.0 ports.

A LEDs driving component [38] on the main electronic board supports the proper operation of the UV, white LEDs and NIR micro-lamps inside the sensing subsystem. Due to a voltage drop at the LEDs driver, which may reduce the power of the NIR micro-lamps, N-channel Metal-Oxide-Semiconductor Field-Effect Transistors (MOSFETs) [39] are used to pull-down this potential.

Extensive expansion sockets are mounted on the main electronic board targeted for connection with the UV-VIS driving board (SPI signals for the ADC, control and clock signals for the UV-VIS spectrometer), expansion through SPI, I2C or Universal Asynchronous Receiver-Transceiver (UART) protocols or direct communication with the real-time subsystem of the microprocessor [19]. Voltage lever shifters [29] are also integrated wherever needed.

For further information on the wired communication components, please refer to Section 2.2.3.2 of the Deliverable Report D2.3 [3]. Here, in Table 4, we report only the changes regarding the components for the wired communication of the main electronic board with the sensing node and for potential expansion compared to Table 4 of the Deliverable Report D2.3 [3]. The components for the wired communication of the main electronic board with the sensing subsystem and for potential expansion, as well as the connections around all these components, are depicted in sheets 8 and 10 of the main electronic board's schematic design in Section 8.1.

Table 4 - Table reporting the changes regarding the components for the wired communication of the main electronic subsystem with the sensing subsystem and for potential expansion compared to Table 4 of the Deliverable Report D2.3.

Component Name (Component Version)	Reference Designator[5]	Description
2x 614004135023 [34] (614004135023)	X2, X3	USB 2.0 Connector Type A, Female, Vertical, Through Hole
7x 53398 [40] (53398-0271)	J6, J7, J8, J9, J10, J11, J12	1.25mm Pitch PicoBlade Header, Surface Mount, Vertical, 2 Circuits – Header for connecting to the illumination units (UV LEDs, NIR micro-lamps, white LEDs) of the sensing subsystem
3x 929 [10] (929975-01-05)	J3, J4, J5	PCB Socket Connector, 10 Positions, 2 Rows, Vertical, Through Hole, 2.54 mm Pitch
929 [10] (929975-01-07)	J2	PCB Socket Connector, 14 Positions, 2 Rows, Vertical, Through Hole, 2.54 mm Pitch
21x Resistors, 38x Capacitors, 4x Ferrite Beads		Passive Components

[5] The reference designator refers to the part name of the component in the schematic of the main electronic board (Section 8.1).

3.3.2.2 Communication with the UV-VIS spectrometer driving board

The communication between the main electronic board and the driving electronic board of the UV-VIS spectrometer includes eight different digital signals. Four of these signals refer to clock and control signalling of the UV-VIS spectrometer, while the four remaining ones comprise the SPI communication between the microprocessor’s SPI module and the ADC on the UV-VIS spectrometer’s driving board. The Deliverable Report 5.3 provides further information on the communication between the main electronic board and the driving board of the UV-VIS spectrometer including a detailed sequence diagram on the data and control messages exchange between the two electronic boards.

3.3.2.3 Communication with the NIR spectrometer driving board

The main electronic board communicates with the NIR driving electronic board using the USB protocol. The Deliverable Report 5.3 provides further information on the communication between the main electronic board and the driving board of the NIR spectrometer including a sequence diagram on the data and control messages exchange between the two electronic boards.

3.3.2.4 Communication with the camera

The communication between the off-the-shelf camera [5] and the main electronic board is achieved using the USB protocol.

3.4 On-board sensors, LEDs and buttons

The main electronic board incorporates two sensors, which support the right operation of the sensing device, and some buttons and LEDs, which are provided as an interface with the end-user of the sensing device. The MPU-9250 [41] integrates an accelerometer and a gyroscope, which can be used to detect any oscillations that can damage the sensing device or result to incorrect measurements. The TMP116 [42] digitally monitors the temperature inside the sensing device. Four tactile switches [43] can be used to control the operation of the sensing device and some LEDs [44] can inform the end-user about some events at the main electronic subsystem (e.g., enabling the Wi-Fi/Bluetooth/BLE module, battery state).

For further information on the on-board sensors, LEDs and buttons, please refer to Section 2.2.4 of the Deliverable Report D2.3 [3]. Here, in Table 5, we report only the changes regarding the sensors, LEDs and buttons of the main electronic board compared to Table 5 of the Deliverable Report D2.3 [3]. The components related to the sensors, LEDs and buttons of the main electronic subsystem, as well as their connections, are depicted in sheet 9 of the main electronic board’s schematic design in Section 8.1.

Table 5 - Table reporting the changes regarding the sensors, LEDs and buttons of the main electronic subsystem compared to Table 5 of the Deliverable Report D2.3.

Component Name (Component Version)	Reference Designator[6]	Description
4x SKQM [43] (SKQMASE010)	POW, RST, MOD, PAU	Tactile Switch
4x LTST-C191KGKT [44]	WIFI_LED, 50%, 75%, FULL	SMD Chip LED, 0603, Green
1x LTST-C191KRKT [44]	25%	SMD Chip LED, 0603, Red
4x LTST-C191KSKT [44]	LED_1, LED_2, LED_3, LED_4	SMD Chip LED, 0603, Yellow
10x Resistors, 4x Capacitors		Passive Components

3.5 Power management

The main power management IC is the Texas Instruments TPS65217B [45], which produces all the voltage supplies required for the right operation of the AM3358 microprocessor [19] and some components of the main electronic board. This IC is powered by a rechargeable battery or from a host external device via the microUSB connection, which can also be used for battery charging. More specifically, the TPS65217B PMIC produces the following supply voltages:

- VDDS_DDR (1.8 V) for the DDR2 SDRAM memory component, which is the same as the VDD_1V8 (1.8 V) used at the microprocessor,
- VDD_MPU (1.1 V) for the MPU core domain of the microprocessor,
- VDD_CORE (1.1 V) for the core domain of the microprocessor,
- VRTC (1.8 V) for the Real-Time Clock (RTC) domain of the microprocessor,
- VDD_3V3A (3.3 V), and
- VDD_3V3B (3.3 V).

The VDD_3V3A voltage level is used for the microprocessor's USBPHY and dual voltage IO domain, the pull-up resistances, and for powering the eMMC and the microSD components. Since the VDD_3V3A voltage level is produced and provided before the VDD_3V3B one, we use it at some vital points of the design due to boot reasons. The VDD_3V3B supplies all the remaining components on the main electronic board, which need a 3.3 V voltage supply. The only exception regarding the 3.3 V voltage supply is the Wi-Fi/Bluetooth/BLE component, which is powered from a distinct DC-to-DC converter [46] due to the large amount of current it may need for its

[6] The reference designator refers to the part name of the component in the schematic of the main electronic board (Section 8.1).

operation [26]. The DC-to-DC converter is powered directly from the rechargeable battery. Based on the same reason, we integrated a DC-to-DC converter [47], which provides the 1.8 V voltage supply that the Wi-Fi/Bluetooth/BLE component needs. Some voltage level shifters and buffers, which are needed for the proper communication of the Wi-Fi/Bluetooth/BLE component with the microprocessor, are also powered by the abovementioned converters.

In addition, a DC-to-DC converter [48] is installed on the main electronic board to produce 5 V, which is essential for the USB-related components and connections and for the proper operation of the UV-VIS spectrometer and its driving board in the sensing subsystem.

A LDO voltage regulator [49] produces the 1.1 V voltage supply for the USB 2.0 hub device [33].

For further information on the power supply and management components, please refer to Section 2.2.5 of the Deliverable Report D2.3 [3]. Here, in Table 6, we report only the changes regarding the power supply and management components of the main electronic board compared to Table 6 of the Deliverable Report D2.3 [3]. The components related to the power supply and management of the main electronic subsystem, as well as their connections, are depicted in sheet 2 of the main electronic board's schematic design in Section 8.1.

Table 6 - Table reporting the changes regarding the components of the power management of the main electronic subsystem compared to Table 6 of the Deliverable Report D2.3.

Component Name (Component Version)	Reference Designator[7]	Description
JST-PH Connector [50] (B2B-PH-K-S(LF)(SN))	J1	Wire-To-Board Connector, Top Entry, 2 mm Pitch, 2 Contacts, 1 Row, Through Hole – Battery connector
LTST-C191KGKT [44]	PWR_LED	SMD Chip LED, 0603, Green – Power LED
17x Resistors, 27x Capacitors, 6x Inductors		Passive Components

4 Matching requirements to the hardware design of the PhasmaFOOD sensing device

In the Deliverable Report D1.2 [51], the consortium specified the PhasmaFOOD system requirements including those concerning the main electronic board and the electronic driving

[7] The reference designator refers to the part name of the component in the schematic of the main electronic board (Section 8.1).

boards of the sensing components, which stand as electronic interfaces for the communication between the main electronic board and the sensing components. In this section, we report in Table 7 how the hardware design of the main electronic board and the electronic interfaces with the sensing components, which have been described and developed so far, match the relevant hardware design requirements documented in the Deliverable Report D1.2 [51].

Table 7 - Matching the requirements to the hardware specifications for the main electronic board and the electronic interfaces with the sensing components.

Reference	Description	Comments
ELECTR-L-1	The VIS spectrometer and the NIR spectrometer MUST each one be equipped with a small control board in order to translate the readings of the detectors after acquisition into a table of wavelength vs. detector counts.	The sensing subunit integrates driving boards for both the UV-VIS and the NIR spectrometers. Section 2.1 provides thorough information on the driving board of the UV-VIS spectrometer and Section 2.2 describes the electronic boards, which host and drive the NIR spectrometer and the data collected from it.
ELECTR-L-2	The CMOS camera MUST also be equipped with a small board in order to process the images according to the acquisition protocol (RGB image/single colour image).	The camera [5] inside the sensing subunit is an off-the-shelf camera with a driving board integrated in its housing. Section 2.3 provides more information on the camera and its driving board.
ELECTR-L-3	The PhasmaFOOD main board MUST be able to drive the single detector units and the lighting system to perform all the different measurements required by the Use Cases.	The microprocessor SoC AM3358 [19], which is mounted on the main electronic board, drives the UV-VIS, NIR spectrometers and the camera inside the sensing subunit. The main electronic board integrates an expansion header targeted for connection with the UV-VIS driving board (SPI signals for the ADC, control and clock signals for the UV-VIS spectrometer). An SPI module and some General Purpose Input-Output (GPIO) pins of the microprocessor are used for the abovementioned connections. Also, two USB 2.0 host ports are provided using a USB 2.0 hub [33] in order to interface with the driving boards of the NIR spectrometer and the camera. Section 3.3.2 provides more information regarding the wired connections between the main electronic board and the electronic boards that drive the sensing components inside the sensing node.

		The illumination sources (UV LEDs, white LEDs, NIR micro-lamps) are driven by a specific LEDs driving component [38] mounted on the main electronic board. In addition, the lighting units are directly connected to the main electronic board using a number of proper connectors [40].
ELECTR-L-4	Also switches (ON/OFF, reset etc.) and LEDs indicating the system status and possible warnings SHOULD be present on the main board.	The main electronic board integrates four tactile switches [43] and some indicating LEDs [44] as for interfacing with the end-user of the sensing device. Section 3.4 provides further information on the tactile switches and the LEDs mounted on the main electronic board.
ELECTR-L-5	The PhasmaFOOD main board MUST be able to collect the signal coming from each sensor as independently routed and processed and it SHOULD provide filtering means to reduce the noise from measurements.	In alignment with ELECTR-L-3 requirement, the main electronic board independently interfaces with each one of the sensing components and collects and processes the sensory data they produce. The microprocessor [19] on the main electronic board can collect the sensory data that each sensing component outputs, and process them to some extent before sending them to the mobile device. These pre-processing functionalities may include data normalization, feature extraction, data compression or image processing. More information on the embedded sensory data pre-processing functions can be found in the Deliverable Report D5.3.
ELECTR-L-6	The PhasmaFOOD main board SHOULD also include an inertial sensor in order to check possible sensor platform movements (slips, abrupt shifts, etc.) that may move the measure spot, invalidating the measurement in progress.	An IMU [41] is integrated on the main electronic board. Section 3.4 can provide more information on the IMU mounted on the main electronic board.
ELECTR-L-7	In all these possible cases, a warning MUST be given about not valid measurements.	An expansion socket available on the main electronic board with either the SPI or the I2C protocol (Section 3.3.2) may be used for connecting a small character screen and providing the end-user with messages and notifications related to the measurements conduction and the current status of the sensing device. The mobile application may also provide such alerting information to the end-user as pop-up messages and notifications.

ELECTR-L-8	Temperature and humidity sensor SHOULD also be present on the main board to warn in case of temperatures/humidity exceeding the sensor platform operating conditions (see Sect. 6.1).	A temperature sensor [42] is mounted on the main electronic board and digitally monitors the temperature inside the sensing device.
ELECTR-L-9	Accelerometer sensor SHOULD also be present on the main board to warn in case of sudden movements of the device, exceeding the sensor platform operating conditions.	In alignment with ELECTR-L-6 requirement, the IMU [41] integrated at the main electronic subsystem includes an accelerometer.
MEM-1	The PhasmaFOOD device MUST have enough on board memory to store all the sensor measurements needed for data preprocessing and communication to the smartphone (transferring measurements in batches).	A DDR2 SDRAM AS4C128M16D2A [22] memory component, which runs at 400 MHz and provides 2 GB of storage, is integrated on the main electronic board. The DDR2 SDRAM component can be used to temporarily store the sensory data collected from the sensing node. The sensory data may be raw or partially processed on the driving boards of the sensing components. Also, the DDR2 SDRAM component can support storing any intermediate calculations during the execution of various functionalities on the board. A SDINBDG4 [23] eMMC memory component also stands as a potential storing point. The main electronic board includes the SDINBDG4-8G-I1 eMMC module, which provides 8 GB of storage. A microSD connector [24] is also mounted in order to connect an external SD card and increase the storage availability of the main electronic board. Section 3.2 provides further information on the external memory components, which are integrated on the main electronic board.
POWER-1	The PhasmaFOOD device SHOULD have enough energy supply to perform more than 50 measurements.	These requirements will be examined after the first PhasmaFOOD prototype will be assembled. In case that the PhasmaFOOD sensing device cannot meet these energy requirements, we will study how we can modify the hardware and software designs of the PhasmaFOOD sensing device accordingly. Such modifications include the replacement of energy consuming hardware components or the
POWER-2	This SHOULD ensure an autonomy of several days in typical usage as envisioned at this stage of the project.	

