# 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**


*Notice:* *For dedicated assistance, submit a request through our online support portal at **www.st.com/support**.*

# 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 |

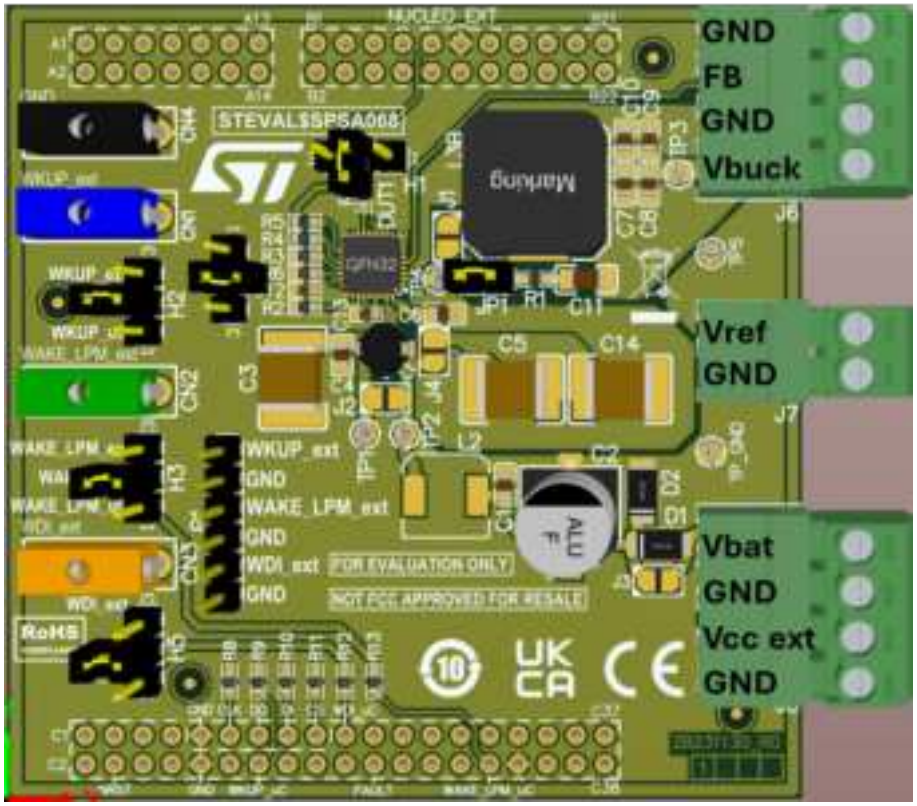
# 2 STEVAL-SPSA068 board description

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).

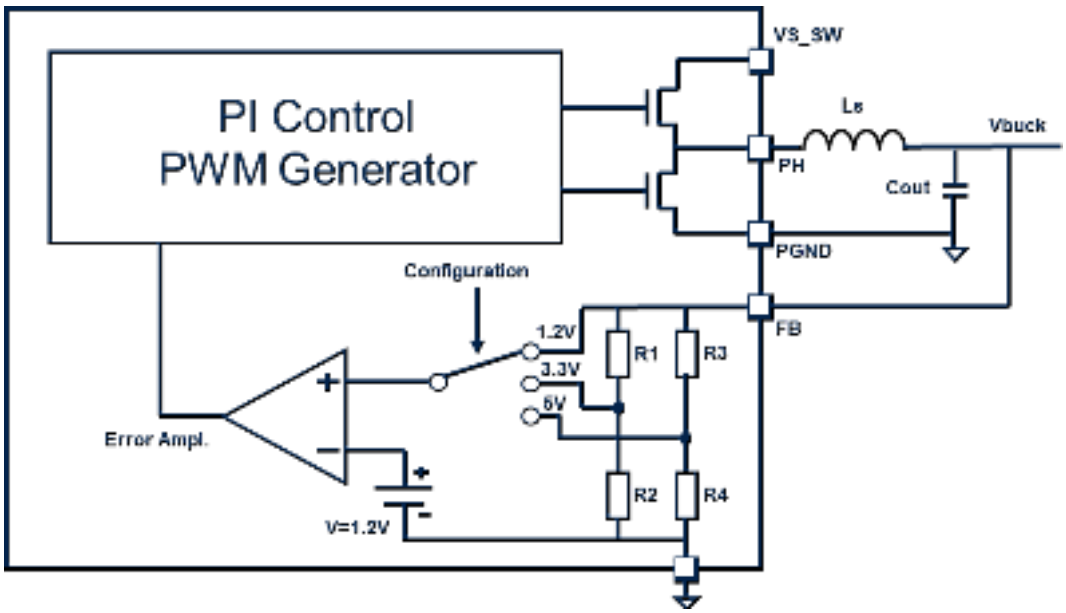
*Important: STMicroelectronics does not provide either firmware or GUI to drive the STEVAL-SPSA068. It is the customer's responsibility to develop their own application and firmware to drive the application board.*

