

Getting started with the Qi MP-A10 wireless charger Tx evaluation board based on STWBC-EP

Introduction

The **STEVAL-ISB044V1** wireless power transmitter evaluation board is based on the MP-A10 (CR419) wireless power consortium (WPC) standard version 1.2.3 and supports FOD (foreign object detection).

The transmitter supports all Qi-compatible receivers (such as those in Qi-enabled mobile phones) as well as resistive or capacitive modulation receivers.

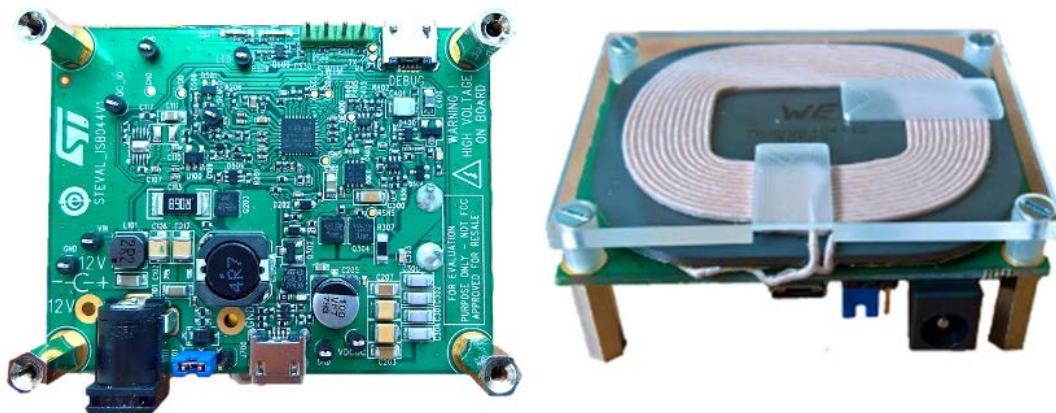
In accordance with the Qi-MPA10 topology, the STEVAL-ISB044V1 supports a 5-13 V input voltage and a half-bridge stage with bridge voltage/frequency control.

The evaluation board is based on the **STWBC-EP** controller which integrates all the functions required to drive and monitor the transmitter, and controls the bridge voltage built in boost topology.

The STWBC-EP supports UART connectivity to a PC and, thanks to the STEVAL-ISB044V1 graphical interface, monitors the transmitter behavior in real-time.

The STEVAL-ISB044V1 reference design provides a complete kit which includes the STWBC-EP, firmware, layout based on cost-effective 2-layer PCB, graphical interfaces and tools.

Figure 1. STEVAL-ISB044V1 evaluation board



1 Getting started

1.1 System requirements

To use the STEVAL-ISB044V1 evaluation board with the graphical user interface (GUI), you need:

- a PC with Microsoft® Windows® operating system (XP or later versions)
- NET Framework 4
- a USB-to-UART cable to connect the board to the PC.

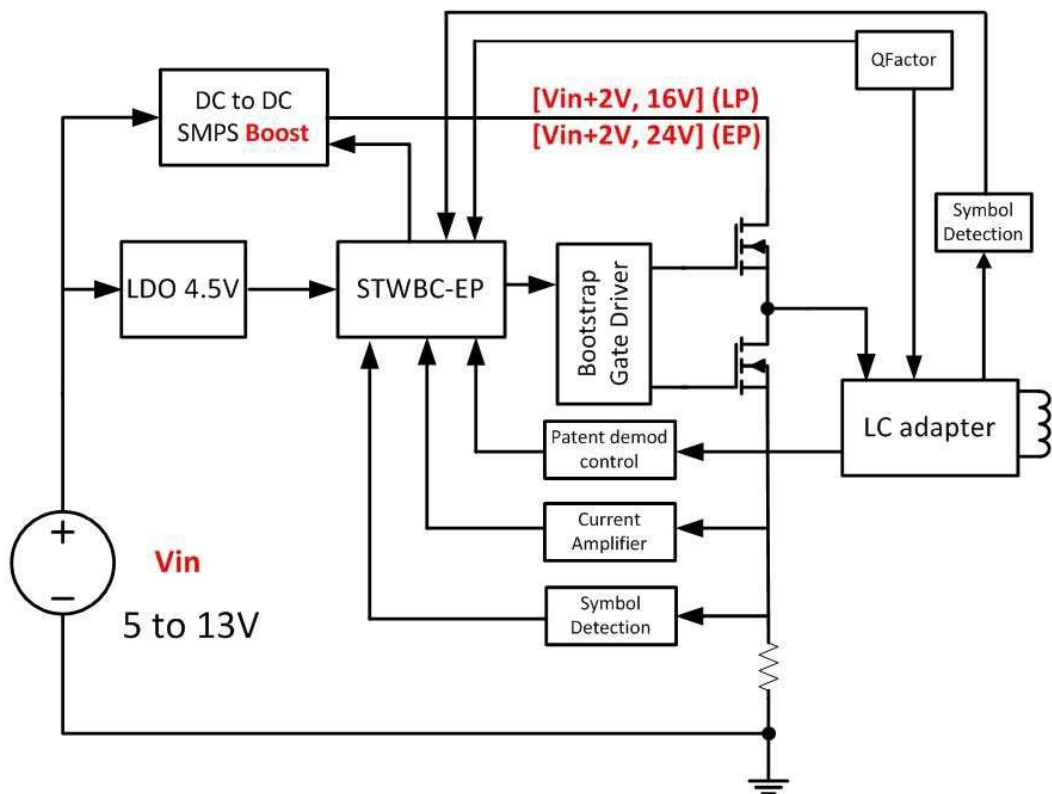
1.2 Package contents

- Hardware:
 - a STEVAL-ISB044V1 evaluation board
 - ST-LINK/V2 in-circuit debugger/programmer with single wire interface module (SWIM), available for download on www.st.com
 - a USB-to-UART interface dongle with a micro-USB cable for board debug and GUI use
- Software:
 - ST-LINK USB driver
 - STVP programming software (integrated in ST_toolset available on www.st.com)
 - FTDI VCP driver (<http://www.ftdichip.com/Drivers/VCP.htm>)
 - PC GUI installation package

2 Hardware description and setup

2.1 System block diagram

Figure 2. STWBC-EP block diagram



2.2 STEVAL-ISB044V1 wireless transmitter board overview

The STEVAL-ISB044V1 evaluation board features:

- STWBC-EP digital controller
- 15 W output power
- Qi MP-A10 reference design
- WPC Qi1.2.3 standard compliant
- Robust demodulation algorithm, with triple path (V, I, f)
- Foreign object detection (FOD)
- Accurate power control
- Active presence detection
- UART protocol to control and monitor the system
- Complete reference design (evaluation board, IC, firmware and tools)
- 2-layer PCB for easy design
- Flash memory-based

- RoHS compliant

Table 1. STEVAL-ISB044V1 electrical performance: input characteristics

Parameter	Input characteristics	Min.	Typ.	Max.	Unit	Notes and conditions
V _{in}	Input voltage	5	12	13	V	
I _{in}	Input current		1.6	2	A	V _{in} nominal, I _{out} = max. on MP1B Rx
	Input no-load current				mA	
	Input stand-by current		1.4		mA	At typical voltage

Table 2. STEVAL-ISB044V1 electrical performance: system characteristics

Parameter	Input characteristics	Min.	Typ.	Max.	Unit	Notes and conditions
F _s	Switching frequency	110		180	kHz	Decrease with load
Duty cycle	Duty cycle modulation	5		50	%	Duty cycle
η	Full load efficiency		80		%	V _{in} = 12 V, P _{Out} Rx = 15 W

Figure 3. STEVAL-ISB044V1 evaluation board: connectors, LEDs and test points

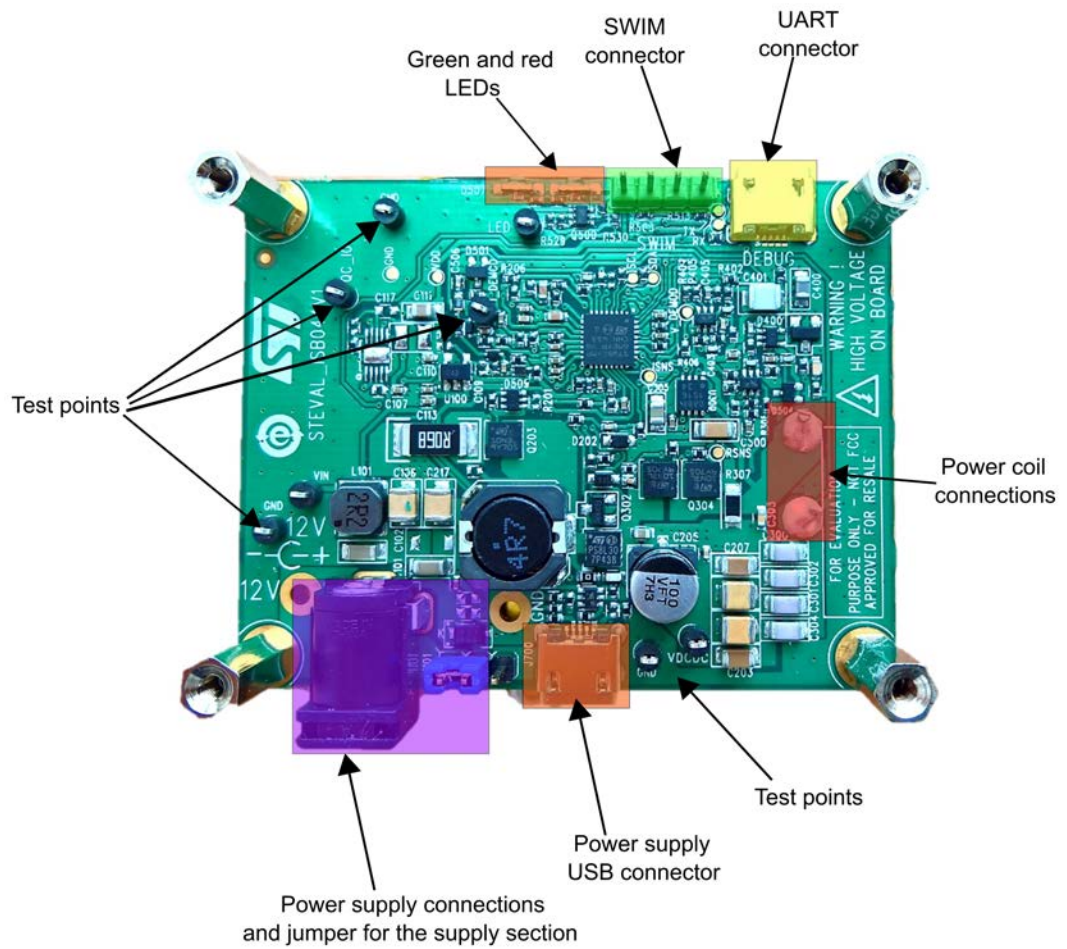
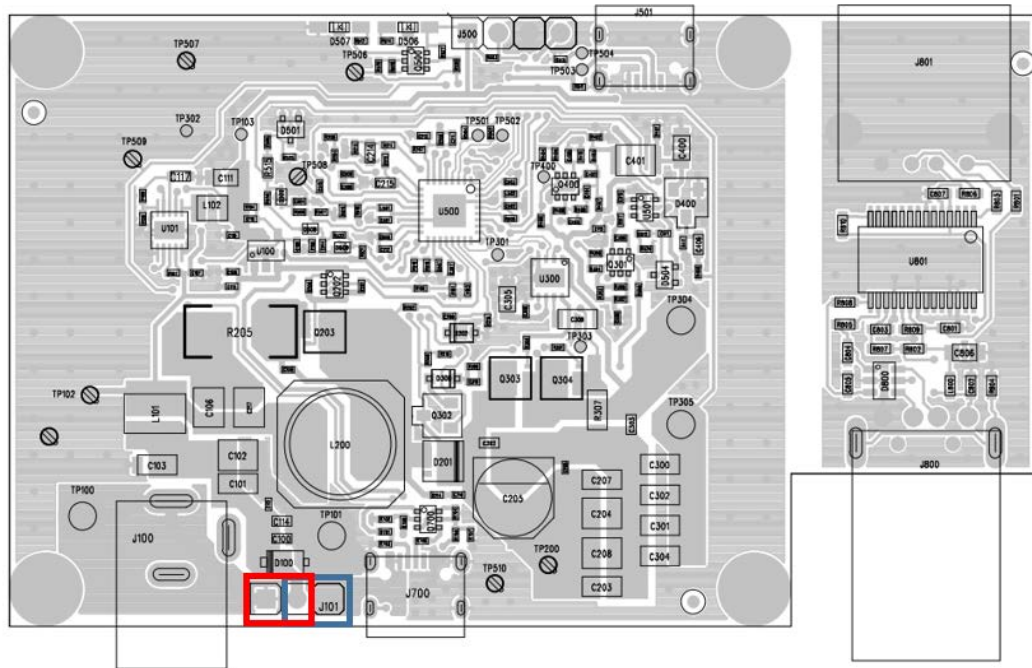


Figure 4. STEVAL-ISB044V1 evaluation board: power supply selection


Power supply selection:

- Jumper in **Red** position for DC jack supply (J100)
- Jumper in **Blue** position for USB power supply (J700)

Table 3. Connector description

Connector reference	Description
J100	DC power jack connector
J101	Power/QC USB connector link
J500	SWIM connector used for the download
J501	UART jack connector used for the GUI
J700	Quick charge USB connector

Table 4. Test point description

Test point reference	Signal	Description
TP100	12 V	12 V power supply connection
TP101	GND	GND power connection
TP102	VIN	Input voltage
TP103	VDD_STWBC	4.5V LDO output voltage
TP200	VDCDC	Boost output voltage
TP301	ISENSE	Current measurement
TP302	GND	Power GND connection (Rsense)
TP303	VRSENSE	Rsense resistor voltage
TP304		Wireless charging coil connection

Test point reference	Signal	Description
TP305		Wireless charging coil connection
TP400	SYMBOL_DETECT	Symbol detector
TP501	I2C_SCL	STWBC I ² C signal
TP502	I2C_SDA	STWBC I ² C signal
TP503	USB_DP	STWBC UART Rx signal
TP504	USB_DM	STWBC UART Tx signal
TP506	GPIO_0	STWBC GPIO signal used for LEDs
TP507	GND	Ground
TP508	CURRENT_DEMOD	Symbol detector
TP509	QC_IO	Quick charge circuit signal
TP510	GND	Ground
TP511	GND	Ground

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 STWBC-EP pinout when the MP-A10 configuration is used.

Figure 5. STWBC-EP pinout in MP-A10 configuration

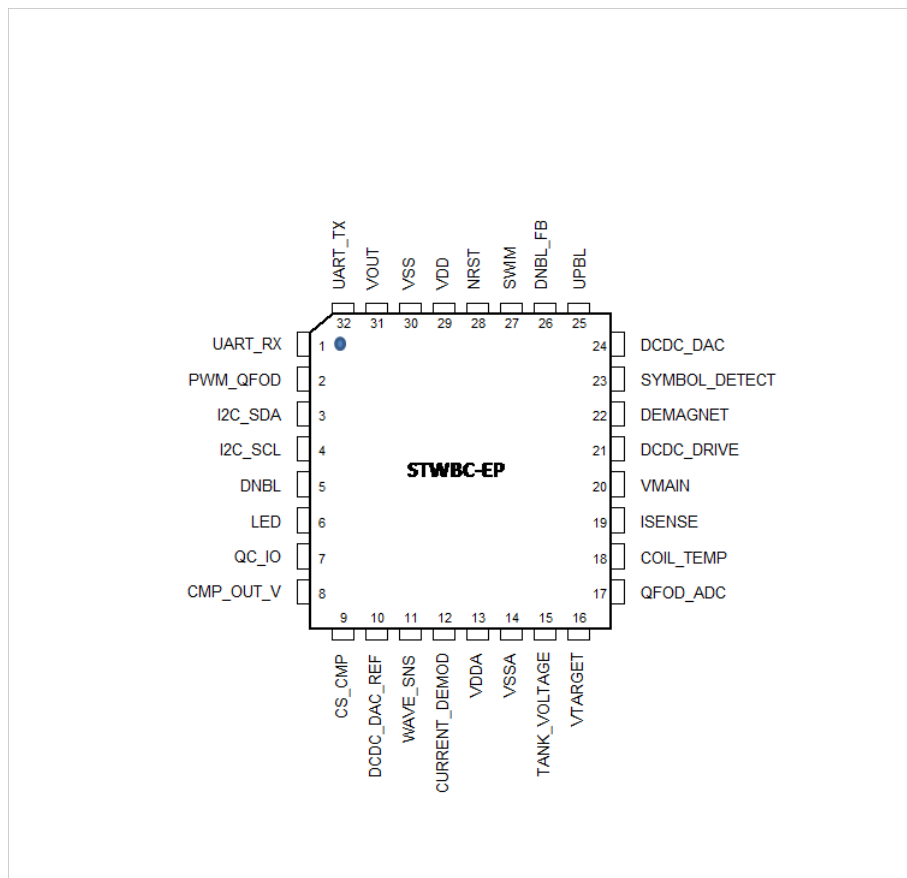


Table 5. STWBC-EP pin description

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
3	I2C_SDA		I2C_SDA
4	I2C_SCL		I2C_SCL
5	DNBL	DO	Output driver for Low side branch
6	LED	DO	Digital output for light indicators
7	QC_IO	DO	Quick charge circuit signal
8	CMP_OUT_V	AI	Boost output voltage sensing
9	CS_CMP	AI	Boost current sensing
10	DCDC_DAC_REF	AI	DAC reference value for Boost output voltage
11	WAVE_SNS	AI	Symbol detector based on delta frequency
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	Boost 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 boost PWM drive
22	DEMAGNET	DI	Boost demagnetization
23	SYMBOL_DETECT	DI	Voltage demodulation
24	DCDC_DAC	DO	Boost PWM output DAC (setting the CPP3 comparator voltage reference)
25	UPBL	DO	Output driver for high side branch
26	DNBL_FB		Used for hardware PWM programming
27	SWIM	DIO	Digital IO for debug interface
28	NRST	DI	Reset
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: All analog inputs are VDD compliant but can be used only between 0 and 1.2 V.

3 Download procedure

To download the firmware to the board, the user has to install the GUI software which allows a complete board monitoring via UART signals. Thus, to use the STSW-STWBCGUI, UART signals must be accessible.

In case of board issues, ST-LINK and STVP software can be installed to erase the STWBC-EP Flash memory.

