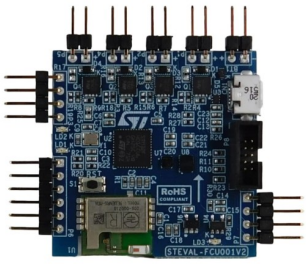


STMicroelectronics UM2958 STEVAL-FCU001V2 Flight Controller Unit Evaluation Board User Manual

UM2958 STEVAL-FCU001V2
Flight Controller Unit Evaluation Board
User Manual

Getting started with the STEVAL-FCU001V2 flight controller unit evaluation board for mini drones

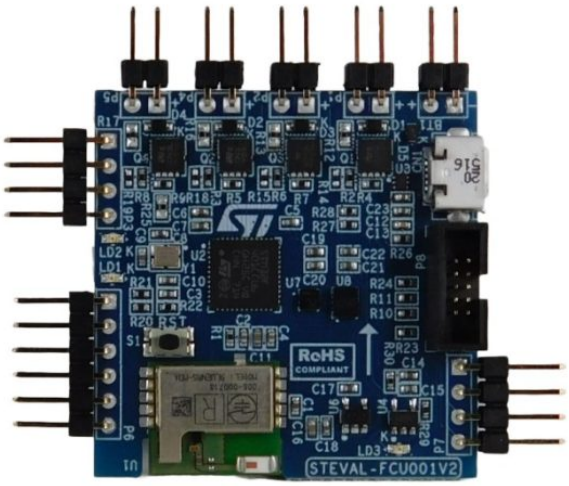
Contents

Introduction

The STEVAL-FCU001V2 evaluation board is designed as a simple platform to develop flight controller unit (FCU) solutions for quadcopters.
A complete sample firmware project (STSW-FCU001) allows you to begin flying small or medium sized quadcopters equipped with DC motors (thanks to four 30 V-9 A on-board MOSFETs), and larger quadcopters with external ESCs (that is, STEVAL- ESC001V1 or STEVAL-ESC002V1).
You can control the board via BLE connectivity (using a smartphone or a tablet) or via an RF receiver module

connected to the PWM input port.
The system embeds a high-performance Arm® Cortex®-M4 microcontroller unit (**STM32F401CCU6**), an iNEMO inertial module (**LSM6DSR**), a Bluetooth® low energy module (**BlueNRG-M0A**), power management circuitry that allows fast charge of the battery (**STC4054**), and four **STL10N3LLH5** N-channel 30 V, 9 A, PowerFLAT(TM) STripFET(TM) V Power MOSFET to drive a quadcopter motor.
An additional barometric pressure sensor (**LPS22HH**) provides altitude estimation.
This reference design can be used to develop sophisticated auto-navigation algorithms thanks to more than 100 DMIPS available on the STM32 and the scalability of the board, which can be connected to the **Teseo-LIV3F** GNSS module or to a set of Time-of-Flight sensors like the **VL53L5CX**.
The system passed the RF test for European certification, FCC certification, and IC certification (FCC ID: S9NBNRGM0AL and IC: 8976C-BNRGM0AL).

Figure 1. **STEVAL-FCU001V2 evaluation board**



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

Getting started

1.1 Board overview

The **STEVAL-FCU001V2** evaluation board features:

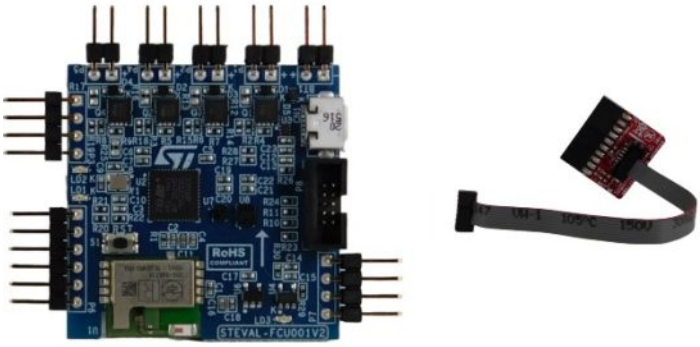
- Compact flight controller unit (FCU) evaluation board complete with sample firmware for a small or medium-sized quadcopter
- On-board LiPo one-cell battery charger
- Possibility to drive directly four DC brushed motors through the low voltage on-board MOSFET or alternatively use external ESC for DC brushless motor configuration

1.2 Package contents

The **STEVAL-FCU001V2** evaluation board package contains:

