life.augmented

Products and solutions for Drones



Introduction



The term Drone is today the informal and generic substitute of RPAS (Remotely Piloted Aerial System) or UAV (Unmanned Aerial Vehicle), it indicates any aircraft intended to be flown without a pilot on board and placed remotely with its pilot station.

The whole experience of piloting a drone is of course heightened dramatically with mounted cameras, as pilots can receive video streams from the perspective of their drones.

Generally speaking, there are three categories of drones:

- Mini drones: usually small and light quadcopters
- Consumer/Commercial drones: larger and more involving drones with cameras less than 500 gr and gimbals
- Professional/industrial drones: can carry payloads like HD cameras and use GPS for autopiloting over long distances. These drones are used in agriculture, logistics and in surveillances

ST offers microcontrollers and sensors that support critical functions such as flight stabilization, altitude control, obstacle avoidance and autonomous navigation. If you add motor control, precision amplifiers, battery management systems and connectivity solutions, as well as design tools and development boards, you understand that our portfolio for drones is indeed thorough.

Drone makers choose ST solutions because they are optizimized in terms of size and efficiency, two crucial factors for longer flight times.

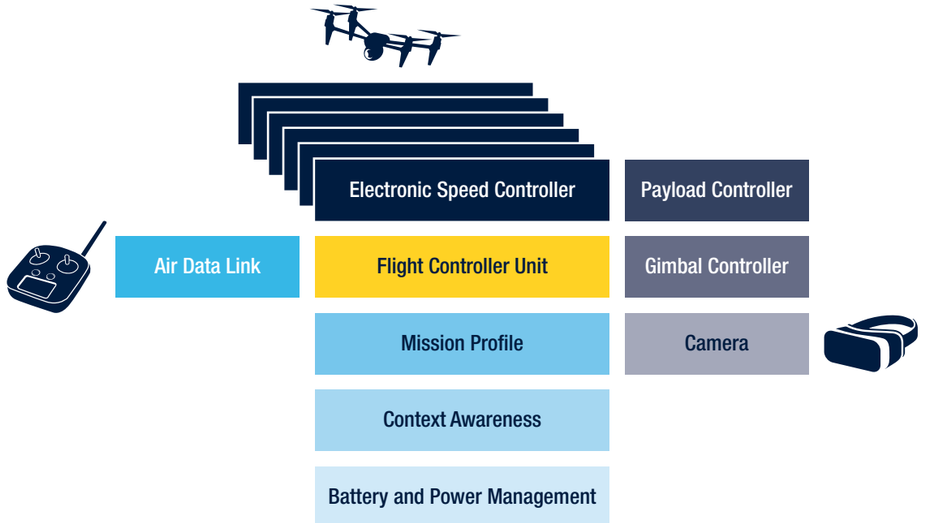
Note: The Products listed in next pages are classified as standard Products, which means that such Products are not qualified nor have been specifically designed for use in: safety critical applications and in aeronautic or aerospace applications.

Drone Sub-Systems

Drone technology is highly intriguing because it involves state-of-the-art design principles attempting to balance flight time, size and weight, stability, system complexity, logic, special functionality and critical maneuvers such as safe landing.

Drone makers typically need to develop the following distinct subsytems to produce a viable final product:

- A Flight Controller Unit (FCU) to manage flight under different conditions, relying on its Inertial Measurement Unit (IMU) to stabilize drone hovering. In professional drones, the FCU embeds a GPS (Global Positioning System) to form an Autopilot System
- Almost four Electronic Speed Controllers (ESCs) to control the electric motors with sophisticated algorithms and allow high rotation speeds while promoting long battery life
- A Camera Gimbal to rotate and stabilize cameras through servo motors
- A command and control system including the Air Data Link, transponders, instruments to connect the remote pilot station to Flight Controller Unit of Drone
- A Mission Profile Unit to manage the operators' missions such as the surveillance, the delivery of medications, the photography, videography and so on
- A power management stage in higher end drones to efficiently distribute battery energy across the different motors



Electronic Speed Controller

Up, up and away!

