

Tests as Run (Legacy)

1. Test campaign 2023-2

2. TEST PLAN- TESTS 1 - Communication with internal blocks

1. Test description and objectives

The purpose of this title is to verify the effective communication with the internal blocks of the EPS board and the OBC. This communication will be carried out using the I2C bus. The test is specifically aimed at reading the values of registers containing crucial data such as temperature, voltage, current and battery state of charge. To perform the test we will first use as OBC the STM32 board that we will use to read the registers of each chip separately and

2.1. Temperature measurement - DS2782E+

1- Test Description and Objectives

For this test, I utilized the STM32 board, the core-476RGD, with the aim of measuring the temperature through readings from the DS2782E+ chip via I2C communication. These measurements will be carried out by the OBC to monitor the system's temperature, ensuring the battery does not enter a charging state when it exceeds 45 degrees Celsius or when it falls below 0 degrees Celsius. In such cases, it can be hazardous as the battery may explode if it's in a charging state.

2 - Requirements Verification

ID Requirement	Description
EPS-0050	The temperature must be between 2 and 40 degrees.
EPS-0060	The EPS board must be the capability to measure the temperature with a accuration of 1 degree.

EPS-0070	The I2C lines SDA and SCL should be connected with two 4.7KOhm pull-up resistors each
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3- Test Set-Up

The following materials were used:

- EPS board
- Two 4.7 kOhm resistors
- Cables for connections (male/male)
- Breadboard
- STM32 board (NUCLEO-I476RG)
- Cable for connecting STM32 with the PC
- PC with STM32cubeide software installed

Below, I present the board and the necessary connections for temperature readings:

imagen.png

imagen.png

4- Pass/Fail Criteria

Since the temperature must be between 0 and 45 degrees Celsius, under normal conditions, it's logical for it to be around 24 to 26 degrees Celsius. 13- Test Plan In this case, the EPS board is powered directly by the 3.3V supply from the STM32. To measure the temperature, we need to read registers 0x0A and 0x0B, the former for the most significant bits and the latter for the least significant bits. Each unit measured in this register represents 0.125 degrees Celsius. Below is an image representing the two registers to read, directly extracted from the DS2782 datasheet:

imagen.png

The code used is as follows:

imagen.png

5- Test Results

Satisfactory results were obtained, with temperature readings ranging from 23.25 °C to approximately 29 °C in multiple iterations. These values fall within the expected range. To ensure that the value varied with exposure to temperature changes, I conducted an experiment by, for example, placing the fingertip (previously discharged from static electricity), and the changes were gradual, with the temperature gradually increasing with each iteration of the I2C register read function. (The values for this test point were considered as floats).

An example of execution was as follows; after placing the fingertip, changes in the read value were observed:

6- Anomalies

No anomalies were found.

7- Conclusions

I must sieve and pass an integer instead of a float because transmitting that information to the OBC is more complicated using floats, and relevant information is lost. Therefore, based on the results, it is concluded that the DS2782E+ chip accurately measures temperature.

Voltage of the battery measurement - DS2782E+

1- Test Description and Objectives

Measuring the voltage is pivotal for understanding the battery's charge status, preventing overcharging or deep discharge, predicting battery life, and optimizing overall system performance by ensuring safe operations and maximizing battery lifespan.

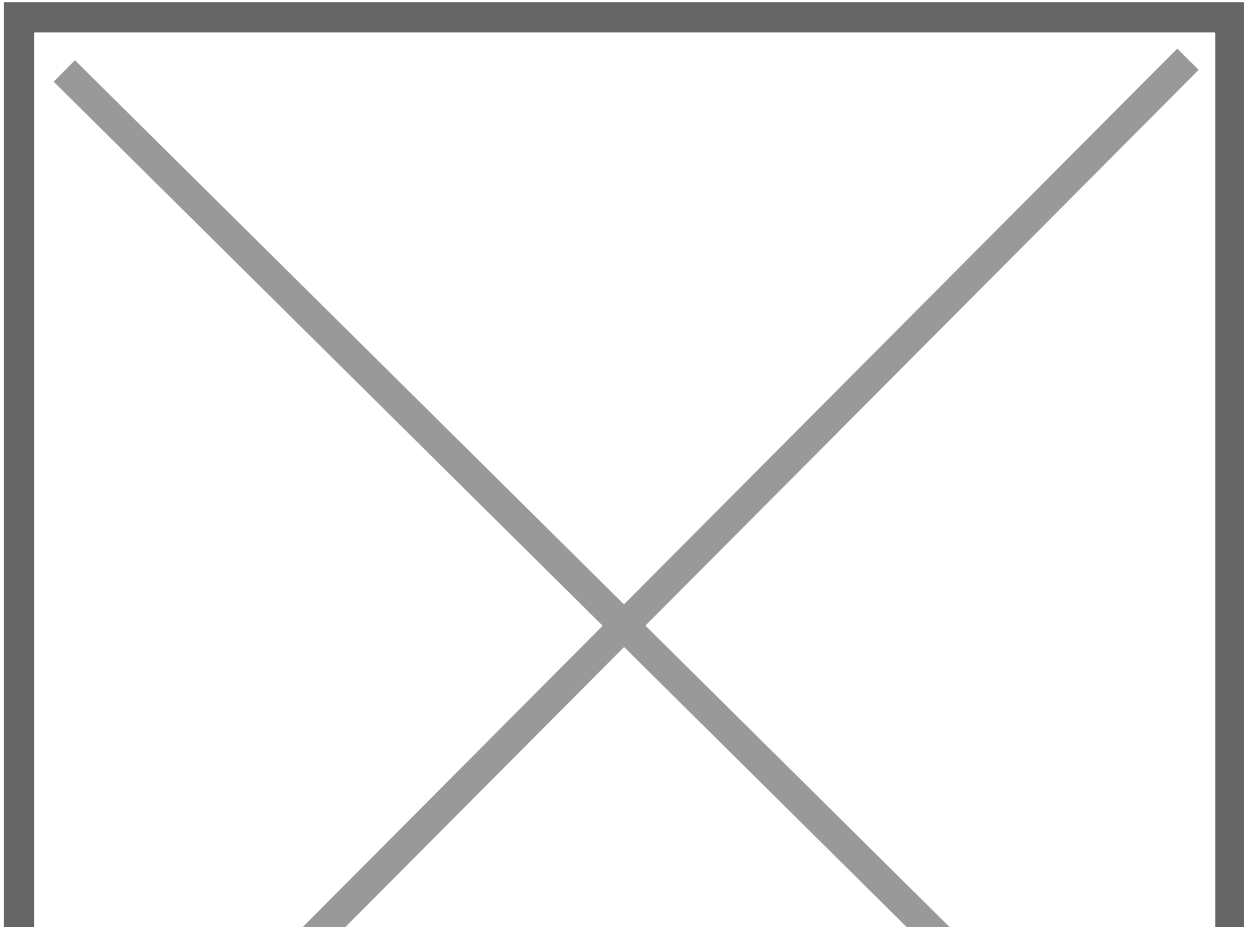
2 - Requirements Verification

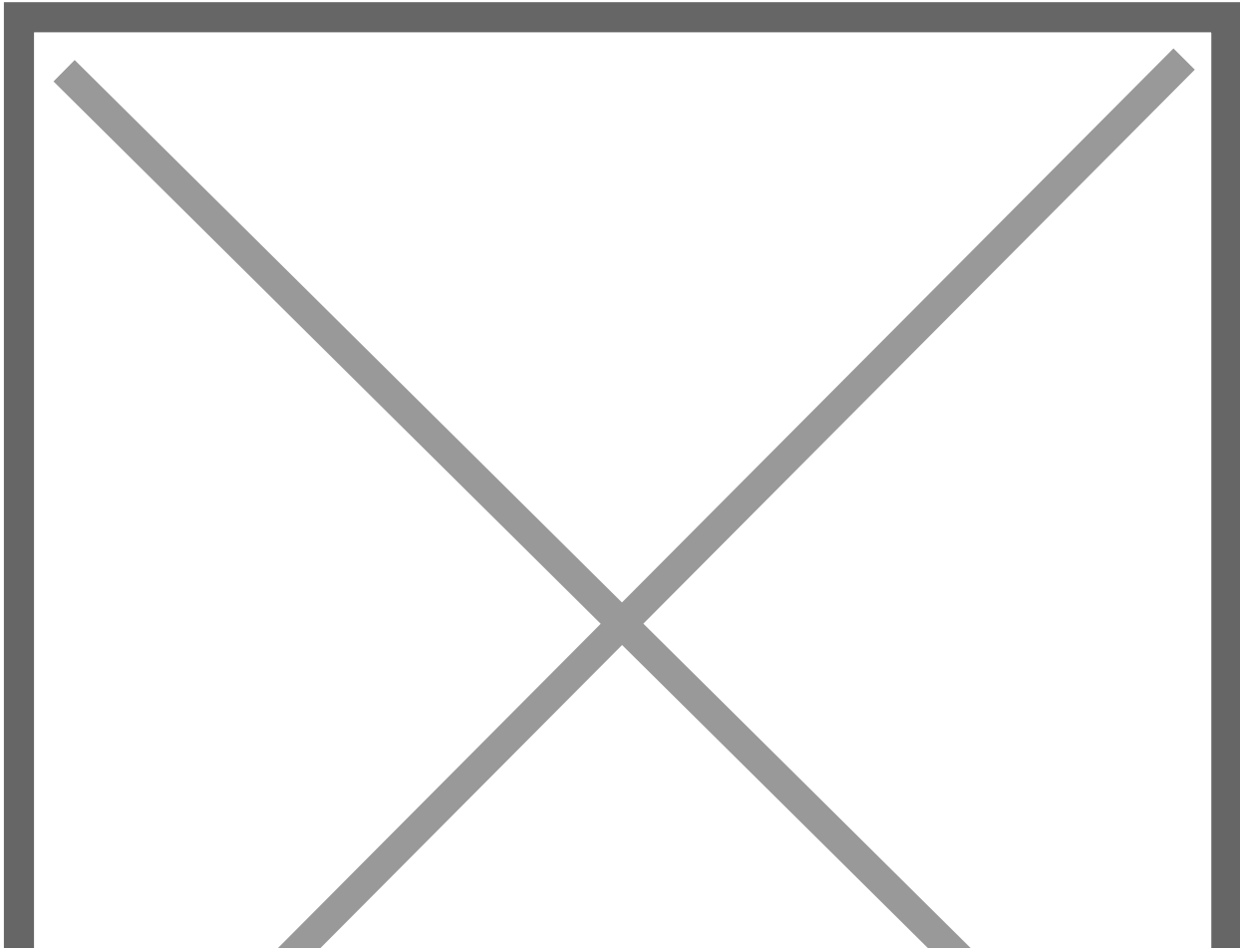
ID Requirement	Description
EPS-03	The voltage must be over than 3,3 V and under than 4,2 V
EPS-04	The value of the voltage must be positive
EPS-05	The I2C lines SDA and SCL should be connected with two 4.7KOhm pull-up resistors each

3 - Test Set-Up

The following materials were used:

- EPS board
- Two 4.7 kOhm resistors
- Li-on Battery for testing - 3.7 V / 1400mAh/5.18Wh - Model 103540
- Cables for connections (male/male)
- Protoboard
- STM32 board (NUCLEO-I476RG)
- Cable for connecting STM32 with the PC
- PC with STM32cubeide software installed



