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Motor Control Solutions for Robotic Applications

STMicroelectronics



Agenda

**System in Package for Motor Control:
STSPIN32F0 Family**



Servo Solution: EVALKIT-ROBOT-1



Full Solution Building Blocks



STSPIN32F0: Ecosystem Snapshot





System in Package for Motor Control: STSPIN32F0 Family

STSPIN32:
Advanced 3-phase BLDC Controller With Embedded STM32 MCU

Compact programmable drivers

Hardware scalability

A variety of control algorithms available now
supported by a comprehensive ecosystem



STSPIN32 Family

From Analog to Digital Motor Control

Highly Integrated System-in-Package

For **Smart Industry** and **High-End Consumer**



7x7 mm QFN or 10x10 mm TQFP
Comes with complete ST ecosystem

High integration

embedded 32-bit STM32F0
ARM Cortex-M0

High performance 3-phase gate driver

0.6A and 45V
0.35 / 1A and up to 600V

Versatile Control

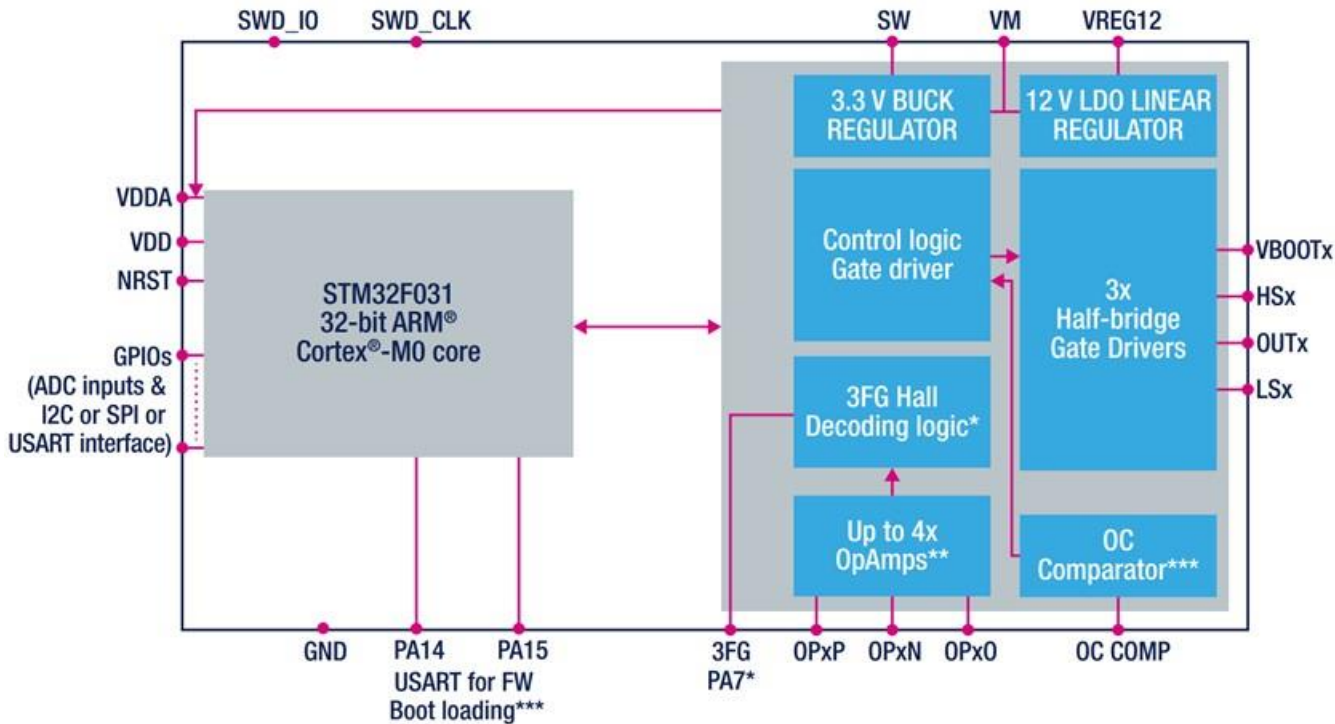
cost-effective sensorless
or accurate Hall sensors