	The power supply can be provided through built in rechargeable batteries and/or through USB connection with the smartphone/tablet and/or portable power bank module.	implementation of software techniques to decrease the energy consumption. The PMIC [45], which is integrated on the main electronic board, is powered by either a rechargeable battery or a microUSB connection to a host external device. This PMIC produces all the voltage supplies required for the right operation of the AM3358 microprocessor [19] and some components on the main electronic board. The 3.3 V and 1.8 V voltage supplies for the WL1835MOD Wi-Fi/Bluetooth/BLE component [26] are produced by two distinct DC-to-DC converters [46], [47] due to the large amount of current it may need for its operation. In addition, a DC-to-DC converter [48] is installed on the main electronic board to produce 5 V, which is essential for the USB-related components and connections and for the proper operation of the UV-VIS spectrometer and its driving board in the sensing subsystem. A LDO voltage regulator [49] produces the 1.1 V voltage supply for the USB 2.0 hub device [33]. All the above mentioned DC-to-DC converters and LDO voltage regulator are powered directly from the rechargeable battery. For further information on the power supply and management components of the main electronic board, please refer to Section 3.5 of the current Deliverable Report.
POWER-3	The system SHOULD support quick charging.	Quick charging has not been studied as an option/feature to be included in the first design of the main electronic board.
POWER-4	In the PhasmaFOOD device the all wireless options SHOULD be implemented by low energy (LE) Bluetooth communication between the smartphone and the portable sensing device.	The communication between the main electronic board and the end-user's mobile device is achieved wirelessly using the WL1835MOD subsystem [26]. It is a 2.4 GHz component providing Wi-Fi and Bluetooth/BLE coexistence and is Bluetooth 4.2 Secure Connection compliant. For further information on the wireless communication components, please refer to Section 3.3.1 of the current Deliverable Report. The main electronic board establishes a wireless communication with the end-user's mobile device using the Bluetooth protocol [31]. The communication between the embedded and

		mobile devices should be achieved based on the BLE specification. The Deliverable Report 5.3 provides further details and information regarding the Bluetooth API and the sequence of actions that take place during the establishment and data exchange of the Bluetooth communication between the embedded and mobile devices.
DATA-1	The PhasmaFOOD device MUST be able to compress data before communication.	In alignment with ELECTR-L-3 and ELECTR-L-5 requirements, the main electronic board integrates a microprocessor [19], which can collect the sensory data and process them to some extent before sending them to the mobile device. These pre-processing functionalities may include data compression. In addition, in alignment with MEM-1 requirement, the main electronic board integrates memory components, i.e., DDR2 SDRAM AS4C128M16D2A [22], SDINBDG4 [23] eMMC, and a microSD connector [24], which provide sufficient memory availability on the board for storing the sensory data collected from the sensing node and pre-processing them. These memory components can support storing any intermediate calculations during the execution of various functionalities on the board, e.g., data compression. Section 3.2 provides further information on the external memory components, which are integrated on the main electronic board.
DATA-2	Data compression SHOULD be performed on the PhasmaFOOD scanner and on the PhasmaFOOD mobile apps.	
DATA-COMM-1	The PhasmaFOOD device MUST be able to communicate data to the PhasmaFOOD cloud through the smartphone in low latency, possibly secured.	In alignment with POWER-4 requirement, the main electronic board communicates wirelessly with the end-user's mobile device using the WL1835MOD subsystem [26]. It is a 2.4 GHz component providing Wi-Fi and Bluetooth/BLE coexistence and is Bluetooth 4.2 Secure Connection compliant. For further information on the wireless communication components, please refer to Section 3.3.1 of the current Deliverable Report. The main electronic board establishes a wireless communication with the end-user's mobile device using the Bluetooth protocol [31]. The communication between the embedded and mobile devices should be achieved based on the BLE specification. The Deliverable Report 5.3
DATA-COMM-2	Communication protocols MUST be open and based on standards to allow for interoperability.	
DATA-COMM-3	The PhasmaFOOD device MUST be able to communicate data to a connected smartphone using low-power and short-range	

	wireless and wired communication.	provides further details and information regarding the Bluetooth API and the sequence of actions that take place during the establishment and data exchange of the Bluetooth communication between the embedded and mobile devices.
DATA-COMM-4	The PhasmaFOOD system MUST offer bidirectional communication between PhasmaFOOD device and the connected smartphone.	
DATA-COMM-5	Communication APIs MUST be defined to specify the communications between the PhasmaFOOD device, the PhasmaFOOD smartphone and the PhasmaFOOD cloud.	
H-PHY_5	The sensing device SHOULD be defined in two parts.	The PhasmaFOOD sensing device comprises two main parts: the sensing node and the main electronic subsystem. The sensing node includes all the sensing components and the driving electronic boards that drive them and interface them to the main electronic board. In addition, the sensing node incorporates illumination sources. The main electronic subsystem collects all the required sensory data, pre-processes them, i.e., processes them to some extent, and communicates them to the end-user's mobile device. For further information on the architecture of the PhasmaFOOD sensing device, as well as the overall system architecture of the PhasmaFOOD solution, please refer to Section 1 of the current Deliverable Report.
H-PHY_8	Humidity and temperature SHOULD be monitored.	In alignment with ELECTR-L-8 requirement, a temperature sensor [42] is mounted on the main electronic board and digitally monitors the temperature inside the sensing device. If the validation and testing activities on the first PhasmaFOOD system prototype will indicate that humidity needs to be monitored inside the sensing device, then we will integrate a humidity sensor inside the PhasmaFOOD scanner.
H-PHY_9	Operational temperature SHOULD be in the range 20 to 25 C (room temperature).	
	Humidity SHOULD be in the range 40-80 rH.	
SAF_3	A LED that indicates when the light sources are ON to avoid exposure to UV light MUST be integrated in the sensor case.	In alignment with ELECTR-L-4 requirement, the main electronic board integrates some indicating LEDs [46] as for interfacing with the end-user of the sensing device. Section 3.4 provides further

SAF_4	The same LED or an addition one MUST warn the end user in case of any malfunctioning of the system.	information on the LEDs mounted on the main electronic board.
SAF_5	The mobile APP/user interface software MUST indicate which kind of failure is happening.	In alignment with ELECTR-L-5 requirement, the main electronic board independently interfaces with each one of the sensing components and collects and processes the sensory data they produce. The microprocessor [21] on the main electronic board can collect the sensory data that each sensing component outputs, and process them to some extent before sending them to the mobile device. Each one of the sensing components is driven by a unique driving electronic board, which resides near it inside the sensing subunit. These electronic boards are essentially the electronic interfaces between the sensing components and the main electronic board. For further information on the driving electronic boards of the sensing components, please refer to Section 2 of the current Deliverable Report.
SAF_6	In this regard, the three sensors MUST be able to work independently to overcome possible failures of one of them.	

5 Layout design of the main electronic board

5.1 Overview of the layout design of the main electronic board

The layout design for the main electronic board was developed using the Autodesk Eagle PCB design tool [14] based on the schematic design described in Section 3 and provided in Section 8.1. The size of the main electronic board is 80 mm by 80 mm.

In the following sections, we provide some figures targeting to present different aspects of the layout design for the main electronic board. Sections 5.1.1 - 5.1.6 present the six layers of copper, which comprise the electronic board. The layer No.2 is dedicated to ground, while the layer No.5 hosts different voltage supplies (split voltage levels). Between each two layers of the electronic board, insulation material resides. Sections 5.1.7 and 5.1.8 present the solder mask [15] for the top and bottom layers of the main electronic board respectively. Sections 5.1.9 and 5.1.10 report on the areas of applying solder paste for the top and bottom layers of the main electronic board respectively. Finally, Sections 5.1.11 and 5.1.12 present the silkscreen for the top and bottom layers of the main electronic board respectively.

5.1.1 Top layer (copper layer No.1) of the main electronic board

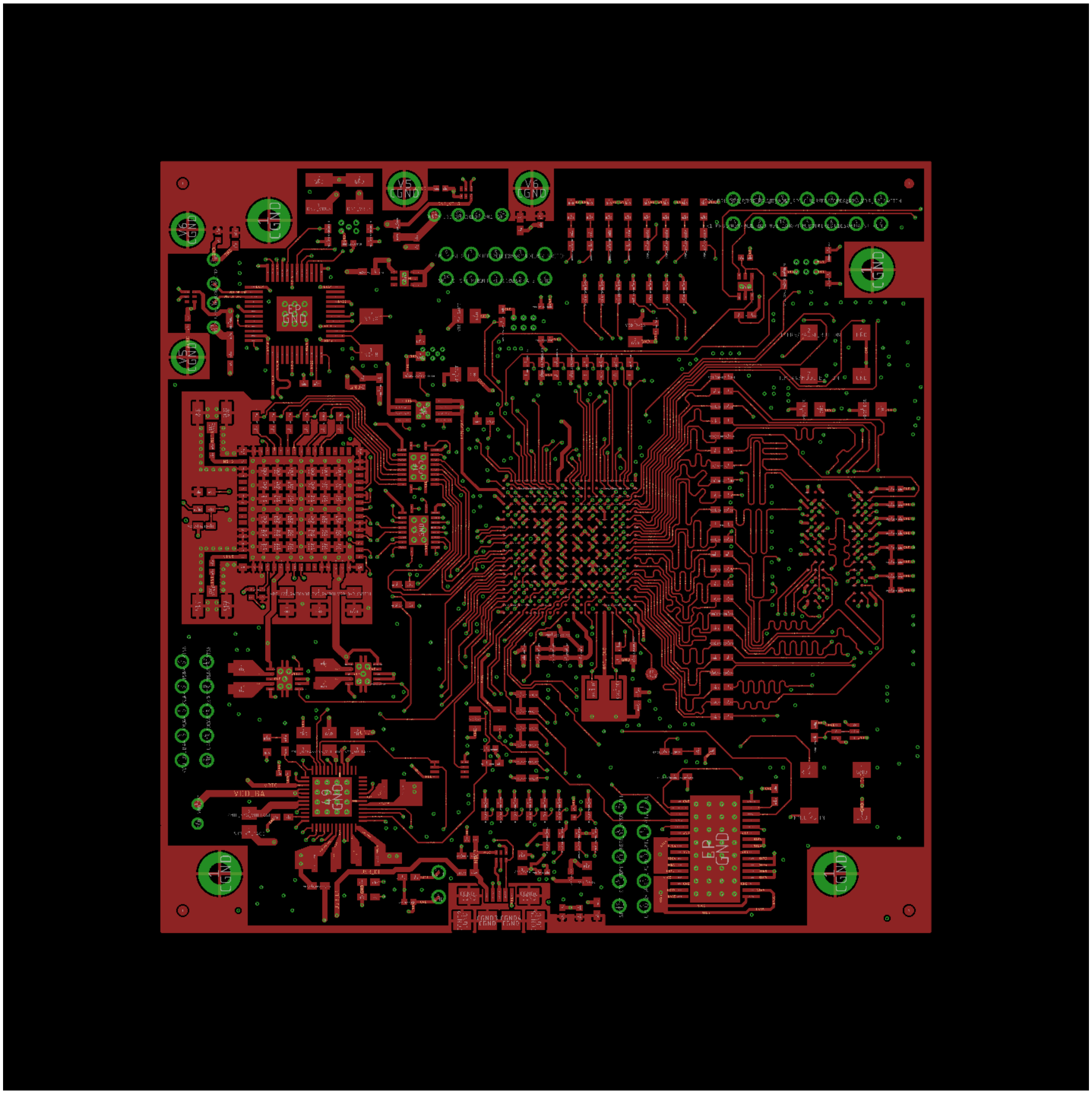

Figure 14 - Top layer (copper layer no. 1) of the main electronic board including all vias and pads.

5.1.2 Copper layer No.2 of the main electronic board

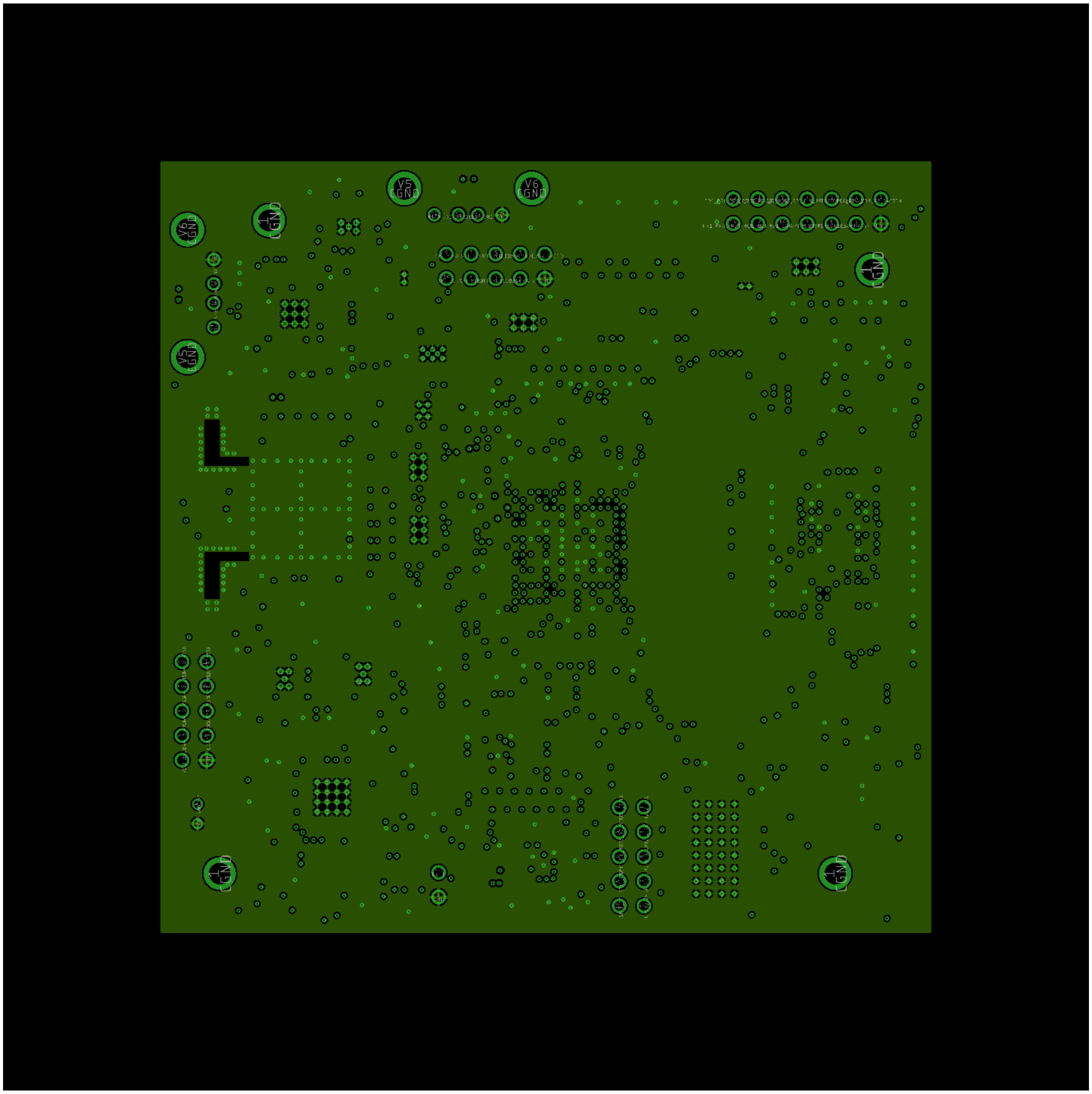

Figure 15 – Copper layer no. 2 (Ground layer) of the main electronic board including all vias and pads.

5.1.3 Copper layer No.3 of the main electronic board

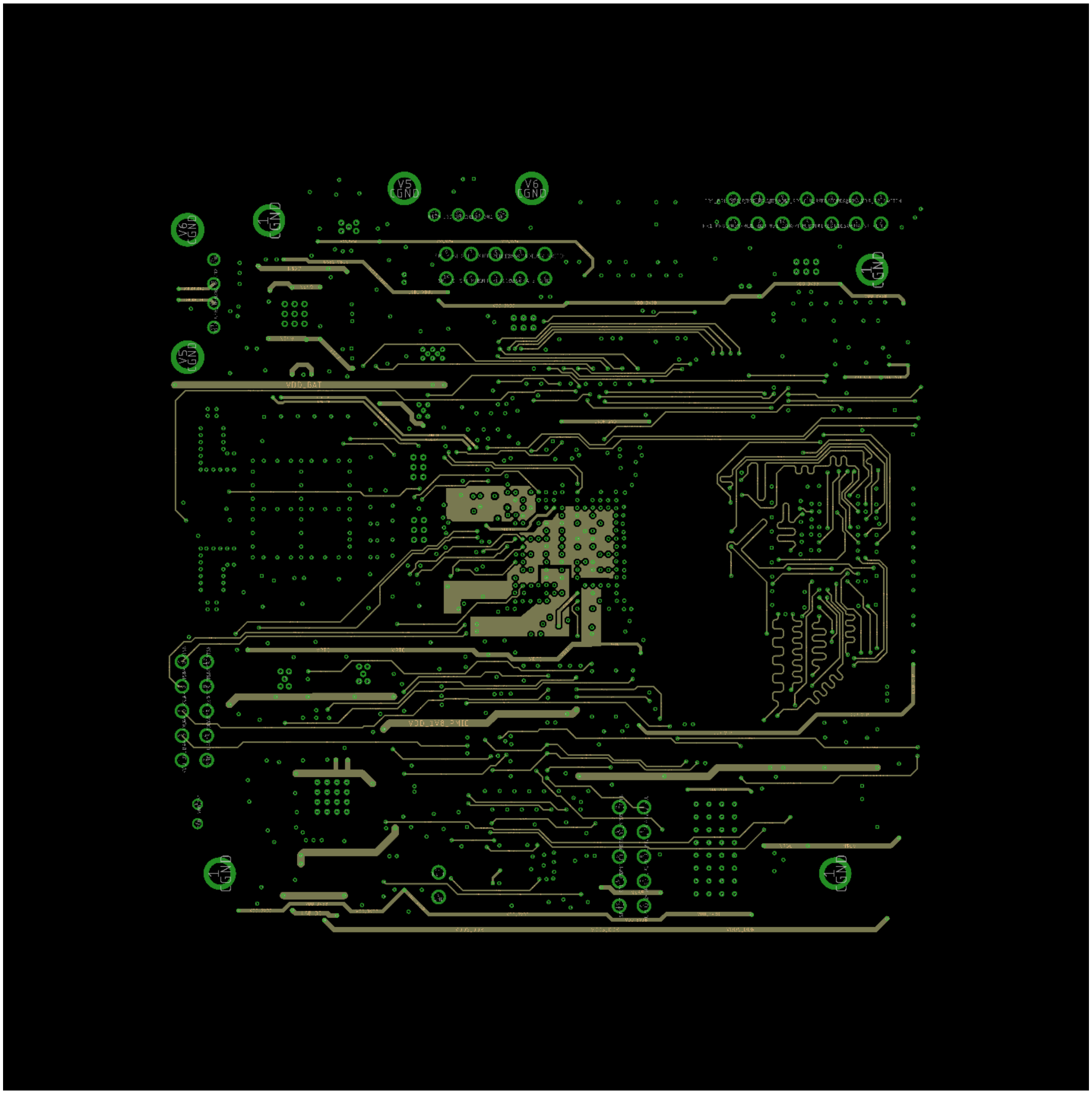

Figure 16 – Copper layer no. 3 of the main electronic board including all vias and pads.