3.1 STSW-STWBCGUI software installation

Step 1. Install the GUI by launching the STWBC_GUI_Setup.msi installation file

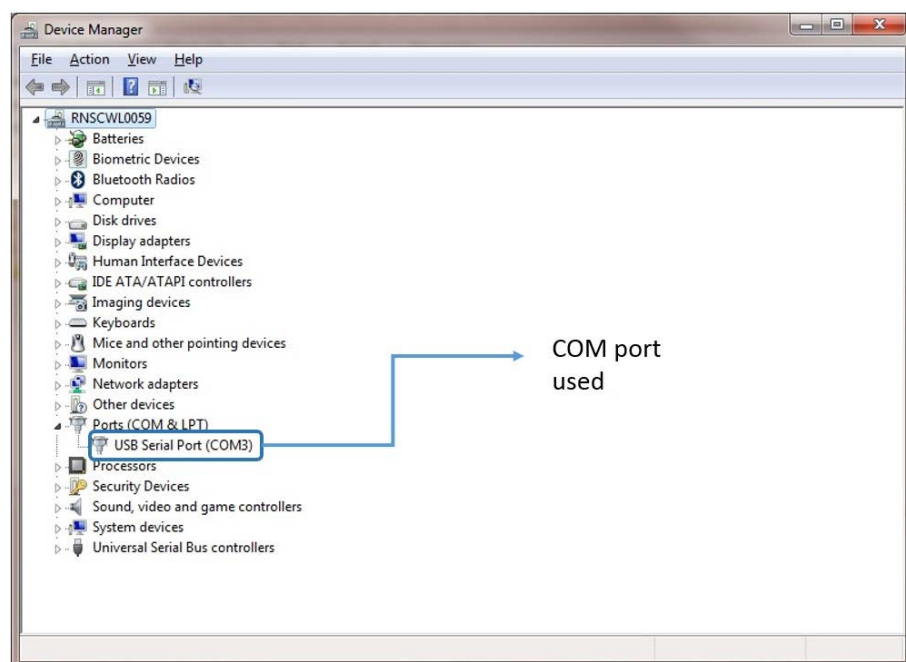
Figure 6. STSW-STWBCGUI installation file

Name	Date modified	Type	Size
setup.exe	3/14/2017 11:49 AM	Application	418 KB
STWBC_GUI_Setup.msi	3/14/2017 11:50 AM	Windows Installer ...	2,011 KB

Step 2. Connect the wireless power transmitter board to the PC via the USB-to-UART connection on J501 UART connector

Step 3. Check Windows Device Manager to identify the correct port number and select the appropriate USB serial COM port

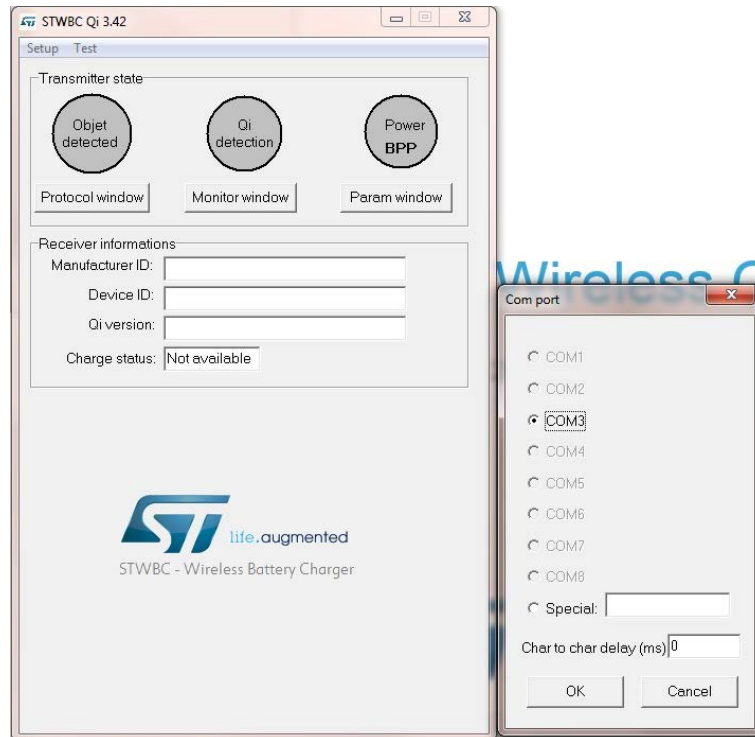
Figure 7. Windows Device Manager: COM port selection



Step 4. Enter a specific COM port number (if not listed in the selection window) in the **Special** text box (e.g., "COM12" or the specific syntax "\\.\COM12")

If the GUI is switched off, ensure that the COM port is not used on your computer. Otherwise, try another USB port.

Figure 8. STSW-STWBCGUI start screen



- Step 5.** Press “OK”.
The GUI is ready to run.

3.2 Firmware download via STSW-STWBCGUI

The following sections describe the firmware download through the UART connector via STSW-STWBCGUI. The download contains 3 files incorporated in a single cabfile.

3.2.1 Download procedure with a new chip (never been programmed)

If the chip has never been programmed, the download mode is enabled by default.

- Step 1.** Connect the USB-to-UART dongle to the computer.

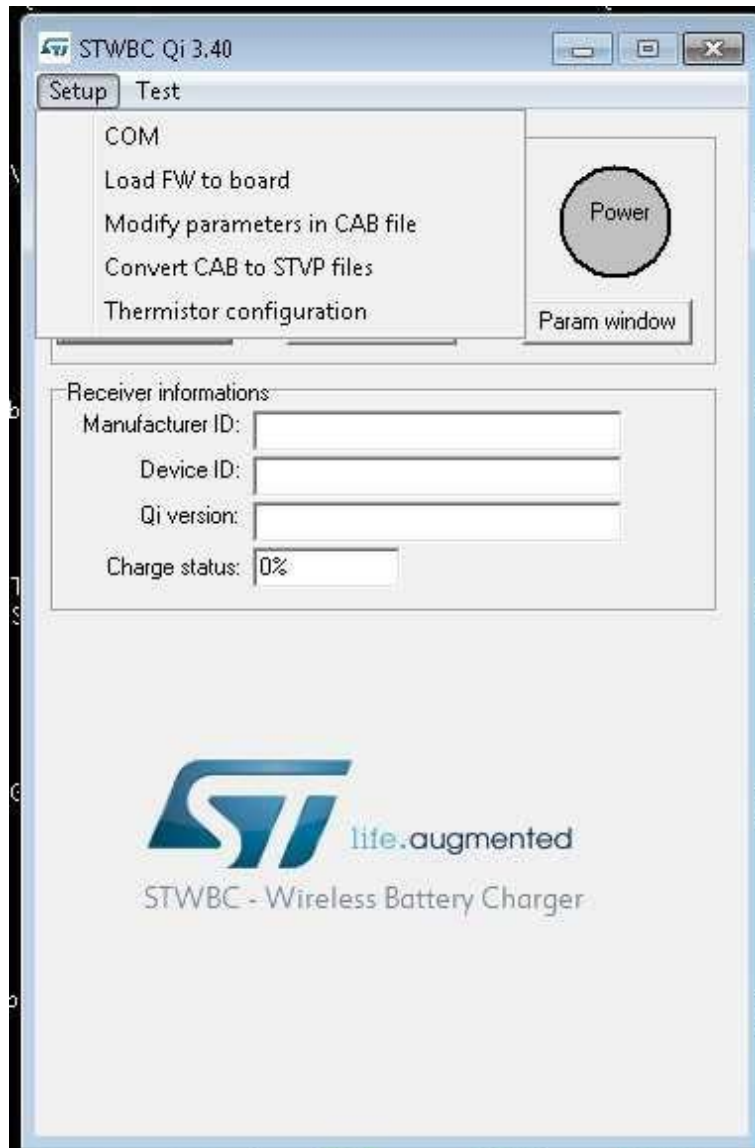
Note: Do not connect the transmitter board for the moment.

Figure 9. Dongle connection



Step 2. From the GUI, select **Load FW to board** from the setup menu.

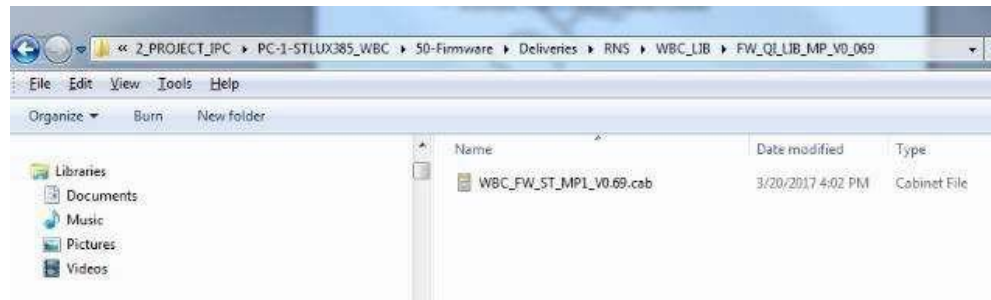
Figure 10. Firmware download via STSW-STWBCGUI



Step 3. As prompted, select the CAB file containing the firmware to download

Figure 11. Firmware file selection message



Figure 12. Firmware file selection


Step 4. Supply the board with 12 V and keep it powered.

Figure 13. Power on message


Step 5. When the DOS window appears, connect the transmitter board to the dongle using a micro-USB cable.

Important:

Take care to connect it to the USB debug connector J501 on the opposite side of the power supply connection.

Figure 14. USB-to-UART dongle to STEVAL-ISB044V1 connection


Step 6. Follow the download progress in the DOS window and power off the board when prompted.

Figure 15. DOS window: download in progress

```

C:\Program Files (x86)\STMicroelectronics\STWBC GUI 3.42\stwbc_loader.exe
Synchronization starting
Synchronization OK
Downloading :
Program : C:\Users\olpalier\AppData\Roaming\STMicroelectronics\STWBC_TMP\program.bin
Parameters : C:\Users\olpalier\AppData\Roaming\STMicroelectronics\STWBC_TMP\parameters.bin
Options : C:\Users\olpalier\AppData\Roaming\STMicroelectronics\STWBC_TMP\options.bin
sending code - OK
sending code - OK
sending C:\Users\olpalier\AppData\Roaming\STMicroelectronics\STWBC_TMP\program.bin_
    
```

3.2.2 Firmware upgrade procedure (chip already programmed)

If a chip has already been programmed with the firmware, the download mode is disabled and special command needs to be sent to STWBC-EP to enable the download mode.

- Step 1.** Supply the transmitter board via a power supply set to 12 V.
- Step 2.** Connect the USB-to-UART dongle to the transmitter board.

- Step 3.** The STWBC-EP UART Rx/Tx signals are accessible on the transmitter board J501 connector, respectively on USB_DP and USB_DM (see [Figure 14. USB-to-UART dongle to STEVAL-ISB044V1 connection](#)).
 - Step 4.** From the STSW-STWBCGUI, select **Load FW to board** from the setup menu (see [Figure 10. Firmware download via STSW-STWBCGUI](#)).
 - Step 5.** As prompted, select the CAB file containing the firmware to download (see [Figure 11. Firmware file selection message](#)).
 - Step 6.** As prompted, power the board on and keep it powered.
 - Step 7.** Follow the download progress in the DOS window and power the board off when prompted (see [Figure 15. DOS window: download in progress](#)).
- In case of problems in downloading the firmware through UART (for example, firmware corruption during update), refer to the following section.

3.3 Erasing firmware procedure using STVP

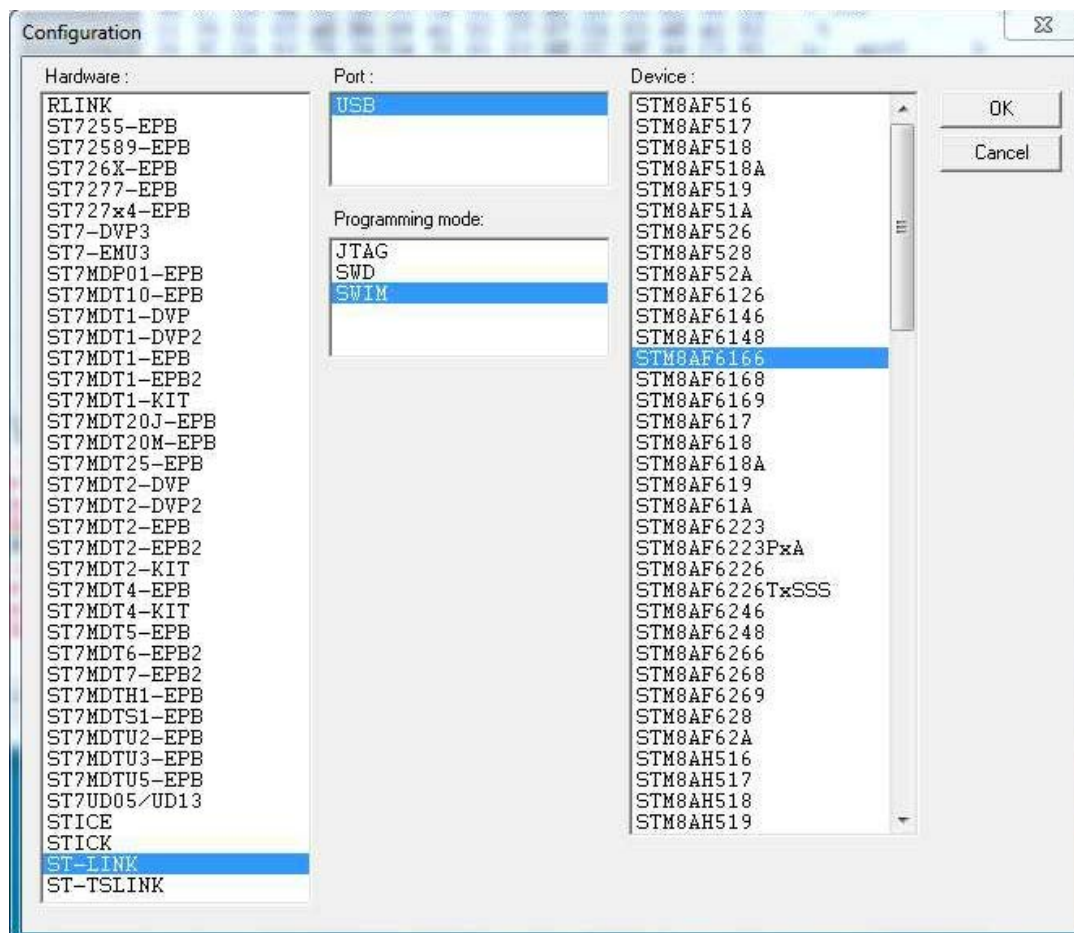
3.3.1 Requirements

To start the firmware erasing procedure using STVP, you have to install on your PC:

- ST-LINK USB driver
- STVP programming tool (available at www.st.com)
- ST-LINK hardware tools

You also need to configure STVP as shown below.

Figure 16. STVP configuration



3.3.2 Procedure

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

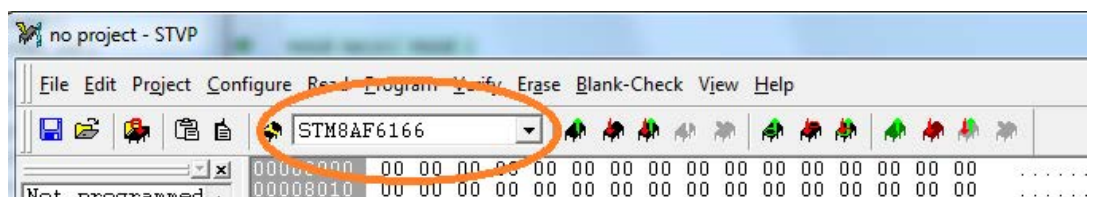
Note: Pay special attention in connecting the SWIM cable to the transmitter board correctly, as shown below.

Figure 17. STEVAL-ISB044V1 evaluation board: ST-LINK connection



- Step 5.** Launch STVP software.
- Step 6.** Select STM8AF6166 as core.

Figure 18. STVP core selection



Note: Do not upload any program into the STVP RAM area, as all bits will be erased (load 00 00 00).

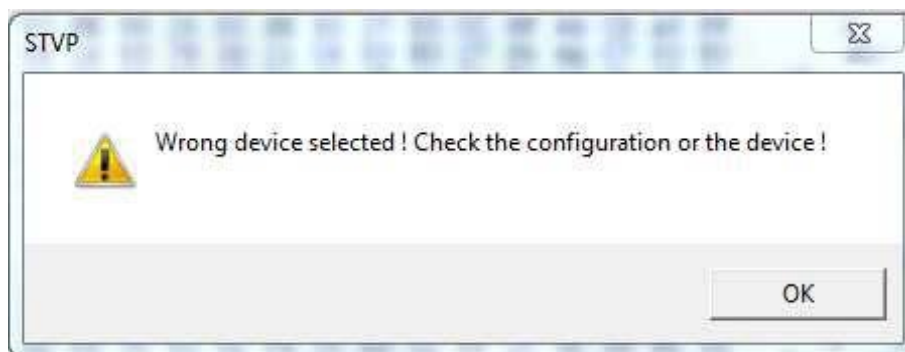
- Step 7.** Transfer the "00 00" to the STWBC-EP via the SWIM interface using the appropriate push button.

Figure 19. STVP download



- Step 8.** Click OK if a "wrong device selected" alert appears.

Figure 20. STVP wrong device selected alert



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

Figure 21. STVP incompatibility device action query



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.
```

Step 10. Exit from the STVP program.

Step 11. Disconnect SWIM.

Step 12. Remove power supply from the STEVAL-ISB044V1 transmitter board.

Step 13. Retry the UART download procedure if necessary.

3.4 Firmware download with command line

3.4.1 Firmware download with written chip

Step 1. Ensure a dedicated directory has the following files:

- STWBC_Loader.exe
- stwbc_loader_not_empty.bat
- enable_boot.bin
- “firmware version”.cab

Step 2. Starting from the STSW-STWBCGUI folder, run the stwbc_loader_not_empty.bat from the command line, specifying the COM number (e.g. COM2) and firmware filename parameters (“firmware name.cab”).

Figure 22. STSW-STWBCGUI command line

```
Administrator: C:\Windows\system32\cmd.exe
C:\Program Files (x86)\STMicroelectronics\STWBC GUI 3.16>stwbc_loader_not_empty.
bat COM2 WBC_FW_Q1_1W_05.094.cab
```

3.4.2 Firmware download with blank chip

If the STWBC-EP memory is erased, the procedure sequence is a bit different.

- Step 1.** Connect the UART cable to the board.
- Step 2.** Select **Load FW to board** from the STSW-STWBCGUI and power the board.
- Step 3.** Execute the command line as per the example below with the appropriate firmware filename.

Figure 23. STSW-STWBCGUI command line with blank chip