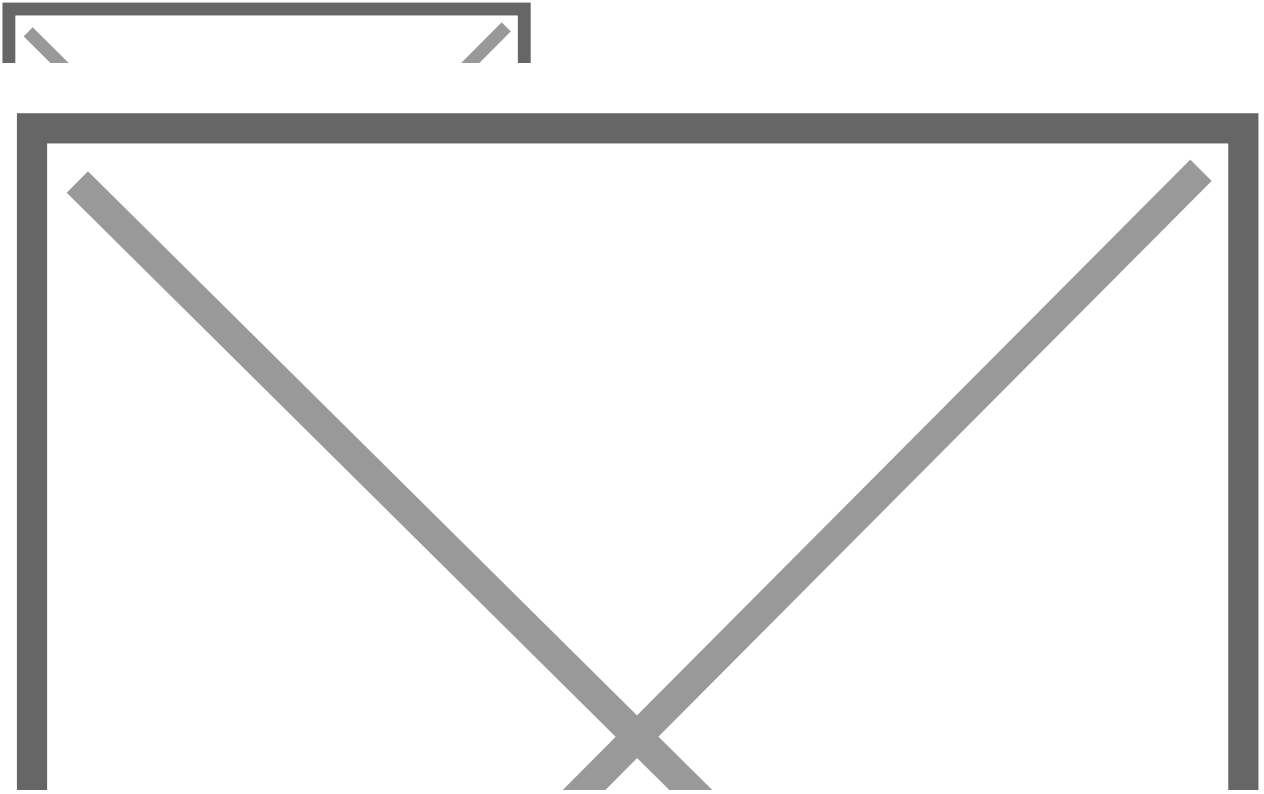


4 - Pass/Fail Criteria

According to the battery specifications and the voltage from the solar cells, the voltage range supported by the battery is from 0 to 4.25V with a maximum of 1A. The solar cells provide between 3.7V and 4.2V, fitting well within the correct voltage range. Regarding the current, at the SPV1040 output, there's an average of 250mA that can vary depending on the Maximum Power Point Tracking (MPPT), adjusting to the energy values received from the solar cells to maximize the power output.

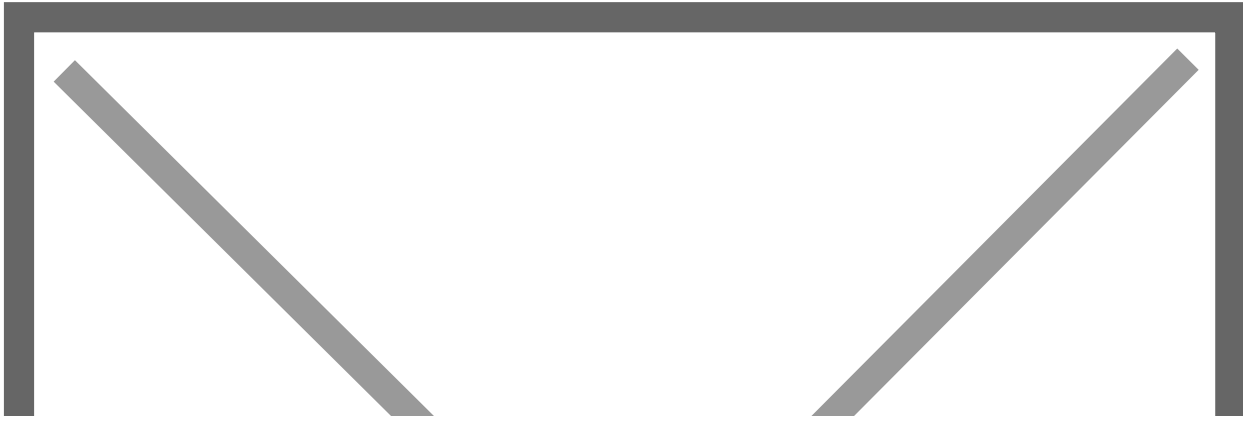
5 - Test Plan

Code:



Running this function in the main.c while having Putty connected to COM3 port at a bus speed of 115200 bits/s will display the battery terminal voltage on the screen.

The registers that I measured are the next:



6 - Test Results

I've obtained an average result of 3.85 V. At times, it dropped to 3.7 V, but it never exceeded 4 V.

7 - Anomalies

No anomalies was found

8 - Conclusions

The voltage values measured at the battery terminals are correct as they fall within the typical operating range.

Current measurement - DS2782E+

1 - Test Description and Objectives

The objective of this test is to determine the current flowing through the battery using a 330-ohm resistor in the circuit, connected between Vcc and GND on the EPS board. This will allow us to assess how the battery discharges and verify if the current values do not exceed the allowed limit of 1 A. This type of measurement allows assessing the battery's charging and discharging efficiency while identifying potential anomalies in the energy flow. This is crucial to ensure optimal performance and safe management of the battery within the system.

2 - Requirements Verification

ID Requirement	Description
EPS-0070	The I2C lines SDA and SCL should be connected with two 4.7KOhm pull-up resistors each
EPS-0080	The current must be under the 1 A

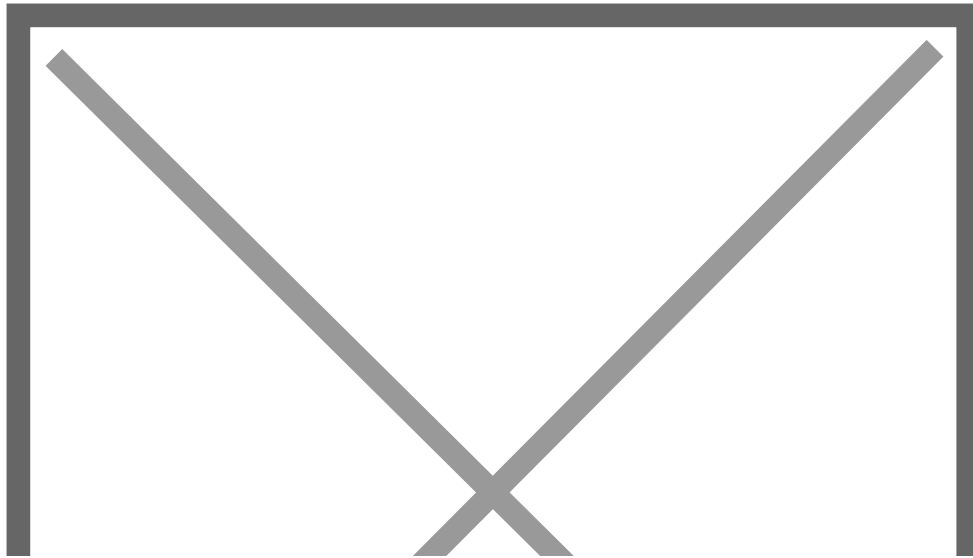
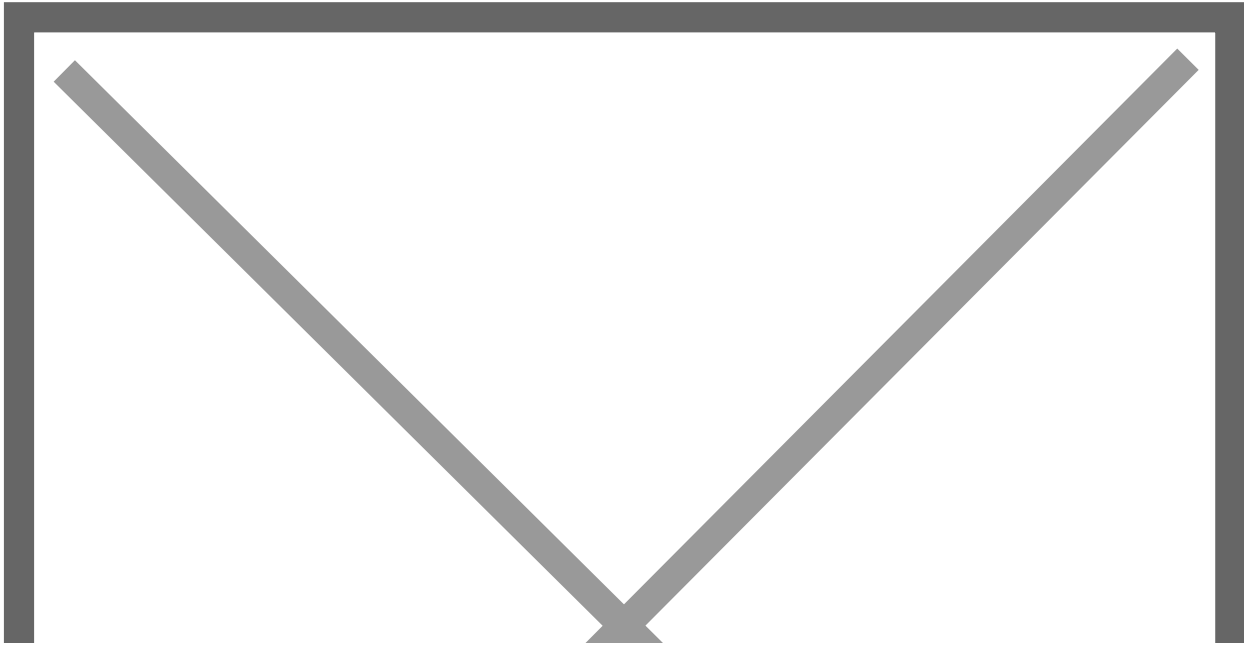
3 - Test Set-Up

Materials:

The following materials were used:

- EPS board
- Two 4.7 kOhm resistors
- 1 resistor of 330 Ohms
- Li-on Battery for testing - 3.7 V / 1400mAh/5.18Wh - Model 103540
- Cables for connections (male/male)
- Protoboard
- STM32 board (NUCLEO-I476RG)
- Cable for connecting STM32 with the PC
- PC with STM32cubeide software installed

We use the same setup as in the previous test, but this time placing a 330-ohm resistor between the Vcc and GND pins of the EPS board, which can be seen in this image:



4- Pass/Fail Criteria

According to the battery specifications, the current flowing through it should not exceed 1A; typically, we obtain values around 100 to 150 mA. When using a 330-ohm resistor, it's expected to yield readings around 10 mA. By verifying this, we can conclude that the measurement is accurate and acceptable within the electrical specifications of the devices involved.

