



Application note

## 2.5W wireless charger transmitter evaluation board deconfiguration guide for 1-watt wearable applications

#### Introduction

The STEVAL-ISB045V1 evaluation kit includes the STEVAL-ISB045V1T wireless battery charger transmitter evaluation board based on the STWBC-WA digital controller, firmware and the STEVAL-WBCDNGV1 USB-to-UART dongle needed to use the STSW-STWBCGUI.

The STSW-ISB045FW firmware lets you modify LED and GPIO behavior, and customize I<sup>2</sup>C and UART signals. The layout is based on a cost-effective two-layer PCB.

The ST website has tools for the STEVAL-ISB045V1 evaluation kit that allow you to access run time information such as regulation error, frequency and protocol status.



#### Figure 1. STEVAL-ISB045V1 evaluation board



## 1 Hardware architecture

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#### Figure 2. Transmitter board components with STWBC-WA controller

## **1.1 STWBC-WA wearable application architecture**

## **1.2** Optimized architecture for 1-watt applications

The following diagram shows a typical schematic for wearable applications.



Figure 3. Wearable application block diagram

We can modify the system to around 1 watt for low power applications by using only a half bridge and no current sense circuitry.

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#### Figure 4. Optimized 1-watt bridge schematics



# 2 How to modify the STEVAL-ISB045V1T transmitter board hardware for 1 watt

Follow the steps below to transform the STEVAL-ISB045V1T transmitter board into 1 watt: **Step 1.** Remove the Power MOSFETS Q2 and Q4 on the right side of the bridge.



#### Figure 5. Board top with the MOSFETS Q2 and Q4 to remove

- Step 2. Swap C16 with a 47 nF COG 1206.
- Step 3.Solder a 0-ohm resistor on the footprint of Q4.This provides a good GND connection on the right side of the capacitors



Figure 6. Zoom with 0-ohm resistor added on Q4

- Step 4.Change the transmitter coil to match the Rx coil size.We recommend the WT151512-22F from TDK or MQQTC151520S6R3 from Sunlord.
- Note: Capacitor tuning can be adjusted according to the coil choice. Bridge frequency parameters can also be adjusted.

#### Figure 7. Schematic with changes for a 1-watt system

1. Wireless charging Coil to change

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- 2. C16 capacitor to change from 100nF to 47nF COG 1206
- 3. Good GND connection to connect to tank capacitors
- 4. MOS to remove for half bridge configuration





## 3 How to update the STWBC-WA firmware

You must modify the STEVAL-ISB045V1T transmitter board hardware to use the updated STSW-ISB045FW firmware for 1 watt applications.

You can download the STSW-ISB045FW firmware with the STSW-STWBCGUI software package.

#### 3.1 Download procedure

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

#### 3.2 How to download the STWBC-WA firmware with the STWBC GUI

This section assumes that you have updated the firmware for your new application and are ready to download the new firmware onto the STWBC-WA controller.

you can use the STSW-STWBCGUI GUI to download the firmware onto the STWBC-WA controller via UART. The firmware is a cab file which contains 3 files.

- Step 1. The UART RX/TX signals of the STWBC-WA are accessible on the micro-USB connector of the transmitter board (muxed respectively on USB\_DP and USB\_DM)
- **Step 2.** Connect the USB to UART dongle to the transmitter board. The transmitter board is powered through the USB dongle.

#### Figure 8. Dongle and transmitter board connections



Step 3. In the GUI, select [Setup]>[Load FW to board].

Step 4. Select the CAB file containing the firmware to download.



