STEVAL-SPSA068 evaluation board

Introduction

The STEVAL-SPSA068 is a low-cost tool designed to evaluate SPSA068, a PMIC designed by STMicroelectronics in VFQFN32L package.

SPSA068 is a PMIC composed by a synchronous current mode buck voltage regulator, with integrated LS and HS power mosfet, and a precise voltage reference. It offers flexibility and ease to use, together with a set of features that make it compliant to the commonly used microcontroller that require functional safety.

SPSA068 provides 2 different regulated voltages: a battery compatible regulator for loads up to 1 A and a 1% accurate reference voltage.

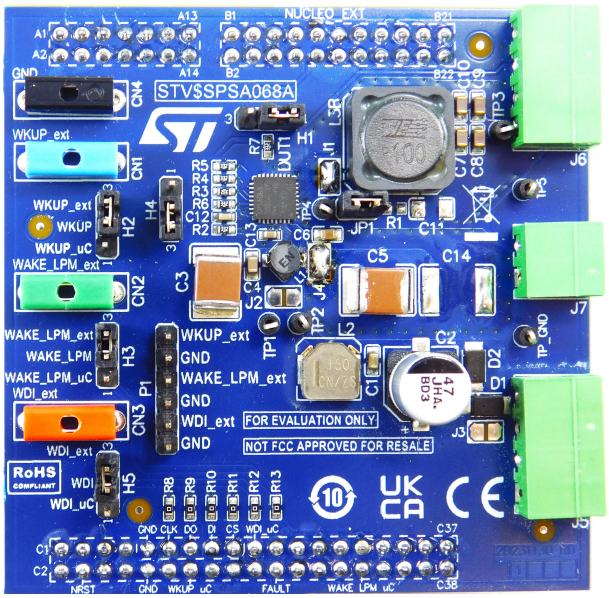
A windows watchdog, a reset output and a SPI bus complete the product.

The output voltages can be selected via non-volatile memory cells that should be programmed before using the PMIC. Among programmable parameters there are the output voltages, the switching frequency, the spread spectrum, the protection thresholds and the BUCK limiting current.

The Low Power Mode allows to supply components at a very optimized quiescent current down to 50 uA. LPM can be activated by SPI command and, if not required, it can be disabled by NVM configuration.

An SPI bus is used to program the PMIC and to communicate with the microcontroller. Through the SPI it is possible to provide a watchdog signal and communicate the status of the regulators in case of faults or warnings.

Figure 1. STEVAL-SPSA068



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1 Hardware description

The STEVAL-SPSA068 is an evaluation tool for the SPSA068, designed to demonstrate all its functionalities with an optimized Bill of Materials (BOM).

Design highlights

- Automotive-grade components (AEC-Q100 compliant).
- BOM optimized for cost and real-world application range.

Power requirements

- Vbat: 4.2 V to 19 V, ≥ 2 A from external power supply.
- Vdd: 5 V or 3.3 V, ≥ 5.5 mA from microcontroller.

Current specifications

- Board output current: up to 1 A.
- Board consumption: up to 12 mA.

SPSA068 NVM programming

The SPSA068 non-volatile memory (NVM) has been programmed according to the following tables.

Table 1. NVM_CONF_CTRL1 config

Field Name	Size	Note	Template	NVM value [bit]
wdg.rec_en	1	REC state in case of WDG failure	Disabled	0
wdg.def	2	No WDG or WDG by pin or WDG by SPI	No WDG	00
vref.ov	1	Vref Over Voltage selection	105% Vref	0
vref.uv	1	Vref Under Voltage selection	95% Vref	0
vref.out	2	Vref Output voltage	3.3V	01
buck.ol_en	1	Enable Buck open-load detection	Enable	1
buck.pgnd_en	1	Enable Buck ground-loss detection	Enable	1
buck.curr_lim	1	Buck current limitation	1.0 A	0
buck.freq	1	Buck switching frequency	400 kHz	0
buck.ov	1	Buck overvoltage selection	105% Vout	0
buck.uv	1	Buck undervoltage selection	95% Vout	0
buck.ss_clk_sel	1	Buck soft start selection	1.10 ms	0
buck.out	2	Buck output voltage	1.2 V	11

Table 2. NVM_CONF_CTRL2 config

Field Name	Size	Note	Template	NVM value [bit]
lp_mode.dis	1	Low Power Mode	Enable	0
nrst.delay	2	NRST release power-up delay	2.5 ms	01
nrst.release	1	NRST release power-up event	Buck Pgood	1
vref.delay	2	Vref Power-up delay	2.5 ms	01
vref.powerup_dis	1	Vref Power-up disabled	Enable	0
buck.ov_rst_dis	1	Buck OV event enables RSTN	Enable	0
buck.uv_rst_dis	1	Buck UV event enables RSTN	Enable	0