- the evaluation board itself
- the ST-LINK adapter with its programming cable to be used with the **ST-LINK/V2** or **STLINK-V3SET**

Figure 2. **STEVAL-FCU001V2 evaluation board: package contents**



1.3 System requirements

To use the board, the following system specifications are required:

- a Windows PC (7, 8, 8.1, 10, 11) with a preinstalled STM32 software development tool (**STM32CubeIDE**)
- **ST-LINK/V2** (or **STLINK/V3SET**) in-circuit debugger/programmer, its USB driver (**STSW-LINK009**) and, optionally, the **STM32CubeProgrammer** for firmware download
- a LiPo one-cell battery to be connected to the battery connector (BT1) for stand-alone operation or a USB type A to Micro-USB male cable to connect the **STEVAL-FCU001V2** evaluation board to the PC for power supply
- four DC motors suitable for 3.7 V operation directly connected to the board, or four DC brushless motors with four matching electronic speed controllers (such as **STEVAL-ESC001V1** or **STEVAL-ESC002V1** evaluation boards)
- four propellers suitable for the motors chosen
- **ST_BLE_DRONE** app for Android and iOS to be used with the **STSW-FCU001** demonstration firmware

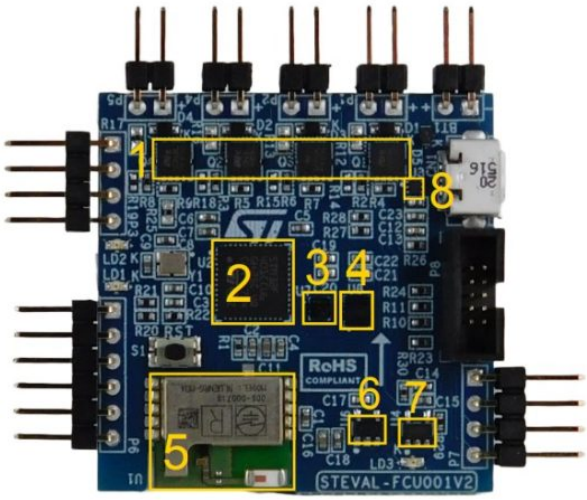
Note: Choose the propellers, motors, and the electronic speed controller (ESC) on the basis of the quadcopter size and weight.

Hardware description

The **STEVAL-FCU001V2** main components are:

1. **STL10N3LLH5** 30 V, 9 A, STripFETTM V Technology in a PowerFLATTM 3×3.3 package
2. **STM32F401CCU6** high performance Arm® Cortex®-M4 MCU with 256 Kbytes of Flash memory, 64 kBytes of RAM in a UFQFPN48 package
3. **LPS22HH** high-performance MEMS nano pressure sensor: 260-1260 hPa absolute digital output barometer
4. **LSM6DSR** iNEMO inertial module: 3D accelerometer and 3D gyroscope
5. **BlueNRG-M0A** very low-power network processor module for Bluetooth® low energy 2
6. **LD39015** low quiescent voltage regulator
7. **STC4054** 800 mA Li-ion and LiPo battery charger directly from USB
8. **USBULC6-2M6** ultra large bandwidth ESD protection

Figure 3. **STEVAL-FCU001V2 evaluation board components**



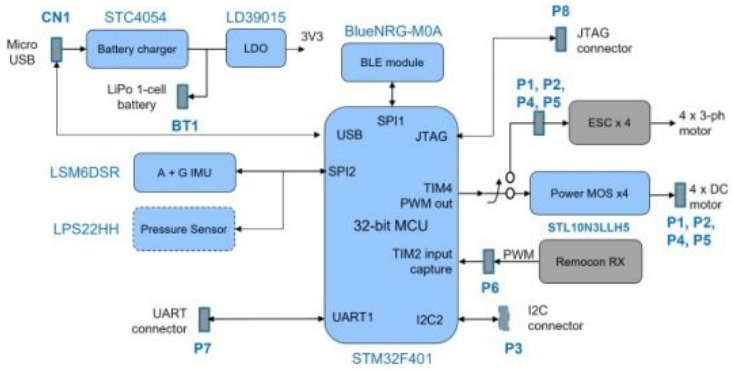
2.1 Hardware architecture overview

The whole system can be split in five different subsystems:

- microcontroller
- sensors
- connectivity
- battery management
- DC motor drivers

The sensors and the **BlueNRG-M0A** devices are connected to the microcontroller through two separate SPI peripherals.