```
Administrator: C:\Windows\system32\cmd.exe
C:\Program Files (x86)\STMicroelectronics\STWBC GUI 3.16>stwbc_loader.exe -COM
COM2 -cab WBC_FW_Q1_1W_05.094.cab_
```

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

Note: A dedicated tool is available for simultaneous downloads (refer to the STSW-STWBCFWDT firmware downloader tool).

3.5 STVP file creation

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

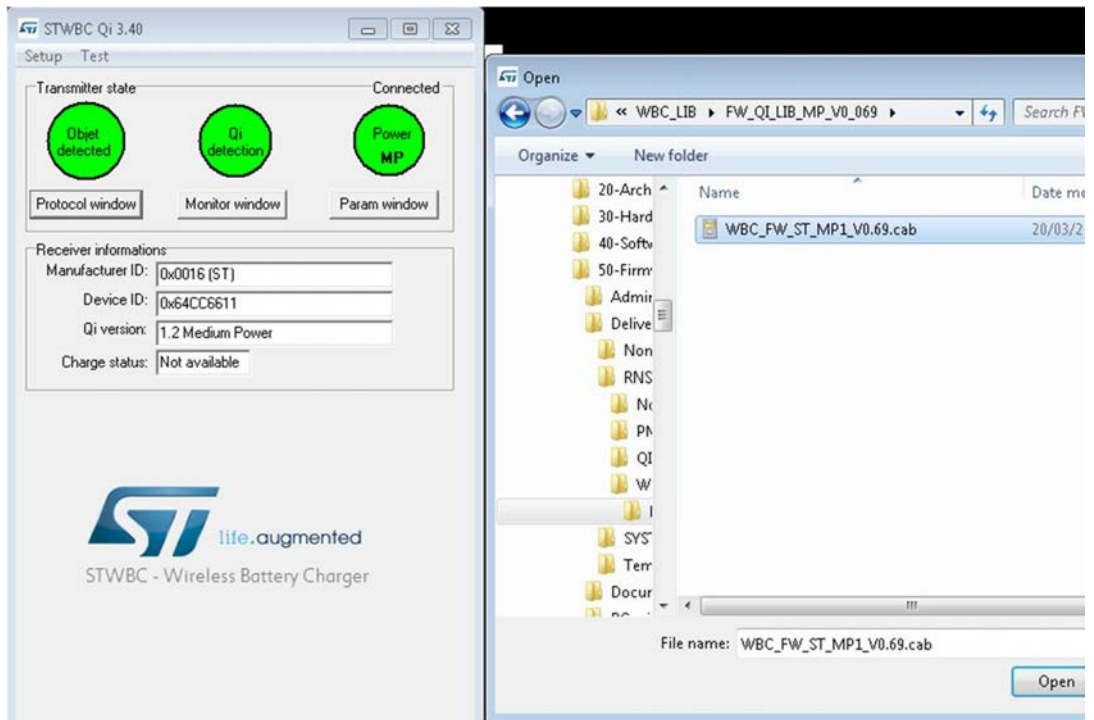
- Step 1.** Select the convert **CAB to STVP files** command from the STSW-STWBCGUI setup menu

Figure 24. STSW-STWBCGUI: convert CAB to STVP files



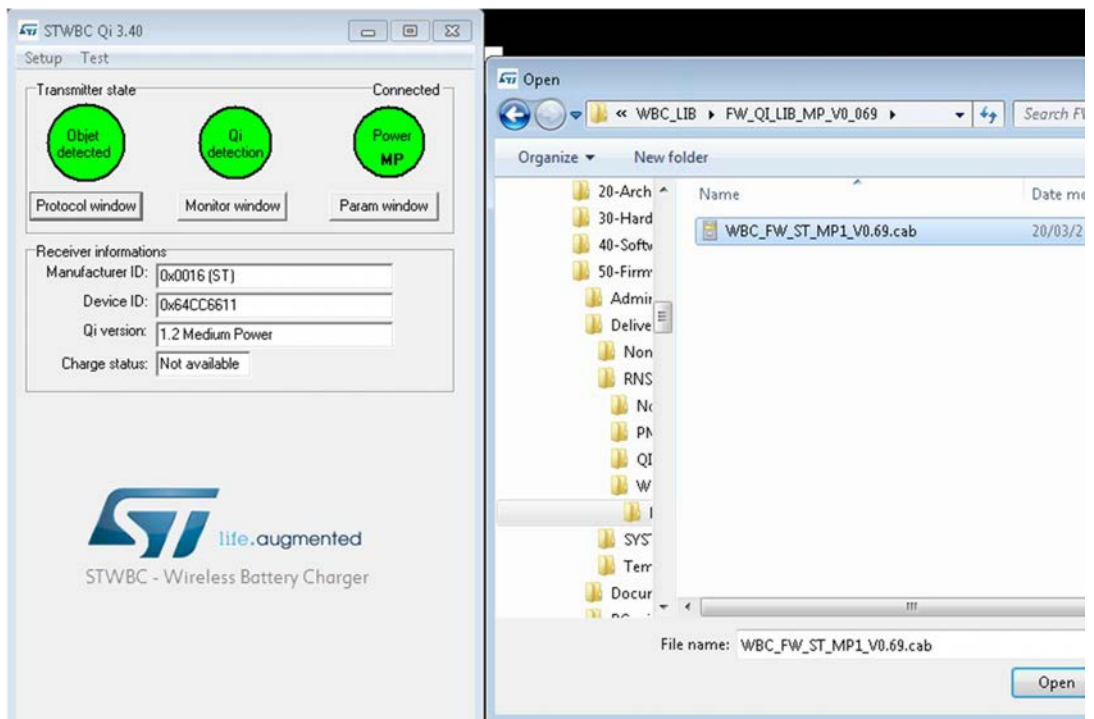
Step 2. Follow the prompt to select the appropriate cabfile.

Figure 25. Selecting the CAB file to be converted

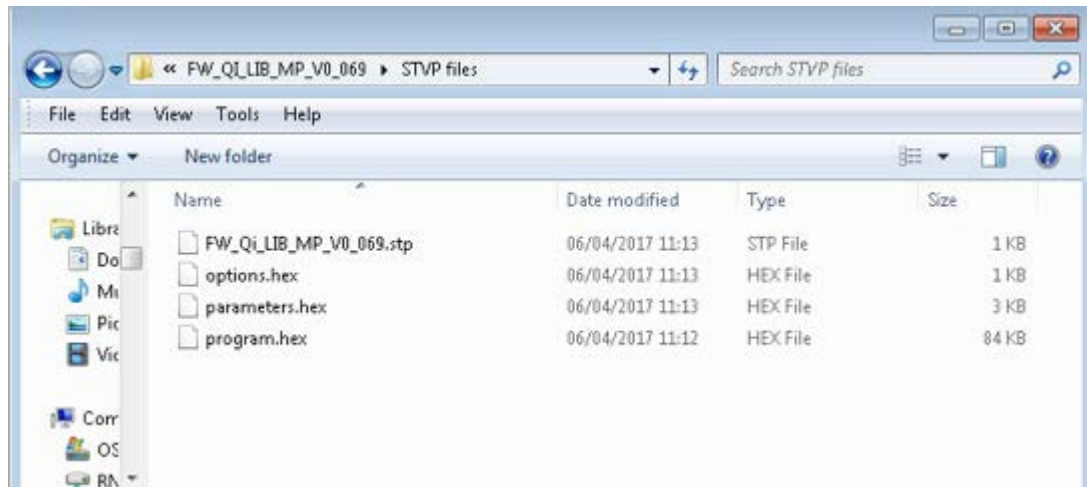


Step 3. Follow the prompt to provide the project file name.

Figure 26. STVP project file name



Four files will be generated as shown below.

Figure 27. STVP files created


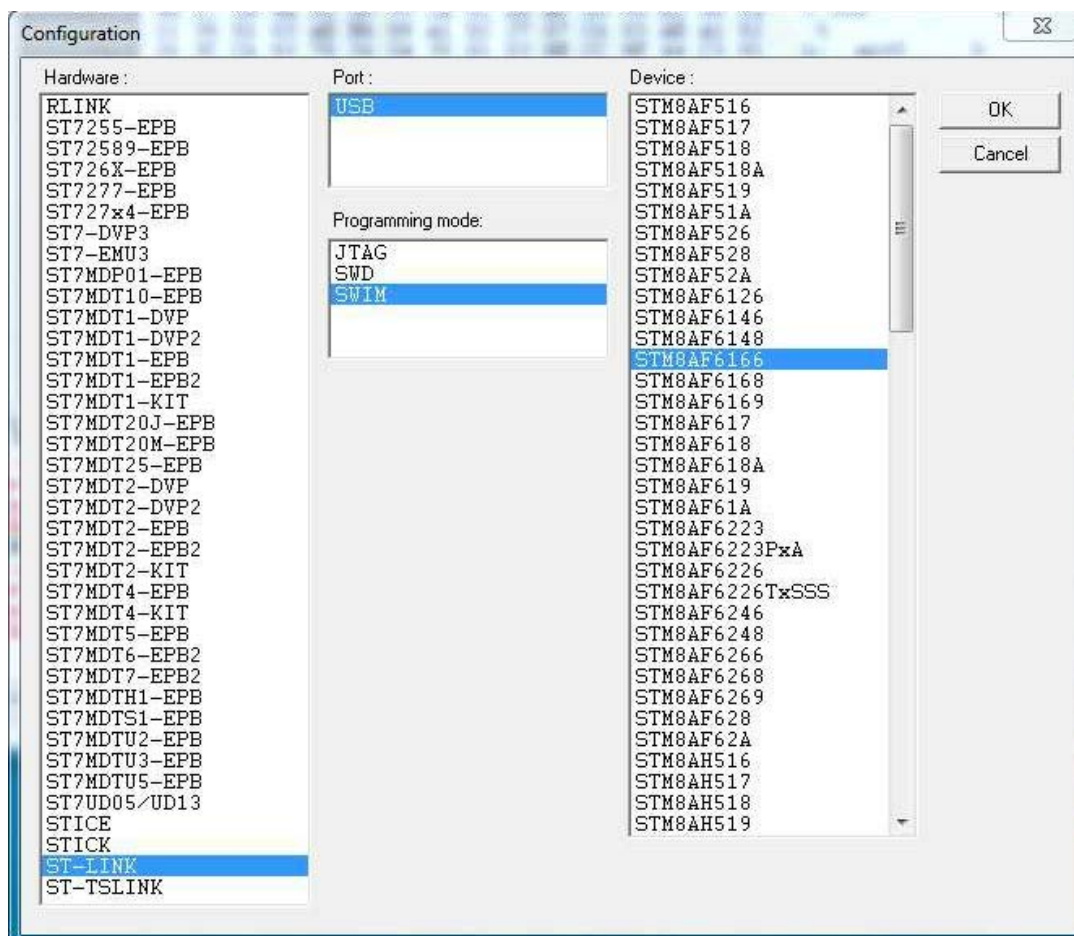
Step 4.

3.6 Firmware download with STVP

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

Note: Pay special attention in connecting the SWIM cable to the transmitter board correctly, as shown in [Figure 17. STEVAL-ISB044V1 evaluation board: ST-LINK connection.](#)

- Step 5.** Launch STVP software.
- Step 6.** Select STM8AF6166 as core (see [Figure 18. STVP core selection.](#)).
- Step 7.** In STVP, open the **Project** menu and click **Open**.
- Step 8.** Select the .stp given in the zip file.

Figure 28. STVP file selection


Step 9. Wait few seconds.

The following message should appear:

```

Loading file program.hex in PROGRAM MEMORY area...
< File successfully loaded. File Checksum 0x1D1205
  
```

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 0x4804 is out of range and is ignored!
  
```

Step 10. In STVP, open the **Program** menu and select **All tabs (on active sectors, if any)**

Step 11. Click OK if a “wrong device selected” alert appears (see [Figure 20. STVP wrong device selected alert](#)).

Step 12. Click YES if “An incompatibility has been found with this device” alert appears (see [Figure 21. STVP incompatibility device action query](#)).