Field Name	Size	Note	Template	NVM value [bit]
buck.ov_rec_dis	1	Buck OV event move in REC state	Enable	0
buck.uv_rec_dis	1	Buck UV event move in REC state	Disable	1

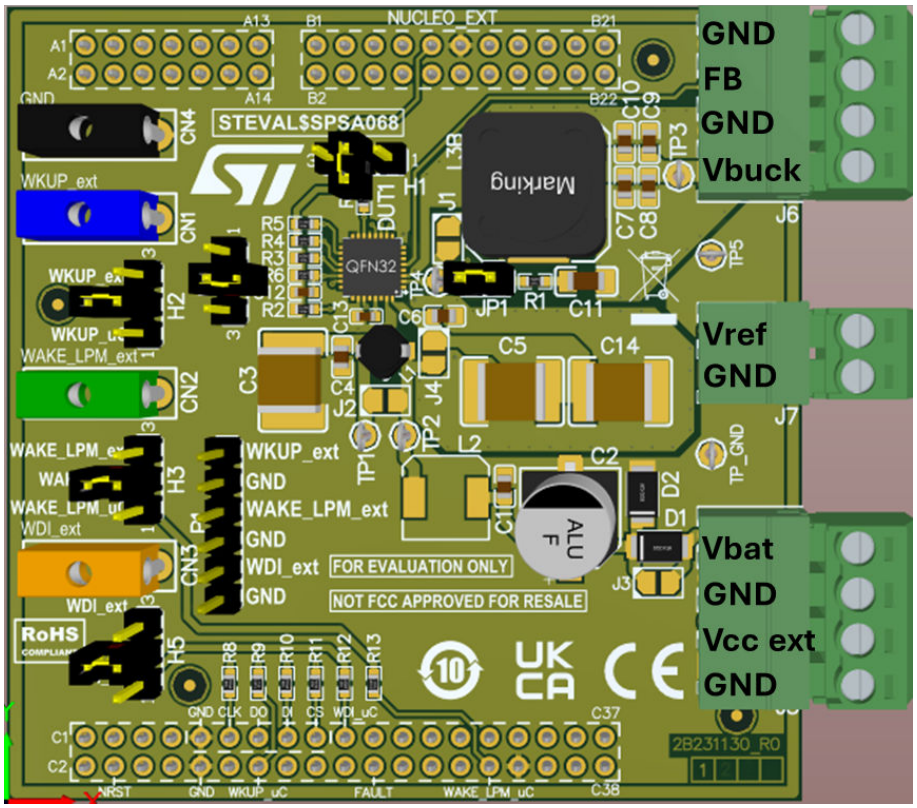
2 STEVAL-SPSA068 board description

This document provides a description of the STEVAL-SPSA068 application board to allow an easy and fast evaluation of the relevant device features.

2.1 Boards connectors and jumpers

To ensure proper operation and avoid damage, the STEVAL-SPSA068 board must be supplied with the correct voltages at its designated connectors.

Figure 2. SPSA068 promo board top view



The board has 3 connectors on the right side:

- **J5:** 4 pin connector for external supplies:
  - Pin 1: GND.
  - Pin 2: VCC_EXT, voltage required for digital outputs pull-up voltage (3.3 V: 5.0 V).
  - Pin 3: GND.
  - Pin 4: VBAT, main supply of the board (6.0 V: 18 V).
- **J6:** 4 pin connector for DC-DC regulator output/feedback:
  - Pin 1: VBUCK, converter output voltage.
  - Pin 2: GND.
  - Pin 3: FB, DC-DC converter feedback voltage.
  - Pin 4: GND.
- **J7:** 2 pin connector for reference voltage:
  - Pin 1: GND.
  - Pin 2: VREF, reference output voltage.

On the left side of the board there are the 4 connectors for device inputs external drivers:

- **CN1**: WKUP_EXT, device wake-up driver.

- **CN2**: WAKE-LPM_EXT, device wake-lpm driver.
- **CN3**: WDI_EXT, device watchdog pin driver.
- **CN4**: GND.

2.2 SPC582B-DIS connectors

STEVAL-SPSA068 promo board can be plugged to the MCU board (SPC582B-DIS).

The 3 connectors (NUCLEO_EXT1 A, B, C) provide the support for the device to MCU interconnections (SPI interface, watchdog, wake-up, wake-up-lpm, VCC).