Maximum efficiency

on-chip supplies for MCU,
driver and external circuitry



STSPIN32F0 for Low Voltage Motor Control



KEY BENEFITS & FEATURES:

- **STM32 Cortex M0 + 3-phase Gate Driver**
- **Fully compatible with STM32 ecosystem**
- **12V LDO & 3.3V DCDC regulators integrated**
- **6-step & FOC sensorless / sensored algorithms**
- $V_S = 6.7V - 45V$, $I_{GATE} = 600mA$ sink / source current
- 48 MHz, 32k Flash & 4k SRAM
- 12 bit ADC , I2C / UART / SPI
- **FW boot loader support** (A & B version)
- Fully protected (UVLO, Short-circuit, OCP, OTP)
- Up to 4 **Op-Amps** & 1 **Comparator**,
- From 15 up to 20 GPIOs;
- **Compact design** with 7x7 mm QFN
- **Extended temp range:** -40 to 125°C



STSPIN32F0 / F0A / F0B Easy Comparison

Feature	STSPIN32F0	STSPIN32F0A	STSPIN32F0B
Operating voltage	8 V to 45 V	6.7 to 45 V	6.7 to 45 V
Embedded MCU	STM32F031x6 with extended temp range	STM32F031x6 with extended temp range	STM32F031x6 with extended temp range
Gate drivers	600 mA triple half-bridge	600 mA triple half-bridge	600 mA triple half-bridge
3.3 V DC/DC buck conv	Embedded	Embedded	Embedded
12 V LDO	Embedded	Embedded	Embedded
OpAmps	4	3	1
Hall Sensor decoding logic	Embedded	Not embedded	Not embedded
Comparator	Embedded	Embedded	Embedded
# of GPIOs	15	16	20
OC protection via comparator	Available	Available	Available
Current control via comparator	Not available	Available	Available
Standby	Available	Available	Available
UVLO	Available	Available	Available
FW upgrade on the field	Not available	Available	Available
Package	QFN 7x7mm, 48L	QFN 7x7mm, 48L	QFN 7x7mm, 48L

Legend:

Differences

Similarities

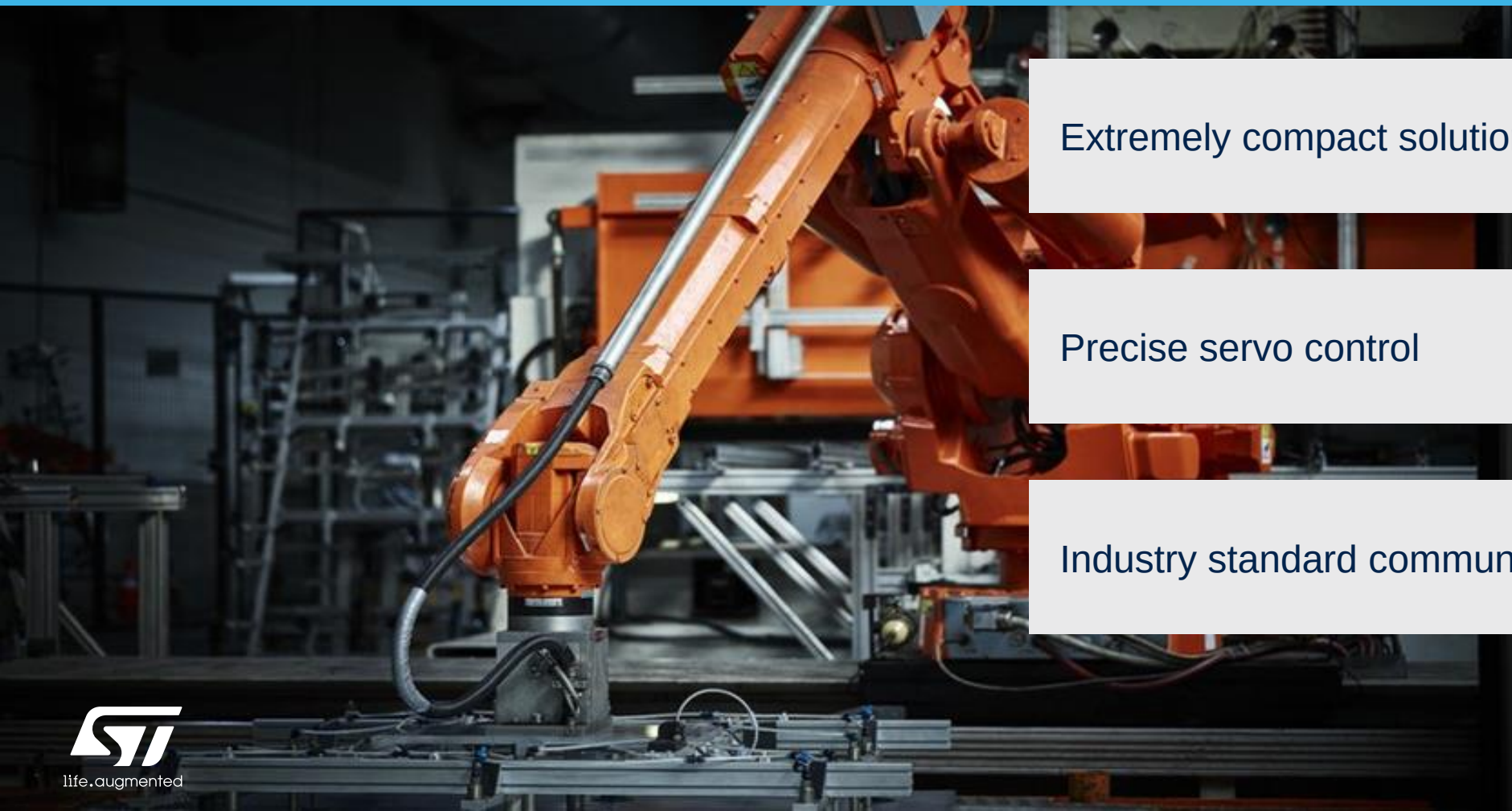


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Servo Solution: EVALKIT-ROBOT-1

EVALKIT-ROBOT-1: Compact Brushless Servo Control Kit



Extremely compact solution

Precise servo control

Industry standard communication embedded



EVALKIT-ROBOT-1

Compact Brushless Servo Control Kit



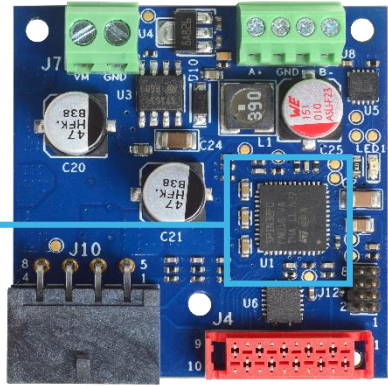


EVALKIT-ROBOT-1

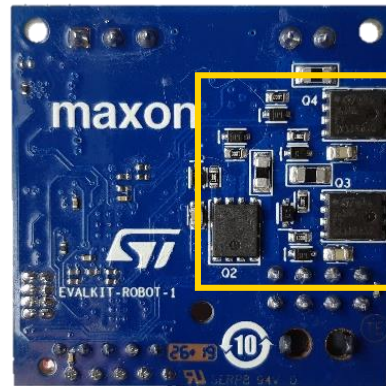
EVALKIT-ROBOT-1: Compact Brushless Servo Control Kit

