

Getting started with STEVAL-IFP045V1 industrial digital output expansion board

Introduction

The **STEVAL-IFP045V1** is an industrial digital output expansion board. It provides a powerful and flexible environment for the evaluation of the driving and diagnostic capabilities of the **IPS1025HQ** single high-side smart power solid state relay, in a digital output module connected to 2.5 A industrial loads.

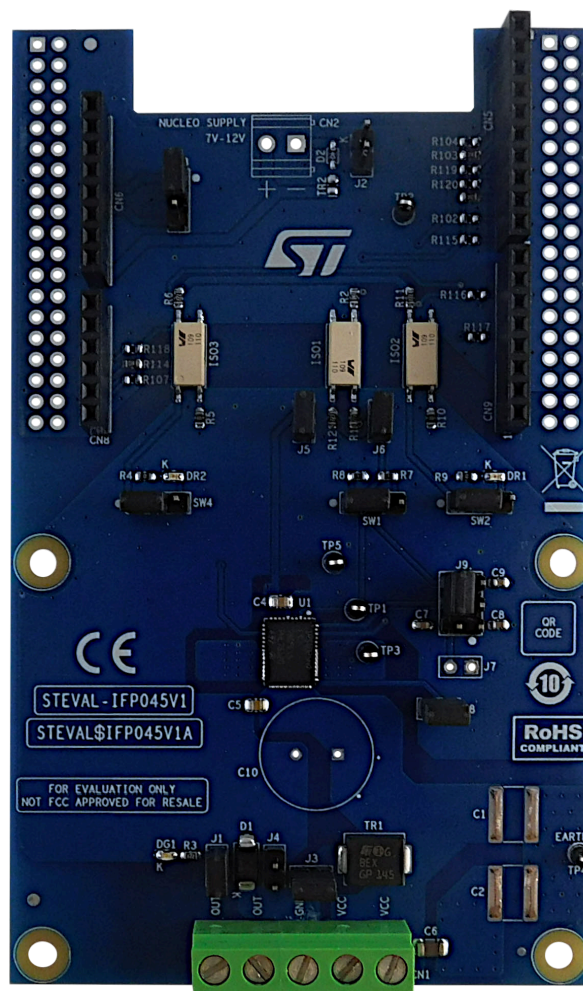
The **STEVAL-IFP045V1** can interface with the microcontroller on the **STM32 Nucleo** via 5 kV optocouplers driven by GPIO pins and Arduino R3 connectors.

The expansion board can be connected to either a **NUCLEO-F401RE** or a **NUCLEO-G431RB** development board.

It is also possible to evaluate a system composed of up to four stacked **STEVAL-IFP045V1** expansion boards.

As an example, a system with four **STEVAL-IFP045V1** expansion boards allows you to evaluate a quad channel digital output module.

Figure 1. STEVAL-IFP045V1 expansion board



1 Getting started

1.1 Overview

The [STEVAL-IFP045V1](#) embeds the [IPS1025HQ](#) intelligent power switch (IPS), featuring overcurrent and overtemperature protection for safe output load control.

The board is designed to meet application requirements in terms of galvanic isolation between user and power interfaces. This requirement is satisfied by an optical isolation implemented through three optocouplers (ISO1, ISO2, and ISO3) for signal forward to the device and FLT pins for feedback diagnostic signals.

The expansion board features:

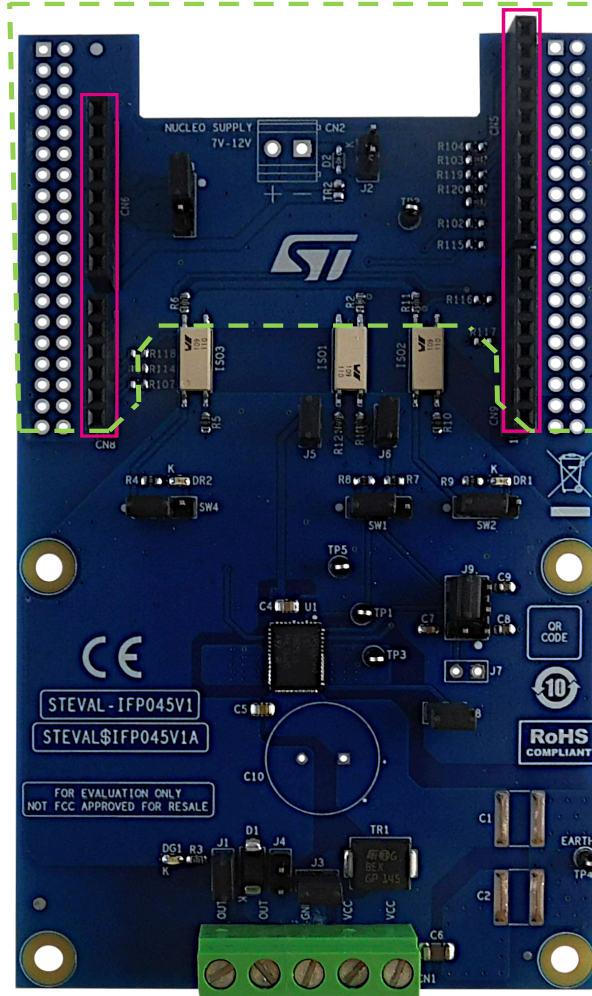
- Based on the [IPS1025HQ](#) single high-side switch, which features:
 - Operating range up to 60 V
 - Low-power dissipation ($R_{ON(MAX)} = 25 \text{ m}\Omega$)
 - Fast decay for inductive loads
 - Smart driving of capacitive loads
 - Undervoltage lock-out
 - Overload and overtemperature protections
 - QFN48L 8x6 mm package
- Application board operating range: 8 to 33 V/0 to 2.5 A
- Extended voltage operating range (J3 open) up to 60 V
- Green LED for output on/off status
- Red LEDs for overload and overheating diagnostics
- 5 kV galvanic isolation
- Supply rail reverse polarity protection
- Compatible with [STM32 Nucleo](#) development boards
- Equipped with Arduino UNO R3 connectors
- CE certified
- RoHS and China RoHS compliant
- Not FCC approved for resale

1.1.1 Digital section

The digital section is associated with the STM32 interface and digital supply voltage to and from the [STEVAL-IFP045V1](#) expansion board.

Figure 2. STEVAL-IFP045V1 expansion board: digital interface section

Dotted green line indicates the whole digital interface section. Pink rectangles identify Arduino UNO R3 connectors



The four Arduino UNO R3 connectors:

- allow expansion board communication with the **STM32 Nucleo** development board microcontroller accessing STM32 peripheral and GPIO resources;
- provide digital supply voltage between the **STM32 Nucleo** development board and the **STEVAL-IFP045V1** expansion board, in either direction.

Normally, the **STM32 Nucleo** development board supplies the expansion board by a 3v3 or 5v0 generated by the USB. You can select the preferred voltage on the expansion board via SW3 (3v3 closing pins 1-2; 5v0 closing pins 2-3).

Alternatively, it is possible to supply the **STM32 Nucleo** development board by the expansion board. In this case, an external supply voltage (7-12 V) should be connected to CN2 connector (not mounted by default) on the expansion board and the ground loop should be closed by mounting D2 (enabling the reverse polarity protection) or by closing J2 (without reverse polarity).

To supply the V_{IN} voltage rail, it is necessary to:

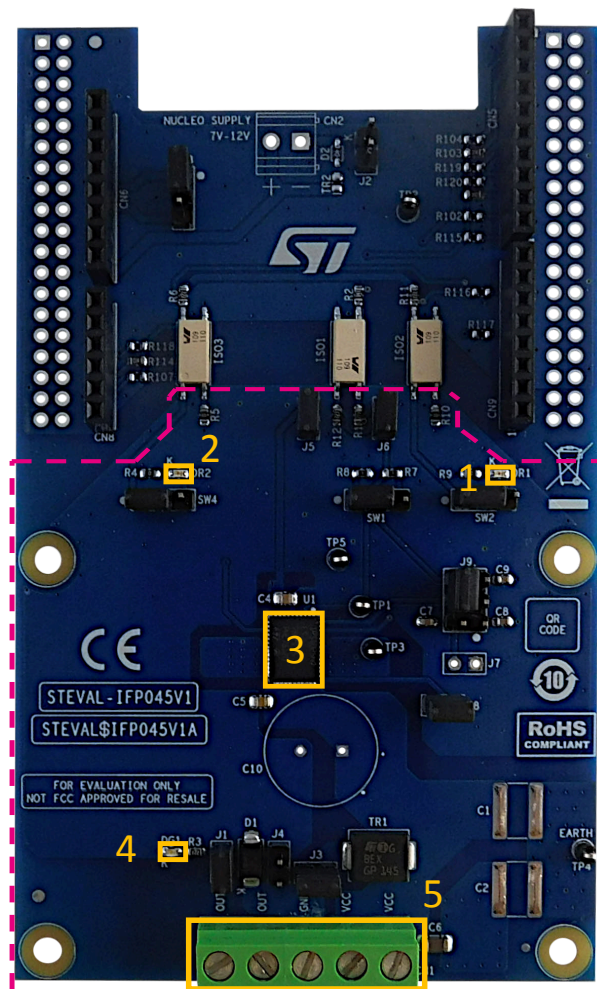
- close jumper JP5 between pins 2 and 3 and open jumper JP1 on the **NUCLEO-F401RE**;
- open jumper JP5 between pins 1 and 2 and close jumper JP5 between pins 3 and 4 on the **NUCLEO-G431RB**.

1.1.2 Power section

The power section involves the power supply voltage (CN1, pins 4 and 5 for V_{CC} , pin 3 for GND), load connection (a load can be connected between pins CN1.1 and CN1.3 or CN1.2, and CN1.3; both output pins are connected to the single output channel as shown in Schematic diagrams) and electromagnetic compatibility (EMC) protection.

Figure 3. STEVAL-IFP045V1 expansion board: power section components

1. Overtemperature red LED
2. Overload red LED
3. [IPS1025HQ](#)
4. Output channel - green LED
5. Output and power supply connector



For EMC:

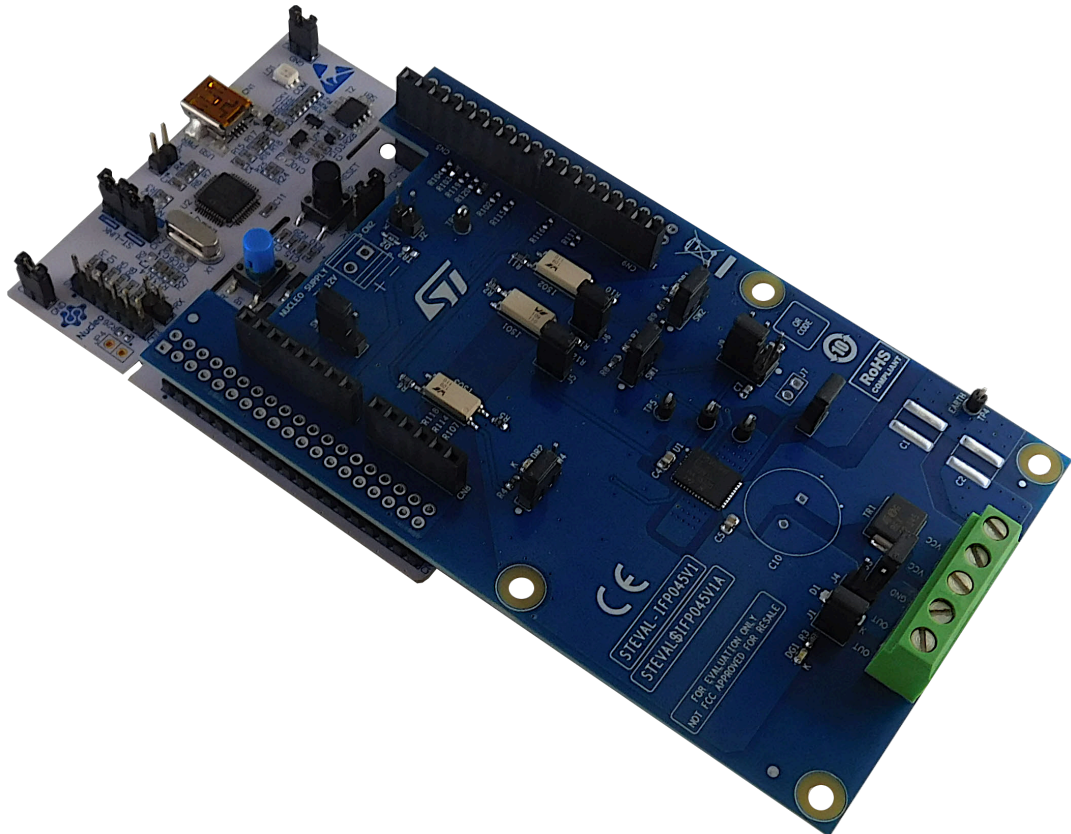
- The [SM15T39CA](#) transient voltage suppressor (TR1), enabled by closing J3, is placed between V_{CC} and GND tracks to protect the [IPS1025HQ](#) against surge discharge on the supply rail path up to $\pm 1 \text{ kV}/2 \Omega$ coupling;
- in common mode surge testing, two single-layer capacitors (C1 and C2 - not included) must be soldered at the predisposed locations;
- the [IPS1025HQ](#) output stages do not require additional EMC protections with respect to the IEC61000-4-2, IEC61000-4-3, IEC61000-4-4, IEC61000-4-5, IEC61000-4-8 standards.