2.3 Jumpers

Board jumpers essentially allow to configure the main inputs driver of the device:

- **H1**: 3 ways jumper, VCC configuration:
  - 1-2: VIO connected to the external VCC (VCC_EXT, J5 pin2).
  - 2-3: VIO connected to the microcontroller VCC (VCC_UC, NUCLEO_EXT1B pin9).
- **H2**: 3 ways jumper, WKUP configuration:
  - 1-2: WKUP connected to the microcontroller (WKUP_UC, NUCLEO_EXT1C pin14).
  - 2-3: WKUP connected to the external (WKUP_EXT, CN1).
- **H3**: 3 ways jumper, WAKE-LPM configuration:
  - 1-2: WAKE-LPM connected to the microcontroller (WAKE-LPM_UC, NUCLEO_EXT1C pin30).
  - 2-3: WAKE-LPM connected to the external (WAKE-LPM_EXT, CN2).
- **H4**: 3 ways jumper, DBUG configuration, must be connected to GND:
  - 1-2: DBUG connected to the VIO.
  - 2-3: DBUG connected to the GND.
- **H5**: 3 ways jumper, WDI configuration:
  - 1-2: WDI connected to the microcontroller (WDI_UC, NUCLEO_EXT1C pin19).
  - 2-3: WAKE-LPM connected to the external (WDI_EXT, CN3).
- **J4**: VS_SW connection, must be closed (shorted).

3 Getting started

The STEVAL-SPSA068 application board can work in two different modes: standalone or plugged to the microcontroller (SPC582B).

3.1 Standalone mode

In standalone mode the device activity is driven by connectors CN1, CN2, CN3 and CN4.

SPI communication, if needed, and FAULTN, RESN activity monitor are possible through the SPC582B-DIS connector pins.

To work in standalone mode, the following configuration must be followed:

- Configure jumper H1 to select an external connector as signal source (1-2).
- Configure jumper H2 to select an external connector as signal source (2-3).
- Configure jumper H3 to select an external connector as signal source (2-3).
- Set WKUP-LPM_EXT low (CN2 connected to GND).
- Set WKUP_EXT low (CN1 connected to GND).
- Set WDI_EXT low (CN3 connected to GND).
- Apply VBAT (J5 connector).
- Apply VCC_EXT (J5 Connector).
- Connect a cable between FB (J6) and Vbuck (J6).

With the above configuration the SPSA68 is in Standby state. Applying a 5 V to the WKUP_EXT connector (CN1) the SPSA068 moves to Active state (both regulators are active).

3.2 Connected to microcontroller mode

When the STEVAL-SPSA068 is connected to the SPC582B-DIS board, the SPSA068 activity is driven by MCU GPIOs and SPI transactions.

To work with STEVAL-SPSA068 connected to the MCU the following configuration must be followed:

- Configure jumper H1 to select MCU connector as signal source (2-3).
- Configure jumper H2 to select MCU connector as signal source (1-2).
- Configure jumper H3 to select MCU connector as signal source (1-2).
- Set WKUP-LPM_UC low (via the GPIO of the microcontroller).
- Set WKUP_UC low (via the GPIO of the microcontroller).
- Set WDI_EXT low (via the GPIO of the microcontroller).
- Apply VBAT (J5 connector).
- Apply VCC_EXT (J5 Connector).
- Connect a cable between FB (J6) and Vbuck (J6).

With the above configuration the SPSA68 will be in Standby state.

Applying a 5V to the WKUP_UC pin the SPSA068 will move to Active state (both regulators are active).

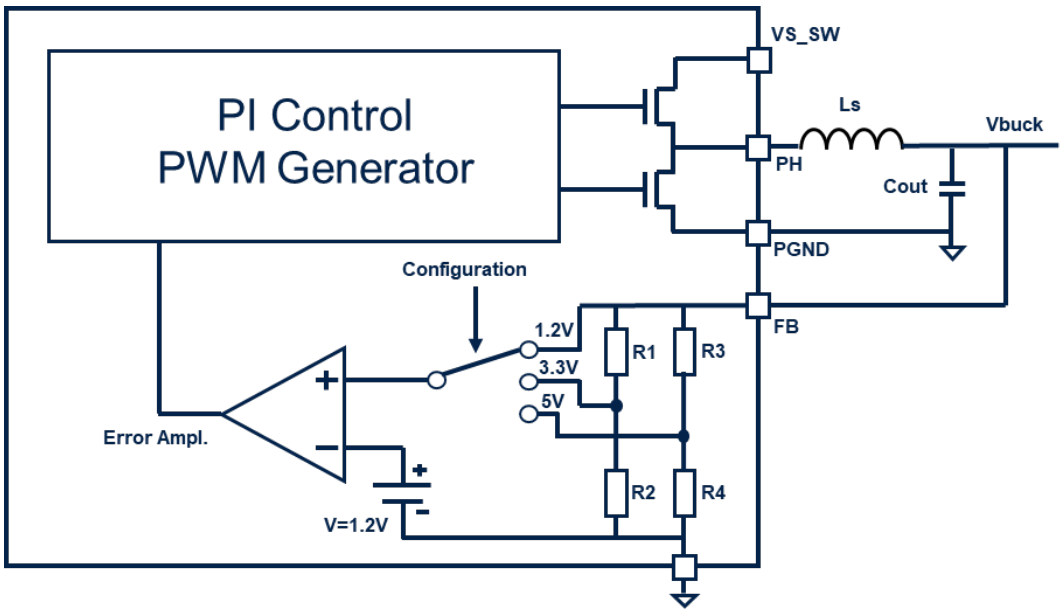
Important: STMicroelectronics does not provide either firmware or GUI to drive the STEVAL-SPSA068. It is the customer's responsibility to develop their own application and firmware to drive the application board.

