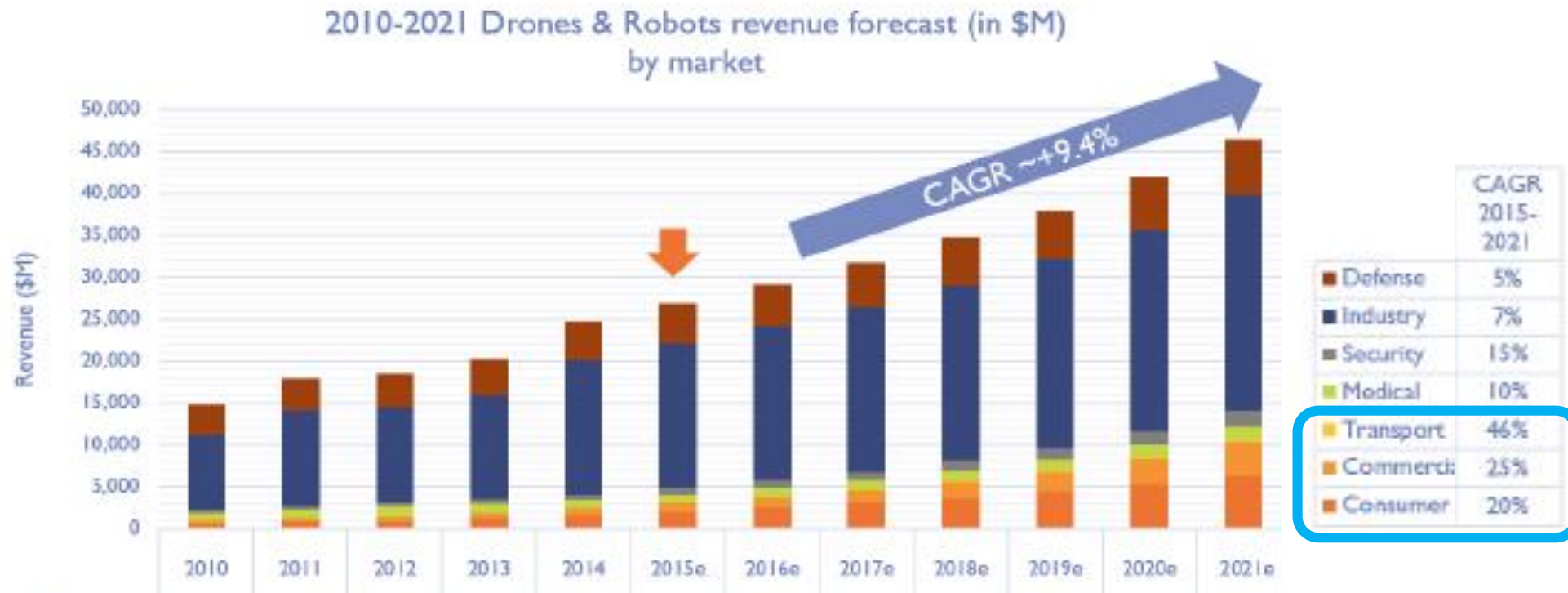


Speeding Up Revolution of Drones



Drones

...with high growth in consumer



Main Growth Rate

Drones - Segmentation

Definition of Drone Segments: By ASP, Functions and Dimensions

Toy/Mini Drones

- **Not Restricted by the Regulation**
- **ASP:** [0 .. \$300]
- **Weight:** ~< 500g
- **Motors:**
 - DC Brushed Motors(Main Stream)
 - BLDC
- **HW Requirements:**
 - ESC, Flight Control
- **Main Functions:**
 - Camera (optional)
 - GPS (optional)



Consumer/Commercial Drones

- **Not Restricted by the Regulation**
- **ASP:** < [\$300 .. \$3000]
- **Weight:** ~<7-10 Kg
- **Motors:**
 - BLDC Motors (≥ 4)
- **HW Requirements:**
 - ESC, Flight control,
 - Gimbal board, GPS
- **Main Functions:**
 - Camera
 - Gimbal (optional)
 - Vision (optional)