# 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:

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

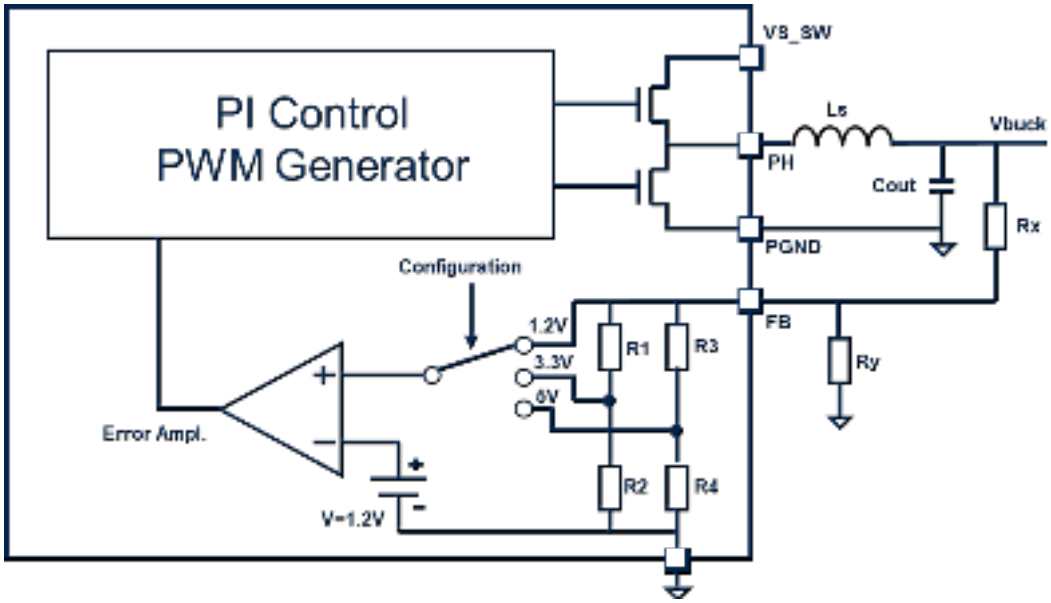
Where Vfb = 1.2 V

So the external resistor ratio is defined as:

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

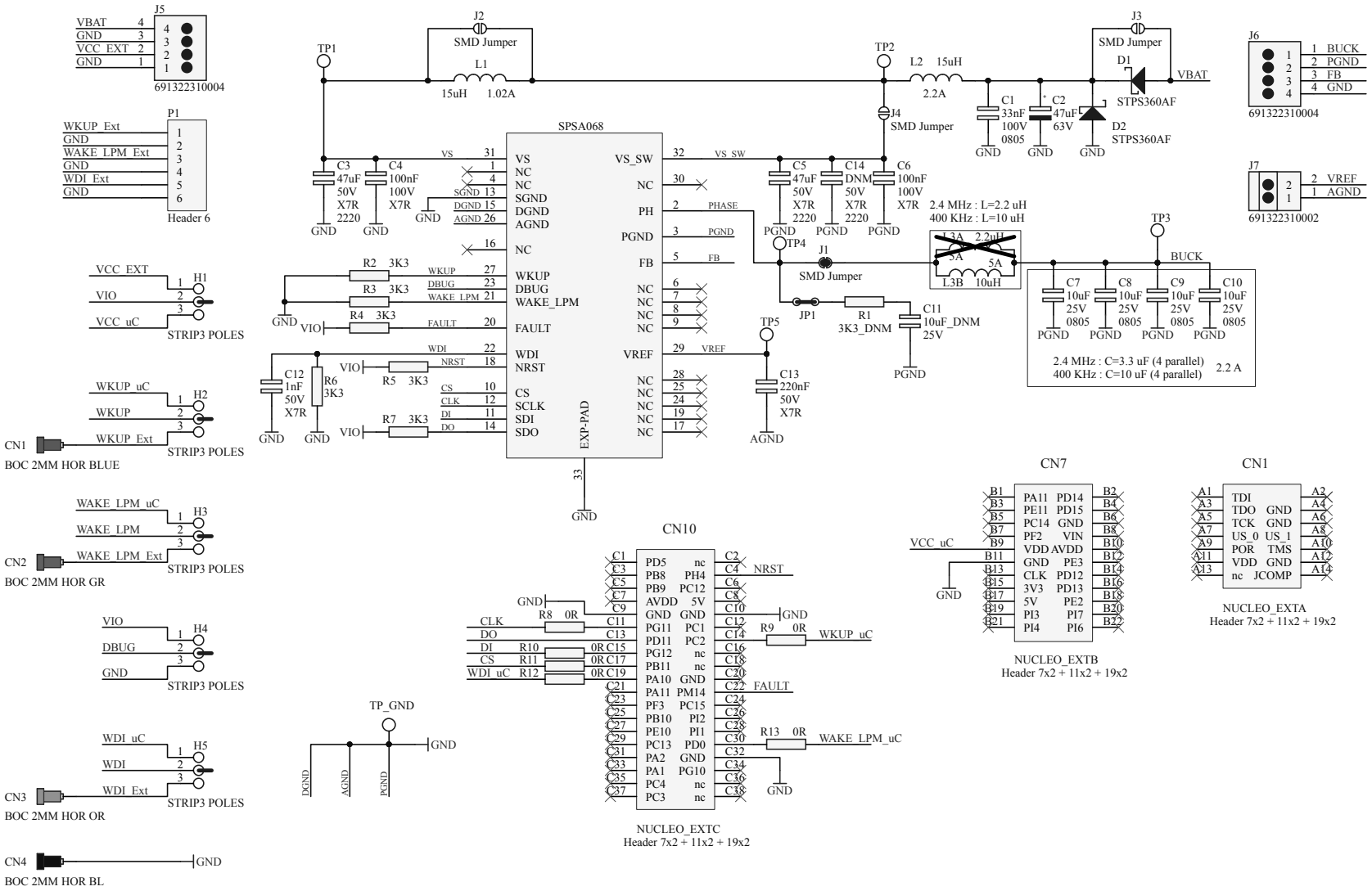
The Rx and Ry values should be selected to reduce the current through the divider.

