Getting started with the STEVAL-IFP043V1 industrial digital output expansion board

Introduction

The STEVAL-IFP043V1 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 IPS2050HQ (dual high-side smart power solid state relay) in a digital output module connected to 2.5 A (max.) industrial loads.

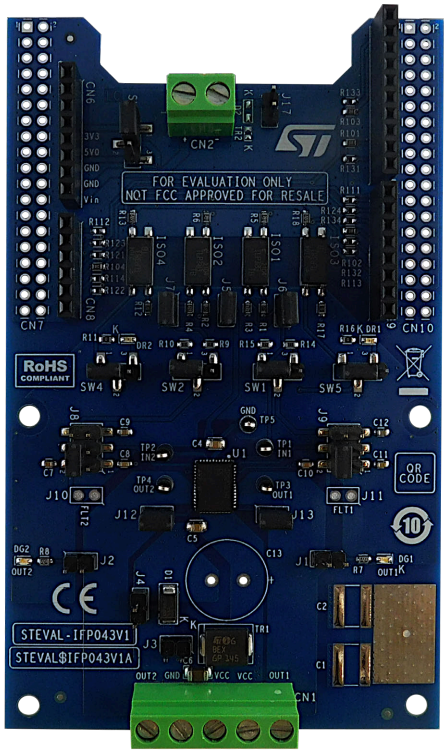
The STEVAL-IFP043V1 can interface with the microcontroller on the STM32 Nucleo via 5 kV optocouplers driven by GPIO pins, Arduino UNO R3 (default configuration) and ST morpho (optional, not mounted) connectors.

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

It is also possible to evaluate a system composed by up to four stacked STEVAL-IFP043V1 expansion boards.

As an example, a system with four STEVAL-IFP043V1 expansion boards allows you to evaluate an eight-channel digital output module with 2.5 A (max.) capability each.

Figure 1. STEVAL-IFP043V1 expansion board



1 Getting started

1.1 Overview

The STEVAL-IFP043V1 embeds the IPS2050HQ 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 optical isolation implemented through four optocouplers (ISO1, ISO2, ISO3 and ISO4) for signal forward to the device and FLT pins for feedback diagnostic signals.

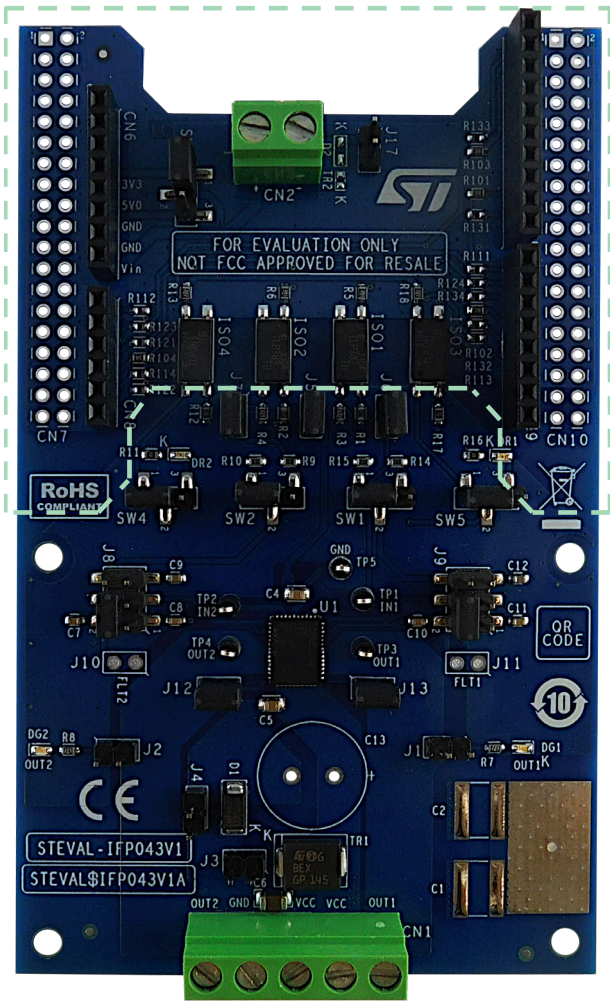
The STEVAL-IFP043V1 features:

- Based on IPS2050HQ dual high-side switch, which features:
  - Operating range up to 60 V/2.5 A
  - Low power dissipation ($R_{ON(MAX)}$ = 50 mΩ)
  - Fast decay for inductive loads
  - Smart driving of capacitive load
  - Under-voltage lock-out
  - Per-channel overload and over-temperature 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 LEDs for output on/off status
- Red LEDs for per-channel diagnostic (overload and overheating)
- 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-IFP043V1 expansion board.

