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.
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<td>STEVAL-ISB044V1 evaluation board: shunt resistor routing details</td>
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<td>STEVAL-ISB044V1 evaluation board: current demodulation</td>
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</table>
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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Input characteristics</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
<th>Notes and conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vin</td>
<td>Input voltage</td>
<td>5</td>
<td>12</td>
<td>13</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>lIn</td>
<td>Input current</td>
<td>1.6</td>
<td>2</td>
<td></td>
<td>A</td>
<td>Vin nominal, Iout = max. on MP1B Rx</td>
</tr>
<tr>
<td></td>
<td>Input no-load current</td>
<td></td>
<td></td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input stand-by</td>
<td>1.4</td>
<td></td>
<td></td>
<td>mA</td>
<td>At typical voltage</td>
</tr>
</tbody>
</table>

Table 2: STEVAL-ISB044V1 electrical performance: system characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Input characteristics</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
<th>Notes and conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fs</td>
<td>Switching frequency</td>
<td>110</td>
<td>180</td>
<td>kHz</td>
<td></td>
<td>Decrease with load</td>
</tr>
<tr>
<td>Duty cycle</td>
<td>Duty cycle modulation</td>
<td>5</td>
<td>50</td>
<td>%</td>
<td></td>
<td>Duty cycle</td>
</tr>
<tr>
<td>ƞ</td>
<td>Full load efficiency</td>
<td>80</td>
<td></td>
<td>%</td>
<td></td>
<td>Vin = 12 V, P Out Rx = 15 W</td>
</tr>
</tbody>
</table>

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 the Blue position → DC jack supply (J100)
- jumper in the Red position → USB power supply (J700)

<table>
<thead>
<tr>
<th>Connector reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>J100</td>
<td>DC power jack connector</td>
</tr>
<tr>
<td>J101</td>
<td>Power/QC USB connector link</td>
</tr>
<tr>
<td>J500</td>
<td>SWIM connector used for the download</td>
</tr>
<tr>
<td>J501</td>
<td>UART jack connector used for the GUI</td>
</tr>
<tr>
<td>J700</td>
<td>Quick charge USB connector</td>
</tr>
</tbody>
</table>

Table 3: Connector description

<table>
<thead>
<tr>
<th>Test point reference</th>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP100</td>
<td>12 V</td>
<td>12 V power supply connection</td>
</tr>
<tr>
<td>TP101</td>
<td>GND</td>
<td>GND power connection</td>
</tr>
<tr>
<td>TP102</td>
<td>VIN</td>
<td>Input voltage</td>
</tr>
<tr>
<td>TP103</td>
<td>VDD_STWBC</td>
<td>4.5V LDO output voltage</td>
</tr>
<tr>
<td>TP200</td>
<td>VDCDC</td>
<td>Boost output voltage</td>
</tr>
<tr>
<td>TP301</td>
<td>ISENSE</td>
<td>Current measurement</td>
</tr>
<tr>
<td>TP302</td>
<td>GND</td>
<td>Power GND connection (Rsense)</td>
</tr>
<tr>
<td>TP303</td>
<td>VRSENSE</td>
<td>Rsense resistor voltage</td>
</tr>
<tr>
<td>TP304</td>
<td></td>
<td>Wireless charging coil connection</td>
</tr>
<tr>
<td>TP305</td>
<td></td>
<td>Wireless charging coil connection</td>
</tr>
</tbody>
</table>
### Test point reference

<table>
<thead>
<tr>
<th>Test point reference</th>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP400</td>
<td>SYMBOL_DETECT</td>
<td>Symbol detector</td>
</tr>
<tr>
<td>TP501</td>
<td>I2C_SCL</td>
<td>STWBC PC signal</td>
</tr>
<tr>
<td>TP502</td>
<td>I2C_SDA</td>
<td>STWBC PC signal</td>
</tr>
<tr>
<td>TP503</td>
<td>USB_DP</td>
<td>STWBC UART Rx signal</td>
</tr>
<tr>
<td>TP504</td>
<td>USB_DM</td>
<td>STWBC UART Tx signal</td>
</tr>
<tr>
<td>TP506</td>
<td>GPIO_0</td>
<td>STWBC GPIO signal used for LEDs</td>
</tr>
<tr>
<td>TP507</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>TP508</td>
<td>CURRENT_DEMOD</td>
<td>Symbol detector</td>
</tr>
<tr>
<td>TP509</td>
<td>QC_IO</td>
<td>Quick charge circuit signal</td>
</tr>
<tr>
<td>TP510</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>TP511</td>
<td>GND</td>
<td>Ground</td>
</tr>
</tbody>
</table>