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**

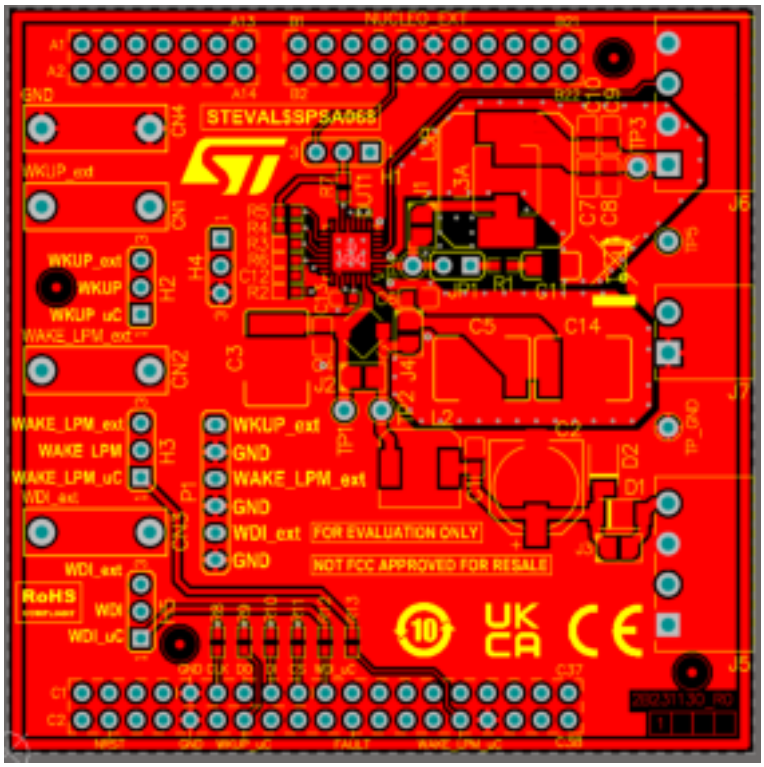



Figure 7. **STEVAL-SPSA068 application board assembly BOTTOM**

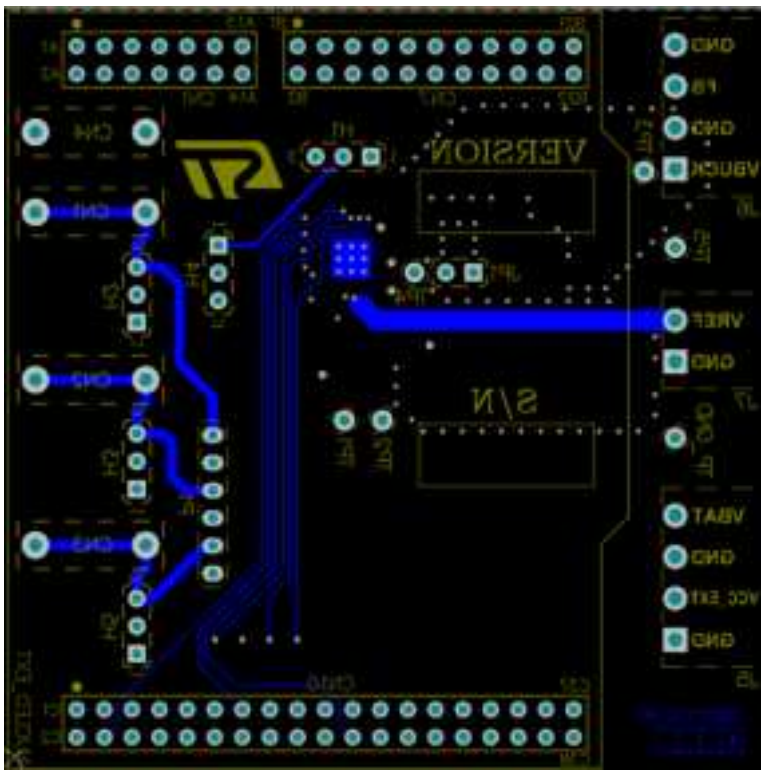


Figure 8. **STEVAL-SPSA068 application board INNER1**

