15W single coil fixed frequency Qi wireless charger Tx evaluation kit based on STWBC-EP

Introduction

The EVALSTWBC-EP wireless charger evaluation kit includes the transmitter reference design board and an EVALWBCDNGV1 USB to UART dongle for PC communication.

The transmitter is based on a single coil, MP-A15 fixed frequency design, with a SEPIC DC/DC stage supplying a half bridge inverter operating at 127.7 kHz fixed frequency, for compatibility with proprietary fast charge modes of popular smartphones. The transmitter is designed to accept 5V to 20V input and limits the output to 5W if supplied by legacy 5V USB Chargers.

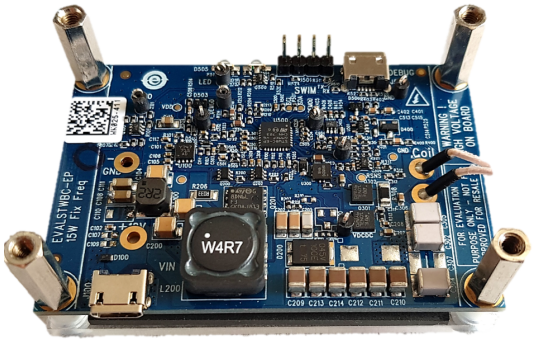
The EVALSTWBC-EP transmitter is compliant with Qi WPC 1.2.4 specification, and is compatible with all Qi-compatible receivers, including mobile phones, and supports resistive and capacitive modulation. The transmitter is capable of Qi EPP bi-directional communication and is backward compatible with 5W BPP receivers.

The STWBC-EP digital controller monitors and drives the EVALSTWBC-EP transmitter, including the digital DC/DC controller that regulates the transmitted power. The controller supports several demodulation paths for robust messaging, as well as a patented Q-factor measurement for accurate foreign object detection (FOD).

You can communicate with the controller via UART, and monitor the behavior of the transmitter on your PC using the STSW-STWBCGUI graphical interface.

Figure 1. Wireless charger kit top side with coil

Figure 2. Wireless charger kit bottom side with transmitter board



1 Getting started

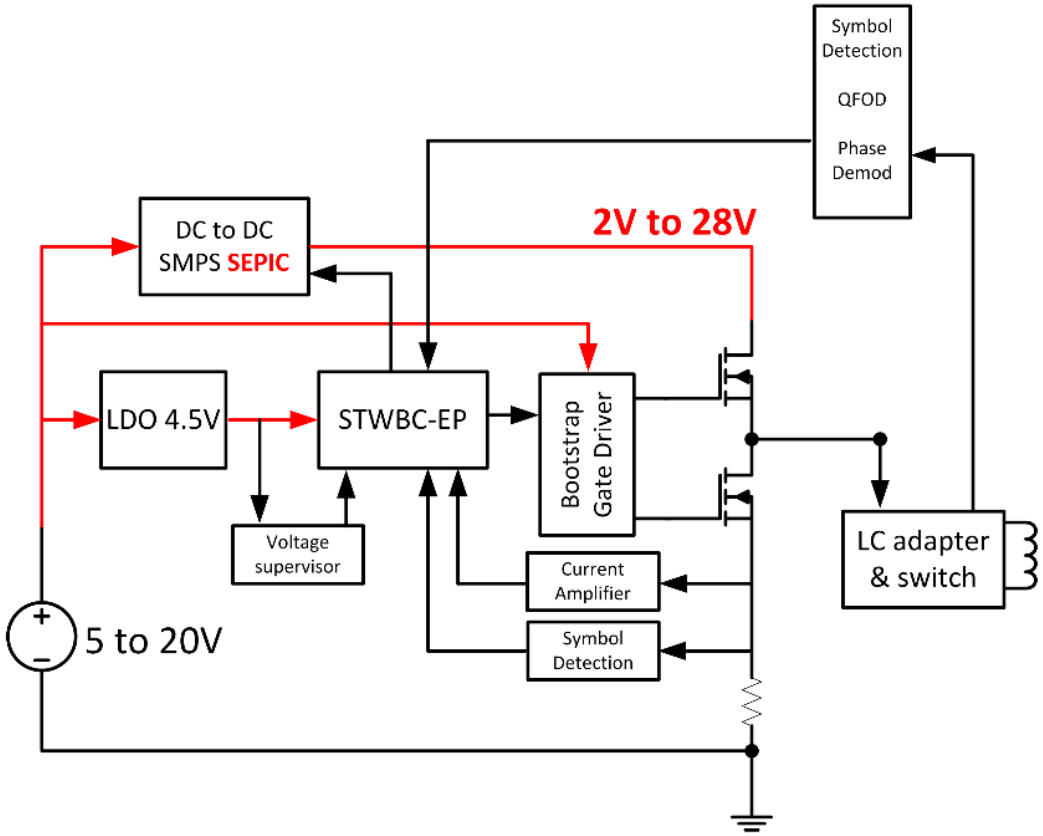
You need the following items to use the evaluation kit:

- Evaluation kit components:
  - Wireless charger system with EVALSTWBC-EP transmitter board
  - EVALWBCDNGV1 USB to UART interface dongle with micro USB cable for debugging and GUI interaction
  - 12 V / 2A, 24 W AC/DC adapter
  - USB Type A to Micro USB Type B cable
  - MicroUSB to 5.5/2.1mm jack adapter
- Additional hardware:
  - PC running Windows XP or higher and the .NET framework 4.0
  - ST-LINK/V2 in-circuit debugger/programmer with single wire interface module (SWIM)
- Software:
  - ST-LINK USB driver
  - STVP programming tool from STMicroelectronics (integrated in the sttoolset available on st.com)
  - FTDI VCP driver http://www.ftdichip.com/Drivers/VCP.htm
  - STSW-STWBCGUI PC GUI installation package

2 EVALSTWBC-EP wireless charger kit overview

2.1 System block diagram

Figure 3. **EVALSTWBC-EP block diagram**



2.2 EVALSTWBC-EP wireless transmitter board

The EVALSTWBC-EP board features

- WPC Qi 1.2.4
- Standard Qi MP-A15 transmitter and coil
- Qi EPP bi-directional communication
- Triple path signal demodulation
- Coil current and temperature monitoring
- Input voltage monitoring
- Foreign Object Detection (FOD)
- Quality factor measurement
- LEDs for charge status indication
- UART connection for user interface and firmware download
- SWIM connection for firmware download
- 5-20V power supply
- USB quick charge

Table 1. EVALSTWBC-EP electrical characteristics

Symbol	Parameter	Notes and Conditions	Min	Typ	Max	Unit
Vin	Input Voltage		5	12	20	V
Iin	Input current	Vin 15V, load 15W on MP1B Rx		1.27	2	A
	Input Standby current (1)		At typical voltage		1.4	mA
Fs	Fixing frequency		120	127.7	136	kHz
Duty cycle	Duty cycle modulation	Duty cycle		50%		%
η	Full load efficiency	Vin = 12V, Pout Rx = 10W (MP1B)		76		%

1. *Value valid if STWBC-EP is set in low power mode (not forced to high power)*

Figure 4. EVALSTWBC-EP evaluation board

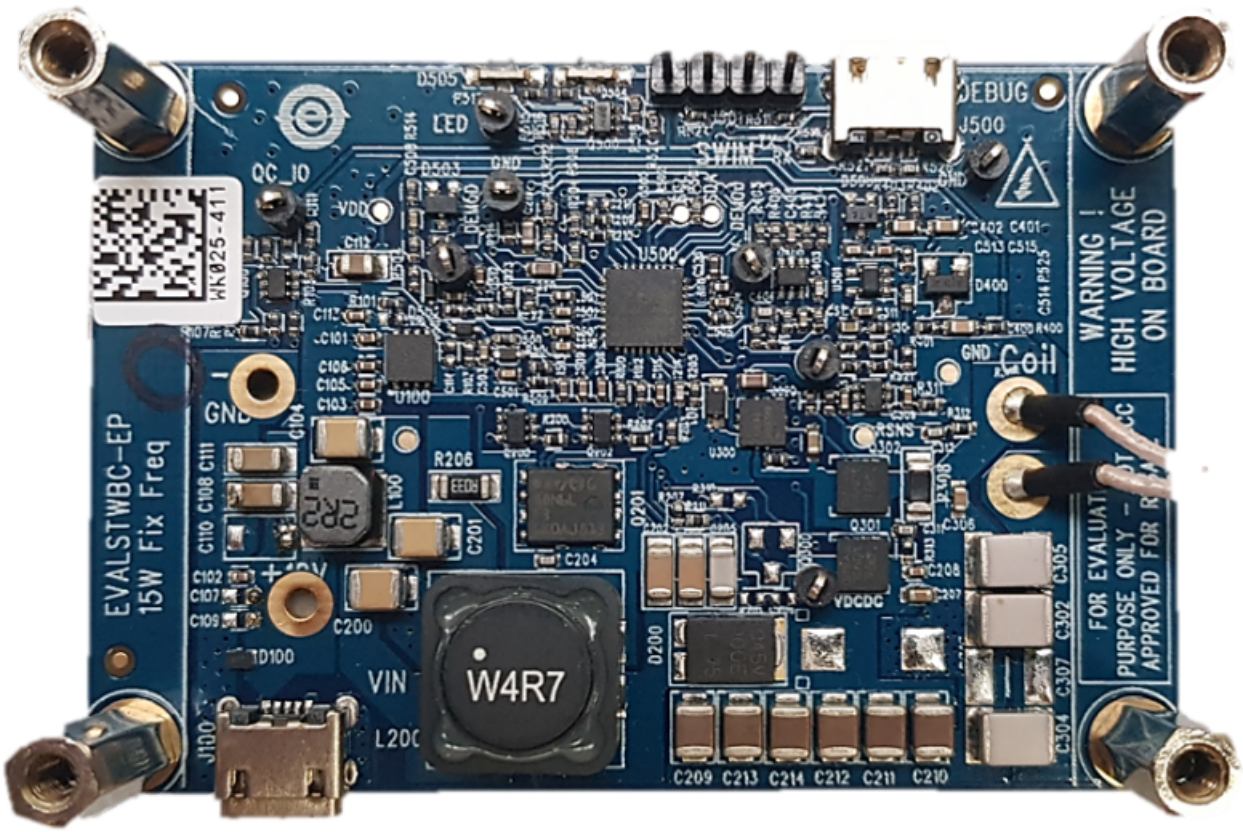


Figure 5. **EVALSTWBC-EP board reference designators**

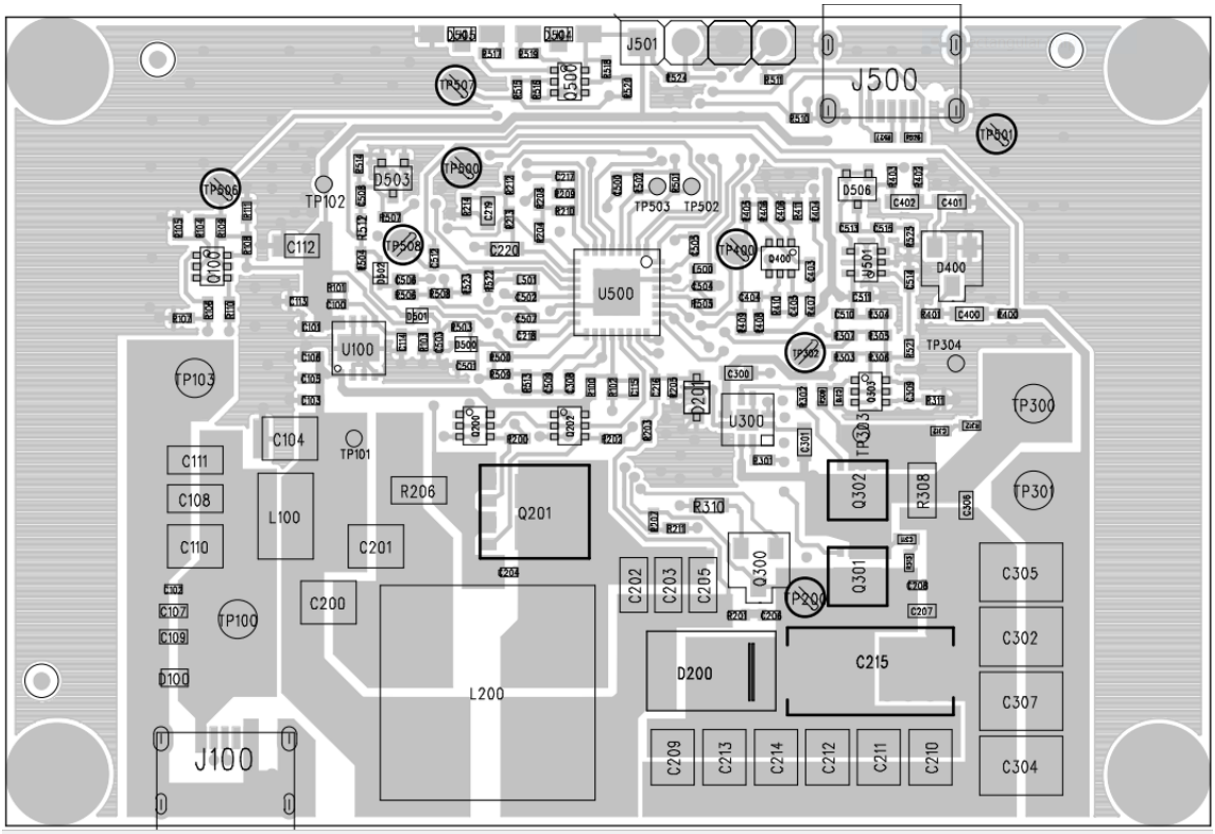


Table 2. **Test Points**

Test point reference	Signal	
TP100	VINPUT	power supply input connection
TP101	VIN	Input voltage
TP102	VDD_STWBC	4.5V LDO output voltage
TP103	GND	GND power connection
TP200	VDCDC	SEPIC output voltage
TP300	BRIDGE_NODE	Power coil connection
TP301	POWER_NODE	Ringing node
TP302	ISENSE	Current sense ADC
TP303	VRSENSE	Rsense resistor voltage
TP304	GND	Rsense power GND connection
TP400	SYMBOL_DETECT	Symbol detector
TP500	GND	Ground
TP501	GND	Ground
TP502	I2C_SDA	STWBC I2C data
TP503	I2C_SCL	STWBC I2C clock
TP506	QC_IO	Quick charge IO
TP507	LED	Led control

Test point reference	Signal	
TP508	CURRENT_DEMOD	Symbol detector

2.3 STWBC-EP pinout and pin description

The STWBC-EP is a multifunction device that can support several wireless charging architectures.

This section shows the pinout used by the STWBC-EP when the single coil MP-A15 Fixed Frequency configuration is used.

Figure 6. STWBC-EP in single coil fixed frequency configuration

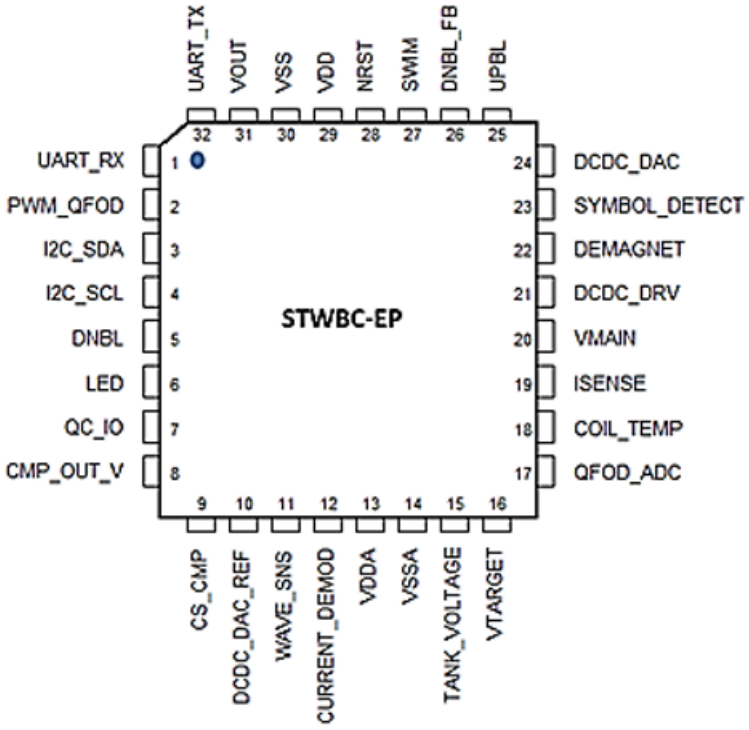


Table 3. Pinout description

Pin Number	Pin Name	Pin Type	Firmware description
1	UART_RX	DI	UART RX link on USB debug connector
2	PWM_QFOD	DO	PWM dedicated to QFOD circuit (optional)
3	I2C_SDA	DO	I2C_SDA
4	I2C_SCL	DO	I2C_SCL
5	DNBL	DO	Output signal for HB low side driver
6	LED	DO	Digital output for green and red LEDs indicators
7	QC_IO	DO	Quick Charge circuit signal
8	CMP_OUT_V	AI	SEPIC output voltage sensing
9	CS_CMP	AI	SEPIC current sensing
10	DCDC_DAC_REF	AI	DAC reference value for SEPIC output voltage
11	WAVE_SNS	AI	Symbol detector based on frequency shift

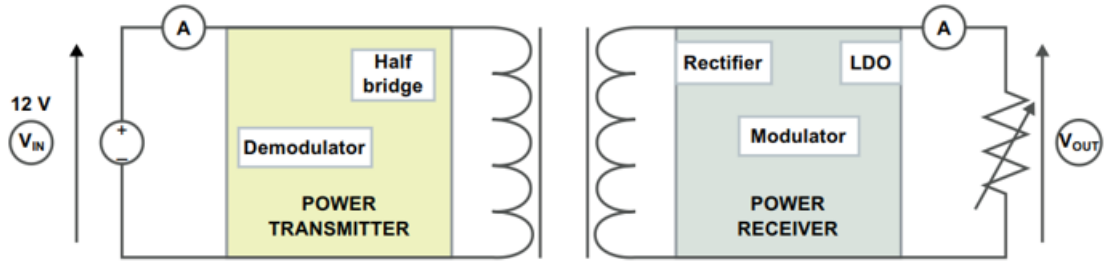
Pin Number	Pin Name	Pin Type	Firmware description
12	CURRENT_DEMOD	AI	Current demodulation
13	VDDA	PS	Analog power supply
14	VSSA	PS	Analog ground
15	TANK_VOLTAGE	AI	Analog input to measure the LC voltage (power calculation)
16	VTARGET	AI	SEPIC voltage measurement
17	QFOD_ADC	AI	High sensitivity peak voltage detector used for Quality Factor measurement
18	COIL_TEMP	AI	Analog input for temperature measurement. The input is connected to external NTC biased to VDD_STWBC
19	ISENSE	AI	Analog input to measure the current flowing into the power bridge
20	VMAIN	AI	Analog input to measure the main power supply
21	DCDC_DRV	DO	DCDC SEPIC PWM drive
22	DEMAGNET	DI	Transformer demagnetization sensing
23	SYMBOL_DETECT	DI	Voltage demodulation
24	DCDC_DAC	DO	SEPIC PWM output DAC (setting the CPP3 comparator voltage reference)
25	UPBL	DO	Output signal for HB high side driver
26	DNBL_FB	DI	Hardware PWM feedback
27	SWIM	DIO	Digital IO for debug interface
28	NRST	DI	Reset input monitoring
29	VDD	PS	Digital and I/O Power supply
30	VSS	PS	Digital and I/O Ground
31	VOUT	Supply	Internal LDO output
32	UART_TX	DO	UART TX link on USB debug connector

Note: The operative voltage of analog inputs (AI) ranges from 0 V to 1.2 V.

3 Setting up the evaluation equipment

Here is the block diagram of the setup configuration for the testing

Figure 7. Measurement setup

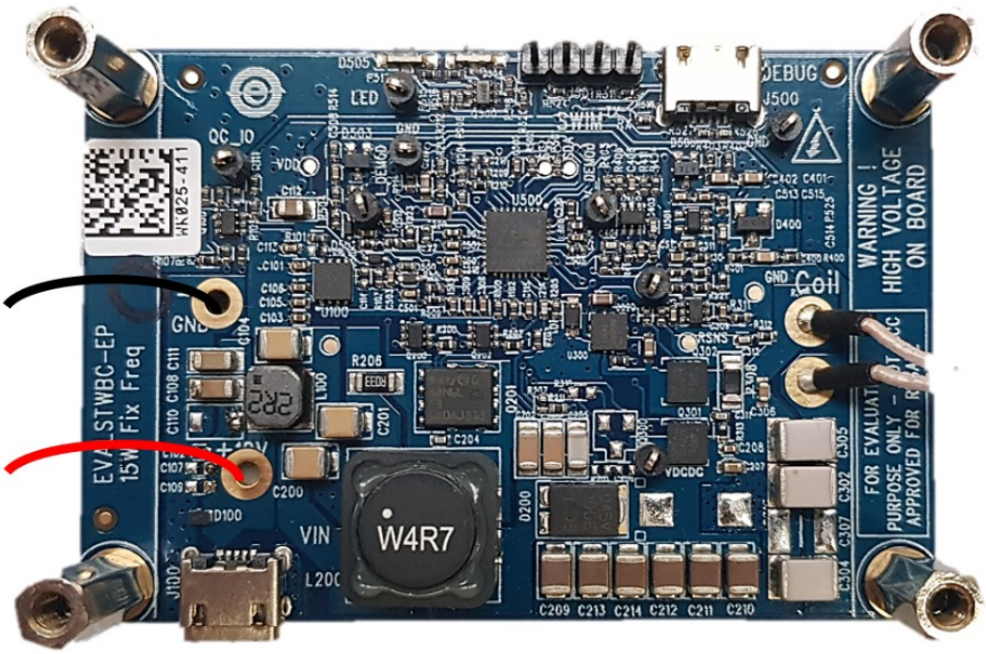


The board is powered with an external power supply or with a USB charger. An electronic load is connected on the receiver output in order to load up to 15W. Voltmeters and ammeters measure input and output voltage and current.

3.1 With external power supply

Power supply is set to 12V/2A for EPP mode and 5V/2A for BPP mode. Wires are used in order to connect the board to the external power supply.

Figure 8. Power supply connection



3.2 With AC/DC adapter or USB charger

The board can be supplied by a USB charger on J100 USB connector. Take care to not connect on J500 USB connector used for debug (UART connection)

The EVALSTWBC-EP contains a 12 V / 2A, 24 W AC/DC adapter and a MicroUSB to 5.5/2.1mm jack adapter. Use this supply as the default option.

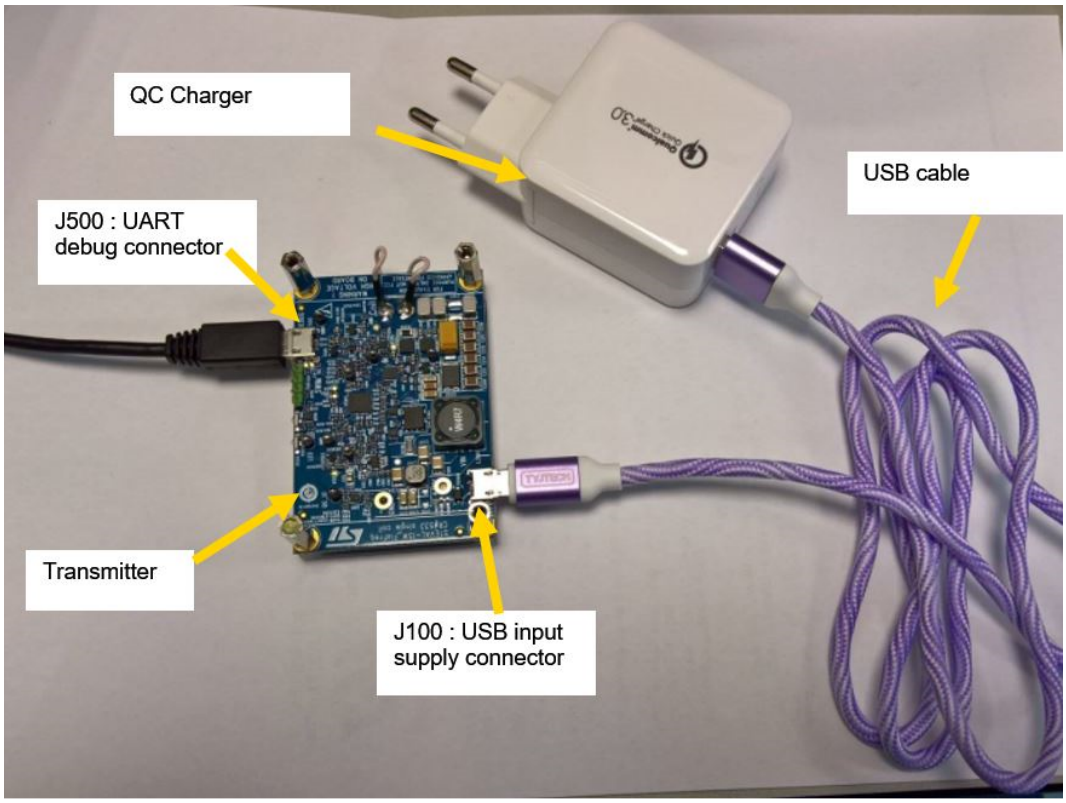
A simple 5V USB charger can also be used. Considering the peak currents and the system efficiency, a **5V/2A** USB charger must be considered. At this input voltage, BPP mode only is available.

