Automotive high voltage hot swap, soft-start and oring STPM801 evaluation board

Introduction

This document provides a description of the STEVAL-STPM801 board, as well as guidelines for setting up an effective evaluation environment, from a hardware point of view.

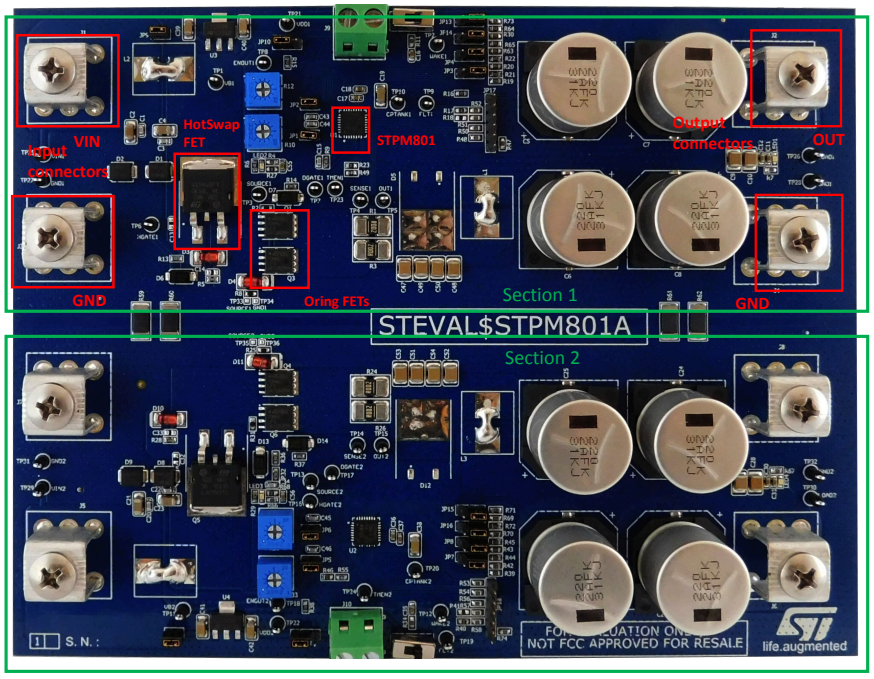
1 Evaluation hardware

1.1 Overview

As shown in Figure 1. STEVAL-STPM801 board overview, the board described in this document is designed as a twin, meaning that the single application circuit of the STPM801 is replicated on each section of the board. A complete test environment is, therefore, available with a dual battery line setup. The user can achieve the hot swap and oring functions between the two input supplies, taking advantage of the STPM801 control. In any case, the board can also work with a single-line approach (leaving the unused line unsupplied). STPM801 samples are soldered on the board.

The STEVAL-STPM801 board is an excellent starter kit for quick evaluation and project development.