### 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

<table>
<thead>
<tr>
<th>Pin number</th>
<th>Pin name</th>
<th>Pin type</th>
<th>Firmware description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>UART_RX</td>
<td>DI</td>
<td>Uart RX link on USB debug connector</td>
</tr>
<tr>
<td>2</td>
<td>PWM_QFOD</td>
<td>DO</td>
<td>PWM dedicated to QFOD circuit</td>
</tr>
<tr>
<td>3</td>
<td>I2C_SDA</td>
<td></td>
<td>I2C_SDA</td>
</tr>
<tr>
<td>4</td>
<td>I2C_SCL</td>
<td></td>
<td>I2C_SCL</td>
</tr>
<tr>
<td>5</td>
<td>DNBL</td>
<td>DO</td>
<td>Output driver for Low side branch</td>
</tr>
<tr>
<td>6</td>
<td>LED</td>
<td>DO</td>
<td>Digital output for light indicators</td>
</tr>
<tr>
<td>7</td>
<td>QC_IO</td>
<td>DO</td>
<td>Quick charge circuit signal</td>
</tr>
<tr>
<td>8</td>
<td>CMP_OUT_V</td>
<td>AI</td>
<td>Boost output voltage sensing</td>
</tr>
<tr>
<td>9</td>
<td>CS_CMP</td>
<td>AI</td>
<td>Boost current sensing</td>
</tr>
<tr>
<td>10</td>
<td>DCDC_DAC_REF</td>
<td>AI</td>
<td>DAC reference value for Boost output voltage</td>
</tr>
<tr>
<td>11</td>
<td>WAVE_SNS</td>
<td>AI</td>
<td>Symbol detector based on delta frequency</td>
</tr>
<tr>
<td>12</td>
<td>CURRENT_demod</td>
<td>AI</td>
<td>Current demodulation</td>
</tr>
<tr>
<td>13</td>
<td>VDDA</td>
<td>PS</td>
<td>Analog power supply</td>
</tr>
<tr>
<td>14</td>
<td>VSSA</td>
<td>PS</td>
<td>Analog ground</td>
</tr>
<tr>
<td>15</td>
<td>TANK_VOLTAGE</td>
<td>AI</td>
<td>Analog input to measure the LC voltage (power calculation)</td>
</tr>
<tr>
<td>16</td>
<td>VTARGET</td>
<td>AI</td>
<td>Boost voltage measurement</td>
</tr>
<tr>
<td>17</td>
<td>QFOD_ADC</td>
<td>AI</td>
<td>High sensitivity peak voltage detector used for Quality Factor measurement</td>
</tr>
<tr>
<td>18</td>
<td>COIL_TEMP</td>
<td>AI</td>
<td>Analog input for temperature measurement. The input is connected to external NTC biased to VDD_STWBC</td>
</tr>
<tr>
<td>19</td>
<td>ISENSE</td>
<td>AI</td>
<td>Analog input to measure the current flowing into the power bridge</td>
</tr>
<tr>
<td>20</td>
<td>VMAIN</td>
<td>AI</td>
<td>Analog input to measure the main power supply</td>
</tr>
<tr>
<td>21</td>
<td>DCDC_DRV</td>
<td>DO</td>
<td>DCDC boost PWM drive</td>
</tr>
<tr>
<td>22</td>
<td>DEMAGNET</td>
<td>DI</td>
<td>Boost demagnetization</td>
</tr>
<tr>
<td>23</td>
<td>SYMBOL_DETECT</td>
<td>DI</td>
<td>Voltage demodulation</td>
</tr>
<tr>
<td>24</td>
<td>DCDC_DAC</td>
<td>DO</td>
<td>Boost PWM output DAC (setting the CPP3 comparator voltage reference)</td>
</tr>
<tr>
<td>25</td>
<td>UPBL</td>
<td>DO</td>
<td>Output driver for high side branch</td>
</tr>
<tr>
<td>26</td>
<td>DNBL_FB</td>
<td>DO</td>
<td>Used for hardware PWM programmation</td>
</tr>
<tr>
<td>27</td>
<td>SWIM</td>
<td>DIO</td>
<td>Digital IO for debug interface</td>
</tr>
<tr>
<td>28</td>
<td>NRST</td>
<td>DI</td>
<td>Reset</td>
</tr>
<tr>
<td>29</td>
<td>VDD</td>
<td>PS</td>
<td>Digital and I/O power supply</td>
</tr>
<tr>
<td>30</td>
<td>VSS</td>
<td>PS</td>
<td>Digital and I/O ground</td>
</tr>
<tr>
<td>31</td>
<td>VOUT</td>
<td>Supply</td>
<td>Internal LDO output</td>
</tr>
<tr>
<td>32</td>
<td>UART_TX</td>
<td>DO</td>
<td>Uart TX link on USB debug connector</td>
</tr>
</tbody>
</table>

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

1. Install the GUI by launching the STWBC_GUI_Setup.msi installation file
   ![Figure 6: STSW-STWBCGUI installation file](image)
<table>
<thead>
<tr>
<th>Name</th>
<th>Date modified</th>
<th>Type</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>setup.exe</td>
<td>3/14/2017 11:49 AM</td>
<td>Application</td>
<td>413 KB</td>
</tr>
<tr>
<td>STWBC_GUI_Setup.msi</td>
<td>3/14/2017 11:50 AM</td>
<td>Windows Installer</td>
<td>2,011 KB</td>
</tr>
</tbody>
</table>

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

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](image)

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

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.