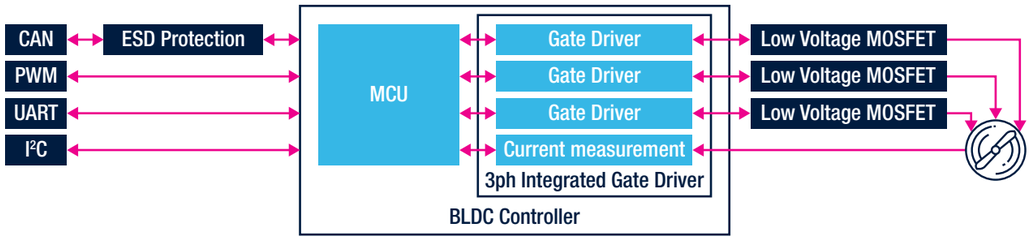
A propulsion system involves propellers, motors, Electronic Speed Controllers (ESCs) and a suitable battery. The ESC design is based on the motors maximum voltage and current, and number of poles of the motors.

For the motor, the KV rating indicates rotation speed for a given voltage, and thrust is the amount of force it can generate with a specific propeller. So motors with a 650 rpm/V KV and a 0.5 Kg thrust from an 11-inch propeller would be required for a drone weighing 2.5 Kg, including payload.

Another important aspect is the firmware, as the latest motor control algorithms featuring Field Oriented Control will optimize efficiency and increase battery life and flight time.

ST can help you with a complete ESC BoM, including fast microcontrollers for high algorithm performance, and gate drivers and MOSFETs for efficient motor operation. ST also offers several reference designs you can use to start building your own drone almost immediately.

Block diagram of an Electronic Speed Controller



ESC bill of materials

MCU	Gate Driver	Low Voltage MOSFET	ESD Protection	BLCD Controller	Current measurement	3ph Integrated Gate Driver
STM32F0 series STM32F3 series STM32G4 series	L639x series	STripFET F7 Series	ESDA6V1L	STSPIN32F0 series STSPIN32G4	TSV991 TSV792 TSV7722 TSC213	STDRIVE101

Hardware Turnkey solutions

Part number	Description
STEVAL-ESC001V1	Electronic speed controller reference design for drones
STEVAL-ESC002V1	Compact Electronic Speed Controller for 6 Steps Motor Control
B-G431B-ESC1	Electronic speed controller designed to drive a single 3-phase brushless motor (BLDC/PMSM), performing both sensorless FOC algorithm and 6-step control with a speed regulation

Firmware basket

Part number	Description
STSW-ESC001V1	Sensorless FOC reference design firmware for STEVAL-ESC001V1
X-CUBE-MCSDK	STM32 FOC Software Development Kit (MCSDK)
STSW-ESC002V1	6 Steps design firmware for STEVAL-ESC002V1

Flight Controller Unit

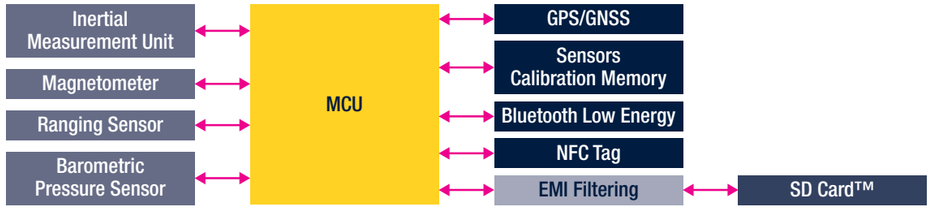
Set your sights on the horizon...

Once you have settled on the drone frame, the motors, the propellers and ESCs, it's time to turn your attention to the Flight Controller Unit (FCU), which ensures stable and secure flight.

The FCU consists of a processor and an Inertial Measurement Unit with a high precision accelerometer and gyroscope, necessary for stable flight. To these two elements is demanded the correct fly once the FCU received inputs by the Remote Controller or by the Mission Profiler. Further functionality is obtained through a barometric pressure sensor for altitude control and a GPS/GNSS for more sophisticted features like Return to Home, Geofencing, No Fly Zone and Inertial Navigation Systems.