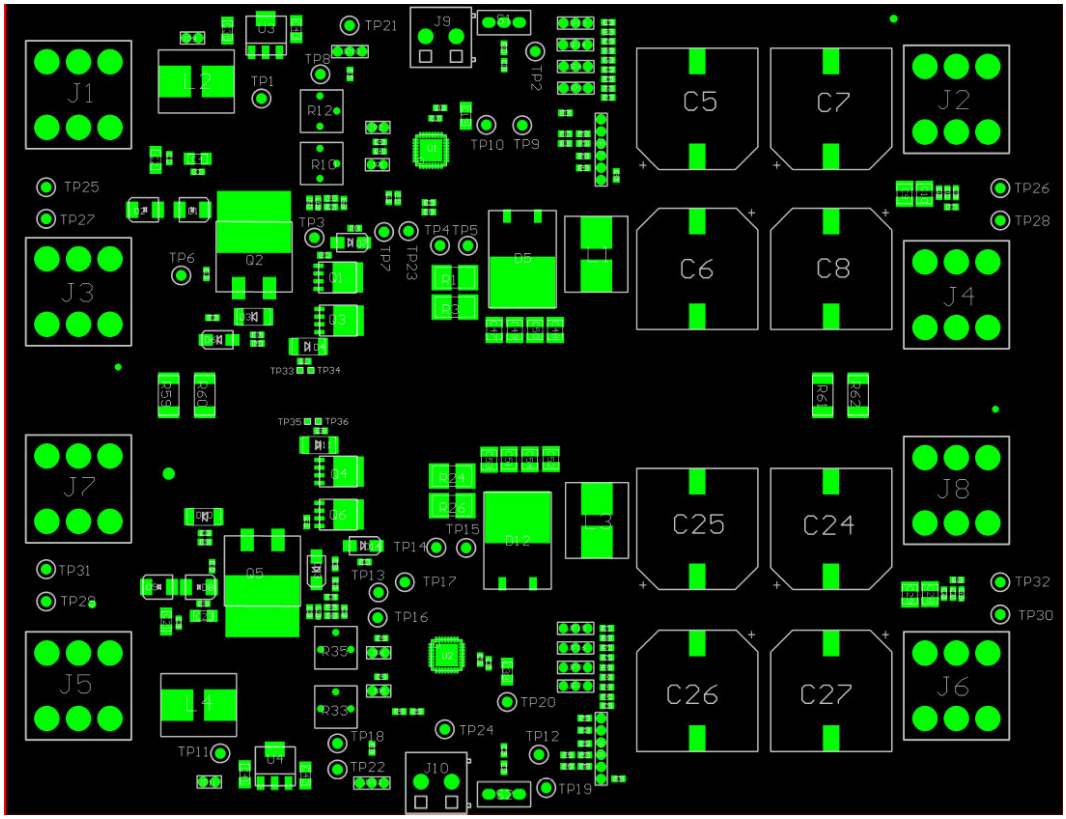
Figure 1. STEVAL-STPM801 board overview



In the following sections all references refer to the first section of the board (first battery line, half-top of the board), but they are of course also valid for the corresponding components duplicated in the second section.

1.2 Layout

Figure 2. **Board PCB layout (component layer)**



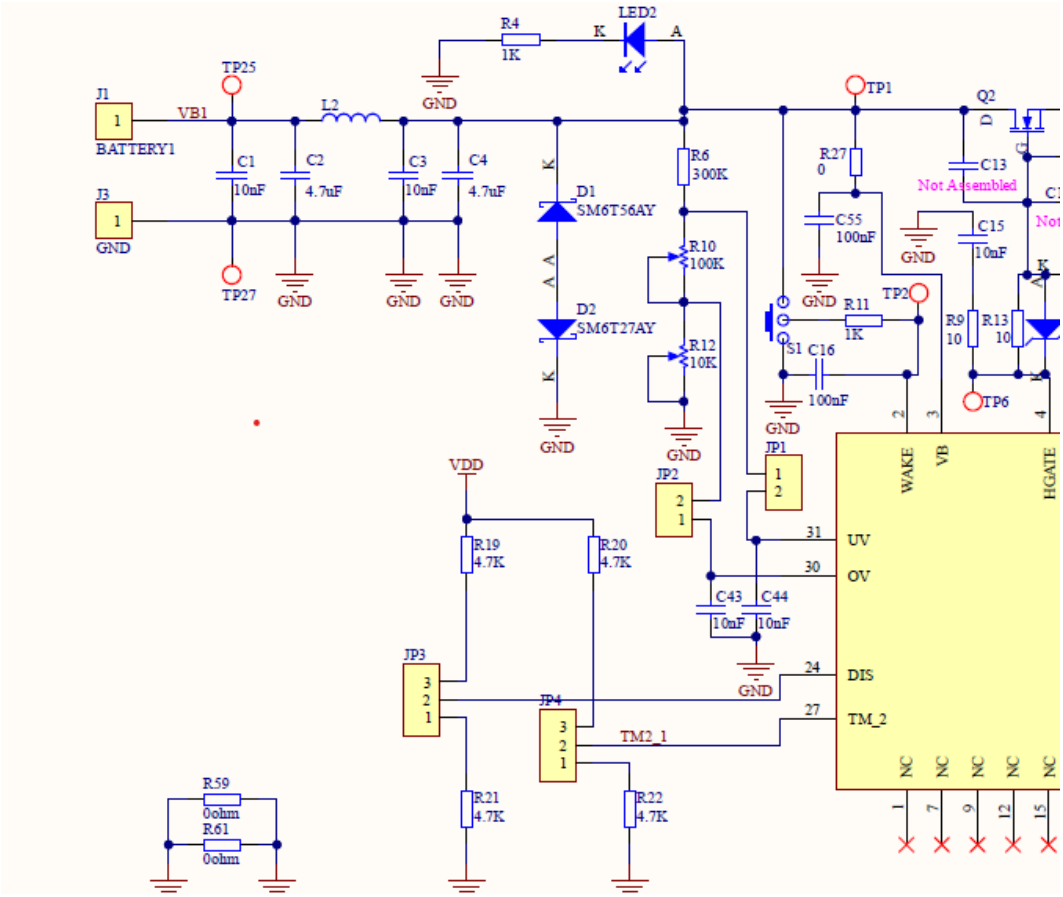
1.3 Power supply section

1.3.1 VB battery line

The main supply of the STEVAL-STPM801 is VB, which is connected to the battery line. As shown in Figure 3, a pi-filter can also be added between the supply line and VB pin, to cut eventual disturbances on the battery line.