Figure 4. **STEVAL-FCU001V2 evaluation board functional block diagram**



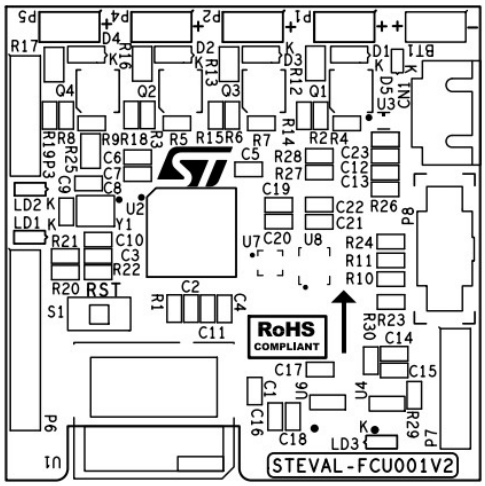
2.2 Board connectors

The **STEVAL-FCU001V2** evaluation board includes several hardware connectors (see Figure 5):

- USB micro B female plug
- Battery two-pin header connector
- Four motor two-pin header connectors
- UART four-pin header connector
- I²C four-pin header connector
- PWM input six-pin header connector
- Micro SWD connector (1.27 mm pitch)

As shown in Figure 3, some of these connectors have not the pins soldered on the board to leave the maximum freedom to users.

Figure 5. **STEVAL-FCU001V2 evaluation board connector description**



The board can be powered via a USB connector or one-cell battery. By connecting both, the embedded battery charger uses the USB current to charge the battery.
Considering the specific application, it is highly recommended to use a LiPo battery with a high value of maximum discharge current rating (this parameter is often indicated with “number of C” where “C” is battery capacity). Thus, a 500 mAh battery with a discharge rating of 50 C has a maximum sustained load of 25 amps: compare this value to the sum of the current absorbed by the motors (x4) and the on-board electronics, which is negligible with respect to the motors.

Table 1. Battery 2-pin header connector (BT1)

Pin	Signal	Description
+	VBAT+	one-cell LiPo battery (3.4 to 4.2 V)
–	GND	–

Note: The + is placed on the board left side (refer to Figure 3 for board orientation). It is important to ensure correct polarity connection as reverse battery protection is not implemented.
The four motor connectors can be used to connect a one-cell 3.7 V motor to each of them or to external ESCs. Depending on the kind of motor, you have to solder the male strip line on the board or directly on the motors pins. In the **STSW-FCU001**, an association between Px connector and motor placement on the drone structure has been considered (for further information, refer to UM2512 on **www.st.com**).
Table 2. Motor 2-pin header connectors (P1, P2, P4, P5)

Pin	Signal	Description
1	VBAT+	To be connected to motor (+) for DC motors (1)
2	MOTOR-	To be connected to motor (-) for DC motors (2)

1. Not connected for external ESC.
2. To be connected to PWM inputs for external ESC.

Note: The + is placed on the board right side (refer to Figure 3 for board orientation).
Note: You can refer to the datasheet of the motor to distinguish + and – wire colors.
As in many commercial flight controllers, the **STEVAL-FCU001V2** hosts a UART and an I²C to connect external peripherals.

Table 3. UART 4-pin header connector (P7)

Pin	Signal	Description
1	VDD	3.3 V of STM32
2	GND	
3	USART1_RX	RXD for STM32
4	USART1_TX	TXD for STM32

Note: Pin 1 is placed on the board top side (refer to Figure 3 for board orientation).
Table 4. I2C 4-pin header connector (P3)

Pin	Signal	Description
1	VDD	3.3 V of STM32
2	I2C2_SDA	–
3	I2C2_SCL	–
4	GND	–

Note: Pin 1 is placed on the board top side (refer to Figure 3 for board orientation).
The **STSW-FCU001** evaluation software has been designed to offer the possibility of controlling the drone through a smartphone app (**ST_BLE_DRONE**) and by an external remote controller.
In this case, you have to connect a remote controller RX module to the P6 connector of the **STEVAL-FCU001V2** evaluation board.
The firmware implementation is compatible with a pulse period modulation (PPM) receiver:

- CH1 is related to AIL control with roll function
- CH2 is related to ELE control with pitch function
- CH3 is related to THR control with thrust function
- CH4 is related to RUD control with yaw function

Table 5. PWM inputs six-pin header connector (P6)