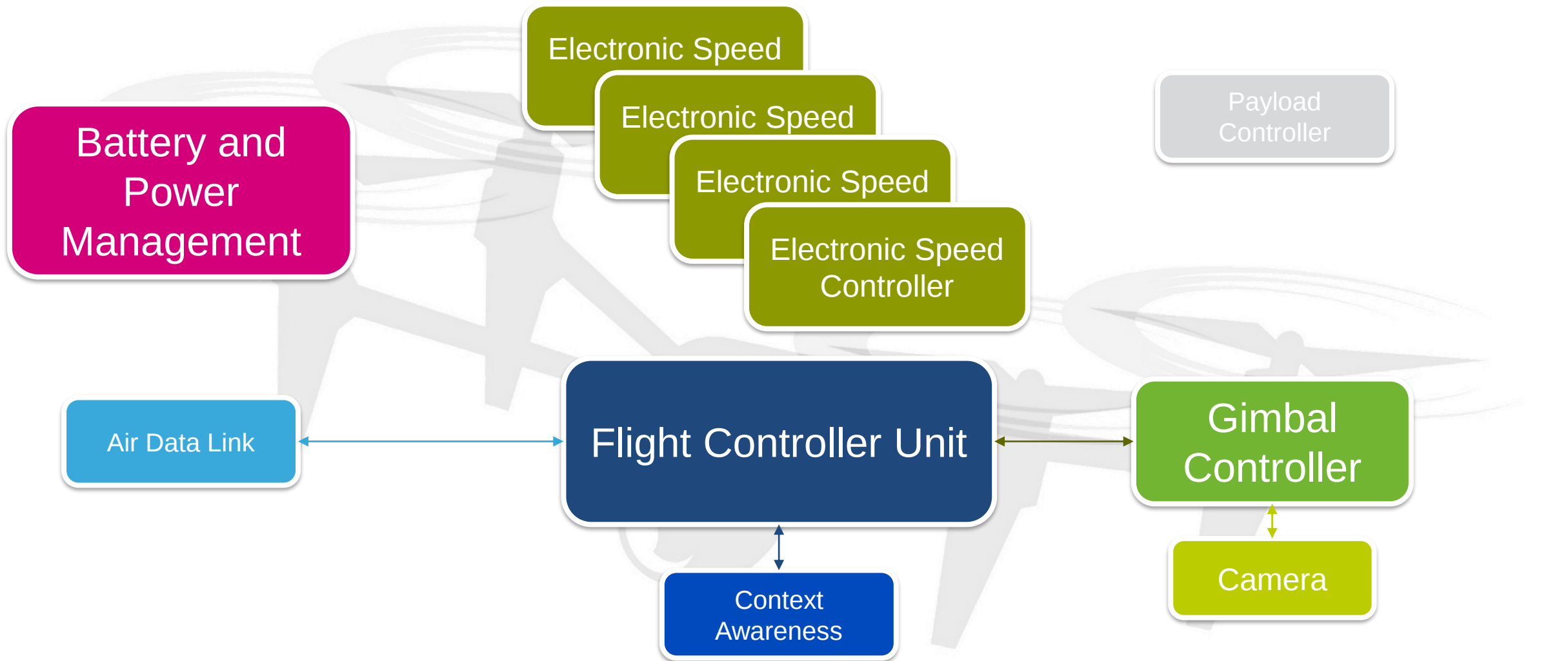


Prosumer/Industrial Drones

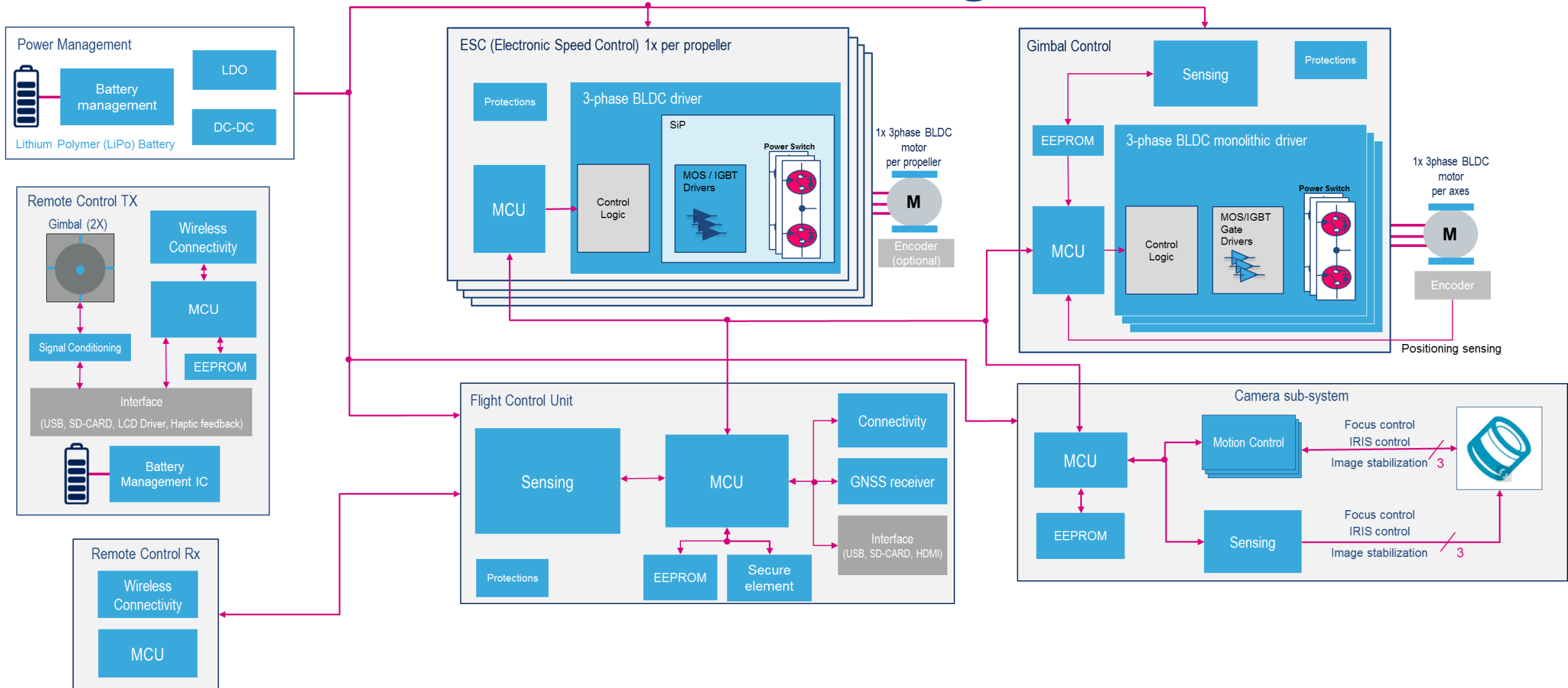
- **Restricted by the Regulation**
- **ASP:** > \$3000
- **Weight:** >10Kg
- **Motors:**
 - BLDC Motors (≥ 4)
- **HW Requirements:**
 - ESC, Flight control, Gimbal board, GPS
- **Main Functions:**
 - Carry on packages
 - Gimbal
 - Camera
 - Collision avoidance
 - Long distance



Drone - Synopsis



Drone Block Diagram



ST devices success stories in Drone

Electronic Speed Controller

32-bit Cortex-M0 **STM32F0 – STM32F3** used in major Chinese Drone Makers

3-ph Gate driver 32-bit Cortex-M0 **STSPIN32F0/A** in major Chinese & USA Drone Makers

Flight Controller Unit

32-bit Cortex-M4 **STM32F1-F3-F4** used in many Drone makers WW

6-axis IMU A+G **LSM6DSx** used in Chinese drone makers

3-axis Magnetometer **LIS3MDL** used in Chinese drone makers

Pressure sensor **LPS22HD** used in EU Drone maker

Power Management

Protection **ESDA13P70-1U1M** in Mass Production at Chinese drone maker

Gimbal camera Controller

32-bit Cortex-M4/M7 **STM32F0-F1-F3** used in many Gimbal makers WW

3-ph Motor driver **STSPIN™ & L6230** in main Gimbal makers WW

6-axis IMU A+G **LSM6DSx** used in Chinese drone makers

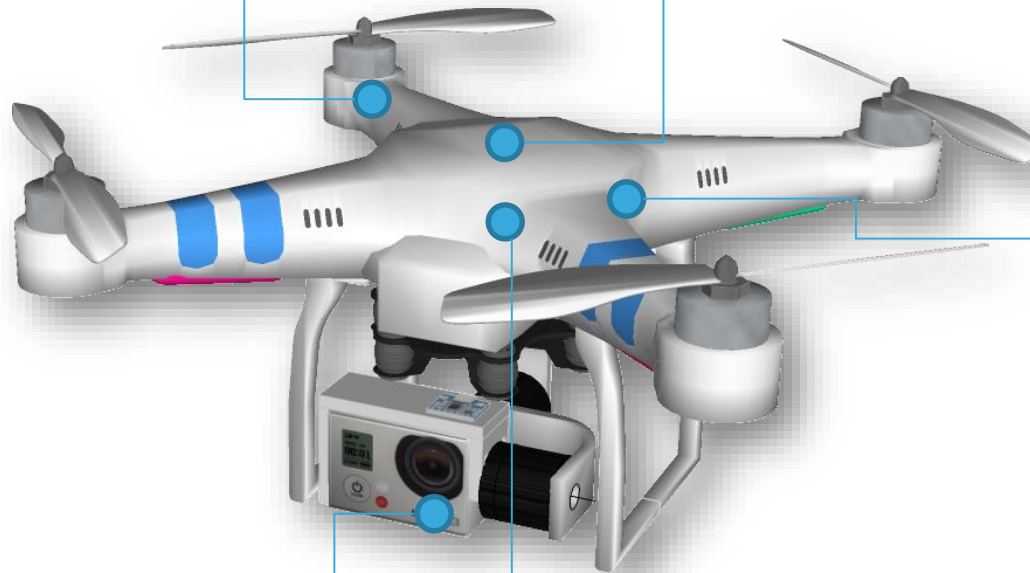
STSPIN233 in DWIN in EU Drone Maker

Mission Profiler

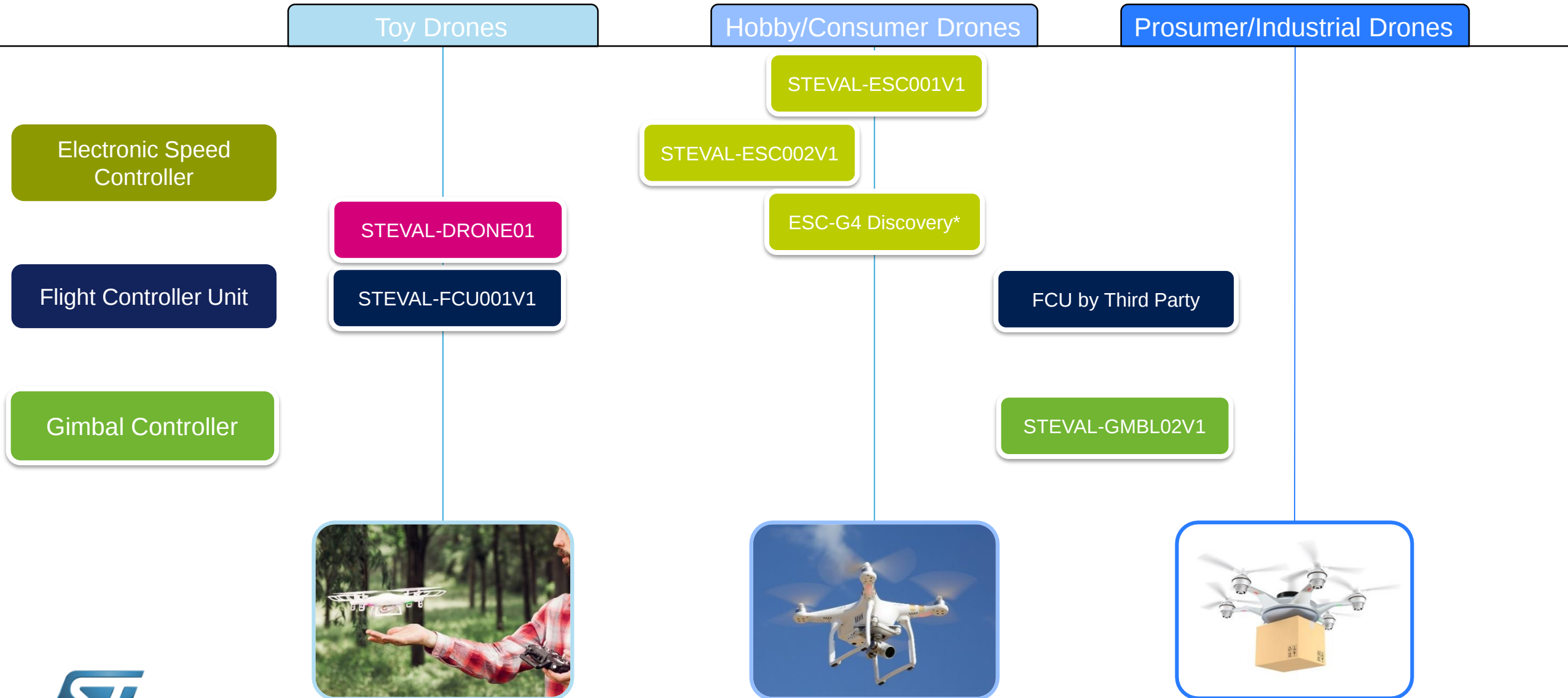
32-bit Cortex-M7 **STM32F7** used in one of main Autopilot Open Platform