1.2 Hardware requirements

The STEVAL-IFP045V1 expansion board is designed to be used with the NUCLEO-F401RE or NUCLEO-G431RB STM32 Nucleo development boards.

To function correctly, the STEVAL-IFP045V1 must be plugged onto the matching Arduino UNO R3 connector pins on the STM32 Nucleo board as shown below.

Figure 4. STEVAL-IFP045V1 and STM32 Nucleo stack



1.3 System requirements

To use the STM32 Nucleo development boards with the STEVAL-IFP045V1 expansion board, you need:

- a Windows PC/laptop (Windows 7 or above)
- a type A to mini-B USB cable to connect the STM32 Nucleo board to the PC when using a NUCLEO-F401RE development board
- a type A to micro-B USB cable to connect the STM32 Nucleo board to the PC when using a NUCLEO-G431RB development board
- the X-CUBE-IPS firmware and software package installed on your PC/laptop

1.4 Board setup

Step 1. Connect the micro-USB or mini/USB cable to your PC to use the STEVAL-IFP045V1 with NUCLEO-F401RE or NUCLEO-G431RB development board

- Step 2.** Download the firmware (.bin) onto the **STM32 Nucleo** development board microcontroller through **STM32 ST-LINK utility**, **STM32CubeProgrammer** and according to your IDE environment as detailed in the table below.

Table 1. NUCLEO-F401RE development board supported IDEs - bin files

NUCLEO-F401RE		
IAR	Keil	STM32CubeIDE
EWARM-OUT05_06-STM32F4xx_Nucleo.bin	MDK-ARM-OUT05_06-STM32F4xx_Nucleo.bin	STM32CubeIDE-OUT05_06-STM32F4xx_Nucleo.bin

Table 2. NUCLEO-G431RB development board supported IDEs - bin files

NUCLEO-G431RB		
IAR	Keil	STM32CubeIDE
EWARM-OUT05_06-STM32G4xx_Nucleo.bin	MDK-ARM-OUT05_06-STM32G4xx_Nucleo.bin	STM32CubeIDE-OUT05_06-STM32G4xx_Nucleo.bin

- Step 3.** Connect the **IPS1025HQ** device supply voltage via CN1 (see [Section 1.1.2 Power section](#)).
- Step 4.** Provide the digital supply voltage (see [Section 1.1.1 Digital section](#)).
- Step 5.** Connect the load on the output connector (see [Section 1.1.2 Power section](#)).
- Step 6.** Reset the example sequence using the black push button.
- Step 7.** Push the **STM32 Nucleo** blue button to select the example provided in the firmware package.