For the input lines (and outputs) screw connectors have been chosen as they can easily withstand high current levels (up to 30 A).

Figure 3. **Board schematic section of battery connection**



1.3.2 VDD voltage

VDD voltage (5 V) is not used as supply for the STPM801, but it is necessary because:

- It provides the high logic level for the outputs FLT, ENOUT (that are connected to VDD through pull-up resistors).
- It can be used to drive a DIS input pin.

The board is equipped with two different ways to provide VDD voltage, that are summarized in Table 1. VDD generation. See also Figure 5. 5 V supply generation for schematic details.

Table 1. **VDD generation**

5V generation	Board setup
Linear voltage regulator (U3)	Jumper JP9 closed Three-way jumper JP10 on position 1-2
External voltage supply	Jumper JP9 open Three-way jumper JP10 on position 2-3 VDD supplied through 5V_EXT connector (J9)

Figure 4. **Power supply section (PCB top side)**

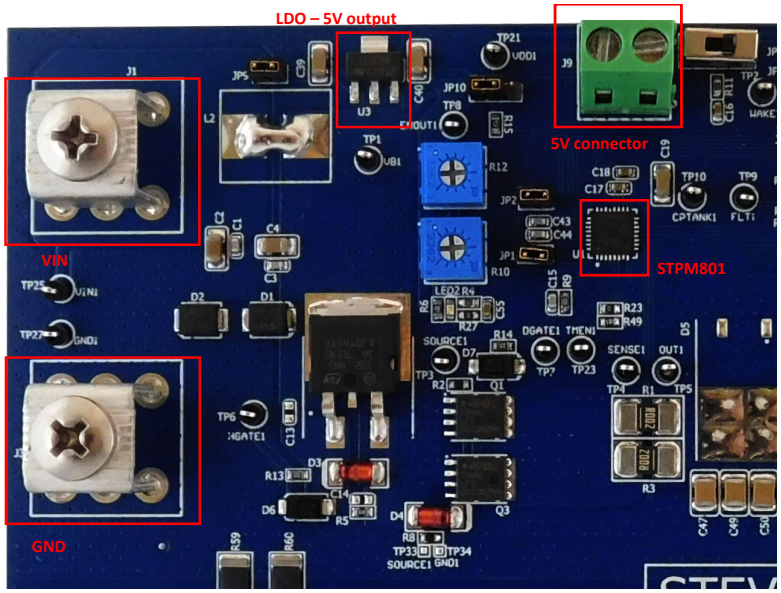
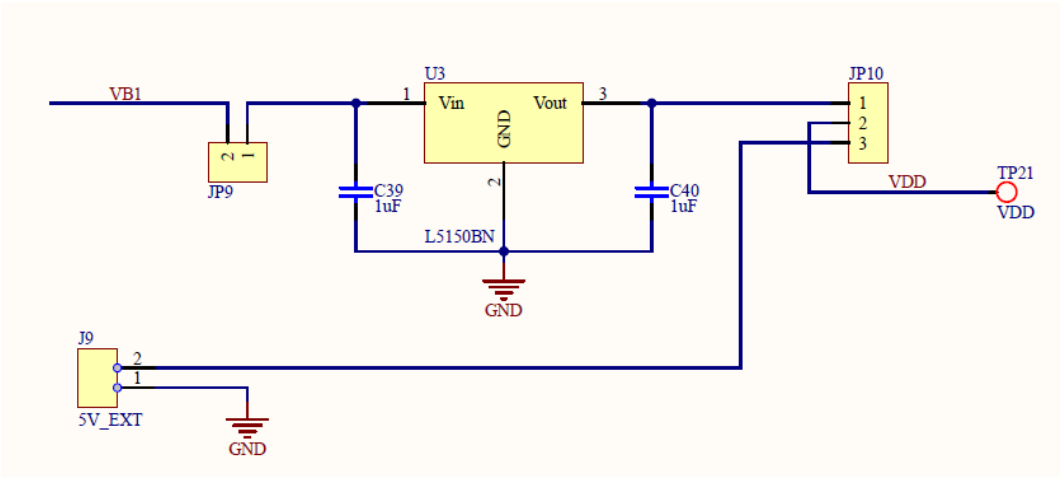


Figure 5. **5 V supply generation**



1.3.3 LEDs for power status

On both sections there are two LEDs connected respectively to:

- Battery input voltage (indicating that the board is supplied) - LED2 and LED3.
- Output OUT of the STEVAL-STPM801 (indicating that the device is operating and OUT enabled) - LED1 and LED4.

They help to debug the board and allow it to detect immediately, at first sight, anomalous conditions (for example OUT switched off when it is expected on).

