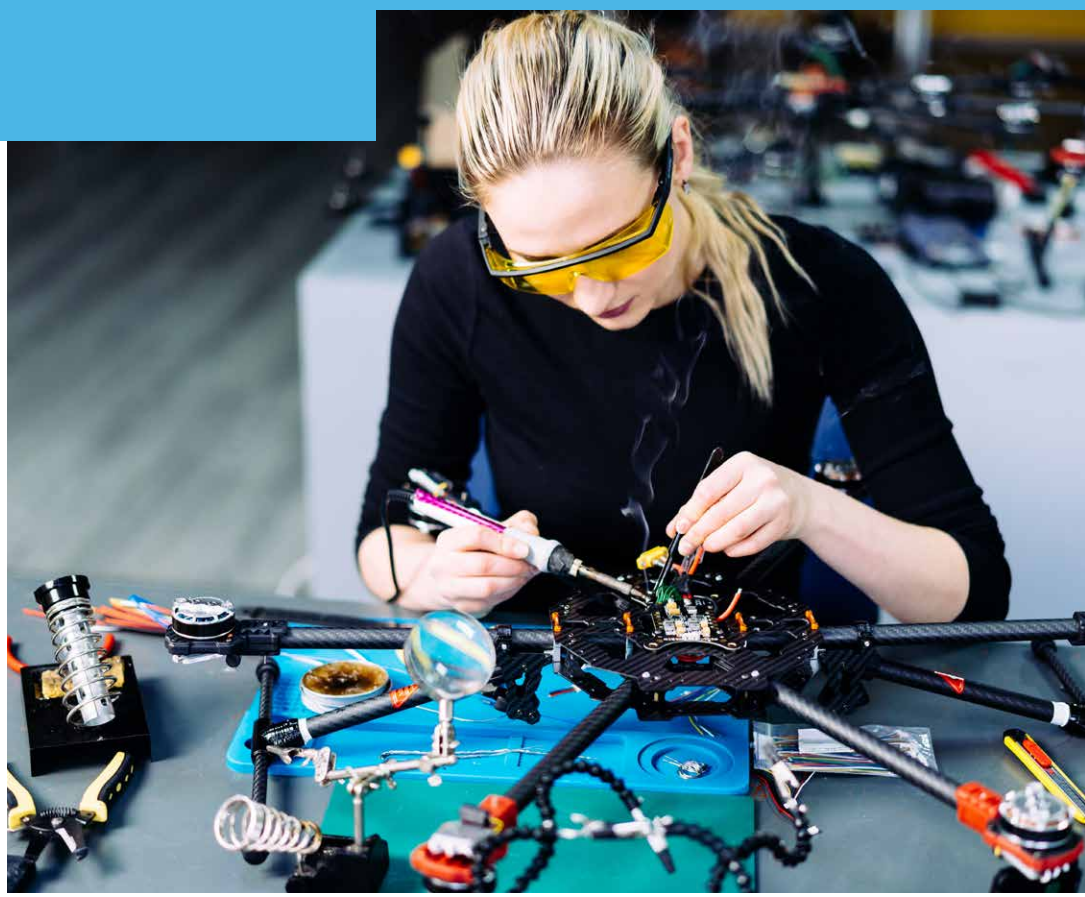
Products and solutions for Drones

Introduction



Remotely piloted aerial systems (RPAS) or unmanned aerial vehicles (UAV) are widely used in various recreational, professional, and defense applications.

Drones are very often equipped with various payloads such as day & night gimbal, IR or multispectral cameras, communications repeaters, multispectral cameras, lidars, etc.

GNSS geolocation devices for autonomous navigation, sensors for obstacle avoidance and precision landing, and Automatic Dependent Surveillance - Broadcast (ADS-B) transmitters allow safe and autonomous operation.

Edge AI is rapidly enabling new drone capabilities such as pattern recognition, visual navigation, predictive maintenance, and even swarm navigation.

ST offers a comprehensive range of solutions for drone development, beginning with microcontrollers and sensors for critical flight stabilization, altitude control, obstacle avoidance, and autonomous navigation. Our portfolio also extends to motor control, precision amplifiers, battery management systems, connectivity solutions, design tools, and development boards.

Drone manufacturers choose ST solutions because they are optimized for performance, size, and efficiency – crucial to achieve longer flight times, precise operation, and greater affordability.

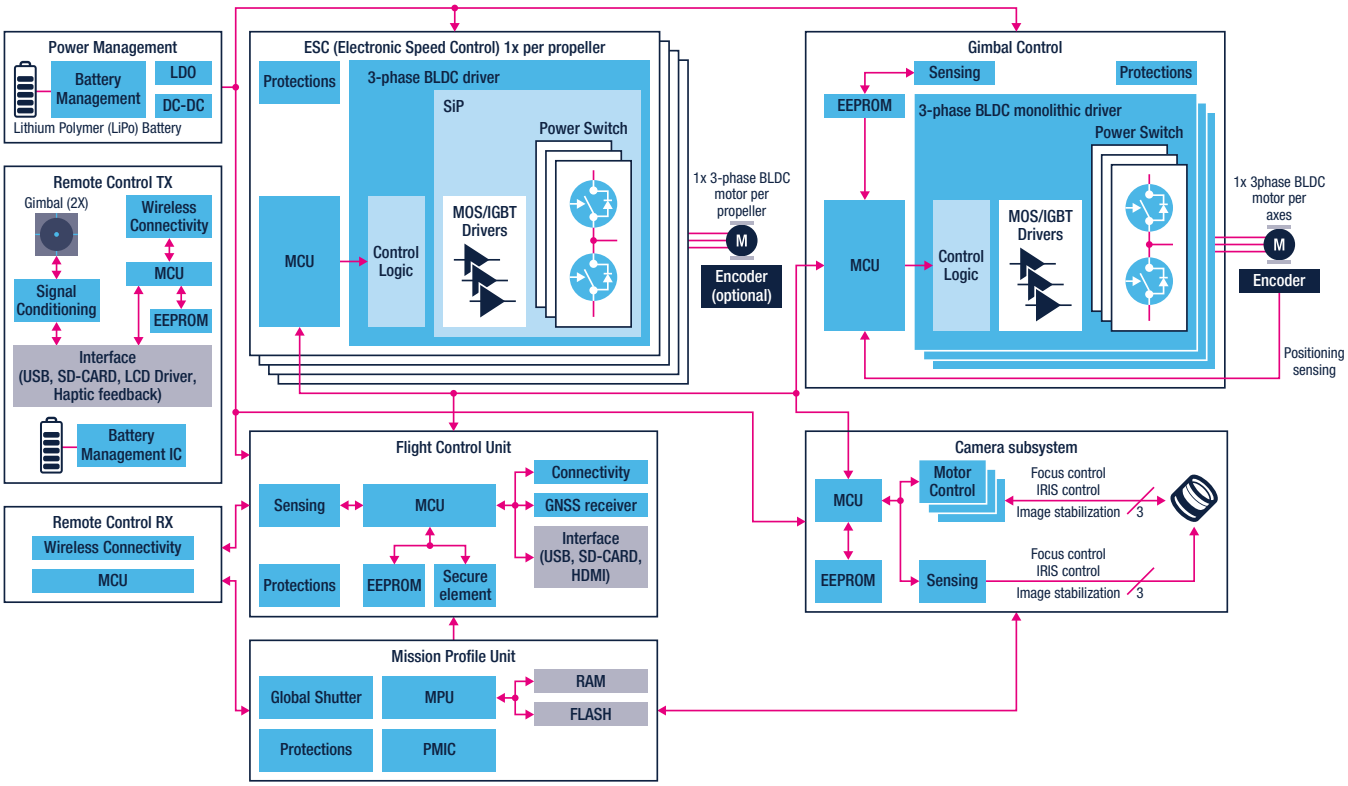
Note: The products listed in the following sections are classified as standard. They are not specifically designed or qualified for aeronautic or aerospace applications.