Pin	Signal	Description
1	VBAT+	Directly connected to battery (+)
2	TIM2_CH1	TIM2_CH1 for RF RX PWM IN signal CH1
3	TIM2_CH2	TIM2_CH2 for RF RX PWM IN signal CH2
4	TIM2_CH3	TIM2_CH3 for RF RX PWM IN signal CH3
5	TIM2_CH4	TIM2_CH4 for RF RX PWM IN signal CH4
6	GND	–

Note: Pin 1 is placed on the board top side (refer to Figure 3 for board orientation).
Table 6. Debugging micro-SWD connector (P8)

Pin	Signal	Description
1	VDD	

Pin	Signal	Description
2	SWDD	SWD debugging data line
3	GND	
4	SWCLK	SWD debugging clock line
5	GND	–
6	N.C.	–
7	GND	–
8	N.C.	–
9	GND	–
10	NRST	NReset for STM32

For further details on debugging, refer to Section 2.3.
Note: Pin 1 is placed on the board bottom-right side (refer to Figure 3 for board orientation).

2.3 ST-LINK connection

To update the firmware, use the **ST-LINK/V2** or **ST-LINK/V3SET** debugger programmer by plugging the adapter and the cable (provided in the **STEVAL-FCU001V2** package as described in **Section 1.2**) to the board and then to the laptop.

Figure 6. ST-LINK/V2 connected to the STEVAL-FCU001V2 evaluation board via adapter

Figure 7. ST-LINK/V3 connected to the STEVAL-FCU001V2 evaluation board via adapter

Note: **ST-LINK/V2** and **STLINK/V3SET** are not included in the package. Go to **www.st.com** to order them.

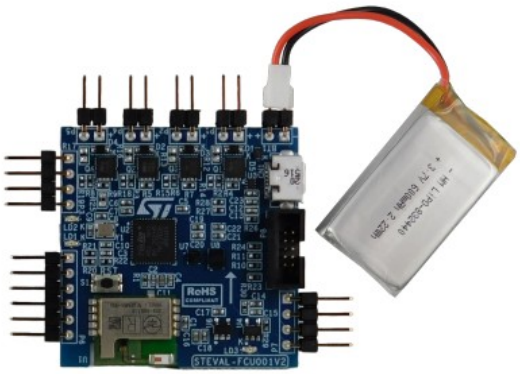
System setup guide

The board is provided with a preinstalled firmware **STSW-FCU001**. The firmware is also retrievable on **www.st.com** as open source code and the **ST BLE Drone** app to exploit its functionalities.

3.1 How to use the board with the preinstalled firmware

Step 1. Connect a LiPo one-cell battery to BT1 battery connector of the **STEVAL-FCU001V2**, paying attention to the polarity, as shown **below.**

Figure 8. **STEVAL-FCU001V2 and LiPo battery connection**

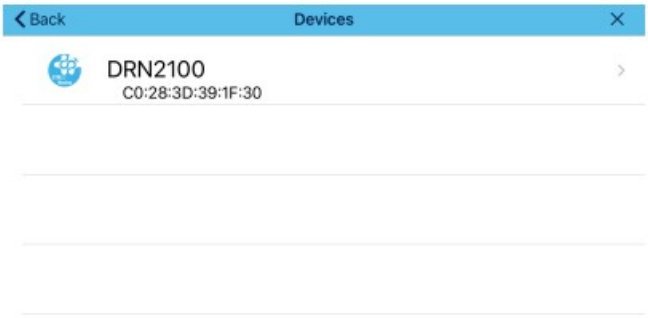


Caution: There is no protection for reverse connection on the circuit.
Step 2. Activate the Bluetooth® connection on your smartphone and enable **ST_BLE_DRONE** app to use it.
Step 3. Open **ST_BLE_DRONE** app on your smartphone and tap [Start discovering].

Figure 9. **ST_BLE_DRONE - main page**

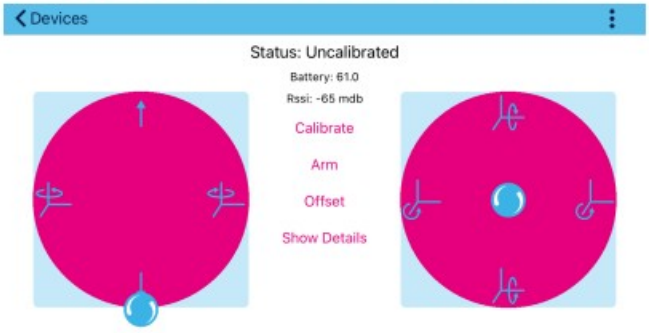
Step 4. Select the DRN2100 device from the list to connect the smartphone to the board.
LD2 turns on to signal that the connection is active.