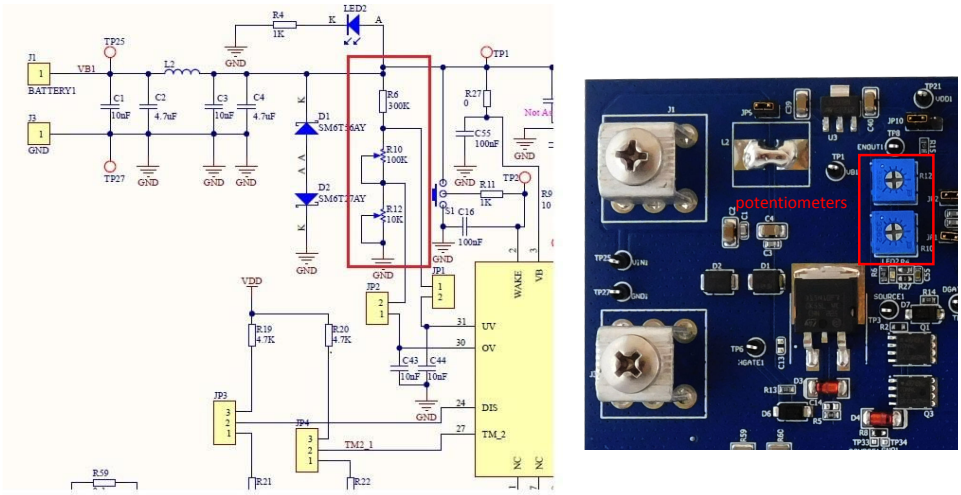
1.4 Battery UV and OV threshold selection

As explained in the product data brief, the user can fix thresholds for overvoltage and undervoltage detection, by sizing the three resistors of a voltage divider connected to the UV and OV pins.

The product application note shows in detail the criteria to size them correctly, considering the desired threshold values.

On the evaluation board, two of three resistors are achieved by potentiometers (R10 and R12, see figure below), offering the possibility to modify the partitioning result, adapting it to the desired values of the thresholds and gaining more flexibility toward different system voltage supplies (12 V or 24 V).

Figure 6. Voltage divider for UV and OV threshold settings



The following set of resistors of the voltage divider is recommended, depending on the supply system used (12 V or 24 V system), and considering that one of the three resistors (R6) has the fixed value of 300 kΩ.

Table 2. Recommended resistor values for UV_OV voltage divider

Supply system	R6 (kΩ)	R10 (kΩ)	R12 (kΩ)
12V	300	50	12
24V	300	30	10

2 System startup

Before supplying the system, make sure that the board is correctly configured as suggested, for example, in Table 3. Recommended setup, but keeping, initially, switches S1 and S2 open (WAKE disabled).

As a starting point, it is better to test only one section at a time, supplying each one separately, and without connecting any load on the output connectors. The following steps are recommended, in sequence:

- Supply one or more sections of the board using the input connectors
- If LED2 (or LED3) is bright, the board is correctly supplied
- Check if the 5 V supply is present (test point T21 or T22)
- If the previous points do not show any anomalies, it is possible to enable WAKE input by closing the switch S1 (or S2)
- As a final check, if everything is working fine:
  - LED1 (or LED4) is expected bright, meaning that it is correctly actuating the predrivers and OUT has reached input battery voltage level
  - FLT pin (test point TP9 or TP19) is expected to be high (since there are no faults)
  - ENOUT pin (test point TP8 or TP18) is expected to be high (meaning that OUT voltage level is close to input battery voltage)
  - CPTANK pin (test point T10 or T20) is expected to be about 10 V higher than the input battery voltage level
  - HGATE pin (test point TP6 or TP16) is expected at about VB+CPTANK voltage
  - DGATE pin (test point TP7 or TP17) is expected, in no load condition, a few volts above VB
- At this point, a load can be connected to the output connectors.

3 Recommended test setup

A recommended setup is shown in this section, with the proper configuration of switches and jumpers, allowing the user to correctly switch on the device in normal mode. On the proposed setup, the VDD voltage is provided by the linear regulator. In case the user prefers to provide it through an external voltage supply, Table 1 shows how to change the settings.