STSPIN32F0A

45V fully integrated
3-phase BLDC driver
(600mA gate current)
embedding
Cortex®-M0 MCU



40 mm



STL7DN6LF3

60V, 35mΩ
Dual N-channel
MOSFETs
in PowerFLAT™ 5x6
Dual Island

36V and 6A_{PEAK} power stage

Encoder + Hall sensors supported

Position control loop based on FOC

MODBUS com. protocol via RS-485



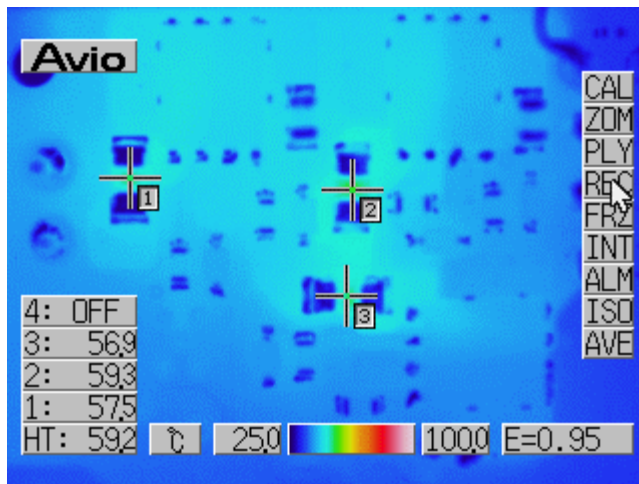
Maxon EC-i40

100W 3-phase BLDC
with 1024 pulses incremental encoder

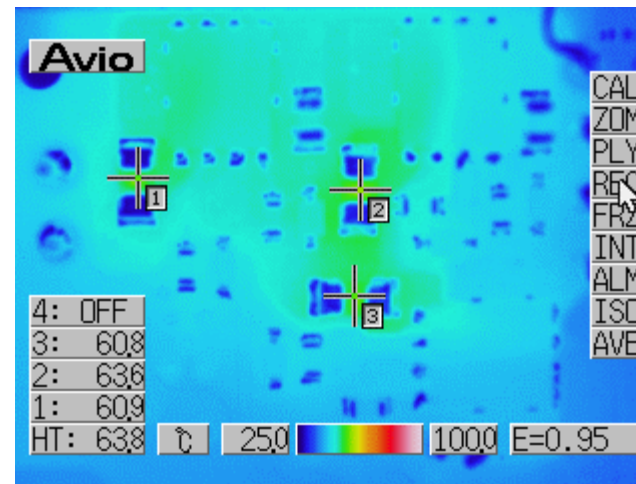


EVALKIT-ROBOT-1 Thermal Performance

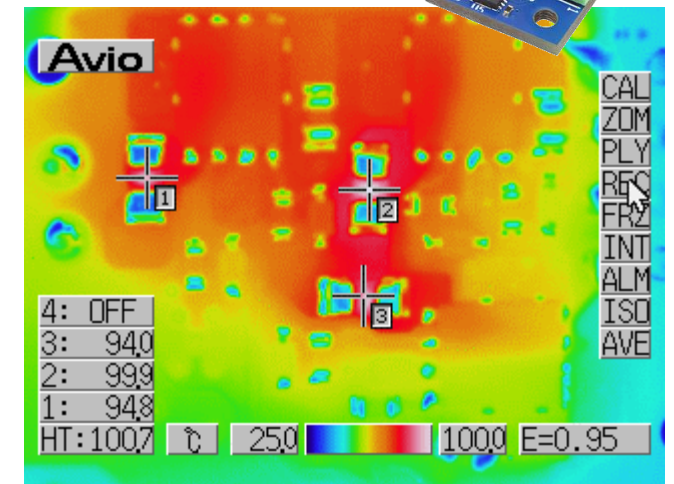
Safety operation guaranteed by overcurrent protection set at 6A



1 A_{RMS}



2 A_{RMS}



3 A_{RMS}



EVALKIT-ROBOT-1

Getting Started

Minimum HW Requirements

- 36V / 120W DC power supply
- RS485 2-wire serial port
- Communication software based on MODBUS protocol
- HW alternative:
- In case you decide to work with STLINK instead of MODBUS:
- 20 pin to 10 pin adapter for JTAG/SWD programmers



All related documentation available on: www.st.com/EVALKIT-ROBOT-1

Full Solution The Building Blocks

Control & Power : What is in EVALKIT-ROBOT-1?