Fully featured FCUs are often refereed to as Autopilot Systems, where a simple command like «land in x,y position» is all you need for the FCU to transform the coordinates, plan a route and perform a safe landing. Even more functionality can be added with a compass for orientation control, a ranging sensor to avoid obstacles and assist landing, a Near Field Communication tag to program flight parameters.

Block diagram of a Flight Controller Unit



FCU bill of materials

MCU	IMU	Magnetometer	Ranging Sensor	Barometric Pressure Sensor
STM32F4 series STM32F7 series STM32H7 series	LSM6DSR LSM6DSV*	LIS2MDL	VL53L1 VL53L5CX	LPS22HH

GPS/GNSS	Sensors Calibration Memory	Bluetooth Low Energy	NFC Tag	EMI Filtering
STA8090 series Teseo-LIV3 Teseo-LIV4 (multi-band, available in 2022)	M24xxx-F Series	BlueNRG-2N	ST25DV	EMIF06-HSD03F3

Note: * available by March 2022

Hardware Turnkey solutions

Part number	Description
STEVAL-FCU001V1	Flight controller unit evaluation board for mini drones
STEVAL-FCU001V2*	Flight controller Unit for mini drone

Note: * available by end of Q1/2022, it will replace the STEVAL-FCU001V1

Firmware basket

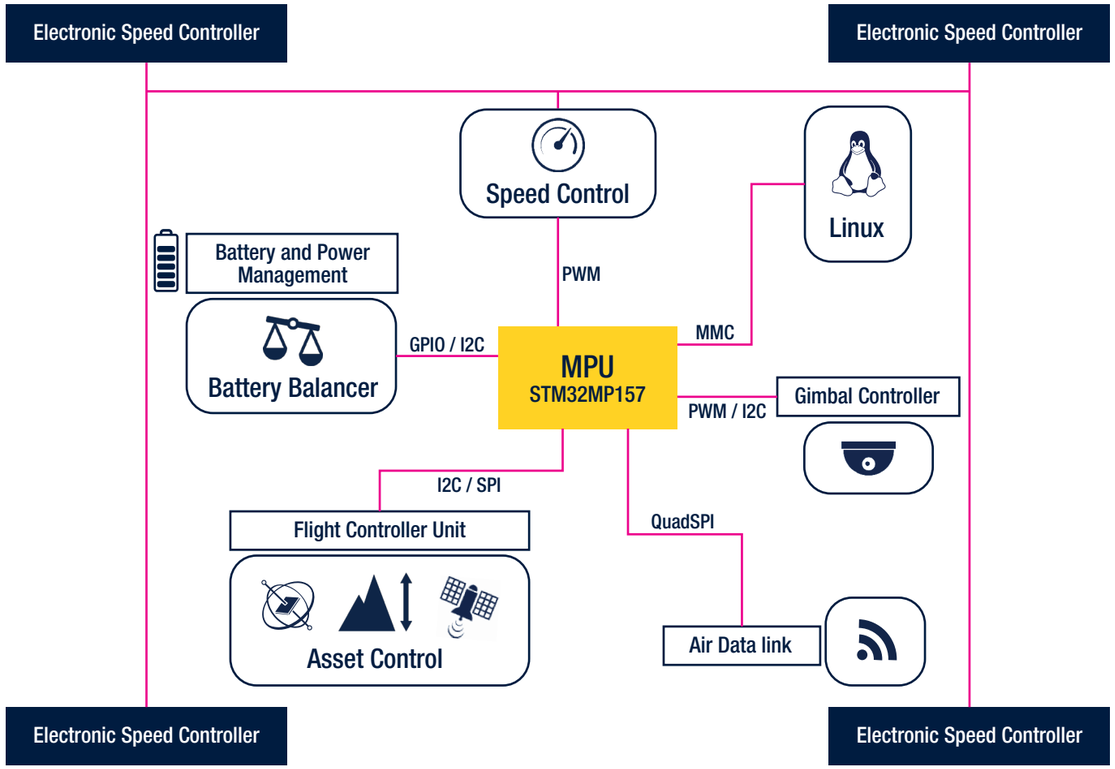
Part number	Description
STSW-FCU001V1	Reference design firmware for mini drones