Table 3. Recommended setup

Header	Setting	Function
Section 1		
S1	closed	Connection of WAKE to battery
JP1	closed	Connection of pin UV with voltage divider
JP2	closed	Connection of pin OV with voltage divider
JP3	1-2	Connection of DIS input to GND (1-2) or VDD (2-3)
JP4	1-2	Connection of STBY_IN to GND (1-2) or VDD (2-3). Connect it to GND to work in normal mode. To work in standby mode connect it to the MCU, sending the pattern to enter to it
JP9	closed	Connection of voltage regulator U3 to battery
JP10	1-2	Connection of VDD line to the output of the voltage regulator (1-2), or to the external 5V supply line (2-3)
JP13	1-2	Connection of STBY_ECHO to GND (1-2) or VDD (2-3). Connect it to GND to work in normal mode. To work in standby mode connect it to the MCU input to acquire standby echo signal
JP14	1-2	Pin 28 not used – it is tied to GND
Section 2		
S2	closed	Connection of WAKE to battery
JP5	closed	Connection of pin UV with voltage divider
JP6	closed	Connection of pin OV with voltage divider
JP7	1-2	Connection of DIS input to GND (1-2) or VDD (2-3)
JP8	1-2	Connection of STBY_IN to GND (1-2) or VDD (2-3). Connect it to GND to work in normal mode. To work in standby mode connect it to the MCU, sending the pattern to enter to it
JP11	closed	Connection of voltage regulator U4 to battery
JP12	1-2	Connection of VDD line to the output of the voltage regulator (1-2), or to the external 5V supply line (2-3)
JP15	1-2	Connection of STBY_ECHO to GND (1-2) or VDD (2-3). Connect it to GND to work in normal mode. To work in standby mode connect it to the MCU input to acquire standby echo signal
JP16	1-2	Pin 28 not used – it is tied to GND