4 STEVAL-SPSA068 output voltage definition

The SPSA068 is already programmed to provide 1.2 V on the Vbuck output pin.

The DC-DC converter integrated into the SPSA068 implements an output voltage “closed loop control” (see Figure 3), so it is possible to change the output voltage.

Figure 3. SPSA068 voltage control loop without external resistors



The Vbuck = 3.3 V or Vbuck = 5 V configurations can be reached without external resistor, same hardware configuration of the Vbuck = 1.2 V, modifying the “buck.out” bits in the “NVM_CONF_CTRL1” register by SPI (microcontroller mode, see SPSA068 datasheet).

An external voltage divider (see Figure 4) can be inserted, between the pins Vbuck and FB (both in J6 connector) and between FB and GND, to allow to set output voltage at any values between 1.2 V and 5 V. Once the Vbuck is chosen, the Rx and Ry resistors (see Figure 4) must be calculated in accordance with:

$$Vfb = Vbuck \times \frac{Ry}{(Rx + Ry)} = Vbuck \times \frac{1}{\left(1 + \frac{Rx}{Ry}\right)}$$

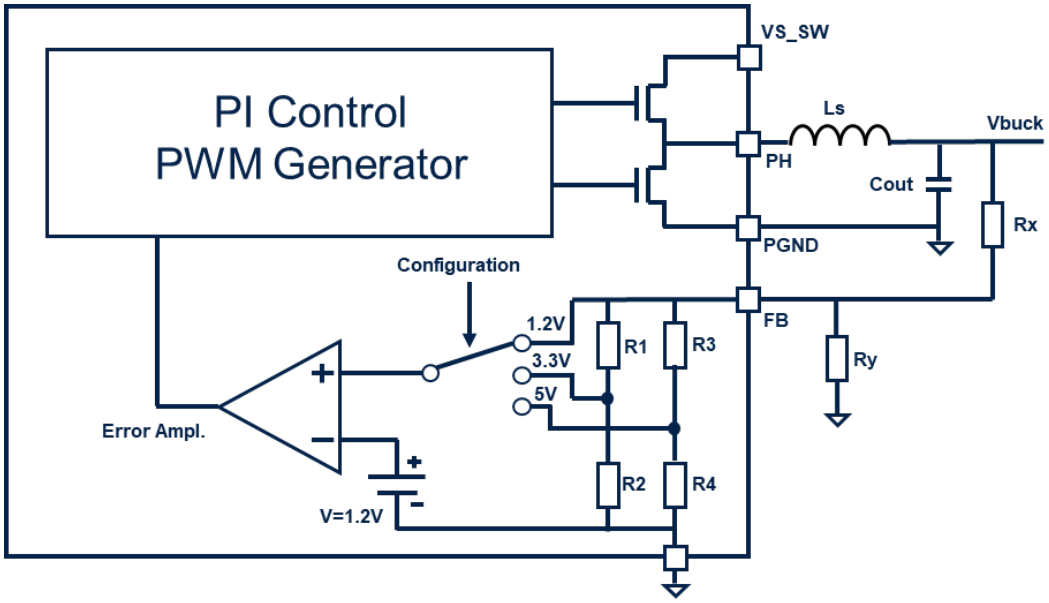
Where Vfb = 1.2 V

So the external resistor ratio is defined as:

$$\frac{Rx}{Ry} = \frac{Vbuck}{Vfb} - 1$$

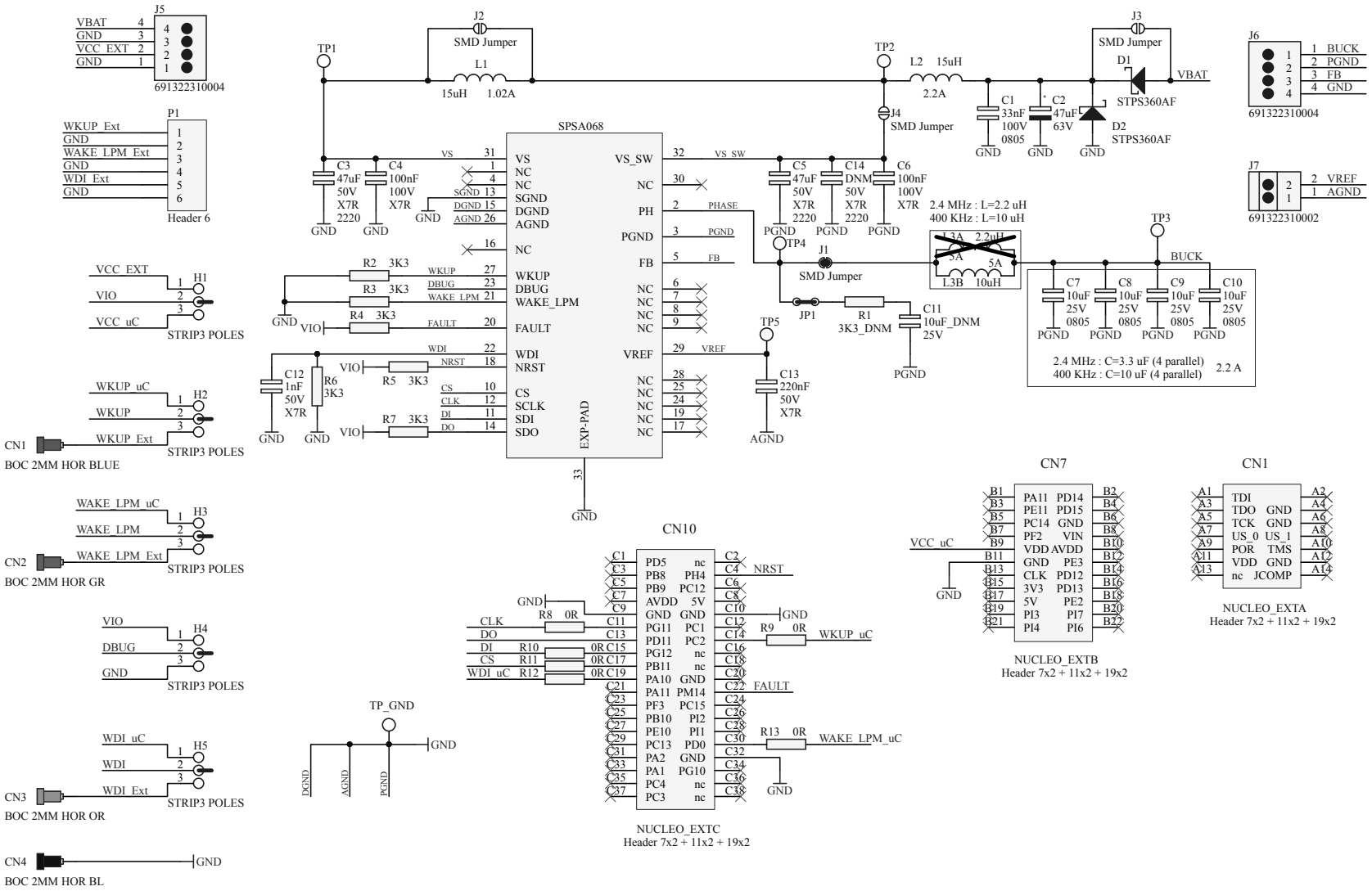
The Rx and Ry values should be selected to reduce the current through the divider.