Compact SiP control IC: STSPIN32F0A

Scalable power with F7 mosfet technology

Making everything work: power management options



STSPIN32F0A



- **Industrial automation**
- **Battery powered Home Appliances**
- **Robotics**
- Drones and aeromodelling
- Power tools
- Fans

Key Features

- **STM32 Cortex M0 + 3-phase Gate Driver**
- **Fully compatible with STM32 ecosystem**
- **12V LDO & 3.3V DC-DC regulators integrated**
- **6step & FOC sensorless / sensored algorithms**
- $V_S = 6.7V - 45V$, $I_{GATE} = 600mA$ driving capability
- 48 MHz, 32k Flash & 4k SRAM
- I2C / UART / SPI
- **16 GPIOs & FW boot loader support**
- Fully protected (UVLO, Short-circuit, OCP, OTP)
- **3 Op-Amps & 1 Comparator**
- Compact design with 7x7 mm QFN
- Extended temp range: -40 to 125°C



STripFET* F7 Series for Motor Control

40V – 100V N-channel Power MOSFET for Low Voltage Applications



Technology & Flexibility
to address your needs

- +100 products available now
- Extremely low $R_{DS(ON)}$
- Outstanding intrinsic body diode
- Superior EMI/EMC behavior thanks to optimized Q_{RR} and C_{RSS}/C_{ISS}

The ideal solution for motion control:

Robots and Industrial Automation, Power Tools, Forklifts, e-Scooters, e-Bikes, Toys & Drones



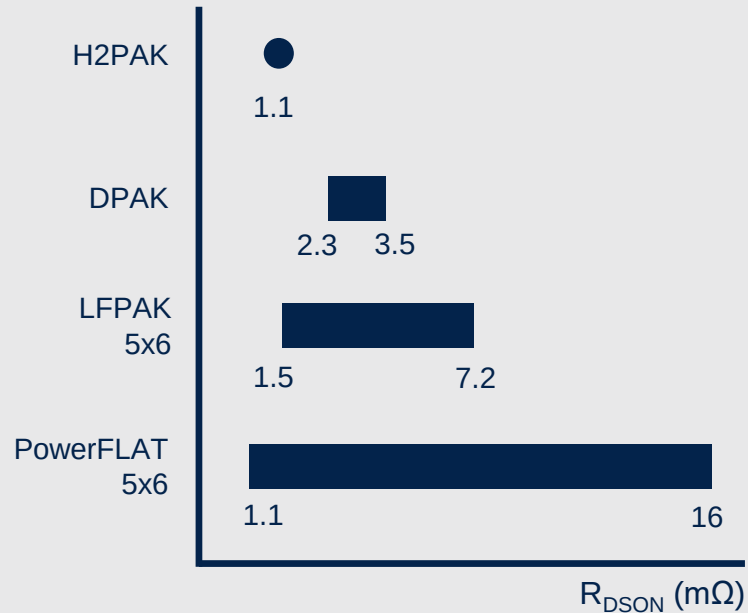
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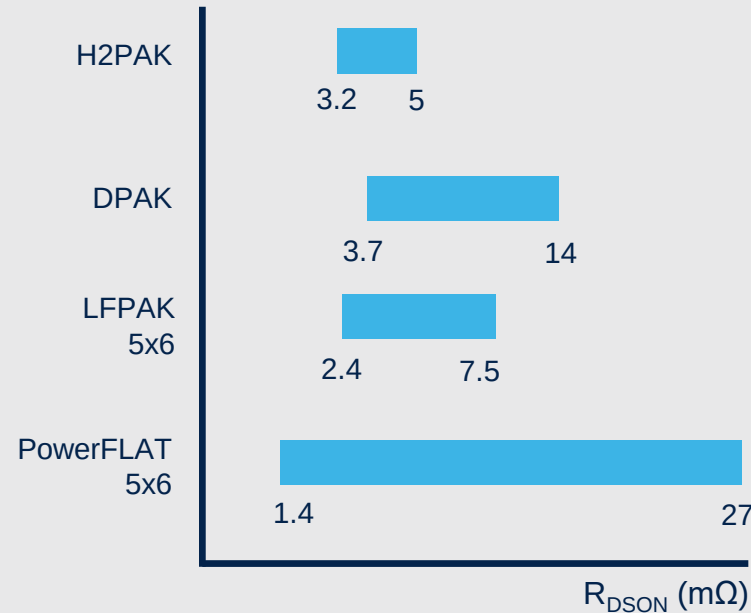