Figure 10. **ST_BLE_DRONE - discovering devices**



Your remote control appears on the screen.

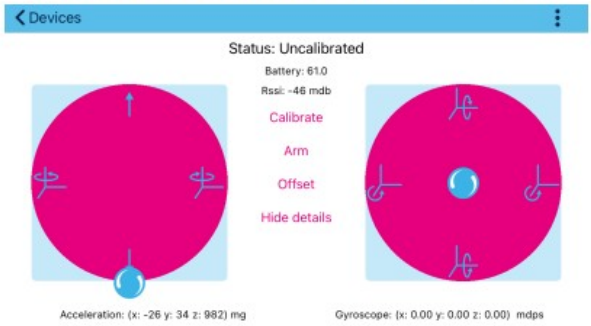
Figure 11. **ST_BLE_DRONE - remote control**



The app shows the battery value and RSSI of the Bluetooth low energy connectivity.
Note: To avoid issues, in case you are using more than one **STEVAL-FCU001V2** evaluation boards in your operating space, you have to reprogram them to show a different name to avoid issues.

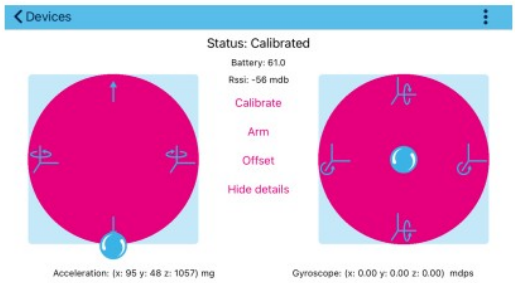
Step 5. Tap [Show Details] to make the MEMS motion sensor data appear on the screen.

Figure 12. **ST_BLE_DRONE - motion sensor data**



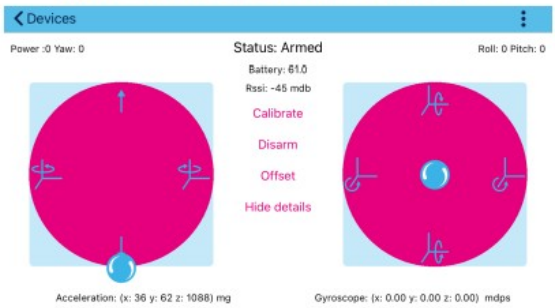
By moving the evaluation board, you can see how data change.
The **STSW-FCU001** firmware also implements the calibration and arming procedure. The **ST_BLE_DRONE** app permits running these functions remotely.
Step 6. Put the evaluation board on a plane and tap [Calibrate] to remove any sensor offset.
The app shows the “Calibrated” status and LED LD1 will switch on.

Figure 13. **ST_BLE_DRONE - calibration successfully performed**



Step 7. To allow flight, tap the button related to the arming procedure.
The status message change to “Armed” and LD2 turns on.

Figure 14. **ST_BLE_DRONE - armed status**



Step 8. Move the smartphone left lever up and down.
The voltage on M1, M2, M3 and M4 change according to the drone flight rules.

3.2 How to use the board with your own firmware

Step 1. Connect a LiPo one-cell battery to BT1 battery connector of the **STEVAL-FCU001V2**, paying attention to the polarity, as shown **below.**

Figure 15. **STEVAL-FCU001V2 and LiPo battery connection**

Caution: There is no protection for reverse connection on the circuit.
Step 2. Connect the ST-LINK adapter included in the package to the **ST-LINK/V2** (or **STLINK/V3SET**) and the

STEVAL-FCU001V2 evaluation board.
Step 3. Connect a USB cable to a PC and to the micro-USB connector (CN1) to supply the board.
Step 4. Check that the LD3 is switched ON.
Step 5. Optionally, download the **STSW-FCU001** firmware package.
Step 6. Program the board (refer to **UM2329**).
Note: It is recommended to connect the USB cable during the programming phase to avoid issues on the power supply.
Once the firmware fine tuning session finishes, you can remove the connection to the micro-USB cable and the ST-LINK adapter.