4 Schematic diagrams

Figure 7. **STEVAL-STPM801 circuit schematic (1 of 3)**

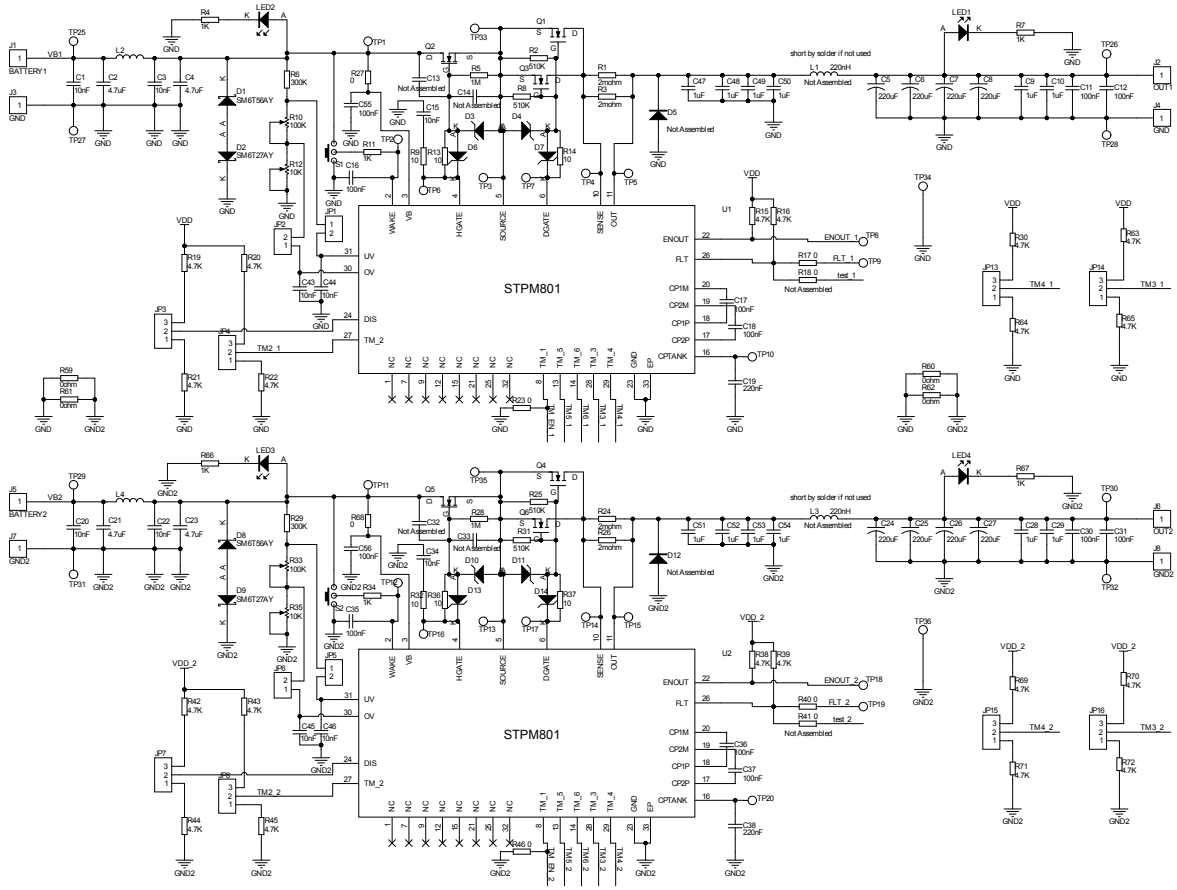


Figure 8. **STEVAL-STPM801 circuit schematic (2 of 3)**

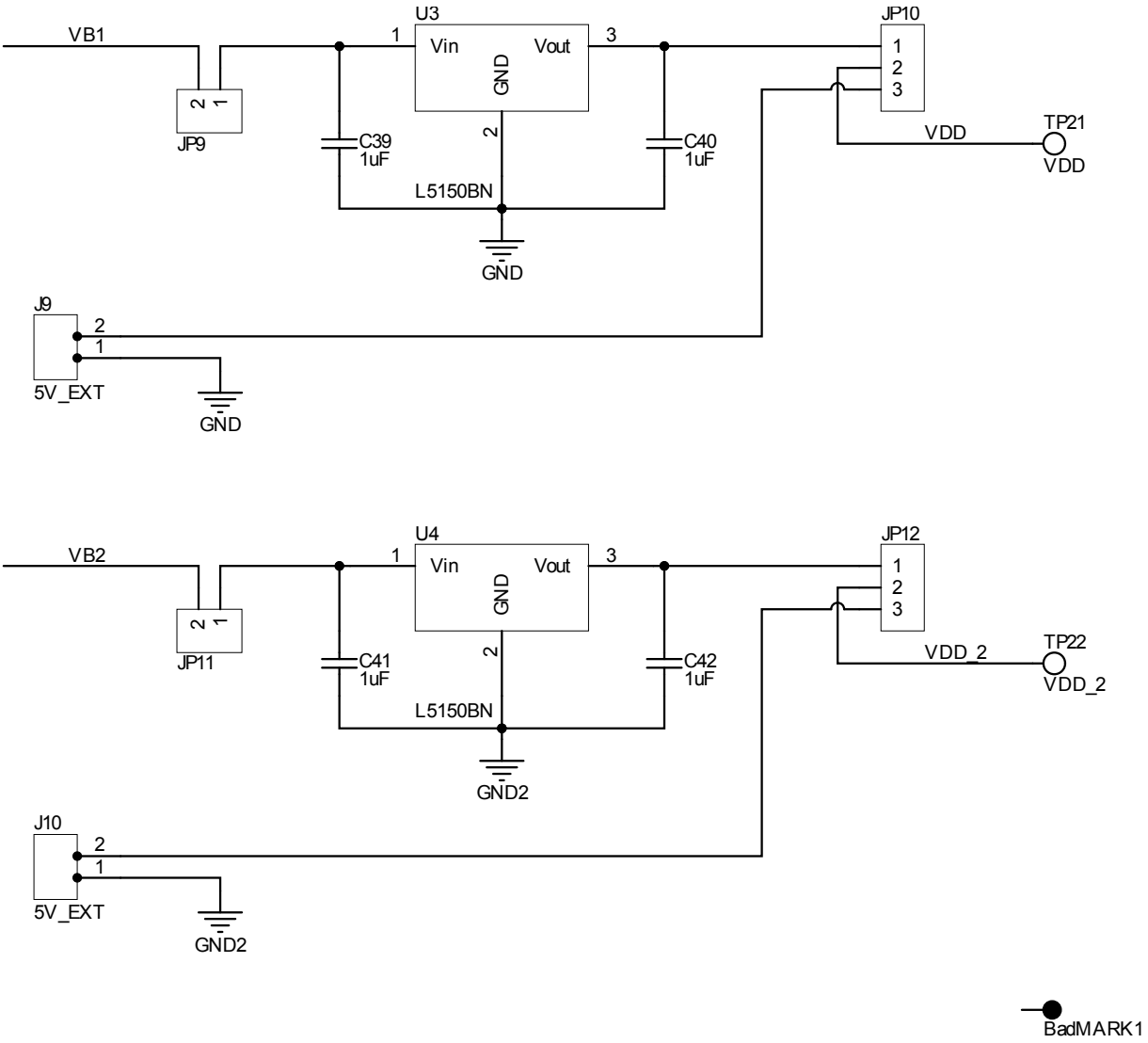
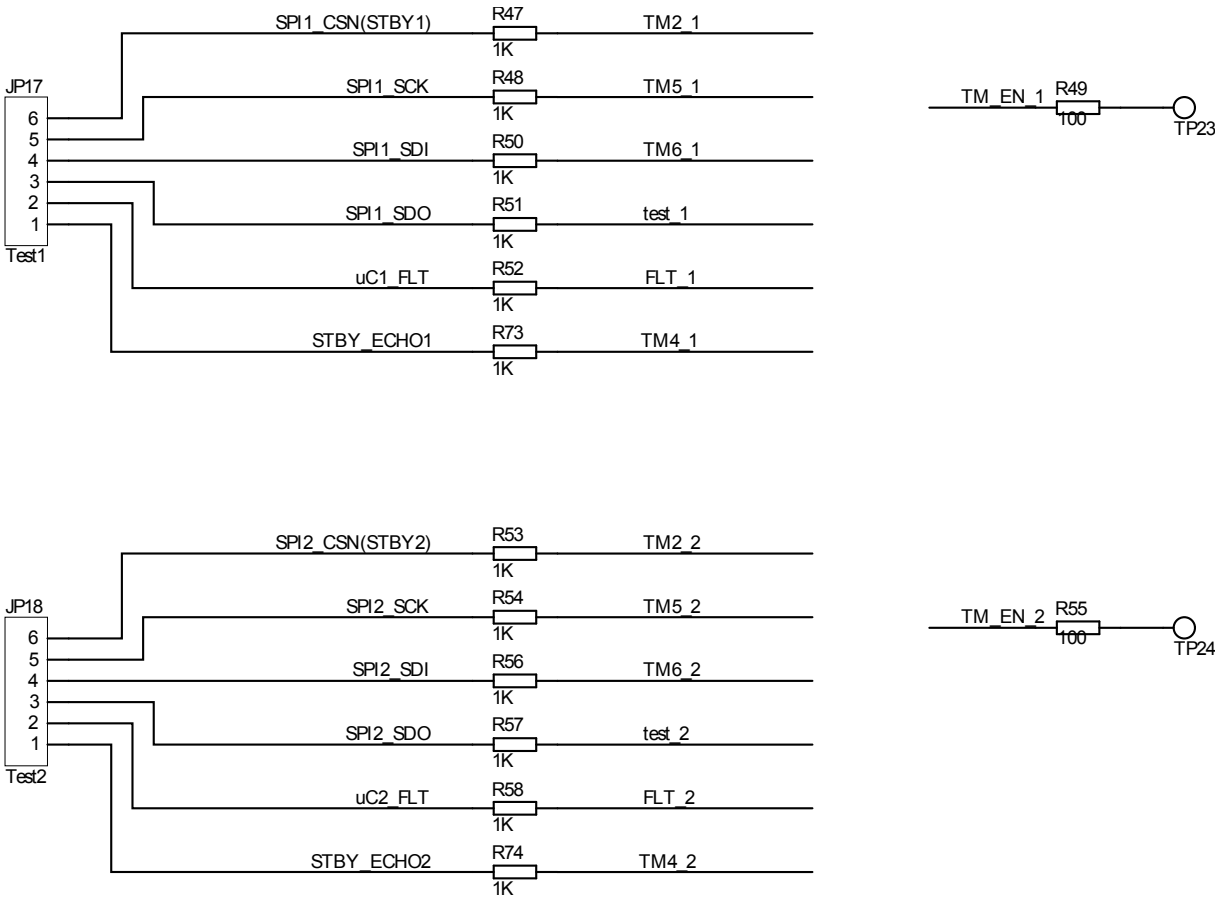