It is also possible to use a supporting Quick Charge in order to provide higher voltage

To provide 15W on receiver side and considering the system efficiency, a **24W USB charger** must be used.

Note: It is important to use a good quality USB cable between the charger and the board to minimize drop voltage

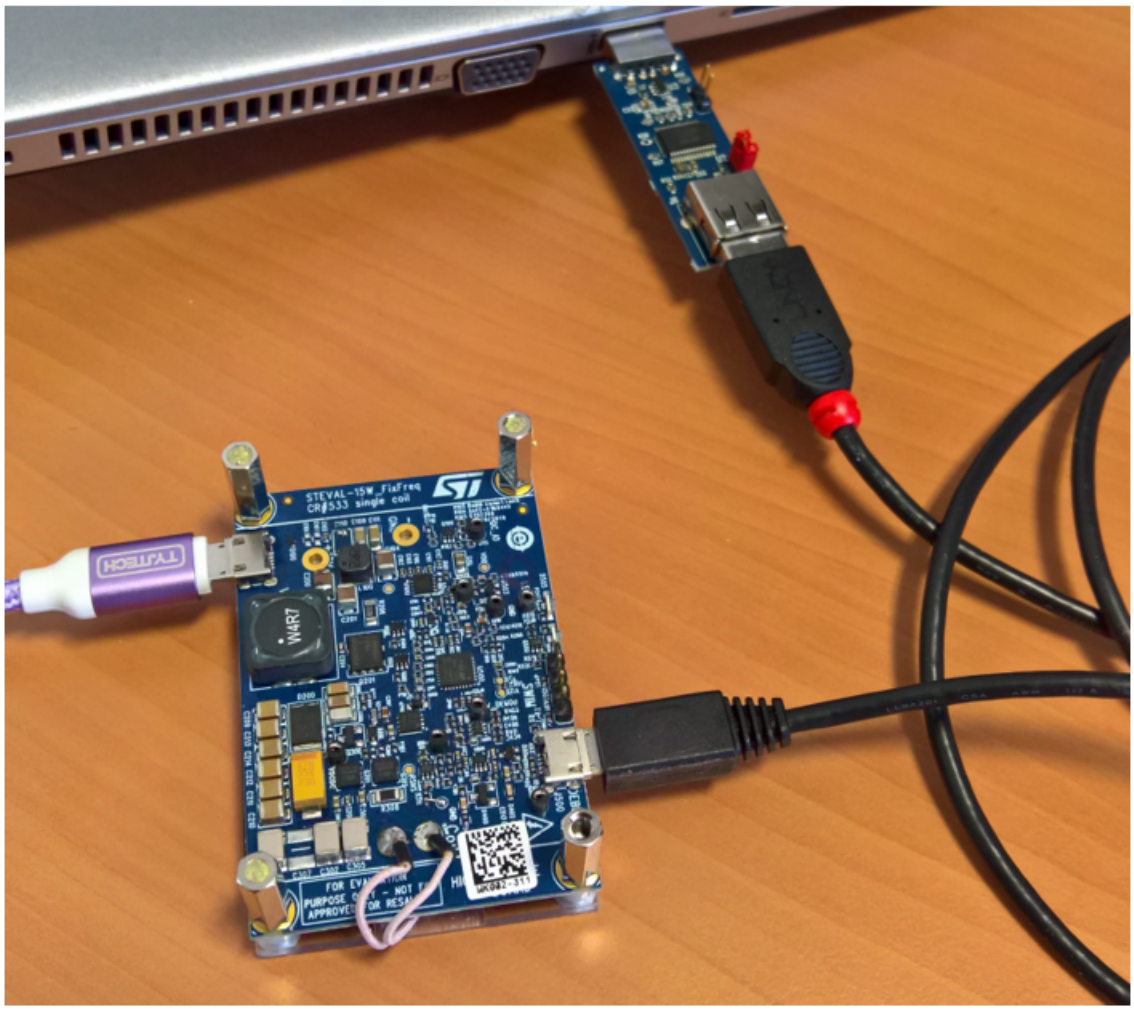
Figure 9. Power supply connection



3.3 UART Configuration

A UART connection between the board and your PC Is necessary to be able to set parameters and monitor the transmitter board through the STSW-STWBCGUI software.

Figure 10. **UART and dongle connections**



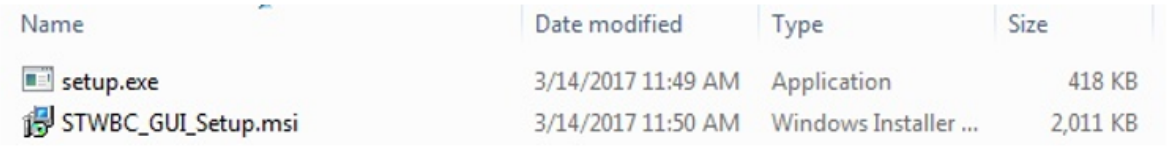
4 GUI and Evaluation procedure

4.1 STSW-STWBC GUI software installation

Step 1 - download the STSW-STWBC GUI from the following link https://www.st.com/en/embedded-software/stsw-stwbcgui.html

Step 2 - - Install the GUI by launching the STWBC_GUI_Setup.msi installer file

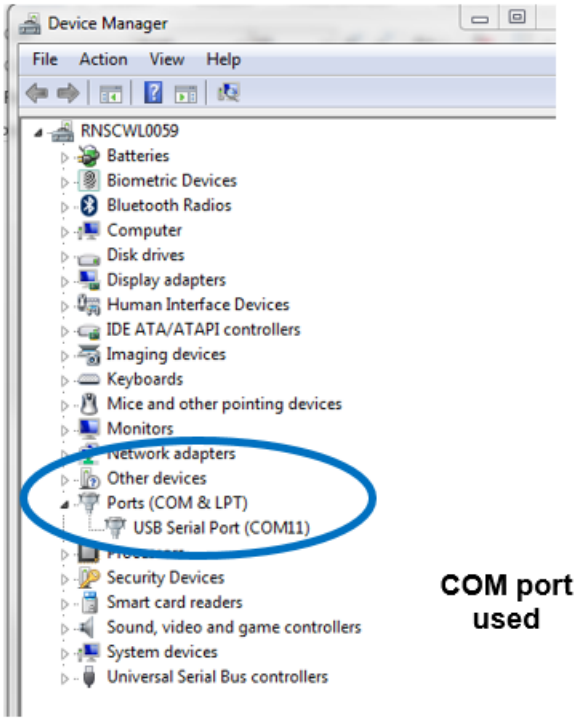
Figure 11. STSW-STWBCGUI installation file



Step 3 - Connect the wireless power transmitter board to the PC with a USB-to-UART connection on J500 UART connector.

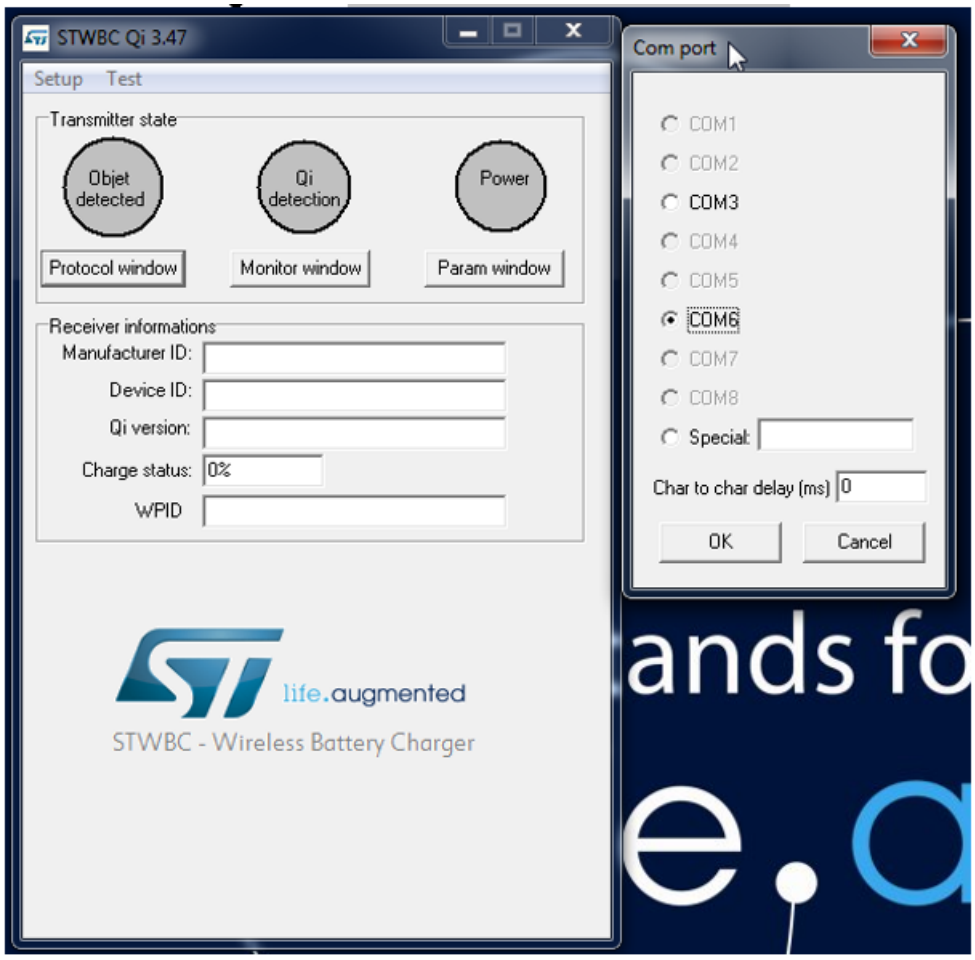
Step 4 - Check Windows Device Manager to identify the correct port number and select the appropriate USB serial COM port.

Figure 12. Windows Computer Management window



Step 5 - If the COM port is not listed in the selection window, enter it in the Special textbox (e.g., “COM12” or the specific syntax “\\.\COM12”). If the STWBC GUI is switched off, be sure the COM port is not used on your computer. Otherwise you can try another USB port.

Figure 13. **STSW-STWBCGUI start screen**

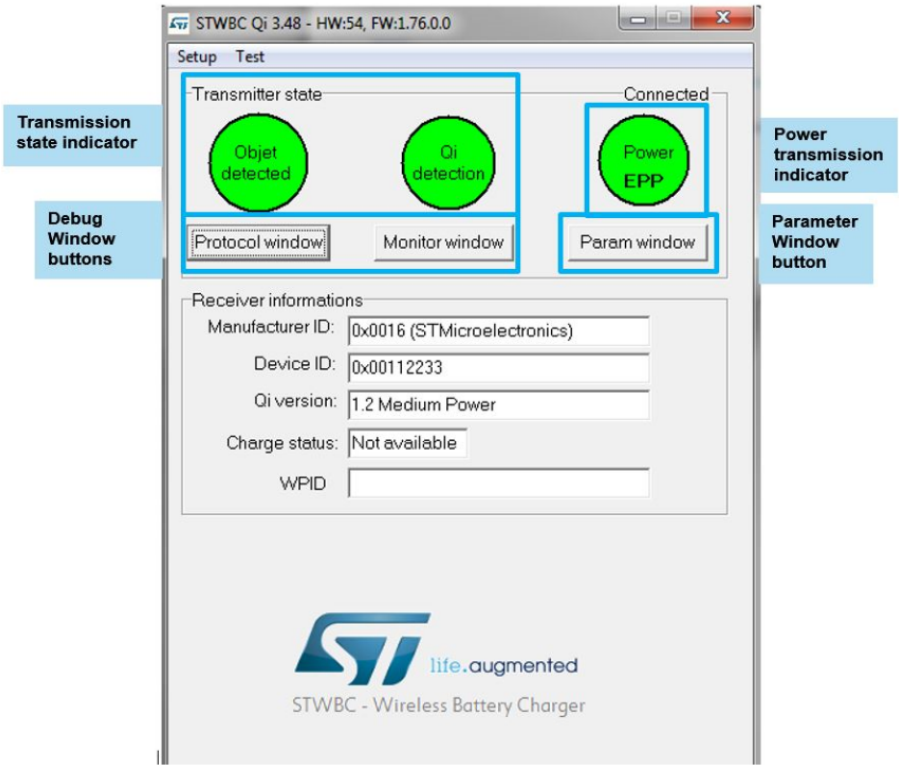


Step 6 - Press “OK” . The GUI is ready to run.

4.2 STSW-STWBCGUI presentation

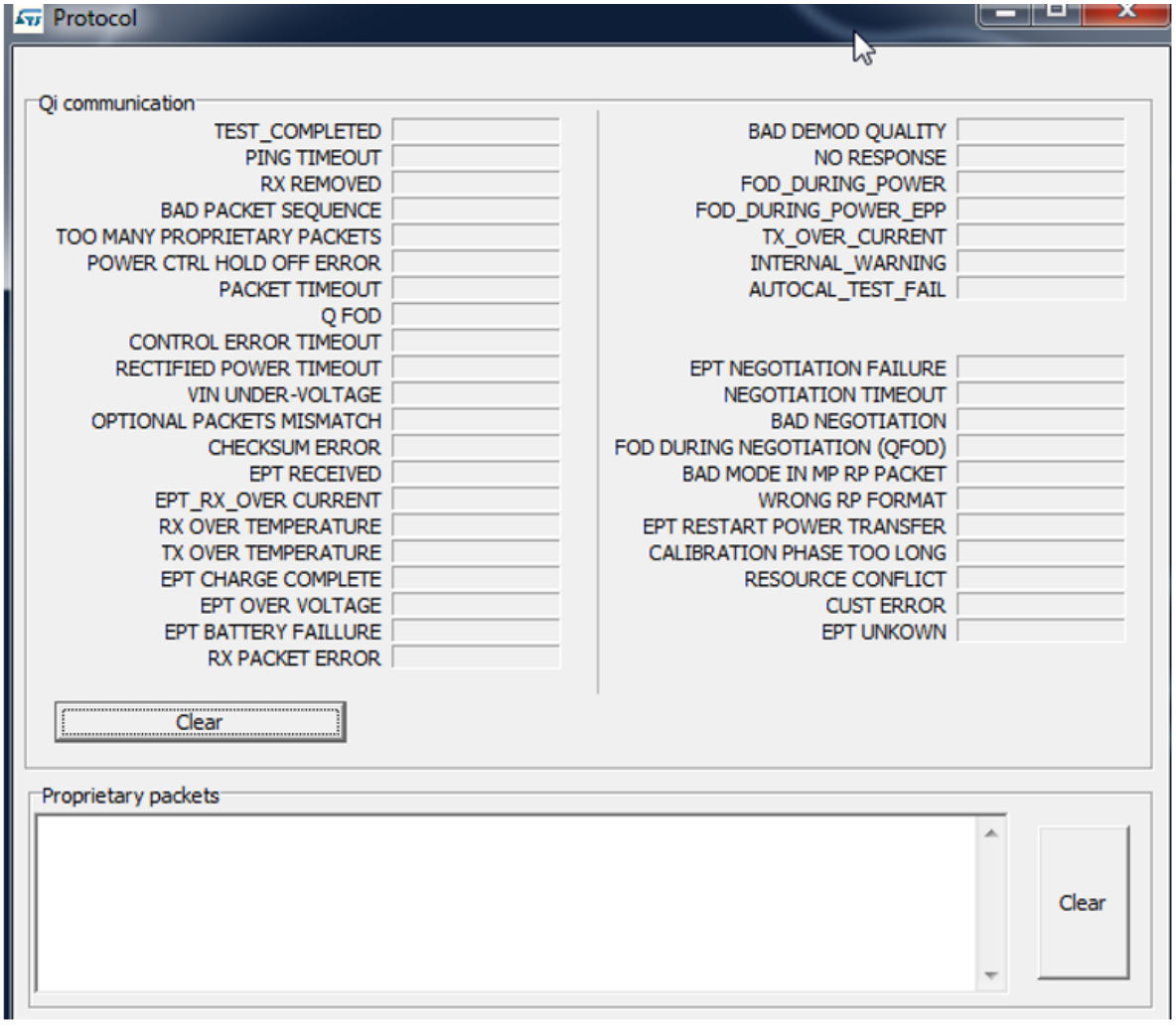
The STSW-STWBCGUI offers complete monitoring of STWBC-EP operation; the main screen provides transmitter and Qi receiver status information.

Figure 14. Object detected and charge in progress



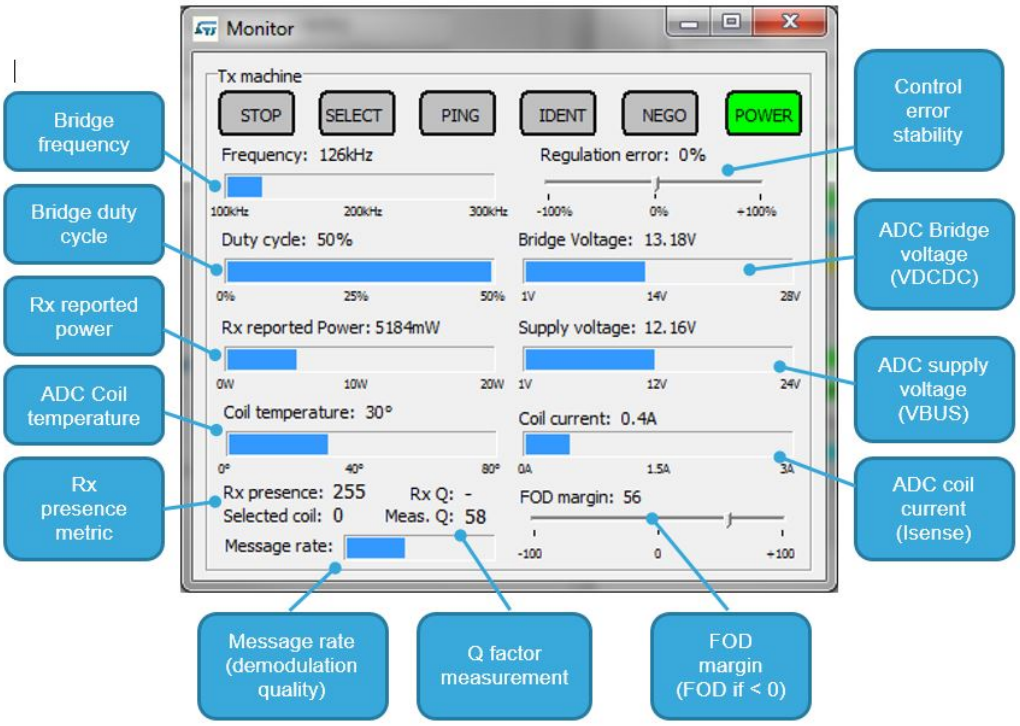
The STSW-STWBCGUI can also display the Rx to Tx communication protocol errors which is helpful for system debugging.

Figure 15. **STWBC GUI Qi Protocol window**



You can also monitor STWBC-EP internal variables such as bridge voltage and frequency, Rx reported power, coil, temperature, etc..

Figure 16. **STSW-STWBCGUI Qi Monitor window**

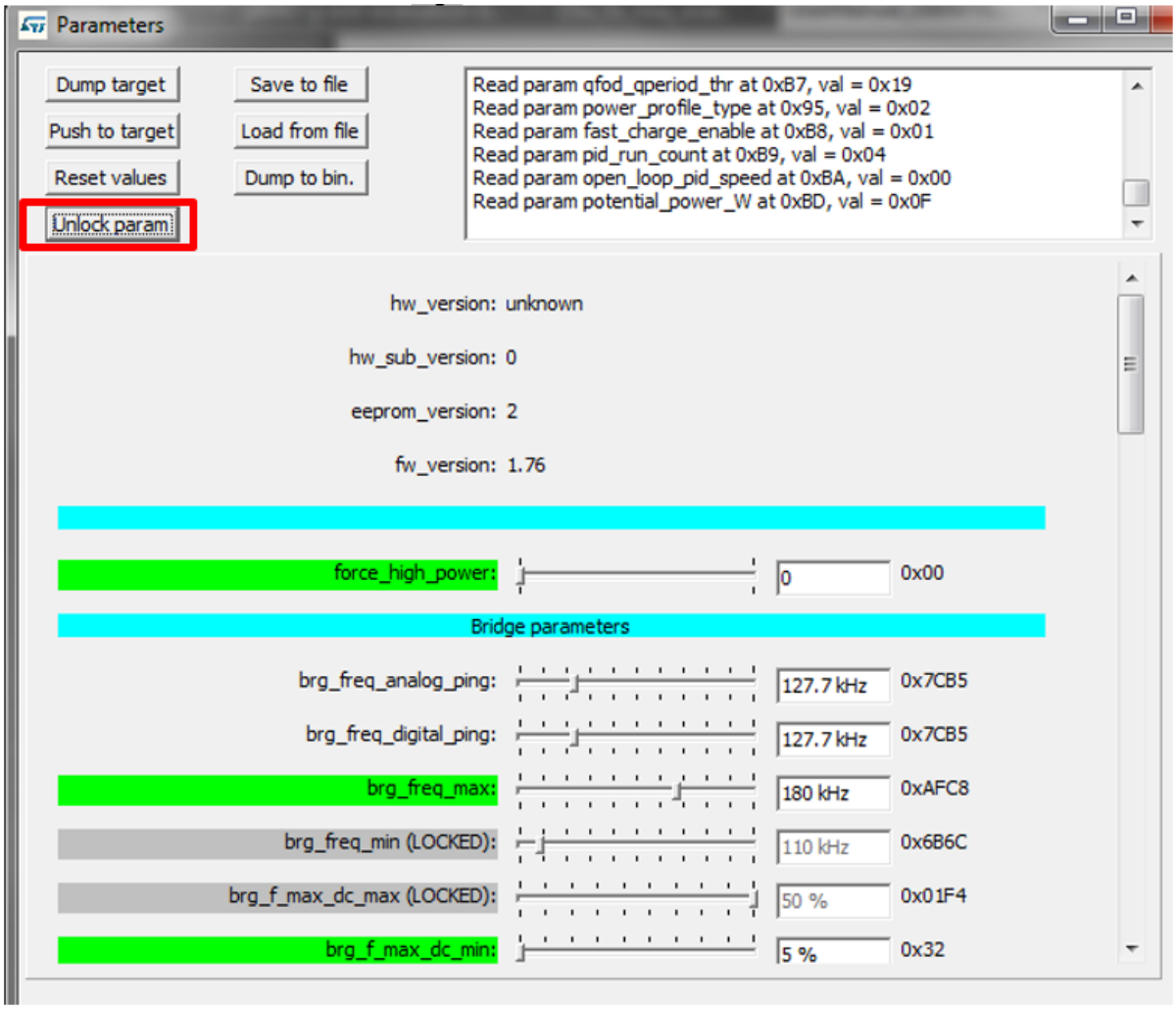


The STSW-STWBCGUI user friendly interface allows efficient system adjustment (thresholds, regulation error) and lets you store parameters to, and load parameters from, your computer.