GNSS **Teseo III** design win in USA avionics and drone market (including ADS-B)

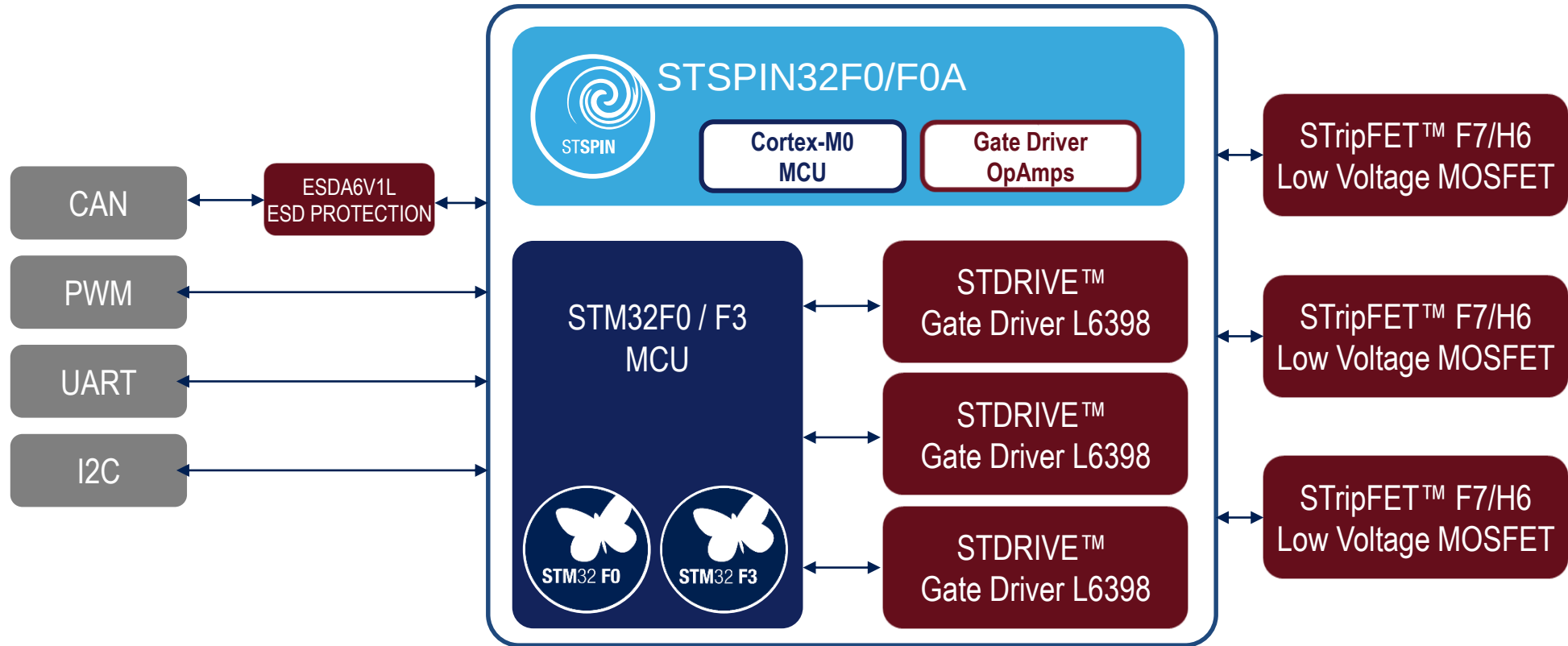
SD-Card interface protection **EMIF06-HSD03F3** in mass production in big Chinese drone maker



ST Solution for Drones



Electronic Speed Controller



Efficiency and high performance self commissioning features
6-Step & FOC motion control algorithms with dedicated libraries and ecosystem

STM32 Microcontrollers



STM32F0 Series

ARM Cortex®-M0



Entry level

- 48MHz - 38 DMIPS
- 1.8 – 3.6V
- 16 to 256 KB Flash
- Motor Control PWM timer
- 12-bit ADC 1Msps
- Multiple serial communication
- Clock free USB FS, CAN 2.0B

STM32F3 Series

ARM Cortex®-M4

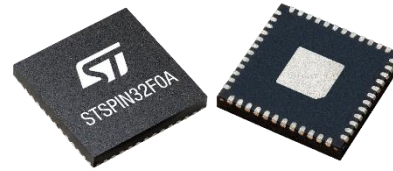


High End Control Loop

- 72MHz - 90 DMIPS - FPU
- 0 wait state Routine booster
- 1.8 – 3.6V
- 16 to 512 KB Flash
- 144Mhz Motor Control PWM timer
- 12-bit ADC 5Msps
- Fast Comparators, Op. Amp., DAC
- Multiple serial communication
- USB FS, CAN 2.0B

STSPIN32F0/A

Advanced BLDC controller with embedded STM32



STSPIN32F0/A System-in-Package: STM32F0 + Advanced 3-phase driver

STM32F031 MCU

- 32-bit ARM M0 Core, 48 MHz
- 32 KB Flash + 4KB SRAM
- 12-bit ADC (9 channels)
- I2C, USART & SPI Interfaces

3-phase gate drivers

- 6.7 V * – 45 V supply, 600 mA capability
- 12 V LDO & 3.3 V DC-DC regulators
- Up to 4 Op Amps * & 1 Comparator
- UVLO, & OTP protections
- Programmable OCP
- Firmware boot loader *

* STSPIN32F0A supporting down to 2LiPo cells, 3x OpAmp and FW boot loader

Drivers and MOSFETs

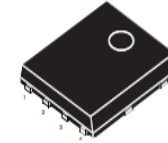


Half bridge gate drivers

L639x

Very compact and Robust

- High reliability
- Integrated bootstrap diode
- Cross-conduction prevention
- UVLO protection



Low voltage MOSFETs

STripFET F7 series

Industry's lower RDS(on)

- F7 device for professional drones with battery voltage > 20V
- Among lowest $R_{DS(on)}$ in the market
- Minimal $R_{DS(on)} \times Q_g$ for increased system efficiency and more compact designs

ESC Reference Design Board

The professional UAV ESC with CAN Interface

- Implementing a sensorless FOC algorithm
- Designed for 6S pack of LiPo batteries
- Ready for communication with any standard FCU: PWM or CAN
- Temperature overheating protection
- BEC 5V / 0.5A for external receiver or FCU
- Complete pre-configured firmware package available (STSW-ESC001V1)
- Maximum Rate 30V, 20A