5.1.4 Copper layer No.4 of the main electronic board

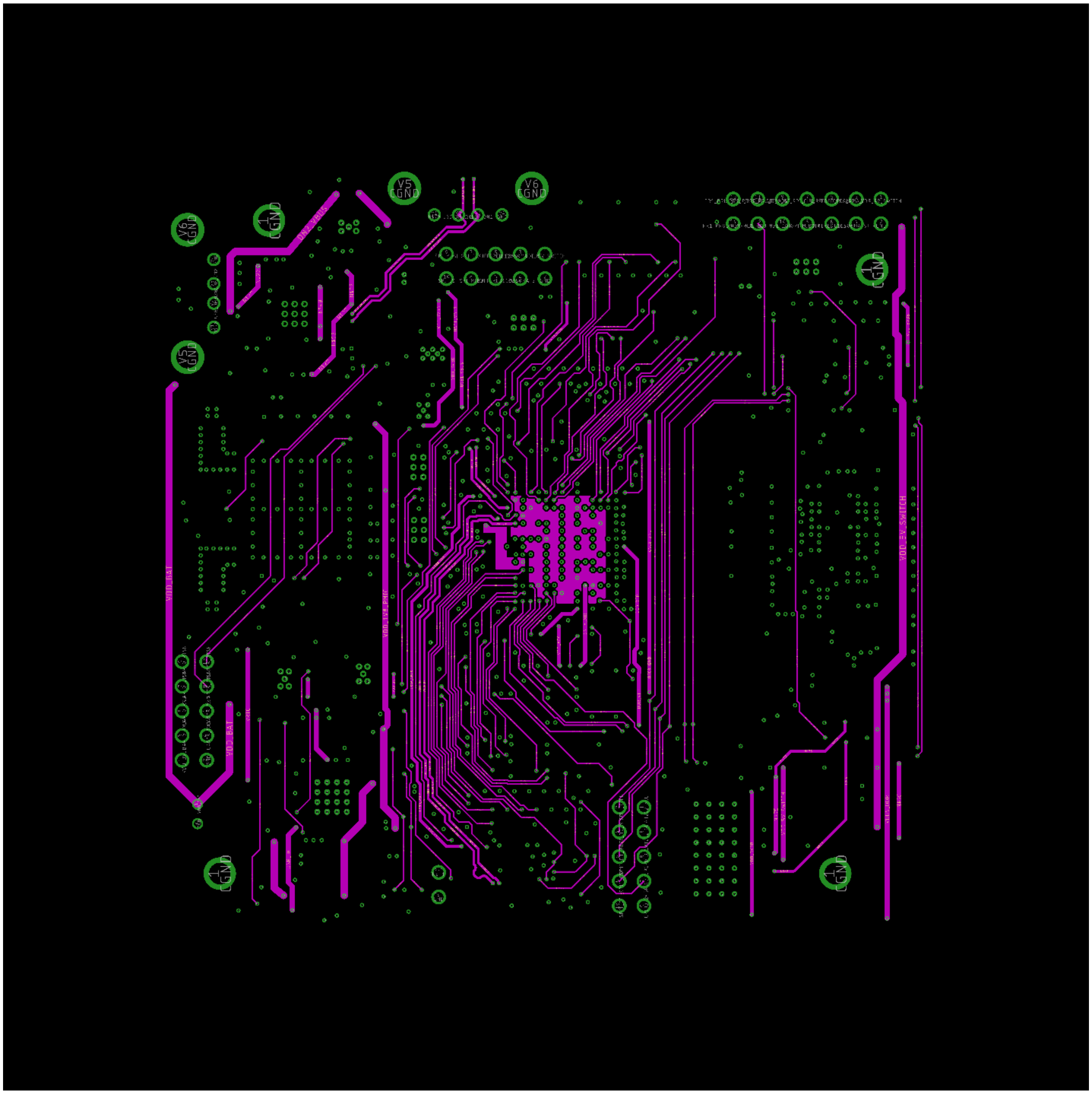

Figure 17 – Copper layer no. 4 of the main electronic board including all vias and pads.

5.1.5 Copper layer No.5 of the main electronic board

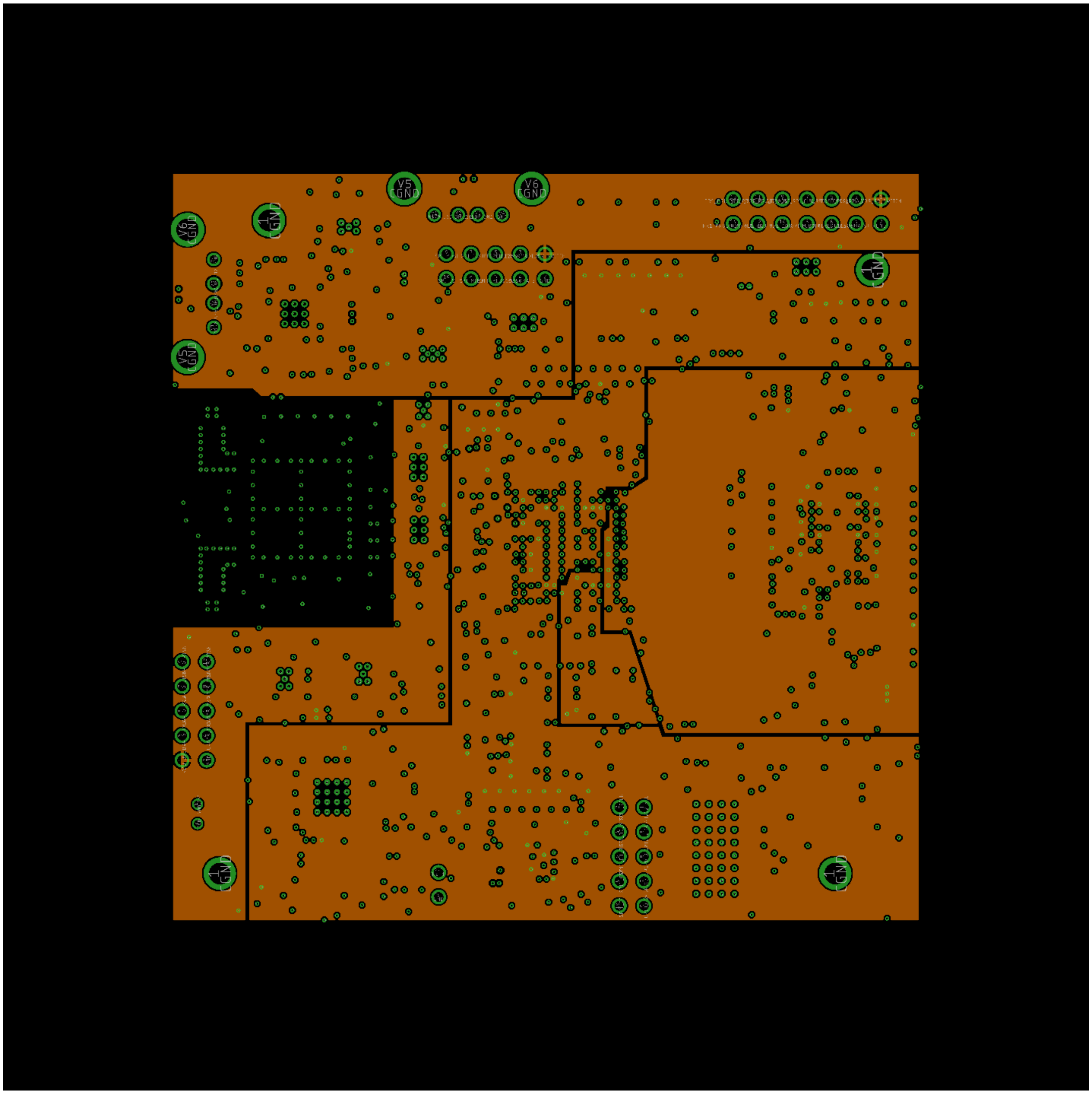

Figure 18 – Copper layer no. 5 (Split voltage levels) of the main electronic board including all vias and pads.

5.1.6 Bottom layer (copper layer No.6) of the main electronic board

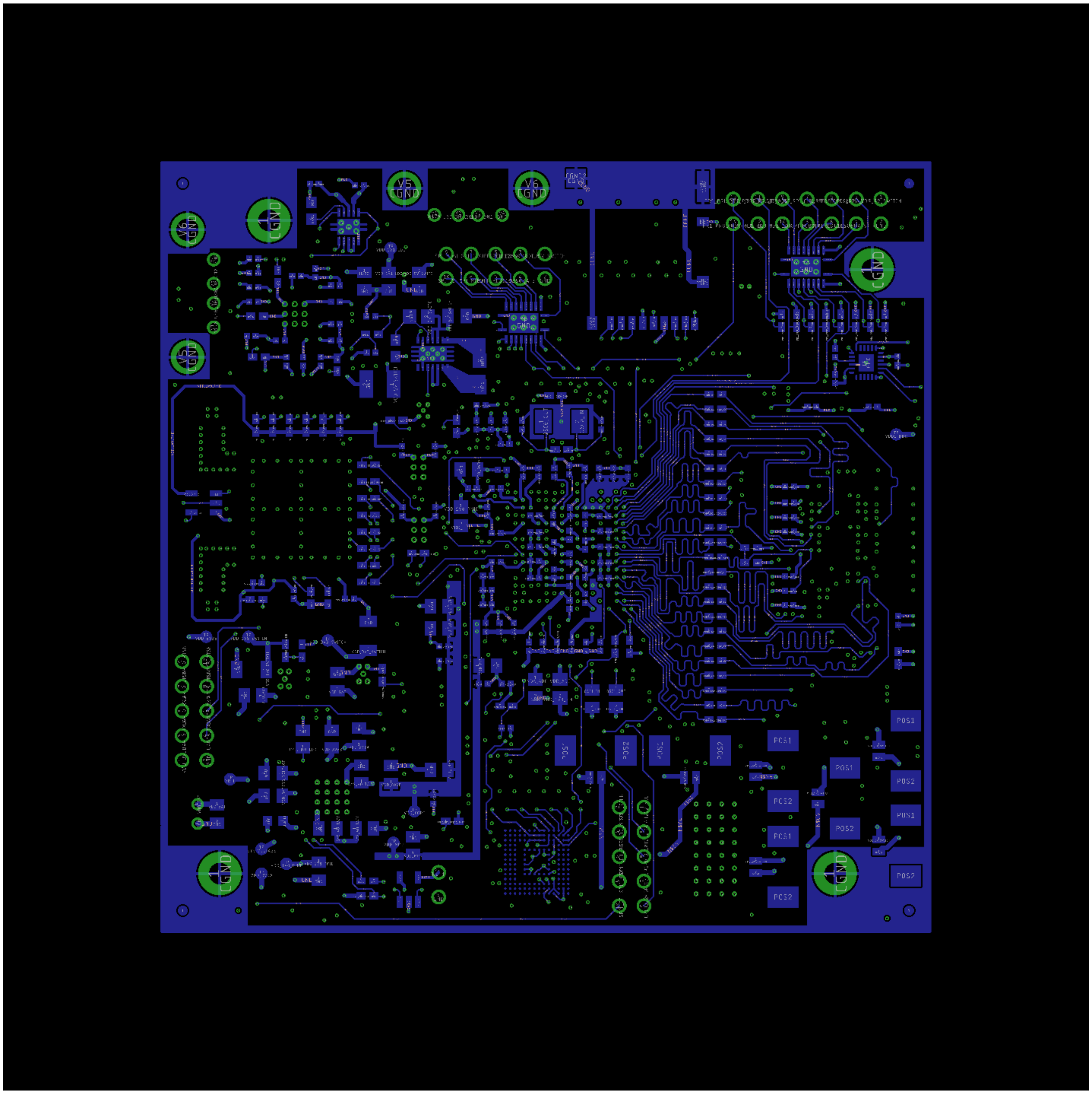

Figure 19 - Bottom layer (copper layer no. 6) of the main electronic board including all vias and pads.

5.1.7 Top layer solder mask of the main electronic board

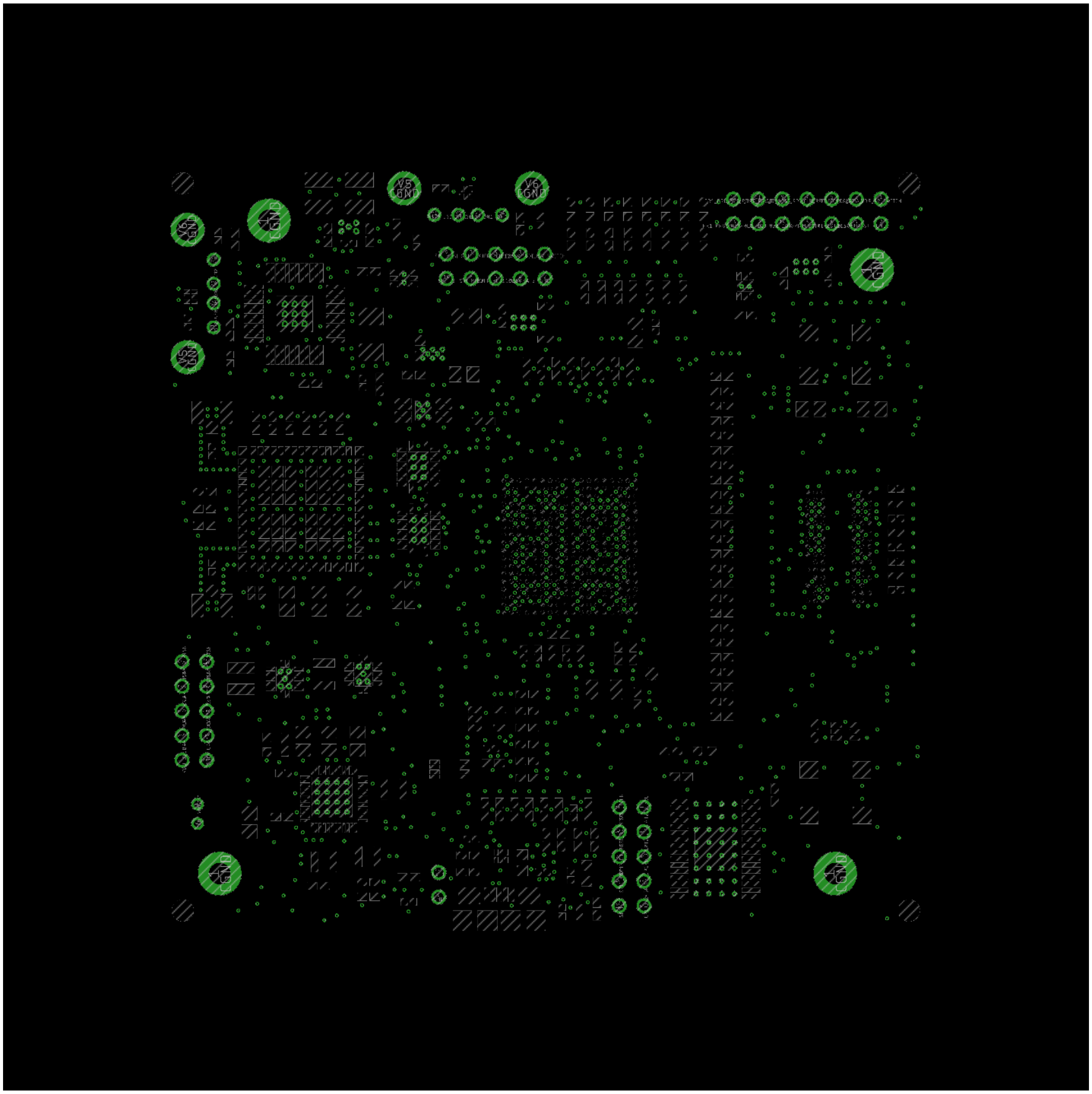

Figure 20 - Top layer solder mask of the main electronic board including all vias and pads.