Mission Profile Unit

Simplify the plan to enjoy the flight

The Mission Profile Unit enables drone to simplify the interaction with users, progressively it increments the autonomy level of drone embedding functionalities such as automatic flight control, system fault adaptive, GNSS assisted navigations, path planning and execution, dynamic mission planning, swarm group decision making and finally full autonomous drones. All these tasks have to be executed in secure way to avoid unintentional intrusions. It can also manage the on-field updates of the different drone blocks through Bluetooth Low Energy (see Communication table).

Since the main tasks are performed by a Microprocessor Units and ST can offer its MP1 product family.



NEW

MPU @ 800 MHz

STM32MP151D	MP151F	STM32MP153D	MP153F	STM32MP157D	MP157F
1520 + 260 DMIPS 800 MHz Cortex-A7 209 MHz Cortex-M4	- - - Security	3040 + 260 DMIPS 800 MHz 2x Cortex-A7 209 MHz Cortex-M4 CAN FD	- - - Security	3040 + 260 DMIPS 800 MHz 2x Cortex-A7 209 MHz Cortex -M4 CAN FD - 3D GPU - DSI	- - - Security

MPU @ 650 MHz

STM32MP151A	MP151C	STM32MP153A	MP153C	STM32MP157A	MP157C
1235 + 260 DMIPS 650 MHz Cortex-A7 209 MHz Cortex-M4	- - - Security	2470 + 260 DMIPS 650 MHz 2x Cortex-A7 209 MHz Cortex-M4 CAN FD	- - - Security	2470 + 260 DMIPS 650 MHz 2x Cortex-A7 209 MHz Cortex-M4 CAN FD - 3D GPU - DSI	- - - Security

STPMIC1

The STPMIC1 is a dedicated companion Power-Management IC (PMIC) for ST's STM32MP1 Microprocessor Unit (MPU) family fully controllable by I2C interface and with integrated NVM. In addition to supplying all the power rails for the MPU and other components on the board, such as DDR memory and various external peripherals (e.g. Wi-Fi, Bluetooth, USB OTG port supplied by Boost converter and power switch to mention some) , the STPMIC1 provides power-rail monitoring and protection, handles power-up/down sequencing, and meets the ST32MP1 accuracy and settling-time specifications.

Gimbal Controller Unit

Admire the world from above

Your drone is almost complete; it can to fly any position and hover there, but it's still too shacky for high quility photographs or films. To do it you first need an image sensor engineered for high speed drone and computer vision.

Camera Imaging Sensors

Global Shutter

VD55G0 (0.4Mpixels)	VD56G3 (1.5Mpixels)
• 644x604 pixels • Only 2.6x2.5mm² sensor • 2.6um BSI GS pixel, low noise • Auto-expo & defect correction • Low power • 4 immediate contexts • 4 multi purpose IO strobe, PMW, sync, GPIO, ...	• 1364x1124 pixels • Only 4.3x3.6mm² sensor • 2.6um BSI GS pixel, low noise • Auto-expo & defect correction • Very low power • 4 immediate contexts • 8 multi purpose IO strobe, PMW, sync, GPIO, ... • Full hardware Optical Flow