STL160N4F7

Low Voltage
STripFET F7 series

28 mm

STM32F303

ARM Cortex™-M4

62 mm

L6398

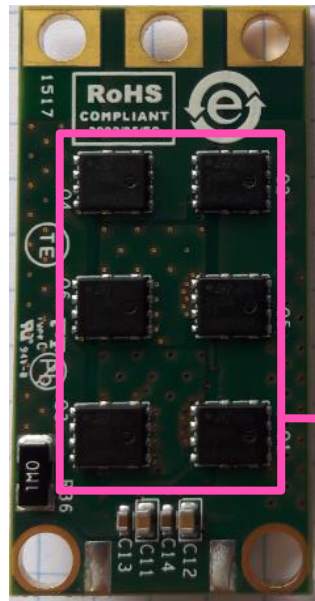
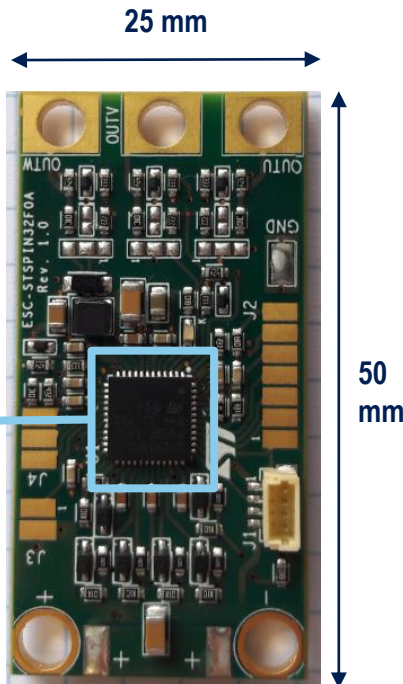
High Voltage Gate Drivers

ESC Compact Reference Design

Super compact turn-key solution for Racing Drones with full support of BLHeli_32 FW



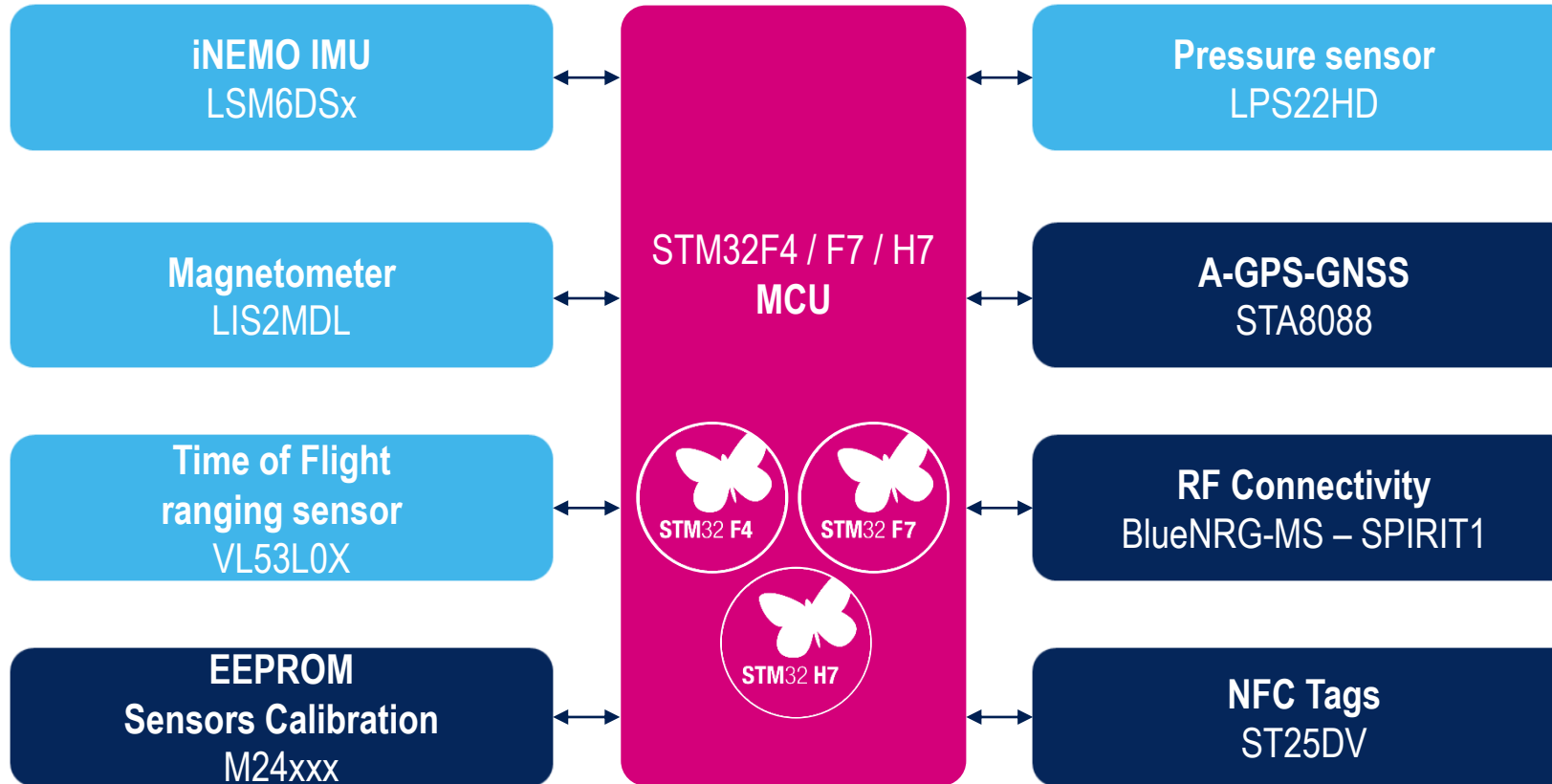
STSPIN32F0A
ARM Cortex™-M0



STL140N6F7
Low Voltage
STripFET F7 series

- Implementing a 6-step voltage mode algorithm
- Designed for 2S-6S pack of LiPo batteries
- Maximum Rate 30V, 20A
- Support of BLHeli_32 FW adapted to STSPIN32F0A (STSW-ESC002V1)
- Complete pre-configured firmware package available (STSW-ESC002V1)

Flight Controller Unit



High resolution and low power consumption
Optimized architecture for GNSS - Sensor fusion algorithm for AHRS
Ground distance measurement for landing assist and hovering
Ceiling and obstacle detection

STM32 Microcontrollers



STM32F4 Series

ARM Cortex®-M4

High performance

- 180MHz - 225 DMIPS – FPU
- Execution ART Accelerator
- Graphic accelerator
- From 64 KB to 2 MB Flash, up to 384 KB RAM
- CAN, Ethernet, Camera
- Dual quad SPI
- From Access lines to Advanced Lines



STM32F7 Series

ARM Cortex®-M7

Very high performance

- 216 MHz – 462 DMIPS - FPU
- Execution ART Accelerator
- Graphic accelerator
- From 512 KB to 1 MB Flash, 320 KB RAM
- CAN, Ethernet, Camera
- Dual quad SPI
- Very High performance from Flash and external mem.

STM32 Microcontrollers

STM32H7 Series

ARM Cortex®-M7

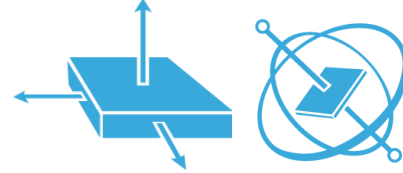
Ultimate performance

- 400 MHz – 856 DMIPS - FPU
- Execution ART Accelerator
- Graphic accelerator
- Up to 2 MB Flash (ECC), 1 MB RAM
- 14 bit ADC 2Msps
- CAN, Ethernet, Camera
- Dual quad SPI
- Very High performance from Flash and external mem.