The parameters have the following levels of protection:

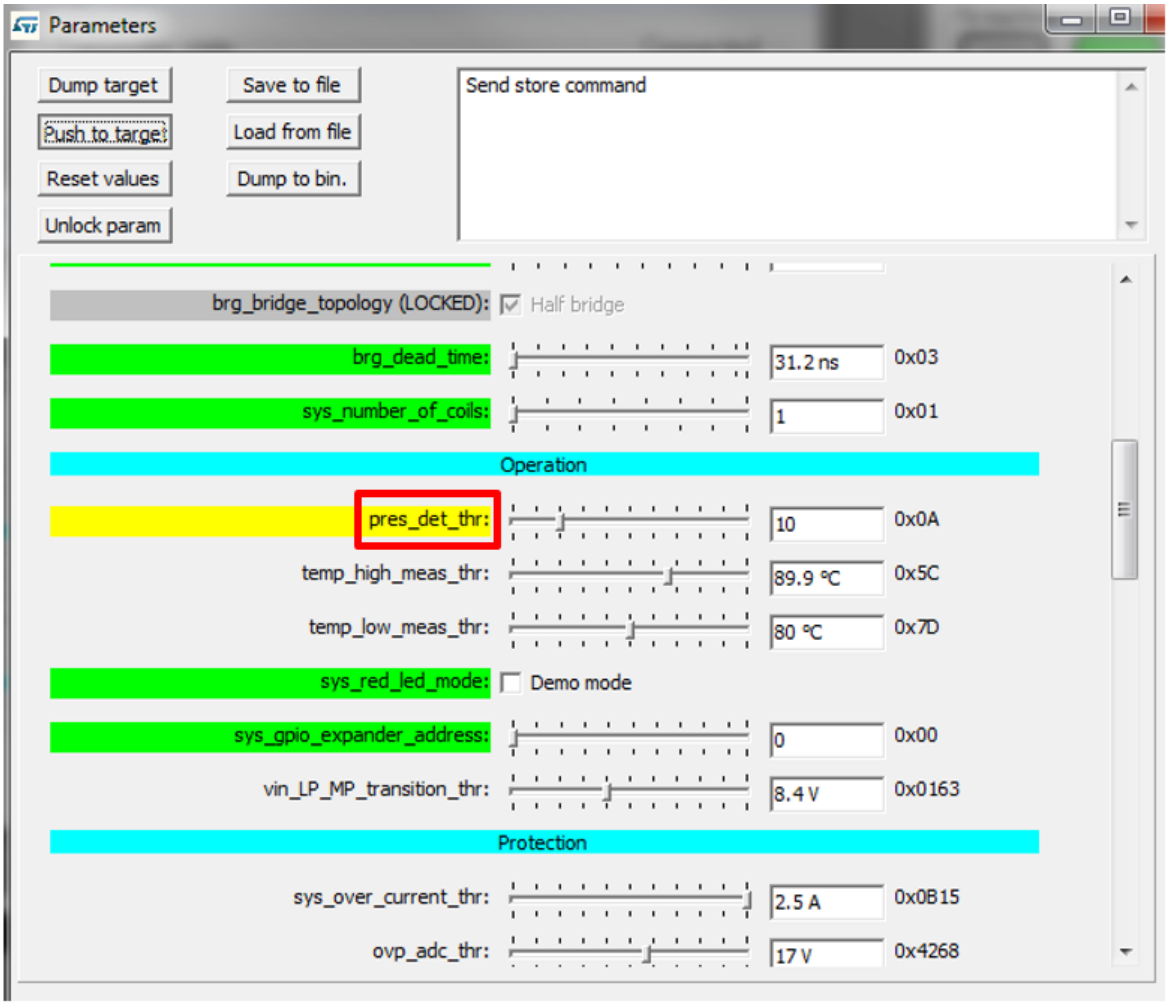
- Level 0: parameters can be modified without protection
- Level 1: more critical parameters that can be modified with caution. You must “unlock param” button before modifying it, but be cautious when doing so because it can lead to system malfunction or trigger unexpected behavior incompatible with Qi standard.

Figure 17. **Parameters window**



Parameters can be modified and their effect can be tested immediately by clicking Push to target; modified parameters are briefly highlighted in yellow then lose their highlighted background

Figure 18. **Parameters modification**



The GUI includes the STSW-STWBCFWDT downloader interface (which uses the UART connection) and includes tools to generate binary files with your changed parameters and to build new firmware packages with these files. Through the GUI, you can change the parameters and produce a new cab to program a batch of new boards**(refer to next chapter 5 for more details on firmware download)**

Figure 19. **STSW-STWBCGUI saving modified parameters (Dump to bin)**

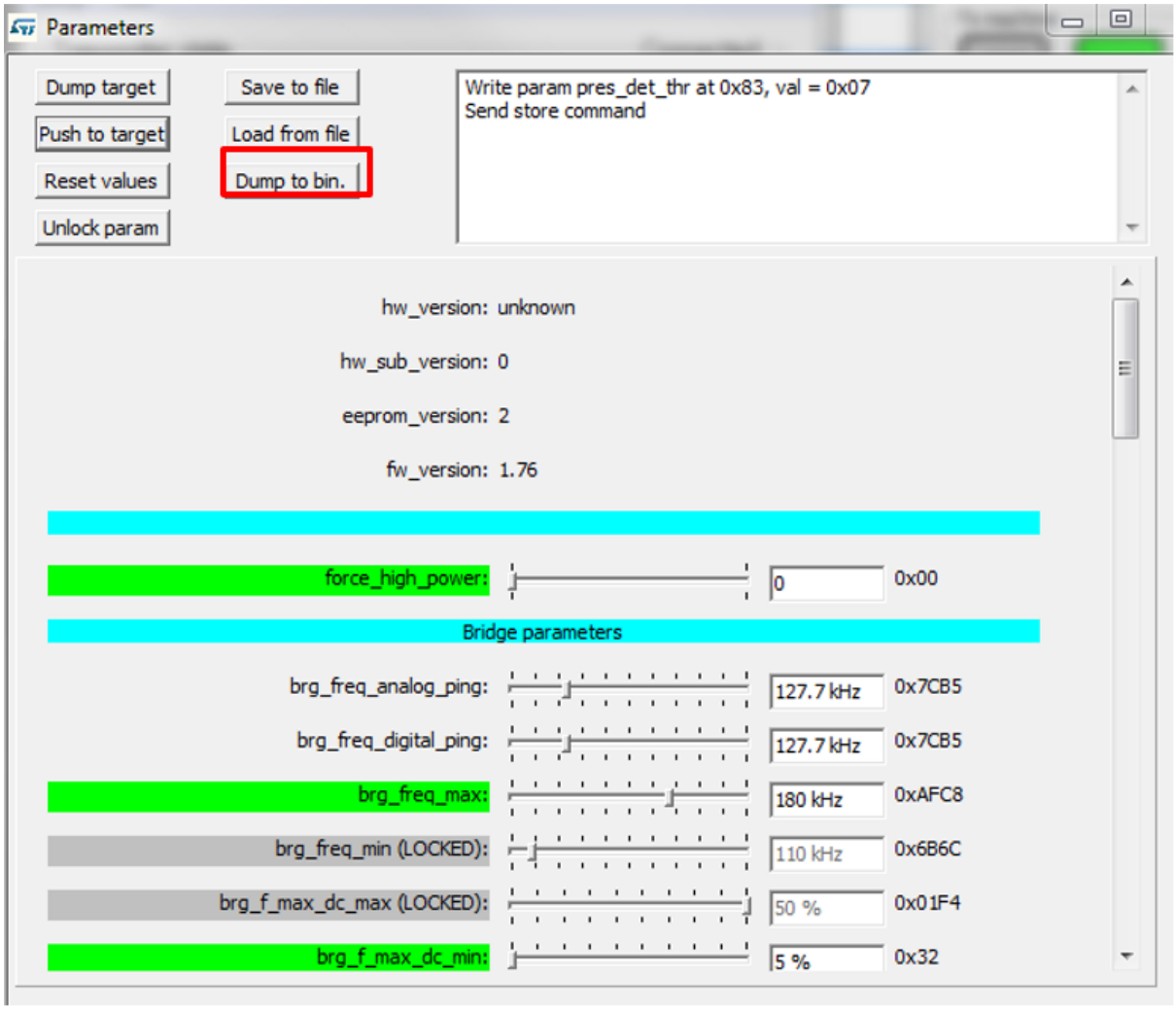
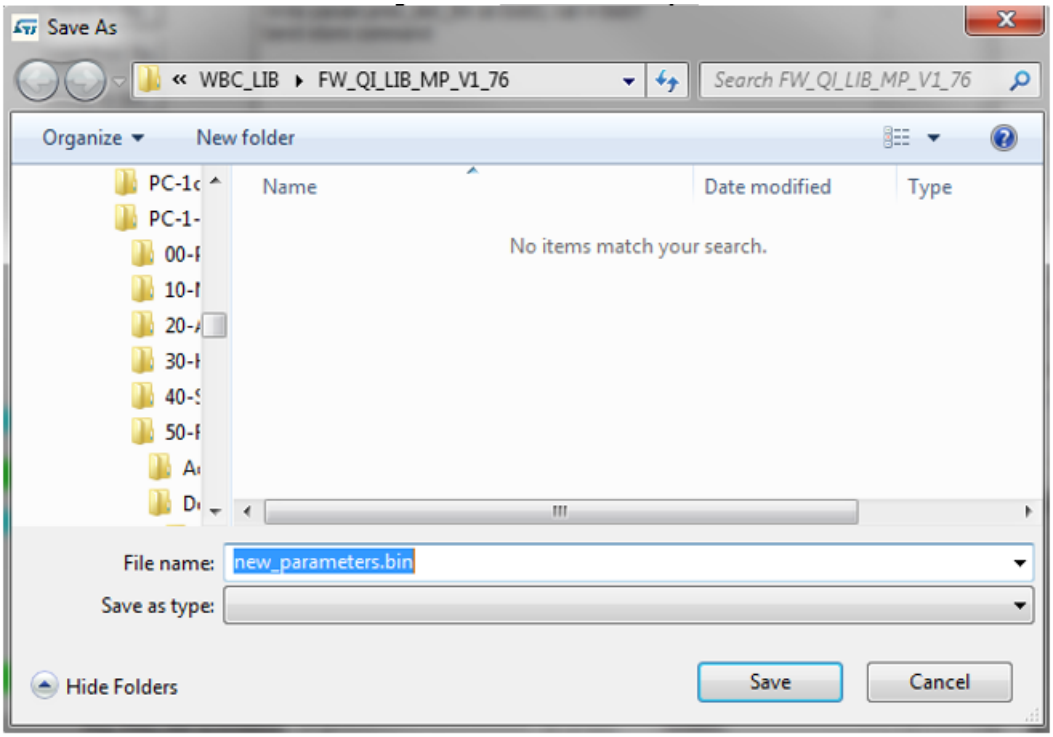


Figure 20. **Bin file backup**



You can then select Modify parameters in CAB file from the Setup menu and select the appropriate firmware CAB file to be patched. This operation will alter the firmware file with new tuning parameters, which can be subsequently loaded using the standard procedure.

Figure 21. **CAB file patch button**

Note that parameters can be also saved in .txt file using the save to file button. But bin format is needed to patch the firmware .cab file.

4.3 Status LEDs

The LEDs status gives the state of the charge:

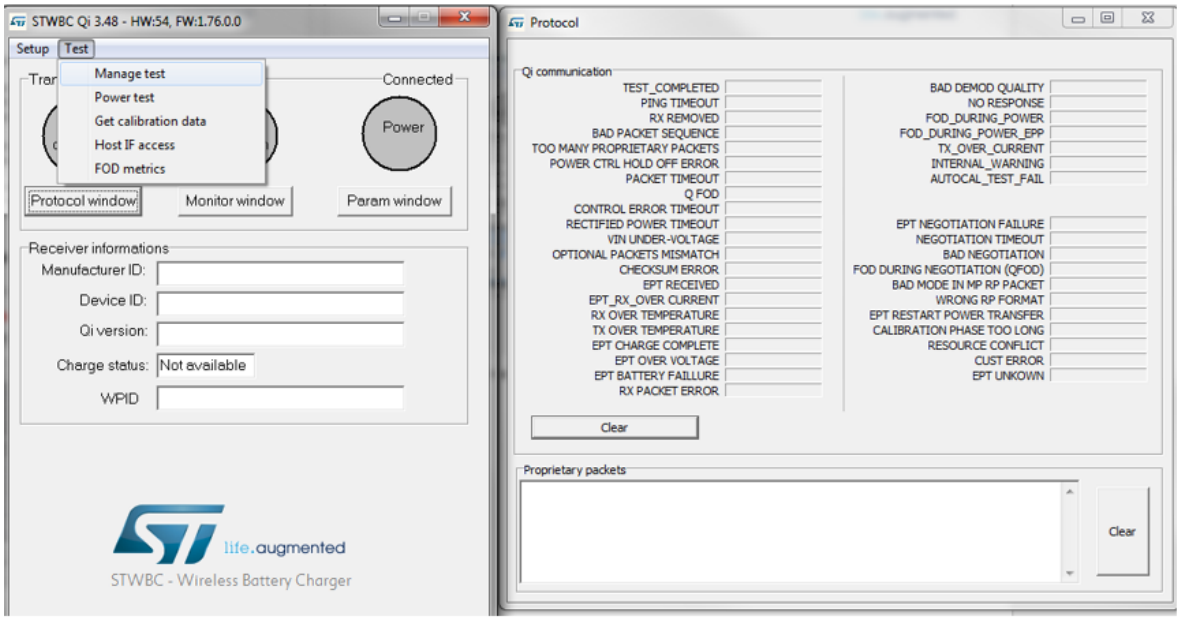
- At startup:
  - Red short blinking: when the auto-calibration of the board is on-going. The user has to wait the LED is switched off before putting a receiver on the surface.
  - Red and Green blinking once: an internal reset occurred.
  - Red and Green Steady state: Firmware / STWBC chip mismatch
  - Red Steady and after 2 seconds Green Steady state : hardware sub version of board detected doesn't match with firmware
- In steady state:
  - Green Blinking normal rate: power transfer in progress (5W maximum)
  - Green Blinking fast rate: power transfer in progress (10W maximum in AFC or 15W in EPP mode)
  - Green Blinking slow rate: Charging at reduce rate due to either
    - Over voltage protection ongoing
    - Power limitation caused by limited supply capabilities
    - Current limitation protection
  - Green Steady state: the charge is complete
  - Red blinking: an error has been detected. It includes bad end of charge like battery fault, over voltage, over current….
  - Red Steady state: the transmitter remains stuck until the receiver is removed, as mentioned in the Qi standard (power transfer stopped three times in a row due to amount of power not provided to the receiver, FOD, …)

4.4 Test procedure for board calibration

There are 2 auto calibration phases including into the GUI, one for the presence detection and the other one for the QFOD.

Note: Those 2 calibrations are mandatory to ensure a good functioning of the transmitter board

Figure 22. **Start auto calibration**

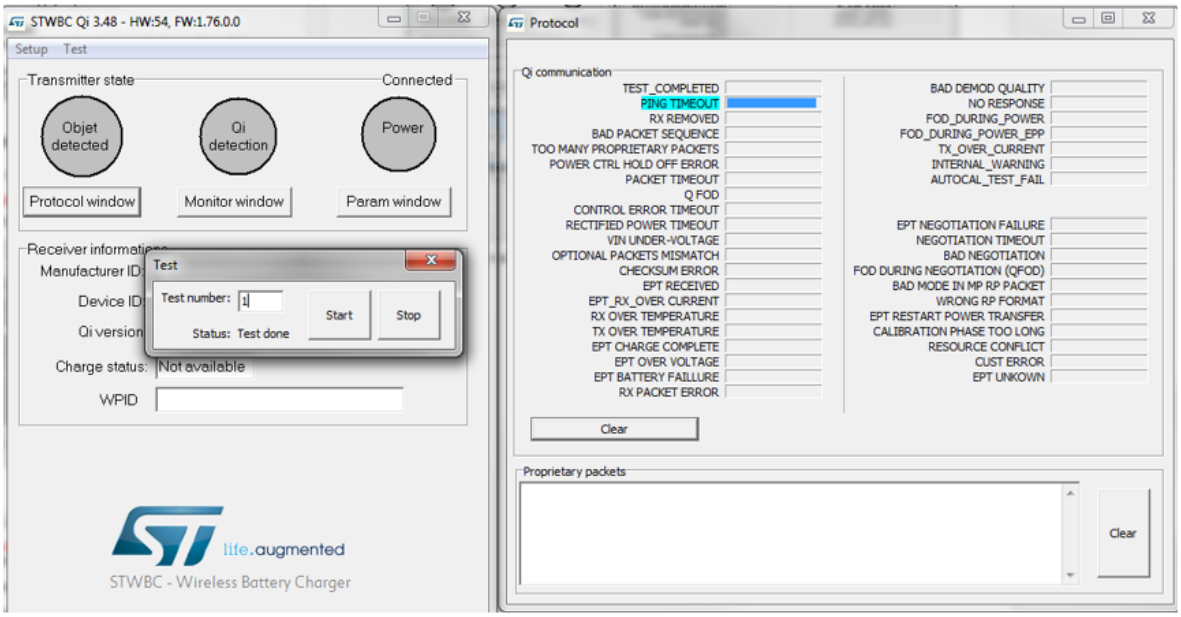


This calibration should be done only once **after each new firmware download**.
It must be done with **NO Receiver** placed on the transmitter

You must first calibrate the presence detection and then the QFOD.

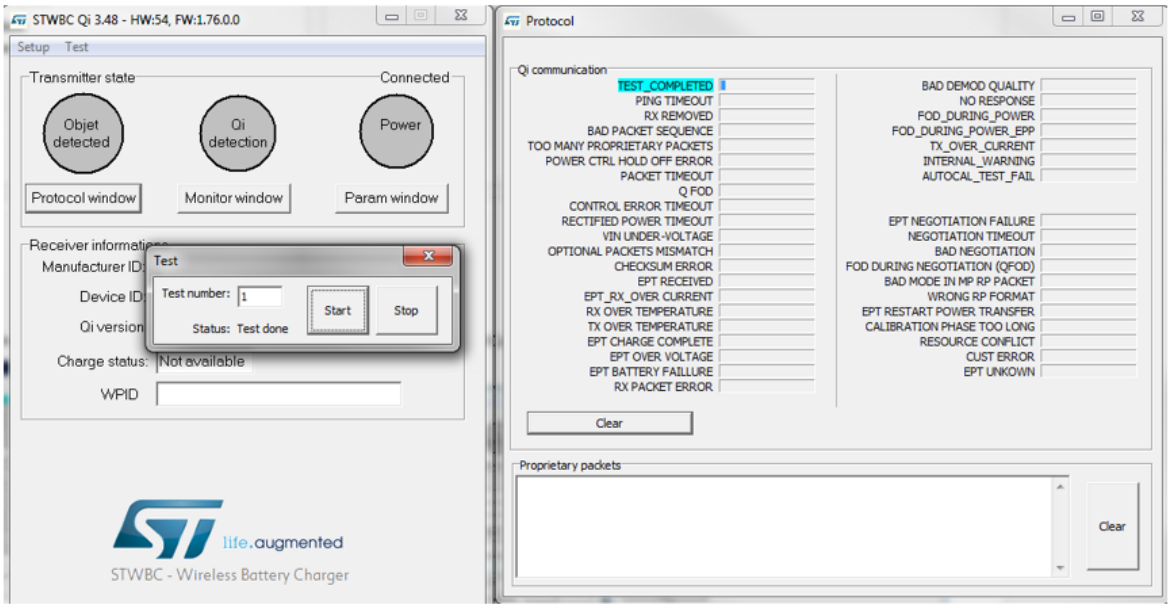
4.4.1 Presence detection Calibration Procedure

Figure 23. **Presence detection test**



You set the test number with 1 and you click the START button.

Figure 24. **Test result**

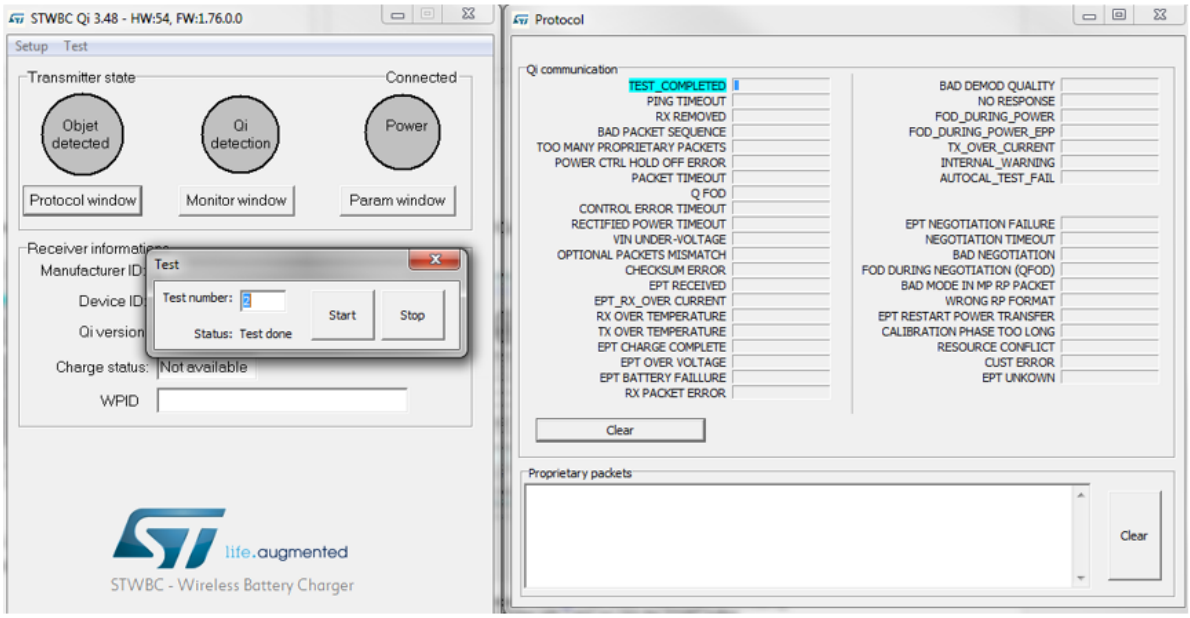


At the end of the test, in the protocol window, the TEST_COMPLETED is set and in the test window the status is Test Done.

If it is not the case, please start the test again.

4.4.2 QFOD Calibration Procedure

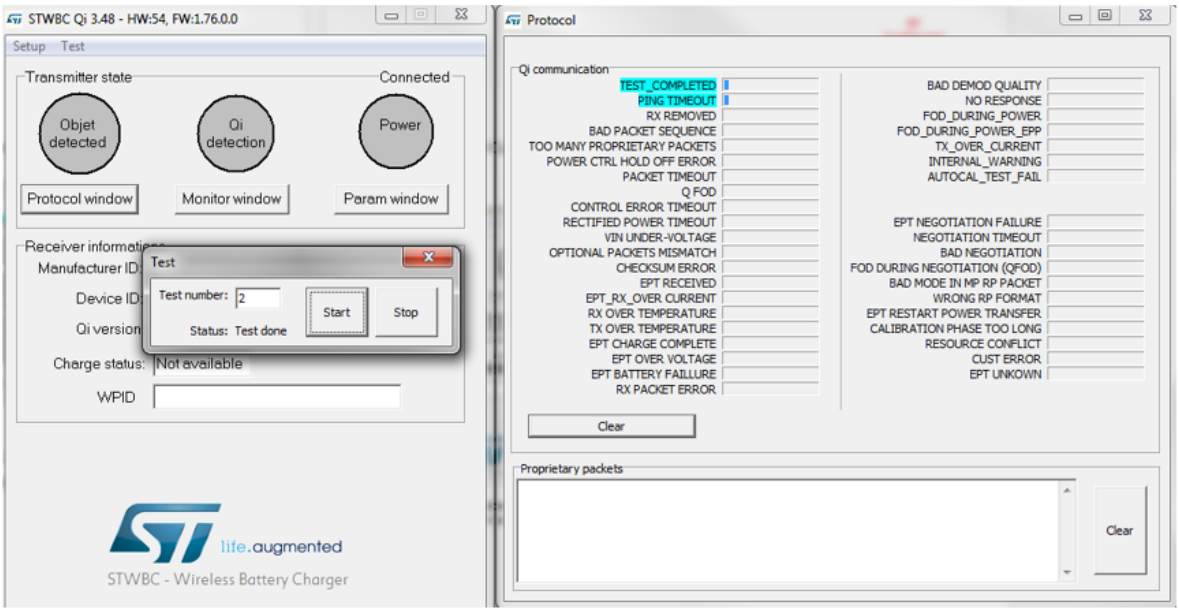
Figure 25. **QFOD test**



On Protocol windows – click “Clear” button – “TEST_COMPLETED” field is cleared”

You set the test number with 2 and you click the START button.

Figure 26. **Test result**



At the end of the test, the TEST_COMPLETED is set in the protocol window and the status is “Test done” in the test window

If it is not the case, please start the test again.

4.5 Efficiency

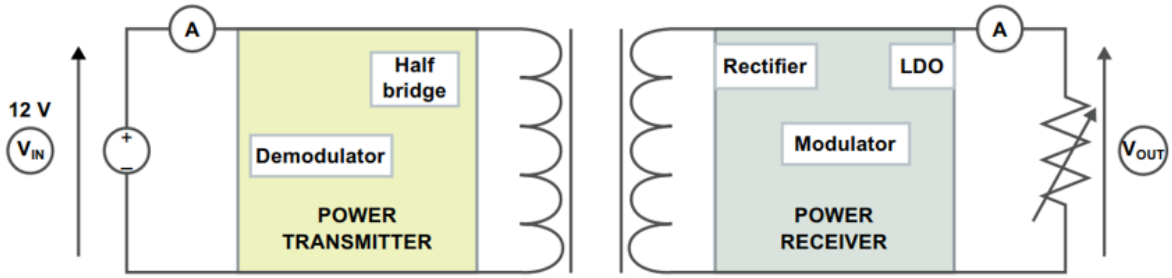
Efficiency measurements are done on a Qi certification tester.

EVALSTWBC-EP Transmitter is supplied by 12V/2A and receiver voltage level is 12V (MP1B).

Pout is the actual output power measured at the output of the receiver and Pin is the input power.