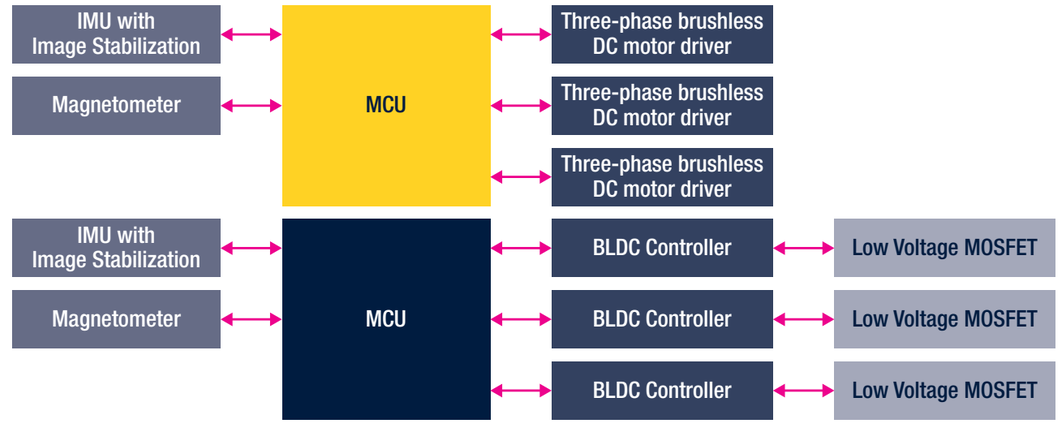
ST offers its the smallest Global Shutter sensors based on the latest backside illumination (BSI) plus stacking technology, VD55G0, which has both a higher resolution and a smaller sensor size, than other VGA sensors with Global Shutter, the pixel ensures not rolling artifacts from the drone. ST sensors offer also high sensitivity both in visible domain but also in near-IR, with high sharpness (MTF), low noise, with low dark current to preserve performance at highest temperature.

This sensor does not require external ISP, thanks to the embedded defect correction and auto-exposure. Both high frame-rate (210fps 640x600 or 500fps 640x240 binning) and low power (35mW/30fps). Includes 4 no-delay switchable contexts, linkable as sequences, perfect for demanding computer visionSupporting both master & slave, with flexible synchronization signals, it enable multiple sensor on the same drone, for 360° SLAM. Several multifunction GPIOs for sensor & illumination control.

Saving host processing and power for the drone navigation, VD56G3 embeds a full optical flow, able to out up to 2000 movement vectors at 60fps for only extra 20mW. Higher frame-rates are possible with the optical flow, like 300fps on lower image resolution (full field-of-view, or image crop), movement vectors can be output alone or interlaced with image data.

If you need a gyrostabilized camera, you need to implement a Gimbal Controller with a powerful micontroller to process data from an Inertial Measurement Unit and move 2 or 3 axis motors to adjust the Gimbal frame orientation independantly of the drone.

Block diagram of a Gimbal Controller Unit (two scalable solutions)



GCC bill of materials

IMU	Magnetometer	MCU	3ph BLDC Motor Driver
LSM6DSR LSM6DSV*	LIS2MDL	STM32F3 series STM32G4 series	STSPN233 STSPIN830 L6230Q

MCU	BLDC Controller	Low Voltage MOSFET
STM32F1 series	STSPIN32F0 series STSPIN32G4	STripFET F7 series

Note: * available by March 2022

Hardware Turnkey solutions

Part number	Description
STEVAL-GMBL02V1	Drone Gimbal Reference Design for triple servo motor control

Firmware basket

Part number	Description
STSW-GMBL02V1	Gimbal controller firmware and GUI for drones and handheld applications

Backbone Components

The importance of power and communication

The communication bus and power management logic form the backbone of your drone and prevent fly-away and fail conditions.

Connectivity

Part number	Description
BlueNRG-M2	Very low power application processor module for Bluetooth® low energy v5.2
BlueNRG-LP	Programmable Bluetooth® LE 5.2 Wireless SoC
S2-LP	Ultra-low power, high performance, sub-1GHz transceiver
SPSGRF	Sub1GHz (433, 868 or 915 MHz) programmable transceiver module with ufl connector
SPSGRFC	Sub1GHz (433, 868 or 915 MHz) programmable transceiver module with ufl connector
S2-LPTX	Low data rate, low power sub-1GHz transmitter
BALF-NRG-02D3	50 Ω/conjugate match balun to BlueNRG transceiver, with integrated harmonic filter
BALF-SPI2-01D3	50 Ω nominal input/conjugate match balun to S2-LP, 433 - 470 MHz with integrated harmonic filter
BALF-SPI2-02D3	50 Ω nominal input/conjugate match balun to S2-LP, 868 - 927 MHz with integrated harmonic filter