5.1.8 Bottom layer solder mask of the main electronic board

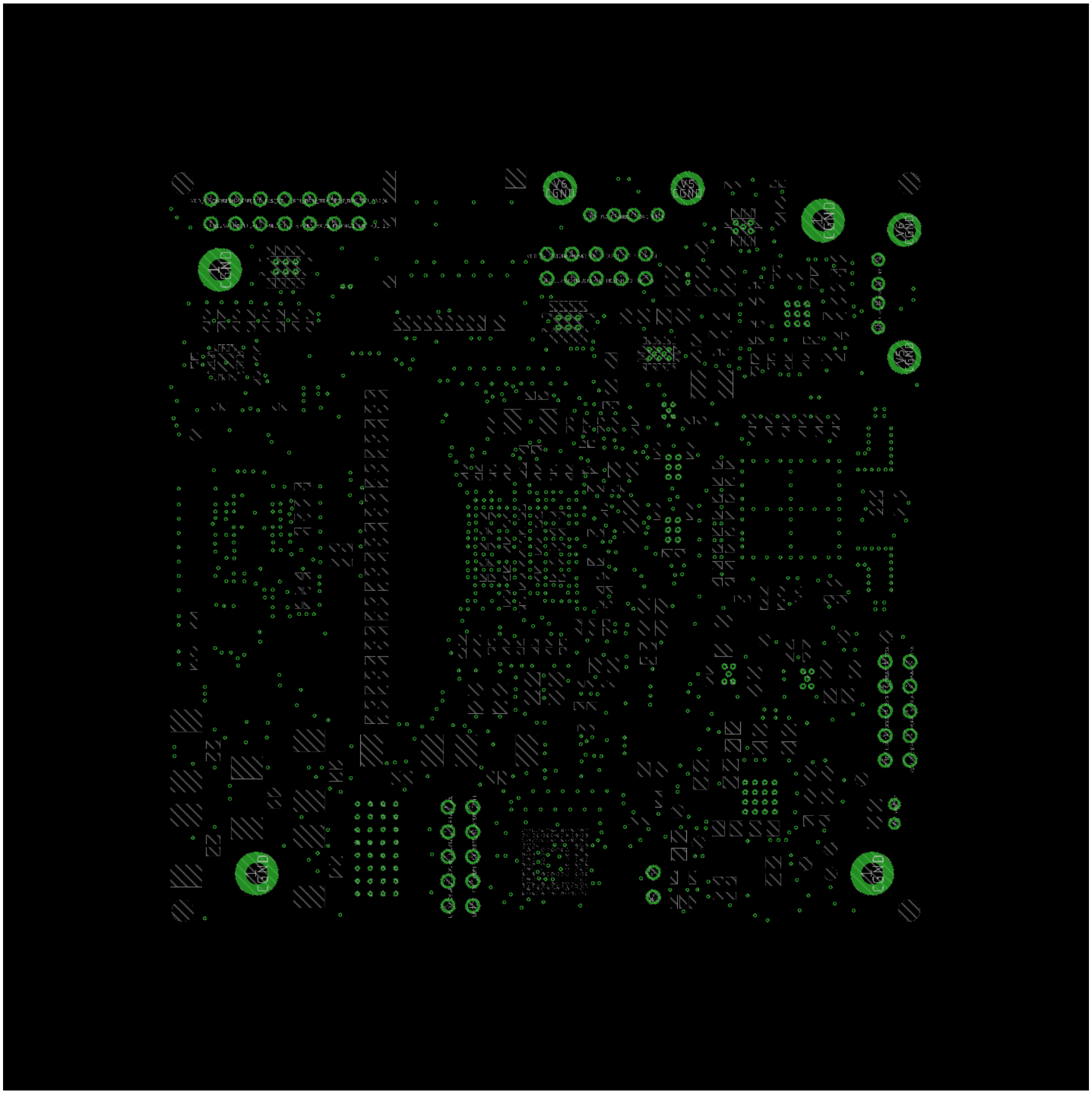

Figure 21 - Bottom layer solder mask of the main electronic board including all vias and pads.

5.1.9 Top layer solder paste of the main electronic board

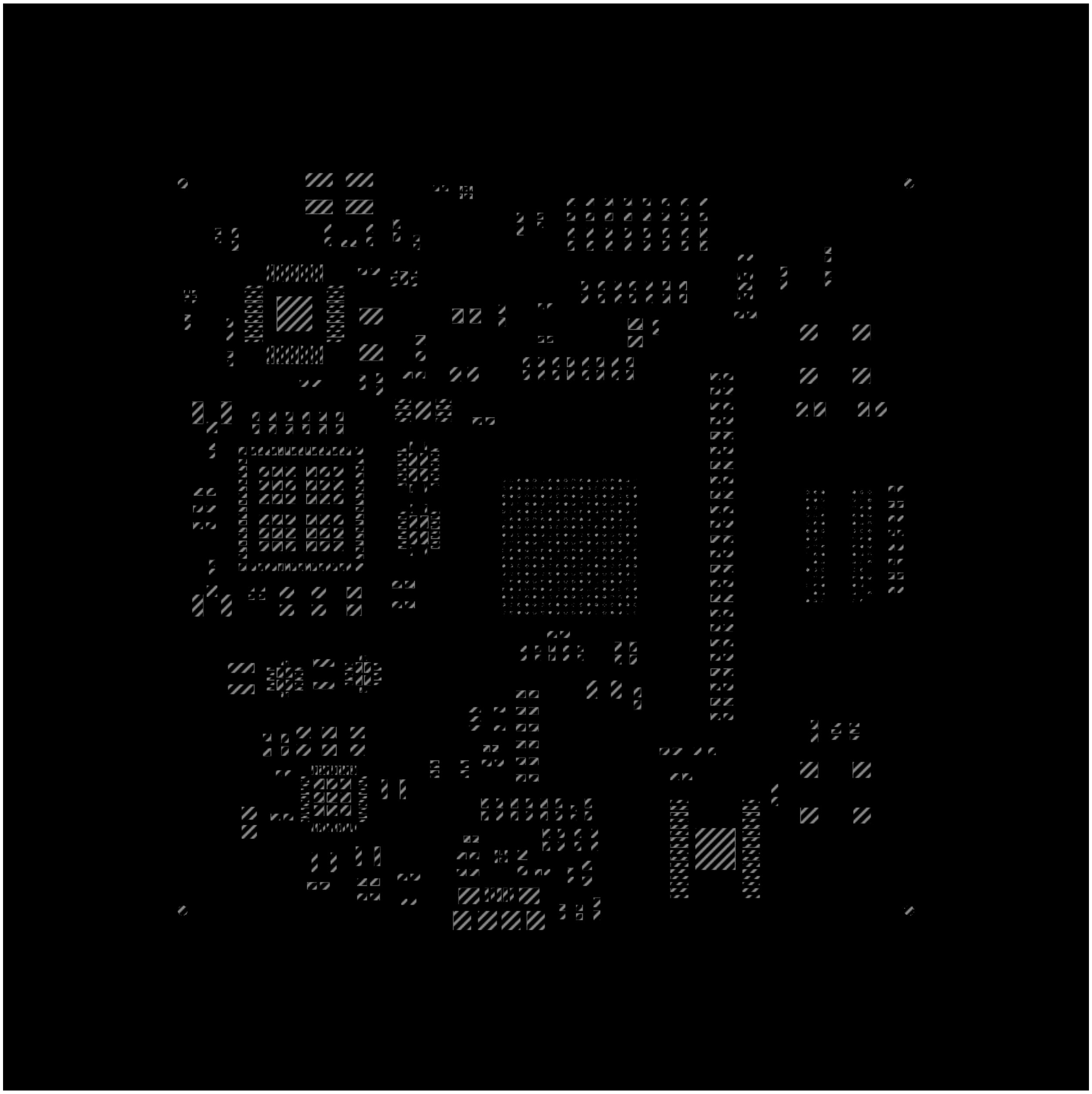

Figure 22 - Top layer solder paste of the main electronic board.

5.1.10 Bottom layer solder paste of the main electronic board

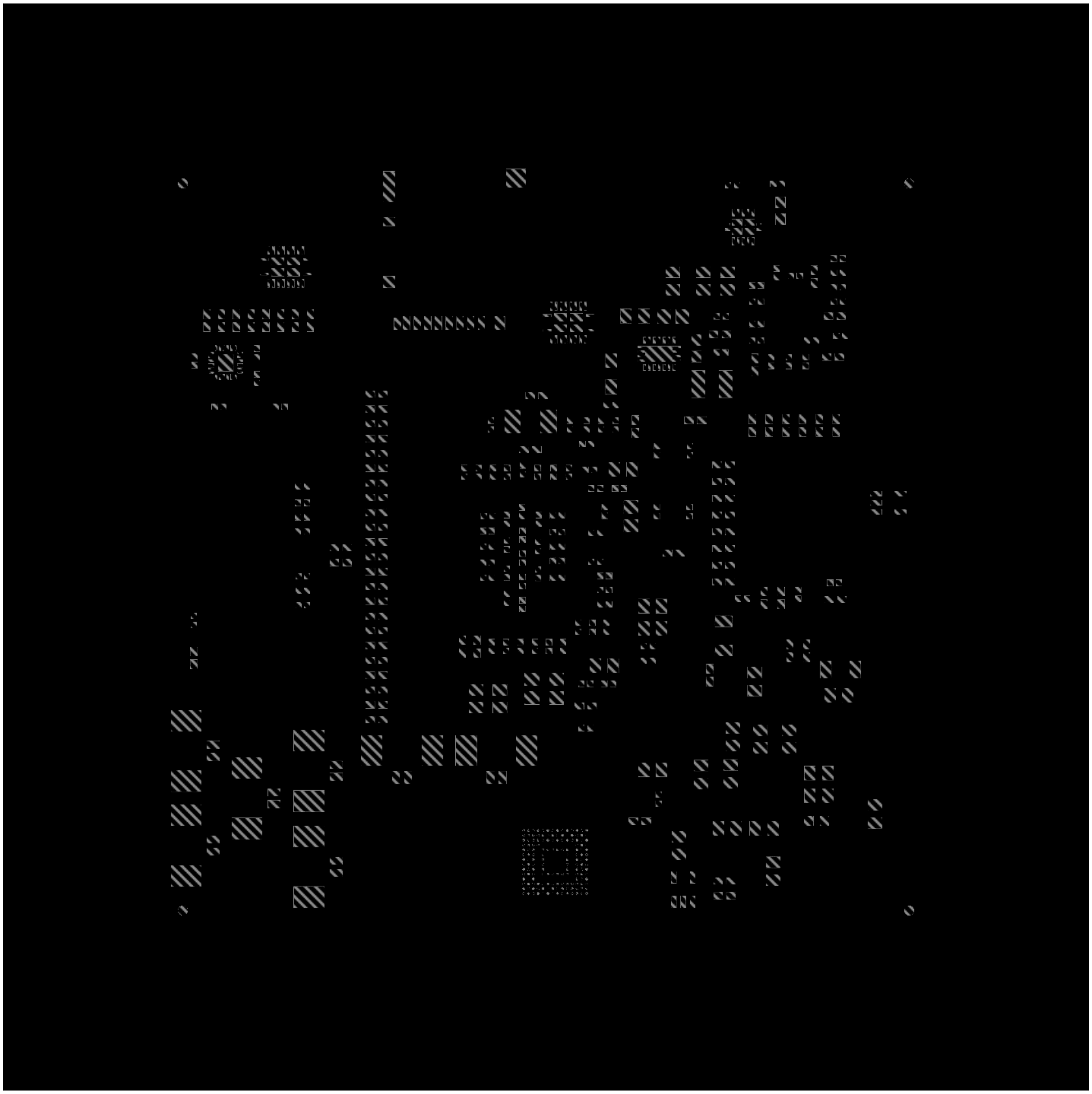

Figure 23 - Bottom layer solder paste of the main electronic board.

5.1.11 Top layer silkscreen of the main electronic board

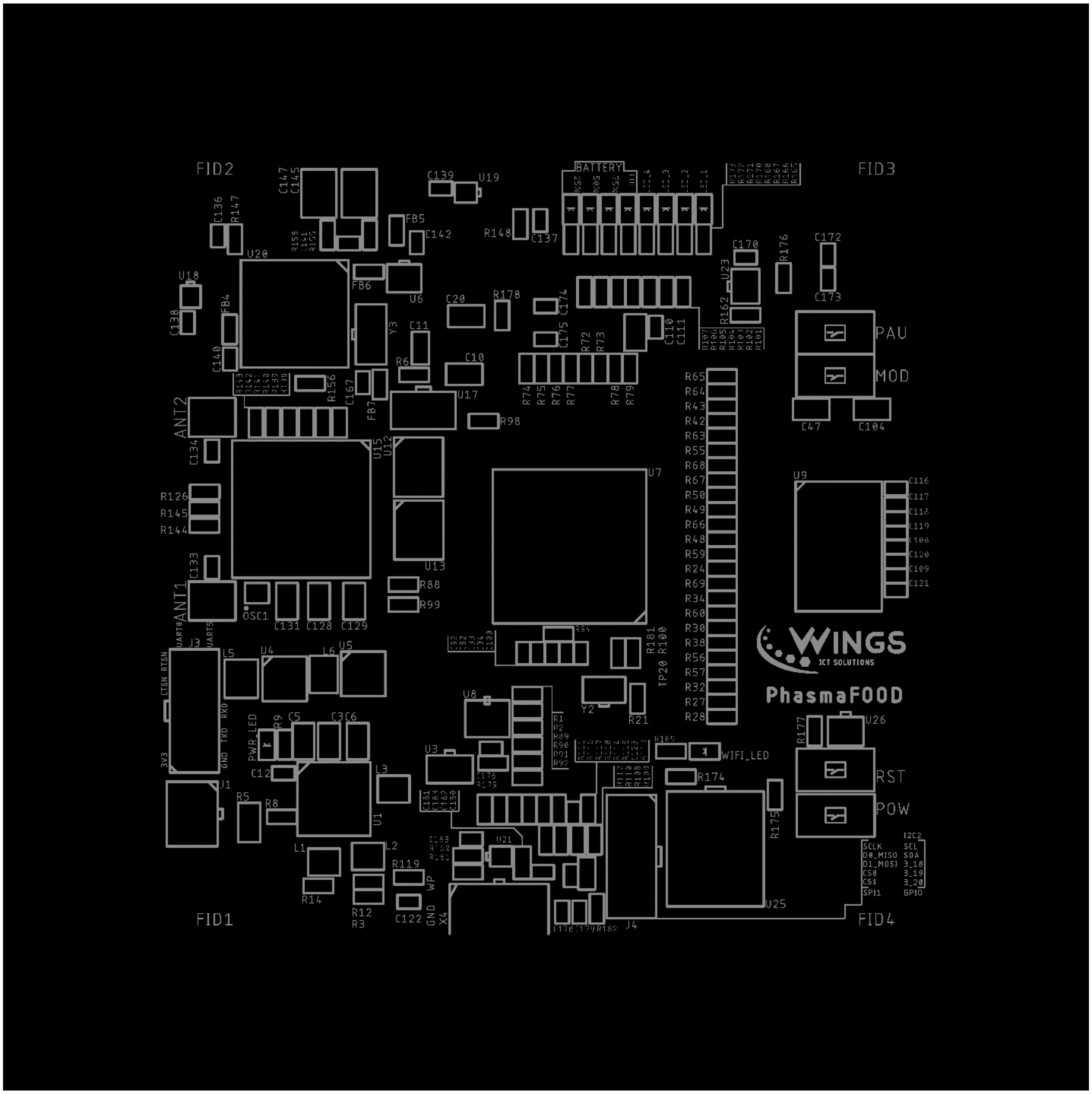

Figure 24 - Top layer silkscreen of the main electronic board.