- 2010 EEMBC® CoreMark®
- 400 MHz
- a new generation of peripherals

Motion Sensors



6-axis Inertial Measurement Unit

LSM6DSR

Designed for UAV

- Sensitivity 1%: narrow sensitivity trimming for flip-over automatic functions
- Advanced features (activity recognition) and accuracy

Coming Soon

6-axis Inertial Measurement Unit

LSM6DSM

OIS features for on-board camera

- Two-channel gyroscope for flight control and EIS/OIS camera stabilization
- No interference between the two channels → no flight miscontrol during movie or photo capture
- Image stabilization: both EIS and OIS

Motion Sensors



e-Compass

LSM303AGR

Superior sensing precision
and low power consumption

- Ultra low magnetic offset and offset stability over temperature
- Easy to compensate despite motor magnetic noise
- Integrated accelerometer for compass tilting compensation

Magnetometer

LIS2MDL

Ultra low-power high performance

- Ultra low magnetic offset and offset stability over temperature
- Easy to compensate despite motor magnetic noise
- Pin-2-pin and SW compatibility with LSM303AGR for easy system upgrade

Ranging Sensors

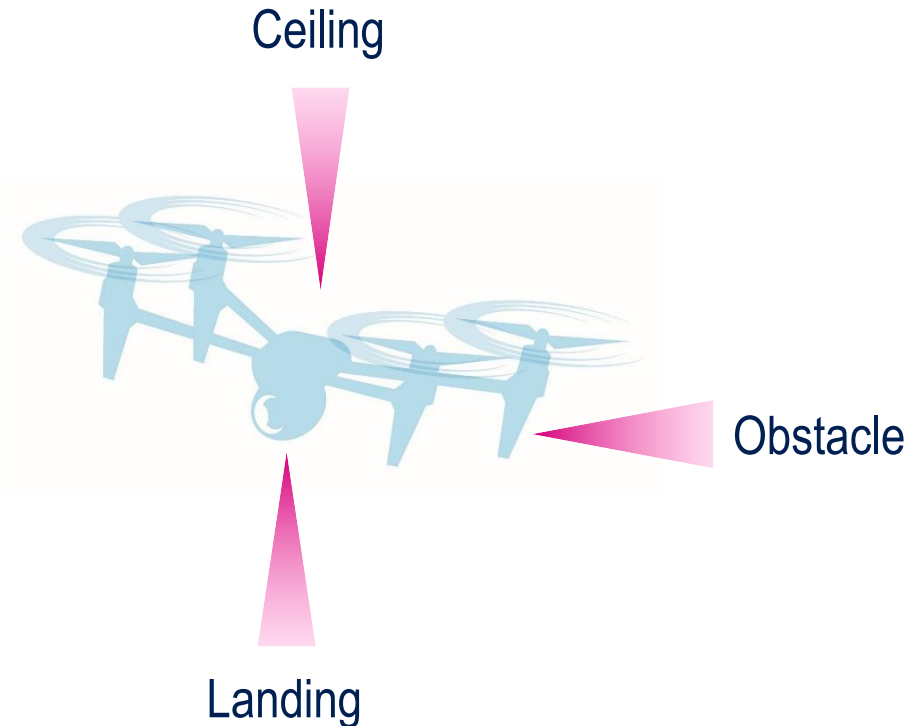


Time-of-Flight ranging sensor

VL53L1

Accurate range measurement
up to 4 meters

- Very fast (up to 50Hz)
- Small form factor, easy integration
- Low Power
- Independent of target reflectance
- Module including Laser class1 IR emitter



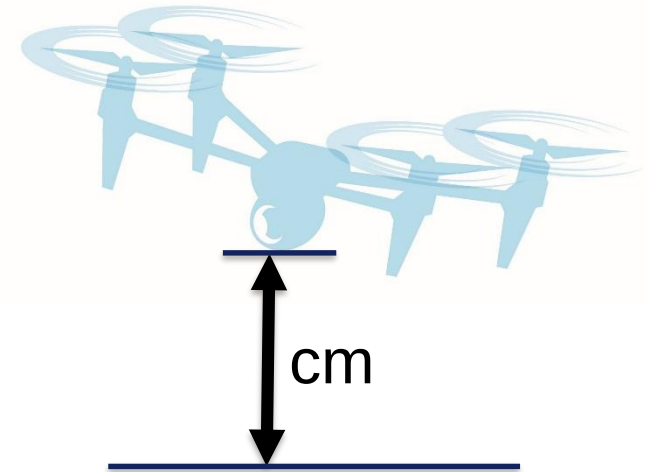
Pressure Sensors

Pressure Sensor

LPS22HD

Designed for UAV

- 8 cm vertical resolution: superior absolute height estimation
- Unprecedented ascent and descent speed estimation: 200Hz equivalent data rate



ST EEPROM

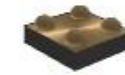
M24xxx-F

I2C series

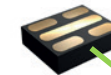
Light and small storage
for module parameters

- Easy data update
 - 1MHz I2C interface
 - 4ms write access time
 - Byte write capability
- Optimized pin counts
 - Available in 4, 5 or 8 pins
- Endurance
 - 4 millions Erase/Write cycles
 - up to 200 years data retention
- Low energy:
 - 150 μ A typ Icc Read @1MHz/1.8V
 - 1.6V min supply voltage
- Lockable page*
 - M24xxx-DF

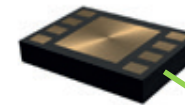
*starting 256 Kbits



WLSCP 4-balls
0.85 mm x 0.85 mm
0.4 mg



DFN5
1.4 mm x 1.7 mm
7 mg



DFN8
2 mm x 3 mm
16 mg

GNSS Positioning

Multi-constellation positioning ICs

Teseo III

- Accurate positioning
- GNSS location HUB
- High Dynamics (5 to 10Hz)
- Access to Carrier Phase Measurements for advanced station hold and precision operations
- Sensor Interfaces (SPI, I2C, ADC)
- Logging/Map SD-Card Storage
- Software SDK for Autopilot and INS code integration



GNSS Positioning Module

Teseo-LIV3F

- GNSS:
 - Teseo III IC based
 - Accurate positioning
 - Multi-constellation
 - Differential GNSS
 - High Dynamics (5 to 10Hz)
- Interfaces:
 - UART
 - I2C
- Assisted-GNSS
 - Autonomous
 - Predictive
 - RealTime
- DataLogging
- Geofencing
- Odometer



Multi-constellation

LLC18 18-pins

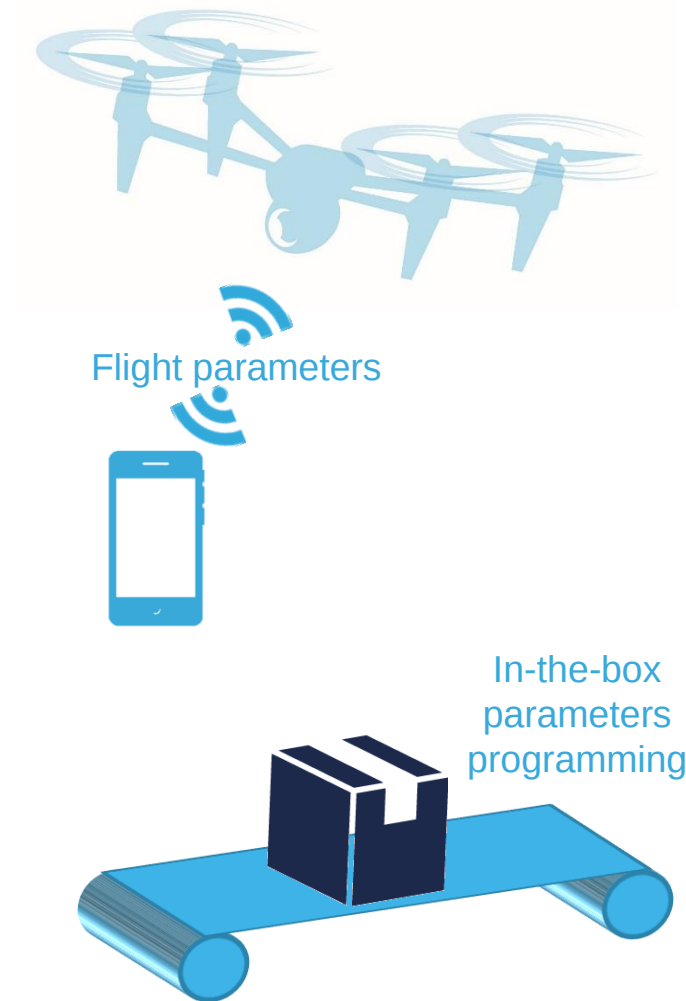
9.7 mm x 10.1 mm
VCC/VCC_IO @ 3.3v

Dynamic NFC Tags & Readers

ST25DV

Usage in UAV

- Program drone parameters in production wirelessly with RFID reader
- Set flight parameters with NFC phone
- Use dynamic NFC tag as drone's wireless black box



Bluetooth® Low Energy



Bluetooth® Low Energy Network Processor



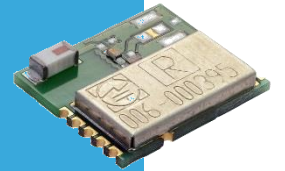
BLUENRG-MS

- Qualified Master and Slave stack
- Supports Bluetooth Smart 4.1
- Superior Battery Life
 - RX 7.3mA
 - TX 8.2mA @0dBm
 - Sleep 1.7µA
 - Shut Down 5nA
- Integrated DCDC converter enables ultra low power operation
- RF certified (ETSI,FCC,IC)