Further sensors

Part number	Description
HTS221	Capacitive digital sensor for relative humidity and temperature
LPS27HHW	Piezoresistive absolute pressure sensor, 260-1260 hPa, digital output barometer, water resistant package
MP23ABS1	High performance MEMS audio sensor single ended analog bottom-port microphone
MP34DT06J	MEMS audio sensor omnidirectional stereo digital microphone

LED Array drivers

Part number	Description
STLA02	20 mA up to 6 white LEDs driver with boost converter
LED1202	12 CH, 12bit, 2.5 V/20 mA, pattern sequences
STLED524	120 LEDs Matrix, 5 rows x 24 column

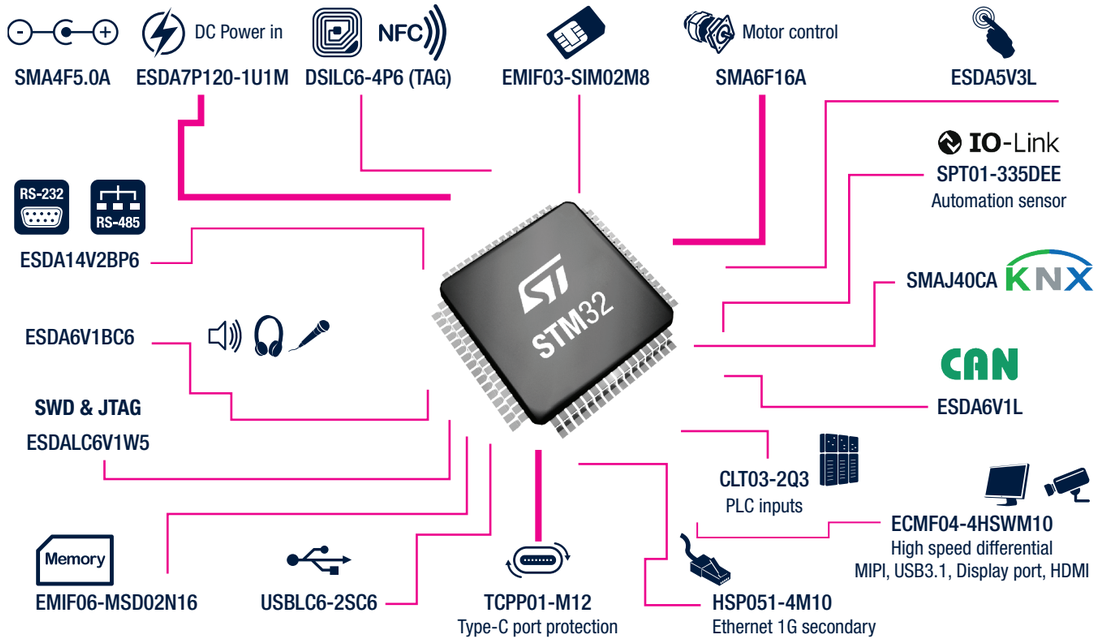
Power management

Part number	Description
L6981	38 V, 1.5 A synchronous step-down converter with low quiescent current
L6982	38 V, 2 A synchronous step-down converter with low quiescent current
L6983	38 V, 3 A synchronous step-down converter with 17 µA quiescent current
LD57100	1A Low Drop LDO
ST730	300mA, 28V, ultra low Iq, LDO
STUSB1602	USB Type-C controller (with Tx/Rx line driver and BMC)
STUSB4500	Stand-alone USB PD controller (with sink Auto-run mode)
TSV991	20 MHz, rail-to rail operational amplifier for low-side current measurement
TSV792	50 MHz, high accuracy operational amplifier for low-side current measurement
TSC213	High side current sense amplifier for power lines up to 26 V
TSV7722	High bandwidth 22 MHz, low offset (200 µV) 5 V op amp
TCPP01-M12	USB-C sink protection against overvoltages and ESD
TCPP02-M18	USB-C source protection against overvoltages and ESD
TCPP03-M20	USB-C DRP protection against overvoltages and ESD