🖅 STWBC Qi 3.42	
Setup Test	
Transmitter state Connected	Search WBC_LIB > WBC_QI_LIB_V5_238_ > • • • •
$\frown$ $\frown$ $\frown$	Organize 🔻 New folder 🔠 🔻 🗍 🔞
Objet Qi Power	WBC_QI_ ^ Name Date modified Ty
	WBC_QI_ STEVAL-ISB045V1_QI_2.5W_V5.238.cab 1/5/2018 11:54 AM C
Protocol window Monitor window Param window	WBC QI
	WBC_QI_
Receiver informations	WBC_QI_
Manufacturer ID:	WBC_QI_
Device ID:	WBC QI
Qi version:	WBC_QI_
Charge status: Not available	WBC_QI_
	WBC_QI_
	File name: Cab
	Open 🔽 Cancel
STWBC - Wireless Battery Charger	

#### Figure 9. Firmware file selection

Step 5. Make sure the baord remains powered.

#### Figure 10. Power ON prompt



Step 6. Select [OK].

Step 7. Follow the download progress in the DOS window and power the board off when prompted.

#### Figure 11. Download success message

Action
Success ! Very important: You MUST power OFF the board NOW
ОК



#### How to recalibrate the board after a firmware update 3.3

It is very important to recalibrate the transmitter board after each firmware download to ensure reliable detection of the receiver when it is placed on the transmitter. Perform the calibration once after each new firmware download without a receiver placed on the transmitter.

Step 1. In the GUI, go to [Test]>[Manage test].

tup []	est		
Trar	Manage ter Power test Get calibrat Host IF acc FOD metric	st tion data ess ts	Connected
Protoc	olwindow	Monitor window	Param window
Cł	Device ID: Qi version: arge status: STWB0	Not available life.augmer	n <b>ted</b> arger

#### ----.

In the Test window, put "1" in the [Test number] field and click [Start]. Step 2.

#### Figure 13. Presence detection test

🐨 STWBC Qi 3.42
Setup Test
Transmitter state Connected
Objet detected Qi detection Power
Protocol window Monitor window Param window
Charge status: Not available
Test
Test number: Start Stop
life.augmented
STVVBC - VVireless Battery Charger



Once calibration is finished, "Test done" appears next to the [Status] field.

#### **3.4** How to check and adjust bridge configuration

The first parameter to check after the firmware download is the bridge topology. This can be done in the STWBC GUI with the [**param window**] button.

Step 1. Ensure the [brg\_bridge\_topology] check box for Half bridge mode is selected.

This setting is necessary for the 1 watt configuration.

Step 2. If the check box is not selected, tick the box and save it into STWBC memory byb pressing the [Push to target] button.

Fir Parameters		3
Dump target Save to file   Push to target Load from file   Reset values Dump to bin.   Unlock param	Read param sys_over_current_thr at 0x9C, val = 0x14 Read param brg_bridge_topology at 0x81, val = 0x00 Read param pid_smoothing at 0x7B, val = 0x00 Read param half_period_comma_thr at 0x7C, val = 0x02 Read param crank_default_control_error at 0xA6, val = 0x00 Read param crank_default_control_error at 0xA7, val = 0x01	•
brg_freq_r	min:	^
pres_det_	thr: 5 0x05	
fod1_	thr: 151 0x97	
temp_high_meas_	thr: 75.3 °C 0x91	
temp_low_meas_	thr: j51 ℃ 0x014A	
sys_red_led_mo	ade: 🗌 Demo mode	
pres_det_dc_offset_me	an:	
force_high_pov	ver: 0 0x00	
sys_over_current_	thr: 1	=
brg_bridge_topolo	gy: ▼ Halfbridge	
pid_smooth	ing:	
half_period_comma_	thr:	
crank_default_control_er	ror: 1	-

Figure 14. STWBC GUI bridge configuration check

Step 3. Perform your initial testing with a receiver, and check the [Regulation error] and [Duty cycle] parameters in the Monitor window.

If the regulation error diverges too far from zero and the duty cycle rises up to 30%, the bridge frequency settings are not correct.

In this case, the max bridge frequency setting should be increased in the STWBC GUI.