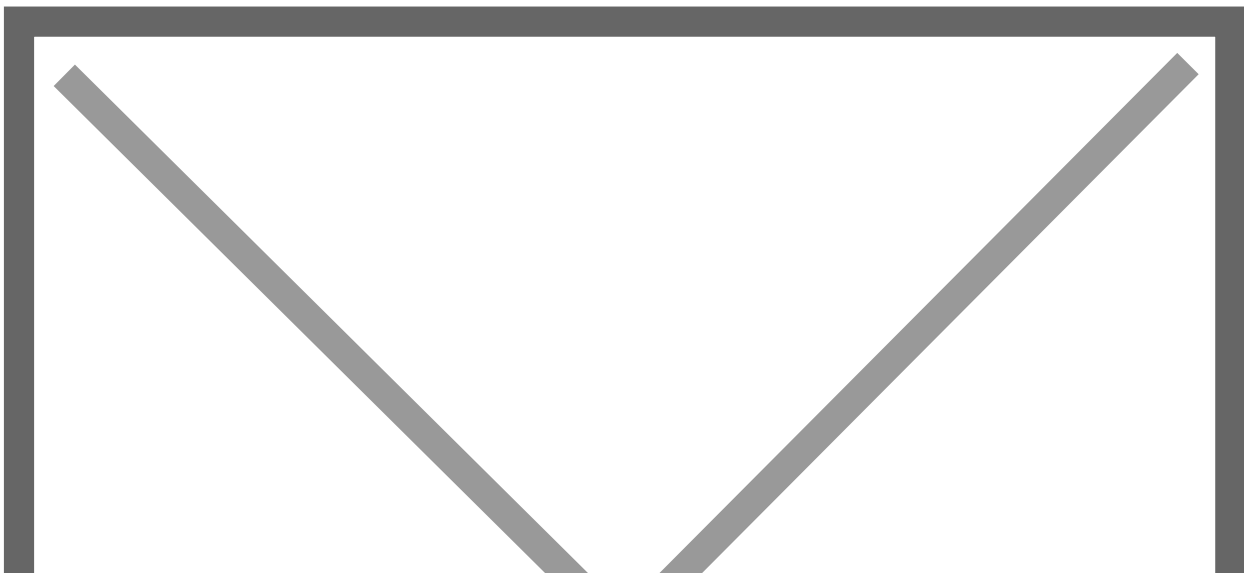
5- Test Plan

With the configuration previously set up in the voltage test, connecting the battery to the EPS board and, in turn, to the NUCLEO-L476RG using I2C communication as in the previous cases, we can carry out the reading of the current registers.

Add the code that I wrote to read the registers that contain the current information. That registers are the next:



Code:



6- Test Results

The obtained result is 11.87 mA when a 330 Ohm resistor is connected between Vcc and GND.

7- Anomalies

Not found any anomalies

8- Conclusions

The result is as expected. In summary, we have successfully measured the discharge current flowing from the battery through the resistor. We can differentiate between input and output current based on whether the battery is charging or discharging, which is reflected in the sign of the measured value.

State of Charge of the battery measurement - DS2782E+

1 - Test Description and Objectives

This test aims to assess the accuracy and reliability of the State of Charge (SOC) measurement conducted by the DS2782E+ chip within the battery system. The objective is to verify whether the SOC readings align with the expected charge levels of the battery during various charging and discharging scenarios.

2 - Requirements Verification

ID Requirement	Description
EPS-0090	The capacity relative of the battery must be between 0 % to 100%
EPS-0100	The full capacity measured in mAh cannot be over the value of the battery capacity established for the each model

3 - Test Set-Up

Materials:

The following materials were used:

- EPS board
- Two 4.7 kOhm resistors
- 1 resistor of 330 Ohms
- Li-on Battery for testing - 3.7 V / 1400mAh/5.18Wh - Model 103540
- Cables for connections (male/male)
- Protoboard
- STM32 board (NUCLEO-I476RG)
- Cable for connecting STM32 with the PC
- PC with STM32cubeide software installed

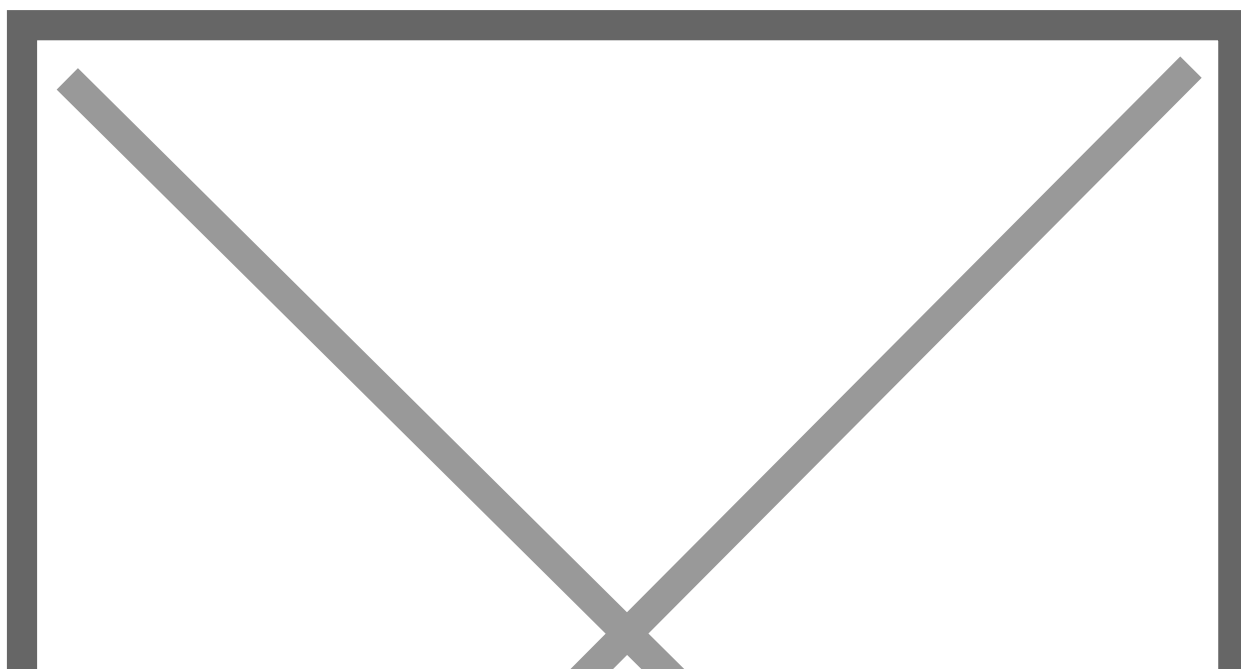
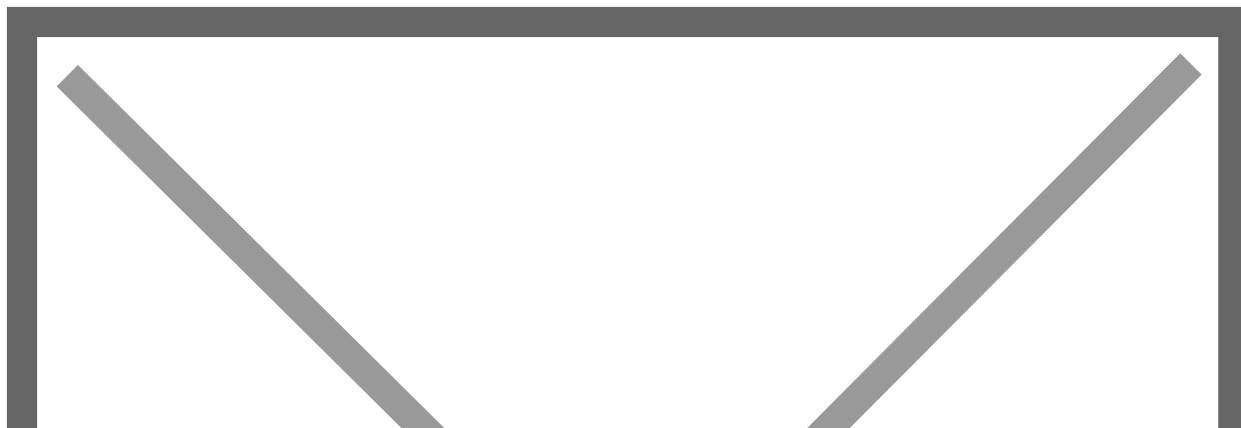
We use the same setup as in the current measurement case. Here, our connections will be similar, with the battery logically connected with the positive terminal at the kill switch and the negative terminal at BATT-.

4- Pass/Fail Criteria

Ensure that the battery capacity reading does not exceed the specified limits of 1400mAh. It should accurately represent the actual capacity and align with calculations derived from the SOC (State of Charge) and RARC (Remaining Standby Absolute Capacity Register Format).

5- Test Plan

Through the I2C code for register reading, we retrieve the RARC register, which provides us with the value directly. Here's the code attached:



In the last image I used the next method to calculate the SOC:



The $V_{max} = 4.2 \text{ V}$ and $V_{min} = 3.7 \text{ V}$ for our battery.

Since it's not feasible to calculate the SOC value in a single iteration, it's necessary to conduct multiple iterations, progressively increasing the value until it stabilizes.

6- Test Results

I have obtained a basic approximation of the State Of Charge using voltage measurement. However, this is not the only method to calculate it. Since I do not have SOC curves for the exact battery model and the capacity obtained through RARC does not give any value other than 0, I have opted for this method. In the last realization of this test, I could see how the battery's state of charge was at 27.17% and was decreasing to values of 26 and 25 as it discharged. I could verify its discharge by connecting a 330 Ohm resistor to the system's output and the current showed negative

7- Anomalies

"It gives a value of '0' through Putty when calling its function within the while loop.

8- Conclusions

It's necessary obtain a SOC curve to accurate the result and use another method that implicate the temperature or the current also.

4.5.9.2 - TEST 2 - Solar cells measurement

1. Test description and objectives

The objective of this test is verify that the solar cells generate the expected electric current under different solar illumination conditions. We will use the EPS connected to the STM32 board and the latter connected to the PC. We will read the voltage measured at the output of the system and we will also perform the manual measurement using a voltage and current tester to verify what voltage is read at the output of: the solar cells, each of the SPV1040 and then the output of the voltage regulator to verify if the 3.3 V supply is reached under maximum incidence of sunlight.

2. Test requirements

Material:

- EPS board
- Two 4.7 kOhm resistors
- 1 resistor of 330 Ohms
- Li-on Battery for testing - 3.7 V / 1400mAh/5.18Wh - Model 103540

- Cables for connections (male/male)
- Protoboard
- STM32 board (NUCLEO-I476RG)
- Cable for connecting STM32 with the PC
- PC with STM32cubeide software installed
- Solar cells

3 - Test Plan

4 - Test Results

With light exposure (in this case, I did not use sunlight), I have obtained values of 1.81 V at the terminals of the solar cell, and it has remained at the input of the SPV1040, when in reality, the voltage should increase to 3.5 V. Measuring with the tester, there is isolation between the different circuits that come from each SPV1040. However, it doesn't seem that the MPPT is working properly.

5 - Anomalies

The SPV1040 not work correctly, because the value of the out voltage is not increased respectively than the enter voltage from the cells.

6 - Conclusions

Could be necessary revise the connections of the circuit.

TEST 3 - Charge/Discharge of the battery

1. Test description and objectives

Charge and discharge the battery until its capacity is reduced to a minimum and obser how many charge and discharge cycles the battery can withstand before its total degradation. The objective is to verify how many charge and discharge cycles the battery can withstand.

2. Test requirements

- EPS board
- Two 4.7 kOhm resistors
- 1 resistor of 330 Ohms
- Li-on Battery for testing - 3.7 V / 1400mAh/5.18Wh - Model 103540
- Cables for connections (male/male)
- Protoboard
- STM32 board (NUCLEO-I476RG)

- Cable for connecting STM32 with the PC
- PC with STM32cubeide software installed
- Solar cells

3. Results

The test was performed in summer of 2023 with favorable results.

Finish of the test plan of 2023-2

3. STUB

1. With the help of the microscope, look at the PCB looking for any outer physical parameters, such as scratches, soldering or joint issues. If any anomaly is detected, re-solder or fix the encountered error.
2. Check the correct connection with the corresponding component of the 40 pins (10 in each lateral side) with the multimeter.
3. Check the value with the multimeter of all the passive components and compare it to the one in the schematic.
4. Verify the active components, checking one by one all the pins with the multi-meter in order to find shorts, open ends, and correct connections among the various pins.
5. Check the connections between all of the components and pins of the PCB

3.1. Test Results

The test for the EPS PCB has been done during the 03/05/2023.