5.1.12 Bottom layer silkscreen of the main electronic board

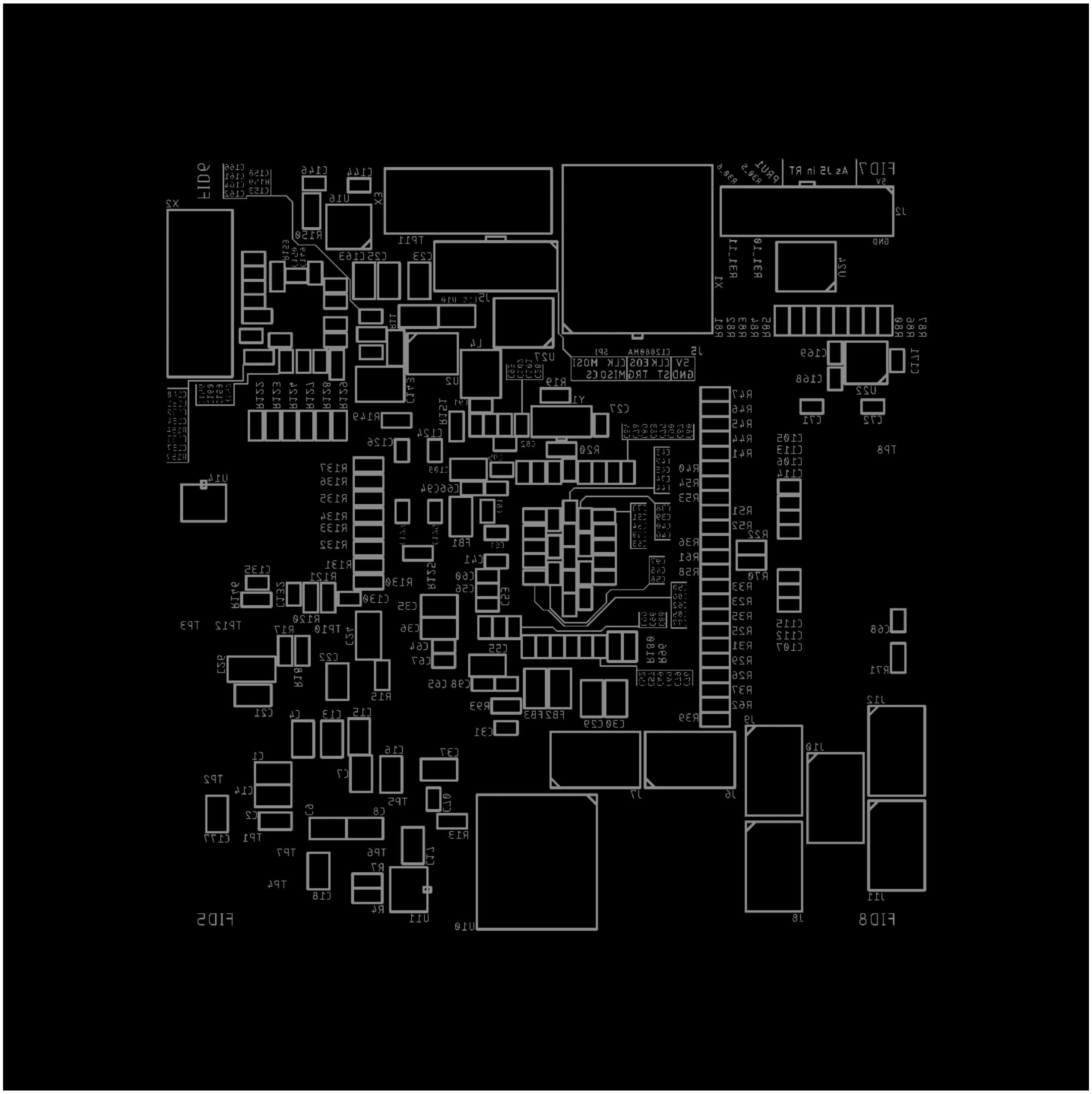

Figure 25 - Bottom layer silkscreen of the main electronic board.

5.2 BoM list for the main electronic board

Table 8 reports the complete BoM list, which includes all the components mounted on the main electronic board. This list was delivered to the chosen company for manufacturing and assembly of the main electronic board. Any changes, which occurred due to the lack of ability of the aforementioned company to find and purchase any of the BoM list's components, are not reported here. The components, which finally replaced the ones being out of stock, feature the same characteristics with the initially chosen ones listed in the BoM list of Table 8.

Table 8 - Complete BoM list with all the components mounted on the main electronic board.

No	Reference	Part Number	Value	Package	Qty	Manufacturer	Comments
1	R14, R19, R21, R94, R98, R160-161	AC0402JR-070RL	0R	402	7	Yageo	Resistor 0402, SMD
2	C32, C136-137, C178	GRM155R71C102KA01D	0.001uF	402	4	Murata	Multi-layer ceramic capacitor 0402, SMD
3	C33-34, C38-46, C48, C50-51, C53-54, C56, C58-75, C77-102, C105-109, C112-121, C176	GRM155R71C103KA01D	0.01uF	402	77	Murata	Multi-layer ceramic capacitor 0402, SMD
4	R5	RL0805JR-070R1L	0.1R	805	1	Yageo	Resistor 0805, SMD
5	C11	06036C104KAT4A	0.1uF	603	1	AVX	Multi-layer ceramic capacitor 0603, SMD
6	C111, C122, C124-127, C130, C135, C138-142, C144, C146, C149-152, C154-157, C159-162, C164-166, C168-169, C171-175, C179, C182-183	C0402C104J4RAC	0.1uF	402	40	KEMET	Multi-layer ceramic capacitor 0402, SMD
7	R146, R153	RC0402FR-071KL	1K	402	2	Yageo	Resistor 0402, SMD
8	R20, R147-148, R159, R182	RC0402FR-071ML	1M	402	5	Yageo	Resistor 0402, SMD
9	C49, C52, C57, C76, C132, C148, C167, C170	GRM155R6YA105KE11D	1uF	402	8	Murata	Multi-layer ceramic capacitor 0402, SMD
10	L4	IHLP1212BZER1R0M11	1uH	1212	1	Vishay	Inductor 1212, 5A Max. DC current, SMD
11	L6	LQM2HPN1R5MG0L	1.5uH	1008	1	Murata	Inductor 1008, 1.5A Max. DC Current, SMD
12	R10	CRCW08051M62FKEA	1.62M	805	1	Vishay	Resistor 0805, SMD
13	R1-2, R6, R8, R15, R89-93, R100-119, R122-124, R126-129, R145, R149, R151, R155, R158, R174, R176-178, R180	RC0402JR-0710KL	10K	402	47	Yageo	Resistor 0402, SMD
14	C133-134	GRM1555C1H100JA01D	10pF	402	2	Murata	Multi-layer ceramic capacitor 0402, SMD

Project Title: PhasmaFOOD
Contract No. 732541
Project Coordinator: INTRASOFT International S.A.

15	C1, C3-9, C13-17, C23, C25, C35-37, C47, C55, C103, C110, C128-129, C131, C163, C177	EMK212BB7106KG-T	10uF	805	27	Taiyo Yuden	Multi-layer ceramic capacitor 0805, SMD
16	C21-22	JMK212BJ106KD-T	10uF	805	2	Taiyo Yuden	Multi-layer ceramic capacitor 0805, SMD
17	R7, R12-13, R72-87, R120-121, R179	RC0402FR-07100KL	100K	402	22	Yageo	Resistor 0402, SMD
18	C143	C1210C107M9PACTU	100uF	1210	1	KEMET	Multi-layer ceramic capacitor 1210, SMD
19	X4	10118192-0001LF		SMD	1	Amphenol FCI	MicroUSB Type B Receptacle, SMD
20	R4, R181	RC0402FR-0712K1L	12.1K	402	2	Yageo	Resistor 0402, SMD
21	FB1-3	LI0805H151R-10	150R	805	3	Laird	Ferrite Bead 0805, 800mA Max. DC Current, SMD
22	C145, C147	JMK325ABJ157MM-T	150uF	1210	2	Taiyo Yuden	Multi-layer ceramic capacitor 1210, SMD
23	R18	RC0402FR-07178KL	178K	402	1	Yageo	Resistor 0402, SMD
24	C27-28, C153, C158	GRM1555C1H180JA01D	18pF	402	4	Murata	Multi-layer ceramic capacitor 0402, SMD
25	R11	RC0603FR-07180KL	180K	603	1	Yageo	Resistor 0603, SMD
26	R22, R70	RC0402FR-072K2L	2.2K	402	2	Yageo	Resistor 0402, SMD
27	C12, C31, C123	GRM155R61C225KE11J	2.2uF	402	3	Murata	Multi-layer ceramic capacitor 0402, SMD
28	L1-3	VLS252010HBX-2R2M-1	2.2uH	VLS252010	3	TDK	Inductor, 2.6A Max. DC Current, SMD
29	C18, C104	C2012X5R1C226K125AC	22uF	805	2	TDK	Multi-layer ceramic capacitor 0805, SMD
30	C10, C19-20	GRM219R60J226ME47D	22uF	805	3	Murata	Multi-layer ceramic capacitor 0805, SMD
31	FB4-7	BLM15PX221SN1D	220R	402	4	Murata	Ferrite Bead 0402, 1400mA Max. DC Current, SMD
32	Y1, Y3	7A-24.000MAAJ-T		SMD	2	TXC Corporation	Crystal 24MHz, SMD
33	R9, R165-173	RC0402FR-07240RL	240R	402	10	Yageo	Resistor 0402, SMD
34	U11	24LC32AT-I/OT		SOT23-5	1	Microchip	Serial EEPROM, SMD
35	C29-30	GQM2195C2E250JB12D	25pF	805	2	Murata	Multi-layer ceramic capacitor 0805, SMD
36	L5	SRN3015-3R3M	3.3uH	SRN3015	1	Bourns	Inductor, 1.6 A Max. DC Current, SMD
37	R162	RC0402FR-07300RL	300R	402	1	Yageo	Resistor 0402, SMD
38	Y2	FX135A-327		SMD	1	Fox	Crystal 32.768kHz, SMD
39	R23-69, R88, R99, R125, R130-144	CRCW040233R0JNED	33R	402	65	Vishay	Resistor 0402, SMD
40	C2, C180-181	GRM188R61C475KAAJD	4.7uF	603	3	Murata	Multi-layer ceramic capacitor 0603, SMD
41	R3, R96, R152, R154, R156	RC0402FR-074K75L	4.75K	402	5	Yageo	Resistor 0402, SMD

42	R17	RC0402FR-07453KL	453K	402	1	Yageo	Resistor 0402, SMD
43	C24, C26	C1206C476M8PACTU	47uF	1206	2	KEMET	Multi-layer ceramic capacitor 1206, SMD
44	R71	RC0402FR-0749R9L	49.9R	402	1	Yageo	Resistor 0402, SMD
45	J6-12	53398-0271		SMD	7	Molex	Header 1.25mm 1x2, SMD, Vertical
46	R175	RC0402FR-07620RL	620R	402	1	Yageo	Resistor 0402, SMD
47	R157	RC0402FR-079K53L	9.53K	402	1	Yageo	Resistor 0402, SMD
48	R150	RT0603BRD0794K2L	94.2K	603	1	Yageo	Resistor 0603, SMD
49	U7	AM3358BZCZA100		PBGA-324	1	Texas Instruments	Microprocessor, SMD
50	U9	AS4C128M16D2A-25BIN		TFBGA-84	1	Alliance Memory	DRAM DDR2, SMD
51	X1	DM3BT-DSF-PEJS		SMD	1	Hirose Electric	microSD connector, Push-Push, Bottom board mounting, SMD
52	U26	FDG8850NZ		SC70-6	1	ON Semiconductor	MOSFET Dual N-CH, SMD
53	OSC1	LFSPXO071976Cutt		SMD	1	IQD	Standard Clock Oscillator 32.768kHz, SMD
54	J1	B2B-PH-K-S(LF)(SN)		Through-Hole	1	JST	Header 2mm 1x2, Through-Hole, Top entry
55	U6	LP5912-1.1DRVR		WSON-6	1	Texas Instruments	500mA LDO, SMD
56	50%, 75%, FULL, PWR_LED, WIFI_LED	LTST-C191KGKT		603_LED	5	Lite-On	LED Green, SMD
57	25%	LTST-C191KRKT		603_LED	1	Lite-On	LED Red, SMD
58	LED_1, LED_2, LED_3, LED_4	LTST-C191KSKT		603_LED	4	Lite-On	LED Yellow, SMD
59	U22	MPU-9250		QFN-24	1	TDK InvenSense	Inertial Measurement Unit, SMD
60	MOD, PAU, POW, RST	SKQMASE010		SMD	4	ALPS	Tactile Switch, SMD
61	U10	SDINBDG4-8G-I1		TFBGA-153	1	SanDisk	Embedded Flash Drive, SMD
62	U14	SN74LV1T126DBVR		SOT23-5	1	Texas Instruments	Single Buffer with 3-State Output CMOS Logic Level Shifter, SMD
63	U8	SN74LVC1G07DBVR		SOT23-5	1	Texas Instruments	Single Buffer/Driver With Open-Drain Output, SMD
64	U3	SN74LVC2G00DCUR		VSSOP-8	1	Texas Instruments	NAND Dual 2-Input Pos, SMD
65	J3-5	929975-01-05		Through-Hole	3	3M	Header Socket 2.54mm 2x10, Through-Hole
66	J2	929975-01-07		Through-Hole	1	3M	Header Socket 2.54mm 2x14, Through-Hole
67	U25	TLC5922DAPR		HTSSOP-32	1	Texas Instruments	16-Channel LED Driver, SMD

68	U23	TMP116AIDRVR		WSON-6	1	Texas Instruments	Digital Temperature Sensor, SMD
69	U18-19, U21	TPD4S012DRYR		USON-6	3	Texas Instruments	4-Channel ESD Solution, SMD
70	U17	TPS2051BDGNR		MSOP-PowerPAD-8	1	Texas Instruments	Single, Current-Limited, Power-Distribution Switch, SMD
71	U16	TPS2561DRCR		VSON-10	1	Texas Instruments	Dual Channel Current-Limited Power Switch, SMD
72	U4	TPS63000DRCR		VSON-10	1	Texas Instruments	Buck-Boost Converter, SMD
73	U5	TPS63001DRCR		VSON-10	1	Texas Instruments	Buck-Boost Converter, 3.3V fixed Output voltage, SMD
74	U2	TPS63020DSJR		VSON-14	1	Texas Instruments	Buck-Boost Converter, SMD
75	U1	TPS65217BRSLT		VQFN-48	1	Texas Instruments	Power Management IC, SMD
76	U20	TUSB4020BIPHPR		HTQFP-48	1	Texas Instruments	Two-Port USB 2.0 Hub, SMD
77	U12-13, U24, U27	TXS0108ERGYR		VQFN-20	4	Texas Instruments	8-Bit Bi-directional Voltage Translator, SMD
78	ANT1-2	U.FL-R-SMT-1(10)		SMD	2	Hirose Electric	Coaxial Connector, SMD
79	X2-3	614004135023		Through-Hole	2	Wurth Electronics	USB Host Port Type A, Through-Hole, Vertical
80	U15	WL1835MODGBMOCT		QFM-100	1	Texas Instruments	Wi-Fi, Bluetooth, and BLE module, SMD

5.3 Manufactured and assembled main electronic board

Using the Autodesk Eagle PCB tool [14], we extracted the Gerber files, which refer to the layout design of the main electronic board (Section 5.1). The Gerber files were extracted using the RS-274X format and comprise one drill file, which shows all the drills/holes of the electronic board, one file per copper layer, i.e., six files for the main electronic board (Sections 5.1.1 - 5.1.6), one file for the solder mask of the top layer (Section 5.1.7), one file for the solder mask of the bottom layer (Section 5.1.8), one file for the solder paste of the top layer (Section 5.1.9), one file for the solder paste of the bottom layer (Section 5.1.10), one file for the silkscreen of the top layer (Section 5.1.11), and one file for the silkscreen of the bottom layer (Section 5.1.12). We should mention although that the figures presented in Sections 5.1.1 - 5.1.12 depict the different aspects of the layout design at the Autodesk Eagle PCB tool [14] since limitations in the exporting features of the tool did not allow us to include the Gerber files in this deliverable. Also, we provided the chosen company for manufacturing and assembly of the main electronic board with the BoM of Section 5.2. Figure 26 and Figure 27 show the top and bottom surfaces of the manufactured and assembled main electronic board respectively.

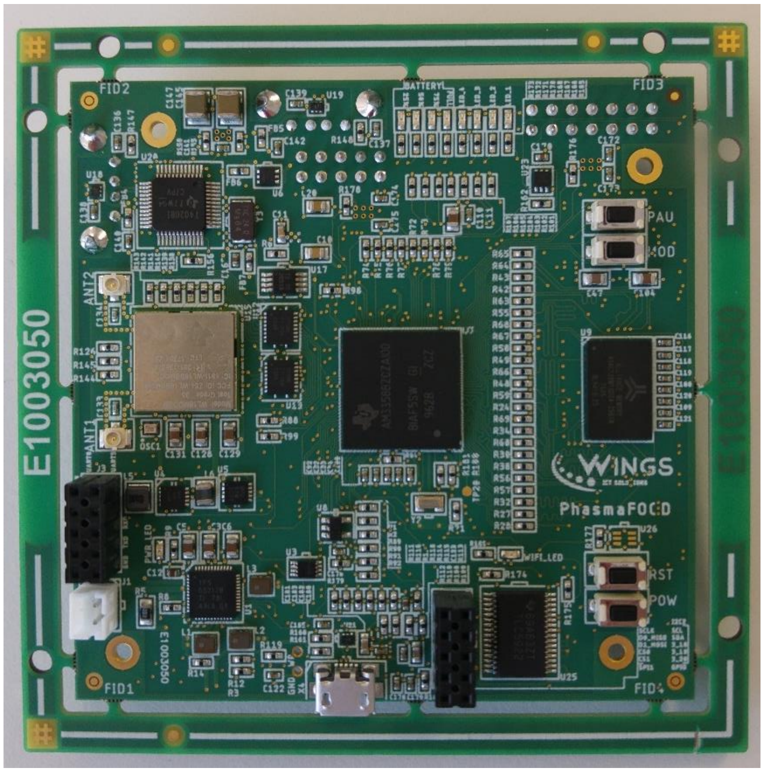

Figure 26 - Top surface of the main electronic board.