Efficiency is measured with the below set up configuration:

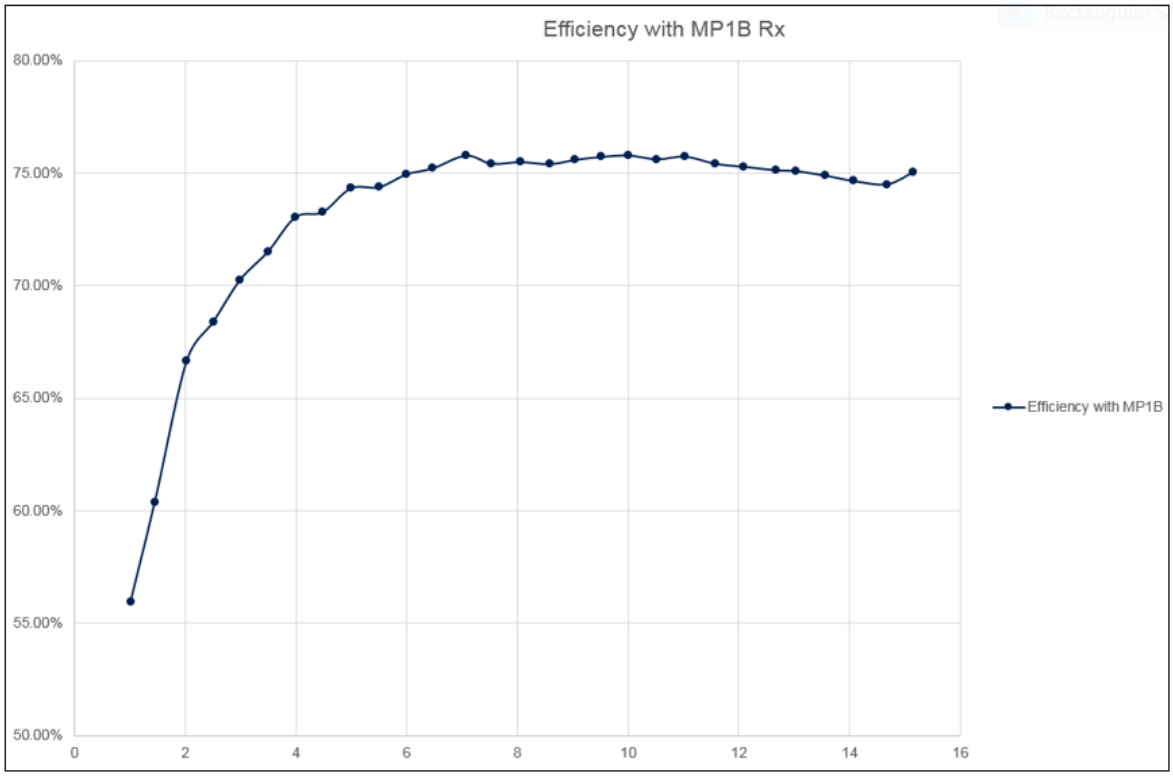
Figure 27. **Efficiency set up**



Below are the typical efficiency performances on the different coils. Efficiency=Pout/Pin:

Here, max efficiency is 76% at 10 W

Figure 28. **Efficiency performances**



4.6 Standby consumption

In Standby, when supplied at 12V, very low power consumption is achieved.

In this mode, device detection is still ensured; power consumption is reduced down to 1.4 mA in average. EVALSTWBC-EP reference board can demonstrate a low standby power of only 17 mW.

To measure such low power consumption, the UART cable must be unplugged and low power mode must be enabled into the STWBC-EP parameters.

5 Firmware download and update procedure

Even if the demo board comes with the firmware already downloaded into the STWBC-EP, the following section describes the procedure to download and update the firmware if needed.

To download the firmware to the board, the GUI software must be installed as described in chapter 4. This software allows also the user to have a complete monitoring of the board using UART signals. To use the STSW-STWBCGUI, UART signals must therefore be accessible.

If you experience problems, you can use ST-LINK and STVP software to erase the STWBC-EP Flash memory.

Important note: Board calibration must be done with STWBC GUI after each firmware download!!

5.1 Firmware download with STSW-STWBC GUI software

This procedure describes the firmware download through UART using the STSW-STWBCGUI.

The download contains 3 files included in a single cab file

5.1.1 Firmware update procedure (chip already programmed)

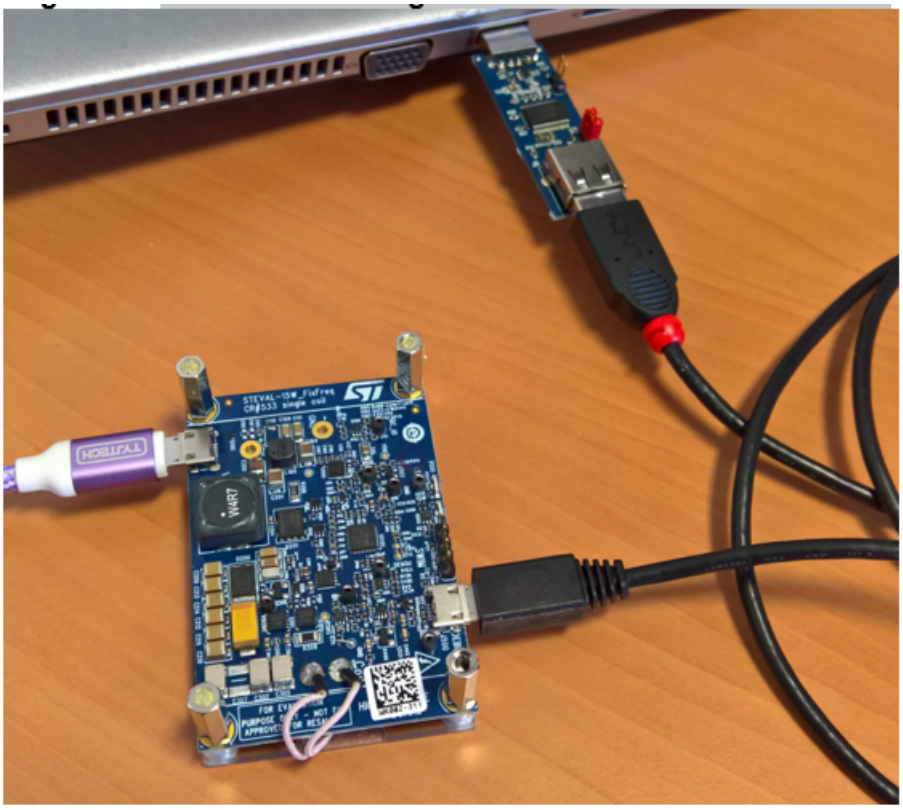
The EVALSTWBC-EP is delivered with pre-installed firmware. Follow the steps below to update it:

1. Click on the following link and download the FW binary CAB file onto your PC: https://www.st.com/en/embedded-software/stsw-stwbc-ep.html
2. Supply the transmitter board with a power supply set to 12V.
3. Connect the USB to UART dongle to the transmitter board.

Figure 29. Dongle connection

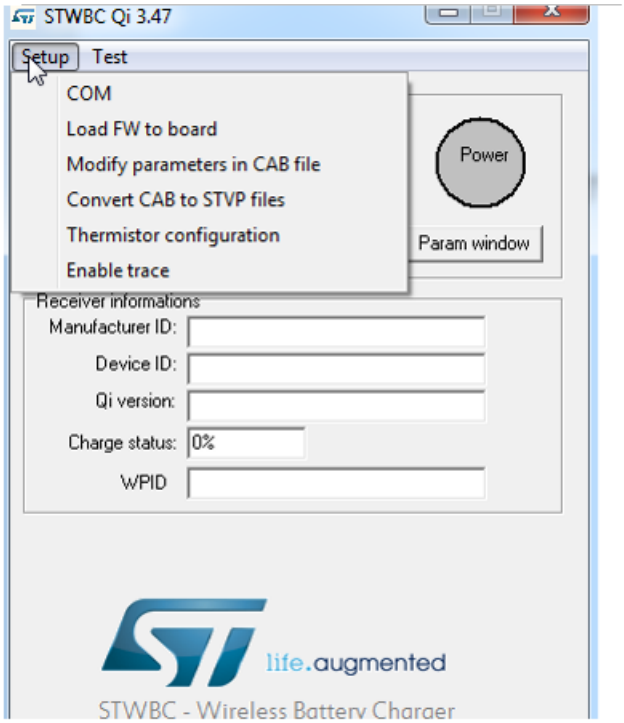
4. The UART RX/TX signals of the STWBC-EP are accessible on J500 connector of the transmitter board.

Figure 30. **USB to UART dongle to EVALSTWBC-EP connection**



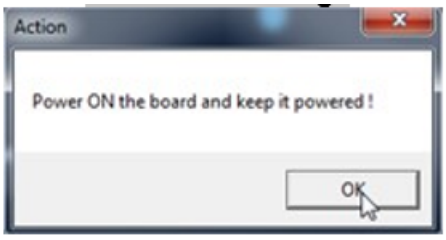
5. From the STWBC GUI, select Load FW to board from the setup menu.

Figure 31. **Firmware download with STSW-STWBCGUI**



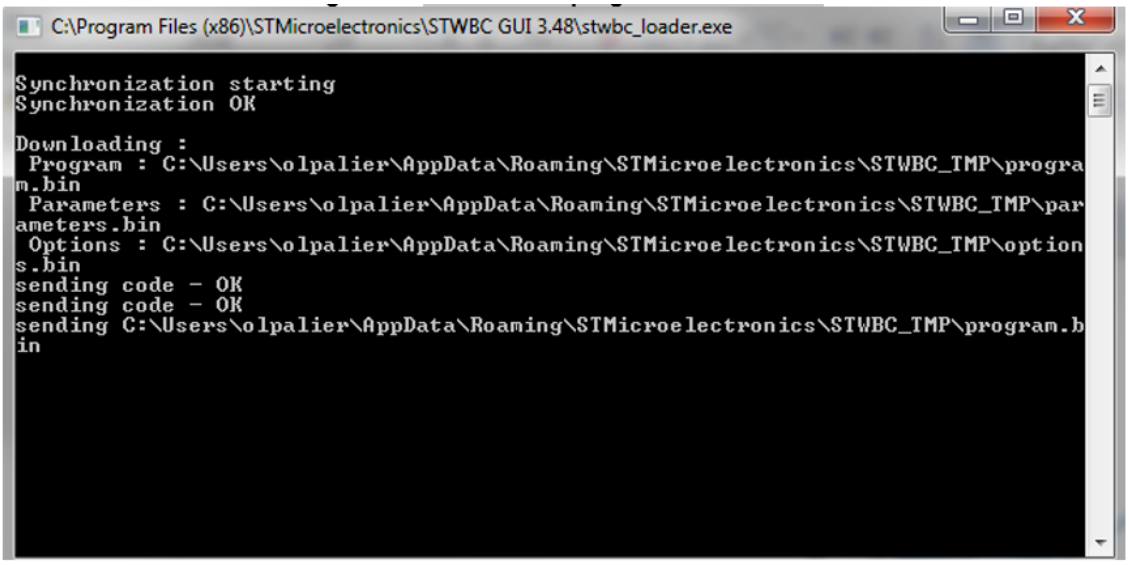
6. As prompted, select the CAB file containing the Firmware to download.
7. As prompted, power on the board and keep it powered.

Figure 32. Power on message



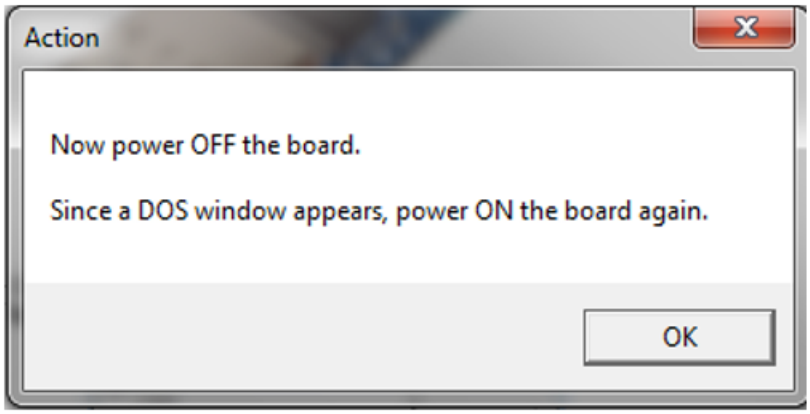
8. You can follow the download progress in the DOS window.

Figure 33. Download in progress



9. Power off the board when prompted.

Figure 34. DOS window message



10. Run the calibration procedure described in section 4.4. In case of problem in downloading the firmware through UART (for example, firmware corruption during update), refer to the section 5.2

5.1.2 Download procedure with a new chip (never programmed)

If for some reason, the STWBC-EP is replaced, it will not have been programmed previously, so Download mode is enabled by default.

1. Connect the USB to UART dongle to the computer and to the transmitter board (see figures 29 and 30)
2. From the STWBC GUI, select Load FW to board from the setup menu (see figure 31)
3. As prompted, select the CAB file containing the Firmware to download
4. Supply the board with 12V and keep it powered
5. As prompted, now power off the transmitter boar
6. When the DOS window appears, power the transmitter board on by connecting 12V power supply on J100 connector.
7. You can follow the download progress in the DOS window. Power off the board when prompted.

5.2 Erasing firmware procedure using STVP

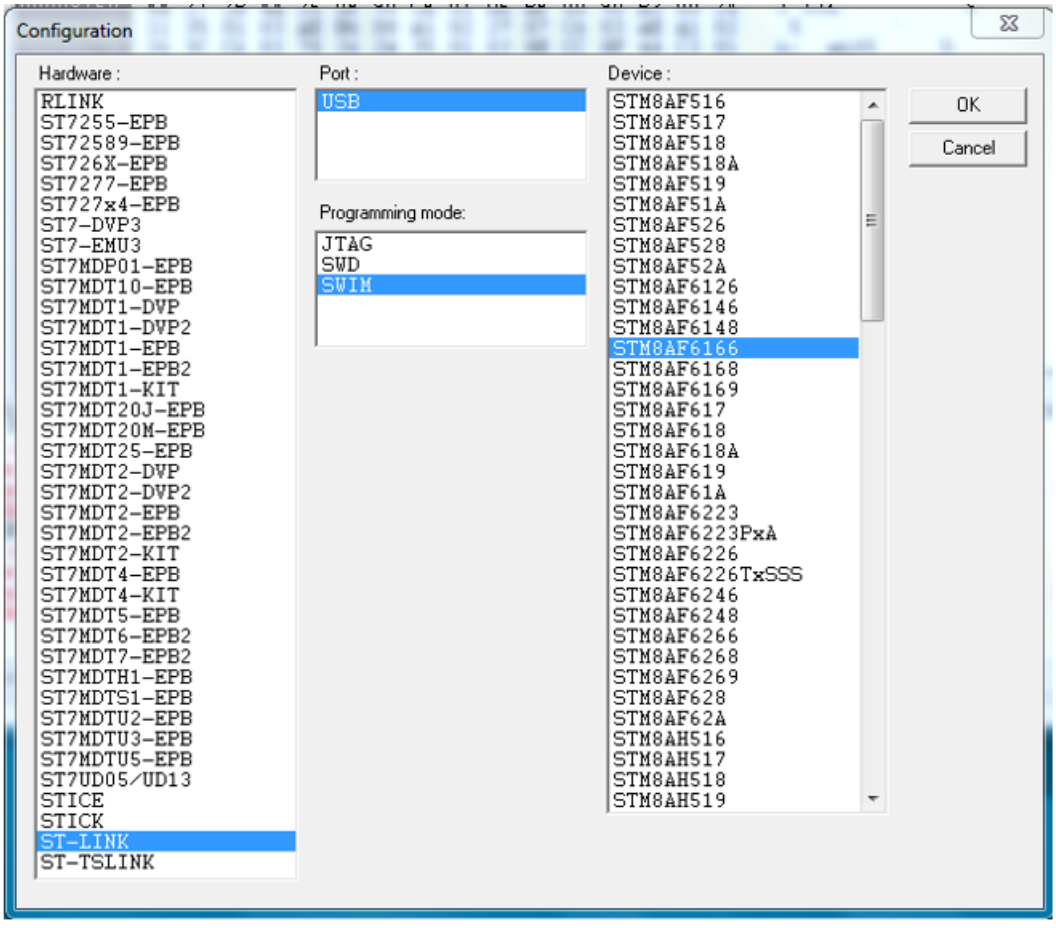
This procedure describes the firmware erasing procedure using STVP. It has to be used in case of problem on the board (e.g. firmware corruption during update)

5.2.1 Requirements

- ST-LINK USB Driver installed.
- STVP programming tool (available on www.st.com)
- ST-LINK hardware tools

You also have to configure STVP as shown below:

Figure 35. Configuration of STVP

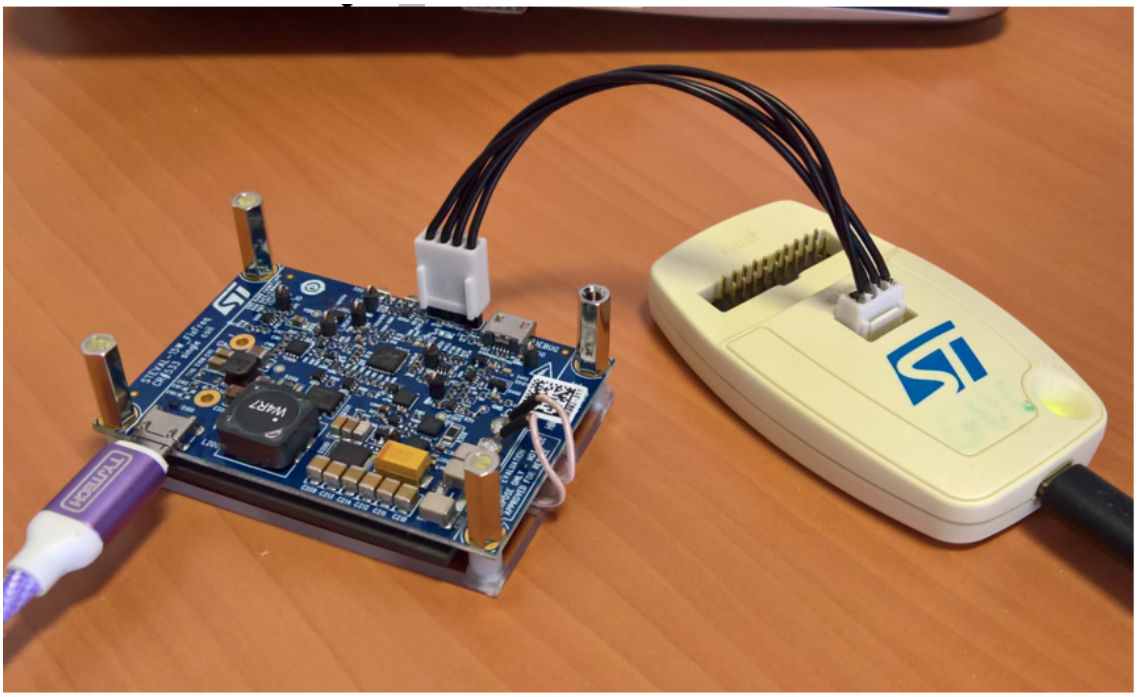


5.2.2 Procedure

1. Power the target off
2. Power the target on
3. Connect ST-LINK circuit to PC via USB
4. Connect ST-LINK-SWIM cable to the target

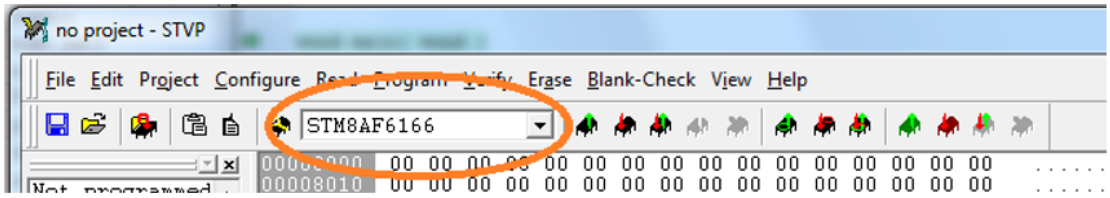
   Pay special attention to connect the SWIM cable to the transmitter board correctly, as shown below

Figure 36. ST-LINK connection on the board



5. Launch STVP program
6. Select STM8AF6166 core

Figure 37. STVP Core selection



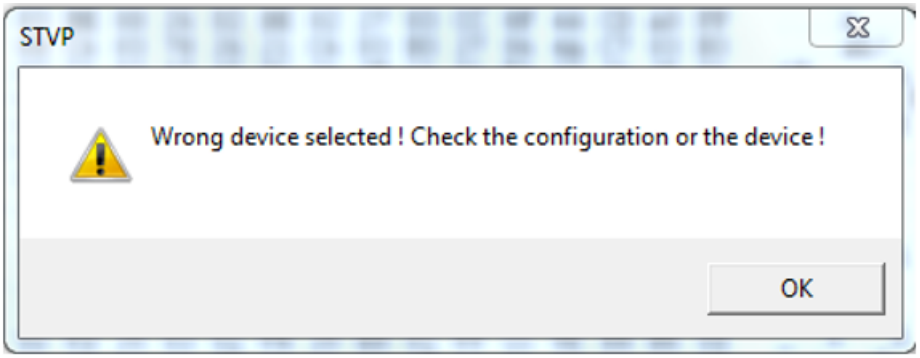
Do not load any program into Ram area of STVP program : as all bits will be erased (load 00 00 00 …)

7. Transfers the ”00 00” into STWBC-EP through the SWIM interface using the appropriate push-button.

Figure 38. **STVP download**

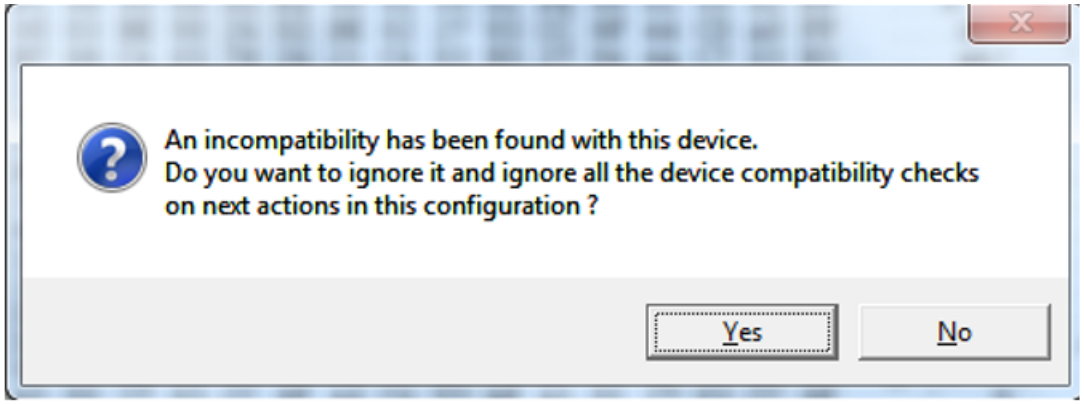
8. Click OK if a “wrong device selected” alert appears

Figure 39. **STVP wrong device selected alert**



9. Click YES if “An incompatibility has been found with this device” query appears

Figure 40. **STVP incompatibility device action query**



10. After this operation, the programming procedure starts. At completion, the STVP informs the user that the program is loaded and verified
    - < PROGRAM MEMORY programming completed.
    - > Verifying PROGRAM MEMORY area...
    - < PROGRAM MEMORY successfully verified.
11. Exit STVP.
12. Disconnect SWIM
13. Remove power from the EVALSTWBC-EP transmitter board
14. Retry the UART download procedure if necessary.