Monitor					o X
Tx machine					
STOP	SELECT	PING	IDENT	NEGO	POWER
Frequency:	143kHz		Regulatio	on error: -499	6
100kHz	200kHz	300kHz	-100%	0%	+100%
Duty cycle:	30%		Bridge Volta	ge: 4.86V	
0%	25%	50%	1V	14V	28V
Rx reported	Power: 98m	nW	Supply volta	age: 4.86V	
	10				
ow	4W	8W	1V	12V	24V
Coil tempera	iture: 36°		Coil current	: 0A	
0°	40°	80°	0A	1.5A	ЗА
Rx presence	: 53		FOD margin	n: N/A	
Selected coil	: 0 Oper	FOD: ()			
Message rat	te:		-100		+100

Figure 15. Regulation error and Duty Cycle parameters

**Step 4.** In the Parameters window, increase the maximum bridge frequency in the [**brg\_freq\_max**] window. In the figure below, the max bridge frequency is increased to 160 Khz (for illustrative purposes)

<b>k</b> ₩ Pa	rameters		I TIEN GILLERAY WILLIN	-		x
Pus Re Unl	Imp target S sh to target Lo iset values D lock param	Save to file ad from file ump to bin.	Write param brg_freq_max at 0x6 Write param brg_freq_max at 0x6 Write param brg_freq_max at 0x6 Write param brg_freq_max at 0x6 Send store command	C, val = 0x00 D, val = 0x00 E, val = 0x01 F, val = 0x2C		*
•		hw_versia hw_sub_versia eeprom_versia fw_versia	on: 1W v2 on: 4 on: 10 on: 5.240			•
		brg_freq_analog_pir brg_freq_digital_pir		29 148.1 kHz	0x1D 0x0115 0x012C	
		brg_freq_r pres_det_t fod1_t		130.1 kHz 5	0x0171 0x05 0x97	
		temp_high_meas_t	hr:	75.3 °C	0x91 0x014A	•

Figure 16. Maximum bridge frequency parameter

Step 5. To save the value in STWBC memory, click on the [Push to target] button.

Step 6. Review the Monitor window to check that the error converges to 0%, which is the target for appropriate power control.