1.5 Multiple board configuration

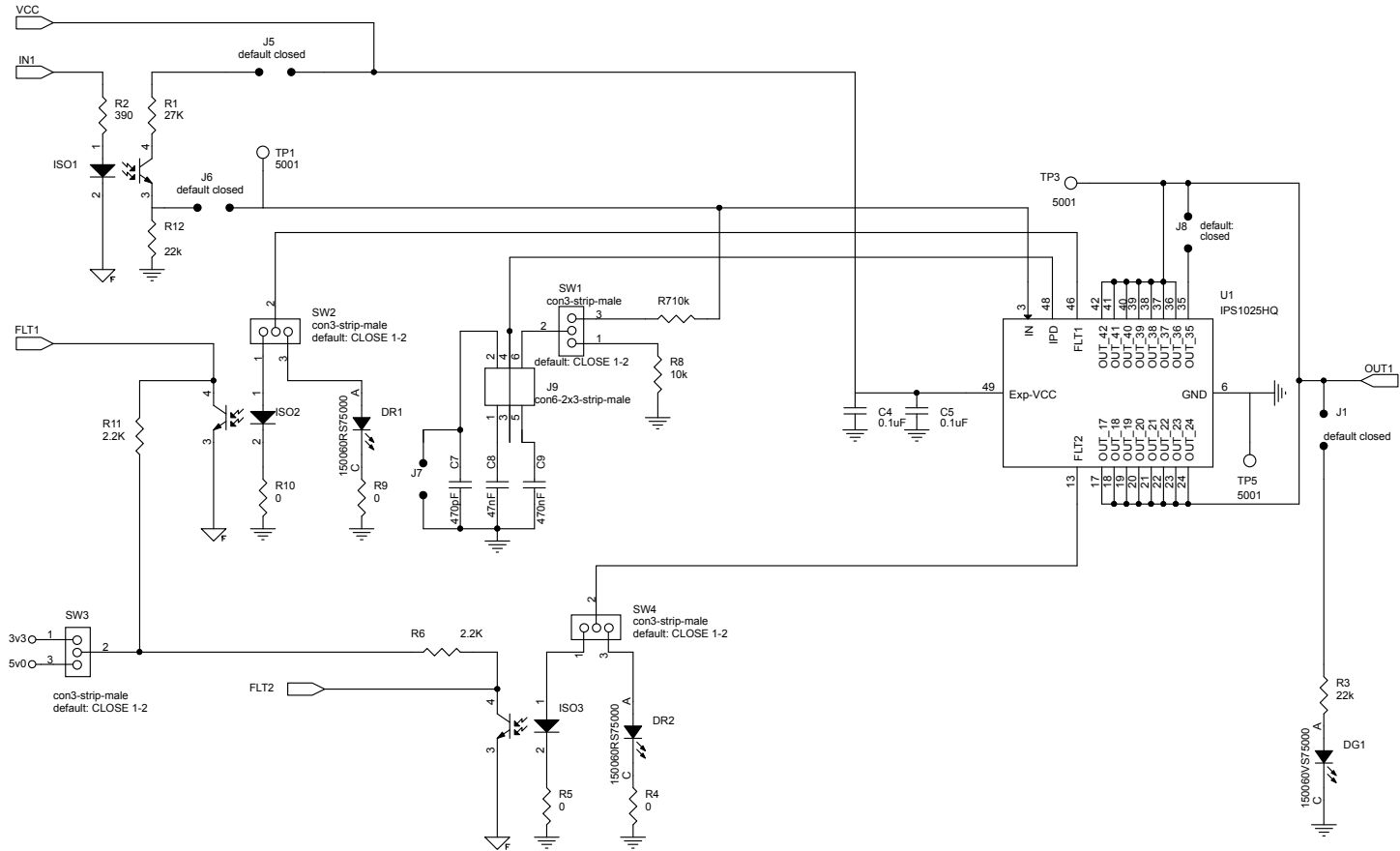
It is also possible to evaluate a four channel digital output module by stacking four **STEVAL-IFP045V1** with shared or independent supply rail and independent loads.

In this case, the four expansion boards (board 0, 1, 2, 3 as shown in the table below) must be properly configured: for board 1, 2 and 3, it is necessary to unsolder three resistors for each board from the default position and solder them back in the alternate positions according to the following table.