STripFET* F7 Series Portfolio at a Glance +100 products

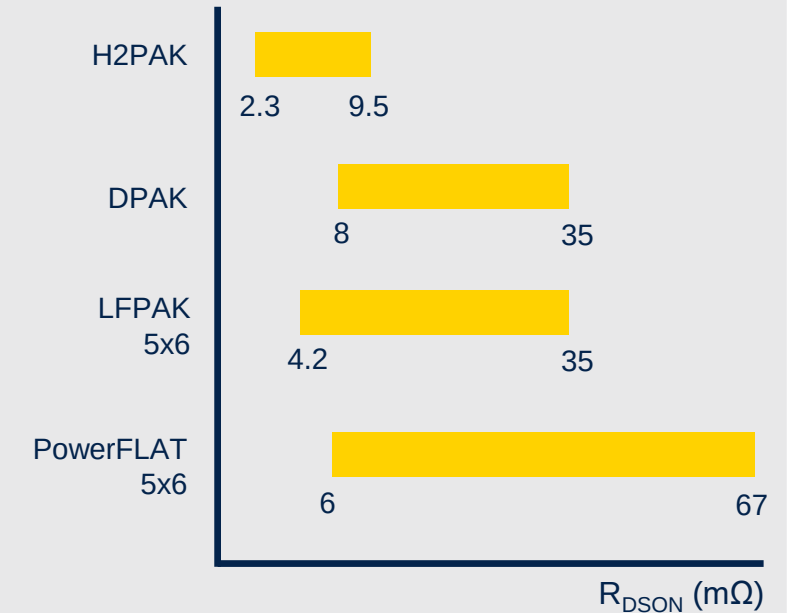
40V



60V – 80V



100V



ST MOSFET Finder



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Package Overview

Available packages



H²PAK-7



LFLPAK 5x6



DPAK



PowerFLAT 5x6
Single Island



PowerFLAT 5x6
Dual Island



PowerFLAT 5x6
Dual Side Cooling

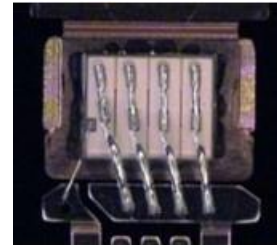


PowerFLAT 3.3x3.3

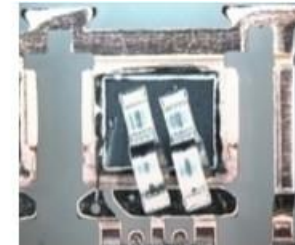


PowerFLAT 2x2

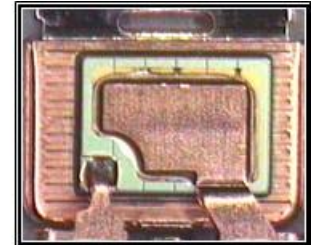
Bonding Processes



Wires

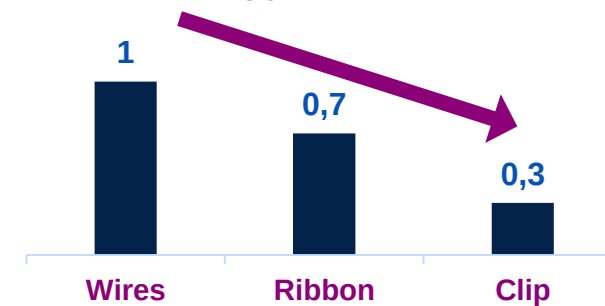