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.
  
```

Step 13. Exit from the STVP program.

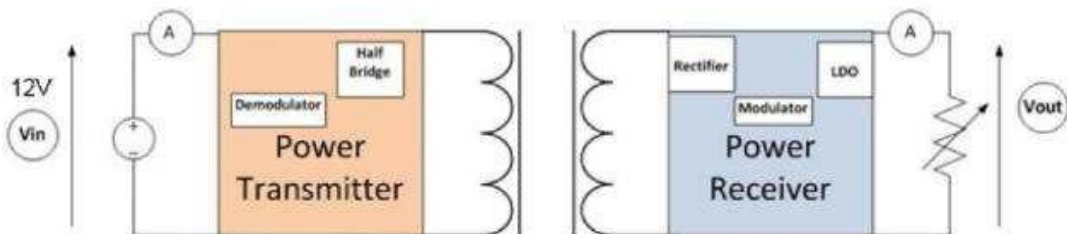
Step 14. Disconnect SWIM.

Step 15. Remove power supply from the STEVAL-ISB044V1 transmitter board.

The IAR toolchain can be installed also for firmware compilation and download.

4 Evaluation equipment setup

Figure 29. STEVAL-ISB044V1 evaluation board: test setup configuration



The board is powered via an external power supply or a USB charger. An electronic load is connected to the receiver output to load up to 15 W.

On the basis of measurements, voltmeters and ammeters measure input/output voltage and current.

4.1 External power supply

The power supply is set to 12 V/2 A for EPP mode and 5 V/2 A for BPP mode.

The board is connected to the external power supply through wires.

The jumper has to be set to select the jack/external power supply input.

Figure 30. STEVAL-ISB044V1 evaluation board: external power supply connection



4.2 USB charger

The board can be supplied by a USB charger. The jumper J101 should be set to select the USB supply input. A simple 5 V USB charger can be used. Considering the peak currents and the system efficiency, a 5 V/2 A USB charger must be considered. At this input voltage, BPP mode only is available.

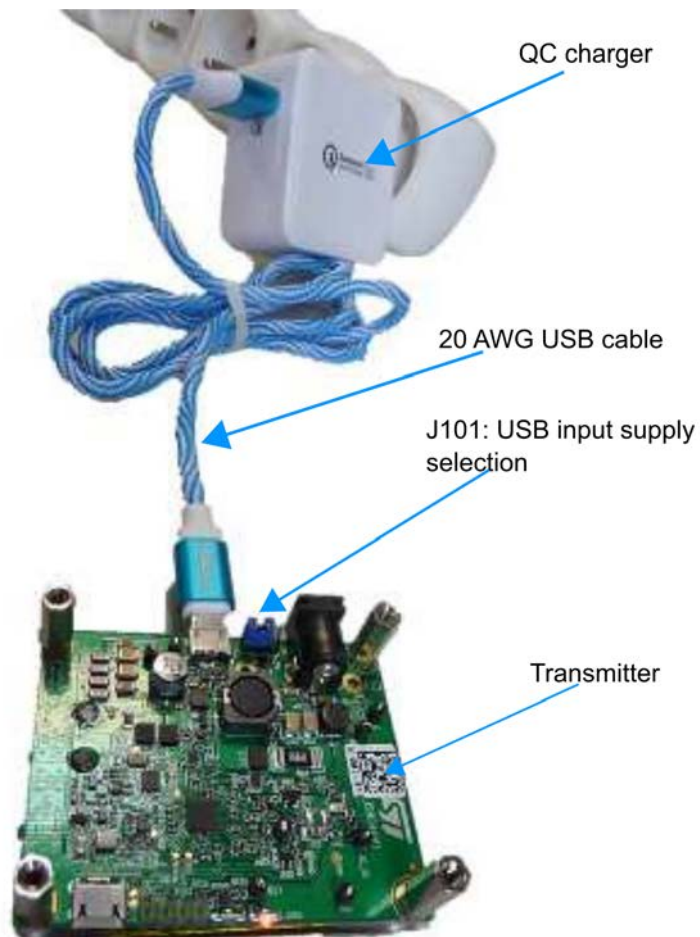
It is also possible to use a Quick Charge (QC) wall charger in order to provide higher voltage. By default, D+/D- interface selects 12V on V_{BUS} . This enables to support EPP mode.

To provide 15 W on the receiver side and considering the system efficiency, a 24 W Quick Charge wall charger should be used.

The 24W QC wall charger, with Quick Charge 3.0, tested with our solution is manufactured by KOVOL.

The USB cable between the charger and the board should be of good quality. To minimize the losses, a 20 AWG USB cable must be used.

Figure 31. STEVAL-ISB044V1 evaluation board: USB charger connection



4.3 UART configuration

The STSW-STWBCGUI is installed on the PC connected to the board via the USB-to-UART cable (connected on the board J501 USB debug connector).

Important:

This UART connection is mandatory for parameter settings and debug of the board which is using the STSW-STWBCGUI.

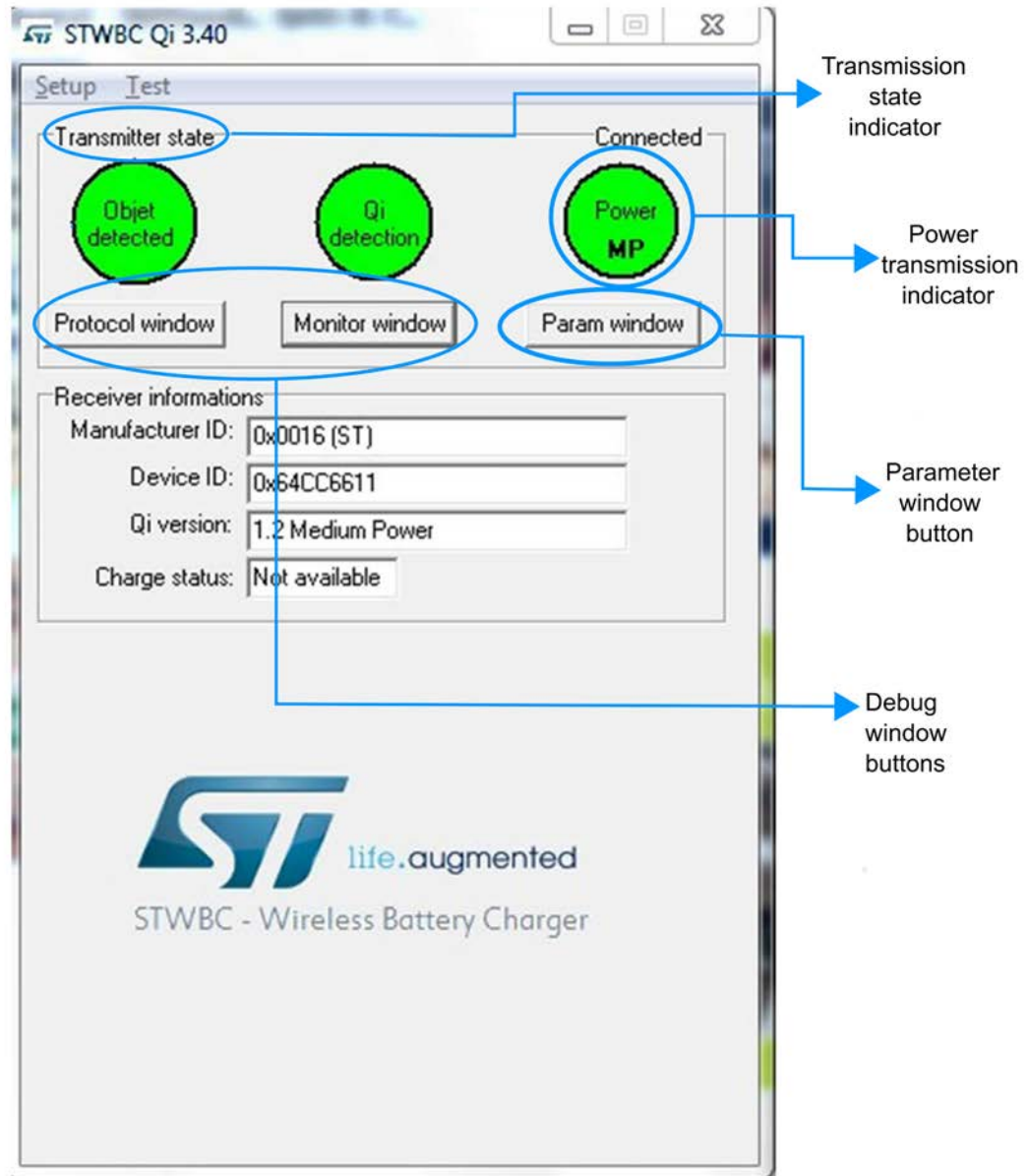
Figure 32. STEVAL-ISB044V1 evaluation board: UART connection



5 GUI and evaluation procedure

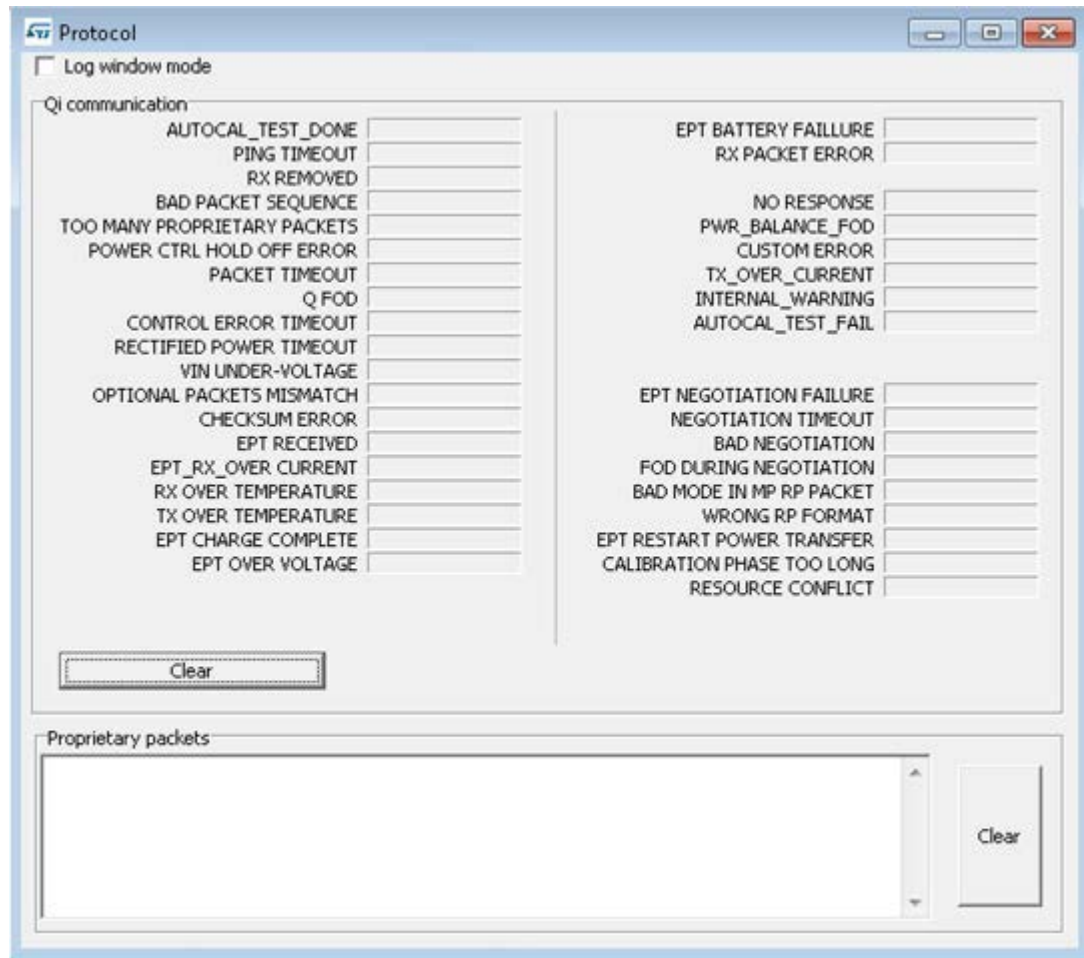
The STSW-STWBCGUI thoroughly monitors STWBC-EP operations.
The main screen provides transmitter and Qi receiver status information.

Figure 33. STSW-STWBCGUI: object detected and charge in progress



The STSW-STWBCGUI can also display the Rx to Tx communication protocol errors, useful for system debugging.

Figure 34. STSW-STWBCGUI: Qi protocol window



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

Figure 35. STSW-STWBCGUI: Qi monitor window

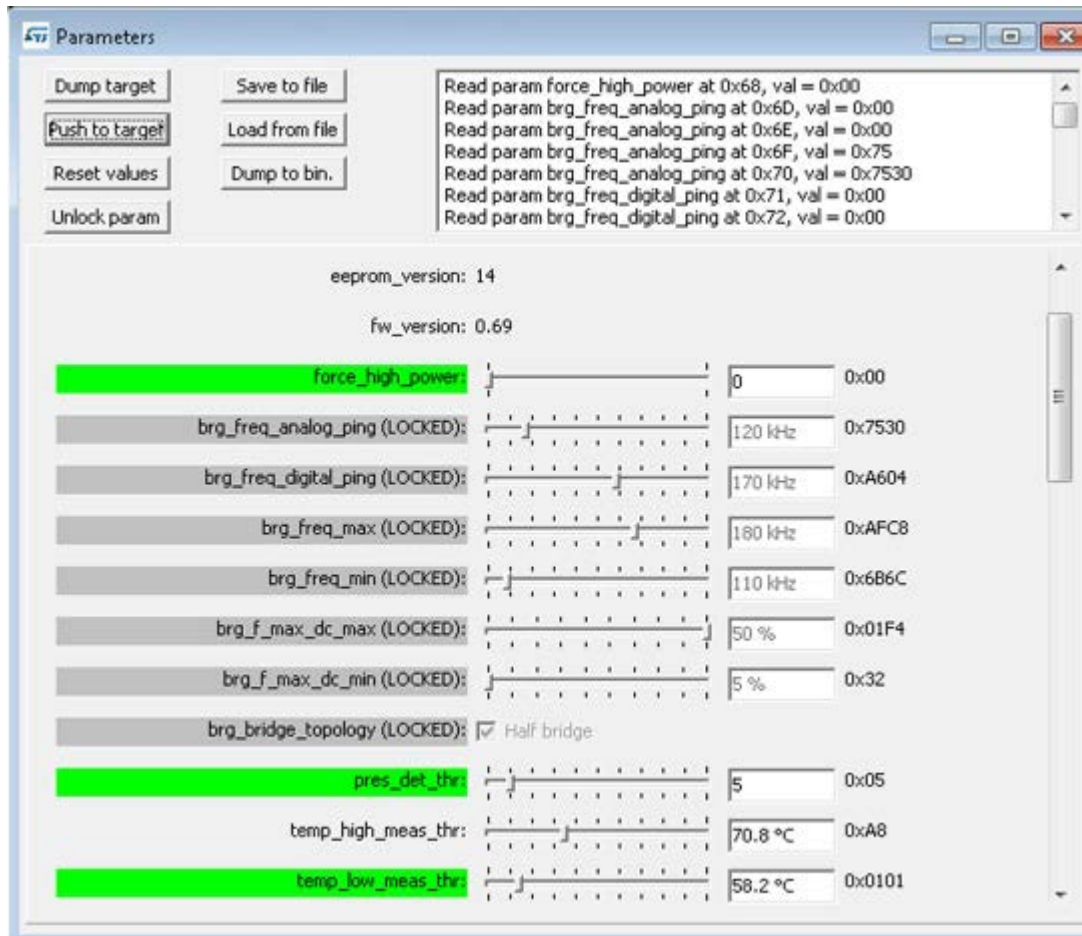


The GUI user-friendly interface allows efficient system adjustment (thresholds, regulation error) and lets you store parameters to and load parameters from your computer.

The parameters have the following levels of protection:

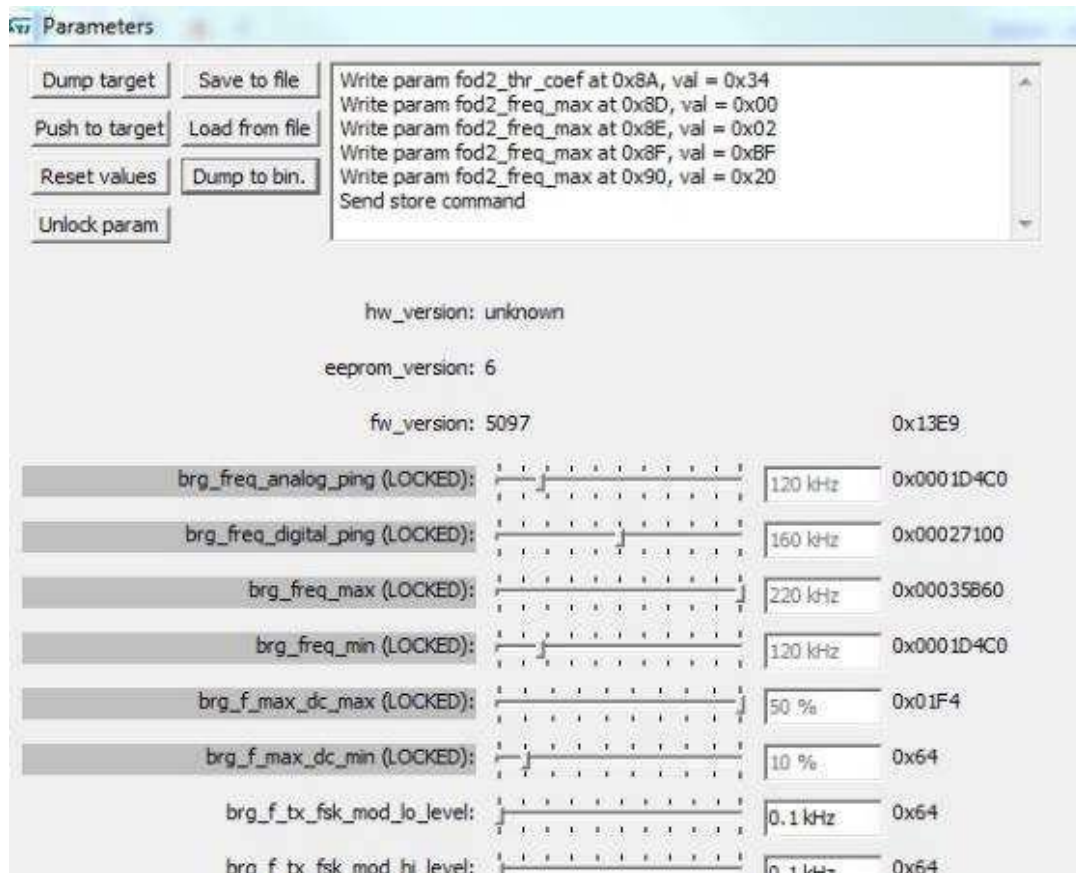
- Level 0: parameters can be modified without protection
- Level 1: more critical parameters to be modified with caution. You must click the **Unlock param** button before modifying it, with caution, as it can lead to system malfunction or trigger unexpected behavior incompatible with Qi standard.

Figure 36. STSW-STWBCGUI: Parameters window



Parameters can be modified and their effect can be tested immediately by clicking **Push to target**; modified parameters lose their highlighted background.

Figure 37. STSW-STWBCGUI: modified parameters



The GUI embeds the STSW-STWBCFWDT downloader interface (which uses UART connection) and includes tools to generate binary files with adjusted parameters and to build new firmware packages incorporating these files.

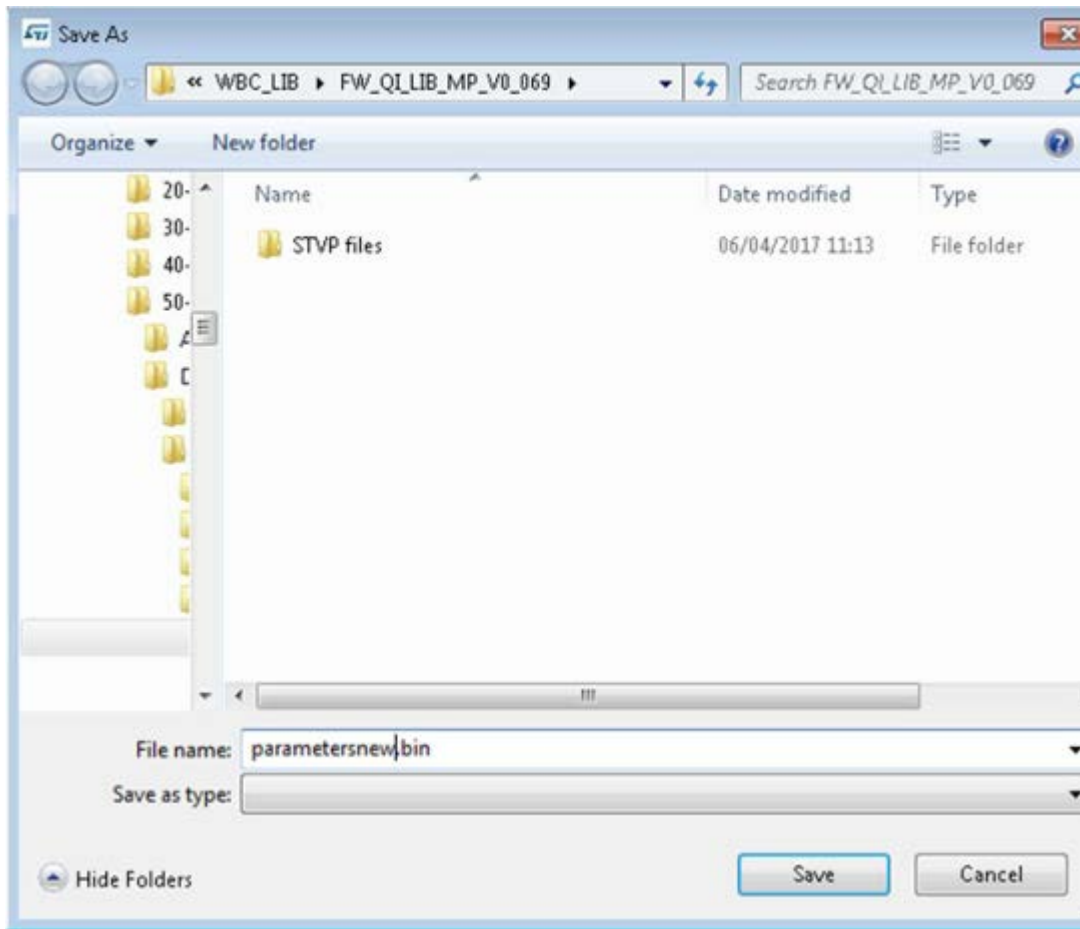