Figure 2. STEVAL-IFP043V1 expansion board: digital interface components



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-IFP043V1 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 CN2 connector (not mounted by default) on the expansion board and the ground loop should be closed by mounting D2 (enable the reverse polarity protection) or by closing J17 (without reverse polarity).

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

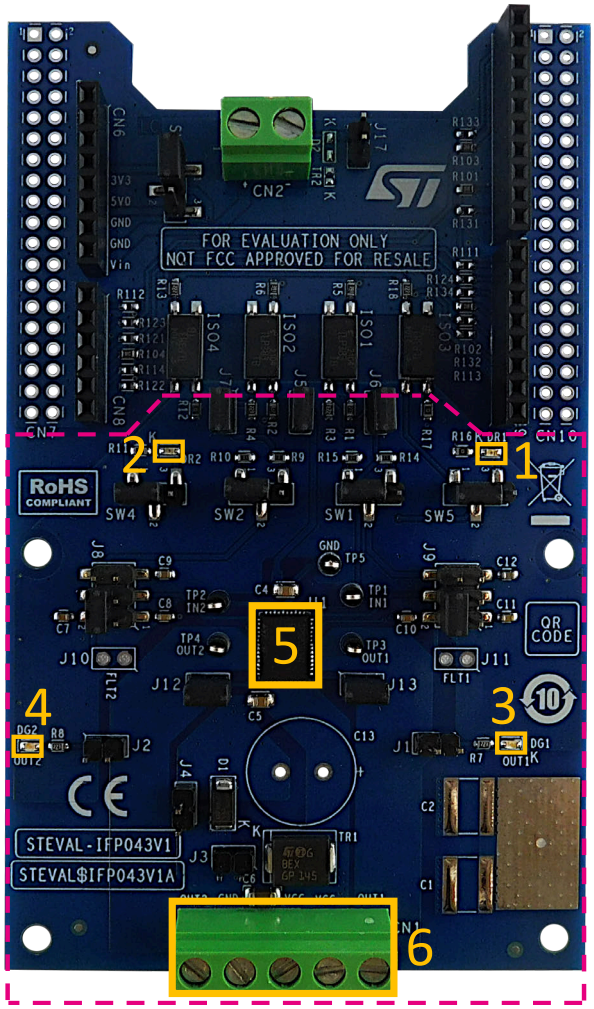
- close jumper JP5 between pins 2 and 3 and open jumper JP1 on the NUCLEO-F401RE
- open jumper JP5 between pins 1 and 2 and close jumper JP5 between pins 3 and 4 on the NUCLEO-G431RB

1.1.2 Power section

The power section involves the power supply voltage (CN1, pin 2 and 3 for V_{CC}, pin 4 for GND), load connection (between CN1 pins 1-4 and CN1 pins 5-4) and electromagnetic compatibility (EMC) protection.

Figure 3. STEVAL-IFP043V1 expansion board: power stage components

1. Output channel 1 - fault red LED
2. Output channel 2 - fault red LED
3. Output channel 1 - green LED
4. Output channel 2 - green LED
5. IPS2050HQ
6. Output and power supply connector



For EMC:

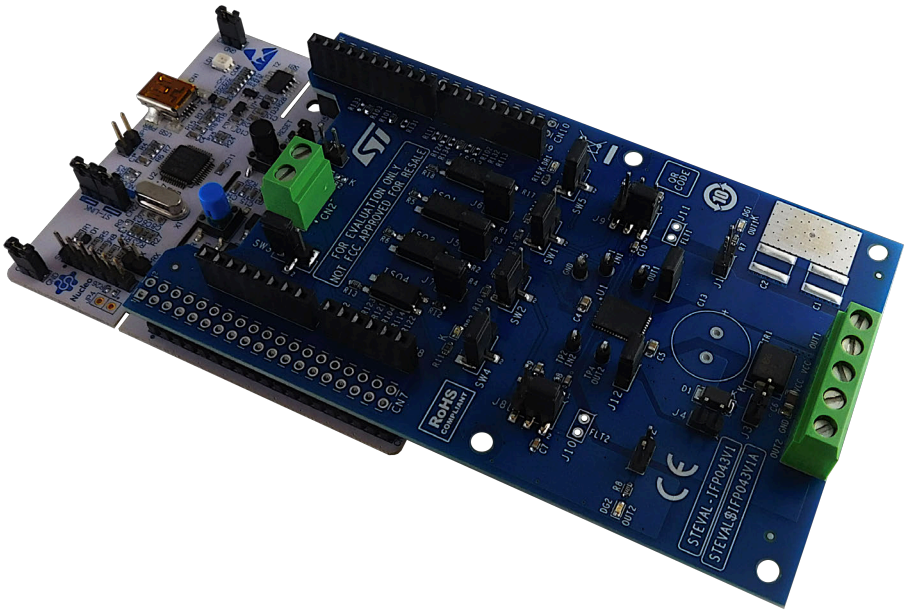
- The SM15T39CA transient voltage suppressor (TR1), enabled by closing JP3, is placed between V_{CC} and GND tracks to protect the IPS2050HQ against surge discharge on the supply rail path up to ±1kV/2Ω coupling;
- in common mode surge testing, two single-layer capacitors (C1 and C2 - not included) must be soldered at the predisposed locations;
- the IPS2050HQ output stages do not require additional EMC protections with respect to the IEC61000-4-2, IEC61000-4-3, IEC61000-4-5 standards.

1.2 Hardware requirements

The STEVAL-IFP043V1 expansion board is designed to be used with the NUCLEO-F401RE or NUCLEO-G431RB STM32 Nucleo development boards.

To function correctly, the STEVAL-IFP043V1 must be plugged onto the matching Arduino UNO R3 connector pins on the STM32 Nucleo board as shown below.

Figure 4. STEVAL-IFP043V1 and STM32 Nucleo stack



1.3 System requirements

To use the STM32 Nucleo development boards with the STEVAL-IFP043V1 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-IFP043V1 with NUCLEO-F401RE or NUCLEO-G431RB development board

Step 2. Download the firmware (.bin or .hex) 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-OUT03_04-STM32F4xx_Nucleo.bin	MDK-ARM-OUT03_04-STM32F4xx_Nucleo.bin	STM32CubeIDE-OUT03_04-STM32F4xx_Nucleo.bin

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

NUCLEO-G431RB		
IAR	Keil	STM32CubeIDE
EWARM-OUT03_04-STM32G4xx_Nucleo.bin	MDK-ARM-OUT03_04-STM32G4xx_Nucleo.bin	STM32CubeIDE-OUT03_04-STM32G4xx_Nucleo.bin

Note: The binary files listed in the tables above are included in the X-CUBE-IPS software package. The STEVAL-IFP043V1 is fully compatible with the X-NUCLEO-OUT03A1.

Step 3. Connect the IPS2050HQ 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 by pushing the black button on the STM32 Nucleo board.

Step 7. Push the blue button on STM32 Nucleo board to choose among the examples provided in the default firmware package.

1.5 Multiple board configuration

It is also possible to evaluate an eight channel digital output module by stacking four STEVAL-IFP043V1 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 four 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	IN2	FLT1	FLT2
Board 0	R101	R102	R103	R104
Board 1	R131	R132	R133	R134
Board 2	R111	R112	R113	R114
Board 3	R121	R122	R123	R124

Important: When using Board 2 and Board 3, two jumpers must close the morpho connectors pins in the STM32 Nucleo board:

- *CN7.35-36 closed*
- *CN10.25-26 closed*

2 Schematic diagrams

Figure 5. **STEVAL-IFP043V1 circuit schematic (1 of 2)**

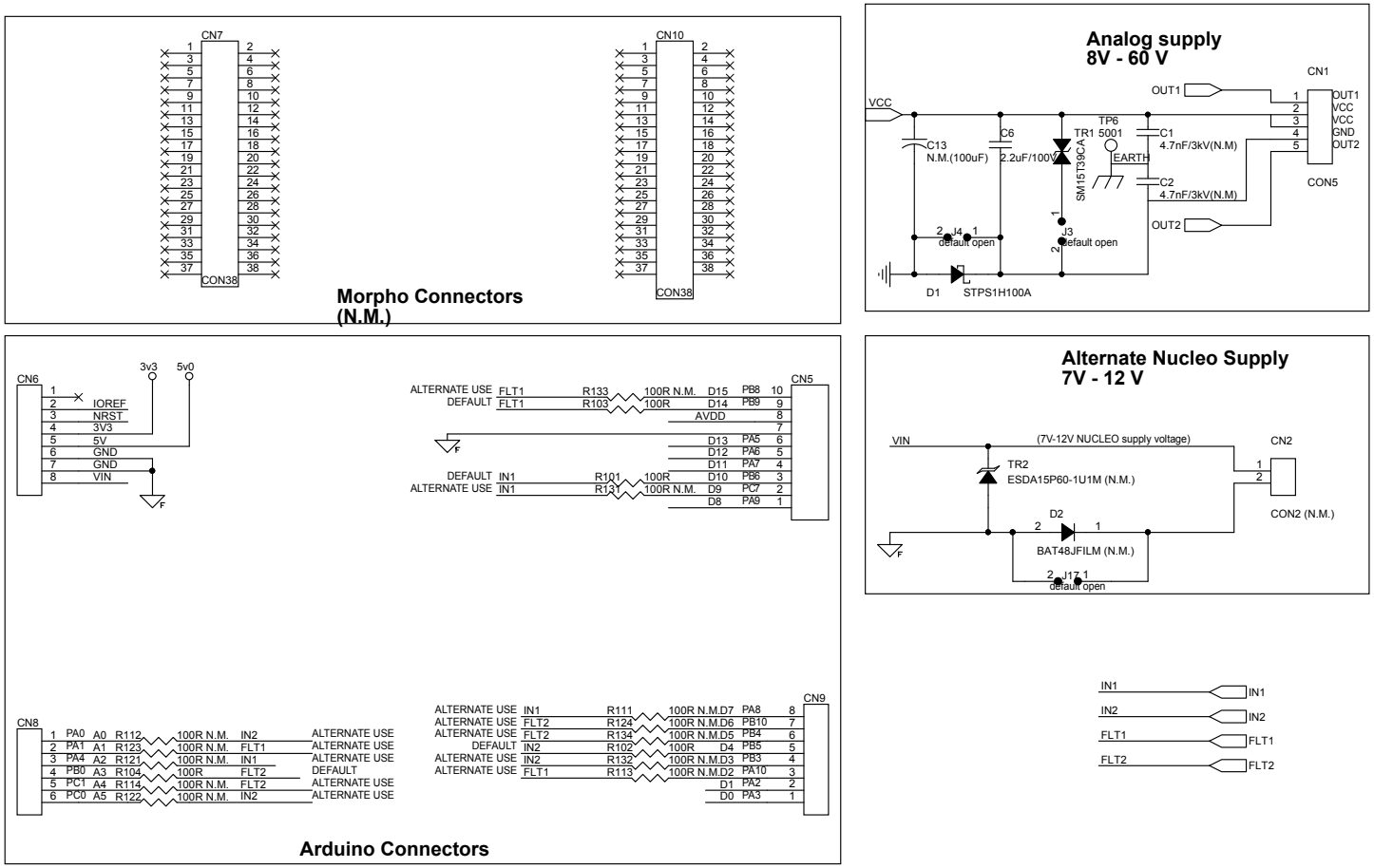
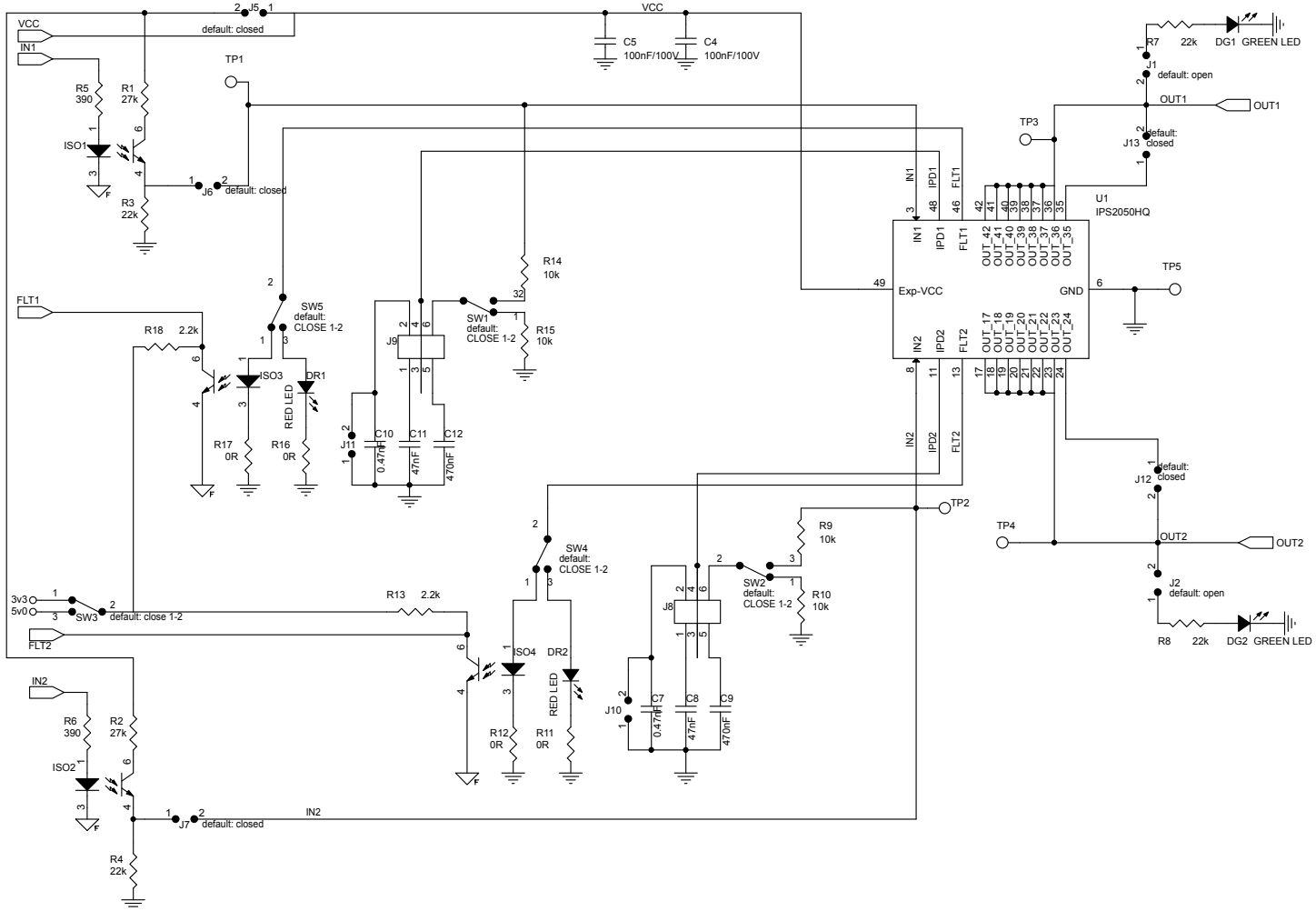