Bluetooth® Low Energy Module

SPBTLE-RF

- Based on BlueNRG-MS
- Tx power: + 4 dBm
- Rx sensitivity: - 88 dBm
- Host IFs: SPI, IRQ, and RESET
- RF certified (ETSI,FCC,IC)
- BQE End Product qualified



BALUN

BALF-NRG-02D3

- 50 Ω nominal input / conjugate match to BlueNRG device
- Low insertion loss
- Low amplitude imbalance
- Low phase imbalance

Sub-GHz Modules



Sub-GHz Module with STM32

SP1ML

- Based on SPIRIT1 transceiver, STM32L1 MCU and BALF-SPI
- 868MHz and 915MHz Frequency
- Embedded antenna on module
- Output power up to +11.6dBm
- Air data rate up to 500kbps
- CE compliant and FCC certified
- 6LoWPAN Contiki and WMBUS

Sub-GHz Module

SPSGRF

- Based on SPIRIT1 transceiver and BALF-SPI-01D3 balun/filter
- Embedded antenna or UFL connector
- Output power up to +11.6 dBm
- RX: 9mA, Tx: 21mA @ +11dBm, Shut Down: 2.5nA
- Air data rate up to 500kbps
- CE compliant and FCC certified
- 6LoWPAN Contiki and WMBUS stack

BALF-SPI-01D3 for SPIRIT1 @ 868-915MHz
BALF-SPI-02D3 for SPIRIT1 @ 433MHz

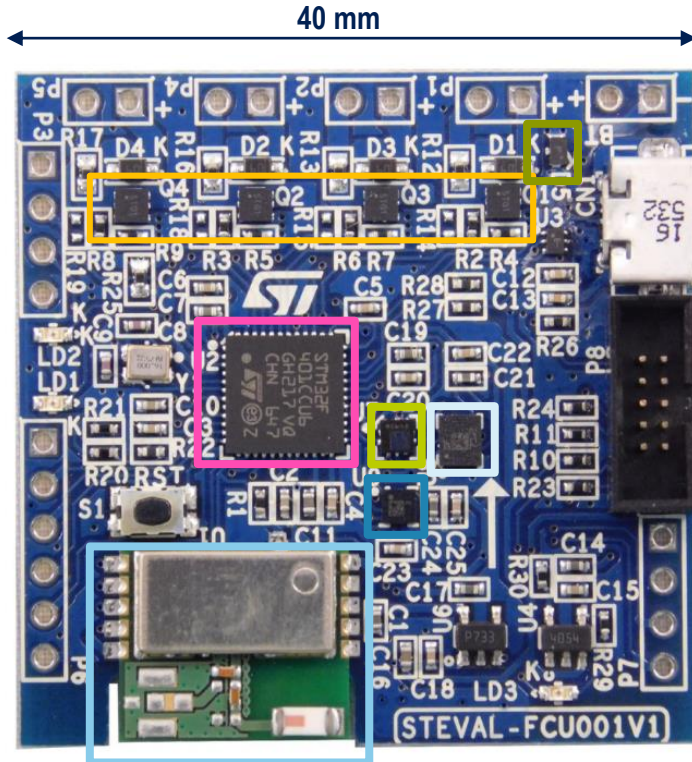
FCU Demo Board

Flight Controller Unit for Toy Drones

LSM6DSL
6-axis IMU

LPS22HD
Pressure Sensor

LIS2MDL
Magnetometer



STL6N3LLH6
Power MOSFET

ESDA7P60-1U1M
TVS Protection

STM32F401
ARM Cortex™-M3

SPBTLE-RF
Bluetooth Smart v4.1 Module

- Designed for quadcopter
- IMU performance for real flight conditions
- Ready to Fly Firmware available on GitHub
- Ready for standard external remote controller or Smartphone App
- LiPo Battery Charger on board (STC4054)

Drone Kit

The First ST Drone Kit for Educational



1 LiPo Battery 600mAh 30C



Based on STEVAL-FCU001V1



6 Propellers
(3 CW and 3 CCW)



4 Motors (CW and CCW)



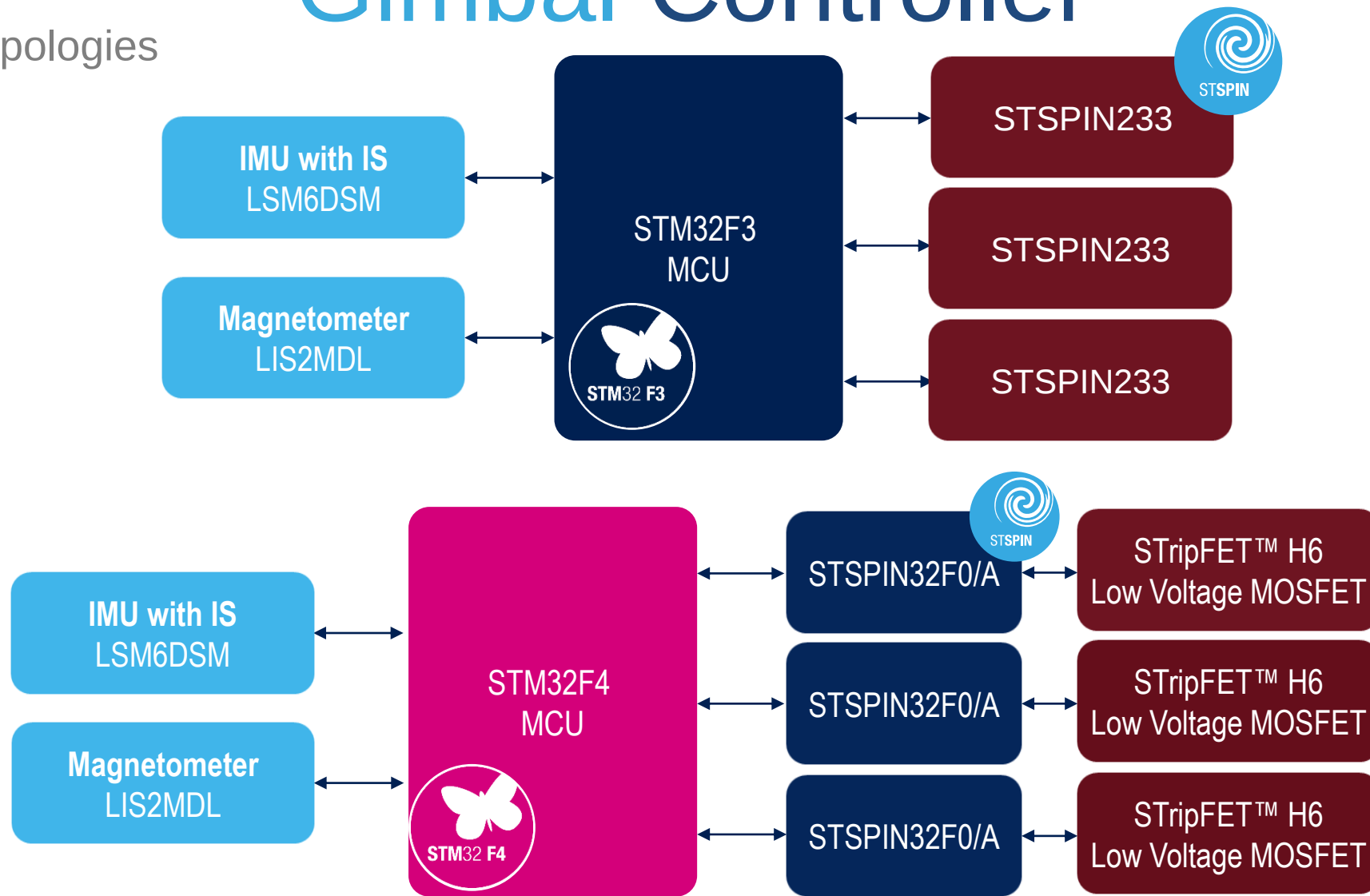
1 Plastic Frame



- Easy to assemble
- Full Firmware available on GitHub
- Ready for standard external remote controller or Smartphone App
- Dedicated ST Community