5.3 Firmware download with command line

5.3.1 Firmware download with written chip

1. Create a dedicated directory with the following files:
   - STWBC_Loader.exe
   - stwbc_loader_not_empty.bat
   - enable_boot.bin
   - “the firmware version “.cab
2. From the STSW-STWBCGUI folder, call the "stwbc_loader_not_empty.bat" file from the command line.When you call the batch file, you must also specify:
   - COM number (e.g. COM2)
   - File name ("firmware name.cab")

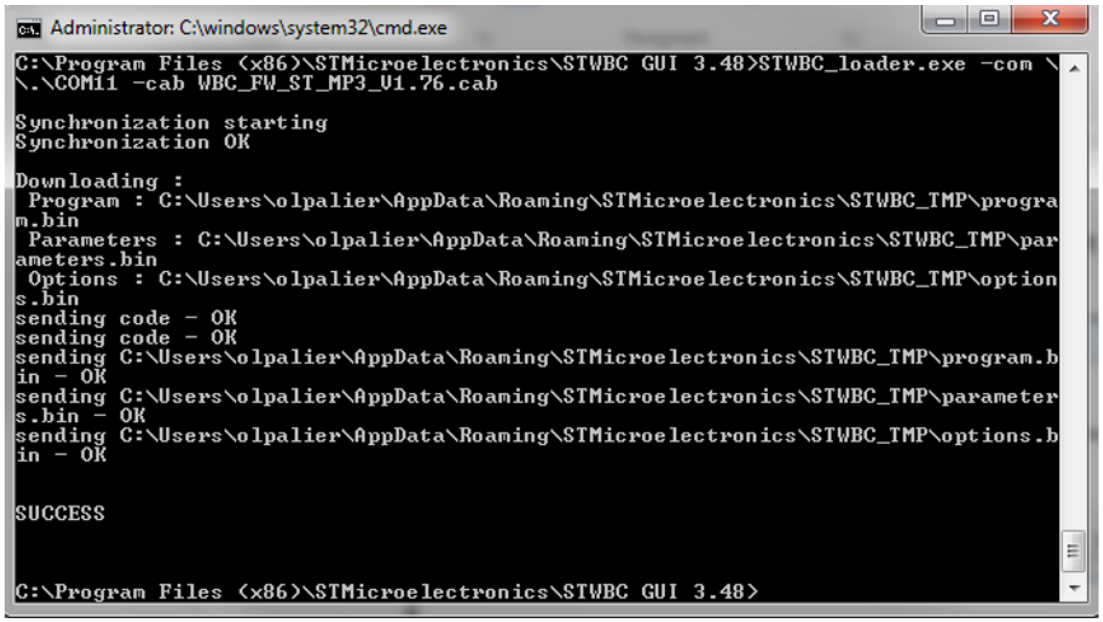
Figure 41. Command line

5.3.2 Firmware download with blank chip

If the STWBC-EP memory is erased, use the procedure below

1. Connect the UART cable to the board
2. From the STSW-STWBCGUI folder, execute the command line as shown in the example below, with the appropriate firmware file name and COM port.STWBC_loader.exe –com “COM port” –cab “firmware file

Figure 42. Command line with blank chip



Note: If the COM port is > COM8, the user needs to use the syntax \\.\COMx where COMx is the COM port number

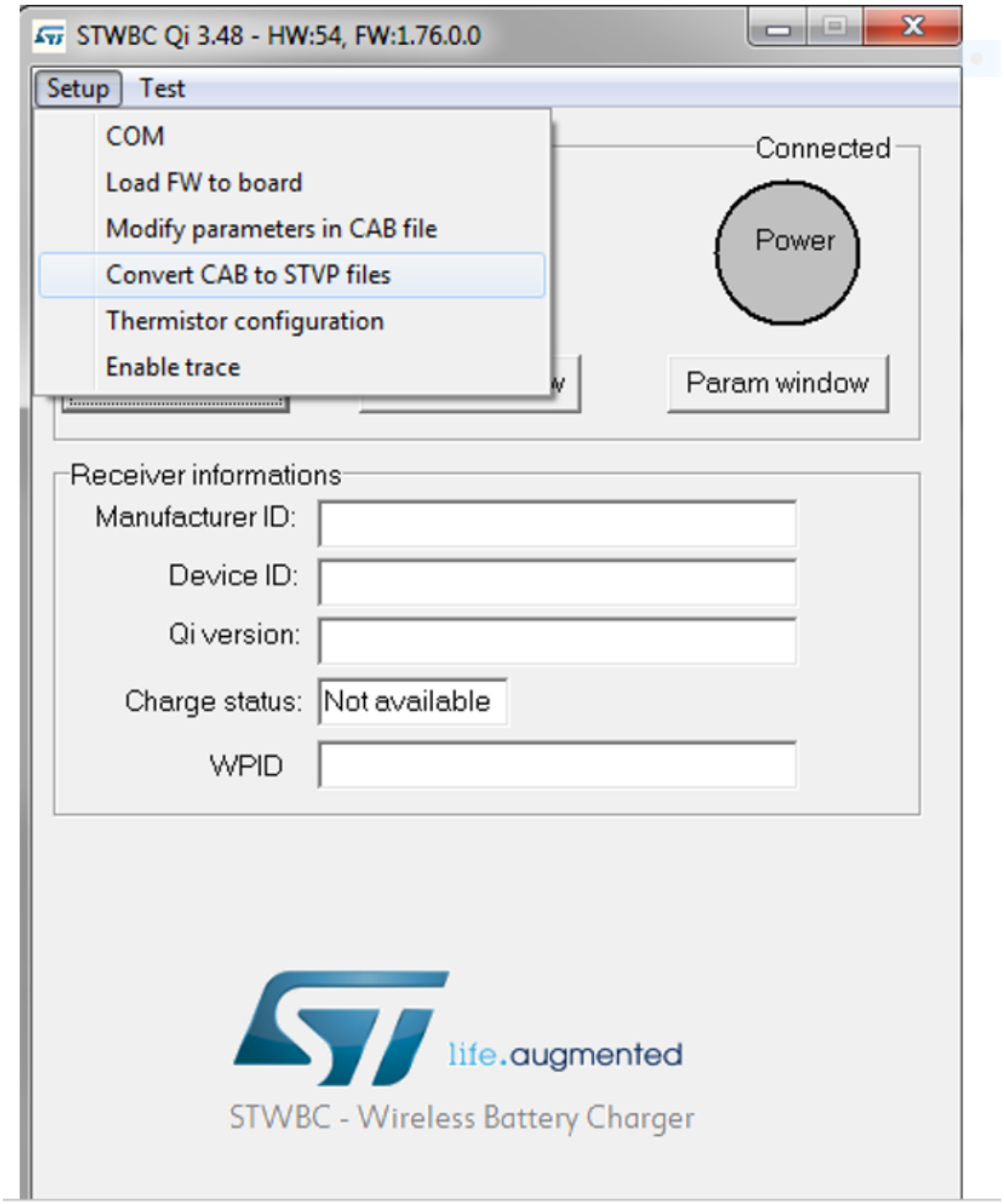
Note a dedicated tool is available for simultaneous downloads. Please refer to STSW-STWBCFWDT Firmware Downloader tool

5.4 STVP file creation to download with STVP

To use STVP to download board, you must generate new files from the *.cab.
The existing GUI gives you this possibility.

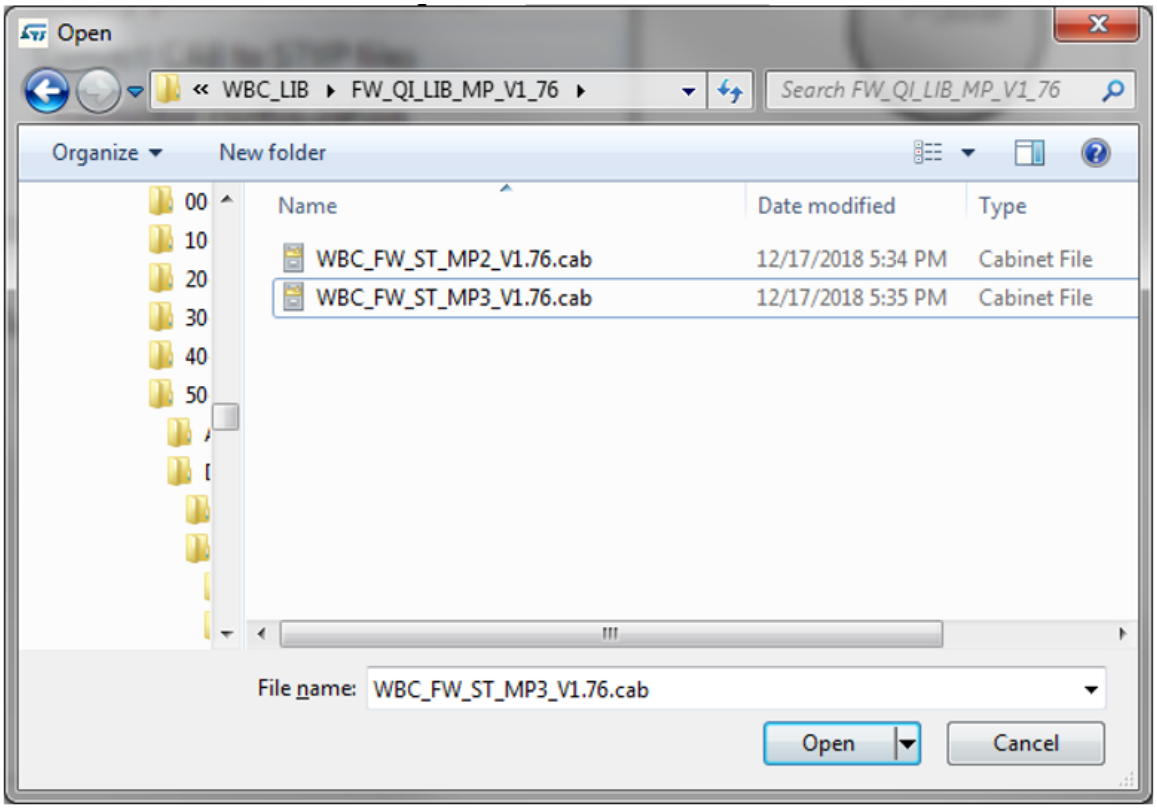
1. Select the convert CAB to STVP files command from the STWBC GUI Setup menu

Figure 43. Convert CAB file to STVP file



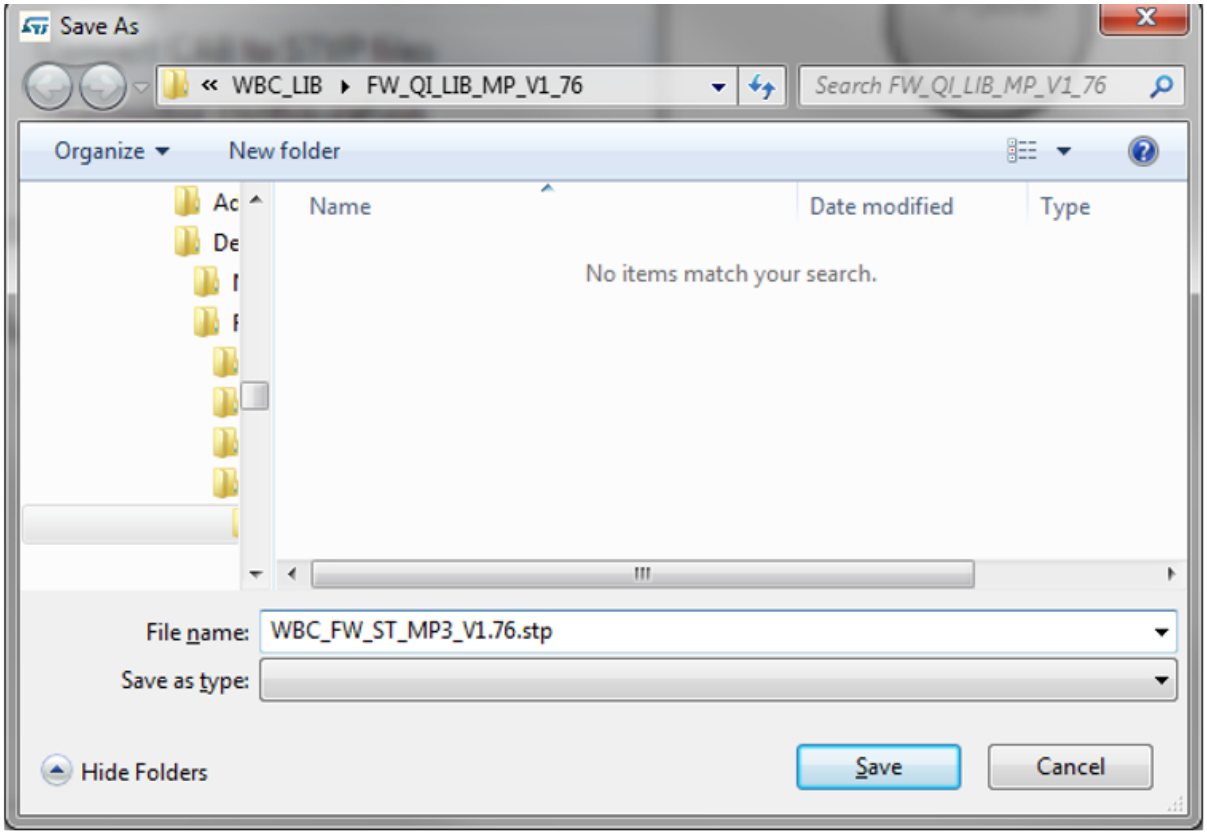
2. Follow the prompt to select the appropriate cab file

Figure 44. **CAB file to convert**



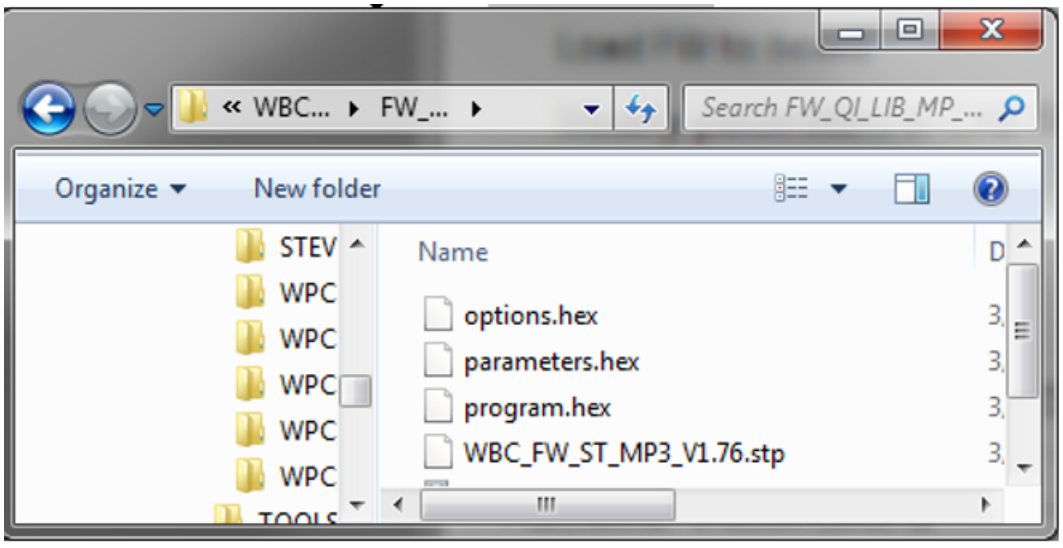
3. Follow the prompt to provide the project file name

Figure 45. **STVP files name**



Four files will be generated as described below

Figure 46. **STVP files name**



Note: Refer to STSW-STWBCFWDT STWBC firmware downloader tool for further details

5.5 Firmware download with STVP

Follow the procedure below to download firmware using the STVP software program.

Note: You can also install and use the IAR toolchain to compile and download firmware.

Step 1. Target power OFF.

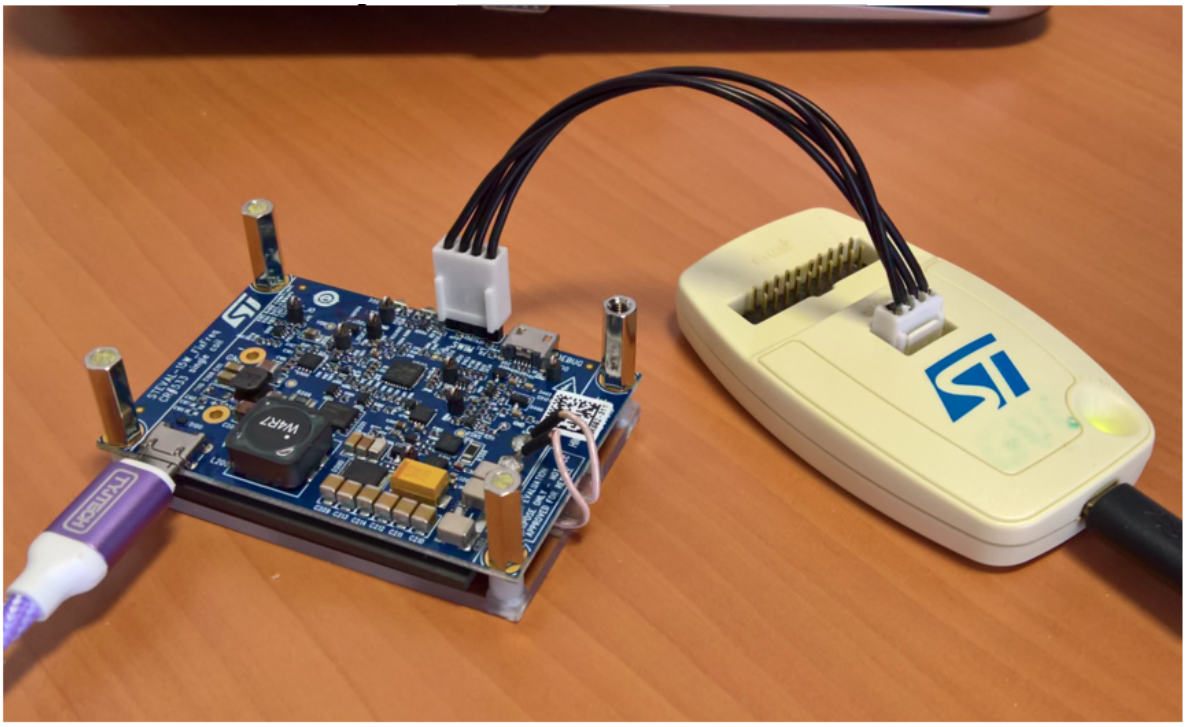
Step 2. Target power ON.

Step 3. Connect ST-LINK circuit to the PC via USB.

Step 4. Connect the ST-LINK–SWIM cable to the target.

Pay special attention to ensure that the SWIM cable is correctly connected to the transmitter board. Refer to the figure below.

Figure 47. ST-LINK connection on the board



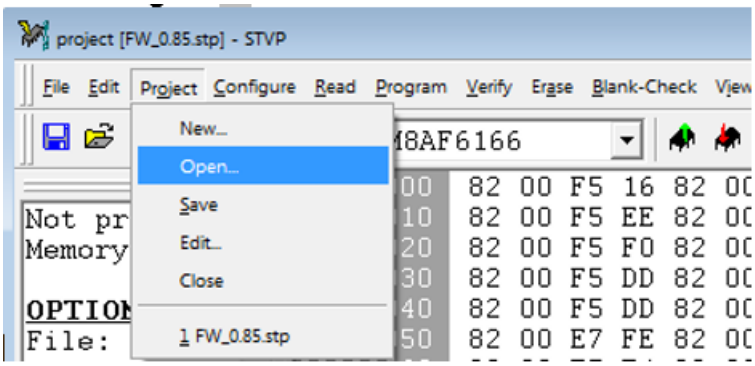
Step 5. Launch STVP program

Step 6. Select STM8AF6166 core

- ***See figure 37 STVP core selection***

Step 7. In STVP, open the “**Project**” menu, then click “**Open**”. Select the .stp given in the zip file

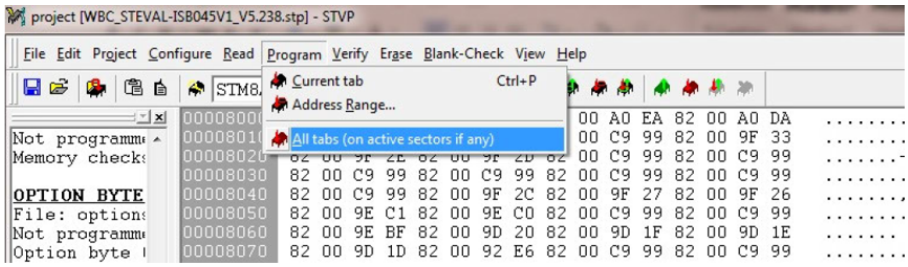
Figure 48. **STVP file selection**



Step 8. After a few seconds, the following message should appear :
Loading file program.hex in PROGRAM MEMORY area.....
< File successfully loaded. File Checsum

Note: it is normal that some warnings appear:
> Loading file options.hex in OPTION BYTE area...
FILE : line 2: Address 0x4802 is out of range and is ignored!
FILE : line 2: Address 0x4802 is out of range and is ignored!
Step 9. In STVP, select [Program]>[All tabs (on active sectors, if any)]

Figure 49. **STVP download**



Step 10. Click [OK] if the following message appears

- ***See figure 39 STVP wrong device selected alert***
-

Step 11. Click [Yes] if the following message appears

- ***See figure 40* STVP incompatibility device action query**
-

Step 12. After this operation, the programming procedure starts.
Step 13. On completion, the following message appears:
< PROGRAM MEMORY programming completed.
> Verifing PROGRAM MEMORY area...
< PROGRAM MEMORY successfully verified.
Step 14. Exit the STVP software program.
Step 15. Disconnect the SWIM cable.
Step 16. Power OFF the transmitter board.

6 Board assembly and layout

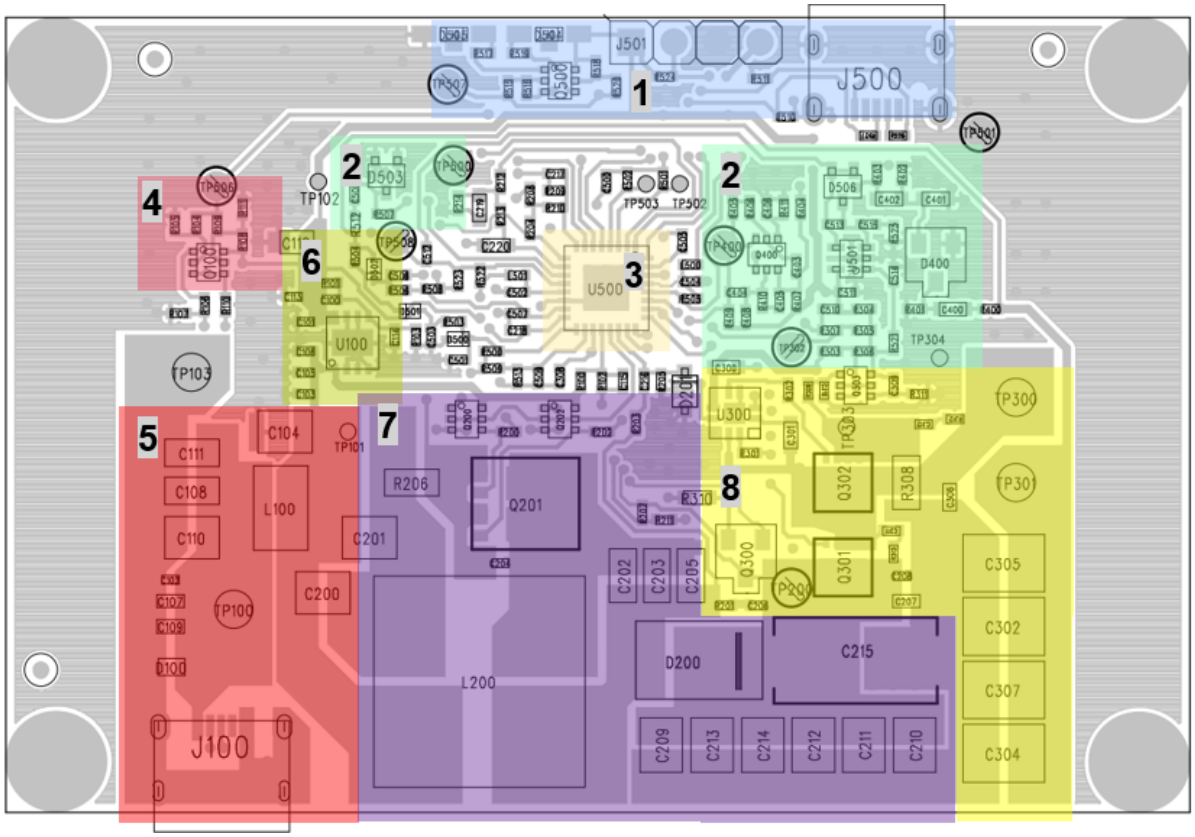
The EVALSTWBC-EP evaluation board is designed using a low cost 2-layers PCB with all the components on the top side.

The test points allow the user to evaluate the STWBC-EP solution with probes.

In addition, UART is accessible through a micro USB connector and SWIM is routed to a header connector.