Figure 6. STEVAL-IFP043V1 circuit schematic (2 of 2)



3 Bill of materials

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	1	U1	IPS2050HQ, QFN48L 8x6 mm,	Dual HS IPS	ST	IPS2050HQ
2	1	CN1	5 ways, 1 row, TH 5mm, 24 A	Terminal block	WURTH	691137710005
3		C1,C2 N.A.	4.7nF, 1825, 3k V	MLCC capacitors	Vishay	HV1825Y472KXHATHV
3	1	TR1	SM15T39CA, SMC	1500 W, 33.3 V TVS in SMC	ST	SM15T39CA
4	1	D1	STPS1H100A, SMA	100 V, 1 A power Schottky rectifier	ST	STPS1H100A
5	10	J1, J2, J3, J4, J5, J6, J7, J12, J13 J17	TH 2.54mm	2 ways, 1 row	WURTH	61300211121
6		J10, J11 N.A.	TH 2.54mm	Jumpers	-	-
7	2	C4, C5	100nF, 0805, 100 V	Capacitors	WURTH	885012207128
8	1	C6	2.2uF, 1206, 100 V	Capacitors	AVX	12061C225KAT2A
9	2	C7, C10	470pF, 0603, 16 V	Capacitors	WURTH	885012206032
10	2	C8, C11	47nF, 0603, 16 V	Capacitors	WURTH	885012206044
11	2	C9, C12	470nF, 0603, 25 V	Capacitors	WURTH	885012206075
12		C13 N.A.	100uF, TH, 100 V	Capacitors	-	-
13	4	ISO1, ISO2 ISO3, ISO4	TLP383, 11-4P1A, VCE = 80V VISO=5k V	Optocoupler	TOSHIBA WURTH	TLP383 140100146000
14	2	R1, R2	27kΩ, 0603, 0.1 W	Resistors	MULTICOMP	MCMR06X2702FTL
15	2	R3, R4	22kΩ, 0603, 0.1 W	Resistors	VISHAY	CRCW060322K0FKEA
16	2	R5, R6	390Ω, 0603, 0.1 W	Resistors	YAGEO	RC0603FR-07390RL
17	2	DG1, DG2	150060GS75000, 0603	Green LED	WURTH	150060GS75000
18	2	R7, R8	22kΩ, 0603, 0.2 W	Resistors	TE-CONN	CRGH0603J22K
19	2	DR1, DR2	150060RS75000, 0603	RED LED	WURTH	150060RS75000
20	2	J8, J9	SMD 2.54mm	6 ways, 2 rows connector	WURTH	61030621121
21	4	R9, R10, R14, R15	10kΩ, 0603, 0.1 W, ±1 %	Resistors	Bourns	CR0603-FX-1002ELF
22	4	R11, R12, R16, R17	0Ω, 0603, 0.1 W	Resistors	MULTICOMP	MCWR06X000 PTL
23	2	R13, R18	2.2kΩ, 0603, 0.1 W	Resistors	MULTICOMP	MCMR06X2201FTL
24	4	R101, R102, R103, R104	100Ω, 0603, 0.1 W, ±0.5 %	Resistors	Panasonic	ERJ3BD1000V
25		R111, R121, R131 R112, R122, R132 R113, R123, R133 R114, R124, R134 N.A.	100Ω, 0603	Resistors	-	-
26	5	SW1, SW2, SW3, SW4, SW5	SMD 2.54mm,	3 ways, 1 row	TE-CONN	1241150-3
27	1	CN2	TH 5mm,	2 ways, 1 row	WURTH	691137710002

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
28		D2 N.A.	BAT48JFILM, SOD-323, 40 V, 0.35 A	VDD reverse polarity protection	ST	BAT48JFILM
29		TR2 N.A.	ESDA15P60-1U1M, QFN-2L	High-power transient voltage suppressor	ST	ESDA15P60-1U1M
30	1	CN5	TH 2.54mm	10 ways, 1 row	SAMTEC 4UCON	ESQ-110-14-T-S 17896
31	2	CN6, CN9	TH 2.54mm,	8 ways, 1row	SAMTEC 4UCON	ESQ-108-14-T-S 15782
32	1	CN8	TH 2.54mm,	6 ways, 1 row	SAMTEC 4UCON	ESQ-106-04-T-S 15781
33		CN7, CN10 N.A.	TH 2.54mm		SAMTEC	ESQ-119-14-T-D
34	5	TP1, TP2, TP3, TP4, TP5	TH d = 1mm	test point	RS	262-2034
35	17		2.54mm	Close Jumper	WURTH	60900213421

4 Board versions

Table 4. **STEVAL-IFP043V1 versions**

PCB version	Schematic diagrams	Bill of materials
STEVAL$IFP043V1A (1)	STEVAL$IFP043V1A schematic diagrams	STEVAL$IFP043V1A bill of materials

1. *This code identifies the STEVAL-IFP043V1 evaluation board first version. It is printed on the board PCB.*

5 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 5. **Document revision history**

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

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