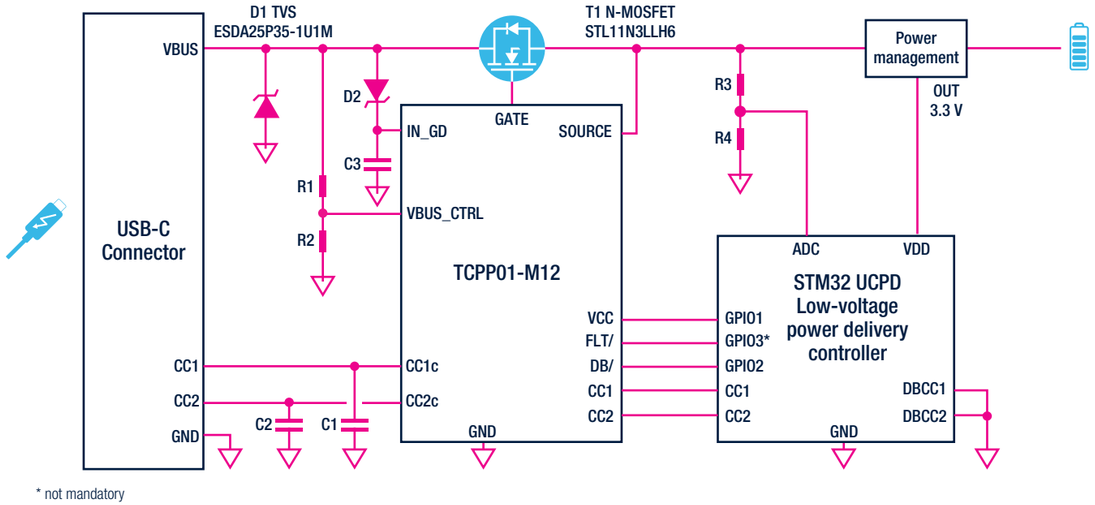
Protection against transient surges (IEC61000-4-5, 8/20 µs)

		Fast charging standard	Medium Power Capability	High Power Capability		Strong Power Capability
3/4S Cells	20 V	USB PD profile 2 & 3 QCM quick-charge 3.0		ESDA25P35-1U1M		ESDA24P140-1U3M ESDA22P150-1U3M
	15 V		ESDA17P20-F2	ESDA17P50-1U1M	ESDA17P100-1U2M	
2S Cells	12 V	USB PD profile 2 QCM quick-charge 2.0	ESDA13P70-1U1M	ESDA15P60-1U1M		
1S Cells	5 V	USB PD profile 1 QCM quick-charge 1.0	ESDA8P30-1T2 ESDA9P25-1T2 ESDA7P60-1U1M ESDA7P80-1U1M	ESDA7P120-1U1M ESDA8P80-1U1M		

Recommended ESD IC Protection for MCU Interfaces



Example of application USB 2.0 Full speed without OTG

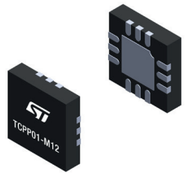


* not mandatory

Featured products

TCPP01-M12 + ESDA25P35-1U1M

- Type C Port Protection
- USB-C fatures : V_{BUS} OVP
- CC OVP + ESD protection



QFN-12

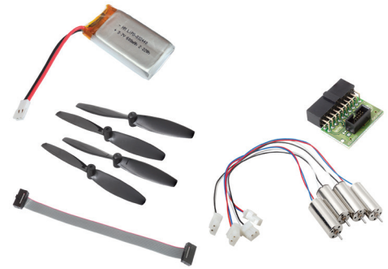
Mini Drone Kit & ST BLE Drone App

The first ST Drone Kit to help you learn about drones

We have created a mini drone kit as companion of the high performance STEVAL-FCU001V1 (and STEVAL-FCU001V2) flight controller unit, along with four motors and propellers, a frame and a battery: everything you need in a single box to build your own mini-drone.

All the necessary information are available at page: www.st.com/Drone-Kit where you can find the firmware and software resources, the STL file to replicate the frame with your own 3D Printer, and some videos explaining how to get started.