Gimbal Controller

Two Scalable Topologies



STM32 Microcontrollers



STM32F0 Series

ARM Cortex®-M0



Entry level

- 48MHz - 38 DMIPS
- 1.8 – 3.6V
- 16 to 256 KB Flash
- Motor Control PWM timer
- 12-bit ADC 1Msps
- Multiple serial communication
- Clock free USB FS, CAN 2.0B

STM32F3 Series

ARM Cortex®-M4



High End Control Loop

- 72MHz - 90 DMIPS - FPU
- 0 wait state Routine booster
- 1.8 – 3.6V
- 16 to 512 KB Flash
- 144Mhz Motor Control PWM timer
- 12-bit ADC 5Msps
- Fast Comparators, Op. Amp., DAC
- Multiple serial communication
- USB FS, CAN 2.0B

3-phase Motor Driver ICs

Low Voltage Motor driver for sensor-less FOC

STSPIN233

- Best for 2/3 Li-Ion battery powered
1.8 V – 10 V, up to 2 A
- $R_{DS(on)} = 0.2 \Omega$
- Fully protected
- Market smallest 3-phase motor driver
(**3x3mm QFN**)
- Market lowest stand-by consumption
(**80nA**)
- Complete ecosystem ensuring fast and easy development



Motor driver for sensor-less FOC

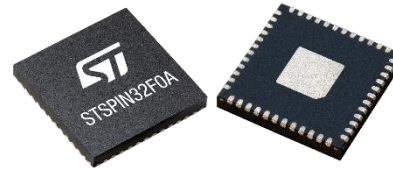
L6230

- Wide V, I ratings (up to 52 V & 2.8 A)
- $R_{DS(on)} = 0.7 \Omega$
- Fully protected
- Broad package offer (QFN, SO & PowerSO)
- Complete ecosystem ensuring fast and easy development



STSPIN32F0/A

Advanced BLDC controller with embedded STM32



STSPIN32F0/A System-in-Package: STM32F0 + Advanced 3-phase driver

STM32F031 MCU

- 32-bit ARM M0 Core, 48 MHz
- 32 KB Flash + 4KB SRAM
- 12-bit ADC (9 channels)
- I2C, USART & SPI Interfaces

3-phase gate drivers

- 6.7 V * – 45 V supply, 600 mA capability
- 12 V LDO & 3.3 V DC-DC regulators
- Up to 4 Op Amps * & 1 Comparator
- UVLO, & OTP protections
- Programmable OCP
- Firmware boot loader *

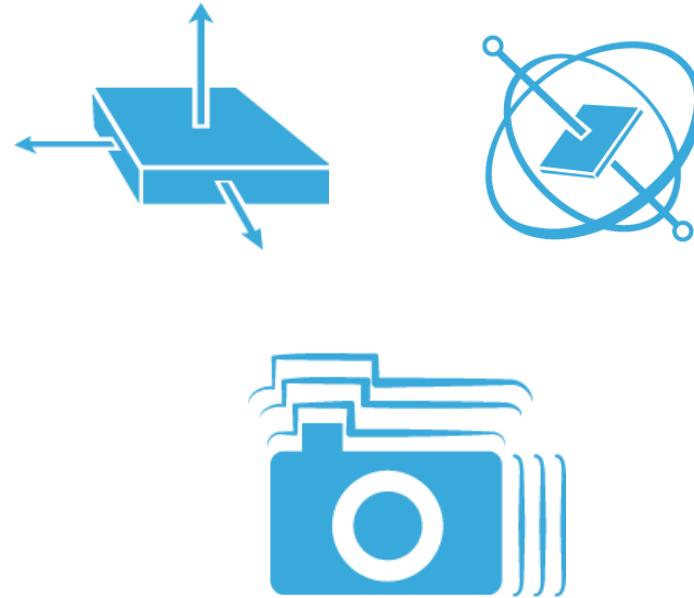
* = STSPIN32F0A supporting down to 2LiPo cells, 3x OpAmp and FW boot loader

Motion Sensors

6-axis IMU with OIS functions

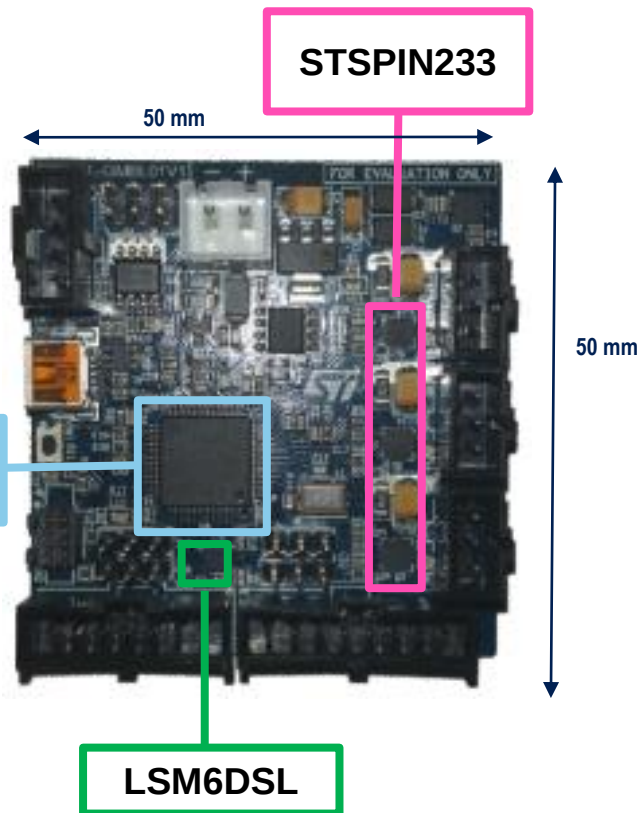
LSM6DSM

- Two-channel gyroscope for flight control and EIS/OIS camera stabilization
- No interference between the two channels → no flight miscontrol during movie or photo capture
- Image stabilization: both EIS and OIS



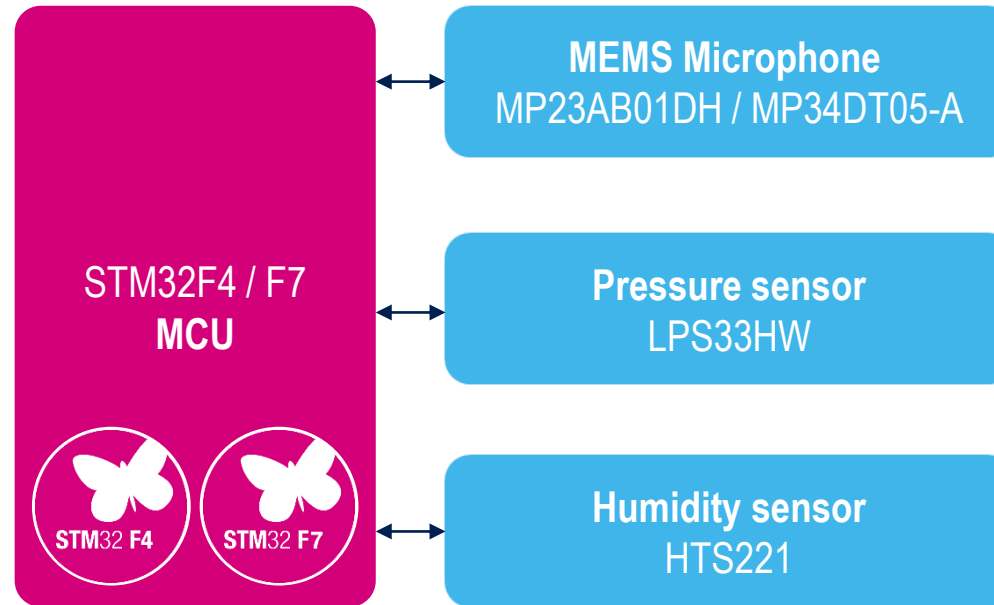
GIMBAL Reference Design

Compact design for Portable & Drones GIMBAL control



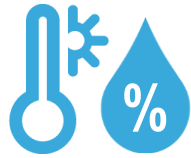
- One Single MCU controlling 3x BLDC motors simultaneously
- Designed for systems powered by 2S LiPo
- **STSPIN233 (x3)** Low voltage three phase and three sense motor driver
- On board **LSM6DSL** (Acc + Gyro) as Inertial Module
- High efficiency **FOC algorithm** compatible with the most common position sensors of Gimbal motors (PWM or analog)
- Cost effective open loop **sensorless algorithm**