Through the GUI, you can change the parameters and produce a new cab to program a batch of new boards. To this aim, dump the parameters into a bin file, but only after clicking the **Push to target** button.

Figure 38. STSW-STWBCGUI: saving modified parameters (Dump to bin)

The screenshot shows the 'Parameters' window in the STSW-STWBCGUI. The 'Reset values' section has a red box around the 'Dump to bin.' button. The main area displays a list of parameters with their current values and addresses.

Parameter Name	Value	Address
hw_version	unknown	
eeeprom_version	6	
fw_version	5097	0x13E9
brg_freq_analog_ping (LOCKED)	120 kHz	0x0001D4C0
brg_freq_digital_ping (LOCKED)	160 kHz	0x00027100
brg_freq_max (LOCKED)	220 kHz	0x00035B60
brg_freq_min (LOCKED)	120 kHz	0x0001D4C0
brg_f_max_dc_max (LOCKED)	50 %	0x01F4
brg_f_max_dc_min (LOCKED)	10 %	0x64
brg_f_tx_fsk_mod_lo_level	0.1 kHz	0x64
brg_f_tx_fsk_mod_hi_level	0.1 kHz	0x64

Figure 39. STSW-STWBCGUI: 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 40. STSW-STWBCGUI: CAB file patch button



5.1 Status LEDs

The status LEDs give the state of the charge:

At startup

- Red short blinking: when the board auto-calibration is on-going. The user has to wait for the LED to be 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: board hardware subversion detected does not match the firmware

In steady state

- Green blinking: power transfer in progress
- Green steady state: the charge is complete
- Red blinking: an error has been detected, as incomplete charge due to battery fault, overvoltage, overcurrent, etc.

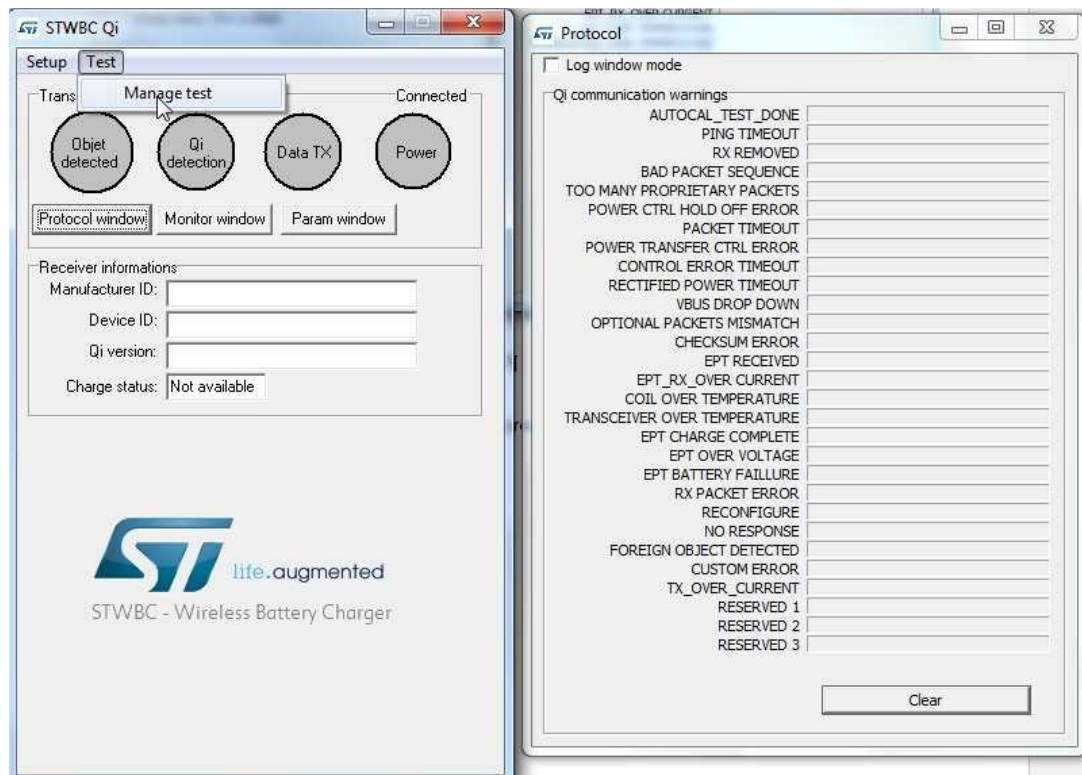
- Red steady state: the transmitter is stuck until the receiver is removed, as mentioned in the Qi standard (power transfer stopped three times in a row due to the amount of power not provided to the receiver, some types of end power transfer or no response error code)

5.2 Test procedure for board calibration

There are 2 auto-calibration phases in the GUI: one for the presence detection and one for the QFOD.

Important: Both calibrations are mandatory to ensure a good functioning of the transmitter board.

Figure 41. STSW-STWBCGUI: start auto-calibration



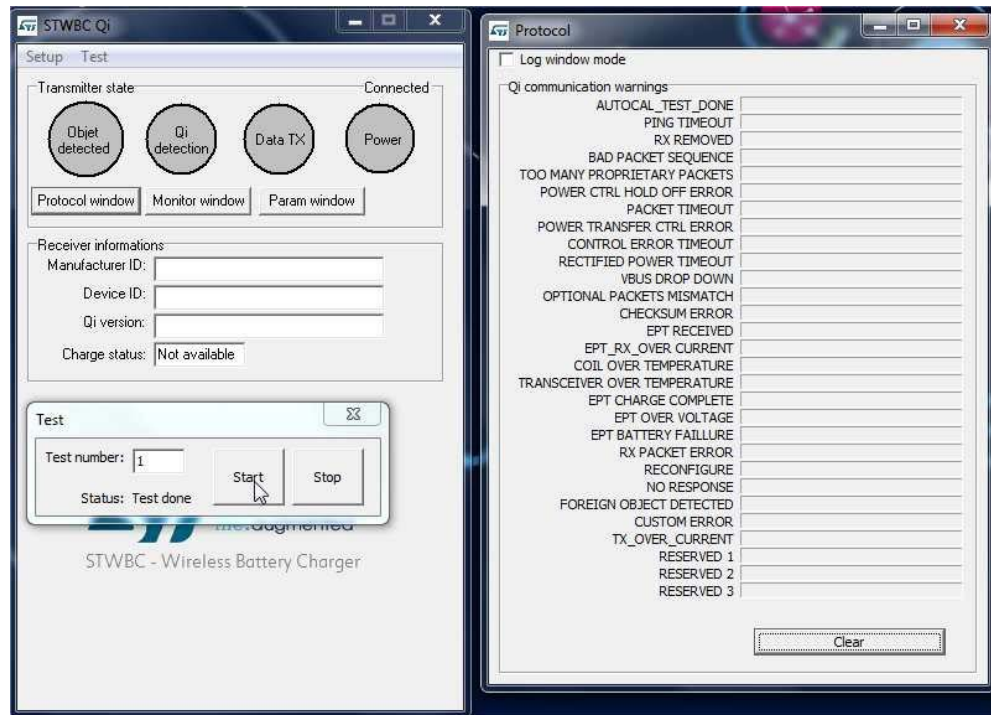
Note: This calibration should be done only once after each new firmware download, with **NO Receiver** placed on the transmitter.

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

5.2.1 Presence detection calibration procedure

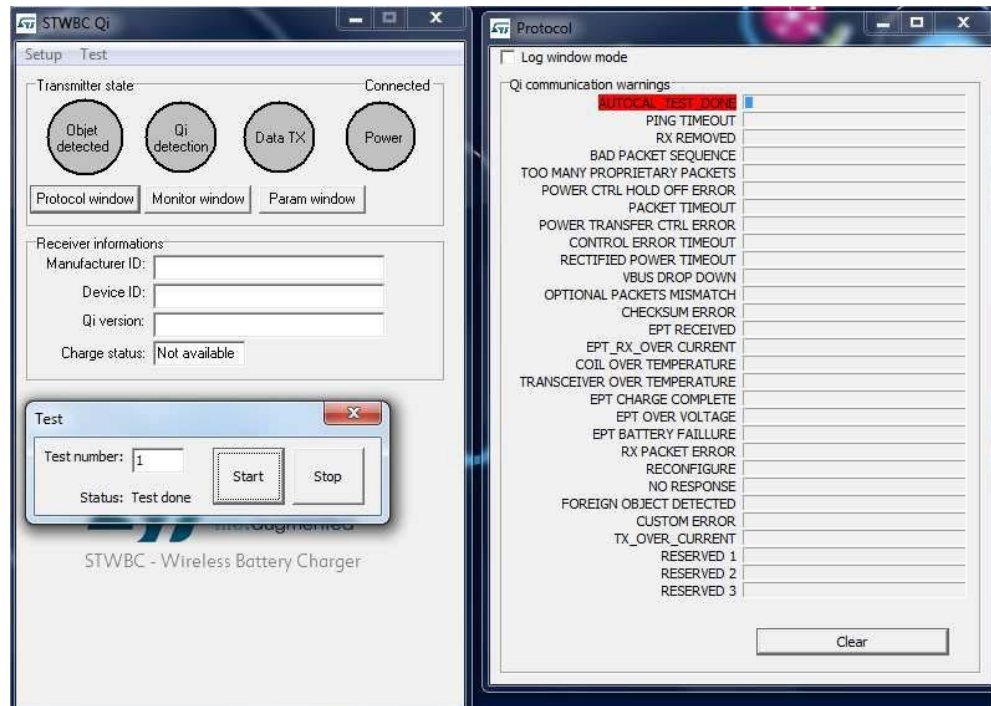
- Step 1.** Set the test number to 1
- Step 2.** Click the **Start** button

Figure 42. STSW-STWBCGUI: presence detection test



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

Figure 43. STSW-STWBCGUI: test result

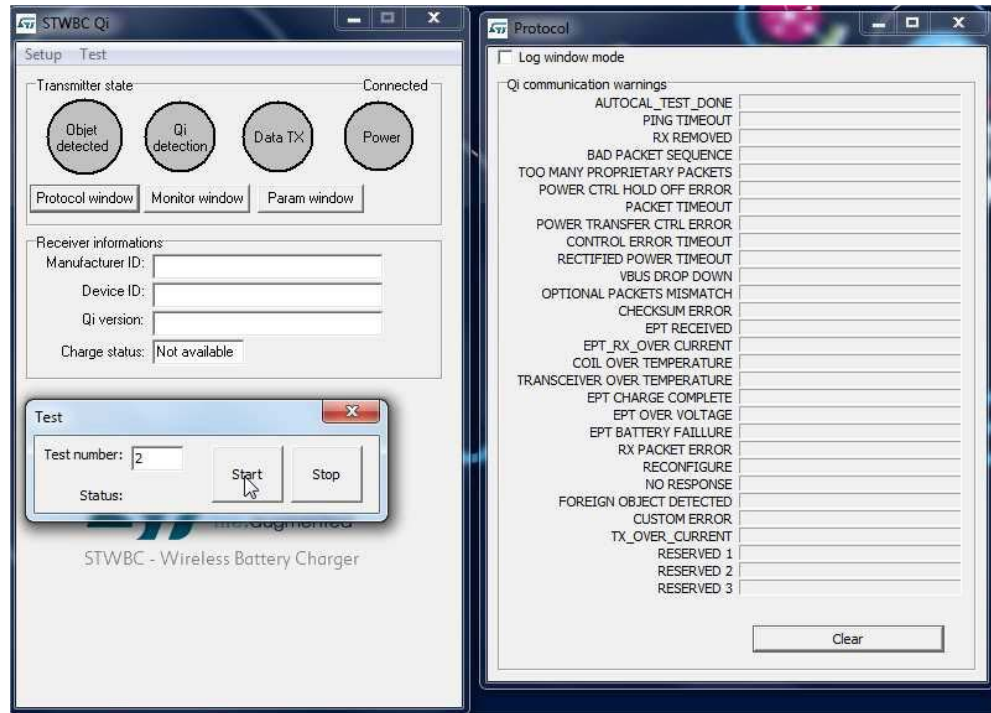


Step 3. Start the test again if the returned status is different.

5.2.2 QFOD calibration procedure

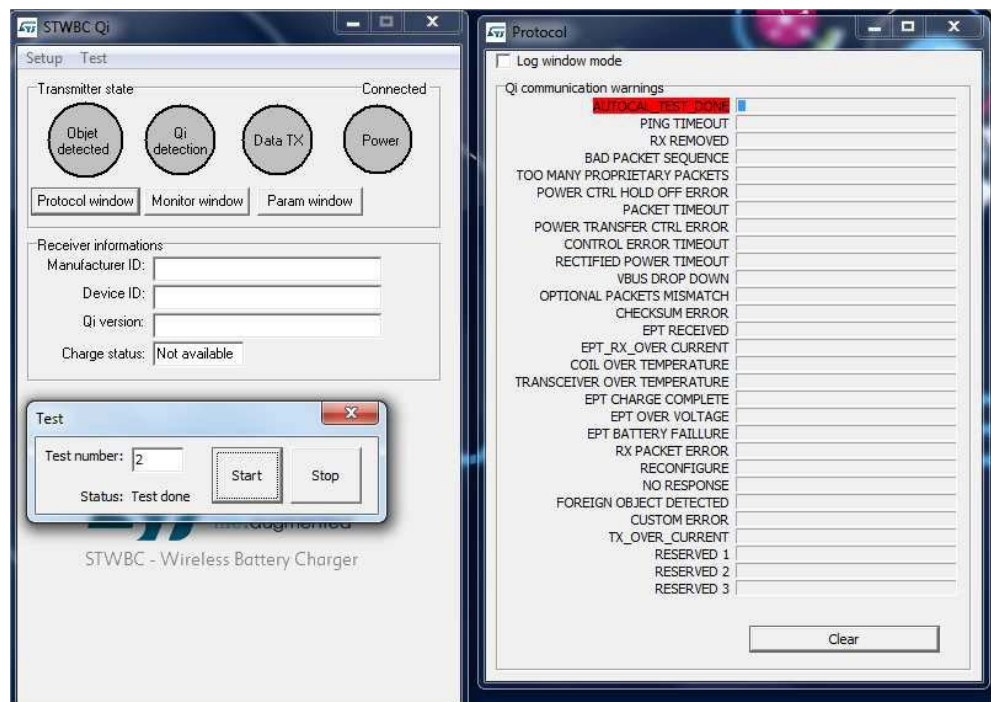
- Step 1. Set the test number to 2
- Step 2. Click the **Start** button

Figure 44. STSW-STWBCGUI: QFOD test



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

Figure 45. STSW-STWBCGUI: QFOD test result



Step 3. Start the test again if the returned status is different.

5.3 Efficiency

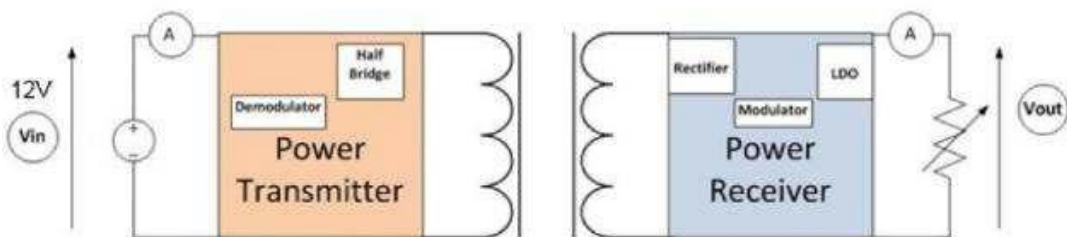
Efficiency measurements are performed on a Qi certification tester.

The STEVAL-ISB044V1 transmitter is supplied by 12 V/2 A and the receiver voltage level is 12 V (MP1B).

P_{OUT} is the output power actually measured at the receiver output (not only at the rectifier output) and P_{IN} is the input power.

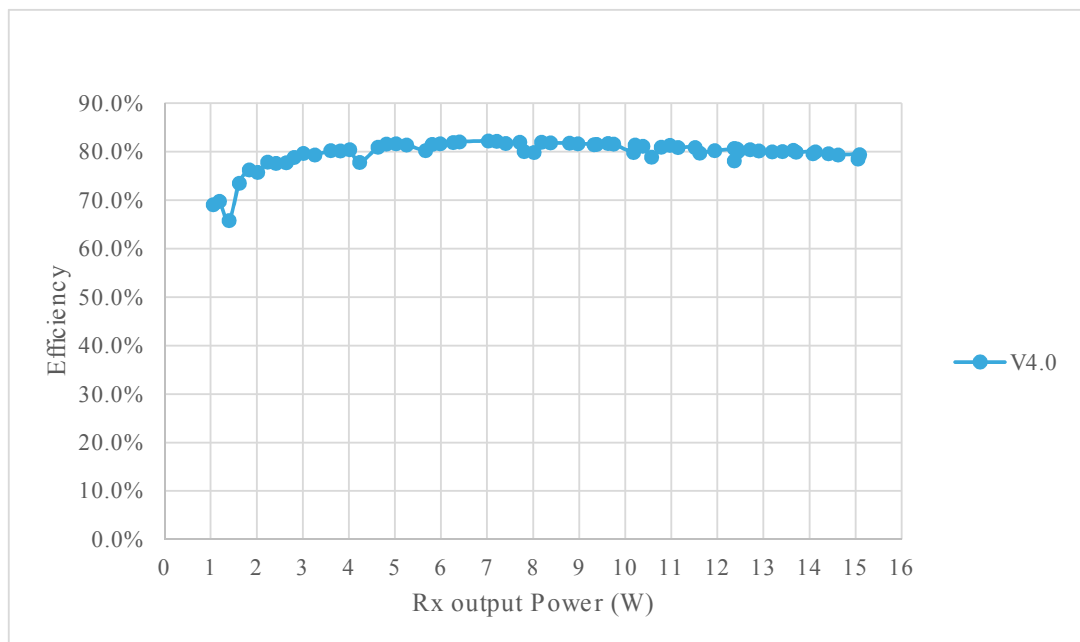
Efficiency is measured the setup configuration as per the picture below.

Figure 46. Efficiency setup



The figure below shows the typical performance on different coils (efficiency= P_{OUT}/P_{IN}).

Figure 47. STEVAL-ISB044V1 evaluation board: efficiency performance with MP1B Rx



The maximum efficiency is 82.2% at 7 W.

5.4 Stand-by consumption

In stand-by, when the board is supplied at 12 V, very low power consumption is achieved.

In this mode, device detection is still ensured; power consumption is reduced down to 1.4 mA average.