Drone Subsystems

Drone technology involves state-of-the-art design principles that balance flight time, size, weight, stability, system complexity, logic, special functionality, and critical maneuvers such as safe landing.

Drone makers typically need to integrate or develop the following subsystems to produce a viable final product:

1. **A flight controller unit (FCU)** to manage flight under different conditions, relying on its inertial measurement unit (IMU) and algorithms to stabilize the flying drone. The FCU might use a Global Navigation Satellite System (GNSS) and additional sensors to form a complete autopilot system.
2. **Electronic speed controllers (ESCs, typically 1 per motor)** to control the electric motors with sophisticated algorithms, allowing extremely precise rotation speed while extending battery life.
3. **An optional mission profile unit** to manage mission planning and execution.
4. **A camera gimbal controller** to rotate and stabilize cameras through servo motors.
5. **A camera block** for image and video capture.
6. **A telemetry link and an air data link** for real-time remote control and FCU commands and real-time transmission of video and images respectively.
7. **A power management stage in higher-end drones** to efficiently distribute battery energy across the different subsystems.



Flight Controller Unit

Set your sights on the horizon...

The flight controller unit (FCU) is at the heart of the drone, ensuring stable and secure flight. It consists of a processor and an inertial measurement unit (IMU) equipped with high-precision accelerometers and gyroscopes. These components guarantee reliable execution of commands from the remote control or mission profile unit. An FCU alone suffices for FPV (first-person view) operations, where a remote pilot directly controls the drone.

By combining the versatile STM32 microcontroller family with our extensive range of MEMS IMUs, we offer a comprehensive portfolio that simplifies selecting the right solution for applications requiring low size, weight, and power (SWaP), while delivering high performance at an affordable cost.

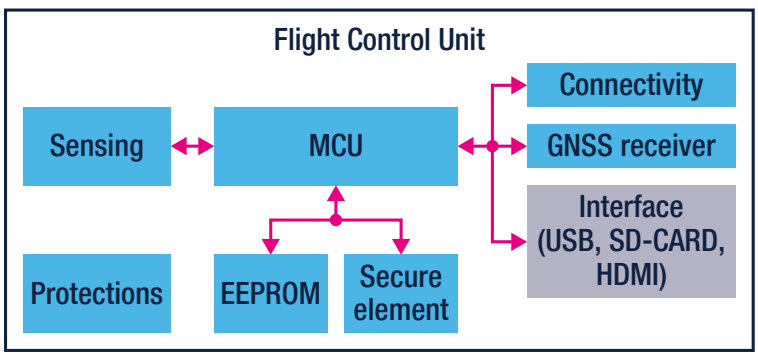
Additional capabilities can be integrated through barometric pressure sensors or lidar for altitude control, and GPS/GNSS modules for advanced functions such as return-to-home, geofencing, no-fly zones, and inertial navigation. Our automotive-grade Quad-Band TESEO 6 modules, featuring an IMU or RTK and equipped with antijamming and antispoofing technologies, ensure high robustness in drone applications.

Fully featured FCUs—often referred to as autopilot systems—typically adhere to open-source standards like PX4 or Ardupilot, both of which have implemented STM32 microcontrollers since the early stages of modern drone development.

Our FlightSense portfolio further enhances drone safety and reliability by enabling obstacle avoidance and precision landing capabilities. Additional functionalities can be incorporated using a compass for orientation control, ranging sensors for obstacle detection, and near field communication (NFC) tags for programming flight parameters. For professional drones requiring pilot licensing, secure element ICs can be integrated to implement pilot passport systems.

Finally, the introduction of the STM32N6 microcontroller, with its advanced AI capabilities, unlocks new operational scenarios and applications—empowering drones to autonomously perform complex tasks.