1. LED, SWIM and USB/UART debug connectors
2. Voltage, current and phase demodulation circuits
3. STWBC-EP
4. Quick charge circuit
5. Power supply connection and input filtering
6. LDO
7. Sepic: coil and power ircuit
8. Half bridge: gate driver, bridge mosfets, tank capacitor and coil

Figure 50. EVALSTWBC-EP evaluation board functional blocks



6.1 Design Routing detail, layout highlights

Figure 51. EVALSTWBC-EP layer 1

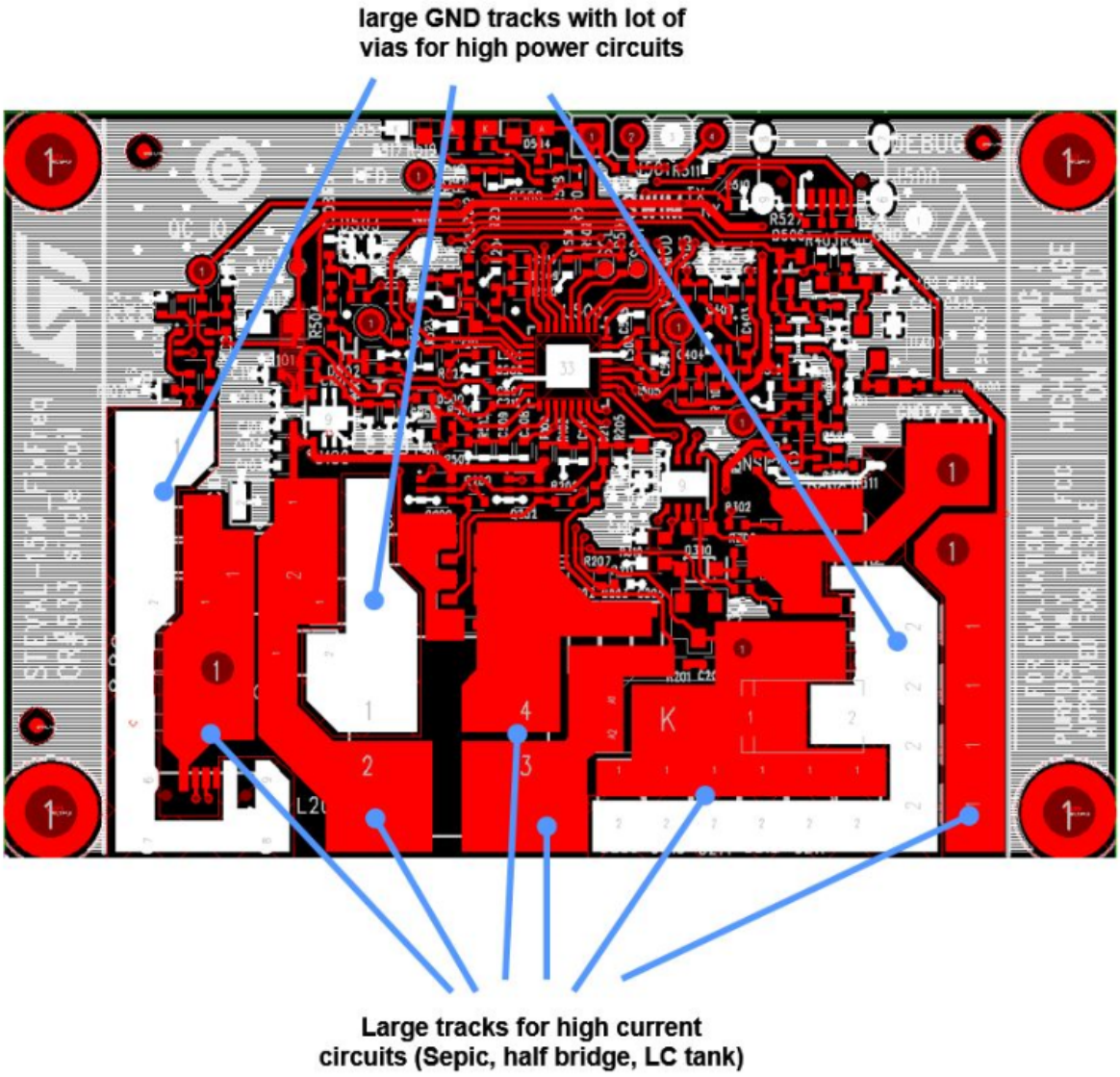
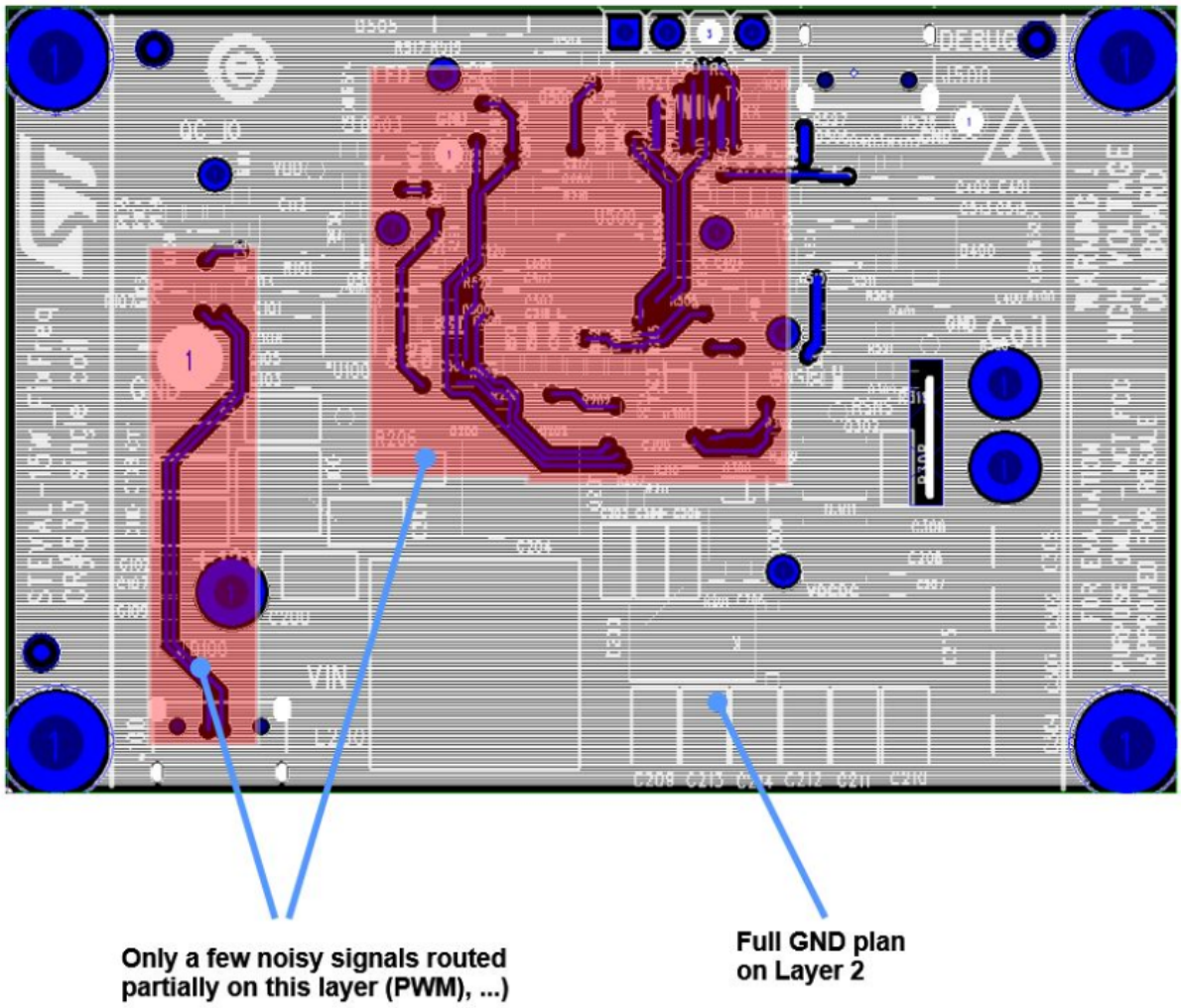


Figure 52. **EVALSTWBC-EP layer 2**



6.2 Design EMI components

EMI and filtering components must be placed close to supply input & L100

See below ceramic capacitors (C107, C102, C108, C109, C110, C111) and L100 power inductor

Figure 53. **Input voltage**

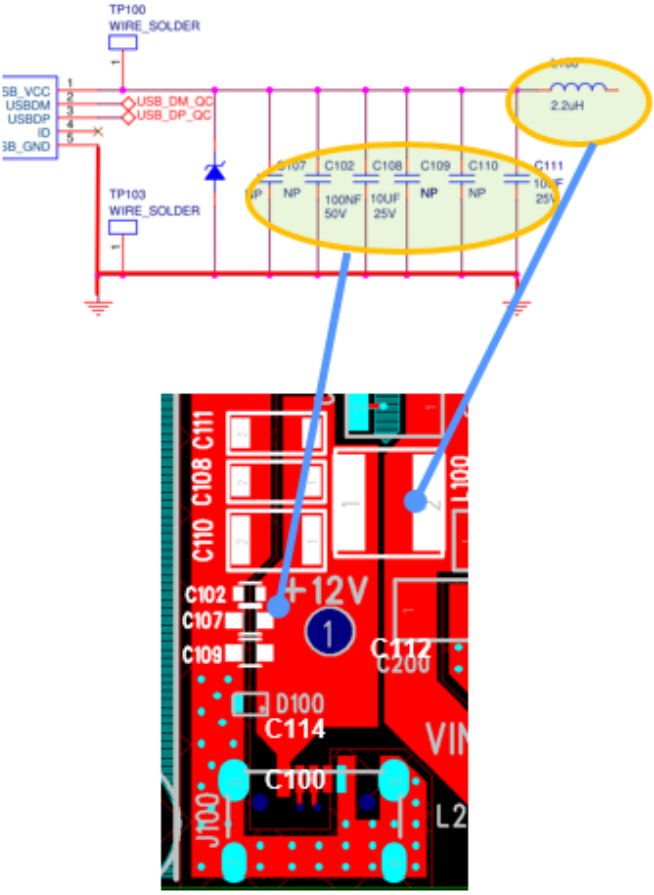


Figure 54. **SEPIC output voltage**

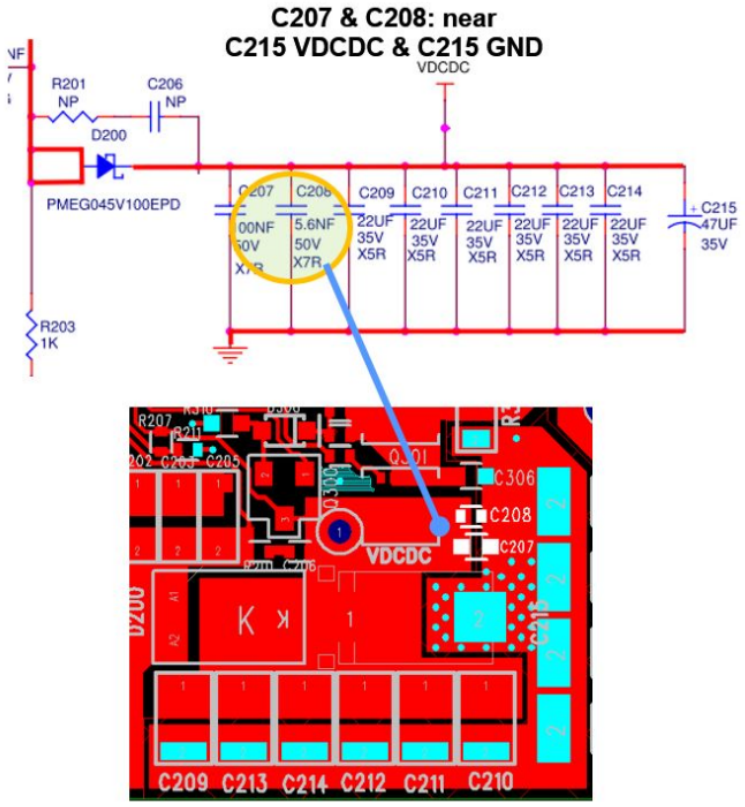
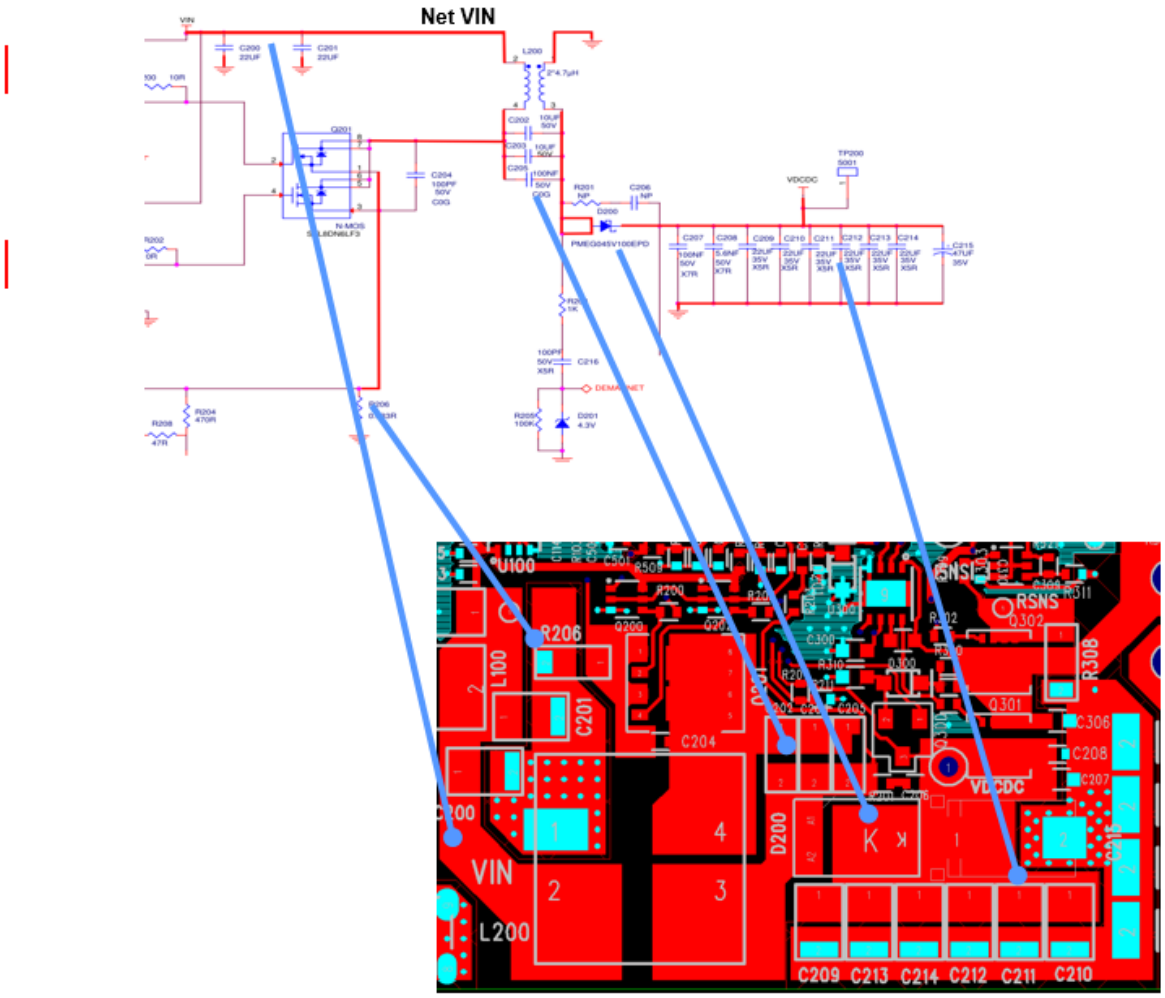


Figure 55. **Bridge node**

6.3 Design SEPIC

SEPIC signals are designed on the same layer tracks must be wider (> 2 mm) for high current.
Components are placed not too far from the input voltage connection, and very closely to avoid long tracks

Figure 56. **SEPIC power paths**



6.4 Design SEPIC GND

There are 2 dedicated area for GND connection on Sepic circuit

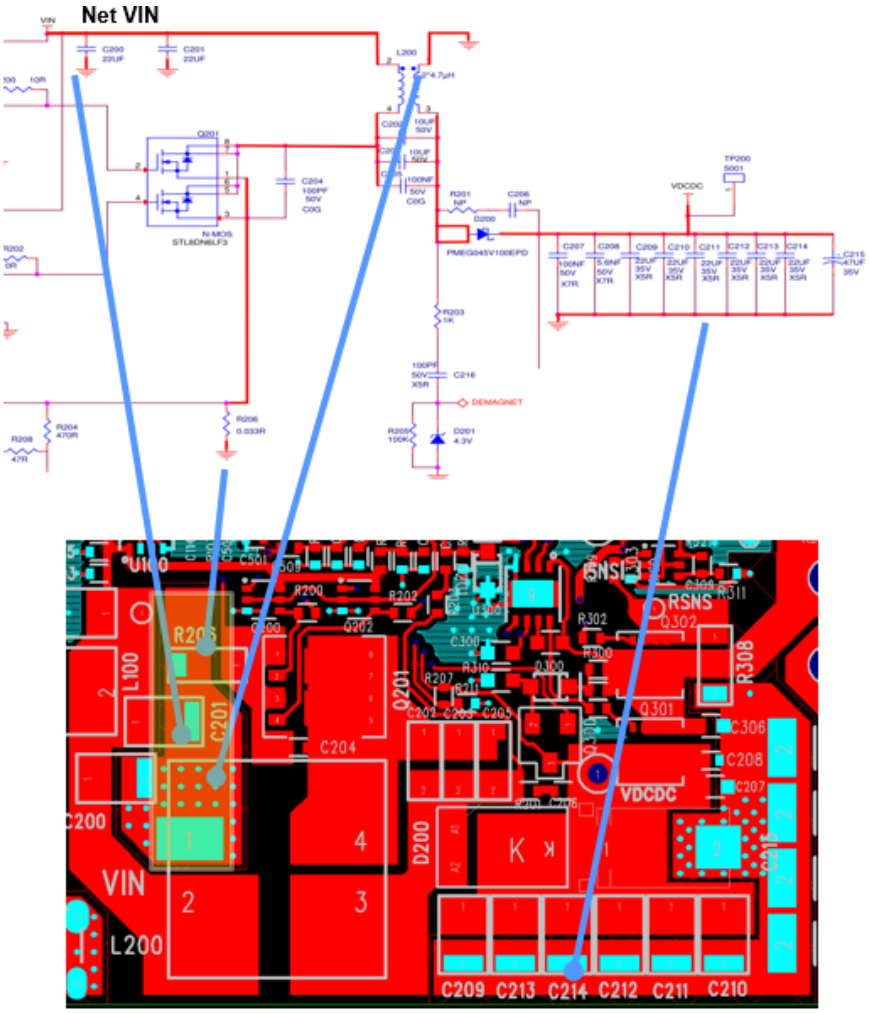
A dedicated GND plan on layer 1 shared between Vin (C200/C201), R206 and L200. This is mandatory for good circulating current. Many vias are located in one single area.

A dedicated GND plan on layer 1 for SEPIC output GND, shared with half bridge power node GND.

Many vias are located in one single area.

General idea is to keep the current loop from the SEPIC as small as possible.

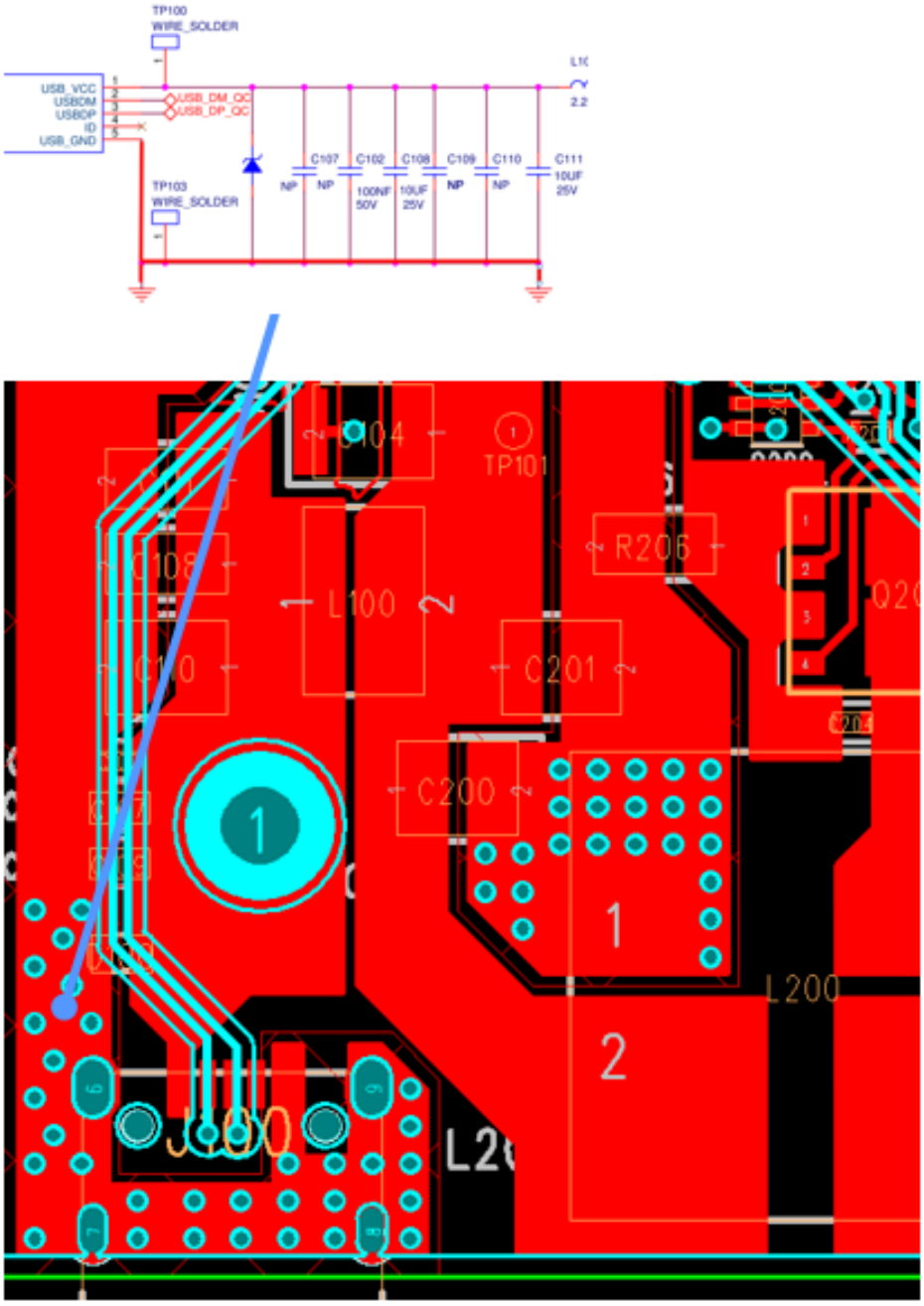
Figure 57. **Input and Sepic GND connections**



6.5 Design Power input GND

GND is directly connected to TP103 & Capacitors
Dedicated GND plane on TOP (not connected to noisy GND plane on TOP) for EMI filtering.
Lots of vias

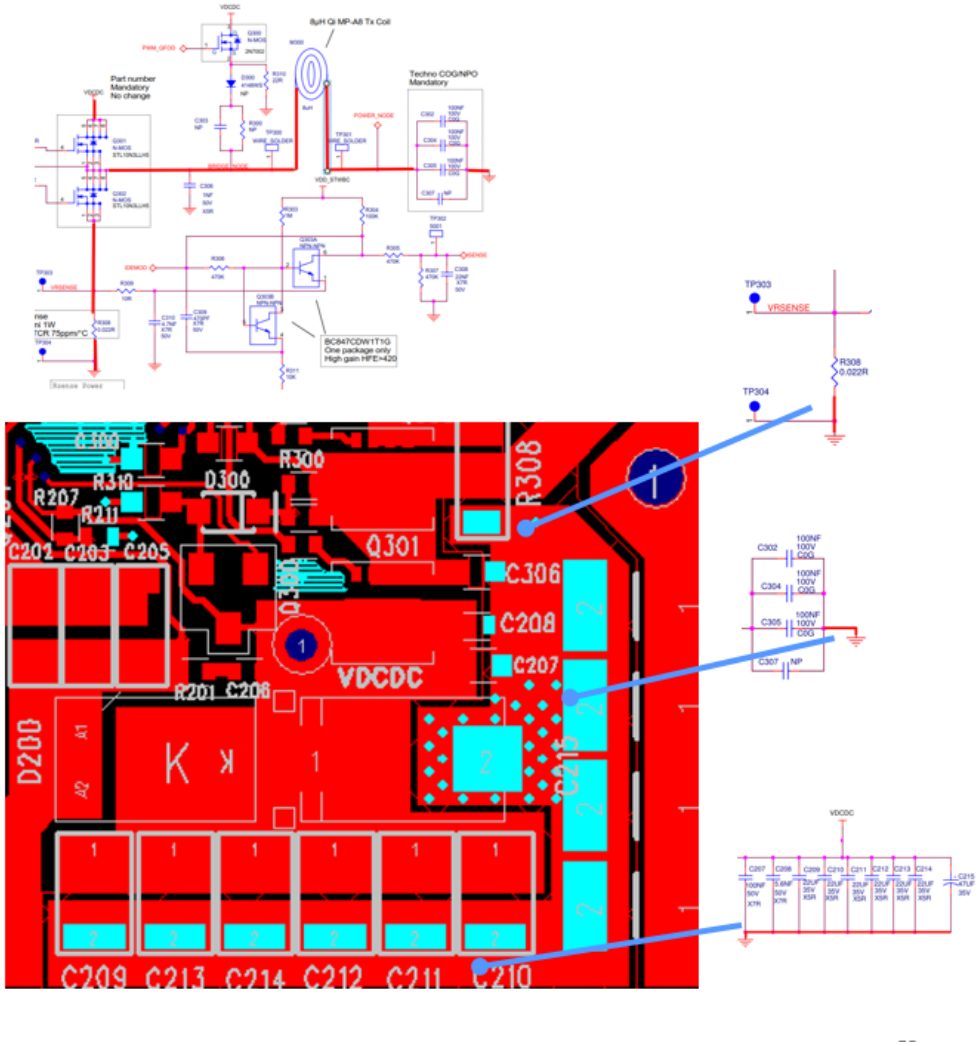
Figure 58. **Input power GND connection**



6.6 Design Power bridge GND

SEPIC and LC tank capacitors GND are connected closely together with many vias into the same dedicated area. Rsense resistor R308 GND is connected near this power GND as well.