The STEVAL-ISB044V1 evaluation board has a low stand-by power of only 17 mW.
To measure this low power consumption, the UART cable must be unplugged.

Figure 49. STEVAL-ISB044V1 circuit schematic (2 of 8)

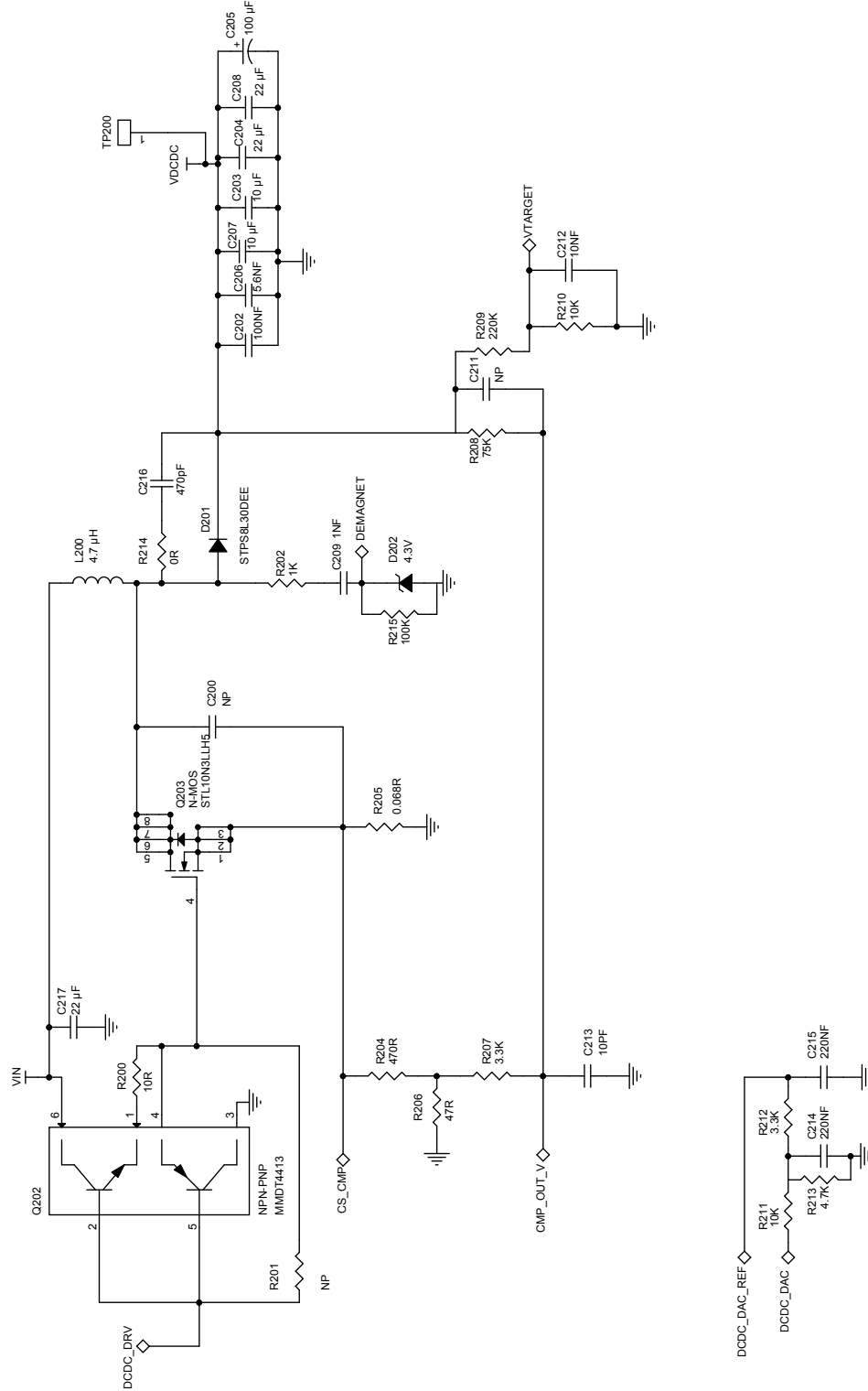


Figure 50. STEVAL-ISB044V1 circuit schematic (3 of 8)

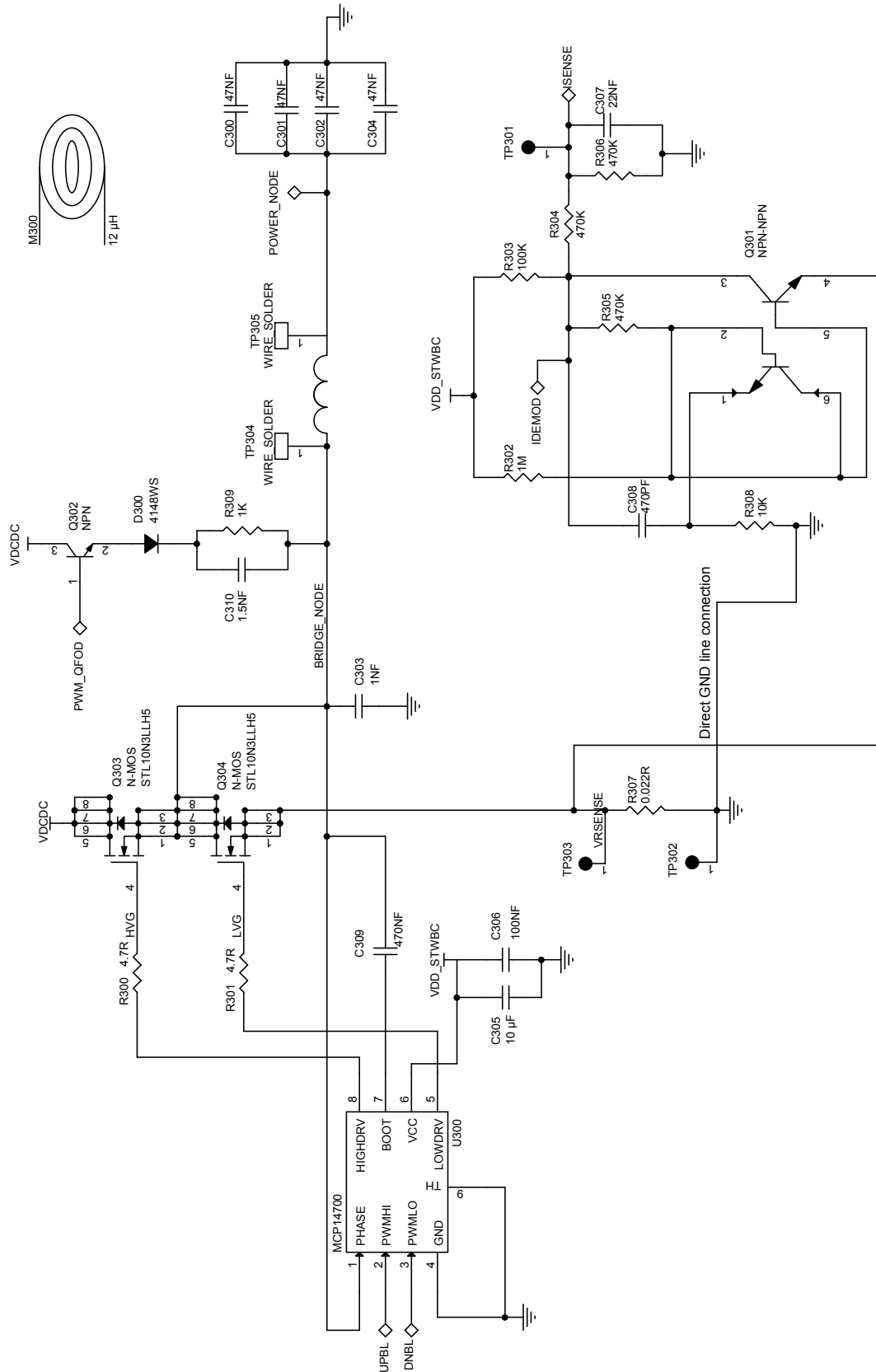


Figure 51. STEVAL-ISB044V1 circuit schematic (4 of 8)

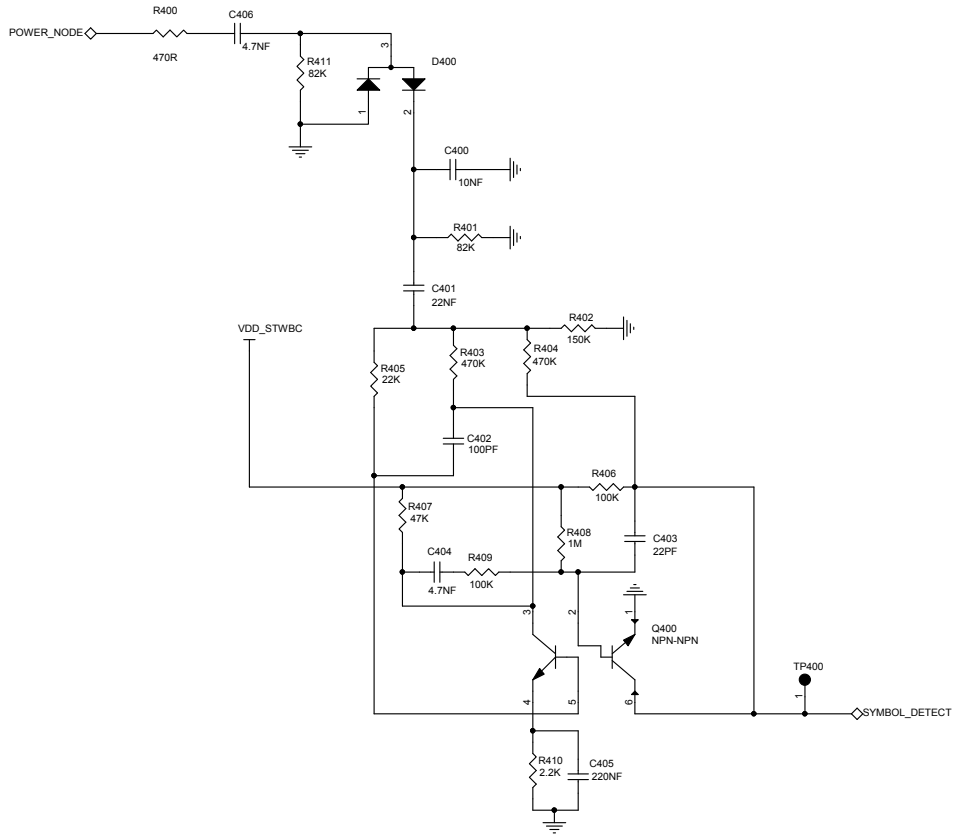


Figure 52. STEVAL-ISB044V1 circuit schematic (5 of 8)

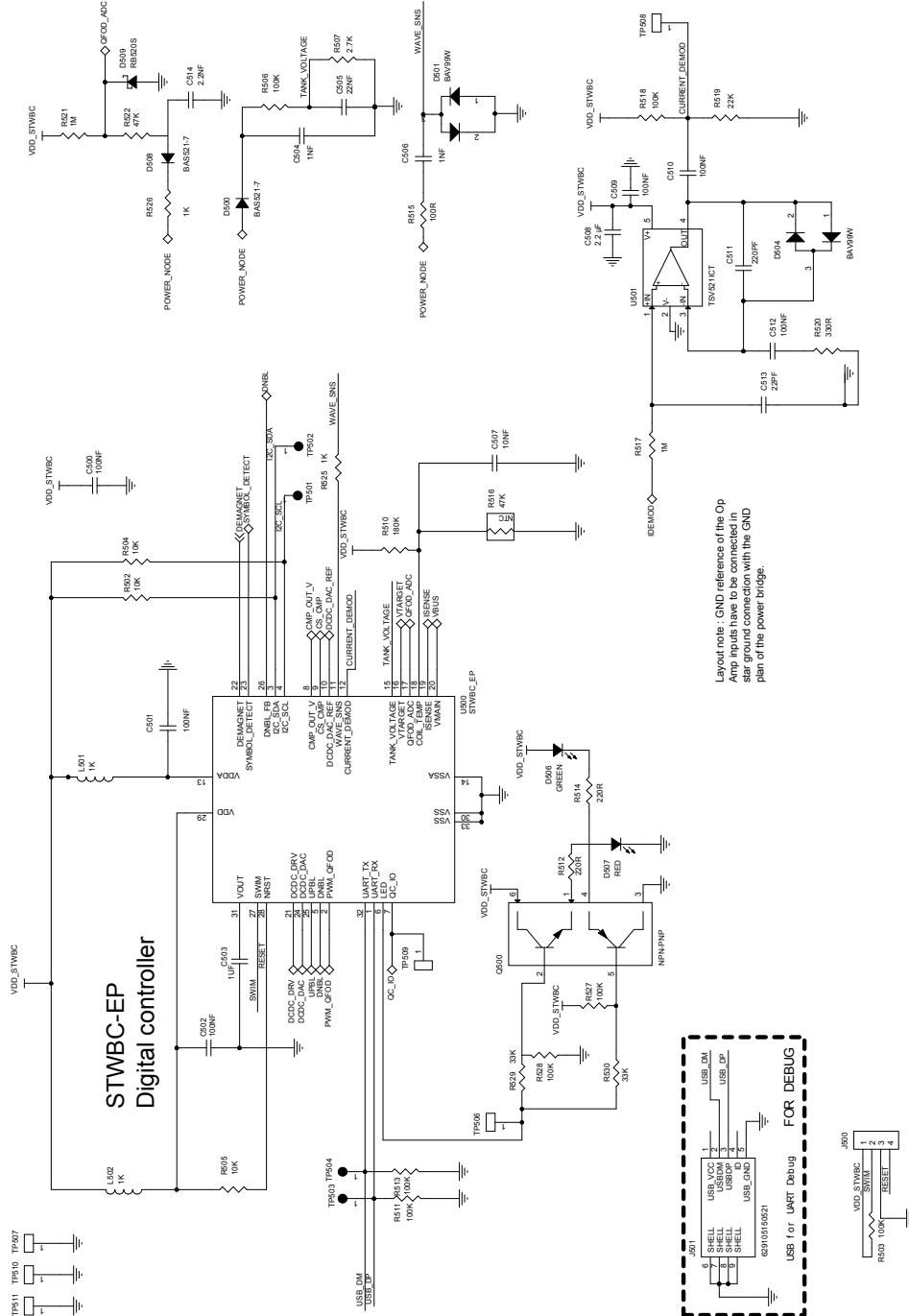


Figure 53. STEVAL-ISB044V1 circuit schematic (6 of 8)

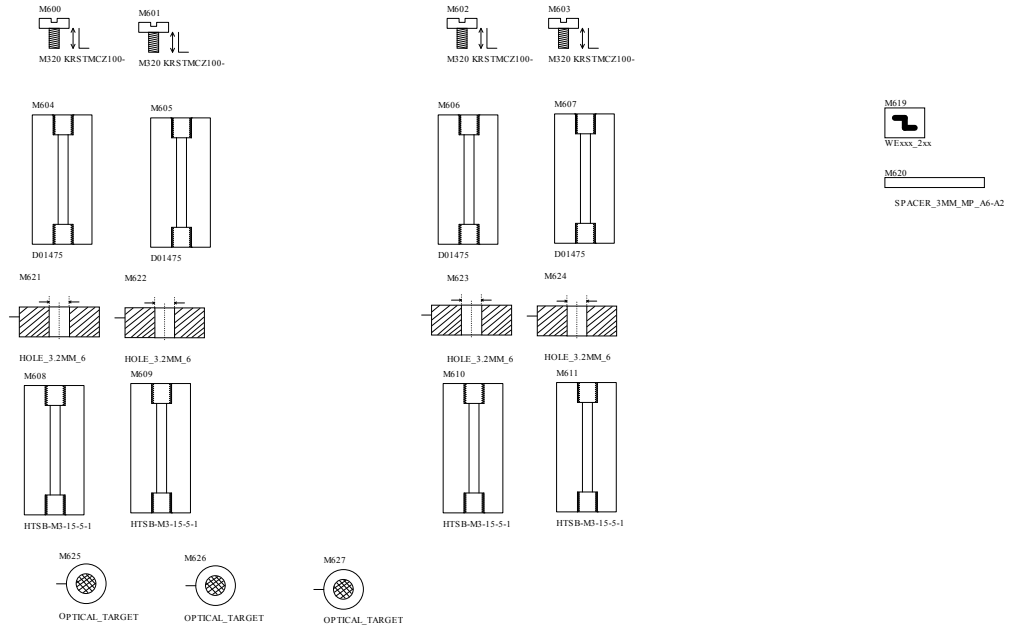


Figure 54. STEVAL-ISB044V1 circuit schematic (7 of 8)

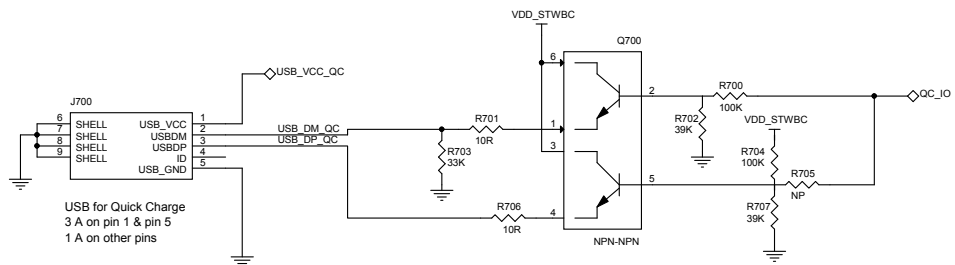
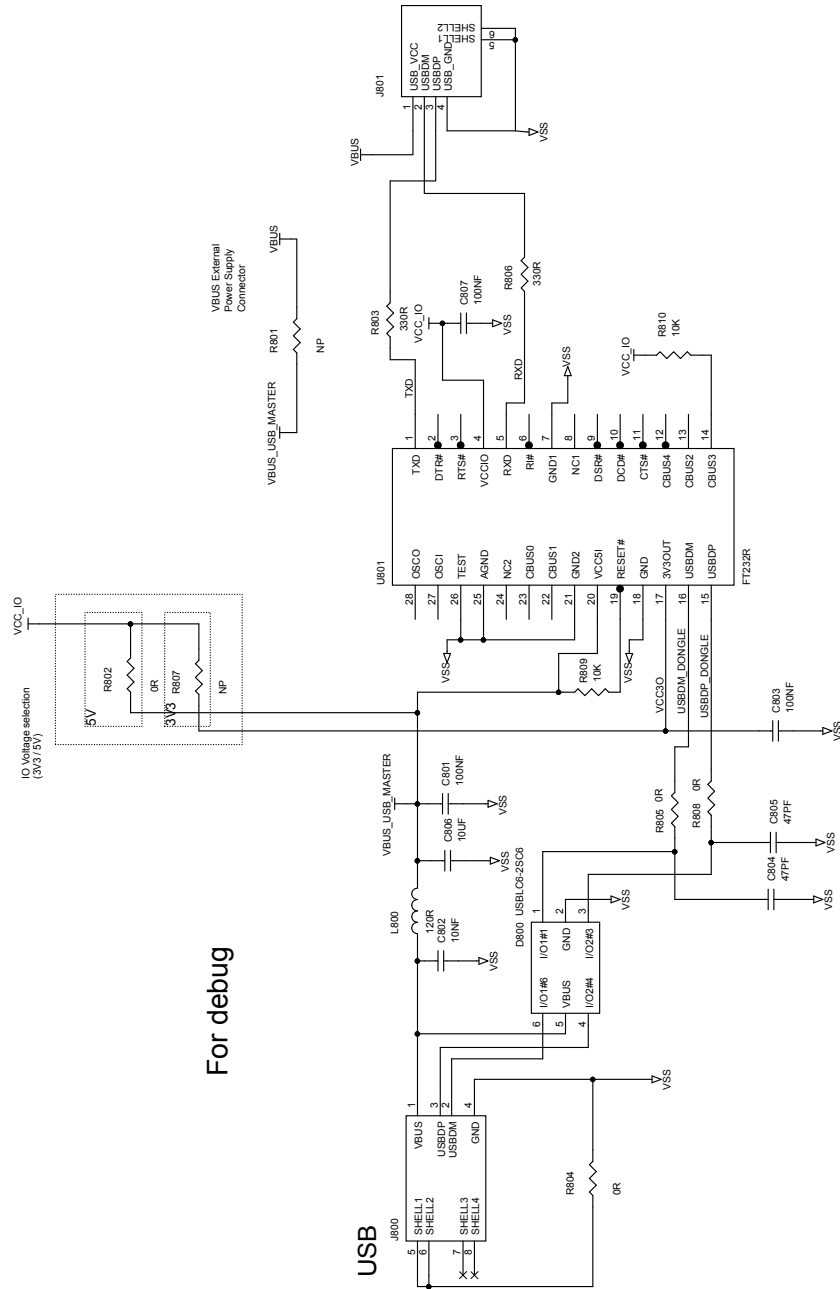


Figure 55. STEVAL-USB044V1 circuit schematic (8 of 8)



7 Bill of materials

Table 6. STEVAL-ISB044V1 bill of materials

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	2	C100, C114	NP, 0603	Ceramic capacitors	Any	C_NP_0603
2	2	C101, C103	10 μ F, 25 V, 1206, \pm 20%	Ceramic capacitors	Würth Elektronik	885012108021
3	1	C102	NP, 1210	Ceramic capacitor	Any	C_NP_1210
4	4	C104, C108, C212, C507	10 NF, 50 V, 0402, \pm 15%	Ceramic capacitors	Any	10NF_50V_X7R_0402
5	4	C106, C204, C208, C217	22 μ F, 25 V, 1210, \pm 20%	Ceramic capacitors	Würth Elektronik	885012109014
6	8	C107, C110, C115, C306, C500, C501, C502, C509	100 NF, 25 V, 0402, \pm 15%	Ceramic capacitors	Any	100NF_25V_X5R_0402
7	4	C109, C116, C200, C211	NP, 0402	Ceramic capacitors	Any	C_NP_0402
8	1	C111	10 μ F, 10 V, 0805, \pm 10%	Ceramic capacitor	Murata	GRM21BR71A106KE51L
9	4	C112, C113, C510, C512	100 NF, 50 V, 0402, \pm 15%	Ceramic capacitors	Any	100NF_50V_X5R_0402
10	1	C117	NP, 0603	Ceramic capacitor	Murata	GRM188R61E105KA12J
11	1	C202	100 NF, 50 V, 0603, \pm 5%	Ceramic capacitor	Murata	GRM188R71H104KA93D
12	2	C203, C207	10 μ F, 50 V, 1206, \pm 10%	Ceramic capacitors	Any	10UF_50V_X5R_1206
13	1	C205	100 μ F, 35 V, \pm 20%	Aluminium capacitor	Panasonic	EEEEFT1V101AP
14	1	C206	5.6 NF, 50 V, 0402, \pm 15%	Ceramic capacitor	Any	5.6NF_50V_X7R_0402
15	1	C209	1 NF, 50 V, 0402, \pm 15%	Ceramic capacitor	Any	1NF_50V_X5R_0402
16	1	C213	10 PF, 50 V, 0402, \pm 15%	Ceramic capacitor	Any	10PF_50V_X7R_0402
17	2	C214, C215	220 NF, 35 V, 0603, \pm 15%	Ceramic capacitors	Any	220NF_35V_X7R_0603
18	1	C216	470pF, 50V, 15%	Ceramic capacitor	Any	470pF_50V_COG_402
19	4	C300, C301, C302, C304	47 NF, 100 V, 1206, \pm 5%	Ceramic capacitors	TDK	C3216C0G2A473J115AC
20	1	C303	1 NF, 50 V, 0603, \pm 15%	Ceramic capacitor	Any	1NF_50V_X5R_0603
21	1	C305	10 μ F, 6.3 V, 0805, \pm 15%	Ceramic capacitor	Any	10UF_6V3_X5R_0805
22	2	C307, C505	22 NF, 50 V, 0402, \pm 15%	Ceramic capacitors	Any	22NF_50V_X7R_0402

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
23	1	C308	470 PF, 50 V, 0402, ±15%	Ceramic capacitor	Any	470PF_50V_X7R_0402
24	1	C309	470 NF, 25 V, 1206, ±15%	Ceramic capacitor	Any	470NF_25V_X7R_1206
25	1	C310	1.5 NF, 50 V, 0402, ±10%	Ceramic capacitor	Any	1.5NF_50V_X7R_0402
26	1	C400	10 NF, 100 V, 0805, ±5%	Ceramic capacitor	TDK	C2012C0G2A103J125AA
27	1	C401	22 NF, 100 V, 1210, ±5%	Ceramic capacitor	TDK	C3225C0G2A223J160AA
28	1	C402	100 PF, 50 V, 0402, ±5%	Ceramic capacitor	Any	100PF_50V_COG_0402
29	2	C403, C513	22 PF, 50 V, 0402, ±5%	Cer,402	Any	22PF_50V_COG_0402
30	1	C404	4.7 NF, 50 V, 0402, ±15%	Ceramic capacitor	Any	4.7NF_50V_X7R_0402
31	1	C405	220NF, 50V,10%	Ceramic capacitor	Any	220NF_50V_X7R_0402
32	1	C406	4.7 NF, 100 V, 0603, ±10%	Ceramic capacitor	TDK	CGA3E2X7R2A472K080AA
33	1	C503	1 µF, 16 V, ±10%	Ceramic capacitor	Any	1UF_16V_X5R_0402
34	2	C504, C506	1 NF, 100 V, 0402, ±15%	Ceramic capacitors	Any	1NF_100V_X7R_0402
35	1	C508	2.2 µF, 25 V, 0402, ±10%	Ceramic capacitor	Any	2.2UF_25V_X5R_0402
36	1	C511	220 PF, 50 V, 0402, ±15%	Ceramic capacitor	Any	220PF_50V_X7R_0402
37	1	C514	2.2 NF, 50 V, 0402, ±15%	Ceramic capacitor	Any	2.2NF_50V_X7R_0402
38	3	C801, C803, C807	100 NF, 50 V, 0603, ±15%	Ceramic capacitors	Any	100NF_50V_X7R_0603
39	1	C802	10 NF, 50 V, 0603, ±15%	Ceramic capacitor	Any	10NF_50V_X7R_0603