Tx machine   STOP   SELECT   PING   IDENT   NEGO   POWE     Frequency:   151kHz   Regulation error:   0%   0%   +100%     00kHz   200kHz   300kHz   -100%   0%   +100%     00%   25%   50%   1V   14V   2     0%   25%   50%   1V   14V   2     0%   4W   8W   1V   12V   2     00   4W   8W   1V   12V   2     00   40°   80°   0A   15A   3     0°   40°   80°   0A   15A   3     0°   40°   80°   0A   15A   3     0°   40°   80°   0A	Monitor					
STOP     SELECT     PING     IDENT     NEGO     POWE       Frequency:     15 1kHz     Regulation error:     0%     0%     100%     0%     +100%       O0KHz     200KHz     300KHz     300KHz     -100%     0%     +100%       Duty cycle:     27%     Bridge Voltage:     4.86V     0%     14V     2       0%     25%     50%     1V     14V     2       0%     25%     50%     1V     14V     2       0%     40%     8W     1V     12V     2       Coil temperature:     35°     Coil current:     0A     15A     3       0°     40°     80°     0A     15A     3       Rx presence:     45     EOD margin:     N/A	Tx machine					
Frequency: 151kHz   Regulation error: 0%     .00kHz   200kHz     Duty cycle: 27%   Bridge Voltage: 4.86V     0%   25%     0%   25%     0%   25%     0%   25%     0%   25%     0%   25%     0%   25%     0%   25%     0%   25%     0%   25%     0%   25%     0%   25%     0%   25%     0%   25%     0%   1V     1V   14/     0%   40%     0%   1V     1V   12V     0%   40°     0%   0A     15A   3     Rx presence: 45   EOD margin: N/A	STOP	SELECT	PING	IDENT	NEGO	POWER
00kHz   200kHz   300kHz   -100%   0%   +100%     Duty cycle:   27%   Bridge Voltage:   4.86V     0%   25%   50%   1V   14V   2     0%   25%   50%   1V   14V   2     0%   25%   50%   1V   14V   2     0%   25%   Supply voltage:   4.99V   0     0W   4W   8W   1V   12V   2     Coil temperature:   35°   Coil current:   0A   15A   3     0°   40°   80°   0A   15A   3     Rx presence:   45   EOD marcin:   N/A	Frequency:	151kHz		Regulatio	on error: 0%	
OOKHE     200KHE     300KHE     -100%     0%     +100%       Duty cycle:     27%     Bridge Voltage:     4.86V       0%     25%     50%     1V     14V     2       0W     4W     8W     1V     12V     2       Coil temperature:     35°     Coil current:     0A     15A     3       0°     40°     80°     0A     15A     3       Rx presence:     45     EOD margin:     N/A						
Duty cycle: 27%   Bridge Voltage: 4.86V     0%   25%     0%   25%     25%   50%     1V   14V     2   Supply voltage: 4.99V     0w   4w     0w   4w     0°   40°     0°   40°     80°   0A     15A   3     Rx presence: 45   EOD margin: N/A	OKHz	200kHz	300kHz	-100%	0%	+100%
0%     25%     50%     1V     14V     2       Rx reported Power: 448mW     Supply voltage: 4.99V     00     00     00     12V     2       0w     4w     8w     1V     12V     2       Coil temperature:     35°     Coil current:     0A     15A     3       0°     40°     80°     0A     15A     3       Rx presence:     45     EOD margin:     N/A	Duty cycle:	27%		Bridge Volta	ge: 4.86V	
0%     25%     50%     1V     14V     :       Rx reported Power: 448mW     Supply voltage: 4.99V						
Rx reported Power: 448mW     Supply voltage: 4.99V       0W     4W     8W     1V     12V     2       Coil temperature: 35°     Coil current: 0A     0°     15A     3       0°     40°     80°     0A     1.5A     3       Rx presence: 45     EOD margin: N/A     100     100	R6	25%	50%	1V	14V	28V
0w     4w     8w     1V     12V     2       Coil temperature:     35°     Coil current:     0A     15A     3       0°     40°     80°     0A     15A     3       Rx presence:     45     EOD margin:     N/A	Rx reported	Power: 448mW	/	Supply volta	age: 4.99V	
ow     4w     8w     1V     1ZV     2       Coil temperature:     35°     Coil current:     0A       0°     40°     80°     0A     1.5A     3       Rx presence:     45     EOD margin:     N/A					-	
Coil temperature:     35°     Coil current:     0A       0°     40°     80°     0A     1.5A     3       Rx presence:     45     EOD margin:     N/A	w	4W	8W	1V	12V	24V
0° 40° 80° 0A 1.5A 3 Rx presence: 45 EOD margin: N/A	Coil tempera	ture: 35°		Coil current	: 0A	
0° 40° 80° 0A 1.5A 3 Rx presence: 45 EOD margin: N/A						
Rx presence: 45 EOD margin: N/A	P	40°	80°	AD	1.5A	3A
· · · · · · · · · · · · · · · · · · ·	Rx presence	: 45		FOD margin	: N/A	
Selected coil: 0 OpenFOD: 0	Selected coil	: 0 OpenF	OD: 0			
Message rate:	Message rat	e:		-100	0	+100

Figure 17. Monitor window with ideal Regulation error

## A References

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Freely available at www.st.com:

- 1. Datasheet (DS11797): STWBC-WA Digital controller for wireless battery charger transmitters for wearable and smartwatch applications.
- 2. Databrief (DB3531): STEVAL-ISB045V1 2.5 W wireless charger transmitter evaluation kit
- 3. User manual (UM2368): STWBC 2.5 W turnkey firmware description
- 4. Databrief (DB3410): STSW-STWBCFWDT STWBC firmware downloader tool

## **Revision history**

#### Table 1. Document revision history

Date	Version	Changes
06-Sep-2018	1	Initial release.

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