Part number	Description
STEVAL-DRONE01	Mini drone kit with flight controller unit, motors, propellers, frame and battery
STEVAL-DRONE02*	Mini drone companion for STEVAL-FCU001V2 flight controller unit

Note: * available by the end of Q1/2022

ST BLE DRONE APP

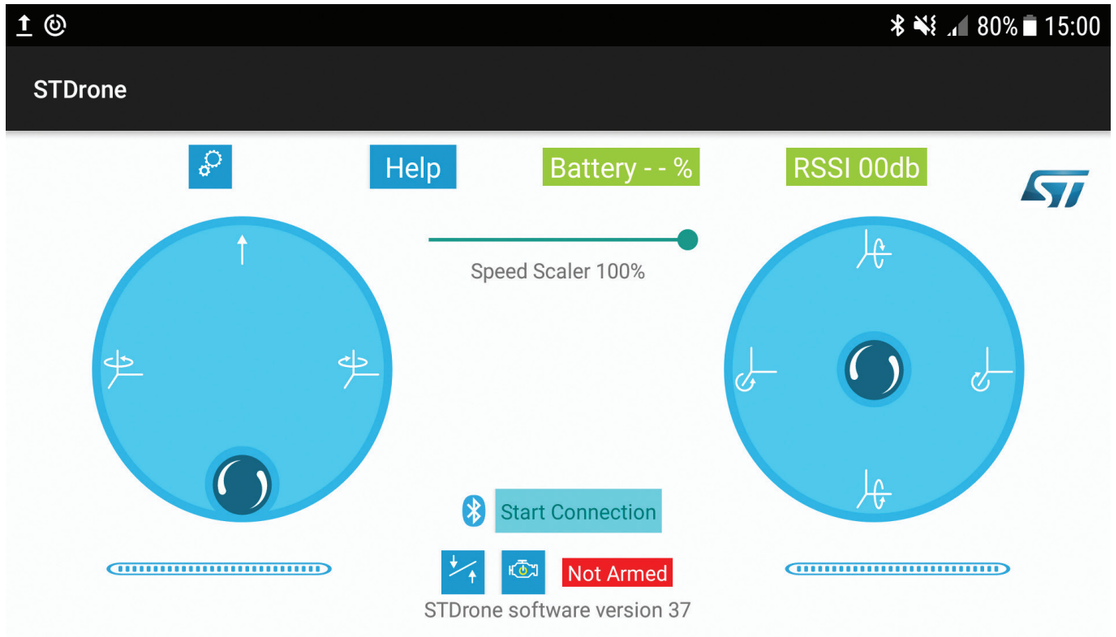
ST has developed a Smartphone App able to connect and control the ST Flight Controller Unit (STEVAL-FCU001V1 and STEVAL-FCU001V2) and the Mini Drone Kit (STEVAL-DRONE01 and STEVAL-DRONE02), in fact you can use it as cheap Remote Control. Drone Kit with your phone. It's available on Google Play and on Apple Store.

All the source code of App is available on GitHub.

https://github.com/STMicroelectronics-CentralLabs/ST_Drone_FCU_F401

GET IT ON Google Play

Download on the App Store



The dedicated ST Drone Community



Want to hear from you

We have created a new Community dedicated to Drone, through it users, partners, and customers can exchange tips and ideas, and collaborate on techniques related to electronic design of drones.

The community is open to everyone to make sure it stays beneficial to all.

You can join to this group, collaborate with your peers and get updates on all the activities ST is doing on Drone World simply by following the link:
community.st.com/dronezone

life.augmented

MIX
Paper from responsible sources
FSC® C003379

Order code: BRDRONE1121

For more information on ST products and solutions, visit www.st.com

© STMicroelectronics - November 2021 - Printed in the United Kingdom - All rights reserved
ST and the ST logo are registered and/or unregistered trademarks of STMicroelectronics International NV or its affiliates in the EU and/or elsewhere. In particular, ST and the ST logo are Registered in the US Patent and Trademark Office. For additional information about ST trademarks, please refer to www.st.com/trademarks.
All other product or service names are the property of their respective owners.

life.augmented