Contextual Awareness



High resolution and low power consumption
Advanced beam-forming, noise suppression, sound source
localization algorithms

Environmental Sensors



Humidity & temperature sensor

HTS221

Extended operating range

- 0 to 100% RH range
- Low-power consumption: 1 μ A @1Hz ODR
- Humidity Accuracy: $\pm 3.5\%$ RH (20% RH to 80% RH)
- 16 bit ADC measurements

Water Resistant Pressure Sensor



LPS33HW

Designed for UAV

- 260 to 1260hPa absolute pressure range with 24 bit data output
- Water-resistant package
- Extended Temperature range from -40°C to +85°C

MEMS Microphones

Fully Differential **Analog** MEMS Microphones

MP23ABS1

High Performance Audio Single Ended

- Ominidirectional sensitivity
- Sensitivity of 38 dB $\pm$ 1 dB
- 64 dB signal-to-noise ratio
- Low power consumption

Omnidirectional **Digital** MEMS Microphones

MP34DT06J

Ready for Smart Functions

- Ominidirectional sensitivity
- Sensitivity of 26 dB $\pm$ 1 dB
- 64 dB signal-to-noise-ratio
- Power-efficient microphones
- Designed to be connected in Stereo configuration



Power Management

High Vin, 2A Buck Converter

L6986

- Supply voltage range 4V to 38V
- Adj output voltage from 0.85V to Vin
- 0.25~2MHz Adj Switching Frequency
- Synchronous Rectification
- Low Iq (30uA) or Low Noise mode
- Adj Soft Start time
- Output sequencing capability
- Internal current limiting
- HTSSOP16 package



Low Noise, High PSRR LDO Regulator

LDLN025

- 250mA output current
- 5.5V max supply voltage
- 250mV max dropout
- 12uA typ. Iq at no-load
- Ideal solution to supply noise sensitive sub-systems: PSRR: 80dB@100Hz, 60dB@100KHz
- Low noise: 6.5uV_{RMS} 10Hz-100KHz
- Flip-chip 0.62x0.62mm² or DFN 1x1mm²

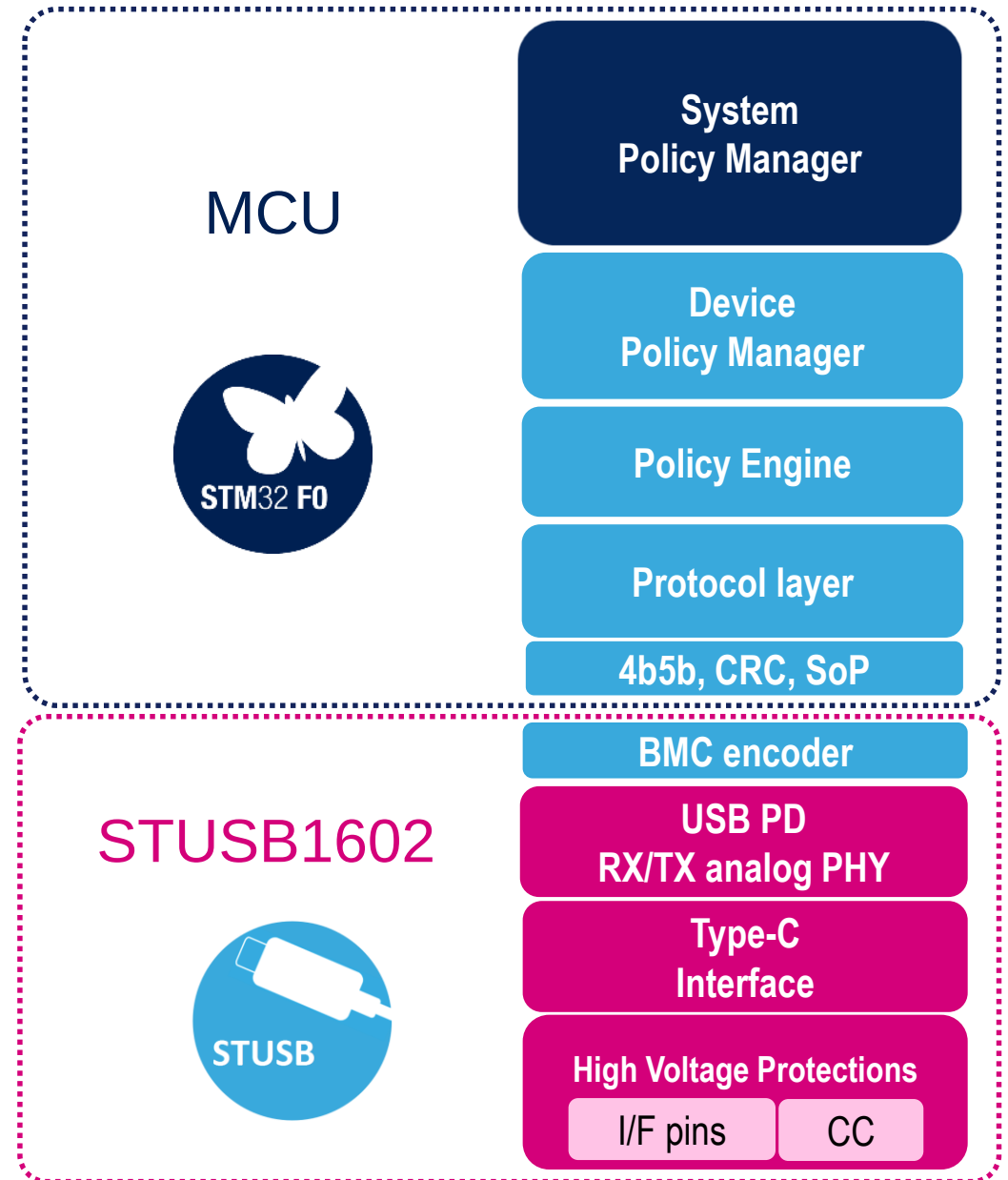
USB Type C and Power Delivery



STUSB1602

- Type-C™ attach and cable orientation detection (r1.2)
- Power role: Dual Role
- USB PD PHY + BMC support.
- VBUS gate drivers for Source and Sink
- OverVoltage protection
- Dead Battery support
- 600mA Vconn switch
- Short-to-VBUS protection
- USB PD 2.0 Certified
- USB PD 3.0 Compliant

Negotiating 15W or more



ESD Protection & EMI Filtering

Make your Drone fly safer with ST ESD Protection & EMI Filtering

SD-CARD™

EMIF06-HSD03F3

- 6-line ESD protection
- Compliant with SD3.0, UHS-1 SDR104 (208 MHz)
- High efficiency in ESD suppression up to + 18 kV IEC 61000-4-2
- Ultralow leakage current: 20 nA max.
- Smart pinout for easier PCB layout
- **Decrease SD bus noisy radiations in FCU and Gimbal Control**

CAN

ESDA6V1L

- 6V ESD Protection
- SOT23-6L package
- **Compliant with IEC61000-4-2 Level 4**



PROTECTION AGAINST TRANSIENT SURGES

**Fast charging
standard**

**MEDIUM POWER
CAPABILITY**

**HIGH POWER
CAPABILITY**

**STRONG POWER
CAPABILITY**

USB3.0 & HDMI 2.0

ECMF04-4HSWM10

- 6 discrete components integrated:
 - Common Mode Choke
 - ESD protection
- **Decrease High speed line noise radiation in FCU and Gimbal Control**
- **Allows 33% PCB space saving**

3/4S Cell
2S Cell
1S Cell

20 V

USB PD profile2 & 3
QCM quick-charge 3.0

ESDA25P35-1U1M

ESDA24P140-1U3M

15 V

ESDA17P50-1U1M ESDA17P100-1U2M

ESDA22P150-1U3M

12 V

USB PD profile2
QCM quick-charge 2.0

ESDA15P60-1U1M

5 V

USB PD profile1
QCM quick-charge 1.0

ESDA8P30-1T2

**ESDA7P120-1U1M
ESDA8P80-1U1M**



Drone Community on ST.com



PUBLIC

Drone Zone

[+ Join Group](#)

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Low Yik Seong (Community Member) asked a question.
October 6, 2018 at 3:01 AM

firmware example for esc001v1

Hi, may I ask will there be a release of firmware example based on ST workbench 5.2 or I have to modify the existing example to suite the current library?

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