Block diagram of a Flight Controller Unit



FCU bill of materials

	Product family	Description with key features	Key products
MCU	• STM32H5 family • STM32H7 family • STM32N6 family	High-performance MCUs SIL ready Dedicated embedded neural processing unit (NPU)	• STM32H523/533 • STM32H747/757 • STM32N6x7
Sensing	• Inertial measurement unit • Pressure sensors • Magnetometers • Time of Flight • 3D Camera (iToF)	High-accuracy IMU enabling positioning, stabilization, and shock detection Implement an altimeter through pressure sensors Time-of-Flight for 3D depth sensing solutions	IMU: • ISM6HG256X • ASM330LHHX/G1 • ASM330LHB/G1 Magnetometers: • IIS2MDC Pressure Sensors: • ILPS22QS • ILPS28QSW Time of Flight: • VD55H1 • VL53L9
GNSS Receiver	Teseo modules	Simultaneous multiconstellation and multiband GNSS (GPS/ Galileo/Glonass/BeiDou/QZSS)	• TESEO-LIV4F • TESEO-VIC6A
Secure Element	Secure MCU	Authentication Secure connection Trusted network access	• STSAFE-A Series • STSAFE-TPM
EEPROM	• M24 family	Designed for small & light modules where robustness is a key factor	M24 Series in DFN8 Packages
Protection	• ECMF04-4HSWM10 • EMIF06-HSD03F3	ECMF EMIF	• USB and HDMI port protection • SD-Card protection

Hardware Turnkey solutions

Part number	Description
STEVAL-FCU001V2	Flight controller unit for mini drones

Firmware basket

Part number	Description
STSW-FCU001	Reference design firmware for mini drones

Electronic speed controller

Up, up and away!

A propulsion system consists of propellers, motors, electronic speed controllers (ESCs), and an appropriate battery.

The ESC design depends on factors such as maximum motor voltage and current, the number of motor poles, and detailed motor specifications.

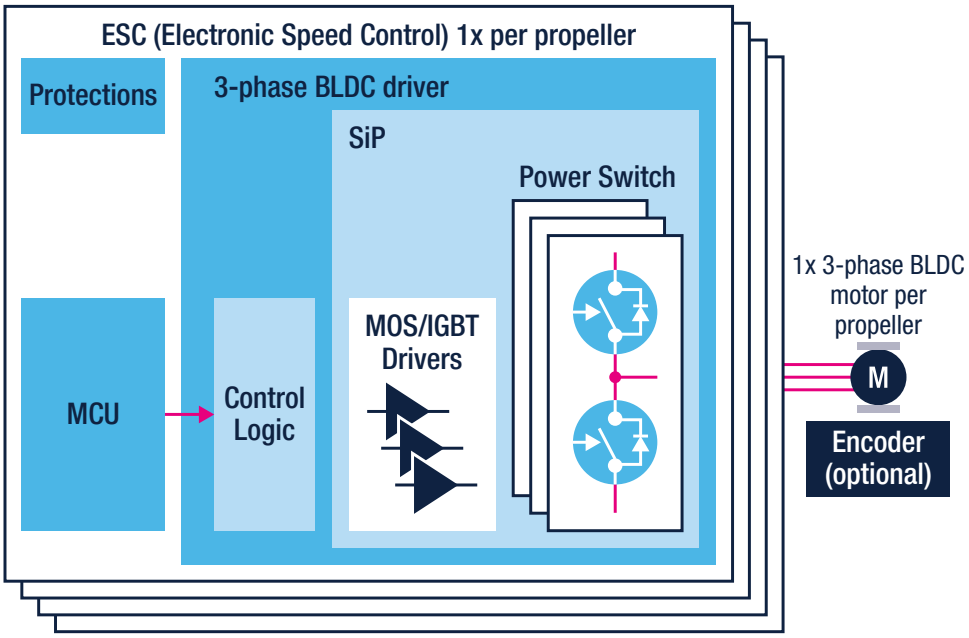
Equally important is the motor control algorithm. Modern approaches, such as field-oriented control (FOC), improve efficiency and extending battery life and increasing flight time.

The performance and efficiency of ESCs are critical to drone operation. STM32 microcontrollers deliver the high-performance processing required for precise motor control and maneuvering, while our GaN MOSFETs and gate drivers provide significant power savings, boosting drone autonomy.

To simplify firmware development, ST offers the X-CUBE-MCSDK software development kit, enabling easy implementation of advanced motor control algorithms on STM32 microcontrollers.

Finally, ST provides a range of reference designs to help accelerate drone development and get you started quickly.

Block diagram of an Electronic Speed Controller



ESC bill of materials

	Product family	Description with key features	Key products
MCU	• STM32G0 family • STM32G4 family	mixed-signal MCUs with DSP and FPU instructions	• STM32G031C8 • STM32G431KB • STM32G473CB
Gate driver	Multiple channel Gate drivers	Triple half-bridge with programmable currents	• STDRIVE102H • STDRIVE102BG
Integrated motor control	• STSPIN32G0 family • ST32SPING4 family	High performance 3-phase motor controller with embedded STM32Gx MCU	• STSPIN32G0B2 • STSPIN32G4
	• STSPIN9P1x family	Half-bridge motor driver	• STSPIN9P1x Series
Power switch	• STripFET F8 • PowerGaN	Low-voltage MOSFETs with optimized gate charge for High Commutation Speeds up to 600 kHz	STL1xx StripFET PowerFLAT serie • SGT3D5R10MEB • SGT1D5R10MEA
Protection	CAN line Protection BLDC Motor Control Protection	Protection of the integrated driver and controller	• ESDA6V1L • EMIF03-22k10M8Y

Hardware Turnkey solutions

Part number	Description
STEVAL-ESC001V1	Electronic speed controller reference design for drones
STEVAL-ESC002V1	Compact electronic speed Controller for 6-step 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

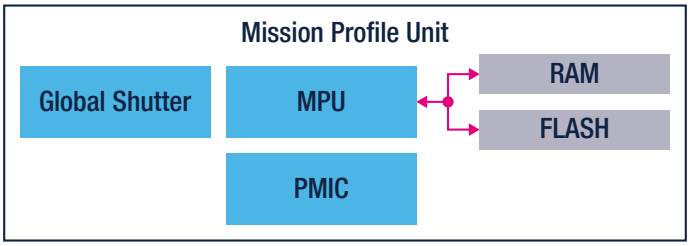
Part number	Description
STSW-ESC001V1	Sensorless FOC reference design firmware for STEVAL-ESC001V1
STSW-ESC002V1	6-step design firmware for STEVAL-ESC002V1
X-CUBE-MCSDK	STM32 FOC Software Development Kit (MCSDK)

Mission profile unit

The **mission profile unit** simplifies interaction between the drone and users while progressively increasing drone autonomy. It achieves this by embedding functionalities such as **automatic flight control, adaptive fault management, GNSS-assisted navigation, path planning and execution, dynamic mission planning, swarm group decision-making**, and ultimately enabling **fully autonomous drones**. Additionally, the unit incorporates **camera vision as an input block,** allowing the drone to form autonomous decisions based on multiple inputs, including visual data.