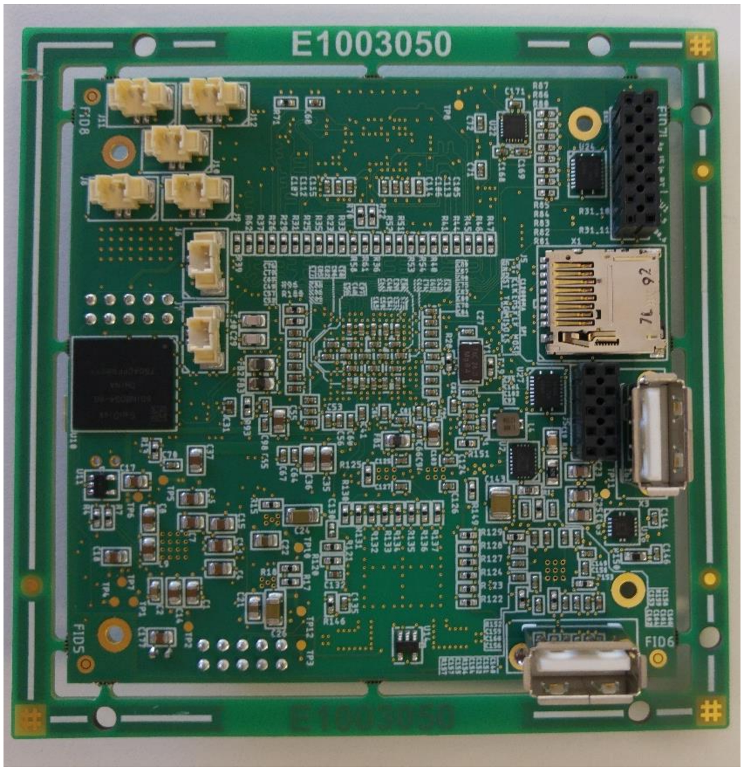

Figure 27 - Bottom surface of the main electronic board.

6 Conclusion and next steps

The current Deliverable Report provides information and details on the design and implementation of the electronic boards that the PhasmaFOOD sensing device comprises. An overview of the hardware design of the driving electronic boards of each of the sensing components and the main electronic board, as well as the changes that have occurred compared to the Deliverable Reports D2.1 [52] and D2.3 [3], are presented. Different aspects of the layout design and the subsequent manufacturing and assembly procedures complement the hardware design of the abovementioned electronic boards.

Regarding the next steps in the PhasmaFOOD project, the current Deliverable Report, as well as the Deliverable Reports D5.1 and D5.3, can stand as the primary sources of information towards the assembly of the PhasmaFOOD sensing device. Task 6.1 should consider the current Deliverable Report, as well as the Deliverable Reports D5.1 and D5.3, for the hardware and software integration of the unified PhasmaFOOD sensing device (M18), which is one of the three main parts of the PhasmaFOOD system architecture. The first complete PhasmaFOOD system prototype of M18 will go under exhaustive testing procedures in the context of the specified use cases of the Deliverable Report D1.1 [1] and any shortcomings, omissions, faults or enhancements that should be processed regarding the sensing device, will then be reported as a starting point for the second and final design of the PhasmaFOOD scanner.

7 References

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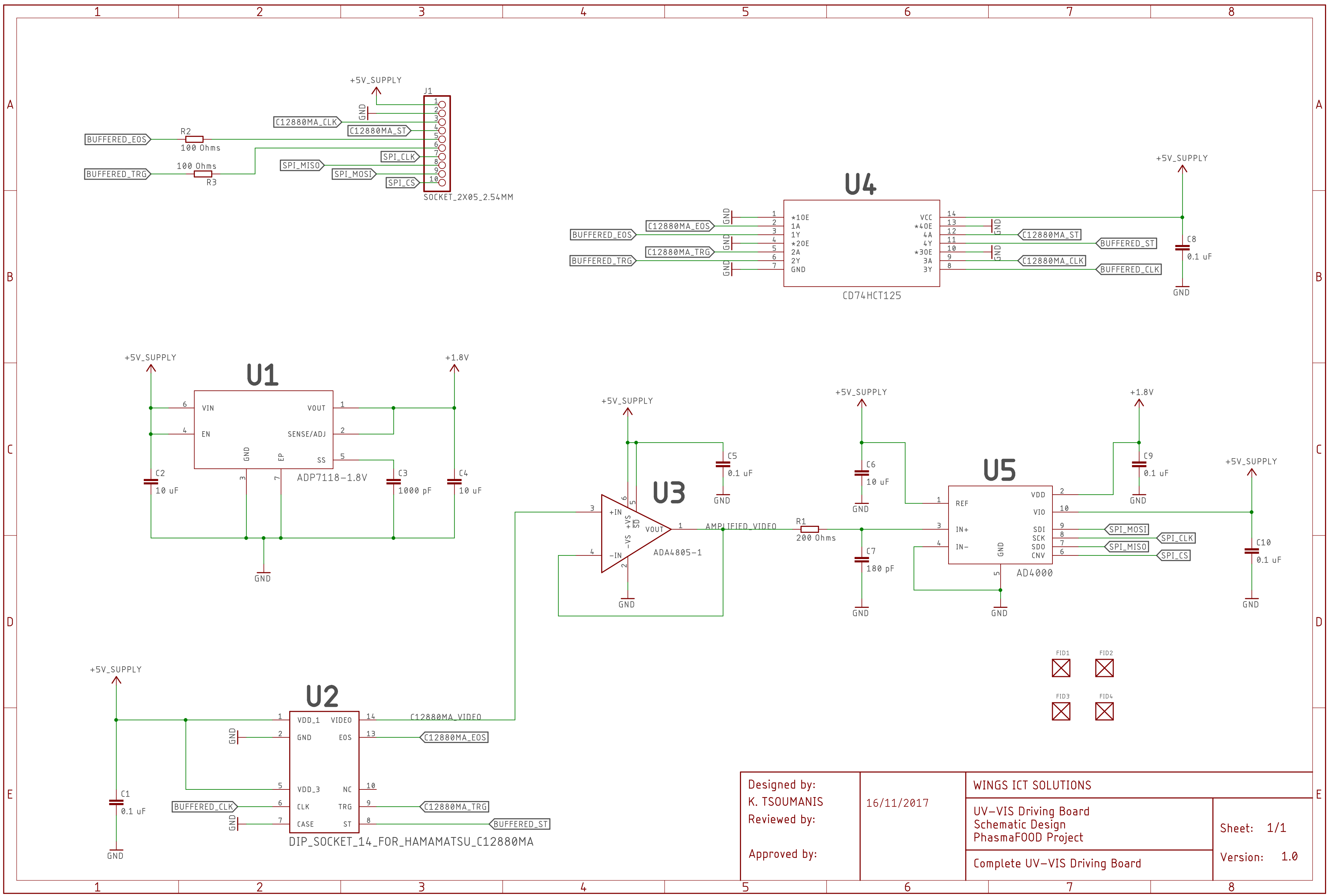
8 Appendix

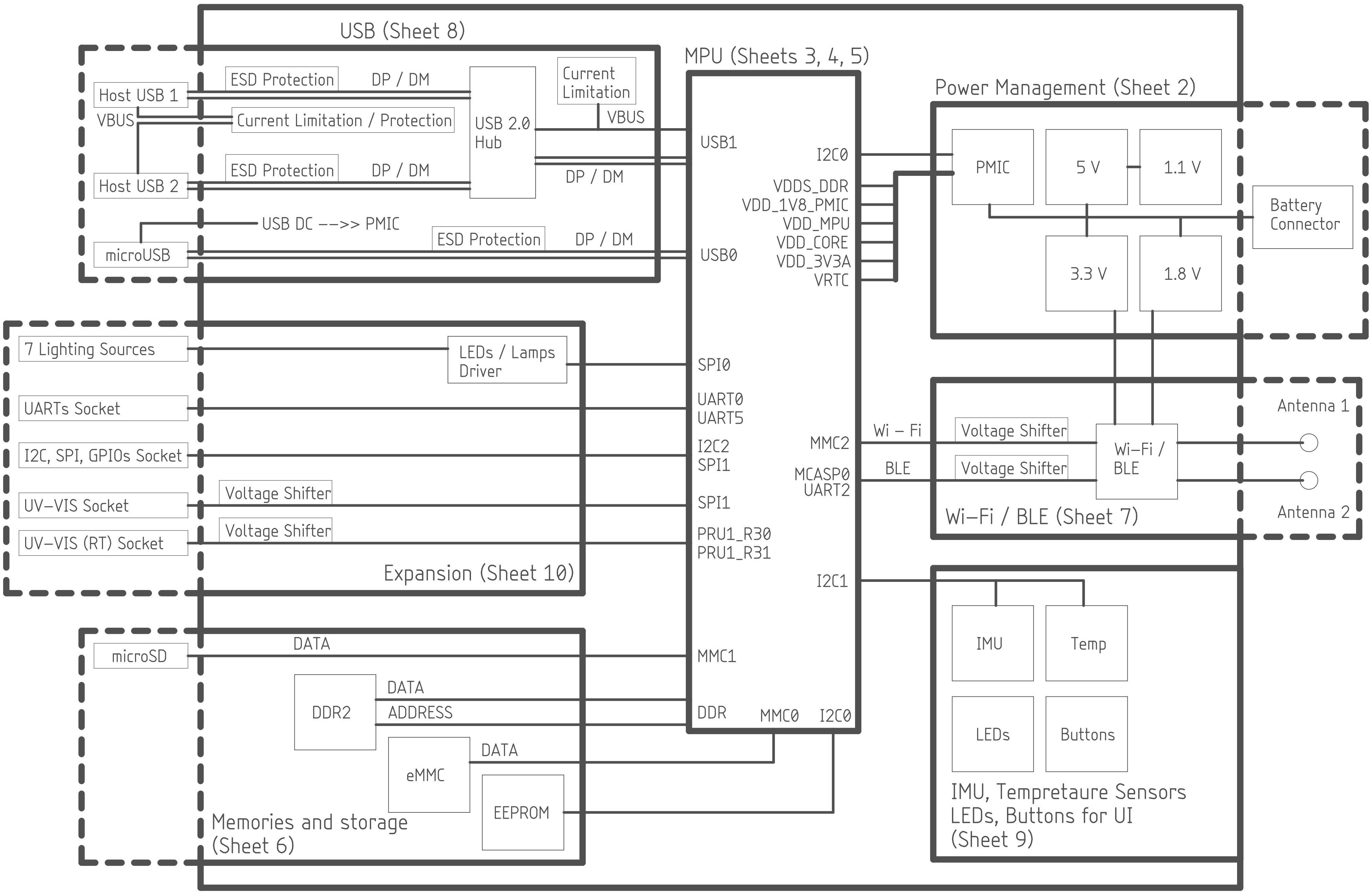
8.1 Schematic designs of the UV-VIS spectrometer driving board and the main electronic board

In this appendix, we provide in full detail the schematic designs, which describe the driving board of the UV-VIS spectrometer inside the sensing subunit and the main electronic board of the PhasmaFOOD sensing device. All these schematic designs were developed using the Autodesk Eagle PCB design tool [14].

More specifically, this appendix includes:

- The schematic design of the driving electronic board of the UV-VIS spectrometer. It includes one sheet and refers to Section 2.1.1 of the current Deliverable Report.
- The schematic design of the main electronic board. It includes ten sheets and refers to Section 3 of the current Deliverable Report.
  - The first sheet (sheet 1 of the main electronic board's schematic design) guides the readers through the subsequent sheets.
  - The sheets 3, 4, 5 and 6 of the main electronic board's schematic design integrate all the components and connections for processing and memory storage (Section 3.2).
  - The sheet 7 of the main electronic board's schematic design shows all the components and connections regarding the wireless communication (Section 3.3.1).
  - The sheets 8 and 10 of the main electronic board's schematic design incorporate all the components and connections for wired communications and potential expansion to external devices (Section 3.3.2).
  - The user interface LEDs, buttons and the oscillations/temperature control sensors are included in the sheet 9 of the main electronic board's schematic design (Section 3.4).
  - Finally, the power supply and management subsystem on the main electronic board is analyzed in the sheet 2 of the main electronic board's schematic design (Section 3.5).


U1
ADP7118-1.8V
U2
DIP_SOCKET_14_FOR_HAMAMATSU_C12880MA
U3
ADA4805-1
U4
CD74HCT125
U5
AD4000
J1
SOCKET_2X05_2.54MM
R1 200 Ohms
R2 100 Ohms
R3 100 Ohms
C1 0.1 uF
C2 10 uF
C3 1000 pF
C4 10 uF
C5 0.1 uF
C6 10 uF
C7 180 pF
C8 0.1 uF
C9 0.1 uF
C10 0.1 uF
+5V_SUPPLY
+1.8V
GND
AMPLIFIED_VIDEO
C12880MA_VIDEO
C12880MA_EOS
C12880MA_TRG
C12880MA_ST
C12880MA_CLK
BUFFERED_EOS
BUFFERED_TRG
BUFFERED_ST
BUFFERED_CLK
SPI_CLK
SPI_MISO
SPI_MOSI
SPI_CS
FID1
FID2
FID3
FID4
Designed by:
K. TSOUMANIS
Reviewed by:
Approved by:
16/11/2017
WINGS ICT SOLUTIONS
UV-VIS Driving Board
Schematic Design
PhasmaFOOD Project
Complete UV-VIS Driving Board
Sheet: 1/1
Version: 1.0