40	2	C804, C805	47 PF, 25 V, 0603, ±15%	Ceramic capacitors	Any	47PF_25V_X5R_0603
41	1	C806	10 µF, 25 V, 0805, ±10%	Ceramic capacitor	Any	10UF_25V_X7R_0805
42	1	D100	SMM4F13A	TVS	ST	SMM4F13A-TR
43	1	D201	STPS8L30DEE	Power Schottky rectifier	ST	STPS8L30DEE-TR
44	1	D202	4.3V	Zener, SOD323	NXP	BZX384-C4V3-AK
45	1	D300	4148WS	Diode, SOD323	Any	Any
46	1	D400	MMBD1503A	Diode, SOT23	Fairchild	MMBD1503A
47	2	D500, D508	BAS521-7	Diode, DIOD_SOD523	Any	Any
48	2	D501, D504	BAV99W	Diode, SOT323	NXP	BAV99W
49	1	D506	GREEN	LED, L3.2_W2.5_H1	Würth Elektronik	155124VS73200

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
50	1	D507	RED	LED, L3.2_W2.5_H1	Würth Elektronik	155124RS73200
51	1	D509	RB520S	Schottky, SOD523	Rohm	RB520S
52	1	D800	USBLC6-2SC6Y	Automotive very low capacitance ESD protection	ST	USBLC6-2SC6Y
53	1	J100	PJ-002A	Jack	CUI	PJ-002A
54	1	J101	61300311121	Header	Würth Elektronik	61300311121
55	1	J500	5-826936-0	Header	Te Connectivity	5-826936-0
56	2	J501, J700	6.29105E+11	USB	Würth Elektronik	629105150521
57	1	J800	48037-0001	USB	Molex	48037-0001
58	1	J801	61400416021	USB	Würth Elektronik	61400416021
59	1	L101	2.2 μ H, 3.8 A, \pm 20%	Inductor, L5_W5_H4	Würth Elektronik	74404054022
60	1	L102	NP	Inductor, L2.5_W2.0_H1. 0	Würth Elektronik	74438323100
61	1	L200	4.7 μ H, 7 A, \pm 20%	Inductor, L10_W10_H5	Würth Elektronik	7447714047
62	2	L501, L502	1 K, 0.2 A, \pm 25%	Ferrite, 402	Murata	BLM15AG102SN1D
63	1	L800	120 R, 0.5 A, \pm 25%	Ferrite, 603	Würth Elektronik	74279262
64	1	M300	12 μ H, 8 A	Inductor,	Würth Elektronik	760 308 104 113
65	4	M600, M601, M602, M603	M320 KRSTMCZ100-	Screw	Duratool	M320 KRSTMCZ100-
66	4	M604, M605, M606, M607	D01475	Spacer	Duratool	D01475
67	4	M608, M609, M610, M611	HTSB- M3-15-5-1	Spacer	Richco	HTSB-M3-15-5-1
68	1	M619	PCB WE - 2 layers	PCB	Any	Any
69	1	M620	SPACER_3MM_ MP_A6-A2, ,	Cover	Any	Any
70	1	Q202	NPN-PNP	CMS, SOT363	OnSemiconducto rs	MMDT4413
71	3	Q203, Q303, Q304	N-MOS	N-channel Power MOSFET	ST	STL10N3LLH5
72	3	Q301, Q400, Q700	NPN-NPN	CMS, SOT363	OnSemiconducto rs	BC847CDW1T1G
73	1	Q302	NPN	CMS, SOT23	Diodes Incorporated	BC817-40-7-F
74	1	Q500	NPN-PNP	CMS, SOT363	OnSemiconducto rs	BC847BPDW1T1G
75	2	R100, R209	220 K, 1/16 W, \pm 1%	Resistors	Any	Any
76	1	R101	18 K, 1/16 W, \pm 1%	Resistor	Any	Any

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
77	1	R104	330 K, 1/16 W, ±1%	Resistor	Any	Any
78	1	R106	120 K, 1/16 W, ±5%	Resistor	Any	Any
79	1	R107	NP	Resistor	Any	Any
80	3	R108, R201, R705	NP	Resistors	Any	Any
81	2	R109,R214	0 R, 1/16 W, ±5%	Resistors	Any	Any
82	3	R200,R701, R706	10 R, 1/16 W, ±5%	Resistors	Vishay	10R_5%_0402
83	3	R202, R309, R525	1 K, 1/16 W, ±1%	Resistors	Any	Any
84	2	R204, R400	470 R, 1/16 W, ±1%	Resistors	Any	Any
85	1	R205	0.068 R, 1 W, ±1%	Resistor	Te Connectivity	TLM3ADR068FTE
86	1	R206	47 R, 1/16 W, ±5%	Resistor	Any	Any
87	2	R207, R212	3.3 K, 1/16 W, ±1%	Resistors	Any	Any
88	1	R208	75 K, 1/16 W, ±1%	Resistor	Any	Any
89	3	R210, R211, R308	10 K, 1/16 W, ±1%	Resistors	Any	Any
90	1	R213	4.7 K, 1/16 W, ±1%	Resistor	Any	Any
91	8	R215, R503, R511, R513, R527, R528, R700, R704	100 K, 1/16 W, ±5%	Resistors	Any	Any
92	2	R300, R301	4.7 R, 1/16 W, ±1%	Resistors	Any	Any
93	3	R302, R408, R521	1 M, 1/16 W, ±1%	Resistors	Any	Any
94	5	R303, R406, R409, R506, R518	100 K, 1/16 W, ±1%	Resistors	Any	Any
95	5	R304, R305, R306, R403, R404	470 K, 1/16 W, ±1%	Resistors	Any	Any
96	1	R307	0.022 R, 1 W, ±0.01	Resistor	Any	Any
97	2	R401, R411	82 K, 1/16 W, ±1%	Resistors	Any	Any
98	1	R402	150 K, 1/16 W, ±1%	Resistor	Any	Any
99	2	R405, R519	22 K, 1/16 W, ±1%	Resistors	Any	Any
100	2	R407, R522	47 K, 1/16 W, ±1%	Resistors	Any	Any

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
101	1	R410	2.2 K, 1/16 W, ±5%	Resistor	Any	Any
102	3	R502, R504, R505	10 K, 1/16 W, ±5%	Resistors	Any	Any
103	1	R507	2.7 K, 1/16 W, ±1%	Resistor	Any	Any
104	1	R510	180 K, 1/16 W, ±1%	Resistor	Any	Any
105	2	R512, R514	220 R, 1/16 W, ±5%	Resistors	Any	Any
106	1	R515	100 R, 1/10 W, ±5%	Resistor	Any	Any
107	1	R516	47 K, ±1%	Resistor	Murata	NCP15WB473F03RC
108	1	R517	1 M, 1/16 W, ±5%	Resistor	Any	Any