The test passed the visual inspection since the outer physical checking was successful.

The pins', passive and active components' connectivity were successfully accomplished considering that there were no open ends or shorts, and the component values were correct.

The in-circuit testing was passed since the connections between all of the components and pints of the PCB were verified.

3.2. Anomalies

During the examination of the PCB for potential short circuits, it were identified three of them. In order to rectify this issue, the affected components were re-soldered and a new test was made to confirm that the problem had been successfully resolved.

3.3. Conclusions

The PCB passed the electrical test and is ready to do more complex tests.

4. TEST 2: In-circuit voltages

4.1. Test Description and Objectives

The objective of this test is to verify that when providing the PCB with the power supply, the voltages and currents are correct on the whole PCB

4.2. Requirements Verification

The voltages required for each component are summarized in the following chart (they can be seen from the datasheet of each component):

COMPONENT	Vin Min (V)	Vin Max (V)	Vo Min (V)	Vo Max(V)
SPV1040TTR	0.3	5.5	2	5.2
LTC4040EUFD#PBF	3.5	5.5	3.5	5
ISL9120IRTNZ	1.8	5.5	1	5.2
DS2782E+	2.5	4.5	-	-

4.3. Test Set-Up

- EPS payload
- Microscope
- Multimeter
- Power supply unit
- Wires

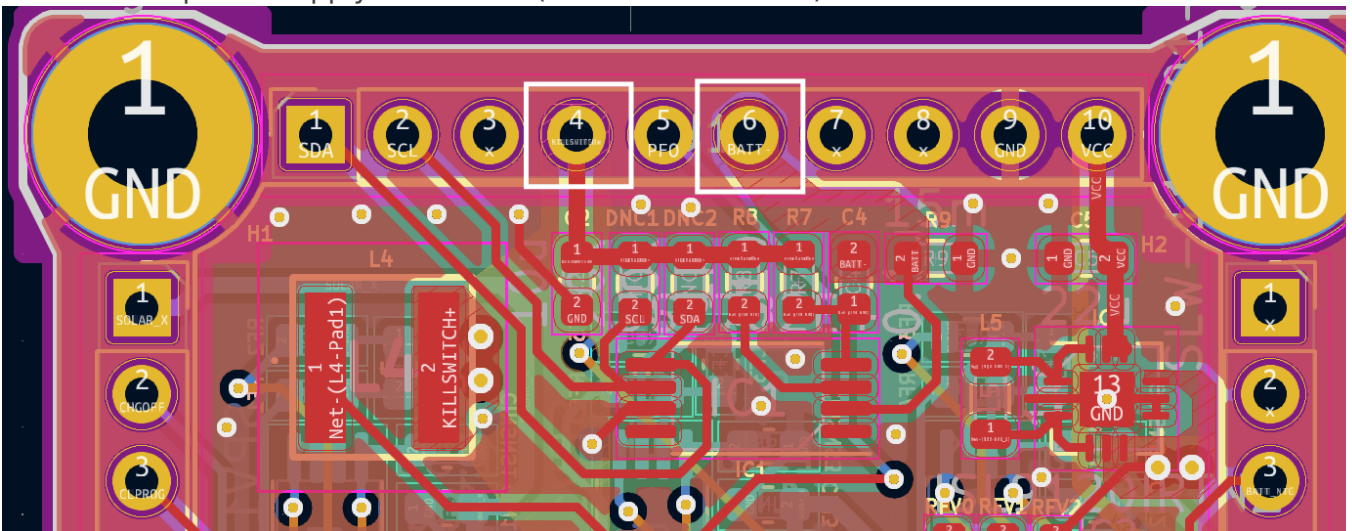
- Pen and paper
- Computer with Ki-Cad and the design

4.4. Pass/Fail Criteria

This test will be verified if the voltage obtained in the measurements of each component of the PCB is between the expected values.

4.5. Test Plan

1. Prepare the power supply with 3.3V and 800mA
2. Connect the power supply to the PCB (killswitch and batt-)



3. With the help of the multimeter, check that the battery inputs pins (killswitch and batt-) has 3.3V
4. With the help of the multimeter, check the voltage levels in the input and output of each component of the 5.2 chart

4.6. Test Results

This test for the EPS PCB has been done during the 22/05/2023.

The test has been correctly passed, since the different measures correspond to the correct values.

4.7. Anomalies

No anomalies has been detected

4.8. Conclusions

The PCB passed the test and is ready to do more complex tests.

5. TEST 3: Voltage Regulator

5.1. Test Description and Objectives

The aim of this test is to verify that the voltage regulator can maintain a constant 3.3V level regardless the input value.

5.2. Requirements Verification

Requirement ID	Description
EPS - 01	It is necessary that the output of the PCB is a constant voltage of 3.3V

5.3. Test Set-Up

- EPS payload
- Microscope
- Multimeter
- Power supply unit
- Wires
- Pen and paper
- Computer with KiCad and the design

5.4. Pass/Fail Criteria

These blocks will be verified if the output of the charge / discharge block is the battery voltage and the output of the voltage regulator is a constant voltage of 3.3V

5.5. Test Plan

1. Prepare the power supply with 3.3V and 800mA

7. Turn on the power supply and with the help of the multimeter check that the value at the VCC pin is 3.3V
8. Change the input value from 2V to 4V in steps of 0.5V and take note of the VCC pin voltage value.

5.6. Test Results

This test for the EPS PCB has been done during the 22/05/2023.

When the chout pin was checked it had the 3.3V of the battery input

Doing the step 8 the following chart is obtained:

VCC	2V	2.5V	3V	3.5V	4V
Vin	3.26V	3.27V	3.27V	3.26V	3.26V

As it can be seen, the voltage regulator always gives the expected 3.3V.

Since the two requirements verification has been accomplished, the EPS PCB can pass to the next test.

5.7. Anomalies

No anomalies has been detected

5.8. Conclusions

The PCB passed the test.

6. TEST 4: Charge / discharge block

6.1. Test Description and Objectives

The objective of this test is to simulate various conditions that can occur in the PCB in order to verify the proper functioning of the charge / discharge block.

6.2. Requirements Verification

Requirement ID	Description
EPS - 11	When only the battery input is connected, the output of the charge / discharge block must be the battery input voltage
EPS - 12	When a voltage is applied to the output of the harvest block, the output of the charge / discharge block has to be the harvest block input, and the battery input must be disconnected.
EPS - 13	When the temperature is above 40 °C, the battery input must be disconnected

6.3. Test Set-Up

- EPS payload
- Microscope
- Multimeter
- 2xPower supply unit
- Hot air blower
- Thermocouple
- Wires
- Pen and paper
- Computer with KiCad and the design

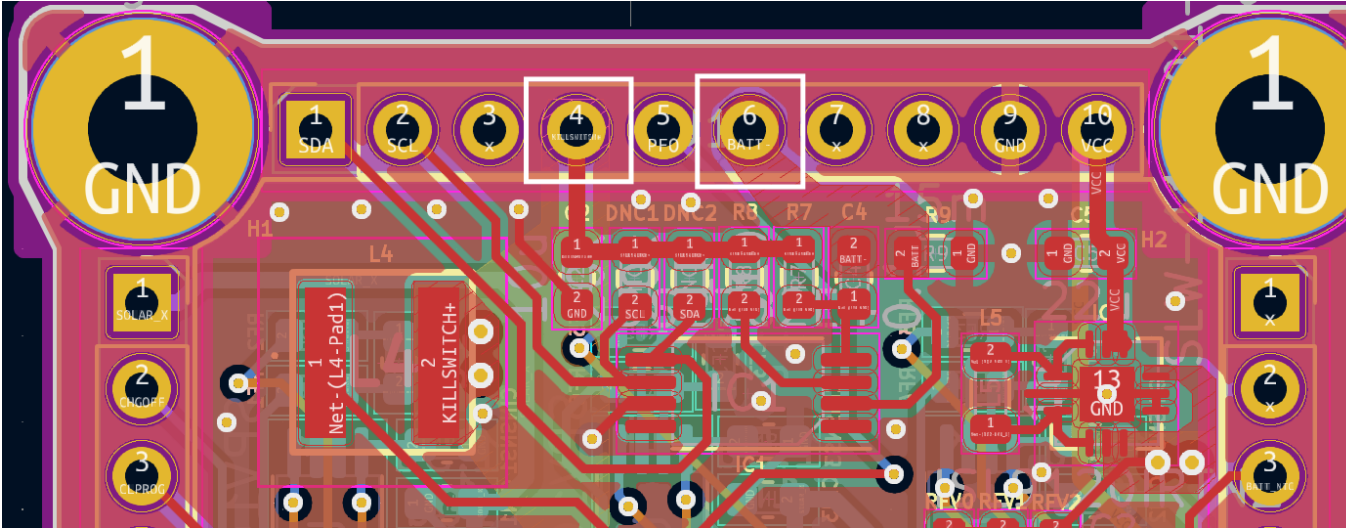
6.4. Pass/Fail Criteria

The test will be successfully completed if all the requirements are met.

6.5. Test Plan

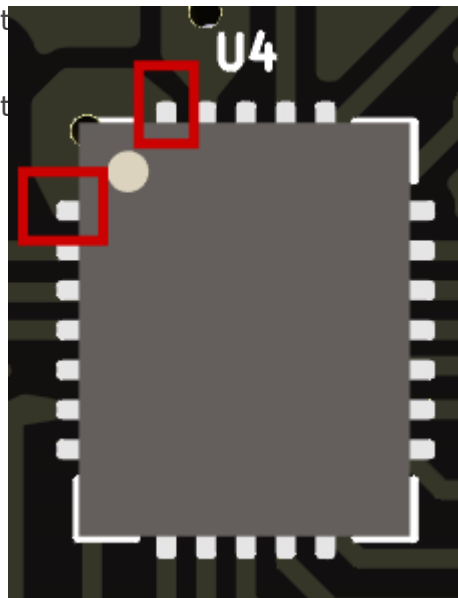
1. Prepare the power supply with 3.3V and 800mA

2. Connect the power supply to the PCB (killswitch and batt-)



3. With the help of the multimeter, check that the batt- (batt-) has a value of 3.3V

4. With the help of the multimeter, check that the out (chout) has the same value as the input pin (3.3V)



(chout) has the same value as the input pin (3.3V)

5. Prepare the other power supply with 3.3V
6. Connect the power supply to the Solar_Y input
7. Turn on the second power supply
8. Measure, with the help of the multimeter, that the output pin value (chout) is 4.68V
9. Turn off the second power supply
10. Connect both power supplies and turn them on
11. Measure that the voltage is the 4.68V of the energy harvest block.
12. Check on the display of the power supply that only the one connected to Solar_Y is having a current consumption.
13. Disconnect the second power supply
14. With the help of the hot air blower and a thermocouple heat the PCB to 40 °C
15. Check with the multimeter that when the temperature is 40°C the VCC output value is 0V

6.6. Test Results

When the chout pin was checked it had the 3.3V of the battery input

When the input connected was the Solar_Y pin, the voltage measured was 4.68V

When both power supplies were connected, the voltage read was 4.68V and the display of the power supplies showed the next values (the right one is connected to Solar_Y)



The output value when the PCB was heated to 40°C was 0.

6.7. Anomalies

No anomalies has been detected

6.8. Conclusions

The PCB passed the test.

7. TEST 5: Energy Harvest Block

7.1. Test Description and Objectives

The objective of this test is to simulate the different combinations of the solar cells illuminated to verify that it can supply the 3.3V needed.