Schematic diagrams

Figure 16. **STEVAL-FCU001V2 – circuit schematic (1 of 4)**

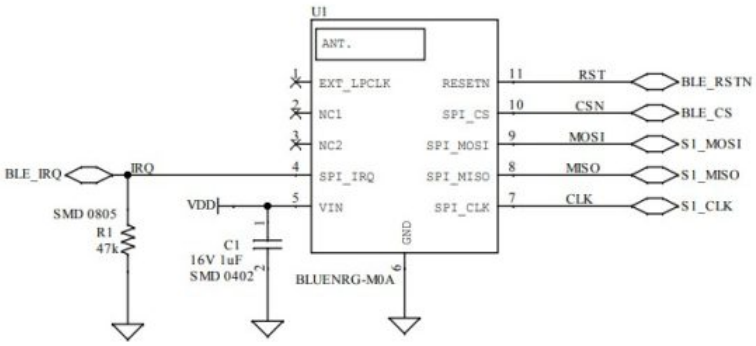


Figure 17. **STEVAL-FCU001V2 – circuit schematic (2 of 4)**

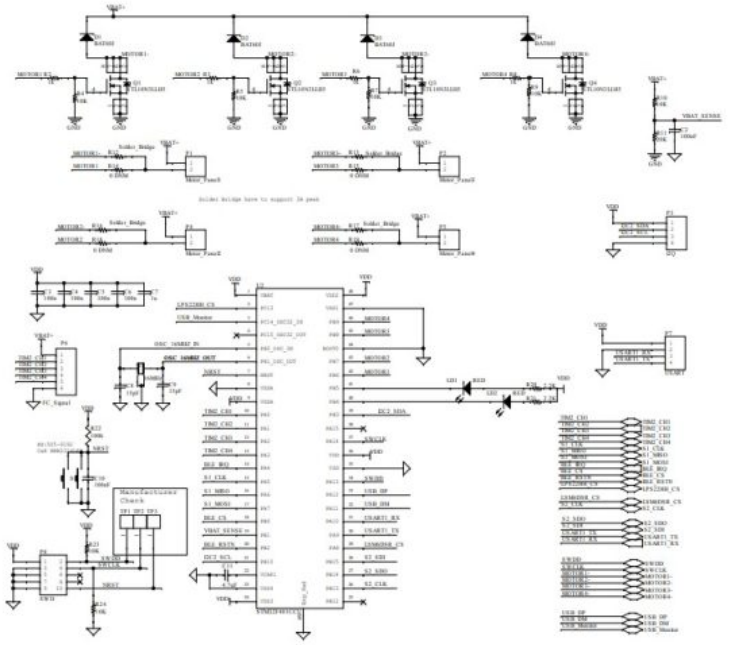


Figure 18. **STEVAL-FCU001V2 – circuit schematic (3 of 4)**

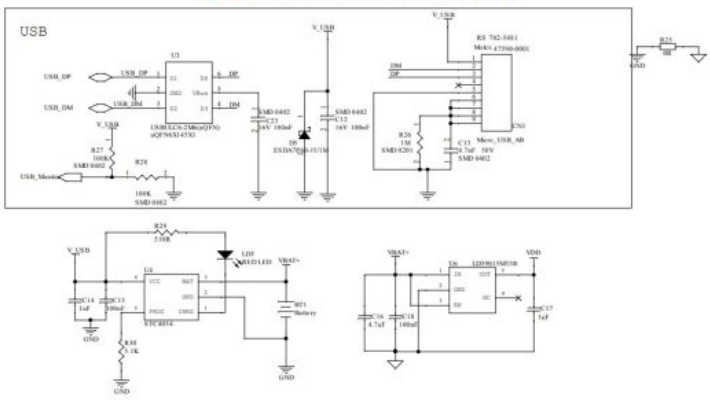
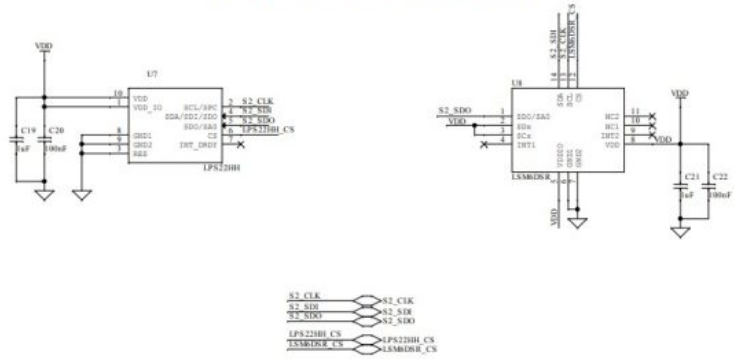


Figure 19. STEVAL-FCU001V2 – circuit schematic (4 of 4)