109	1	R520	330 R, 1/16 W, ±5%	Resistor	Any	Any
110	1	R526	1 K, 1/16 W, ±5%	Resistor	Any	Any
111	3	R529, R530, R703	33 K, 1/16 W, ±1%	Resistors	Any	Any
112	1	R702	39 K, 1/16 W, ±1%	Resistor	Any	Any
113	1	R707	39 K, 1/16 W, ±5%	Resistor	Any	Any
114	2	R801, R807	NP	Resistors	Any	Any
115	4	R802, R804, R805, R808	0 R, 1/10 W, ±5%	Resistors	Any	Any
116	2	R803, R806	330 R, 1/10 W, ±5%	Resistors	Any	Any
117	2	R809, R810	10 K, 1/10 W, ±5%	Resistors	Any	Any
118	4	TP100, TP101, TP304, TP305	WIRE_SOLDER	Test point	Any	Any
119	8	TP102, TP200, TP506, TP507, TP508, TP509, TP510, TP511	5001	Test point	Keystone	5001
120	9	TP103, TP301, TP302, TP303, TP400, TP501, TP502, TP503, TP504	TPSMD-1MM	Test point	Any	Any
121	1	U100	LDK320M-R	Low drop voltage regulator	ST	LDK320M-R
122	1	U101	NP	Step-down monolithic switching regulator	ST	L6984
123	1	U300	MCP14700	Driver, DFN8_L3_W3	Microchip	MCP14700_DFN8

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
124	1	U500	STWBC_EP	Digital controller for wireless battery charger transmitters	ST	STWBC-EP
125	1	U501	TSV521ICT	CMOS op-amps	ST	TSV521ICT
126	1	U801	FT232R	Converter, SSOP28	FTDI	FT232R

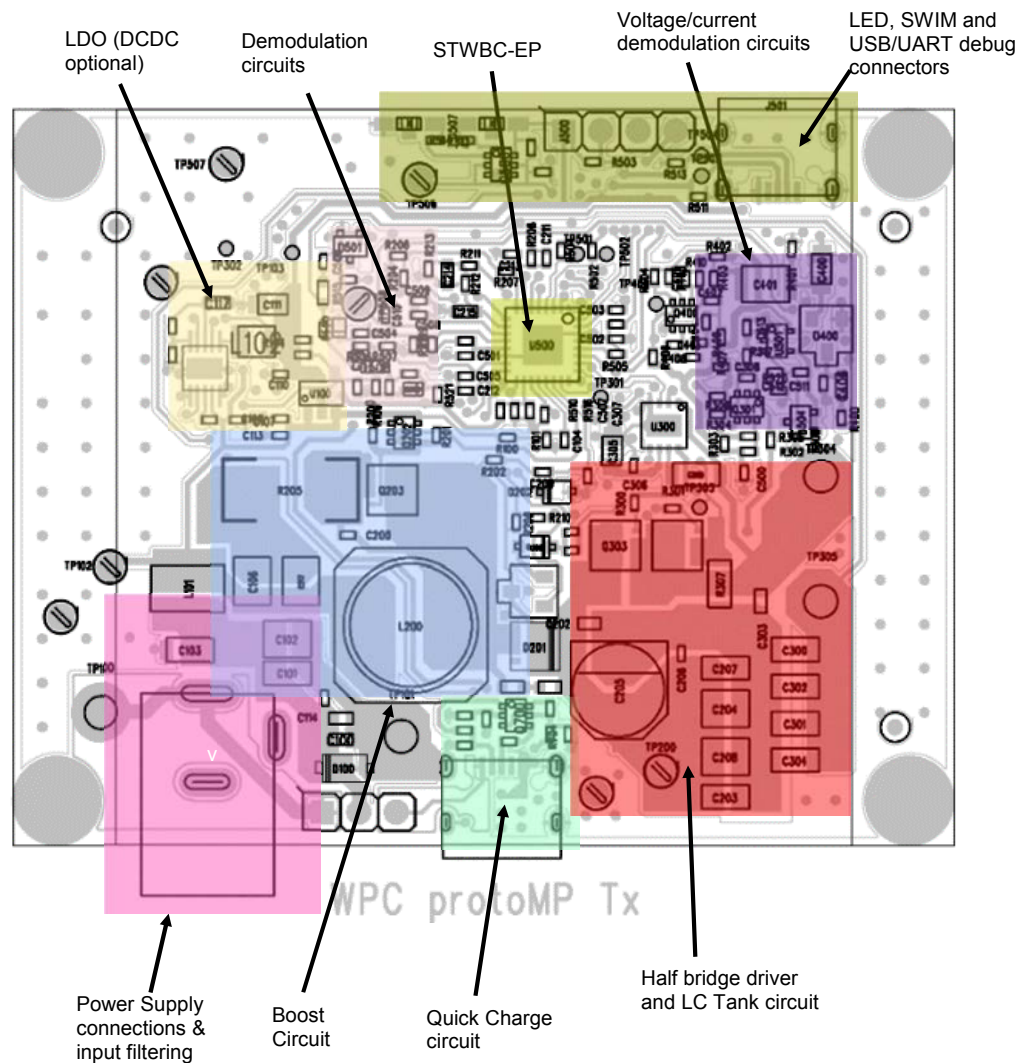
8 Board assembly and layout

The STEVAL-ISB044V1 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 the SWIM is routed to a header connector.

Figure 56. STEVAL-ISB044V1 evaluation board: functional block assembly



8.1 Power signals (BOOST, GND, LC)

Figure 57. STEVAL-ISB044V1 evaluation board: power signal routing

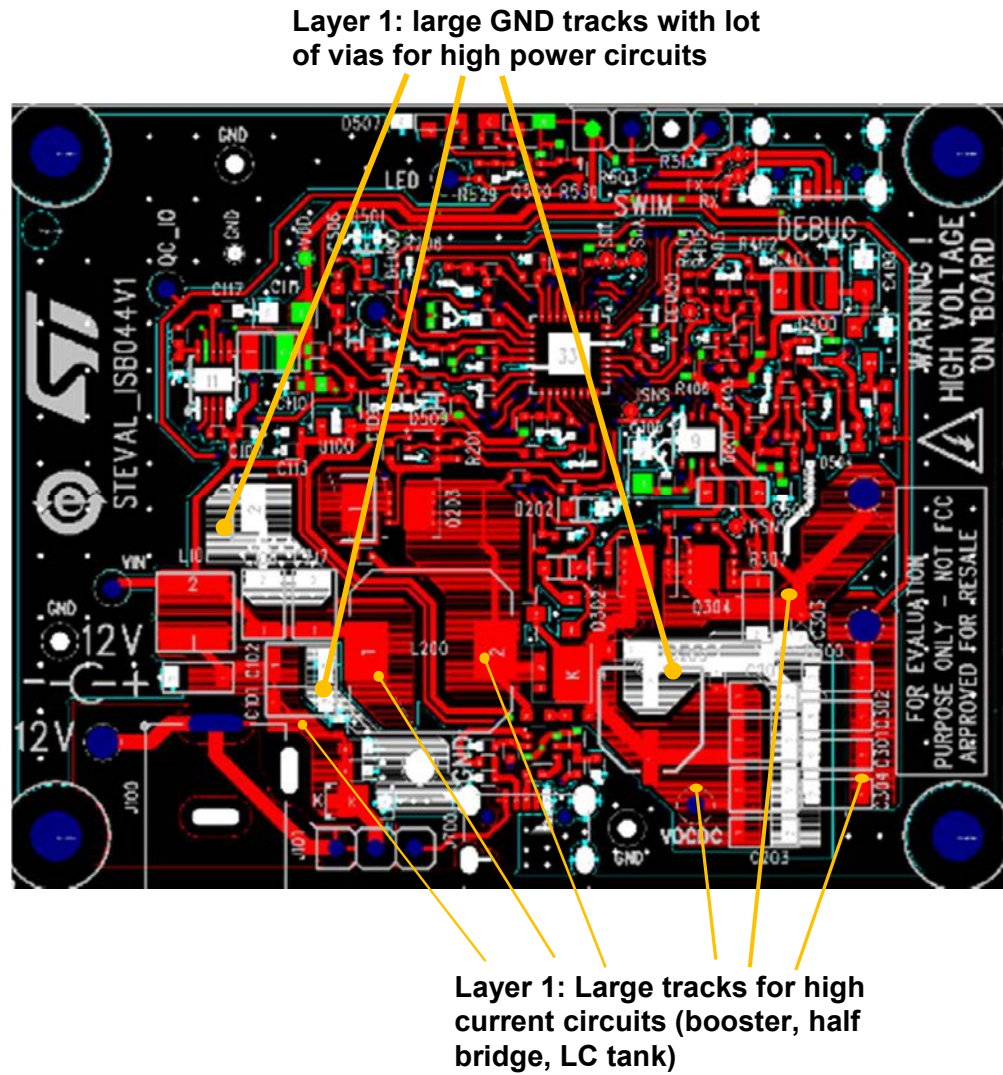
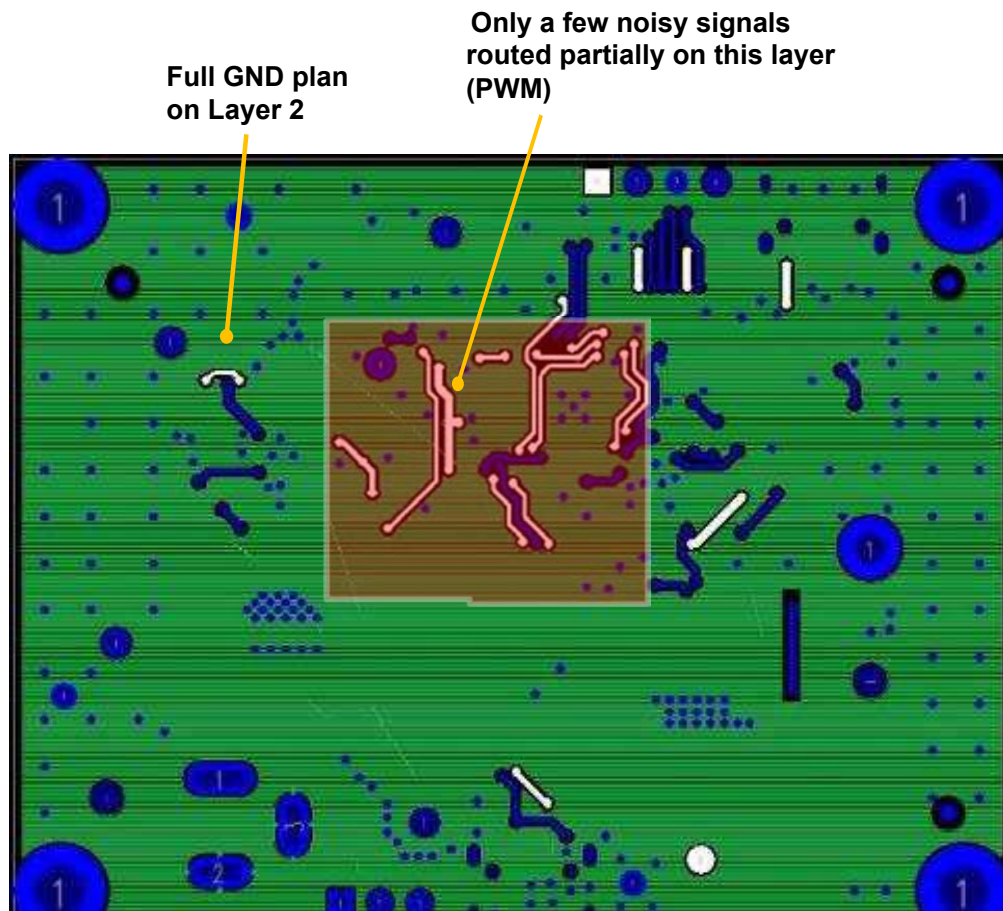


Figure 58. STEVAL-ISB044V1 evaluation board: ground plan



DC-DC boost signals are designed on the same layer: tracks must be wide (>2 mm) to handle high current.

Figure 59. STEVAL-ISB044V1 evaluation board: DC-DC boost routing details

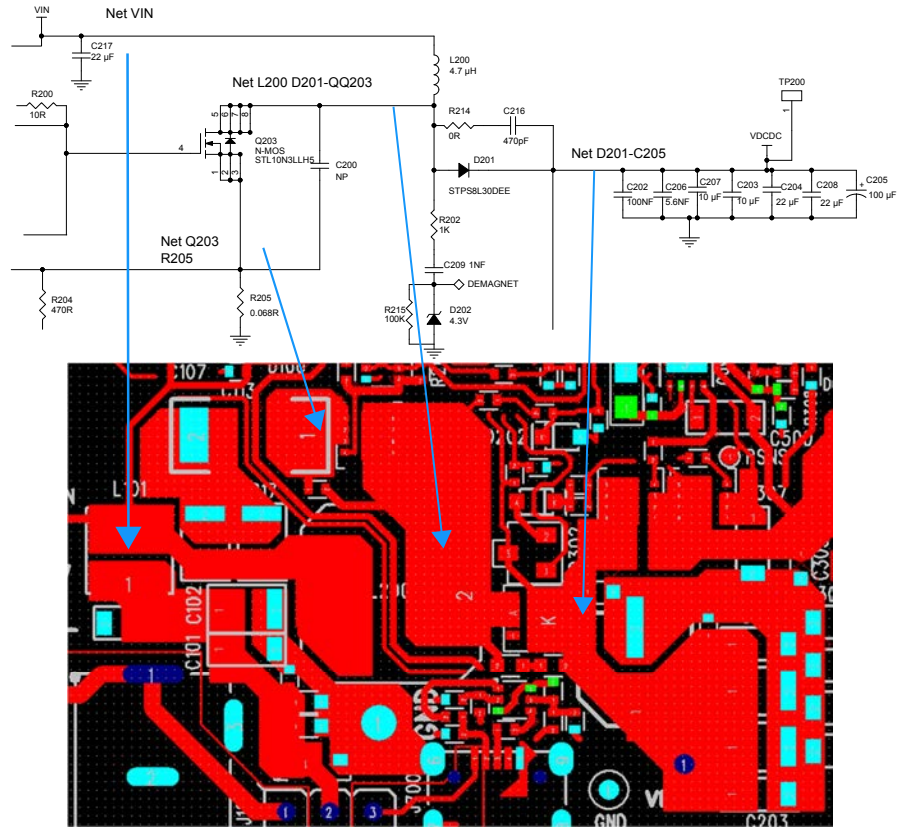
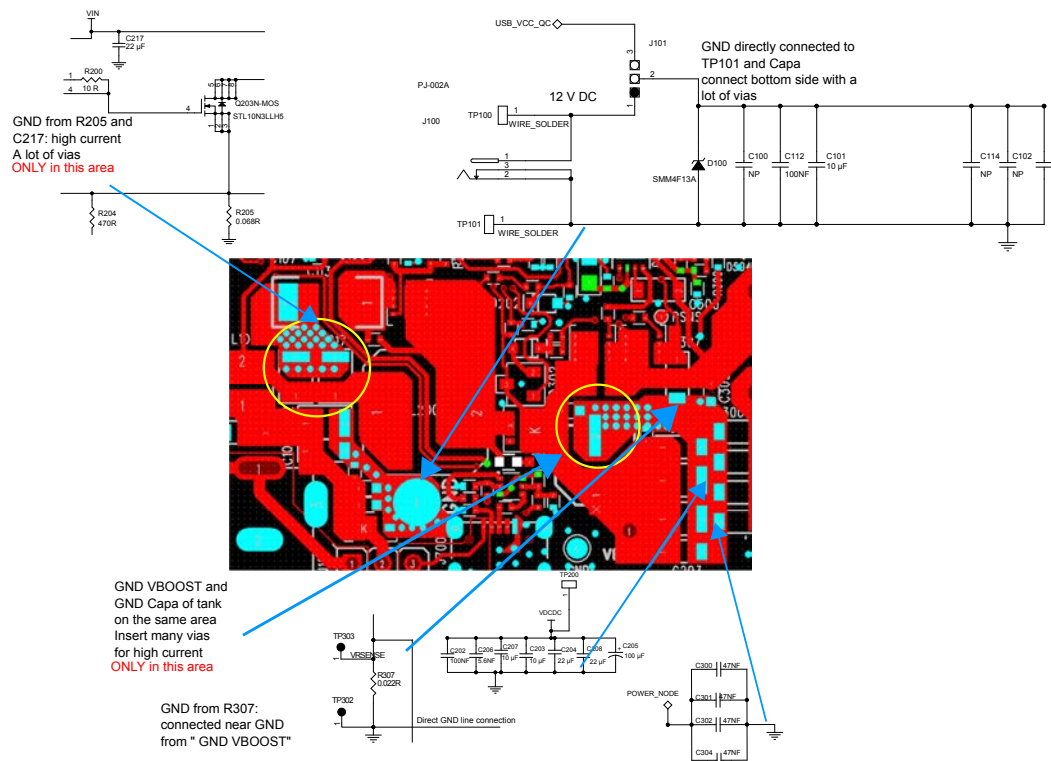


Figure 60. STEVAL-ISB044V1 evaluation board: power GND routing details


Bridge nets are designed on the top layer; traces must be very large (>2 mm).

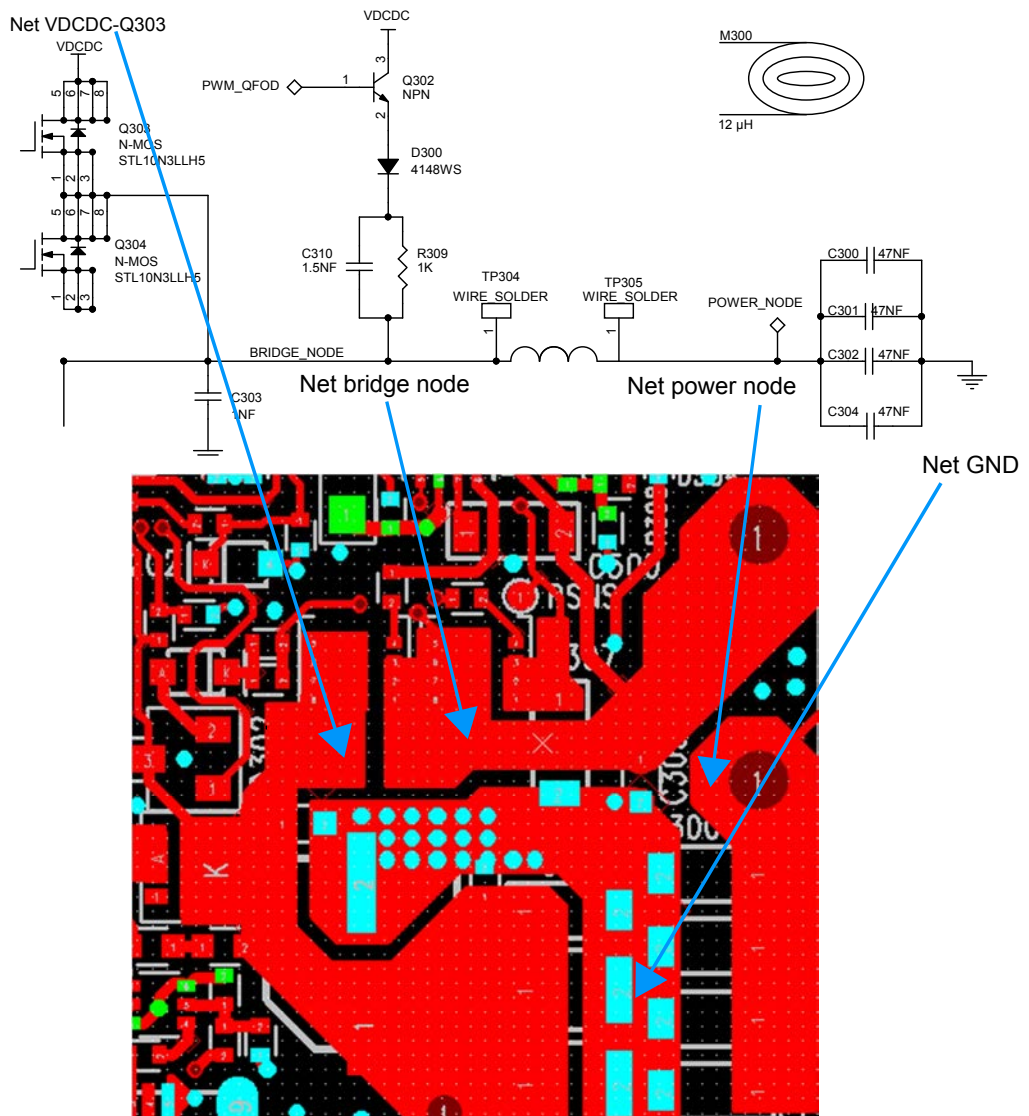
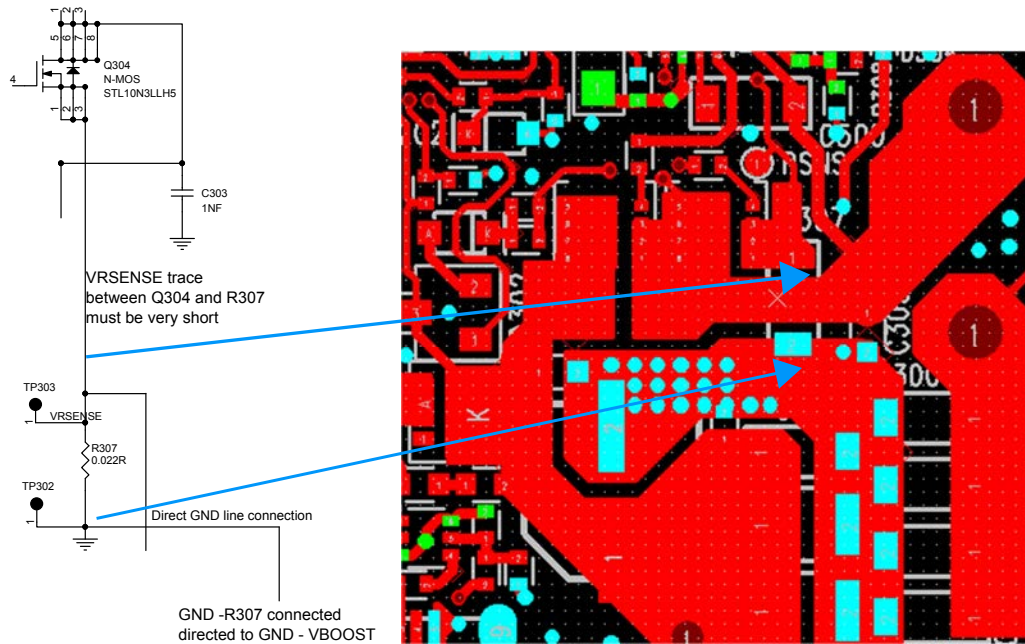
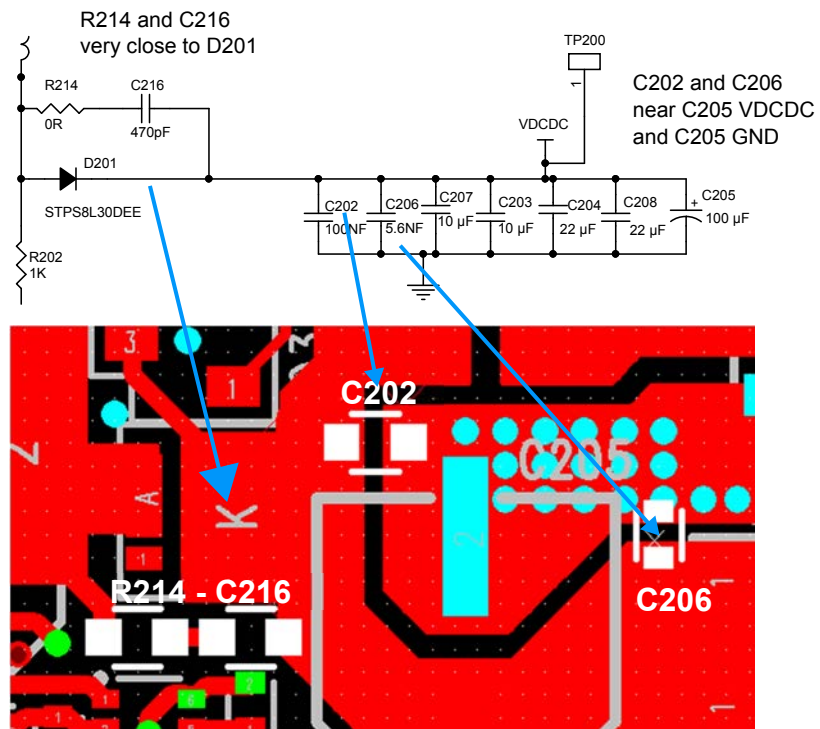
Figure 61. STEVAL-ISB044V1 evaluation board: bridge node routing details


Figure 62. STEVAL-ISB044V1 evaluation board: shunt resistor routing details



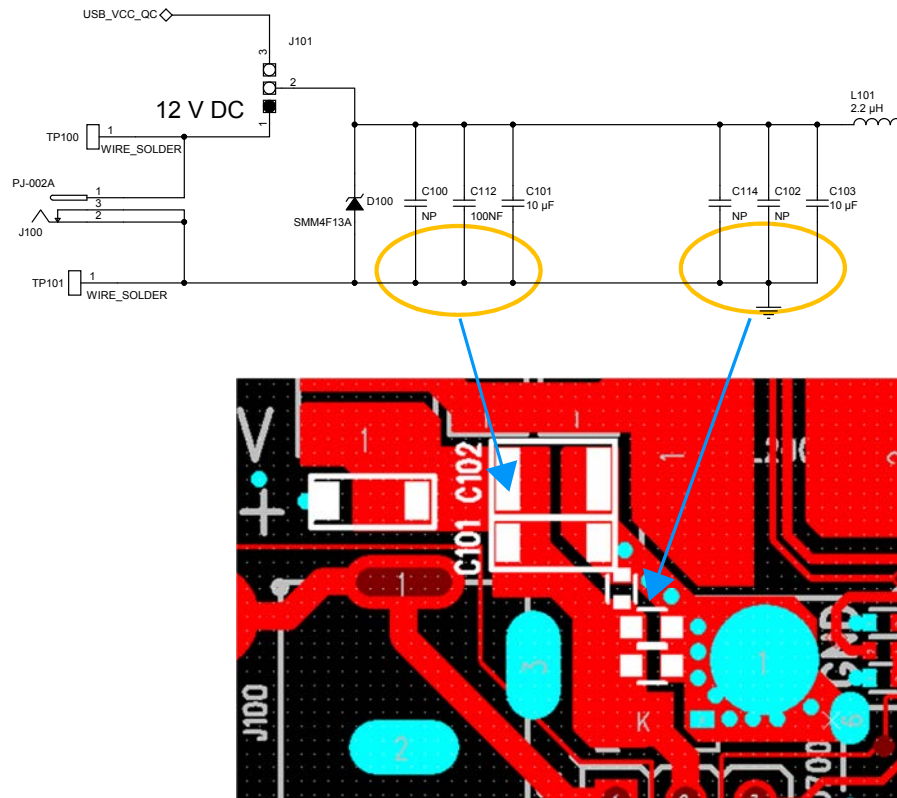
8.2 EMI components

Figure 63. STEVAL-ISB044V1 evaluation board: EMI components (1 of 2)



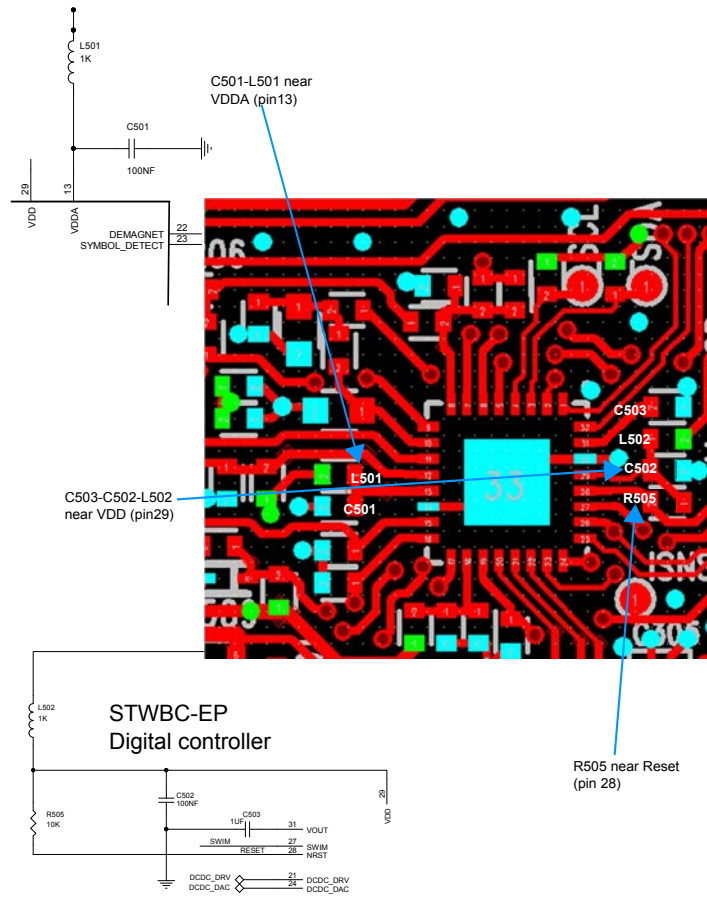
Ceramic capacitors (C100, C101, C103, C112, C114 and C100) for EMI and filters must be placed close to the supply input and L101.

Figure 64. STEVAL-ISB044V1 evaluation board: EMI components (2 of 2)



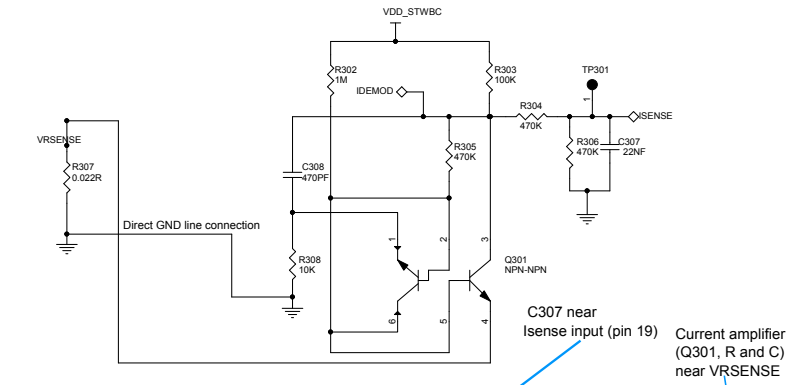
8.3 STWBC-EP layout

Figure 65. STWBC-EP digital controller layout



8.4 Current sensing and demodulation

Figure 66. STEVAL-ISB044V1 evaluation board: current sensing



Warning:
R308 GND is done through
a trace connected to GND
on Rsense R307

**Don't mix this track with
ground plane**

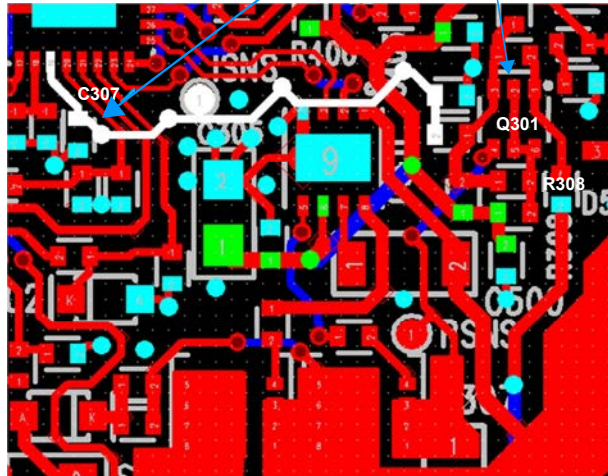
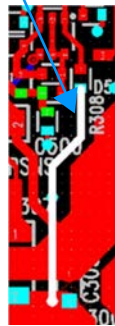
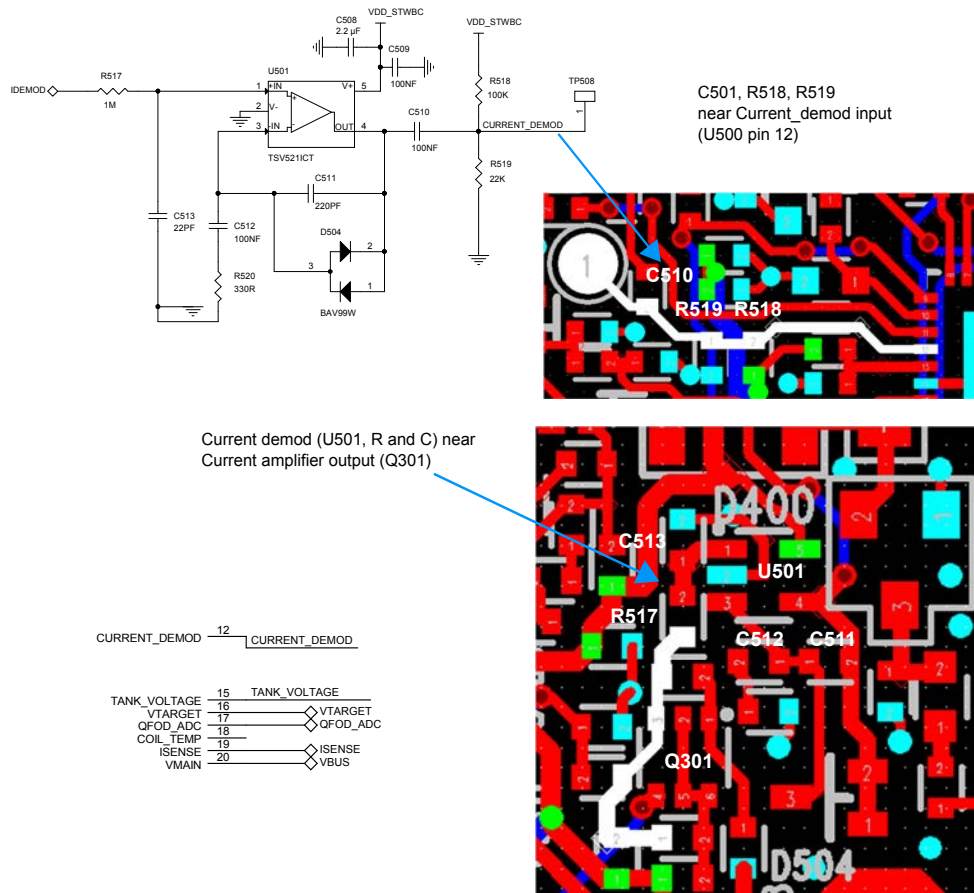


Figure 67. STEVAL-ISB044V1 evaluation board: current demodulation



9 References

Freely available on www.st.com:

1. STWBC-EP datasheet
2. STEVAL-ISB044V1 data brief (DB3408): "Qi MP-A10 15 W wireless charger TX evaluation kit based on STWBC-EP"
3. STSW-ISB044FW data brief (DB3409): "Firmware for the STEVAL-ISB044V1 wireless power transmitter evaluation board based on STBWC-EP"
4. STSW-STWBCFWDT data brief (DB3410): "STWBC firmware downloader tool"
5. STSW-STWBCGUI data brief (DB3418): "Graphical user interface for wireless power transmitter evaluation boards based on the STWBC chip family"

Revision history

Table 7. Document revision history

Date	Version	Changes
30-Oct-2017	1	Initial release.
14-May-2018	2	Updated Figure 4. STEVAL-ISB044V1 evaluation board: power supply selection and Section 7 Bill of materials .

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