Figure 59. **Bridge power GND connection**

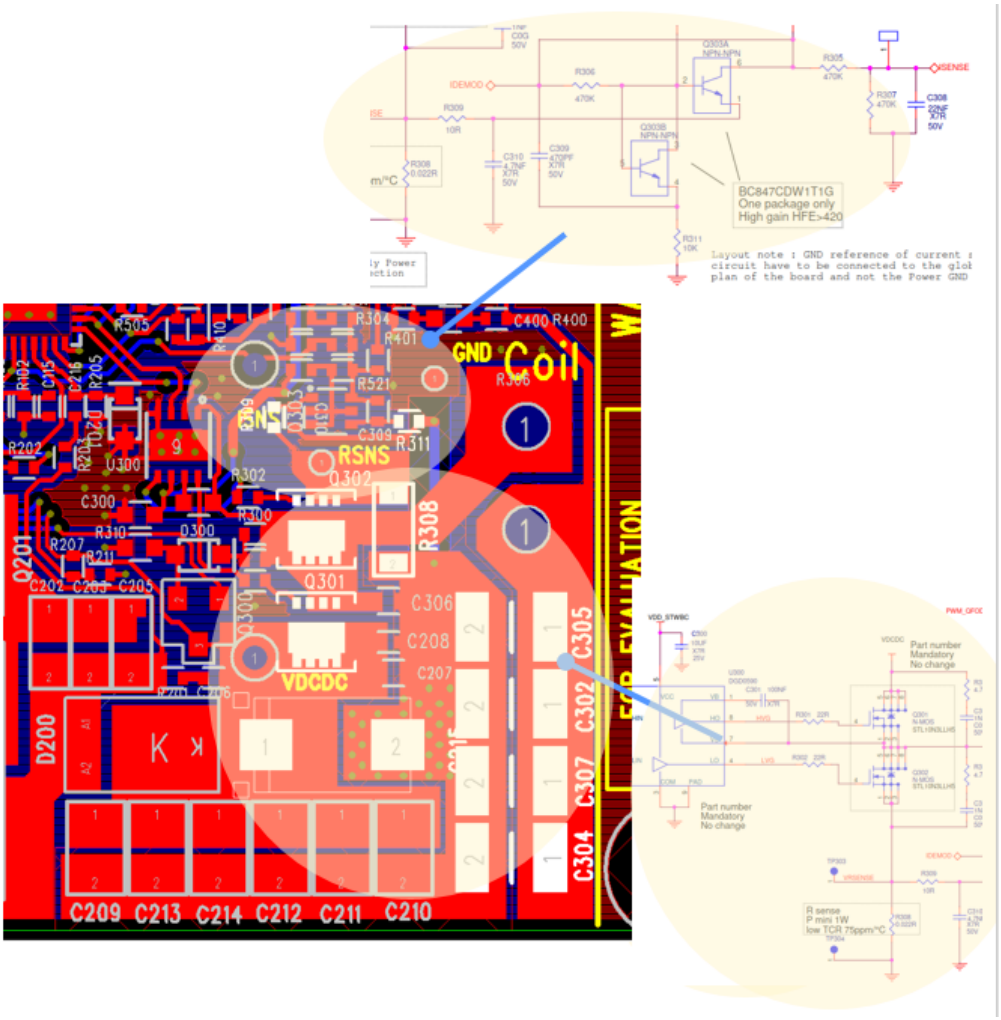


6.7 Design Bridge layout

Again, general idea is to keep the current loop from the bridge as small as possible.

- Current amplifier connection must be close to Rsense.
- Isense measurement is very sensitive so serial resistor on Isense (R305) must be close to STWBC-EP.
- Important note : GND of current amplifier is connected to general GND plan and not to power GND.

Figure 60. **Bridge components layout**



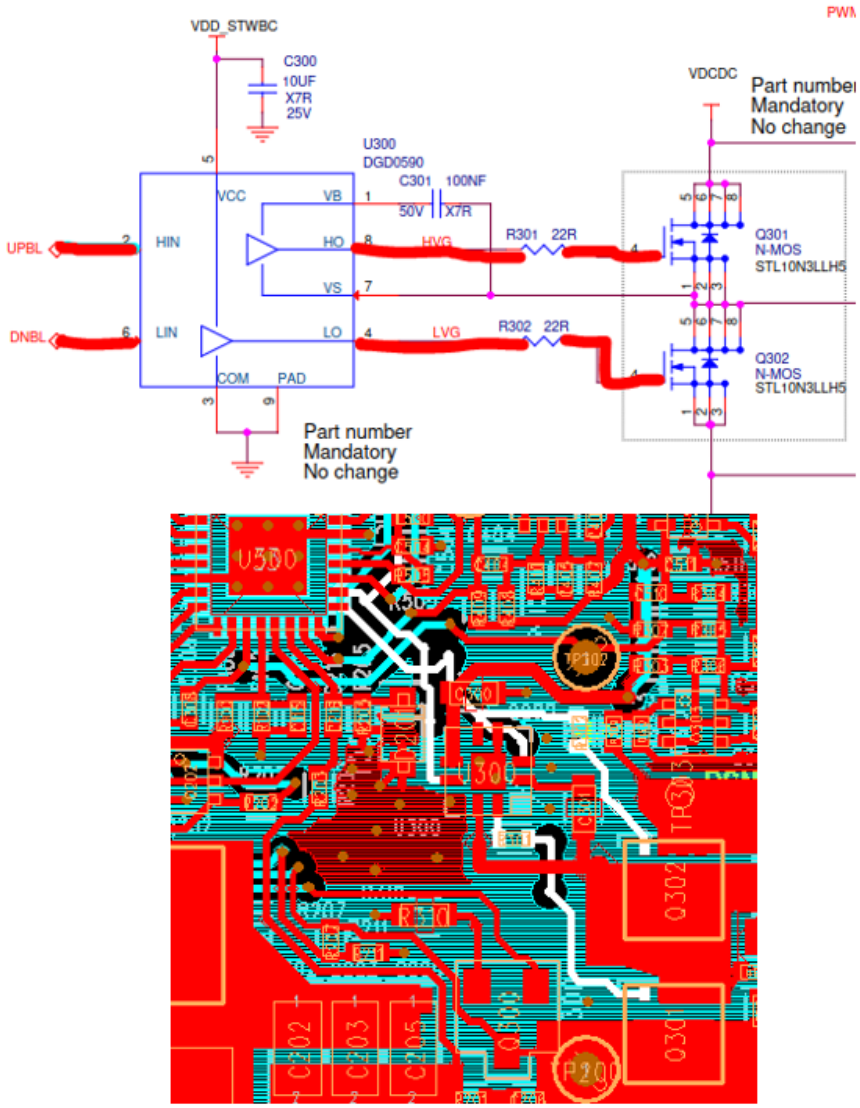
Large copper area used for power path (VDCDC, Bridge Node, Power Node, Rsense) to ensure good power dissipation and avoid power losses.

6.8 Design Bridge gate driver and mosfets

UPBL and DNBL are noisy PWM signals, and must be routed carefully.

Thus Gate driver U300 should be placed close to STWBC-EP and close to bridge mosfets Q301/Q302

Figure 61. **Bridge gate driver and mosfets**

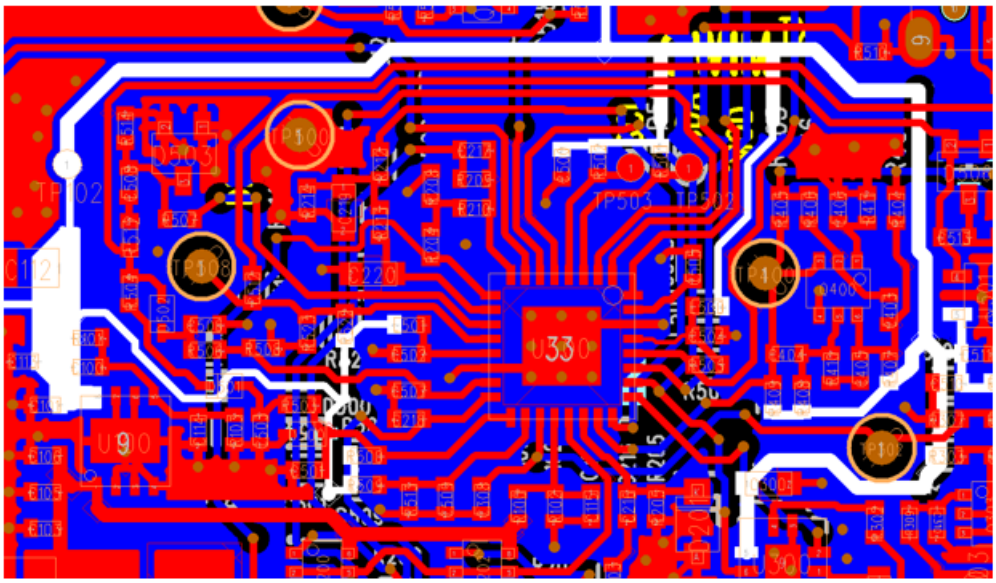


6.9 Design VDD_STWBC

VDD_STWBC tracks should be large enough to supply the following circuits:

- STWBC-EP
- LEDs
- Current op amplifier
- Bridge Gate driver

Figure 62. **VDD_STWBC routing**



7 Schematic diagrams

7.1 EVALSTWBC-EP schematic diagrams

Figure 63. **EVALSTWBC-EP circuit schematic (1 of 6)**

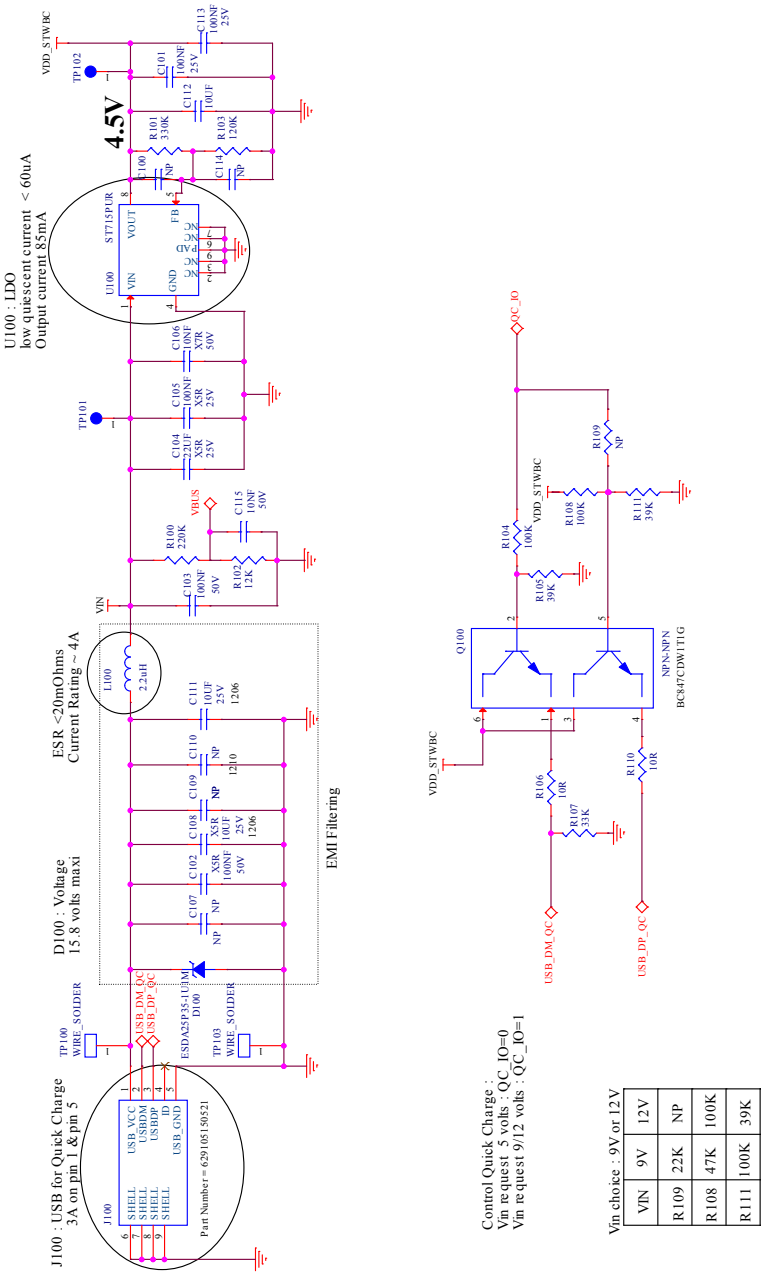


Figure 64. **EVALSTWBC-EP circuit schematic (2 of 6)**

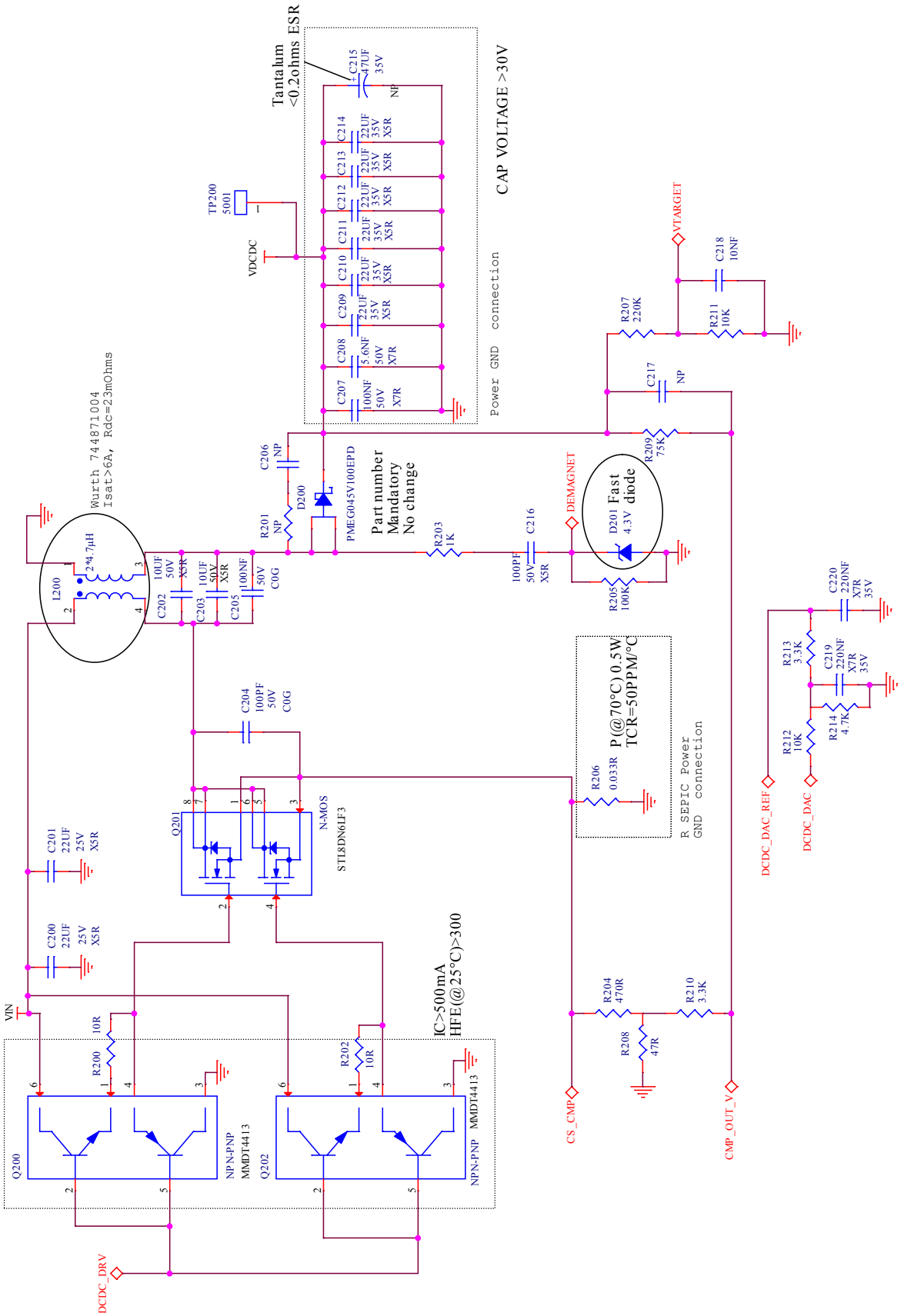


Figure 65. **EVALSTWBC-EP circuit schematic (3 of 6)**

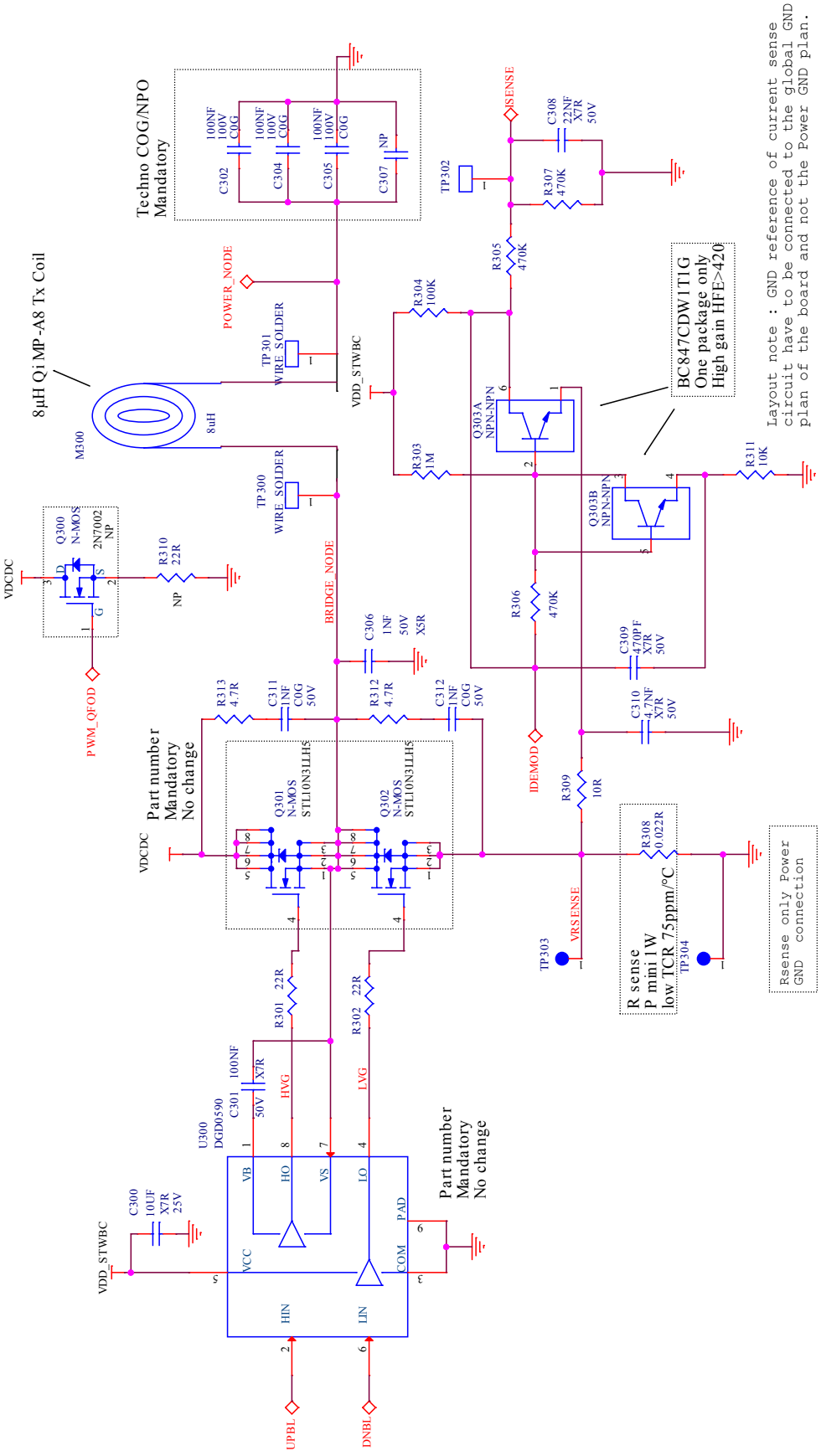


Figure 66. **EVALSTWBC-EP circuit schematic (4 of 6)**

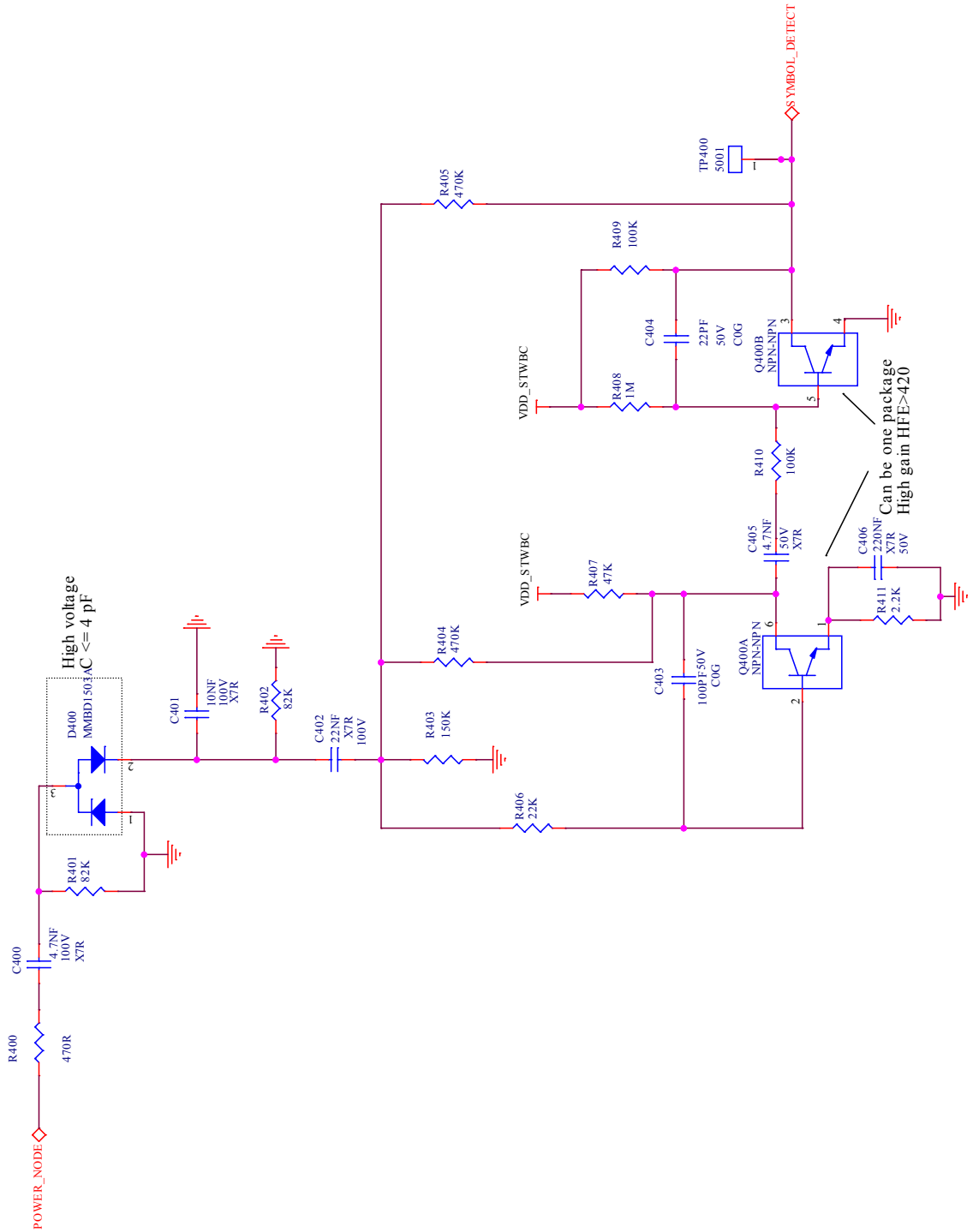


Figure 67. **EVALSTWBC-EP circuit schematic (5 of 6)**

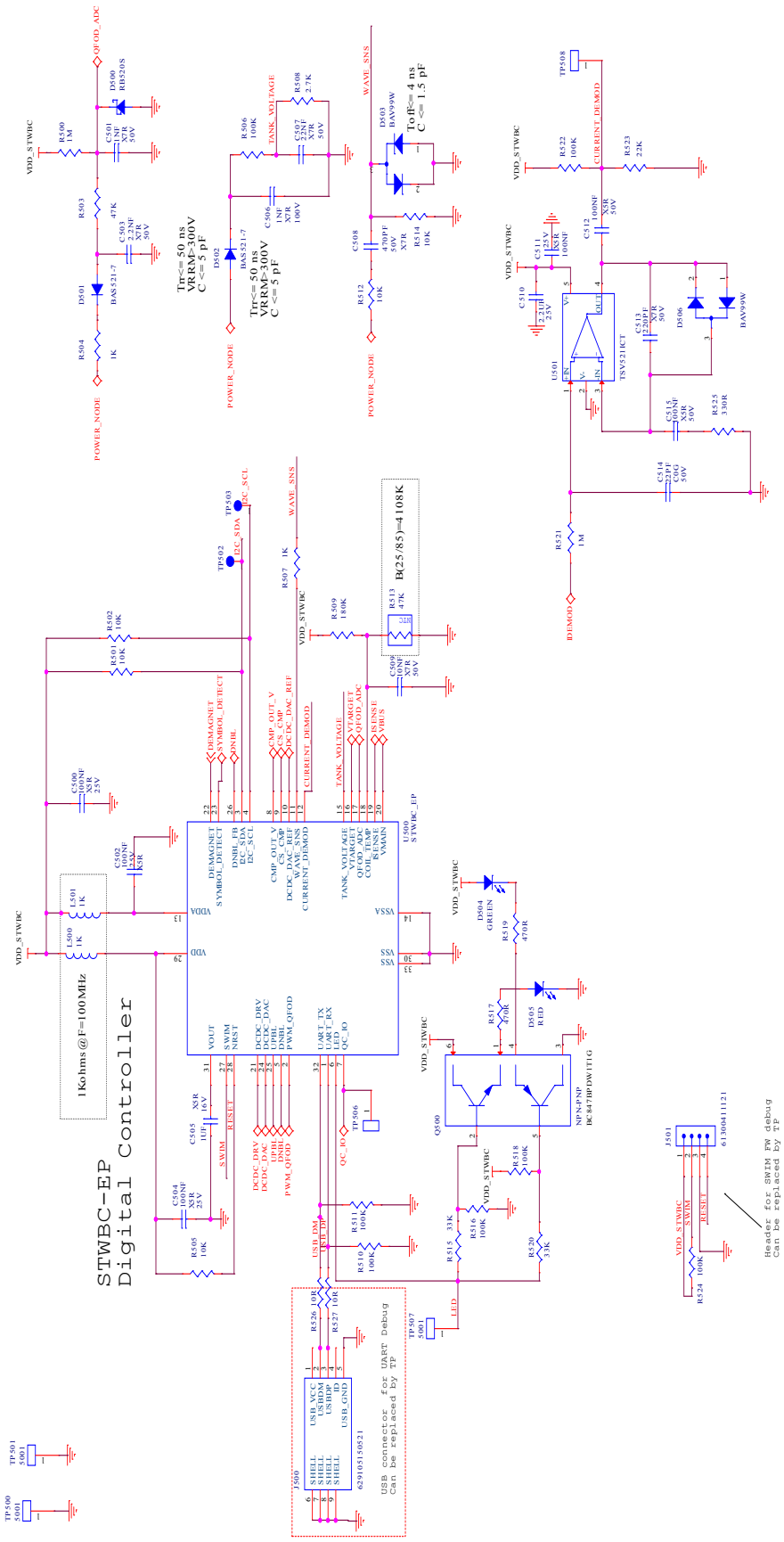
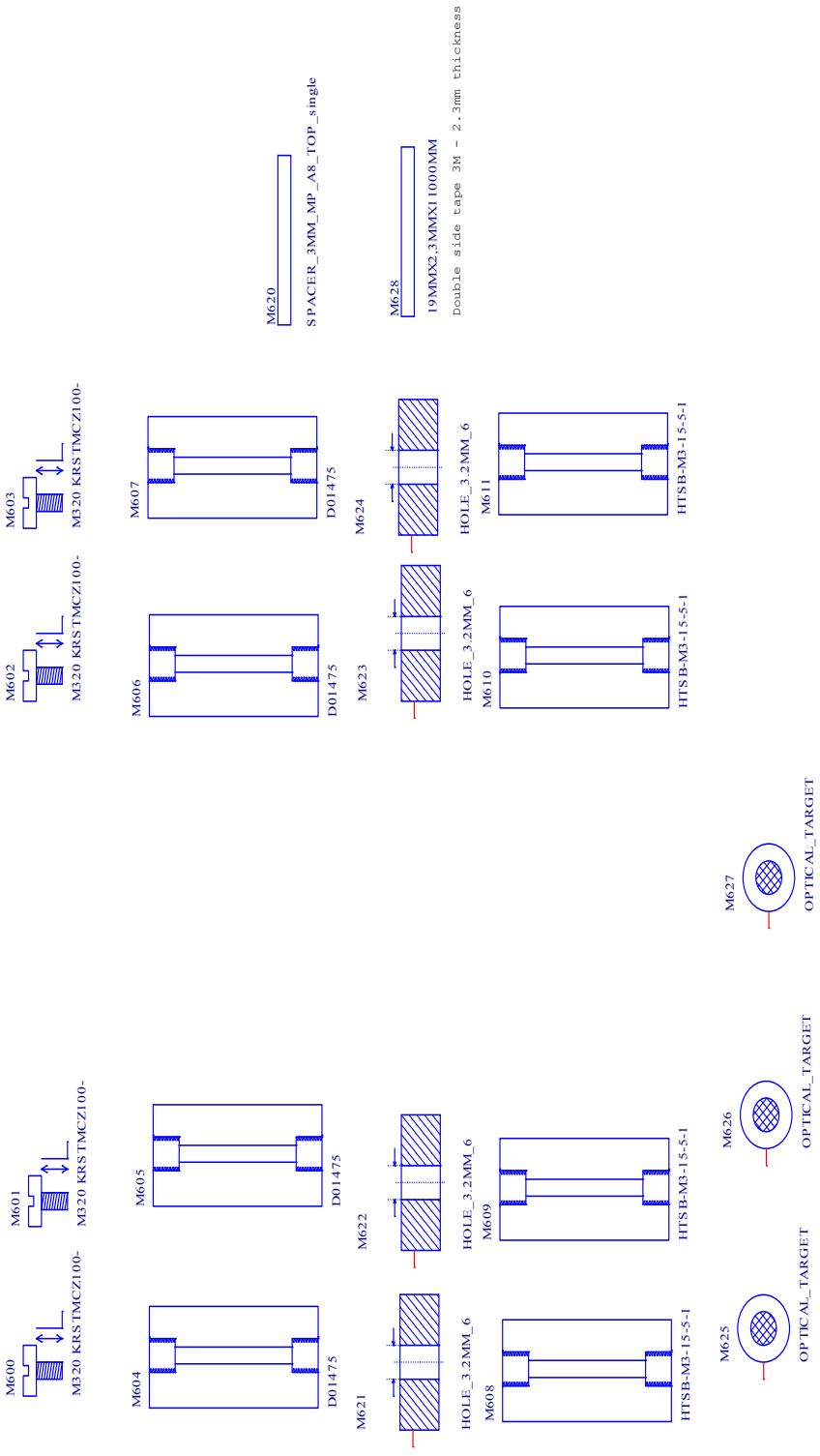
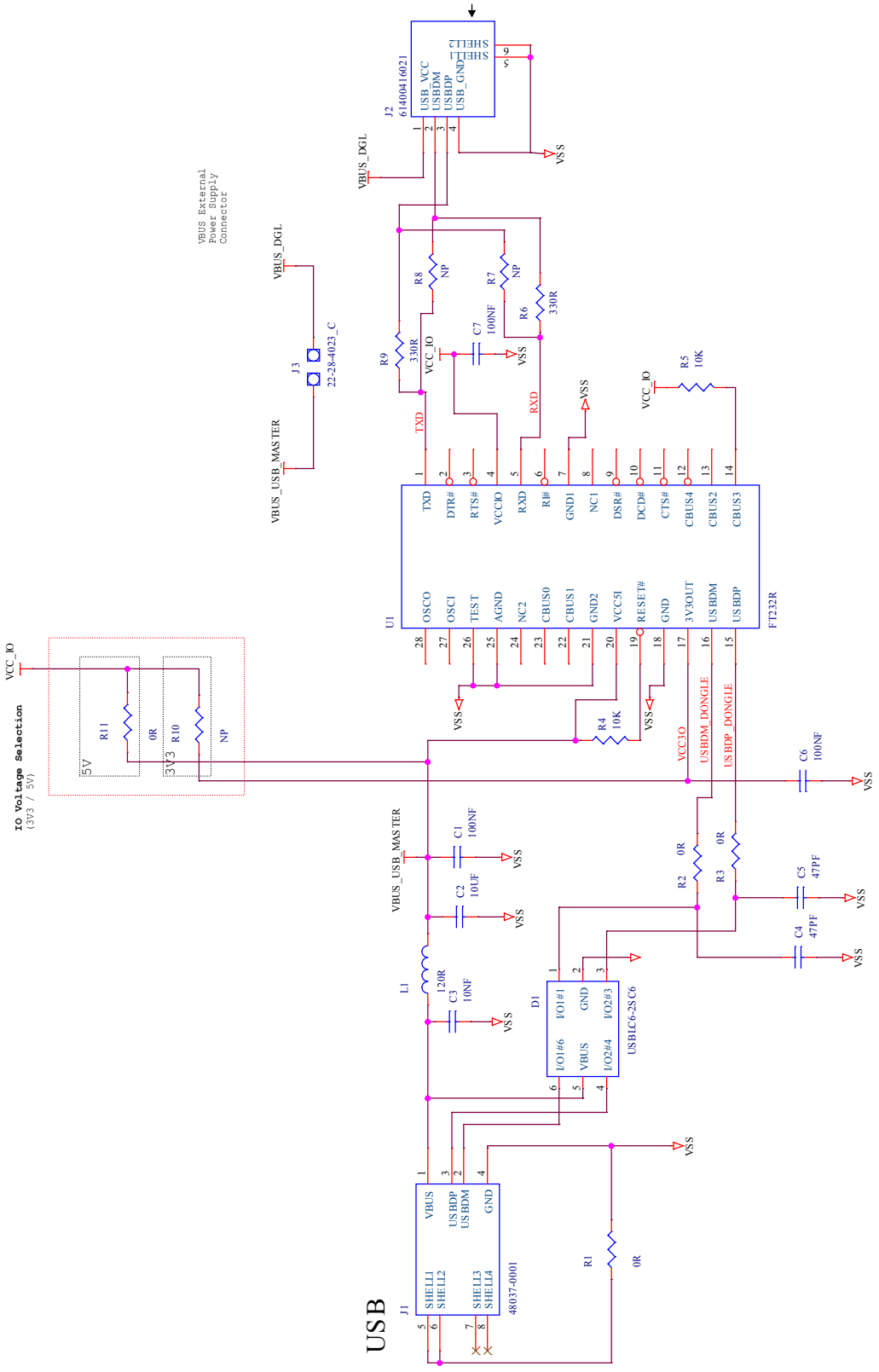


Figure 68. **EVALSTWBC-EP circuit schematic (6 of 6)**



7.2 EVALWBCDNGV1 schematic diagrams

Figure 69. **EVALWBCDNGV1 circuit schematic**



8 EVALSTWBC-EP Bill of materials

Table 4. EVALSTWBC-EP kit bill of materials

Item	Qty	Ref	Part / Value	Description	Manufacturer	Order code
1	1	-	EVALSTWBC-EP	Qi single coil 15W wireless charger TX board	ST Microelectronics	EVALSTWBC-EP
2	1	-	EVALWBCDNGV1	Dongle USB To UART	ST Microelectronics	EVALWBCDNGV1
3	1	-	12V, 24W	VER24US120-JA - Alimentation AC/DC, Prise murale, 1 sortie, 24 W, 12 V, 2 A	XP Power	VER24US120-JA
4	1	-	ADA2727	Adafruit MicroUSB Plug to 5.5/2.1mm Barrel Jack Adapter [ADA2727]	Adafruit	ADA2727
5	1	-	1 m length	USB Type A Plug to Micro USB Type B Plug, USB 2.0, 1 m Length, Black	Molex	68784-0001

Table 5. EVALSTWBC-EP transmitter board bill of materials

Item	Qty	Ref	Part/Value	Description	Manufacturer	Order code
1	4	C100,C114,C206,C217	NP	Cer, 402	any	
2	7	C101,C105,C113,C500,C502,C504,C511	100nF, 25V ,15%	Cer, 402	any	
3	4	C102,C103,C512,C515	100NF, 50V ,15%	Cer, 402	any	
4	3	C104,C200,C201	22UF, 25V ,20%	Cer, 1210	Wurth Elektronik	8.85012E+11
5	4	C106,C115,C218,C509	10NF, 50V ,10%	Cer, 402	any	10NF_50V_X7R_0402
6	2	C107,C109	NP	Cer, 603	any	C_NP_0603
7	2	C108,C111	10UF, 25V ,20%	Cer, 1206	Wurth Elektronik	8.85012E+11
8	1	C110	NP	Cer, 1210	any	C_NP_1210
9	1	C112	10UF, 10V ,10%	Cer, 805	Murata	GRM21BR71A106KE51L
10	2	C202,C203	10UF, 50V ,10%	Cer, 1206	any	10UF_50V_X5R_1206
11	2	C204,C403	100PF, 50V ,5%	Cer, 402	any	100PF_50V_COG_0402
12	1	C205	100NF, 50V ,5%	Cer, 1206	Murata	GRM31C5C1H104JA01L
13	2	C207,C301	100NF, 50V ,15%	Cer, 603	any	100NF_50V_X7R_0603
14	1	C208	5.6NF, 50V ,15%	Cer, 402	any	5.6NF_50V_X7R_0402
15	6	C209,C210,C211,C212,C213,C214	22UF, 35V ,20%	Cer, 1210	Taiyo Yuden	GMK325BJ226MM-P

Item	Qty	Ref	Part/Value	Description	Manufacturer	Order code
16	1	C215	NP	TANT, TANT_E	Kemet	T495X476M035ATE185
17	1	C216	100PF, 50V ,15%	Cer, 402	any	100PF_50V_X5R_0402
18	2	C219,C220	220NF, 35V ,15%	Cer, 603	any	220NF_35V_X7R_0603
19	1	C300	10UF, 25V ,10%	Cer, 603	any	10UF_25V_X7R_0603
20	3	C302,C304,C305	100NF, 100V ,5%	Cer, 1812	TDK	C4532C0G2A104J320KA
21	1	C306	1NF, 50V ,15%	Cer, 603	any	1NF_50V_X5R_0603
22	1	C307	NP	Cer, 1812	any	C_NP_1812
23	2	C308,C507	22NF, 50V ,15%	Cer, 402	any	22NF_50V_X7R_0402
24	2	C309,C508	470PF, 50V ,15%	Cer, 402	any	470PF_50V_X7R_0402
25	2	C310,C405	4.7NF, 50V ,15%	Cer, 402	any	4.7NF_50V_X7R_0402
26	2	C311,C312	1NF, 50V ,5%	Cer, 402	Murata	GRM1555C1H102JA01D
27	1	C400	4.7NF, 100V ,10%	Cer, 603	TDK	CGA3E2X7R2A472K080AA
28	1	C401	10NF, 100V ,15%	Cer, 603	any	10NF_100V_X7R_0603
29	1	C402	22NF, 100V ,15%	Cer, 603	any	22NF_100V_X7R_0603
30	2	C404,C514	22PF, 50V ,5%	Cer, 402	any	22PF_50V_COG_0402
31	1	C406	220NF, 50V ,10%	Cer, 402	any	220NF_50V_X7R_0402
32	1	C501	1NF, 50V ,10%	Cer, 402	any	1NF_50V_X7R_0402
33	1	C503	2.2NF, 50V ,15%	Cer, 402	any	2.2NF_50V_X7R_0402
34	1	C505	1UF, 16V ,10%	Cer, 402	any	1UF_16V_X5R_0402
35	1	C506	1NF, 100V ,15%	Cer, 402	any	1NF_100V_X7R_0402
36	1	C510	2.2UF, 25V ,10%	Cer, 402	any	2.2UF_25V_X5R_0402
37	1	C513	220PF, 50V ,15%	Cer, 402	any	220PF_50V_X7R_0402
38	1	D100	ESDA25P35-1U1M	TVS/ESD/EMI, QFN1610	ST Microelectronics	ESDA25P35-1U1M
39	1	D200	PMEG045V100EPD	Schottky, SOT1289	NXP	PMEG045V100EPD
40	1	D201	4.3V	Zener, SOD323	NXP	BZX384-C4V3-AK
41	1	D400	MMBD1503A	Diode, SOT23	Fairchaild	MMBD1503A
42	1	D500	RB520S	Schottky, SOD523	ROHM	RB520S
43	2	D501,D502	BAS521-7	Diode, Diod_SOD523	any	BAS521-7
44	2	D503,D506	BAV99W	Diode, SOT323	NXP	BAV99W
45	1	D504	GREEN	LED, L3.2_W2.5_H1	Wurth Elektronik	155124VS73200
46	1	D505	RED	LED, L3.2_W2.5_H1	Wurth Elektronik	155124RS73200
47	2	J100,J500	6.2911E+11	USB Micro USB Type B SMD	Wurth Elektronik	6.29105E+11
48	1	J501	6.13E+10	Header, TH_Header_1x4_P2.54	Wurth Elektronik	61300411121

Item	Qty	Ref	Part/Value	Description	Manufacturer	Order code
49	1	L100	2.2uH, 3.8A ,20%	Inductor, L5_W5_H4	Wurth Elektronik	74404054022
50	1	L200	2*4.7µH, 8A ,0%	CM_Choke,	Wurth Elektronik	744871004
51	2	L500,L501	1K, 0.2A ,25%	Ferite, 402	Murata	BLM15AG102SN1D
52	1	M300	8uH, 8A ,0%	Inductor,	Wurth Elektronik	760 308 103 146
53	4	M600,M601,M602,M603	M320 KRSTMCZ100-, , 0%	Screw,	Duratool	M320 KRSTMCZ100-
54	4	M604,M605,M606,M607	D01475, ,0%	Spacer,	Duratool	D01475
55	4	M608,M609,M610,M611	HTSB-M3-15-5-1	Spacer,	Richco	HTSB-M3-15-5-1
56	1	M620	Spacer_3MM_MP_A8_TOP_single	Spacer,	any	Spacer_3MM_MP_A8_Single_coil
57	1	M628	19MMX2,3MMX11000MM	Spacer,	3M	4991F 19MMX50M
58	3	Q100,Q303,Q400	NPN-NPN	Cms, SOT363	ON Semiconductor	BC847CDW1T1G
59	2	Q200,Q202	NPN-PNP	Cms, SOT363	ON Semiconductor	MMDT4413
60	1	Q201	N-MOS, ,0%	Cms, Powerflat-5x6	ST Microelectronics	STL8DN6LF3
61	1	Q300	NP	Cms, SOT23	ST Microelectronics	2N7002
62	2	Q301,Q302	N-MOS	Cms, Ppwerflat-3x3	ST Microelectronics	STL10N3LLH5
63	1	Q500	NPN-PNP	Cms, SOT363	ON Semiconductor	BC847BPDW1T1G
64	2	R100,R207	220K, 1/16W,1%	Res, 402	any	220K_1%_0402
65	1	R101	330K, 1/16W,1%	Res, 402	any	330K_1%_0402
66	1	R102	12K, 1/16W,5%	Res, 402	any	12K_5%_0402
67	1	R103	120K, 1/16W,5%	Res, 402	any	120K_5%_0402
68	8	R104,R108,R205,R510,R511,R516,R518,R524	100K, 1/16W,5%	Res, 402	any	100K_5%_0402
69	1	R105	39K, 1/16W,1%	Res, 402	any	39K_1%_0402
70	7	R106,R110,R200,R202,R309,R526,R527	10R, 1/16W,5%	Res, 402	Vishay	10R_5%_0402
71	3	R107,R515,R520	33K, 1/16W,1%	Res, 402	any	33K_1%_0402
72	2	R109,R201	220K, 1/16W,1%	Res, 402	any	R_NP_0402
73	1	R111	39K, 1/16W,5%	Res, 402	any	39K_5%_0402
74	2	R203,R507	1K, 1/16W,1%	Res, 402	any	1K_1%_0402
75	2	R204,R400	470R, 1/16W,1%	Res, 402	any	470R_1%_0402
76	1	R206	0.033R, 1/2W,1%	Res, 1206	any	0R033_1%_1206_0.5W
77	1	R208	47R, 1/16W,5%	Res, 402	any	47R_5%_0402

Item	Qty	Ref	Part/Value	Description	Manufacturer	Order code
78	1	R209	75K, 1/16W,1%	Res, 402	any	75K_1%_0402
79	2	R210,R213	3.3K, 1/16W,1%	Res, 402	any	3.3K_1%_0402
80	3	R211,R212,R311	10K, 1/16W,1%	Res, 402	any	10K_1%_0402
81	1	R214	4.7K, 1/16W,1%	Res, 402	any	4.7K_1%_0402
82	2	R301,R302	22R, 1/16W,5%	Res, 402	any	22R_5%_0402
83	3	R303,R408,R500	1M, 1/16W,1%	Res, 402	any	1M_1%_0402
84	5	R304,R409,R410,R506,R522	100K, 1/16W,1%	Res, 402	any	100K_1%_0402
85	5	R305,R306,R307,R404,R405	470K, 1/16W,1%	Res, 402	any	470K_1%_0402
86	1	R308	0.022R, 1W,1%	Res, 1206	any	0.022R_1%_1206
87	1	R310	3.3K, 1/16W,1%	Res, 603	any	22R_5%_0603
88	2	R312,R313	4.7R, 1/16W,1%	Res, 402	any	4.7R_1%_0402
89	2	R401,R402	82K, 1/16W,1%	Res, 402	any	82K_1%_0402
90	1	R403	150K, 1/16W,1%	Res, 402	any	150K_1%_0402
91	2	R406,R523	22K, 1/16W,1%	Res, 402	any	22K_1%_0402
92	2	R407,R503	47K, 1/16W,1%	Res, 402	any	47K_1%_0402
93	1	R411	2.2K, 1/16W,5%	Res, 402	any	2.2K_5%_0402
94	5	R501,R502,R505,R512,R514	10K, 1/16W,5%	Res, 402	any	10K_5%_0402
95	1	R504	1K, 1/16W,5%	Res, 402	any	1K_5%_0402
96	1	R508	2.7K, 1/16W,1%	Res, 402	any	2.7K_1%_0402
97	1	R509	180K, 1/16W,1%	Res, 402	any	180K_1%_0402
98	1	R513	47K, ,1%	Thermistance, 402	Murata	NCP15WB473F03RC
99	2	R517,R519	470R, 1/16W,5%	Res, 402	any	470R_5%_0402
100	1	R521	1M, 1/16W,5%	Res, 402	any	1M_5%_0402
101	1	R525	330R, 1/16W,5%	Res, 402	any	330R_5%_0402
102	4	TP100,TP103,TP300,TP301	WIRE_SOLDER	Test Point,	any	WIRE_SOLDER
103	6	TP101,TP102,TP303,TP304,TP502,TP503	TPSMD-1MM	Test Point,	any	TPSMD-1MM
104	8	TP200,TP302,TP400,TP500,TP501,TP506,TP507,TP508	5001	Test Point,	Keystone	5001
105	1	U100	ST715PUR	Cconverter, DFN8_L3_W3	ST Microelectronics	ST715PUR
106	1	U300	DGD0590	Driver, V-QFN3030-8	Diodes Inc	DGD0590
107	1	U500	STWBC_EP	Controller, QFN32	ST Microelectronics	STWBC_EP
108	1	U501	TSV521ICT	Amplifier, SOT353	ST Microelectronics	TSV521ICT

Table 6. EVALWBDDNGV1 USB/UART dongle bill of materials

Item	Qty	Ref	Part / Value	Description	Manufacturer	Order code
1	3	C1,C6,C7	100NF, 50V, 15%	CER, X7R, 0603	any	100NF_50V_X7R_0603
2	1	C2	10UF, 25V, 10%	CER, X7R, 0805	any	10UF_25V_X7R_0805
3	1	C3	10NF, 50V, 15%	CER, X7R, 0603	any	10NF_50V_X7R_0603
4	2	C4,C5	47PF, 25V, 15%	CER, X5R, 0603	any	47PF_25V_X5R_0603
5	1	D1		very low capacitance ESD protection, SOT23-6L	ST Microelectronics	USBLC6-2SC6
6	1	J1		Usb	Molex	48037-0001
7	1	J2		Usb	Wurth Elektronik	61400416021
8	1	J3	JUMP254P-M-2	Header	Molex	22-28-4023_C
9	1	L1	120R, 0.5A, 25%	Ferrite	Wurth Elektronik	74279262
10	4	R1,R2,R3, R11	0R, 1/10W, 5%	Res, 0603	any	0R_5%_0603
11	2	R4,R5	10K, 1/10W, 5%	Res, 0603	any	10K_5%_0603
12	2	R6,R9	330R, 1/10W, 5%	Res, 0603	any	330R_5%_0603
13	3	R7,R8,R10	NP	Res, 0603	any	R_NP_0603
14	1	U1	FT232R, SSOP28	Conveerter	FTDI	FT232R

9 References

1. **Datasheet**: Digital controller for wireless battery chargers transmitters for Qi 15 W applications..
2. **Data Brief**: Qi MP-A15 15W wireless charger TX evaluation kit based on STWBC-EP
3. **Data Brief**: STSW-STWBCGUI Graphical user interface for wireless power transmitter evaluation board on STWBC chip family
4. **Data Brief**: Firmware for EVALSTWBC-EP 15W single coil Qi MP-A15 wireless power TX evaluation kit based on STBWC-EP
5. **Data Brief**: STSW-STWBCFWDT Firmware downloader tool

Revision history

Table 7. **Document revision history**

Date	Version	Changes
26-June-2019	1	Initial release.

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