Bill of materials

Table 7. Bill of materials

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	1	BT1	Battery Connector, siptm2002	Strip line male 1X2 pitch 2.54 mm 90 degrees	Adam Tech	PH1RA-02-UA
2	1	CN1	Micro_USB 2.0 Female SMt, microusb7025481	Micro-USB connector	Molex	47590-0001
3	6	C1,C7,C14, C17,C19,C2 1	1uF, smc0402, 16V, +/-10%	Ceramic capacitor XR7	Any	Any
4	12	C2,C3,C4, C 5,C6,C10,C12,C15,C18,C 20,C22, C23	100nF, smc0402, 16V, +/-10%	Ceramic capacitor XR7	Any	Any
6	2	C8,C9	15pF, smc0402, 16V, +/-10%	Ceramic capacitor XR7	Any	Any
7	2	C11,C16	4.7uF, smc0402, 16V, +/-10%	Ceramic capacitor XR7	Any	Any
8	1	C13	4.7nF, SMC0402, 16V, +/-10%	Ceramic capacitor XR7	Any	Any
9	4	D1,D2,D3,D 4	BAT60J, sod323, 10V, 3A	10 V general purpose signal Schottky diode	ST	BAT60J
10	1	D5	ESDA7P60-1U1M, SMD1610	High-power transient voltage suppressor (TVS)	ST	ESDA7P60-1U1M

11	3	LD1,LD2,LD 3	RED LED, smd0603, SMD	Red LED	OSRAM Opto	LRQ396
13	1	P1	Motor_Panel1, siptm2002	Strip line male 1X2 pitch 2.54 mm 90 degrees	Adam Tech	PH1RA-02-UA
14	1	P2	Motor_Panel3, siptm2002	Strip line male 1X2 pitch 2.54 mm 90 degrees	Adam Tech	PH1RA-02-UA
15	1	P3	i2Q, siptm4004	Strip line male 1X4 pitch 2.54 mm	Wurth Elektronik	61300411121
16	1	P4	Motor_Panel2, siptm2002	Strip line male 1X2 pitch 2.54 mm 90 degrees	Adam Tech	PH1RA-02-UA
17	1	P5	Motor_Panel4, siptm2002	Strip line male 1X2 pitch 2.54 mm 90 degrees	Adam Tech	PH1RA-02-UA
18	1	P6	FC_Signal, siptm6006	Strip line male 1X6 pitch 2.54 mm	Wurth Elektronik	61300611121

Item	**Q.ty**	**Ref.**	**Part/Value**	**Description**	**Manufacturer**	**Order code**
19	1	P7	USART, siptm4004	Strip Line male 1X4 pitch 2.54 mm	Wurth Elektronik	61300411121
20	1	P8	SWD, Ampmode10X1M27	Connector 2X5 pitch 1,27 mm	SAMTEC	FTSH-105-01-F-D-K
21	4	Q1,Q2,Q3,Q4	STL6N3LLH6, powerFLAT2X2	N-channel 30 V, 0.021 Ohm typ., 6 A STripFET H6 power MOSFET in a PowerFLAT 2×2 package	ST	STL6N3LLH6
22	1	R1	47k, smr0402, 1/16W, +/-1%	SMD thick film resistor	Any	Any
23	4	R2, R3, R6, R8	1K, smr0402, 1/16W, +/-1%	SMD thick film resistors	Any	Any

24	7	R4, R5, R7, R9, R10, R23, R24	10K, smr0402, 1/16W, +/-1%	SMD thick film resistors	Any	Any
25	1	R11	20K, smr0402, 1/16W, +/-1%	SMD thick film resistor	Any	Any
26	4	R12, R13, R16, R17, R25	smr0603, 1/16W, +/-1%	SMD thick film resistors	Any	Any
27	4	R14, R15, R18, R19	NA, smr0402, 1/16W, ±1%	SMD Thick Film Resistor	Any	Any
28	2	R20, R21	2.2K, smr0402, 1/16W, ±1%	SMD Thick Film Resistor	Any	Any
29	3	R22,R27, R28	100K, smr0402, 1/16W, ±1%	SMD Thick Film Resistor	Any	Any
30	1	R26	1M, SMR0402, 1/16W, ±1%	SMD Thick Film Resistor	Any	Any
31	1	R29	510R, smr0402, 1/16W, ±1%	SMD Thick Film Resistor	Any	Any
32	1	R30	5.1K, smr0402, 1/16W, ±1%	SMD Thick Film Resistor	Any	Any
33	1	S1	Reset, PushKMR22	Push Botton	C&K	KMR231GLFS
34	1	U1	BLUENRG-M0A, spbtrfle	Very low power network processor module for Bluetooth® low energy v4.2	ST	BlueNRG-M0
35	1	U2	STM32F401CCU, UFQFPN48X7X7	High- performance access line, Arm Cortex- M4 core with DSP and FPU, 256 Kbytes of Flash memory, 84 MHz CPU,	ST	STM32F401CCU