7.2. Requirements Verification

It is necessary that the output voltage of the energy harvest block, when at least one of the solar cells is active, is at least 3.3V

7.3. Test Set-Up

- EPS payload
- Microscope
- Multimeter
- Power supply unit
- Wires
- Pen and paper
- Computer with Ki-Cad and the design

7.4. Test Plan

1. Prepare the power supply with 1V
2. With the power supply off, connect it to the solar-x input
3. Turn on the power supply
4. With the help of the multimeter, take measures of the output of the energy harvest block
5. Take the same value increasing the power supply voltage 1V until 4V, and making the different combinations of solar cells activated.

7.5. Test Results

With all the combinations of active solar cells tried, the voltage at the output of the energy harvest block has been proved to always have a level of around 4.68V

7.6. Anomalies

No anomaly was detected.

7.7. Conclusions

The payload has passed the test

8. TEST 5: Battery Sensors

8.1. Test Description and Objectives

The aim of this test is to verify that the battery sensor situated in the PCB works properly and that it can communicate with the computer using the I2C protocol.

8.2. Requirements Verification

Requirement ID	Description
Sensor correctly supplied	Check again that the pins in charge of the supply of the sensor receive the necessary 3.3V.
I2C Connection	It is necessary that the battery sensor can communicate correctly using the I2C pins
Correct lectures	The output values of the battery sensor (temperature, voltage and current), shown in the PC, has to correspond to the expected ones (temperature is the easiest to check, since it can be compared with a thermocouple).

8.3. Test Set-Up

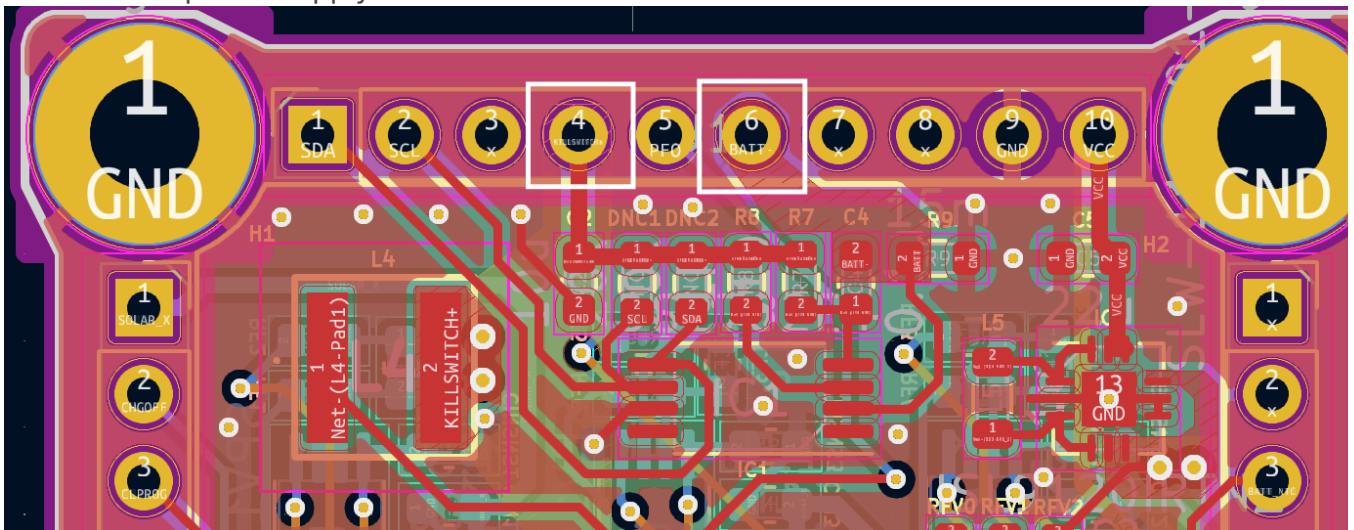
- EPS payload
- STM32L476RG nucleoboard
- Power Supply
- Wires
- Multimeter
- Thermocouple
- Oscilloscope
- Calculator, pen and paper
- Laptop with STM32CubeIDE and Ki-Cad installed

8.4. Pass/Fail Criteria

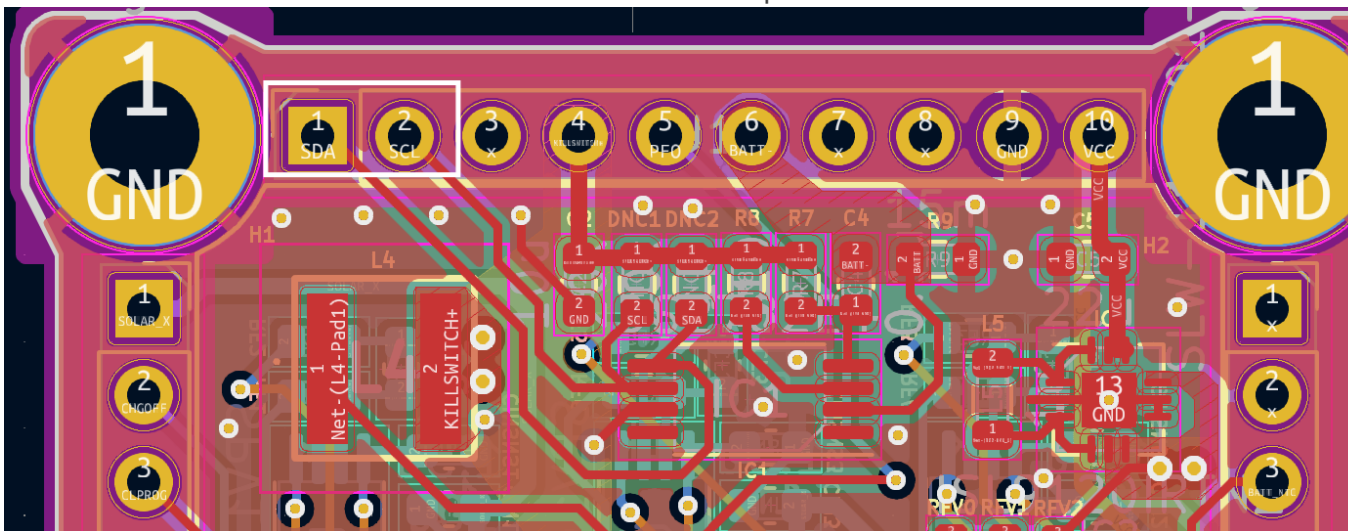
The battery sensor will be verified if the requirements mentioned before are fulfilled. If in one of them it is detected any anomaly it will have to be corrected, otherwise the board can not pass to the other tests.

8.5. Test Plan

1. Prepare the power supply with 3.3V and 800mA
2. Connect the power supply to the PCB



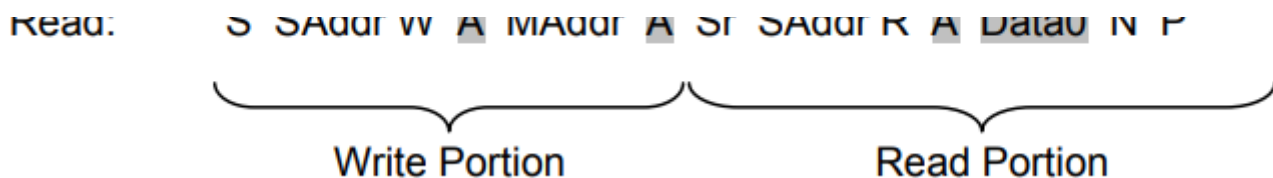
3. With the help of the multimeter, check that the VCC inputs pins has the correct 3.3V
4. Turn of the power supply and disconnect it
5. Turn on the computer and open the STM32CubeIDE program
6. Prepare a code that can read from the battery sensor using I2C
7. Connect the nucleoboard to the EPS PCB with the I2C pins



8. Connect the oscilloscope input to the SDA and SCL pins
9. Run the code and look in the oscilloscope if the communication is made
10. Check if the received data is correct (check the temperature value with a thermocoupler)

6.5.1 Code

The first thing that it is necessary to look at is the i2c protocol employed by the DS2782E+. This information is shown in the page 26 of its datasheet.



In this

image the protocol is resumed.

It can be seen that the first thing to do is send a start bit, followed by the slave device address and a write bit. The device will acknowledge the communication with an ACK signal. Upon the receipt of the ACK, confirming a successful connection with the device, it is send the memory address from which we want to read, and the device will respond with another ACK.

With the previous steps done, another start bit is transmitted, followed by the the slave device address and a read bit. The DS2782E will respond with an ACK and proceed to provide the data from the memory address previously specified.

To conclude the communication, a non-acknowledgment (NACK) signal is transmitted, followed by a stop bit.

Another crucial aspect to consider is the addresses required to communicate with each sensor. This addresses are specified in the page 23 of the DS2782E datasheet:

DS2782E slave Address: 0x34 (HEX)

Temperature register: 0A (HEX)

Remaining Active Absolute Capacity register: 0x02 (HEX)

Voltage register: 0C (HEX)

Current register: 0E (HEX)

It is also important to know the frequency that is needed in order to do a proper communication with the DS2782E. This is shown in page 3 of the datasheet.

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
SCL Clock Frequency	f_{SCL}	(Note 6)	0		400	kHz

Taking all of this into account, a possible code implementation is the following one:

```

int main(void) {
    /* USER CODE BEGIN 1 */
    HAL_StatusTypeDef ret;
    uint8_t buf[12];
    int16_t val;
    float temp_c;
    uint8_t buf2;
    /* USER CODE END 1 */

    /* MCU Configuration-----*/

    /* Reset of all peripherals, Initializes the Flash interface and the Systick. */
    HAL_Init();

    /* USER CODE BEGIN Init */

    /* USER CODE END Init */

    /* Configure the system clock */
    SystemClock_Config();

    /* USER CODE BEGIN SysInit */

    /* USER CODE END SysInit */

    /* Initialize all configured peripherals */
    MX_GPIO_Init();
    MX_I2C1_Init();
    /* USER CODE BEGIN 2 */

    /* USER CODE END 2 */

    /* Infinite loop */
    /* USER CODE BEGIN WHILE */
    while (1) {
        ret = HAL_I2C_Master_Transmit(&hi2c1, TMP102_ADDR, &REG_TEMP, 1,
            0x000000FFU);
        ret = HAL_I2C_Master_Receive(&hi2c1, TMP102_ADDR, &buf2, 1,
            0x000000FFU);
        temp_c = (buf2 / 32) * 4.88;
        HAL_Delay(1);
    /* USER CODE END WHILE */

```

6.5.2 I2C Problem

When trying to make the communication with the sensor, no response was obtained. To solve this problem the following steps were followed:

1. Verify the connections

All the I2C connections are well connected with the corresponding PINS, and the 3.3V are detected in the input pin (killswitch).

2. Check the components

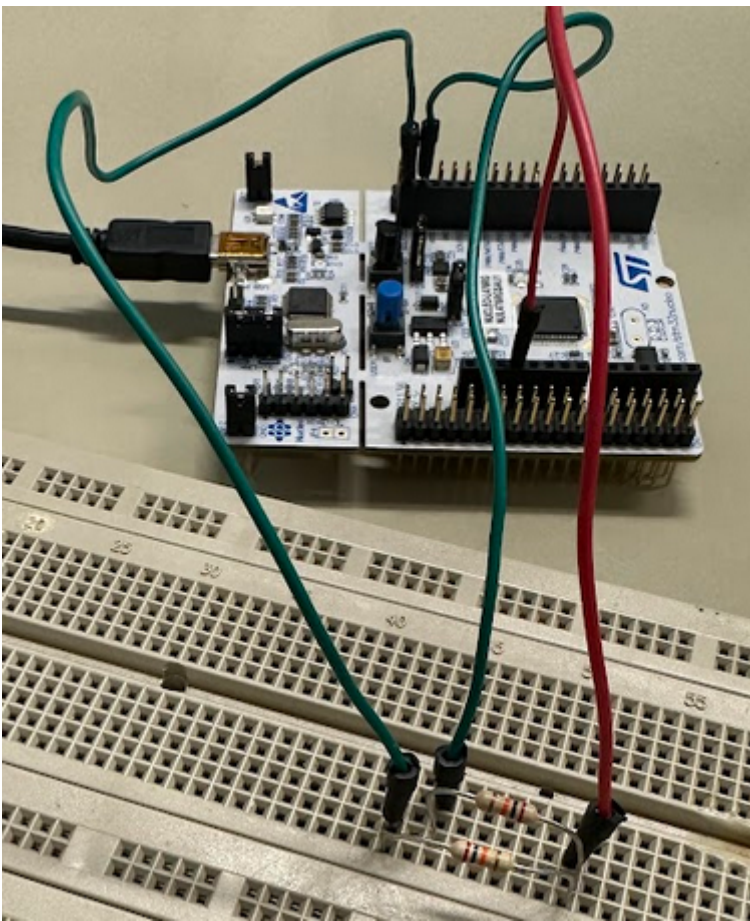
The components connected are the corresponding ones and in the correct positions according to the Ki-Cad schematic. It is also important to check that no component has any short circuit.