Figure 9. **STEVAL-STPM801 circuit schematic (3 of 3)**



5 STEVAL-STPM801 bill of materials

Table 4. **STEVAL-STPM801 bill of materials**

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	10	C1,C3,C15,C20,C22,C34,C43,C44,C45,C4	10nF	CAPACITOR C0G	Murata	GRM1885C1H103JA01D
2	4	C2,C4,C21,C23	4.7uF	CAPACITOR X7R	Samsung	CL31B475KBHNNNE
3	8	C5,C6,C7,C8,C24,C25,C26,C27	220uF	CAPACITOR 18(Dia.)x17mm	Panasonic	EEVFK2A221M
4	12	C9,C10,C28,C29,C47,C48,C49,C50,C51,C52,C53,C54	1uF	CAPACITOR X7R	Kemet	C1210C105K5RACTU
5	12	C11,C12,C16,C17,C18,C30,C31,C35,C36,C37,C55,C56	100nF	CAPACITOR X7R	Murata	GRM188R72A104KA35D
6	2	C19,C38	220nF	CAPACITOR X7R	Murata	GRM31MR72A224KA01L
7	4	C39,C40,C41,C42	1uF	CAPACITOR X7R	Samsung	CL31B105KCHNFNE
8	2	D1,D8		SM6T56AY, SMB	STMicroelectronics	SM6T56AY
9	2	D2,D9		SM6T27AY, SMB	STMicroelectronics	SM6T27AY
10	4	D3,D4,D10,D11		Zener diode	Vishay	ZM4742A-GS08
11	4	D6,D7,D13,D14		Schottky diode	SMC diode	SS210ATR
12	8	J1,J2,J3,J4,J5,J6,J7,J8		Screw terminals, 6 contacts	Keystone	8196
13	2	J9,J10		PCB connectors, 2 poles, 5 mm	Degson	DG128-5.0-02P-14-00A(H)
14	6	JP1,JP2,JP5,JP6,JP9,JP11		Male jumper, single row, 1x2 2 mm pitch 2mm	3M	951102-8622-AR
15	10	JP3,JP4,JP7,JP8,JP10,JP12,JP13,JP14,JP15,JP16		Male jumper, single row, 1x3 pitch 2 mm	3M	951103-8622-AR
16	2	JP17,JP18		Male jumper, single row, 1x6 pitch 2 mm	3M	951106-8622-AR
17	2	L2,L4				
18	4	LED1,LED2,LED3,LED4		Led Green 198,5mcd	Everlight	EAST16084GA1
19	4	Q1,Q3,Q4,Q6		STL70N4 N-channel Power MOSFET, PowerFLAT 5x6 WF	STMicroelectronics	STL70N4LLF5