Table 3. Configuration of a stack of four expansion boards

Board no.	IN1	FLT1	FLT2
Board 0	R101	R103	R114
Board 1	R102	R104	R117
Board 2	R115	R116	R107
Board 3	R120	R119	R118

Figure 6. STEVAL-IFP045V1 circuit schematic (2 of 2)



3 Bill of materials

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	0	C1 C2	4700pF 1825 (4564 Metric) 3000V (3kV) 10%	CAP CER 4700PF 3KV X7R 1825 (not mounted)	Vishay Vitramon	HV1825Y472KXHATHV
2	2	C4 C5	0.1uF 0805 (2012 Metric) 100V 10%	CAP CER 0.1UF 100V X7R 0805	Würth Elektronik	885012207128
3	1	C6	2.2uF 1206 (3216 Metric) 100V 10%	CAP CER 2.2UF 100V X7R 1206	AVX Corporation	12061C225KAT2A
4	1	C7	470pF 0603 (1608 Metric) 50V 5%	CAP CER 470PF 50V C0G/NP0 0603	Würth Electronics Inc.	885012006061
5	1	C8	47nF 0603 (1608 Metric) 50V 10%	CAP CER 0.047UF 50V X7R 0603	Murata Electronics North America	GCM188R71H473KA55D
6	1	C9	470nF 0603 (1608 Metric) 25V 10%	CAP CER 0.47UF 25V X7R 0603	Würth Electronics Inc.	885012206075
7	0	C10	100uF Radial, Can 100V 20%	CAP 100 UF 20% 100 V (not mounted)	Würth Elektronik	860130878011
8	1	CN1	691137710005	TERM BLK 5POS SIDE ENTRY 5MM PCB	Würth Elektronik	691137710005
9	0	CN2	691214110002 7.4X7 pitch 3.5	TERM BLK 2POS SIDE ENT 3.5MM PCB (not mounted)	Würth Electronics Inc.	691214110002
10	1	CN5	TH 2.54mm	10 ways, 1 row	Samtec Inc. 4UCONN	ESQ-110-14-T-S 17896
11	2	CN6 CN9	TH 2.54mm	8 ways, 1 row	Samtec Inc. 4UCONN	ESQ-108-14-T-S 15782
12	0	CN7 CN10	-	CONN RCPT 38POS 0.1 GOLD PCB (not mounted)	-	-
13	1	CN8	TH 2.54mm	6 ways, 1 row	Samtec Inc. 4UCONN	ESQ-106-04-T-S 15781
14	1	D1	STPS1H100A, SMA	100 V, 1 A power Schottky rectifier	ST	STPS1H100A
15	0	D2	BAT48JFILM, SOD323	40 V, 350 mA axial general purpose signal Schottky diode (not mounted)	ST	BAT48JFILM
16	1	DG1	150060GS7500 0 0603 (1608 Metric) 20mA	LED GREEN CLEAR 0603 SMD	Würth Electronics Inc.	150060GS75000