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
				ART accelerator		
36	1	U3	USBULC6-2M6(uQFN), uQFN6X145X1	Ultra large bandwidth ESD protection	ST	USBULC6-2M6
37	1	U4	STC4054GR, SOT23L5	800 mA standalone linear Li-Ion battery charger with thermal regulation	ST	STC4054GR
39	1	U6	LD39015M33R, sot23l5	150 mA low quiescent current low noise voltage regulator	ST	LD39015M33R
40	1	U7	LPS22HHTR, HLGA10X2X2X07	High- performance MEMS nano pressure sensor: 260-1260 hPa absolute digital output barometer	ST	LPS22HHTR
41	1	U8	LSM6DSRTR, lga14X2m5X3X086	iNEMO inertial module: 3D accelerometer and 3D gyroscope	ST	LSM6DSRTR
42	1	Y1	16 MHz, 15 ppm	Quartz	NDK	NX2520SA-16,000000MHz-STD-CSW-4
43	1	None	ARM-JTAG-20-10	Mini-board and cable	Olimex LTD	ARM-JTAG-20-10

Board versions

Finished good	Schematic diagrams	Bill of materials
STEVAL$FCU001V2A(1)	STEVAL$FCU001V2A schematic diagrams	STEVAL$FCU001V2A bill of materials

1. This code identifies the STEVAL-FCU001V2 evaluation board first version.

Regulatory compliance information

Formal Notices Required by the U.S. Federal Communications Commission (FCC)
Responsible party's contact located in the United States: name: Francesco Doddo; address: STMicroelectronics Inc, 200 Summit Drive, Suite 405, Burlington MA, 01803, U.S.A.; e-mail: **francesco.doddo@st.com** This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.
Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Standard applied: FCC CFR Part 15 Subpart B. Test method applied: ANSI C63.4 (2014).
Formal Product Notice Required by Industry Canada
Responsible party's contact located in Canada: name: John Langner; address: STMicroelectronics, Inc., 350 Burnhamthorpe Road West, Suite 303 L5B 3J1, Mississauga, ON, Canada; e-mail: **john.langner@st.com**
Innovation, Science and Economic Development Canada Compliance
This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence exempt RSS(s). Operation is subject to the following two conditions: (1) This device may not cause interference. (2) This device must accept any interference, including interference that may cause undesired operation of the device.
Standard applied: ICES-003 Issue 7 (2020), Class B. Test method applied: ANSI C63.4 (2014).
Notice for the European Union
The kit STEVAL-FCU001V2 is in conformity with the essential requirements of the Directive 2014/53/EU (RED) and of the Directive 2015/863/EU (RoHS). Harmonized standards applied are listed in the EU Declaration of Conformity.
Notice for the United Kingdom
The kit STEVAL-FCU001V2 is in compliance with the UK Radio Equipment Regulations 2017 (UK SI 2017 No. 1206 and amendments) and with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (UK SI 2012 No. 3032 and amendments). Applied standards are listed in the UK Declaration of Conformity.
Revision history
Table 9. Document revision history

Date	Revision	Changes
22-Aug-2023	1	Initial release.
24-Jun-2024	2	Updated Introduction, Section 2: Hardware description, Section 3: System setup guide, Section 3.1: How to use the board with the preinstalled firmware, Section 3.2: How to use the board with your own firmware and Section 4: Schematic diagrams.

to ST’s terms and conditions of sale in place at the time of order acknowledgment.
Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of purchasers’ products.
No license, express or implied, to any intellectual property right is granted by ST herein.
Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.
ST and the ST logo are trademarks of ST. For additional information about ST trademarks, refer to **www.st.com/trademarks**. All other product or service names are the property of their respective owners.
Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

life.augmented

Documents / Resources

	**STMicroelectronics UM2958 STEVAL-FCU001V2 Flight Controller Unit Evaluation Board** [pdf] User Manual UM2958, UM2958 STEVAL-FCU001V2 Flight Controller Unit Evaluation Board, STEVAL-FCU001V2 Flight Controller Unit Evaluation Board, Flight Controller Unit Evaluation Board, Controller Unit Evaluation Board, Evaluation Board

References

- **User Manual**