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
20	2	Q2,Q5		STH315N10F7-2 IGBT Module, H2PAK-2	STMicroelectronics	STH315N10F7-2
21	4	R1,R3,R24,R26	2mΩ	RESISTOR	Bourns	CRE2512-FZ-R002E-3
22	4	R2,R8,R25,R31	510KΩ	RESISTOR	VISHAY DALE	CRCW0603510KFKEA
23	18	R4,R7,R11,R34,R47,R48,R50,R51,R52,R53,R54,R56,R57,R58,R66,R67,R73,R74	1KΩ	RESISTOR	Yageo	RC0603JR-071KL
24	2	R5,R28	1MΩ	RESISTOR	Vishay	CRCW06031M00FKEA
25	2	R6,R29	300KΩ	RESISTOR	Yageo	RC0603FR-07300K
26	6	R9,R13,R14,R32,R36,R37	10Ω	RESISTOR	Yageo	RC0603JR-0710RL
27	2	R10,R33	100kΩ	TRIMMER	Bourns	3362P-1-104LF
28	2	R12,R35	10kΩ	TRIMMER	Bourns	3362P-1-103LF
29	20	R15,R16,R19,R20,R21,R22,R38,R39,R42,R43,R44,R45,R30,R63,R64,R65,R69,R70,R71,R72	4.7KΩ	RESISTOR	Stackpole	RMCF0603FT4K70
30	6	R17,R23,R40,R46,R27,R68	0Ω	RESISTOR	TE Connectivity	CRG0603ZR
31	2	R49,R55	100Ω	RESISTOR	Yageo	RC0603JR-07100RL
32	4	R59,R60,R61,R62	0Ω	RESISTOR	Vishay	WSL2512000000ZEA9
33	2	S1,S2		Micro Switch Vertical scroll 3 Pin SPDT	Gebildet	SS-12D00
34	32	TP1,TP2,TP3,TP4,TP5,TP6,TP7,TP8,TP9,TP10,TP11,TP12,TP13,TP14,TP15,TP16,TP17,TP18,TP19,TP20,TP21,TP22,TP23,TP24,TP25,TP26,TP27,TP28,TP29,TP30,TP31,TP32		TESTPOINT	RS Pro	262-2179
35	2	U1,U2		STPM801, VFQFN 5X5X0.9 32+4L WETT. FLANKS	STMicroelectronics	STPM801
36	2	U3,U4		L5150BN VOLTAGE REGULATOR, SOT-223	STMicroelectronics	L5150BNTR

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
37	2	JP_1,JP_2		Jumper STEP 2mm	FCI	86730-101LF
38	1	BadMARK1		BadMARK		
39	4	C13,C14,C32,C33	100nF	CAPACITOR X7R	Murata	GRM188R72A104KA35D
40	2	D5,D12		STPS30H60-Y POWER Schottky rectifier, D2PAK	STMicroelectronics	STPS30H60CGY-TR
41	2	L1,L3		VLP6045LT POWER INDUCTOR	TDK	VCMT104T-R19MN54M
42	2	R18,R41	0Ω	RESISTOR	TE Connectivity	CRG0603ZR
43	4	TP33,TP34,TP35,TP36		TESTPOINT		

6 Board versions

Table 5. **STEVAL-STPM801 versions**

PCB version	Schematic diagrams	Bill of materials
STEVAL$STPM801A (1)	STEVAL$STPM801A schematic diagrams	STEVAL$STPM801A bill of materials

1. *This code identifies the STEVAL-STPM801 evaluation board first version. The STEVAL$STPM801A code is printed on the board.*

7 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 2015/863/EU (RoHS).

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 6. **Document revision history**

Date	Revision	Changes
09-Sep-2023	1	Initial release.

Contents

List of tables

List of figures