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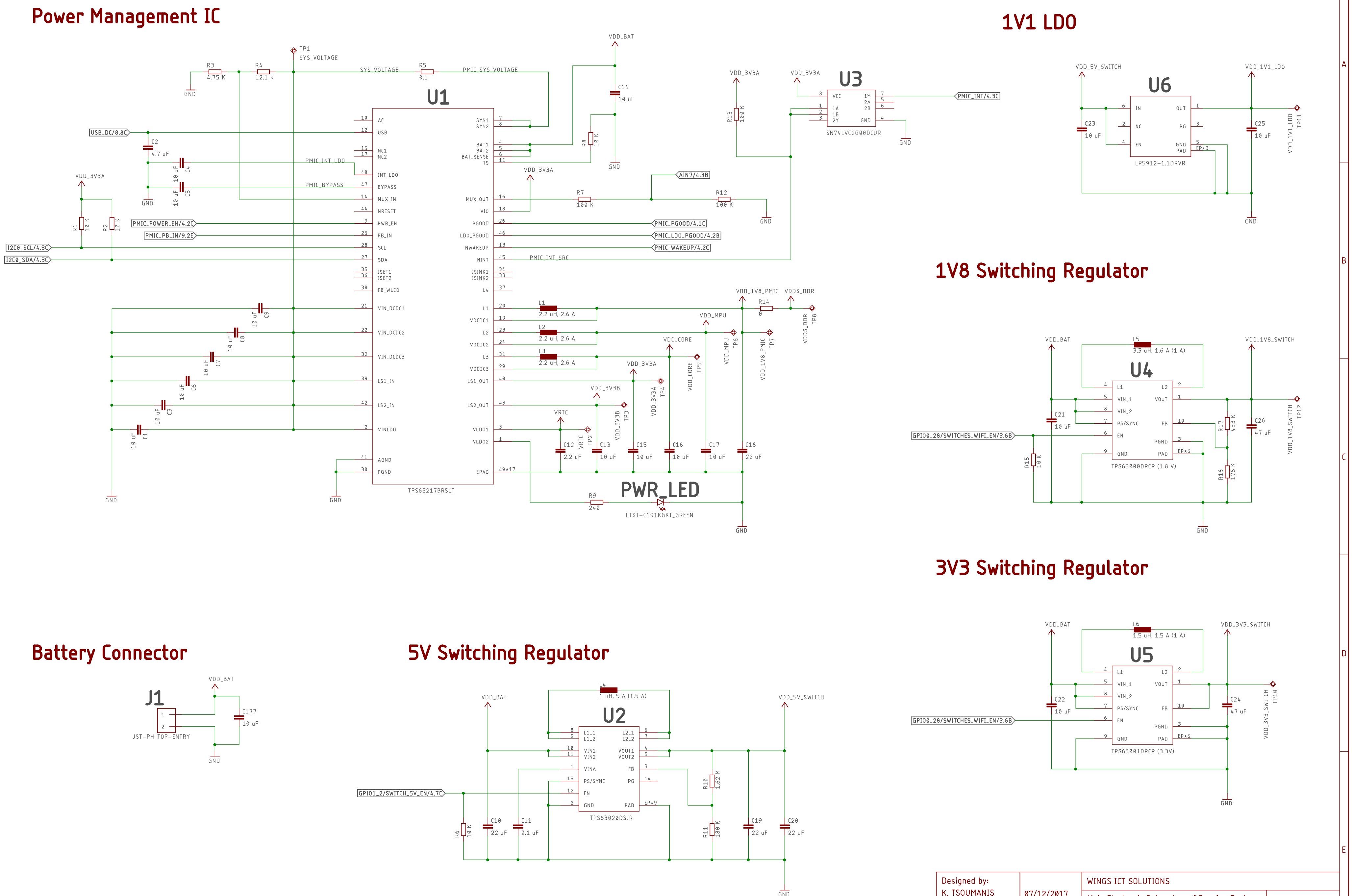
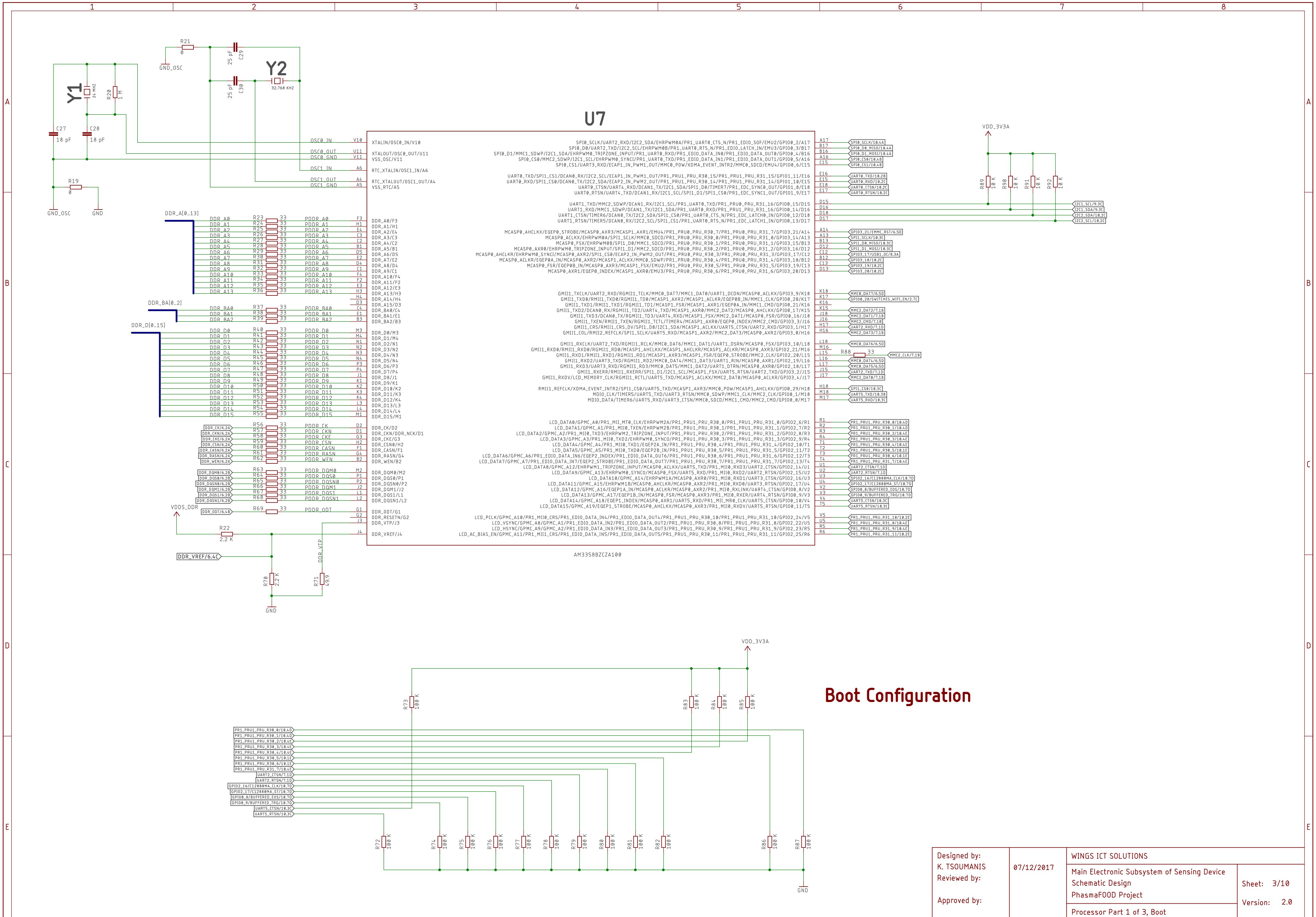
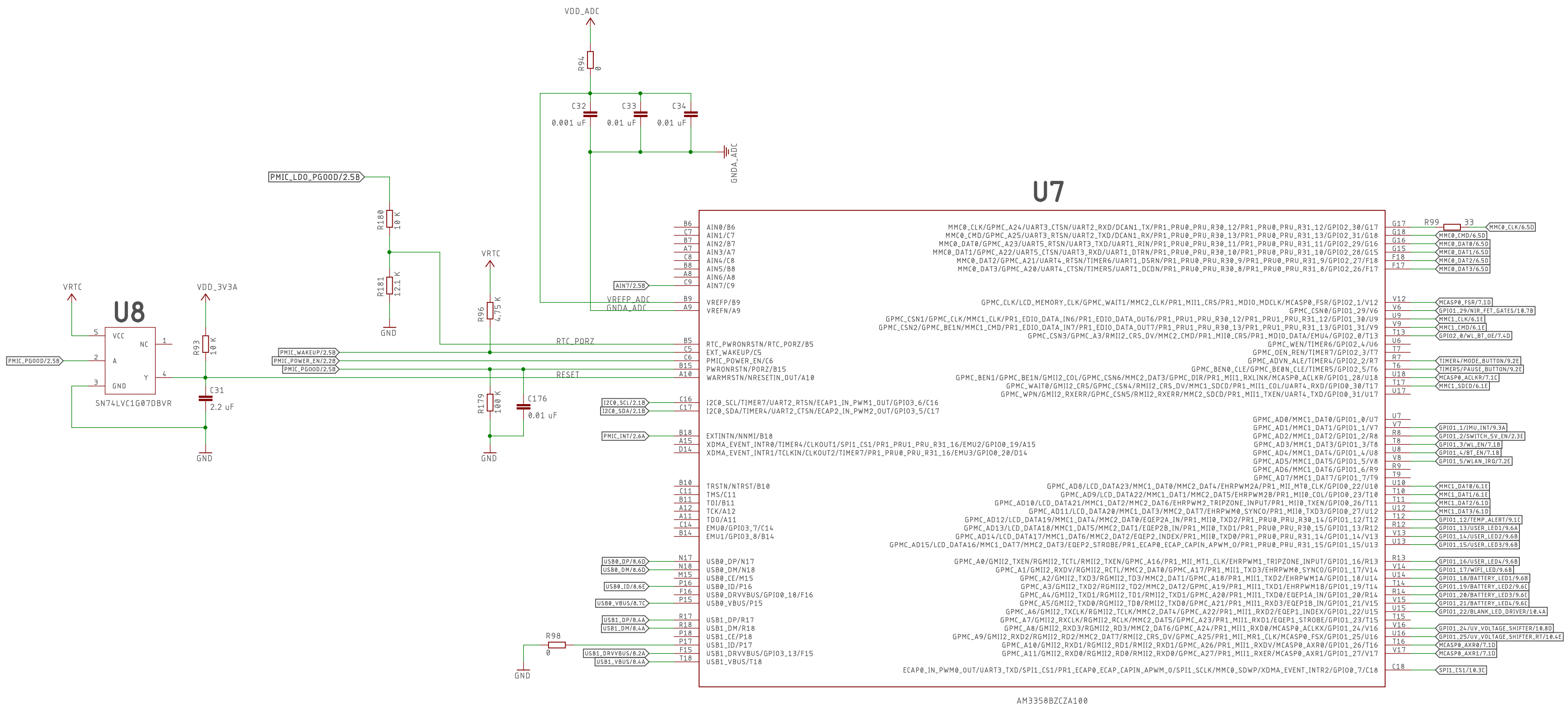
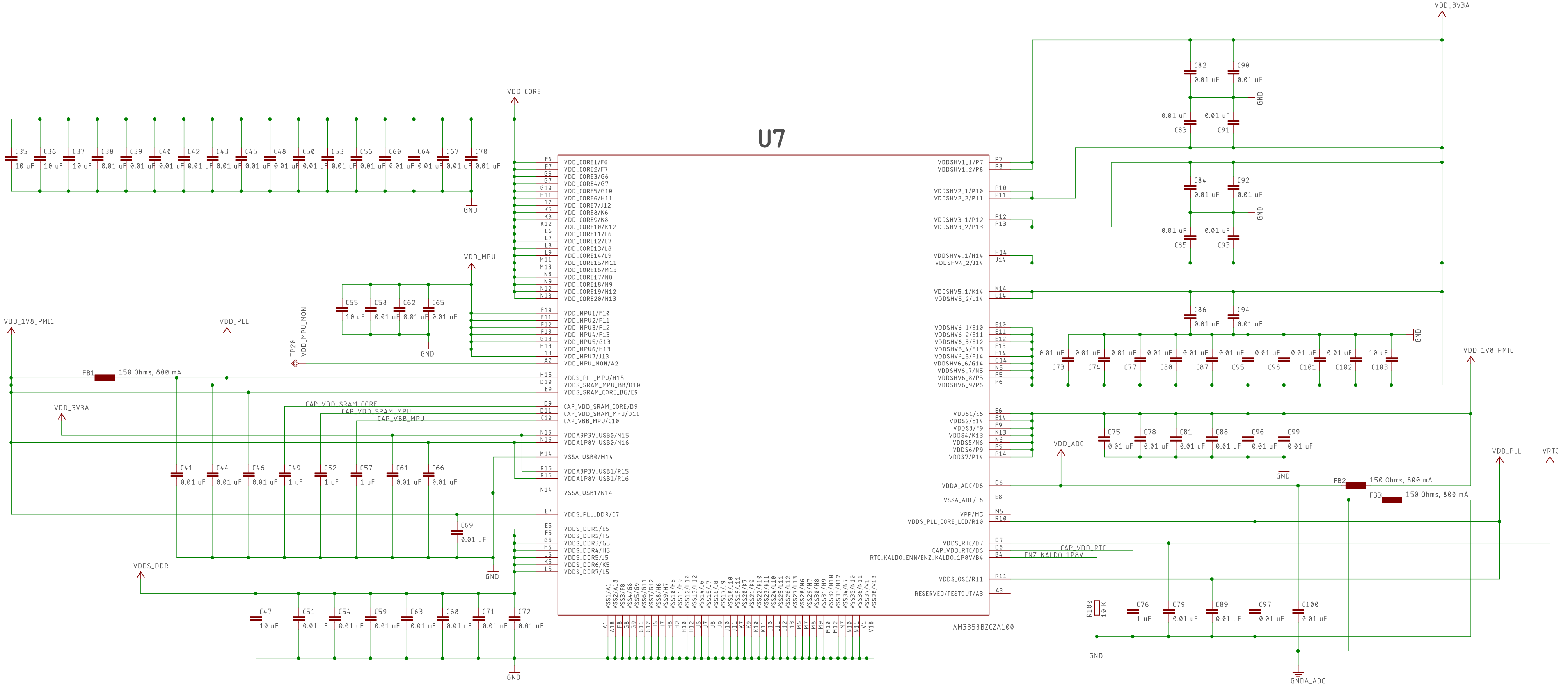


Designed by: K. TSOUMANIS Reviewed by: Approved by:	07/12/2017	WINGS ICT SOLUTIONS Main Electronic Subsystem of Sensing Device Schematic Design PhasmaFOOD Project Power Management	Sheet: 2/10 Version: 2.0

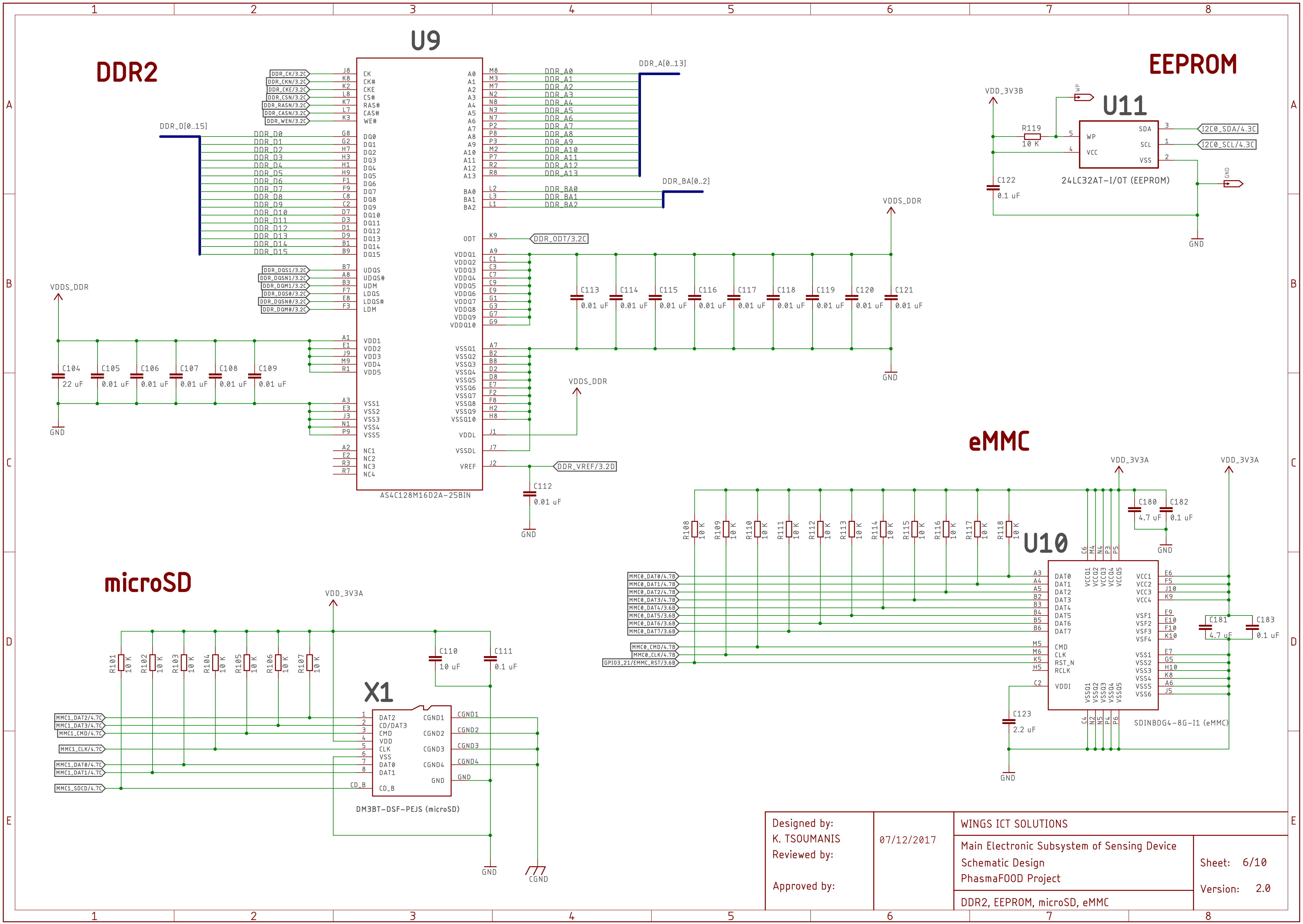

U7
AM3358BZCZA100
Y1
24 MHZ
Y2
32.768 KHZ
Boot Configuration
VDD_3V3A
GND_OSC
GND
VDDS_DDR
DDR_VREF/6.4C
DDR_A[0..13]
DDR_BA[0..2]
DDR_D[0..15]
Designed by:
K. TSOUMANIS
Reviewed by:
Approved by:
07/12/2017
WINGS ICT SOLUTIONS
Main Electronic Subsystem of Sensing Device
Schematic Design
PhasmaFOOD Project
Processor Part 1 of 3, Boot
Sheet: 3/10
Version: 2.0