Figure 4. **SPSA068 voltage control loop with external resistors**



5 Schematic diagram

Figure 5. **STEVAL-SPSA068 schematic**



6 Bill of materials

Table 3. **STEVAL-SPSA068 bill of materials**

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	1	C1	33nF	SMD Multilayer Ceramic Cap. Automotive	MURATA	GCM219R72A333KA37D
2	1	C2	47uF	SMD Electrolytic Cap. Automotive	PANASONIC	EEE-HA1J470UP
3	2	C3, C5	47uF	SMD Multilayer Ceramic Cap.	TDK	CKG57NX7R1H476M500JH
4	1	C14	DNM	SMD Multilayer Ceramic Cap.	TDK	CKG57NX7R1H476M500JH
5	2	C4, C6	100nF	SMD Multilayer Ceramic Cap. Automotive	MURATA	GCM21BR72A104KA37L
6	4	C7, C8, C9, C10	10uF	SMD Multilayer Ceramic Cap.	MURATA	GRM21BC71E106ME11L
7	1	C11	10uF_DNM	SMD Multilayer Ceramic Cap. Automotive	TDK	CGA5L1X7R1E106K160AC
8	1	C12	1nF	SMD Multilayer Ceramic Cap.	KEMET	C0603C102K5RAC7867
9	1	C13	220nF	SMD Multilayer Ceramic Cap. Automotive	MURATA	GCM188R71H224KA64D
10	1	CN1	BOC 2MM HOR BLUE	Terminal Bushing 2mm Blue horiz for pcb	Cinch Connectivity Solutions	105-0760-001
11	1	CN2	BOC 2MM HOR GR	Terminal Bushing 2mm Green horiz for pcb	Cinch Connectivity Solutions	105-0754-001
12	1	CN3	BOC 2MM HOR OR	Terminal Bushing 2mm Orange horiz for pcb	Cinch Connectivity Solutions	105-0756-001
13	1	CN4	BOC 2MM HOR BL	Terminal Bushing 2mm Black horiz for pcb	Hirschmann	930224100
14	2	D1, D2	STPS360AF, SOD128 Flat	SMD Power Schottky Rectifier	ST	STPS360AF
15	5	H1, H2, H3, H4, H5	STRIP3 POLES	Male Strip, Single row, 3 poles, p=2,54mm - See Mech Parts - FLAG MOUNTED	HARWIN	M20-9990345
16	1	J1	SMD Jumper	Jumper_SMD MEDIUM - CLOSE with SOLDER DROP	ANY	ANY
17	3	J2, J3, J4	SMD Jumper	Jumper_SMD MEDIUM - Leave OPEN	ANY	ANY
18	2	J5, J6	6.91322E+11	Terminal box 4 poles male 90° Pitch 3,81mm (See Mech Part)	WURTH ELEKTRONIK	6.91322E+11
19	1	J7	6.91322E+11	Terminal box 2 poles male 90° Pitch 3,81mm (See Mech Part)	WURTH ELEKTRONIK	6.91322E+11
20	1	JP1	STRIP2 POLES	Male Strip, Single row, 2 poles, p=2,54mm - See Mech Parts - CLOSED	HARWIN	M20-9990245

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
21	1	L1	15uH	SMD Power Inductor	Sumida	CDRH3D28NP-150NC
22	1	L2	15uH	SMD Power Inductor	MURATA	DFEH7030D-150M=P3
23	1	L3B	10uH	SMD Shielded Power Inductors - Automotive	WURTH ELEKTRONIK	74477110
24	1	NUCLEO_EXT	SAMTEC SSW-107-01-T-D	Female Strip SAMTEC SSW, Dual row, vertical	SAMTEC	SSW-107-01-T-D
25	1	NUCLEO_EXT	SAMTEC SSW-111-01-T-D	Female Strip SAMTEC SSW, Dual row, vertical	SAMTEC	SSW-111-01-T-D
26	1	NUCLEO_EXT	SAMTEC SSW-119-01-T-D	Female Strip SAMTEC SSW, Dual row, vertical	SAMTEC	SSW-119-01-T-D
27	1	P1	STRIP6PM	Male Strip 6 pins pitch 2.54 180°	HARWIN	M20-9990645
28	1	R1	3K3_DNM	SMD Resistor	ANY	ANY
29	6	R2, R3, R4, R5, R6, R7	3K3	SMD Resistor	YAGEO	RC0603FR-073K3L
30	6	R8, R9, R10, R11, R12, R13	0R	SMD Resistor	YAGEO	RC0603JR-070RL
31	6	TP1, TP2, TP3, TP4, TP5, TP_GND	TP	PCB ring test point - Black (drill 1.0mm) without plastic spacer	VERO	20-2137
32	1	DC-DC Converter, QFN-32L WF	SPSA068	DC-DC Converter, Buck regulator	ST	SPSA068-TR