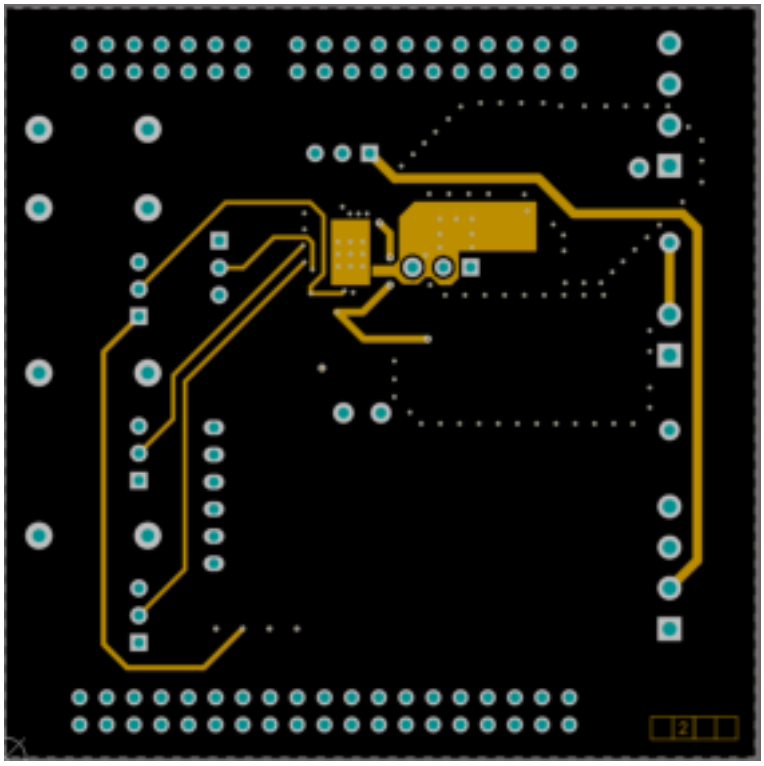
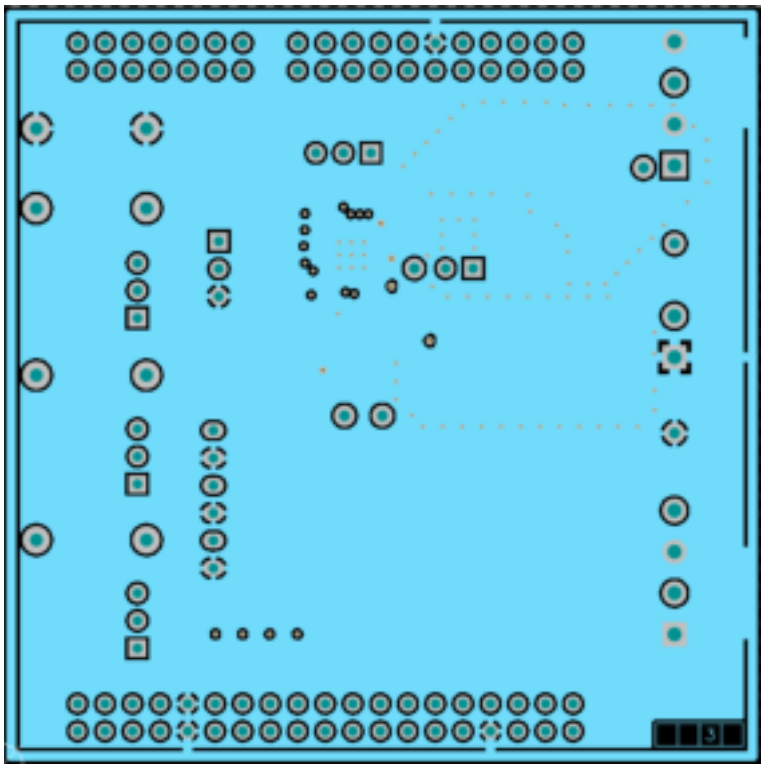


Figure 9. **STEVAL-SPSA068 application board INNER2**



# 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

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