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
17	2	DR1 DR2	150060RS7500 0 0603 (1608 Metric) 20mA	LED RED CLEAR 0603 SMD	Würth Electronics Inc.	150060RS75000
18	3	ISO1 ISO2 ISO3	140109146000 LSOP04	OPTOISO 5KV TRANSISTOR	Würth Electronics Inc.	140109146000
19	7	J1 J2 J3 J4 J5 J6 J8	JUMPER-con2- strip-male TH 2.54mm	JUMPER- CONN HEADER .100 STR 2POS	Würth Electronics Inc.	61300211121
20	0	J7	JUMPER-con2- strip-male	JUMPER- CONN HEADER .100 STR 2POS (not mounted)	-	-
21	1	J9	con6-2x3-strip- male	CONN HEADER .100 DUAL STR 6POS	Würth Electronics Inc.	61300621121
22	1	R1	27K 0603 (1608 Metric) 0.1W, 1/10W 1%	RES SMD 27K OHM 1% 1/10W 0603	Yageo	RC0603FR-0727KL
23	1	R2	390 0603 (1608 Metric) 0.1W, 1/10W 1%	RES SMD 390 OHM 1% 1/10W 0603	Yageo	RC0603FR-07390RL
24	2	R3 R12	22k 0603 (1608 Metric) 0.1W, 1/10W 1%	RES SMD 22K OHM 1% 1/10W 0603	Yageo	RC0603FR-0722KL
25	4	R4 R5 R9 R10	0 0603 (1608 Metric) 0.1W, 1/10W Jumper	RES SMD 0 OHM JUMPER 1/10W 0603	Panasonic Electronic Components	ERJ-3GEY0R00V
26	2	R6 R11	2.2K 0603 (1608 Metric) 0.1W, 1/10W 1%	RES SMD 2.2K OHM 1% 1/10W 0603	Yageo	RC0603FR-072K2L
26	2	R7 R8	10k 0603 (1608 Metric) 0.1W, 1/10W 1%	RES SMD 10K OHM 1% 1/10W 0603	Yageo	RC0603FR-0710KL
28	3	R101 R103 R114	100 0603 (1608 Metric) 0.1W, 1/10W 1%	RES SMD 100 OHM 1% 1/10W 0603	Yageo	RC0603FR-07100RP
29	0	R102 R104 R107 R115 R116 R117 R118 R119 R120	100 0603 (1608 Metric) 0.1W, 1/10W 1%	RES SMD 100 OHM 1% 1/10W 0603 (not mounted)	Yageo	RC0603FR-07100RP
30	4	SW1 SW2 SW3 SW4	con3-strip-male TH 2.54mm	CONN HEADER .100 STR 3POS	Würth Electronics Inc.	61300311121
31	5	TP1 TP2 TP3 TP4 TP5	5001 0.100" Dia x 0.180" L (2.54mm x 4.57mm)	TEST POINT PC MINI .040"D BLACK	Keystone Electronics	5001
32	1	TR1	SM15T39CA, SMC	1500 W, 33.3 V TVS in SMC	ST	SM15T39CA

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
33	0	TR2	ESDA15P60-1U 1M, QFN-2L	High-power transient voltage suppressor (not mounted)	ST	ESDA15P60-1U1M
34	1	U1	IPS1025HQ QFN48L 8x6 mm	High Side Switch with smart driving for capacitive loads	ST	IPS1025HQ
35	12	N/A	2.54mm	Close Jumper	Würth Electronics Inc.	60900213421

4 References

Freely available on www.st.com:

1. [IPS1025H datasheet](#)
2. [UM2864: "Getting started with X-CUBE-OUT5 industrial digital output software for STM32 Nucleo"](#)
3. [NUCLEO-F401RE data brief](#)
4. [NUCLEO-G431RB data brief](#)

5 Board versions

Table 4. STEVAL-IFP045V1 versions

PCB version	Schematic diagrams	Bill of materials
STEVAL\$IFP045V1A ⁽¹⁾	STEVAL\$IFP045V1A schematic diagrams	STEVAL\$IFP045V1A bill of materials

1. This code identifies the STEVAL-IFP045V1 evaluation board first version. It is printed on the board PCB.

6 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.

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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 5. Document revision history

Date	Revision	Changes
29-Aug-2022	1	Initial release.

Contents

1	Getting started	2
1.1	Overview	2
1.1.1	Digital section	2
1.1.2	Power section	4
1.2	Hardware requirements	5
1.3	System requirements	5
1.4	Board setup	5
1.5	Multiple board configuration	6
2	Schematic diagrams	7
3	Bill of materials	9
4	References	12
5	Board versions	13
6	Regulatory compliance information	14
	Revision history	15
	List of tables	17
	List of figures	18

List of tables

Table 1.	NUCLEO-F401RE development board supported IDEs - bin files	6
Table 2.	NUCLEO-G431RB development board supported IDEs - bin files	6
Table 3.	Configuration of a stack of four expansion boards	6
Table 4.	STEVAl-IFP045V1 versions	13
Table 5.	Document revision history	15

List of figures

Figure 1.	STEVAL-IFP045V1 expansion board	1
Figure 2.	STEVAL-IFP045V1 expansion board: digital interface section	3
Figure 3.	STEVAL-IFP045V1 expansion board: power section components	4
Figure 4.	STEVAL-IFP045V1 and STM32 Nucleo stack	5
Figure 5.	STEVAL-IFP045V1 circuit schematic (1 of 2)	7
Figure 6.	STEVAL-IFP045V1 circuit schematic (2 of 2)	8

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