All these tasks must be executed in a **secure manner** to prevent external interferences.

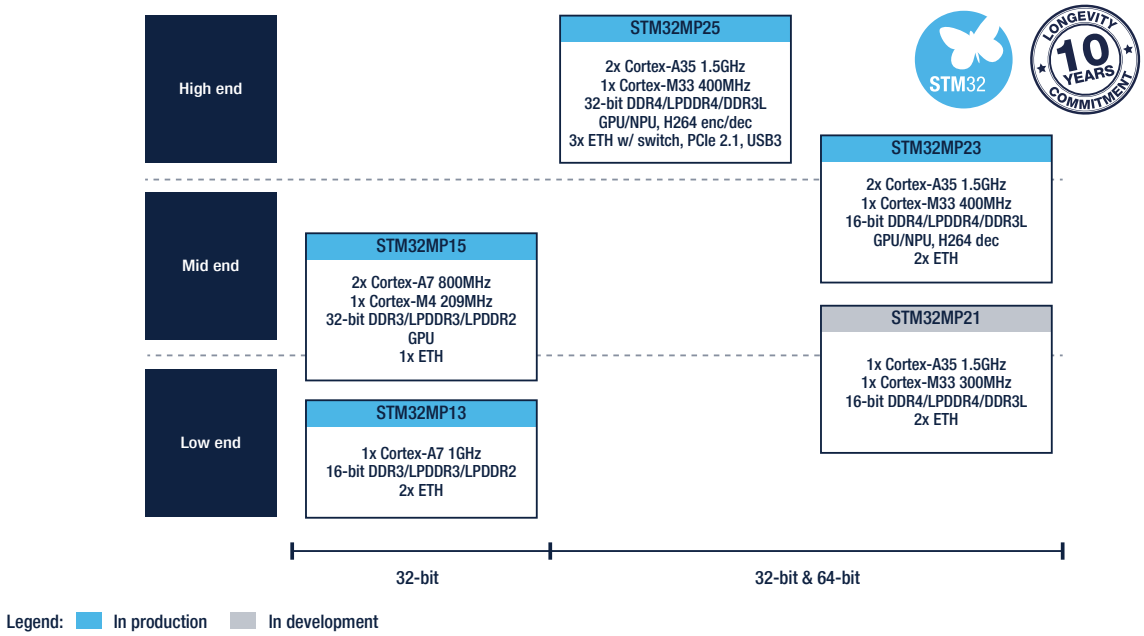
The primary processing tasks are performed by **microprocessor units (MPUs),** with **STM32MP1 and STM32MP2** product families fully able to support these advanced capabilities.



STM32 ARM CORTEX MPUs

The STM32 family of general-purpose 32-bit microprocessors (MPUs) provides developers with greater design flexibility and performance. STM32 application processors are based on single or dual Arm Cortex®-A cores, combined with a Cortex®-M core. From cost-effective, single-core MPUs to more advanced, multicore MPUs, ST offers a scalable approach to help developers find the right fit.

Discover our portolio:



STM32MP2 is a family of 64-bit microprocessors based on a dual ARM® Cortex®-A35 and a single Cortex®-M33 cores, several products embed a neural processing unit:

Product lines	Arm Cortex®-A35	Arm Cortex®-M33	AI NPU	FD-CAN	Ethernet ports
STM32MP257	2	1	*	3	3
STM32MP255	2	1	*	3	2
STM32MP253	2	1		3	2
STM32MP251	1	1			1
STM32MP235	2	1	*	2	2
STM32MP233	2	1		2	2
STM32MP231	1	1			1

STPMIC1

The chip is optimized as a companion PMIC for ST's STM32MP1. The STPMIC1 provides power-rail monitoring and protection, handles power-up/down sequencing, and meets the ST32MP1 accuracy and settling-time specifications. In addition to supplying power rails for the microprocessor unit (MPU) and external system components, the STPMIC1 also provides a DDR memory reference voltage, a 500 mA USB OTG power switch, and a general-purpose power switch. An I^2C interface and additional pins allow the MPU to manage the PMIC.

STPMIC25

The STPMIC25 is a fully integrated power management IC designed for the STM32MP2x MPU family applications requiring low power and high efficiency.

The device integrates advanced low power features controlled by a host processor via I^2C and IO interfaces.

The STPMIC25 regulators are designed to supply power to the application processor as well as to the external system peripherals such as: DDR, flash memories, and other system devices.

It contains seven Switched Mode Power Supply (SMPS) in buck configuration, which are optimized to provide an excellent transient response and output voltage precision for a wide range of operating conditions. Very high efficiency in the full output load range is achieved due to low power mode (LPM) and high power mode (HPM) selection. All the buck converters are capable of a smooth transition from LPM to HPM. The converters use an advanced PWM phase shift synchronization technique with integrated PLL and a programmable spread spectrum frequency modulation to reduce EMI.

Gimbal controller unit and camera unit

Admire the world from above

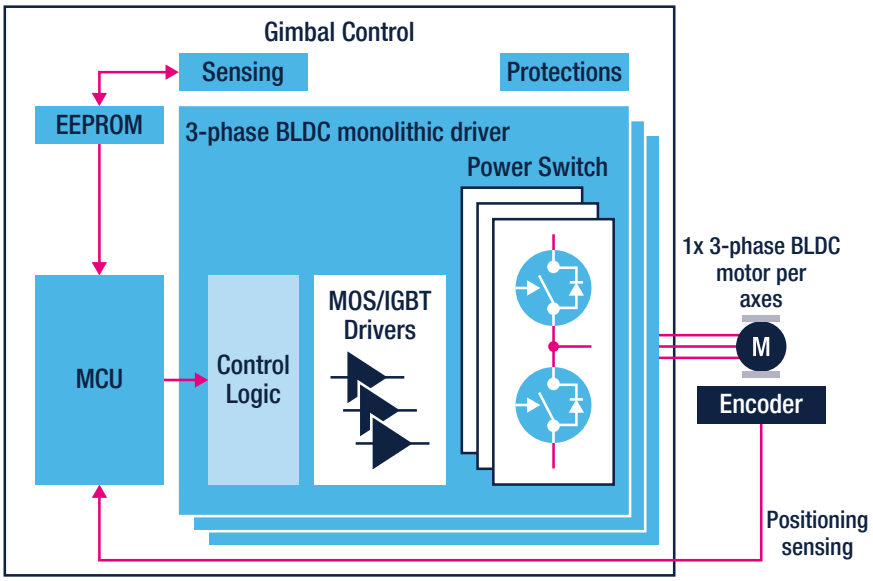
While the FCU stabilizes the drone frame, the gimbal ensures camera stability.