Ribbon



Clip

Parasitic $R_{DS\ ON}$ Comparison (m Ω)



More on www.st.com/mosfets

ST1S14

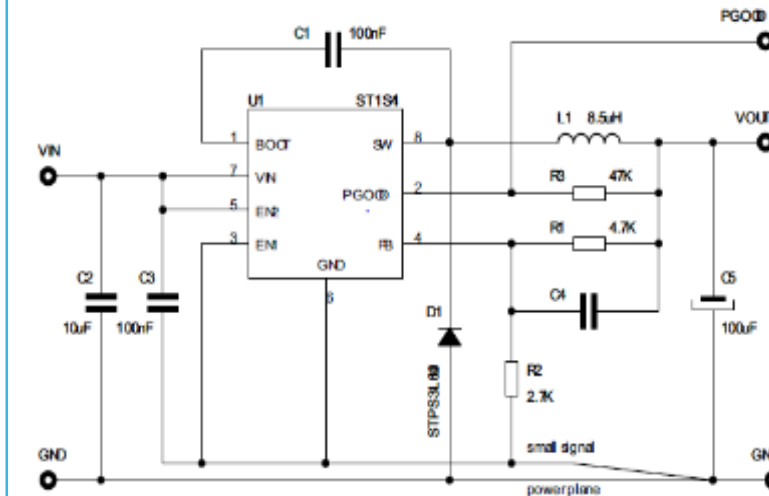
DC-DC Converter

48V, 3A, 850kHz Asynchronous Step Down Converter

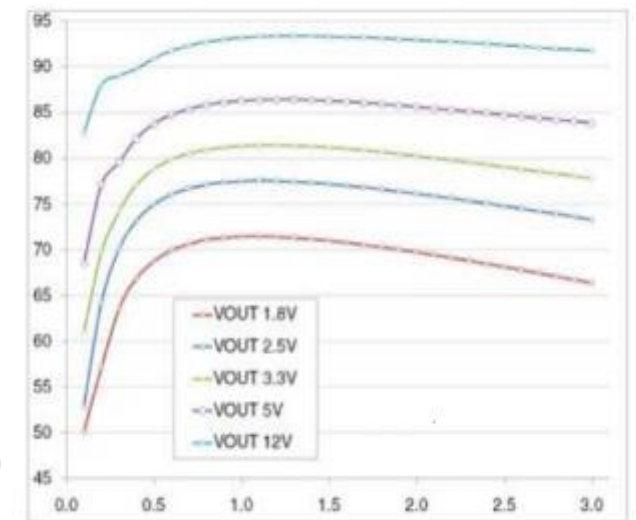
Main features

- V_{IN} : 5.5V – 48V
- V_{OUT} : 1.22V – 90% V_{IN}
- I_{OUT} : 3A
- Switching Frequency: 850kHz
- **Stand-by** current 16 μ A typ.
- **Internal Compensation (Embedded)**
- **Internal Soft Start**
- **Enable & Inhibit**
- **Power Good**
- Over Current and Thermal Protections
- Package: HSOP-8L