3. Verify the addresses of the device

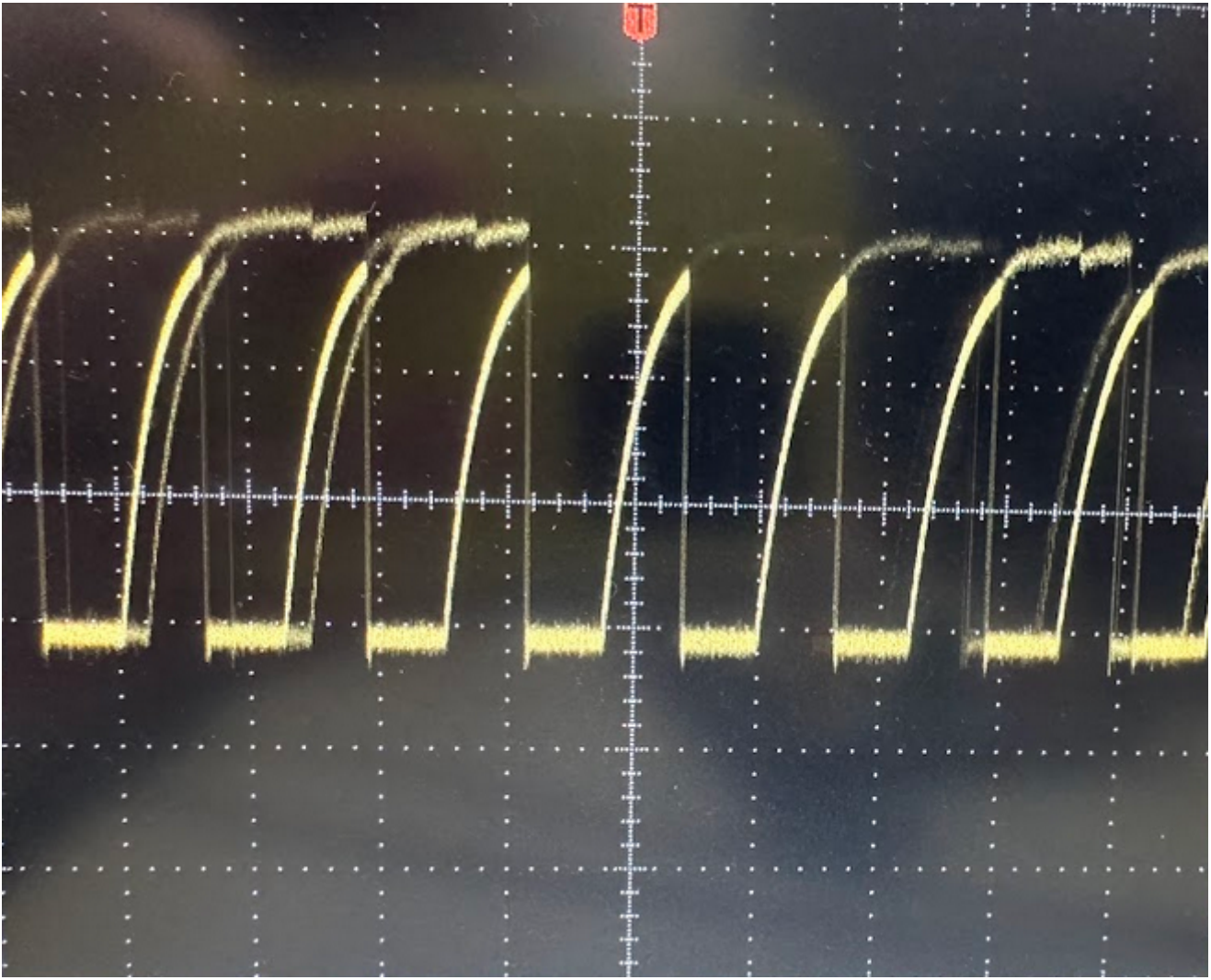
The device address is the correct one (0x34). It can be seen in the I2C Addresses document of the nanosatlab wiki or in the datasheet of the device

5. Use the oscilloscope to check the I2C bus to see which is the problem

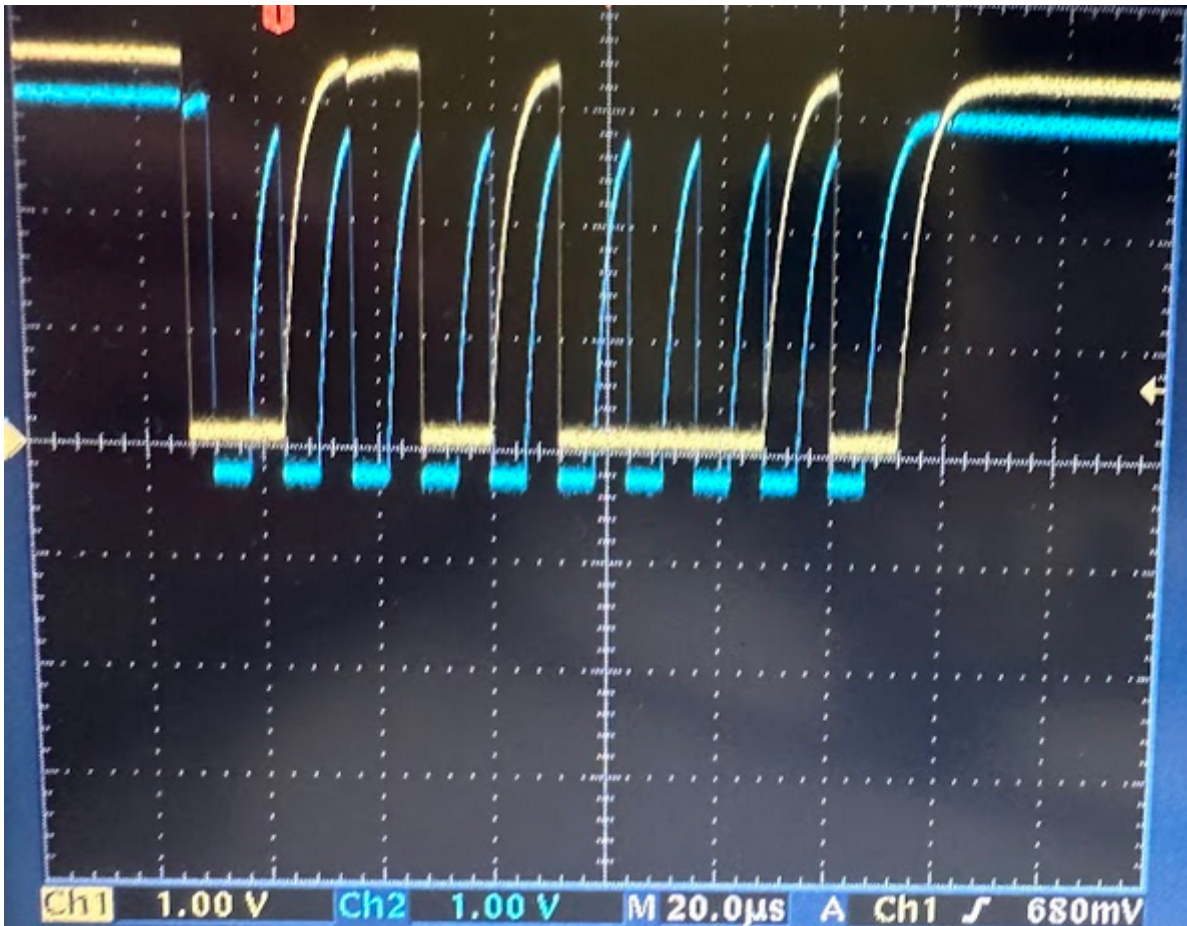
When checking the signal with the oscilloscope, the signal of the clock was not clear and it made strange changes. To try to solve this problem, the intern pull-up resistance of the nucleo-board were disconnected and they were placed in a protoboard with a value of 20K Ohms.



With that done the signal was checked again using the oscilloscope and, as it can be seen in the following image, the SCL signal was working properly.

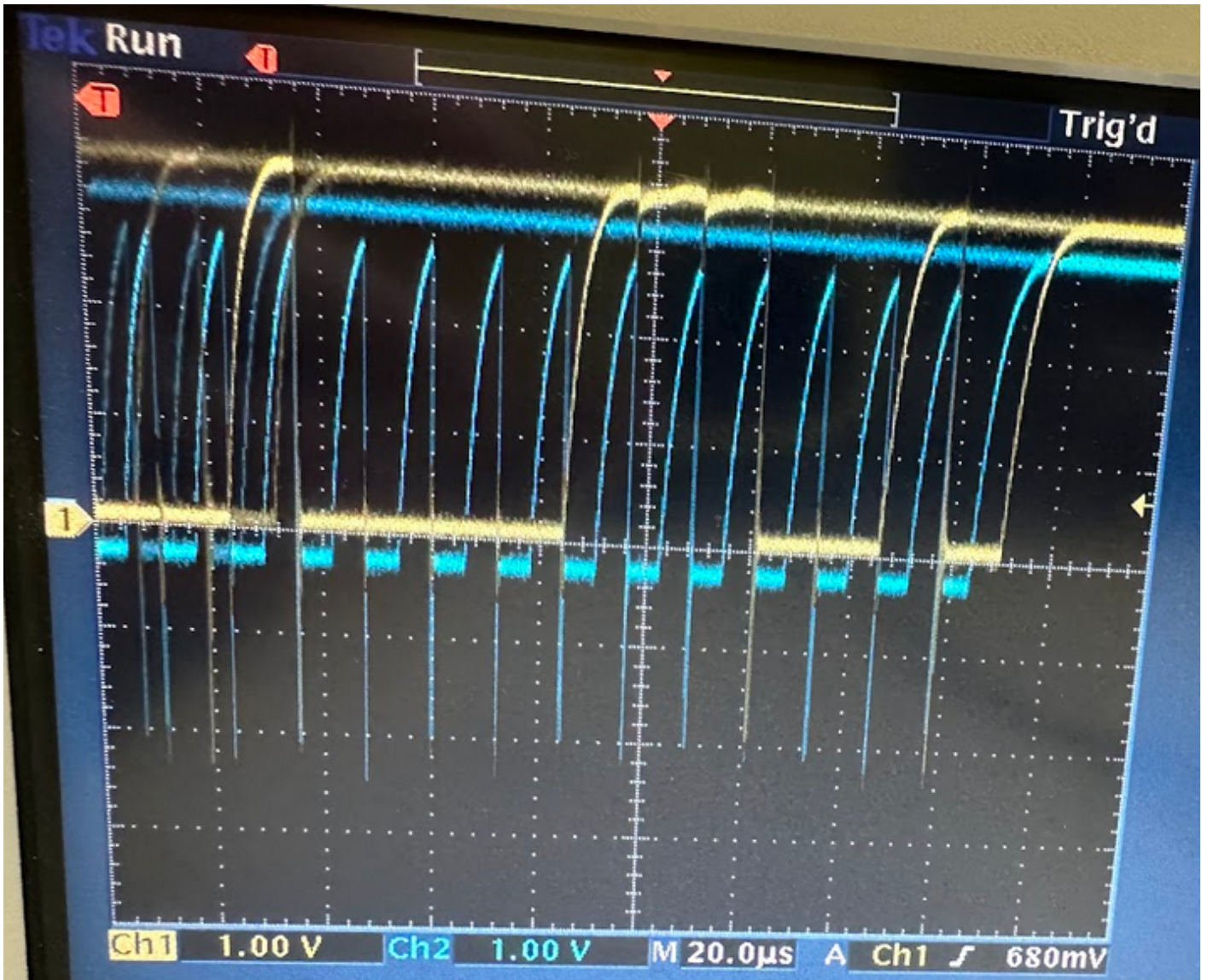


The next thing to be checked was that the message from the nucleo-board was well send and with the correct value (the address of the battery sensor). To do that, the oscilloscope was connected to the SDA pin and the signal from the following image was shown. The value send is "1101000" (0x34), followed by the write bit.