Both systems rely on a high-performance MCU, typically from the STM32 family, processing data from an inertial measurement unit and adjusting the gimbal frame orientation through independent control of 2- or 4-axis motors.

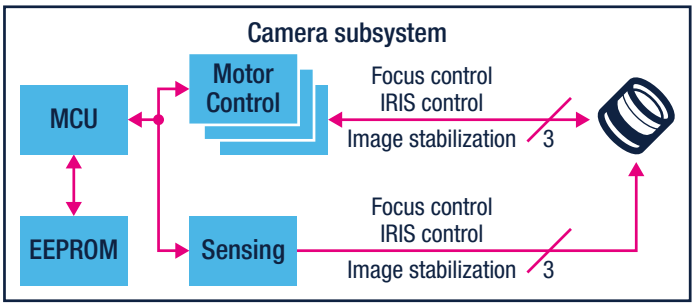
Our ST60 family introduces contactless connectivity, eliminating traditional wiring and connectors for improved precision, robustness, and design flexibility.

Global shutter cameras deliver accurate vision with low noise and high dynamic performance in both daylight and infrared conditions, making them ideal for capturing sharp, detailed images during movement.

Block diagram of a Gimbal Controller Unit



Block diagram of a camera subsystem



Gimbal and camera subsystem bill of materials

	Product family	Description with key features	Key products
MCU	• STM32G4 family	Mixed-signal MCUs with DSP and FPU instructions	• STM32G431KB • STM32G473CB
Gate driver	Multiple channel gate drivers	Triple half-bridge with programmable currents	• STDRIVE102H • STDRIVE102BG
Integrated motor control	• ST32SPING4 family • Compact sense and sensorless motor drivers	High-performance 3-phase motor controller with embedded STM32Gx MCU	• STSPIN32G4 • STSPIN830 • STSPIN233
Power switch	• STripFET F8 • PowerGaN	Low-voltage MOSFETs with optimized gate charge for high commutation speeds up to 600 kHz	STL1xxN4 StripFET F8 PowerFLAT series SGT3D5R10MEB SGT1D5R10MEA
Sensing	Inclinometer Vibration Sensor	High accuracy and ultrawide bandwidth	IIS2ICLX IIS3DWB
Imaging sensor	Global Shutter Sensor	High dynamic human vision	VD1943 VD5943
Internal connection	Contactless Connectivity	High-speed, low power, short range	ST60 series
EEPROM	M24 family	M24 family designed for small & light modules where robustness is a key factor	M24 Series in DFN8 packages
Protection	CAN line Protection BLDC Motor Control Protection	Protection of the integrated driver and controller	ESDA6V1L EMIF03-22k10M8Y

Hardware Turnkey solutions

Part number	Description
STEVAL-GMBL02V1	Drone gimbal reference design for triple servo motor control

Firmware basket

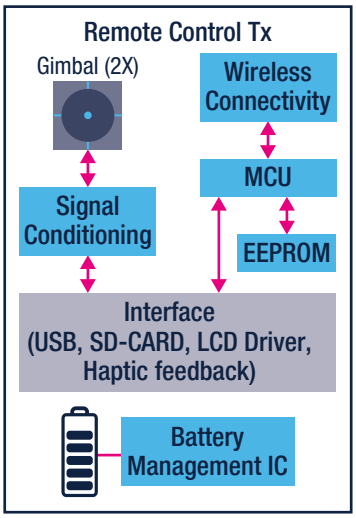
Part number	Description
STSW-GMBL02V1	Gimbal controller firmware binary and GUI for drones (*)

Note: (*) Contact ST to have access to source code

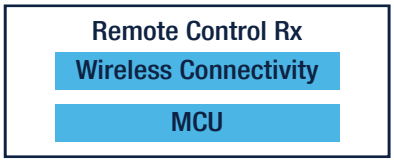
Remote control

Wireless connectivity is the primary element of a remote controller. It should ensure robust performance by supporting both high-bandwidth communication and seamless short- and long-range connections. Additionally, the remote controller functions as an access point for configuring flight parameters via NFC connection, enabling efficient and user-friendly interaction with the drone.

Block diagram of a drone remote control tx



Block diagram of a drone remote control rx



Remote control Tx and Rx bill of materials

	Product family	Description with key features	Key products
MCU	• STM32WB modules • STM32WL family • STM32WL5M module	Easy to integrate – smooth certification process Certified for LoRaWAN® and Sigfox protocols	• STM32WB5MMG • STM32WL3x series • STM32WL55/E5 • STM32WL5M
Wireless connectivity	• ST4SIM family • NFC family	Secure cellular connectivity Near field communication to manage ID Card and flight parameter setting	ST4SIM-300 ST25R300 ST25TV512C/02KC ST25DV04KC/16KC/64KC
Protection	• ECMF04-4HSWM10 • EMIF06-HSD03F3 • TCPP01-M12 • TCPP02-M18 • TCPP03-M20	ECMF EMIF USB-C	• USB and HDMI port protection • SD-CARD protection • USB-C protection, Sink, Source, DRP