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

Do not connect the transmitter board for the moment.
2. From the GUI, select **Load FW to board** from the setup menu.

*Figure 10: Firmware download via STSW-STWBCGUI*
3 As prompted, select the CAB file containing the firmware to download

![Figure 11: Firmware file selection message](image1)

Supply the board with 12 V and keep it powered.

![Figure 12: Firmware file selection](image2)

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

![Figure 13: Power on message](image3)

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

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

![Warning Icon](image4)
Follow the download progress in the DOS window and power the board off when prompted.

**Figure 15: DOS window: download in progress**

---

### 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.

1. Supply the transmitter board via a power supply set to 12 V.
2. Connect the USB-to-UART dongle to the transmitter board.
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"**).
4 From the STSW-STWBCGUI, select **Load FW to board** in the setup menu (see Figure 10: "Firmware download via STSW-STWBCGUI").

5 As prompted, select the CAB file containing the firmware to download (see Figure 11: "Firmware file selection message").

6 As prompted, power the board on and keep it powered.

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](image-url)
3.3.2 Procedure

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

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

5. Launch STVP software.
6. Select STM8AF6166 as core.

Do not upload any program into the STVP RAM area, as all bits will be erased (load 00 00 00).
Transfer the "00 00" to the STWBC-EP via the SWIM interface using the appropriate push button.

Click OK if a "wrong device selected" alert appears.

Click YES if "An incompatibility has been found with this device" alert appears.

After this operation, the programming procedure starts. At completion, the STVP informs the user that the program is loaded and verified.

Exit from the STVP program.

Disconnect SWIM.

Remove power supply from the STEVAL-ISB044V1 transmitter board.

Retry the UART download procedure if necessary.

### 3.4 Firmware download with command line

#### 3.4.1 Firmware download with written chip

Ensure a dedicated directory has the following files:

- STWBC_Loader.exe
- stwbc_loader_not_empty.bat
- enable_boot.bin
- "firmware version".cab
Starting from the STSW-STWBCGUI folder, run the stwb_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

3.4.2 Firmware download with blank chip

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

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

Figure 23: STSW-STWBCGUI command line with blank chip

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

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.

1. Select the convert **CAB to STVP files** command from the STSW-STWBCGUI setup menu.
2  Follow the prompt to select the appropriate cabfile.

Figure 25: Selecting the CAB file to be converted

3  Follow the prompt to provide the project file name.
3.6 Firmware download with STVP

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

5. Launch STVP software.
Select STM8AF6166 as core (see Figure 18: “STVP core selection”).

In STVP, open the Project menu and click Open.

Select the .stp given in the zip file.

Wait few seconds.

The following message should appear:

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

It is normal that some warnings appear:

FILE: line 2: Address 0x4804 is out of range and is ignored!
FILE: line 2: Address 0x4802 is out of range and is ignored!

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

Click OK if a “wrong device selected” alert appears (see Figure 20: “STVP wrong device selected alert”).

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.

13 Exit from the STVP program.
14 Disconnect SWIM.
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

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. CIA 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 24 W 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: power supply 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).

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

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-STWB CFWDT 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)**

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 39: STSW-STWBCGUI: bin file backup**
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.

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

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

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

#### 5.2.2 QFOD calibration procedure

1. Set the test number to 2
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**.
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 with a setup configuration as per the picture below.

Figure 46: Efficiency setup

The figure below shows the typical performance on different coils (efficiency=$\frac{P_{OUT}}{P_{IN}}$).
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.
6 Schematic diagram

Figure 48: STEVAL-ISB044V1 circuit schematic (1 of 8)
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 53: STEVAL-ISB044V1 circuit schematic (6 of 8)

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

USB for Quick Charge
3 A on pin 1 & pin 5
1 A on other pins
For debug

USB
## Bill of materials

### Table 6: STEVAL-ISB044V1 bill of materials

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<th>Item</th>
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<th>Ref.</th>
<th>Part/Value</th>
<th>Description</th>
<th>Manufacturer</th>
<th>Order code</th>
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<td>10UF_25V_X7R_0805</td>
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<td>42</td>
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<td>SMM4F13A</td>
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<td>43</td>
<td>1</td>
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<td>STPS8L30DDE</td>
<td>Power Schottky rectifier</td>
<td>ST</td>
<td>STPS8L30DDE-TR</td>
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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)

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

- C501: 100NF
- L501: 1K
- VDD: 29
- VDDA: 13
- DEMAGNET: 22
- SYMBOL_DETECT: 23
- C501-L501 near VDDA (pin13)
- C503-C502-L502 near VDD (pin29)
- R505 near Reset (pin 28)

STWBC-EP Digital controller

Downloaded from Arrow.com.
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

Current demod (U501, R and C) near Current amplifier output (Q301).
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-STWBCFWD 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

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<tr>
<th>Date</th>
<th>Version</th>
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<td>30-Oct-2017</td>
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<td>Initial release.</td>
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