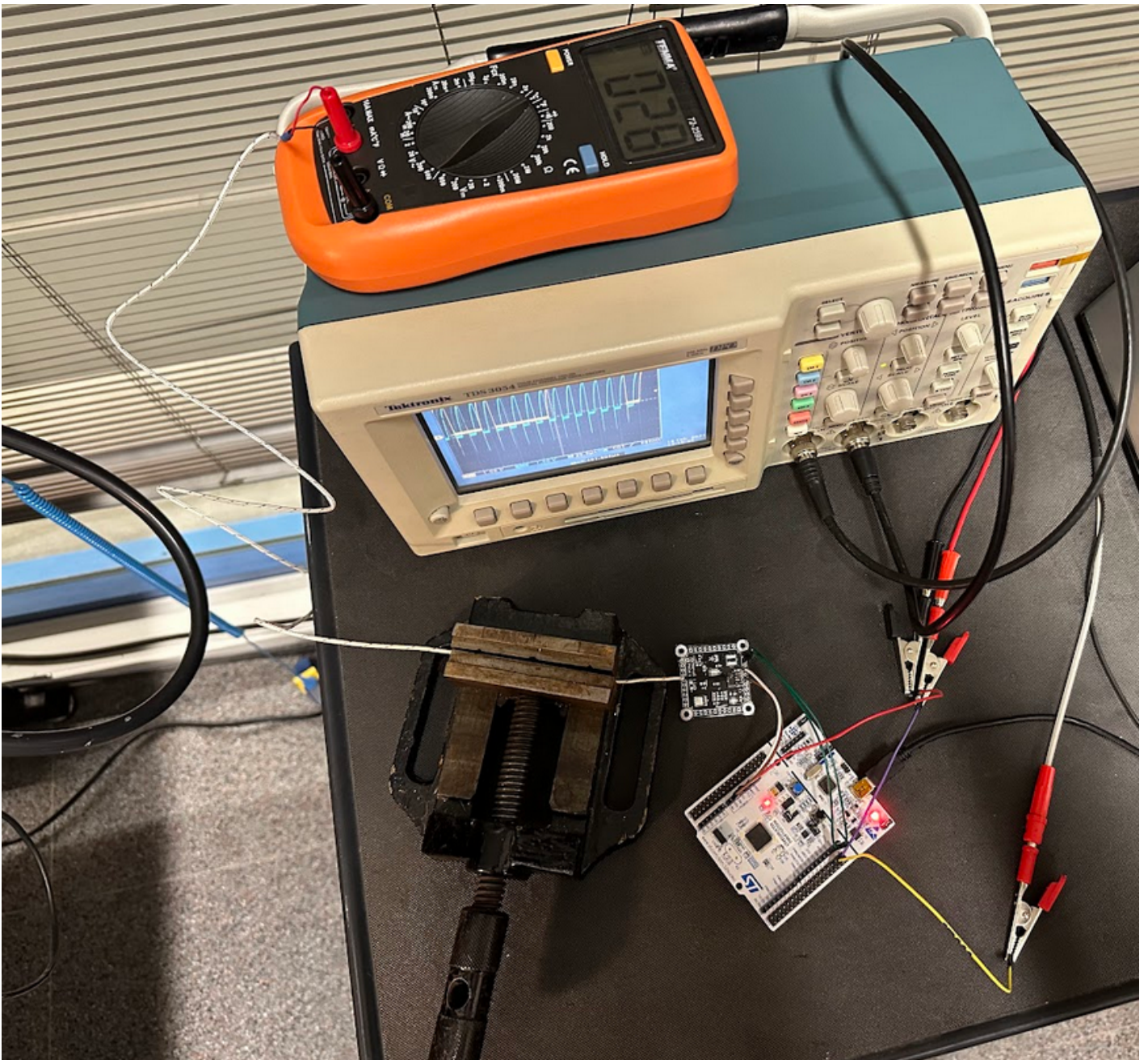


Once the nucleo-board I2C transmission was working as expected, it was time to connect the nucleo-board to the EPS board, removing first the pull-up resistances of the protoboard and checking that the ones placed in the EPS were also the 20K ohms ones.

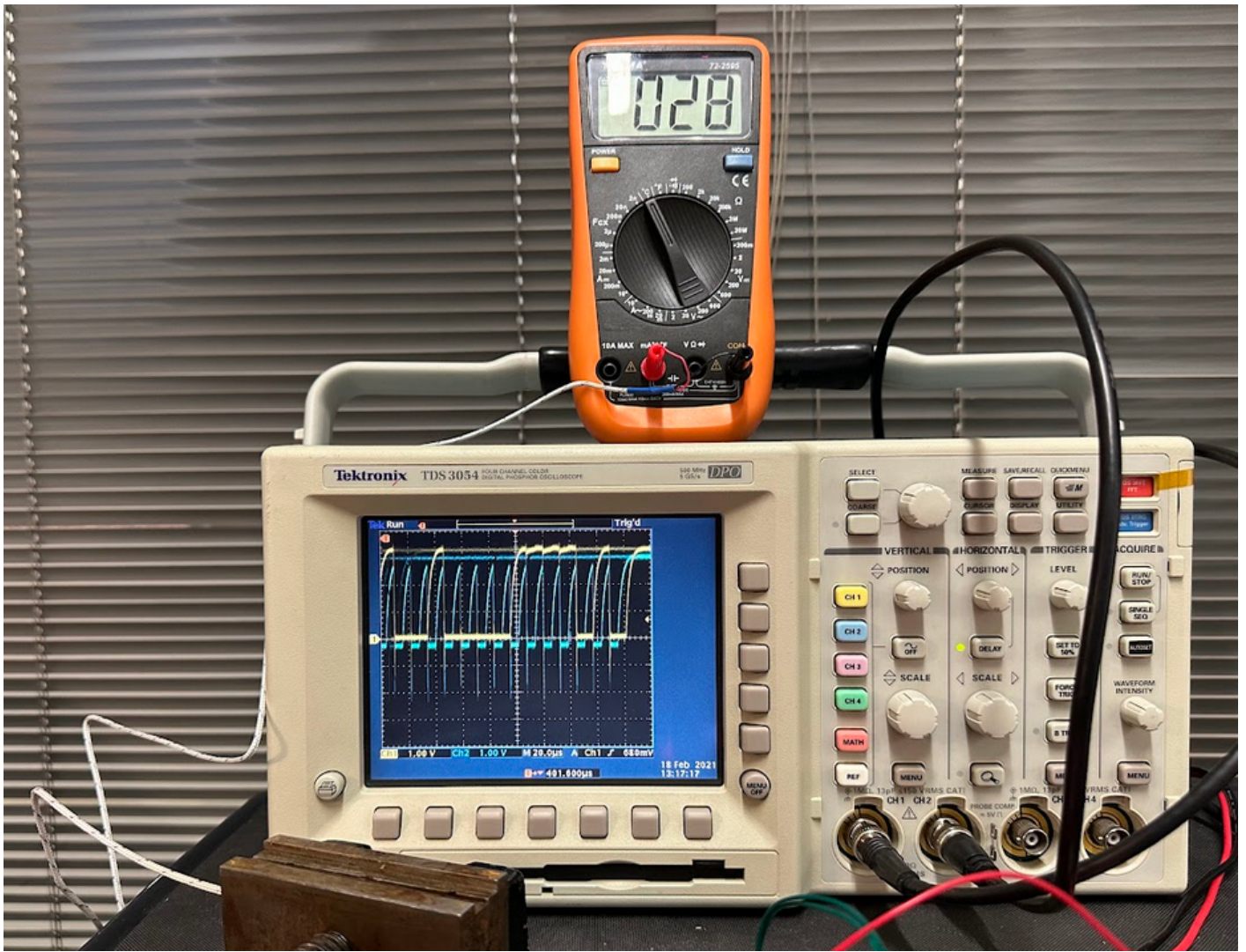
Looking again the signals in the oscilloscope, it can be seen that the EPS battery sensor was responding with the temperature value that was asked.



To make sure that this value was real, the board was heated with the hot air blower, and the temperature given by the EPS was compared with the temperature given by a thermocoupler. The following images shown the test set up

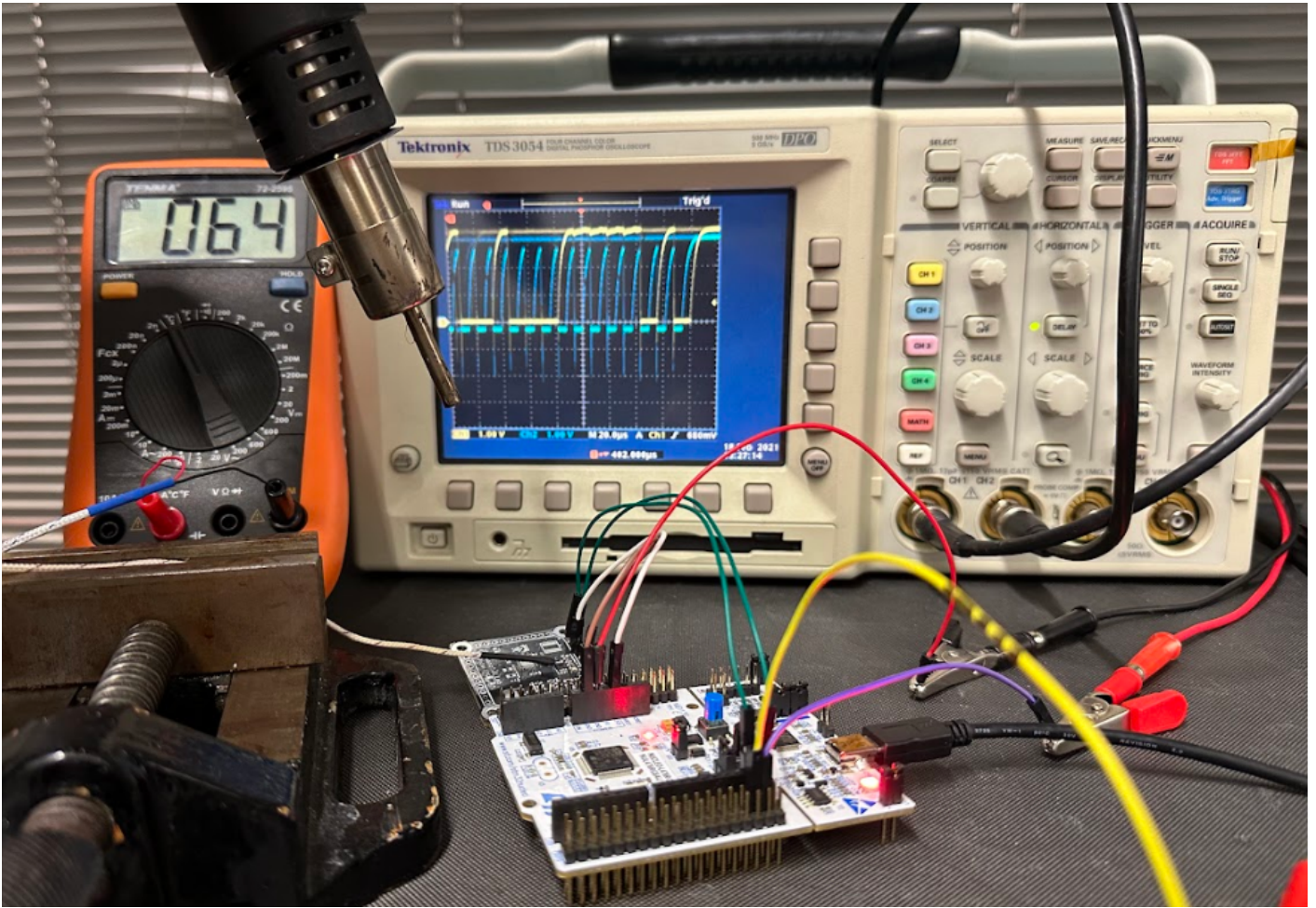


Two figures are now shown comparing the values of temperature:



EPS value: 00011110 (30°)

Thermocoupler value: 28°



EPS value: 00111110 (62°)

Thermocoupler value: 64°

It can be concluded that the temperature given by the temperature sensor of the EPS is correct.