Backbone components

The importance of power and communication

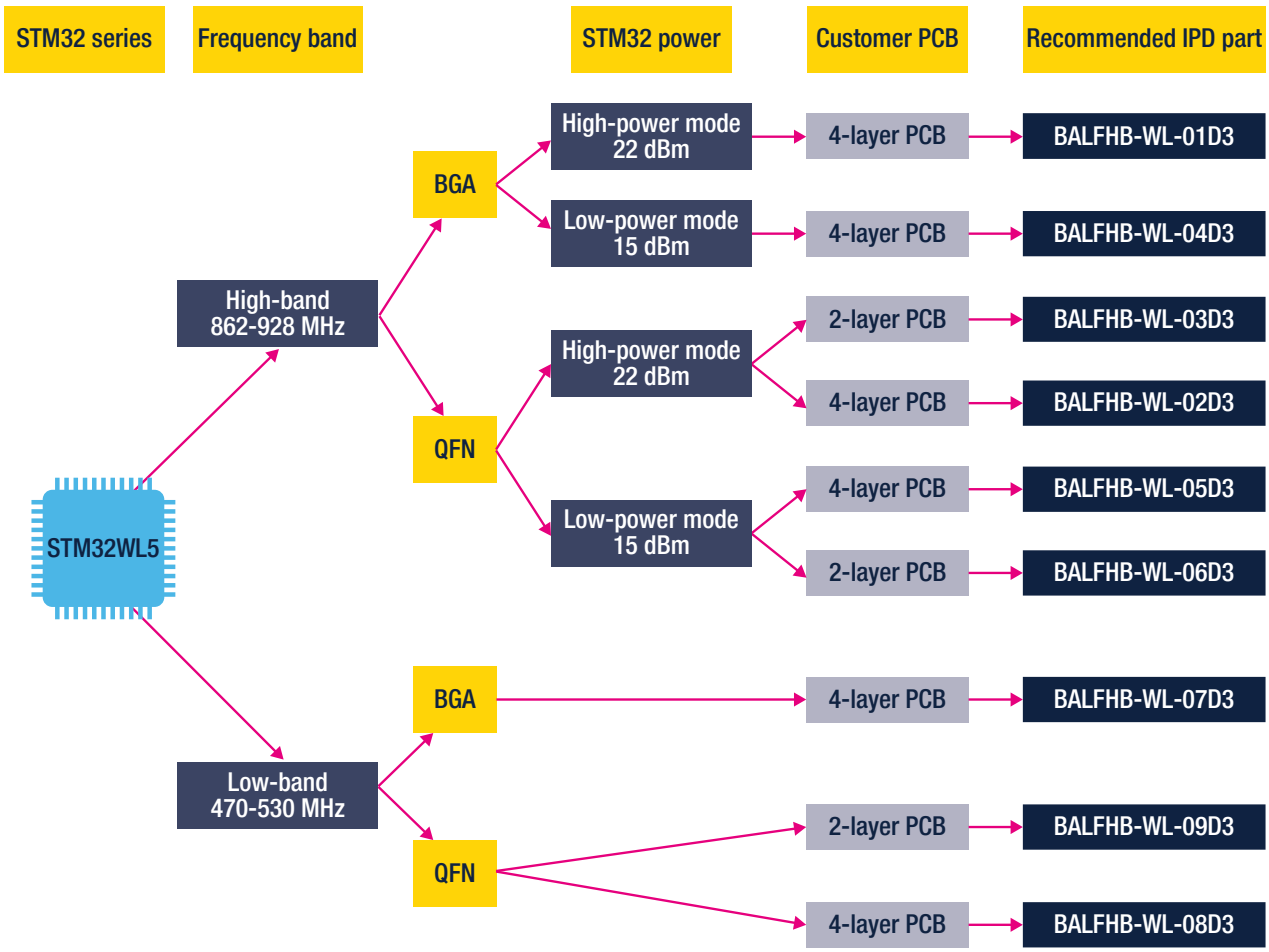
The communication bus and power management logic form the backbone of your drone and prevent fly-away and fail conditions.

Connectivity

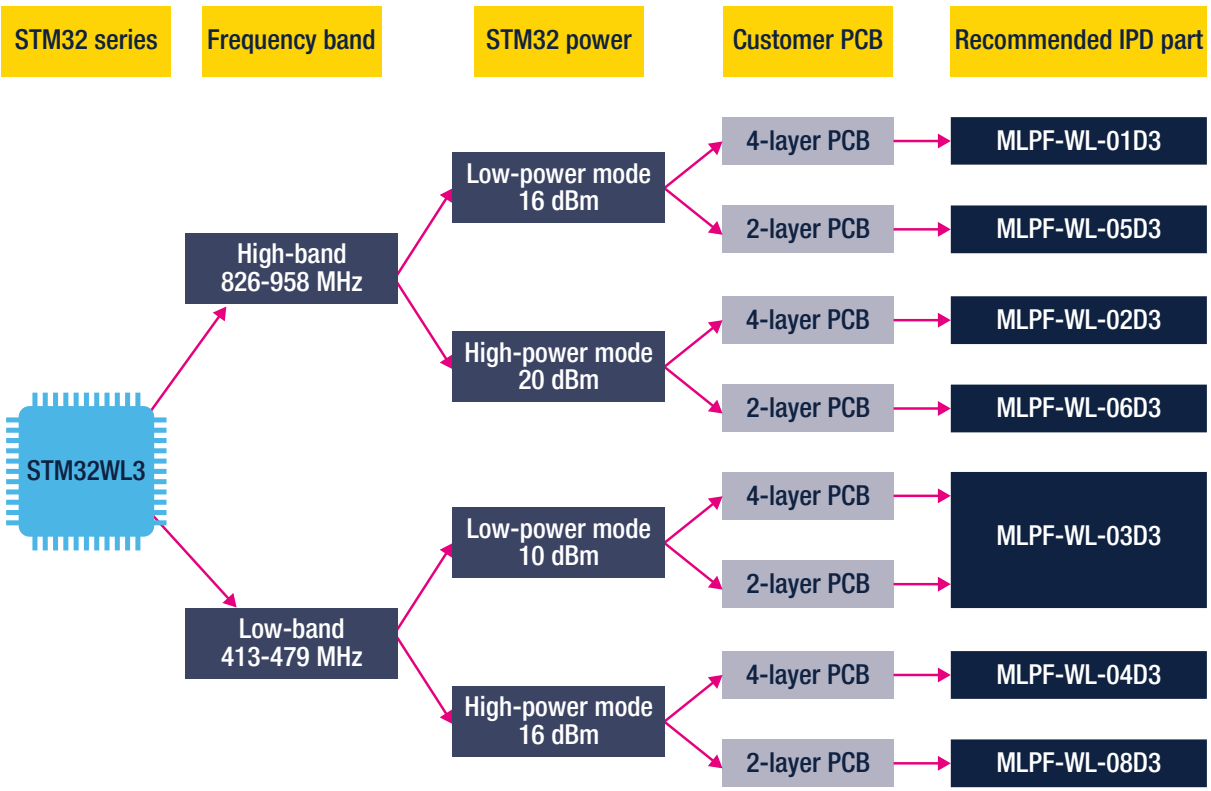
The RF integrated passive device (RF IPD) uses a glass wafer substrate to integrate high-quality factor components such as capacitors and indictors. Many functions like impedance matching networks, harmonic filters, couplers, baluns, and power combiners/splitters can be designed using IPD technology. ST IPDs are manufactured using thick-film and glass wafer manufacturing technology and photolithography processing.