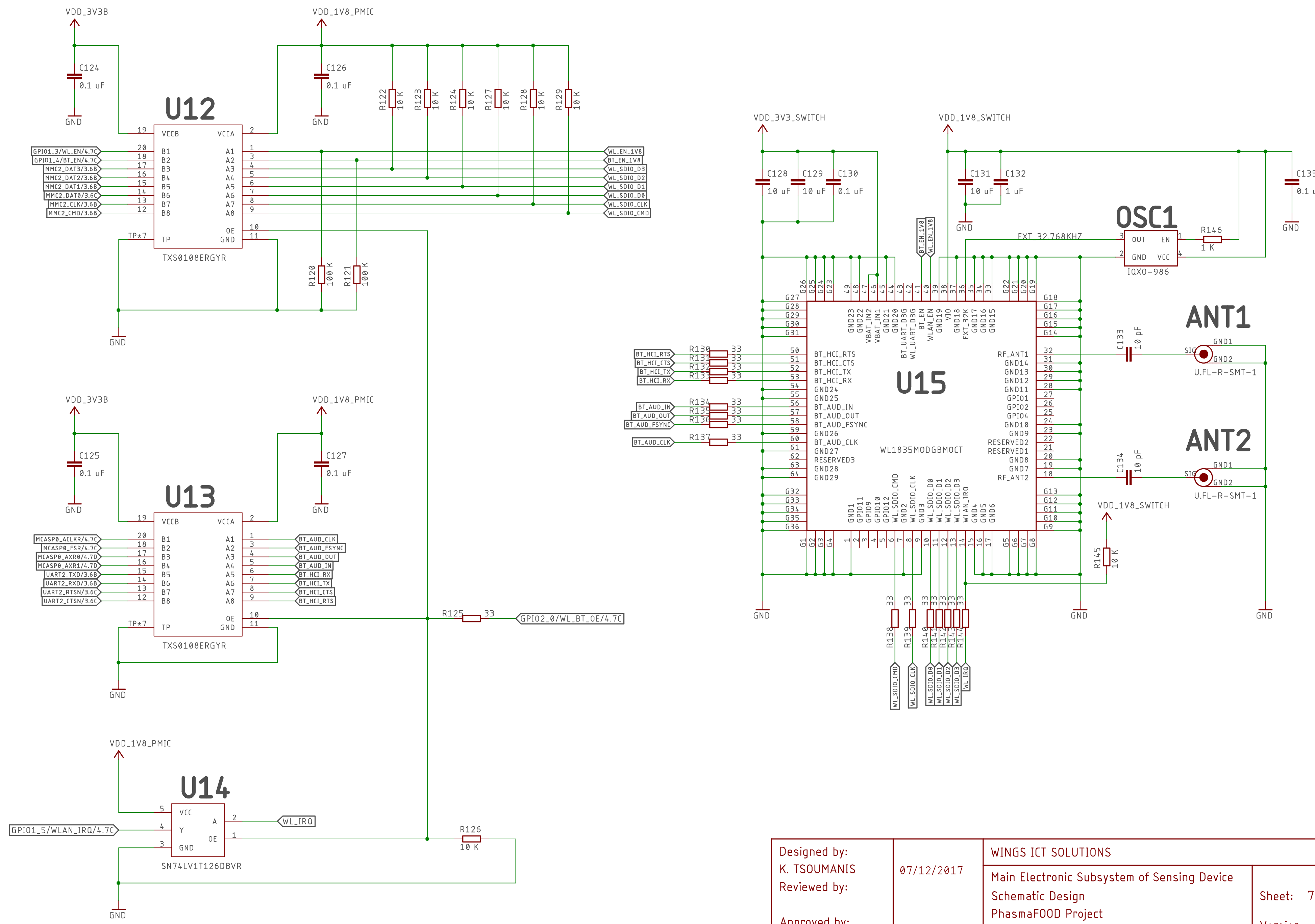
Designed by: K. TSOUMANIS	07/12/2017	WINGS ICT SOLUTIONS	
Reviewed by:		Main Electronic Subsystem of Sensing Device Schematic Design PhasmaFOOD Project	Sheet: 4/10
Approved by:		Processor Part 2 of 3	Version: 2.0



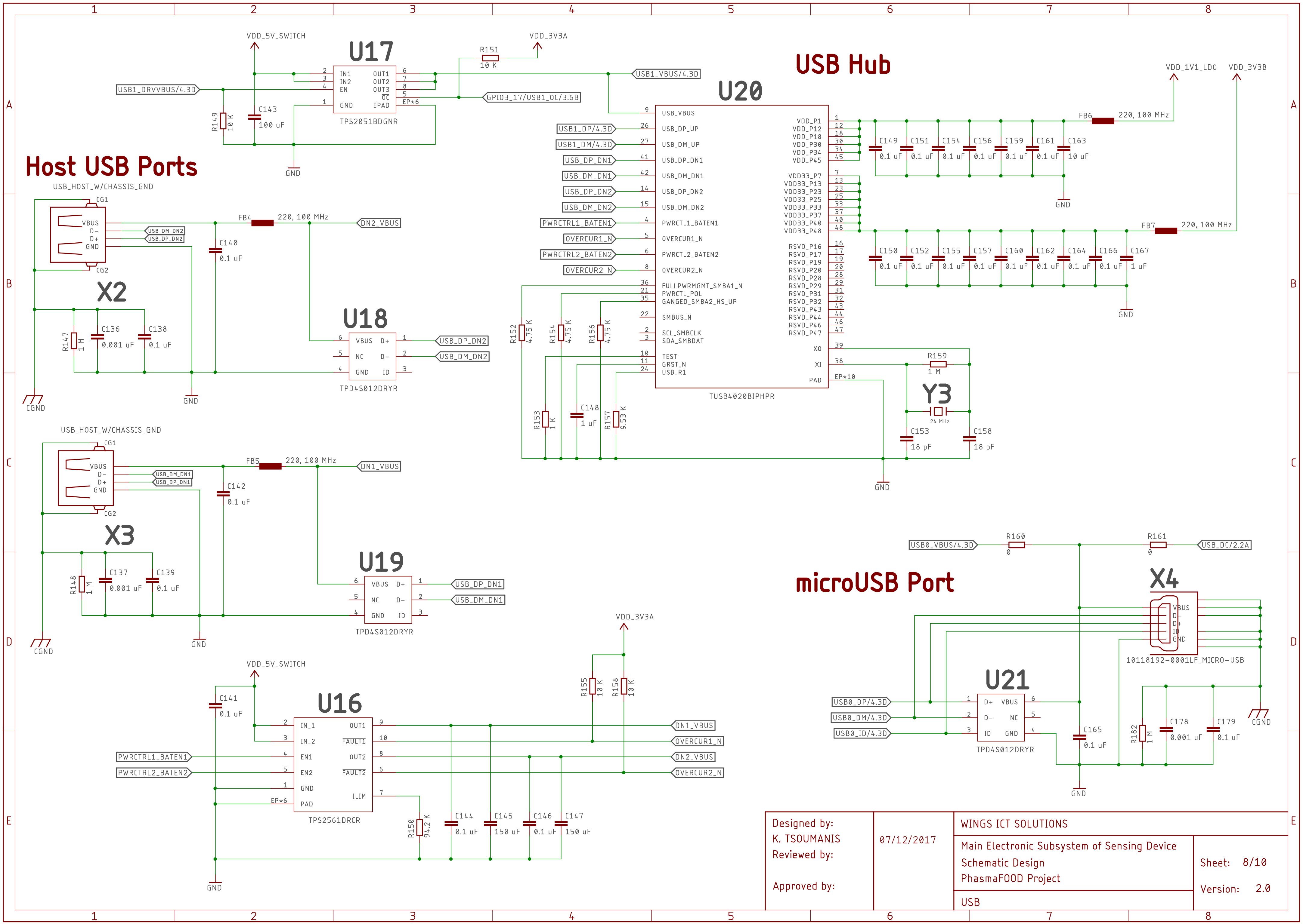
Designed by: K. TSOUMANIS Reviewed by: Approved by:	07/12/2017	WINGS ICT SOLUTIONS Main Electronic Subsystem of Sensing Device Schematic Design PhasmaFOOD Project Processor Part 3 of 3 – Voltages, Grounds	Sheet: 5/10 Version: 2.0

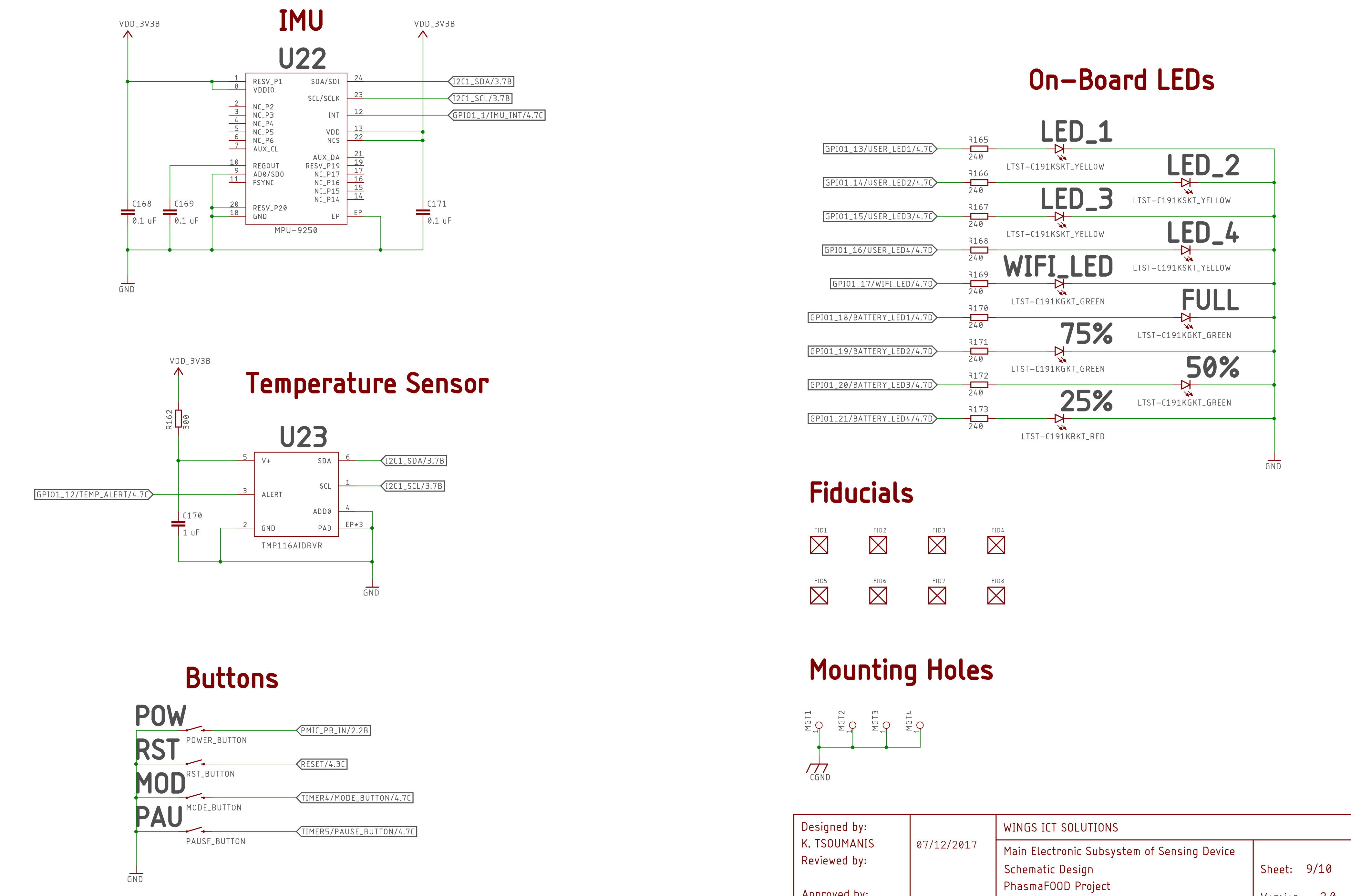


Designed by: K. TSOUMANIS	07/12/2017	WINGS ICT SOLUTIONS	
Reviewed by:		Main Electronic Subsystem of Sensing Device Schematic Design PhasmaFOOD Project	Sheet: 6/10 Version: 2.0
Approved by:		DDR2, EEPROM, microSD, eMMC	

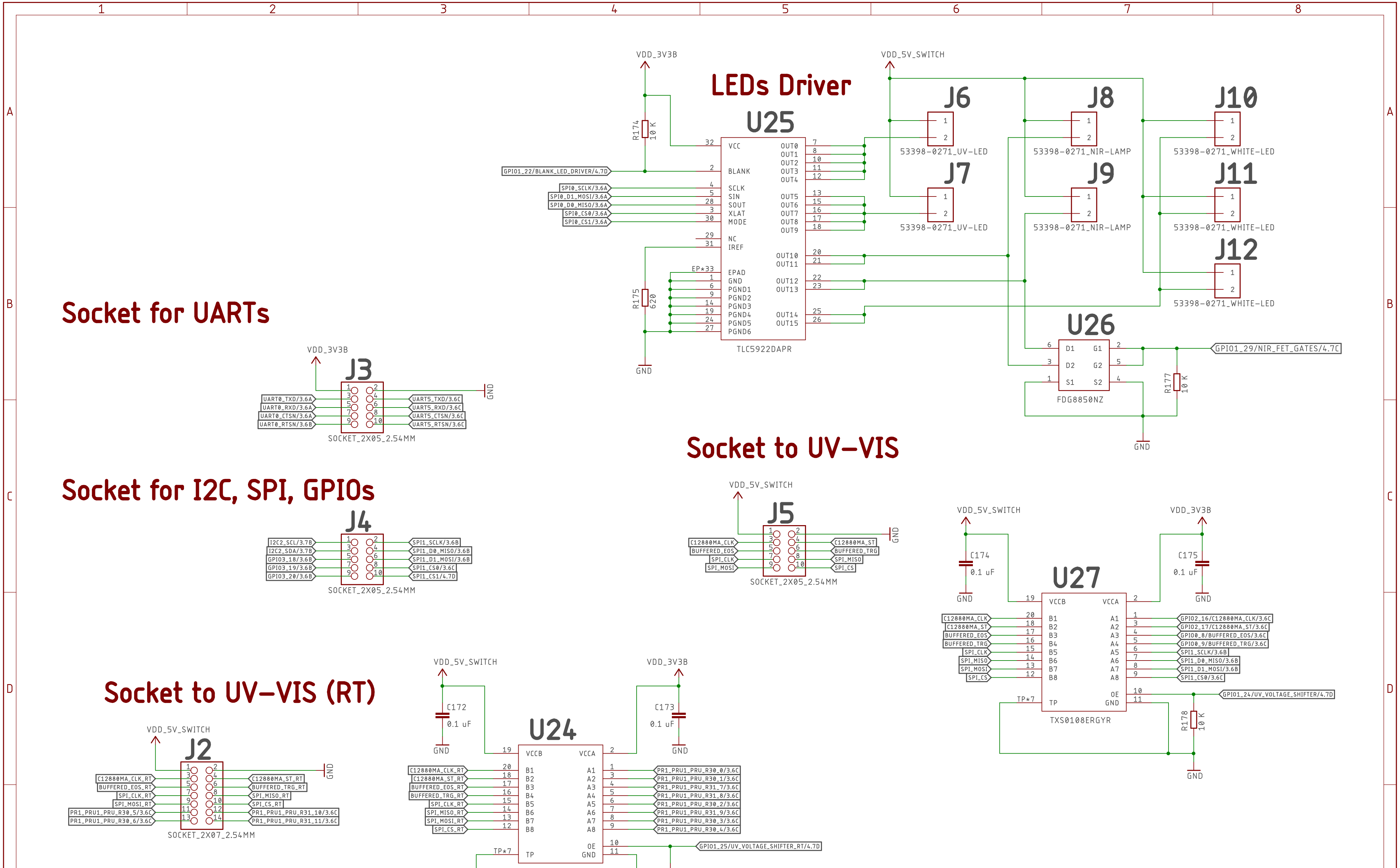


Designed by: K. TSOUMANIS	07/12/2017	WINGS ICT SOLUTIONS	
Reviewed by:		Main Electronic Subsystem of Sensing Device Schematic Design PhasmaFOOD Project	Sheet: 7/10
Approved by:		WiFi / BLE	Version: 2.0


USB Hub
U20
TUSB4020BIPHPR
Host USB Ports
U17
TPS2051BDGNR
U18
TPD4S012DRYR
U19
TPD4S012DRYR
U16
TPS2561DRCR
X2
X3
Y3
24 MHz
microUSB Port
X4
10118192-0001LF_MICRO-USB
U21
TPD4S012DRYR
USB_HOST_W/CHASSIS_GND
VDD_5V_SWITCH
VDD_3V3A
VDD_1V1_LDO
VDD_3V3B
GND
CGND
Designed by:
K. TSOUMANIS
Reviewed by:
Approved by:
07/12/2017
WINGS ICT SOLUTIONS
Main Electronic Subsystem of Sensing Device
Schematic Design
PhasmaFOOD Project
USB
Sheet: 8/10
Version: 2.0



Designed by: K. TSOUMANIS	07/12/2017	WINGS ICT SOLUTIONS	
Reviewed by:		Main Electronic Subsystem of Sensing Device Schematic Design PhasmaFOOD Project	Sheet: 9/10
Approved by:		Sensors, On-Board LEDs, Buttons	Version: 2.0



Designed by: K. TSOUMANIS	07/12/2017	WINGS ICT SOLUTIONS	
Reviewed by:		Main Electronic Subsystem of Sensing Device Schematic Design PhasmaFOOD Project	Sheet: 10/10
Approved by:		Expansion sockets	Version: 2.0