7 PCB layout

Figure 6. **STEVAL-SPSA068 application board assembly TOP**

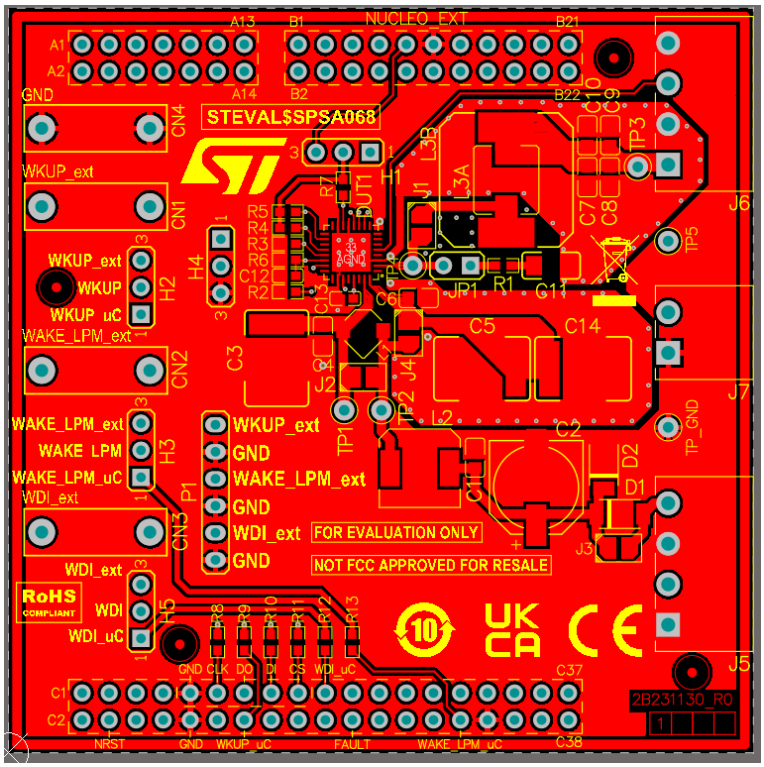


Figure 7. **STEVAL-SPSA068 application board assembly BOTTOM**

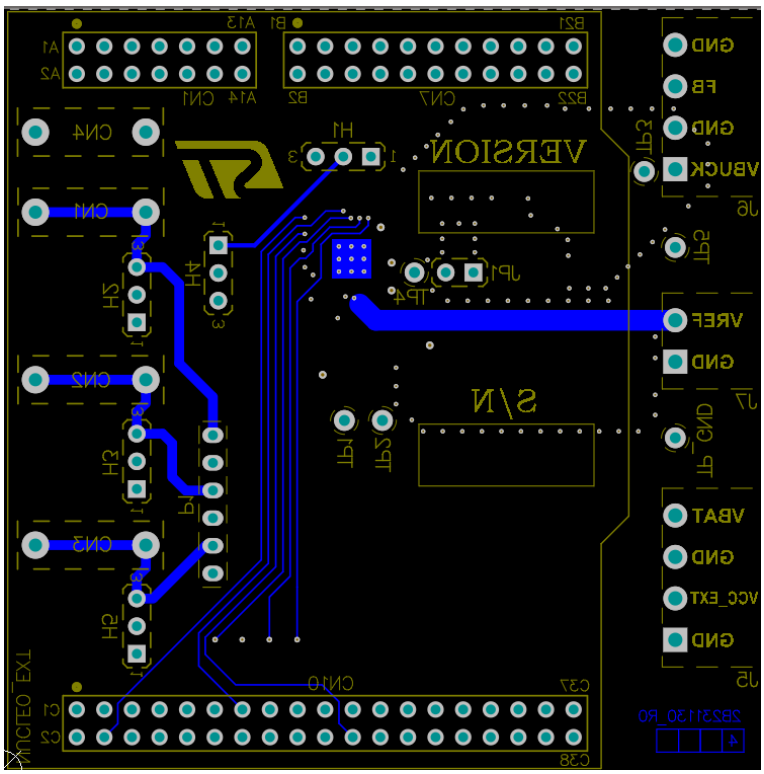


Figure 8. **STEVAL-SPSA068 application board INNER1**

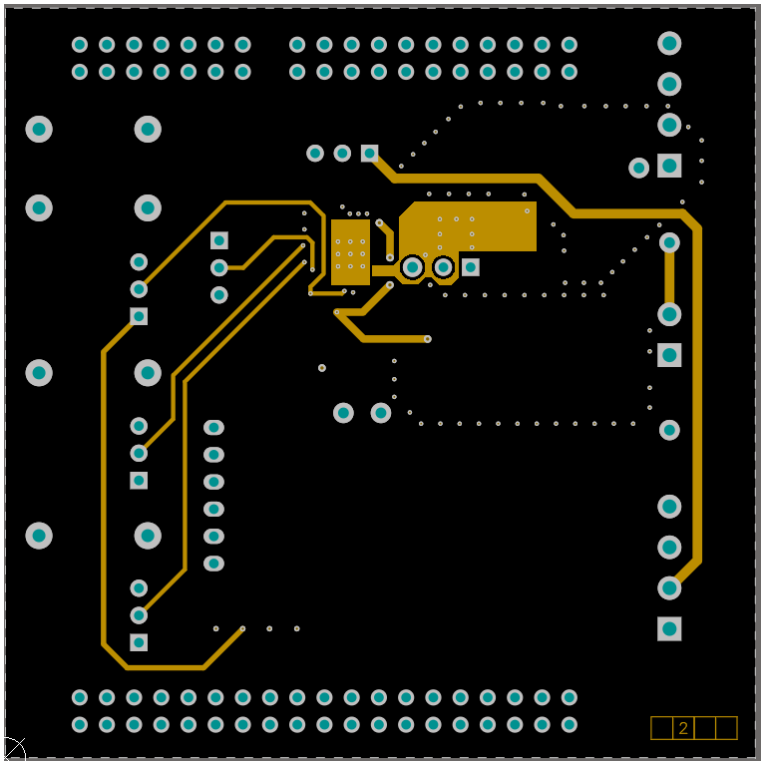
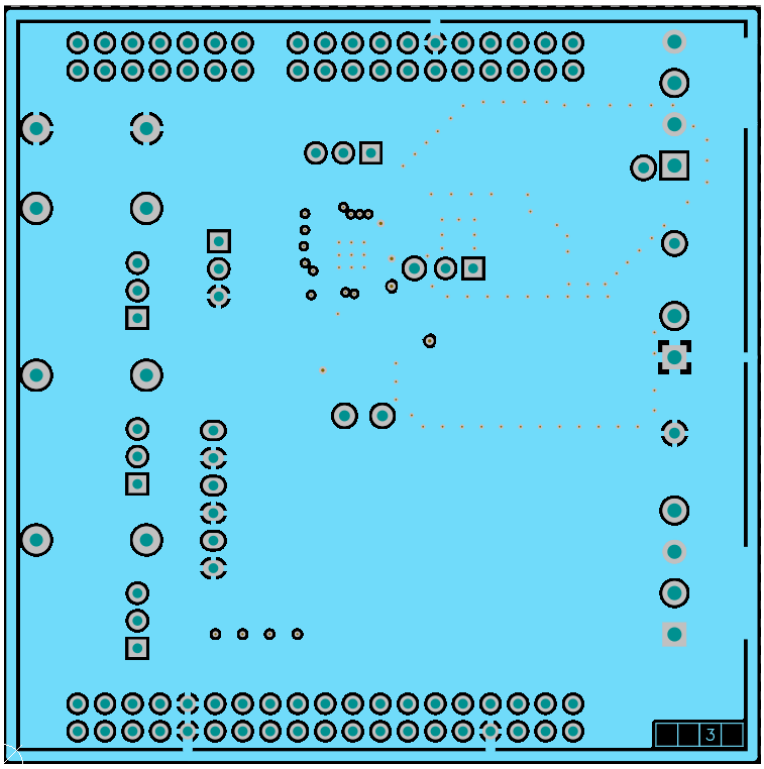


Figure 9. **STEVAL-SPSA068 application board INNER2**



8 Board versions

Table 4. **STEVAL-SPSA068 versions**

Finished good	Schematic diagrams	Bill of materials
STV$SPSA068A[1]	STV$SPSA068A schematic diagrams	STV$SPSA068A bill of materials

1. *This code identifies the STEVAL-SPSA068 evaluation board first version.*

9 Regulatory compliance information

Notice for US Federal Communication Commission (FCC)

For evaluation only; not FCC approved for resale

FCC NOTICE - This kit is designed to allow:

(1) Product developers to evaluate electronic components, circuitry, or software associated with the kit to determine

whether to incorporate such items in a finished product and

(2) Software developers to write software applications for use with the end product.

This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter 3.1.2.

Notice for Innovation, Science and Economic Development Canada (ISED)

For evaluation purposes only. This kit generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to Industry Canada (IC) rules.

À des fins d'évaluation uniquement. Ce kit génère, utilise et peut émettre de l'énergie radiofréquence et n'a pas été testé pour sa conformité aux limites des appareils informatiques conformément aux règles d'Industrie Canada (IC).

Notice for the European Union

This device is in conformity with the essential requirements of the Directive 2014/30/EU (EMC) and of the Directive 2011/65/EU (RoHS II), including subsequent revisions and additions, as well as amended by the Delegated Directive 2015/863/EU (RoHS III).

Notice for the United Kingdom

This device is in compliance with the UK Electromagnetic Compatibility Regulations 2016 (UK S.I. 2016 No. 1091) and with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (UK S.I. 2012 No. 3032).

Revision history

Table 5. **Document revision history**

Date	Revision	Changes
04-Jun-2025	1	Initial release.

Contents

List of tables

List of figures