The selection of the right RF IPD companion chip depends on the RF application and the number of PCB layers.

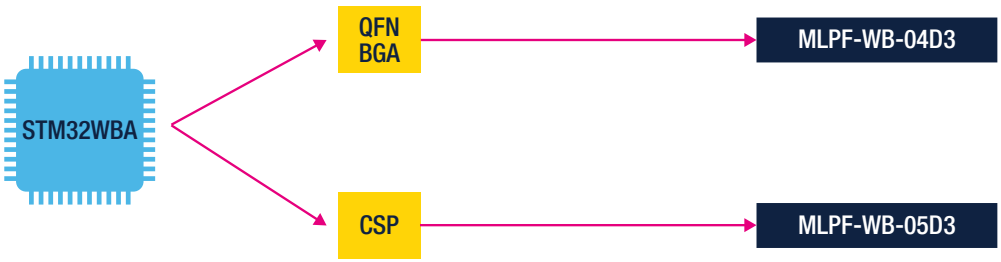
RF IPD companion chips for STM32WL



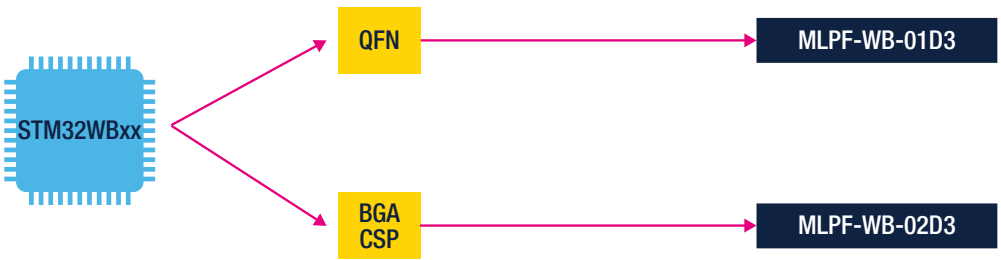
RF IPD companion chips for STM32WL3



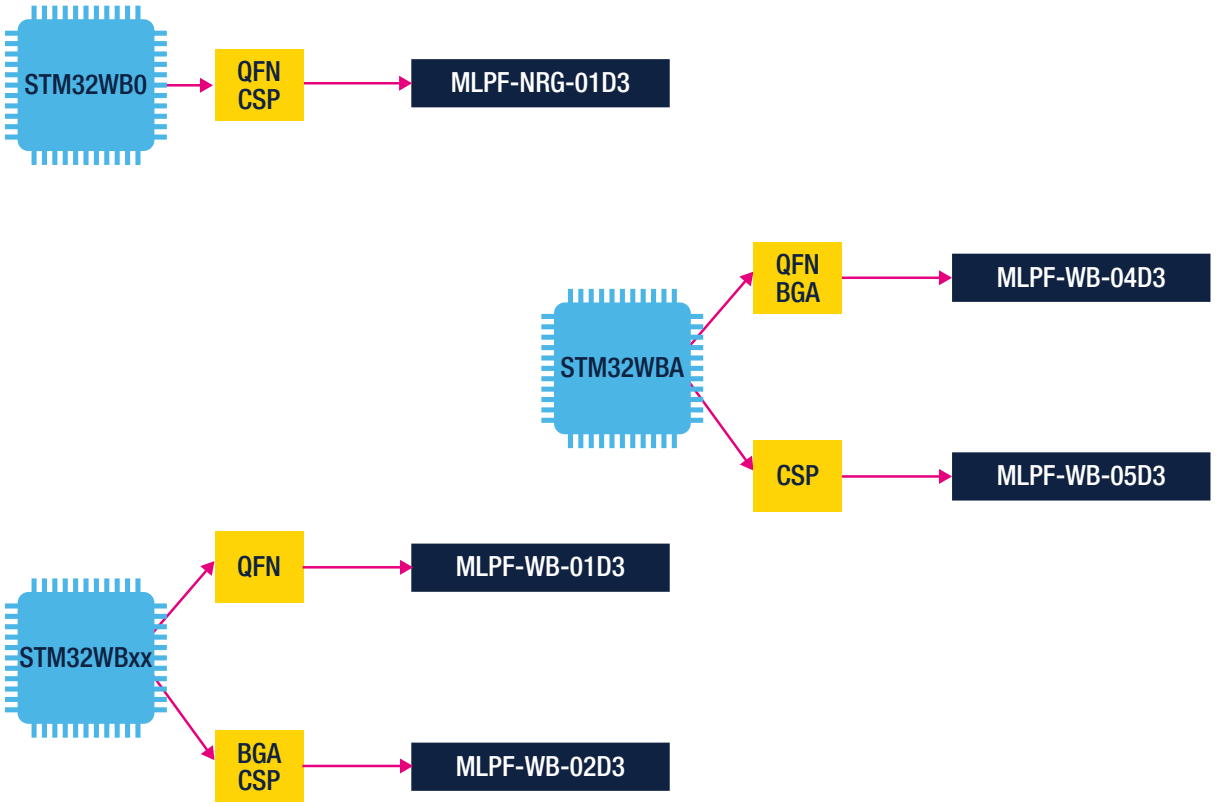
RF IPD companion chips for STM32WBA



RF IPD companion chips for STM32WB



RF IPD portfolio: BLE applications



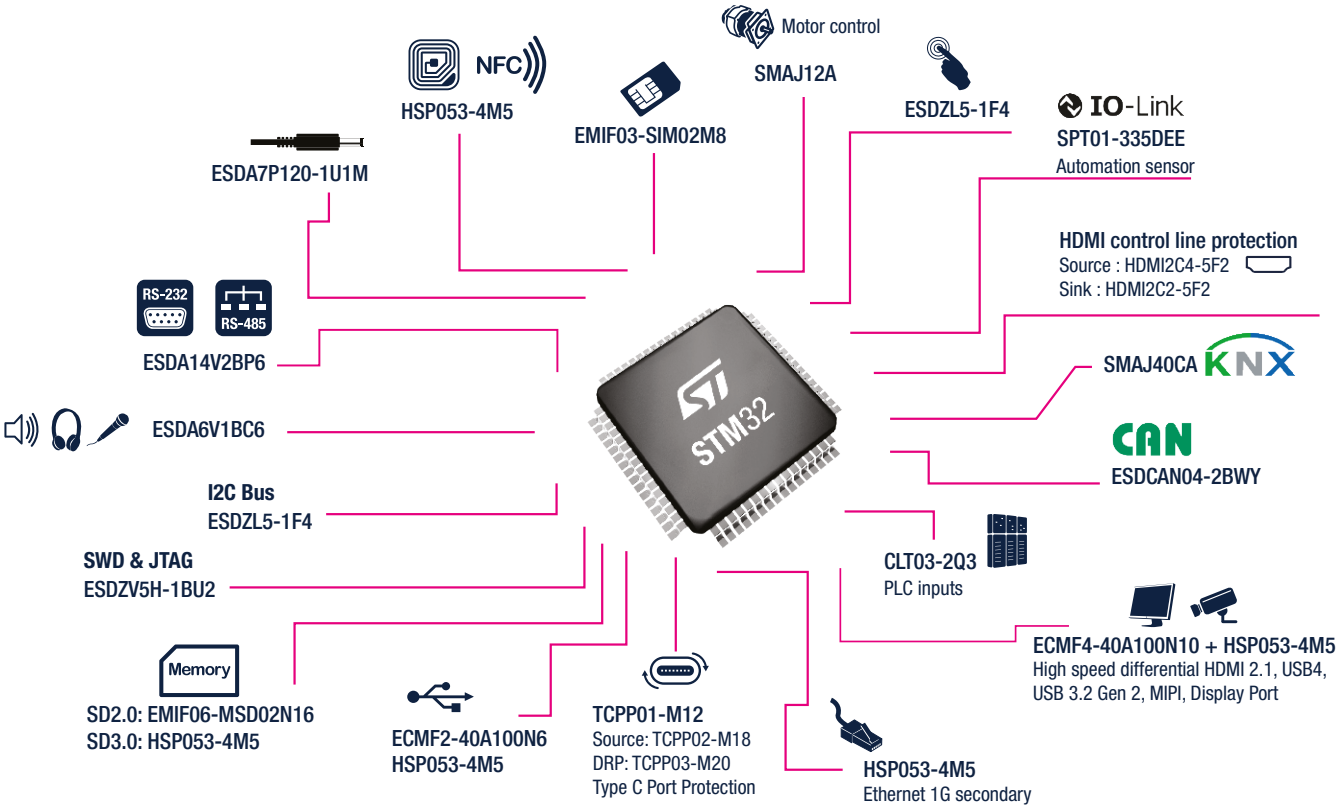
Power management

Part number	Description
L6986	38 V 2 A synchronous step-down switching regulator with 30 µA quiescent current
LD39020	200 mA very low quiescent current Linear regulator IC
STUSB4500L	Standalone USB Type-C port controller for power sinking devices
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

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

	Medium power capability	High power capability
15 V - 20 V		ESDA25P35-1U1M
9 V		ESDA13P70-1U1M
5 V	ESDA8P30-1T2	ESDA7P120-1U1M