8.6. Test Results

The test for the EPS battery sensor has been done during the 01/06/2023.

The test has been passed successfully, since the communication with the battery sensor was done and the values are correct.

8.7. Anomalies

The anomalies detected during this test are explained with detail in 6.5.2.

8.8. Conclusions

The PCB passed the I2C test and is ready to do more complex tests.

9. TEST 6: ADCS powered by EPS

9.1. Test Description and Objectives

The aim of this test is to verify that the ADCS board can be powered with the EPS board.

9.2. Requirements Verification

Requirement ID	Description
Input Power	It is required to check that the input pin of the ADCS when it is connected to the EPS output is 3.3V
Sensor reading	It is necessary to be able to read from a sensor of the gyroscope using I2C

9.3. Test Set-Up

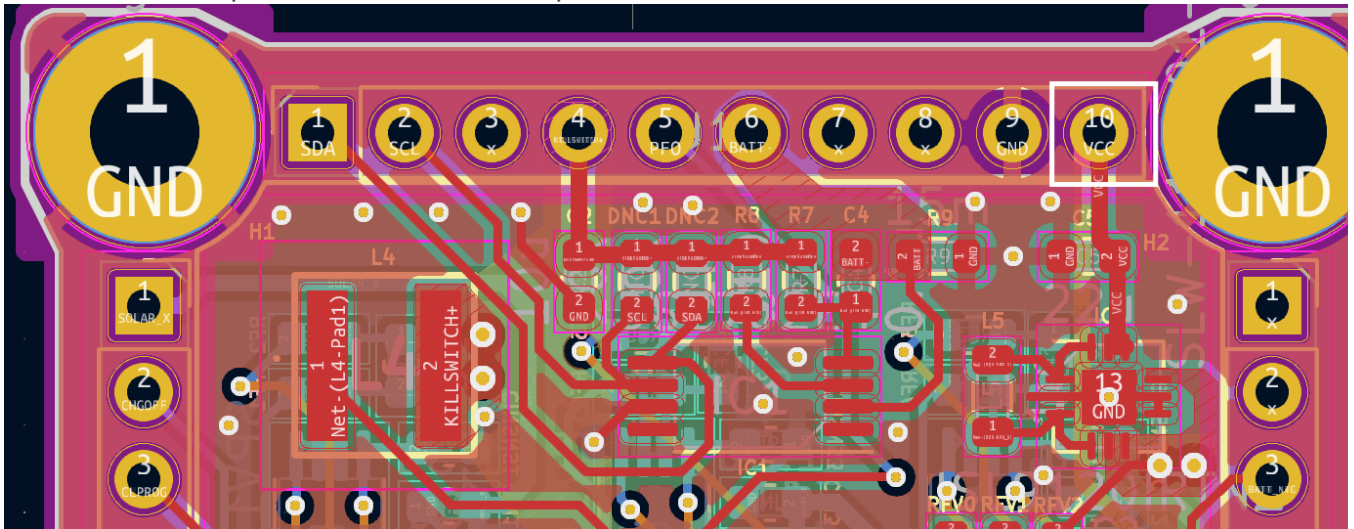
- EPS payload full soldered and tested
- ADCS payload full soldered and tested
- STM32L476RG NucleoBoard
- Power Supply
- Wires
- Multimeter
- Protoboard
- 2 resistances of 20K ohms
- Calculator, pen and paper
- Laptop with Ki-Cad

9.4. Pass/Fail Criteria

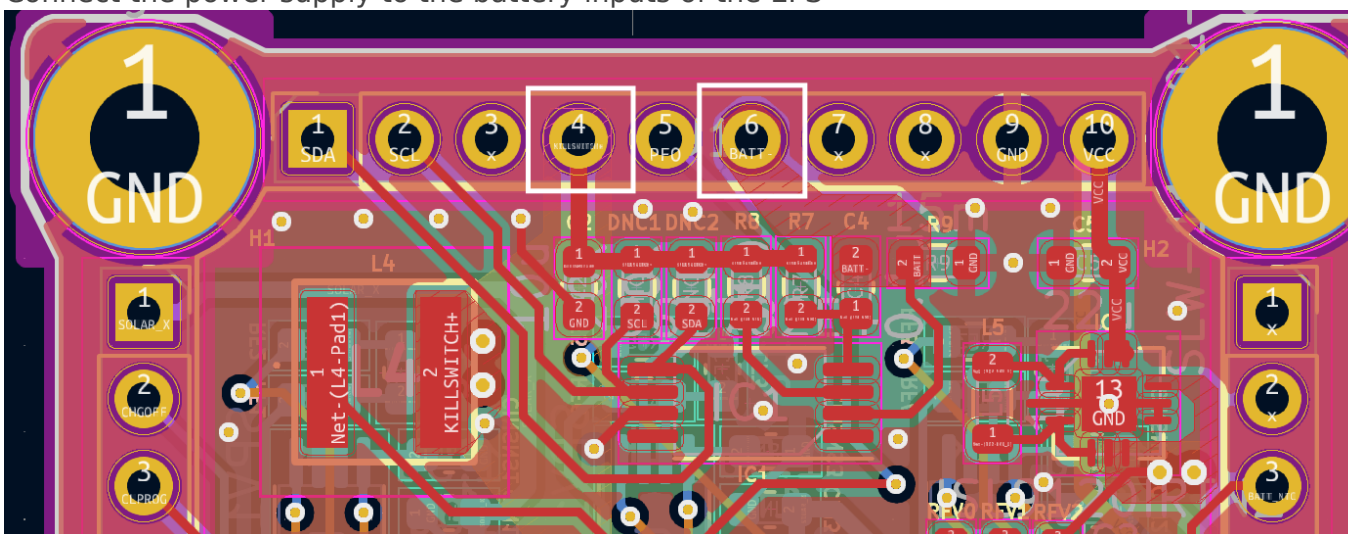
The PCB will be verified if the input power of the ADCS when it is connected to the EPS is 3.3V and it is possible to read from the gyroscope sensor.

9.5. Test Plan

1. Connect the output of the EPS to the input of the ADCS



2. Prepare the power supply with 3.3V and 800mA and turn it off
3. Connect the power supply to the battery inputs of the EPS



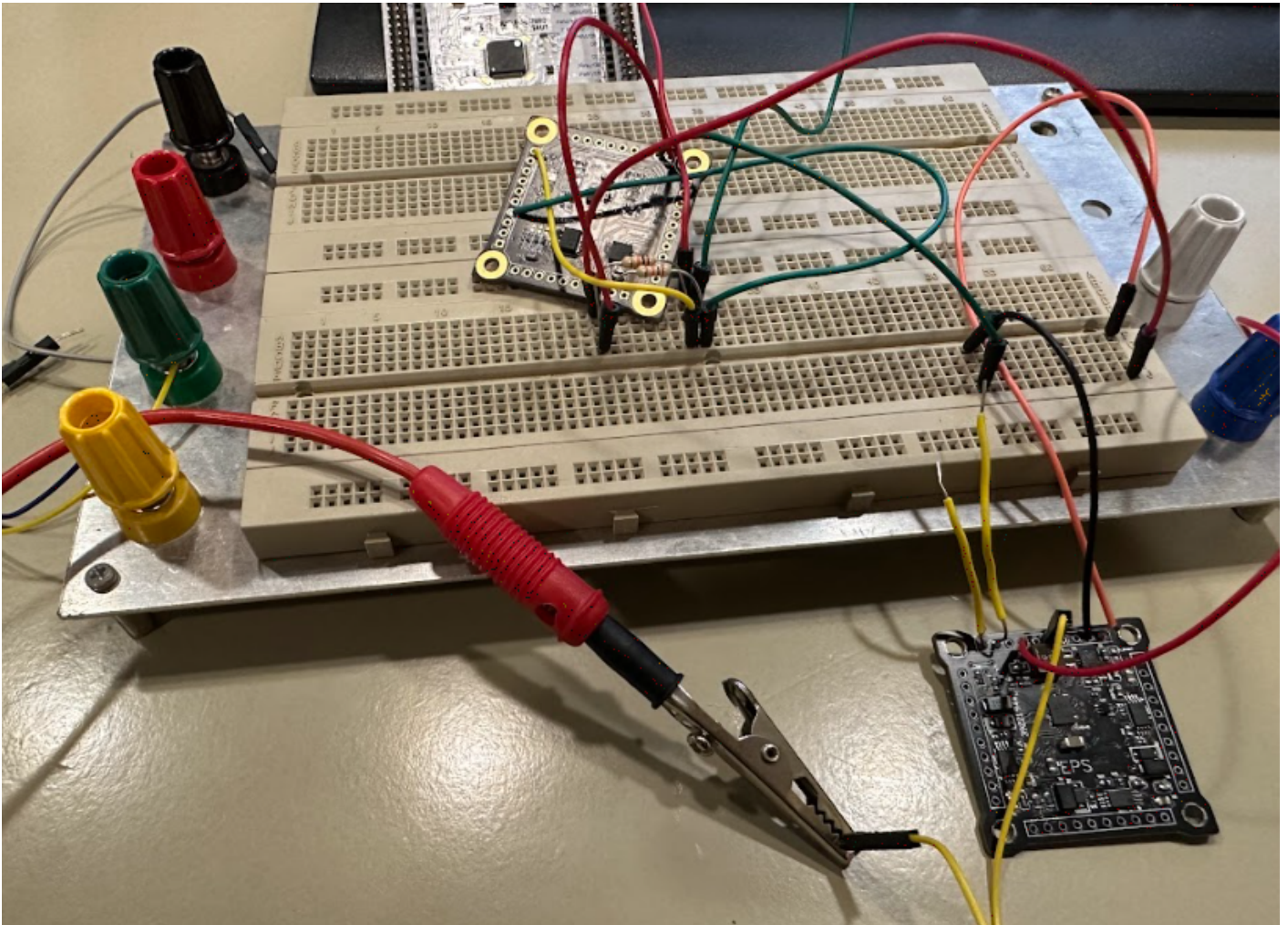
4. Turn on the power supply
5. With the help of the multimeter check that the voltage at the input pin of the ADCS is 3.3V
6. Turn off the power supply
7. Prepare a protoboard with two resistances with a value of 20K ohms connected between VCC of the EPS and SCL and SDA
8. Connect the SCL and SDA pins to the nucleoboard
9. Connect the nucleoboard to the PC
10. Turn on the power supply
11. Debug the code and check the registers from the gyroscope

9.6. Test Results

The test for the EPS PCB has been done during the 02/06/2023.

The input of the ADCS when connected with the EPS is the expected 3.3V.

The following two images show the test set-up and the received values of the gyroscope



9.7. Anomalies

No anomalies has been detected

9.8. Conclusions

The EPS can supply successfully the ADCS board and the data from the gyroscope can be read. Therefore, the EPS has passed this test.

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