Recommended ESD IC protection for MCU interfaces



Mini Drone Kit & ST BLE Drone App

The first ST Drone Kit to help you learn about drones

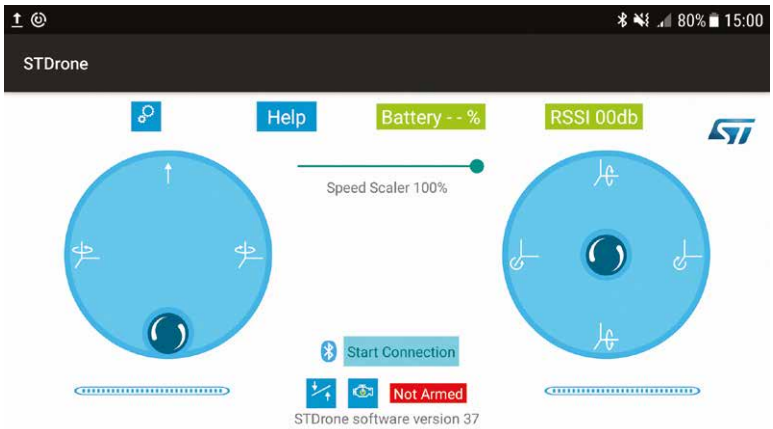
We have created a mini drone companion kit for the high-performance STEVAL-FCU001V2 flight controller unit, along with four motors and propellers, a frame and a battery: everything you need in a single box to build your own mini drone.

All the necessary information is available at: 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-DRONE02	Mini drone companion for STEVAL-FCU001V2 flight controller unit

ST BLE DRONE APP

ST has developed a Smartphone App able to connect and control the ST Flight Controller Unit STEVAL-FCU001V2 and the Mini Drone Kit STEVAL-DRONE02. You can use it as a low-cost remote control unit for the Drone Kit with your phone. It's available on Google Play and on Apple Store.



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