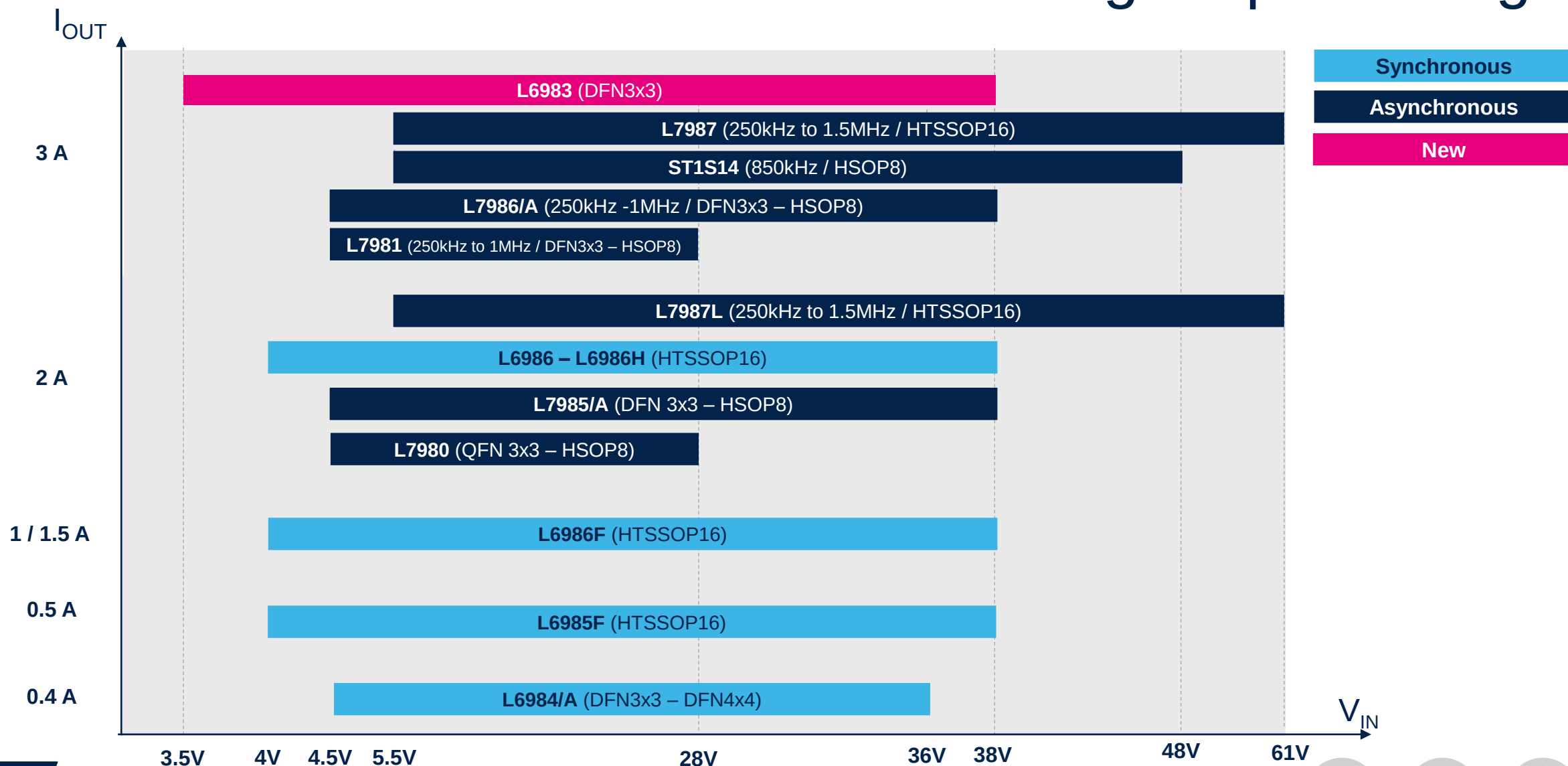
Application and efficiency



Efficiency curves vs. I_{OUT} @ $V_{IN} = 24V$



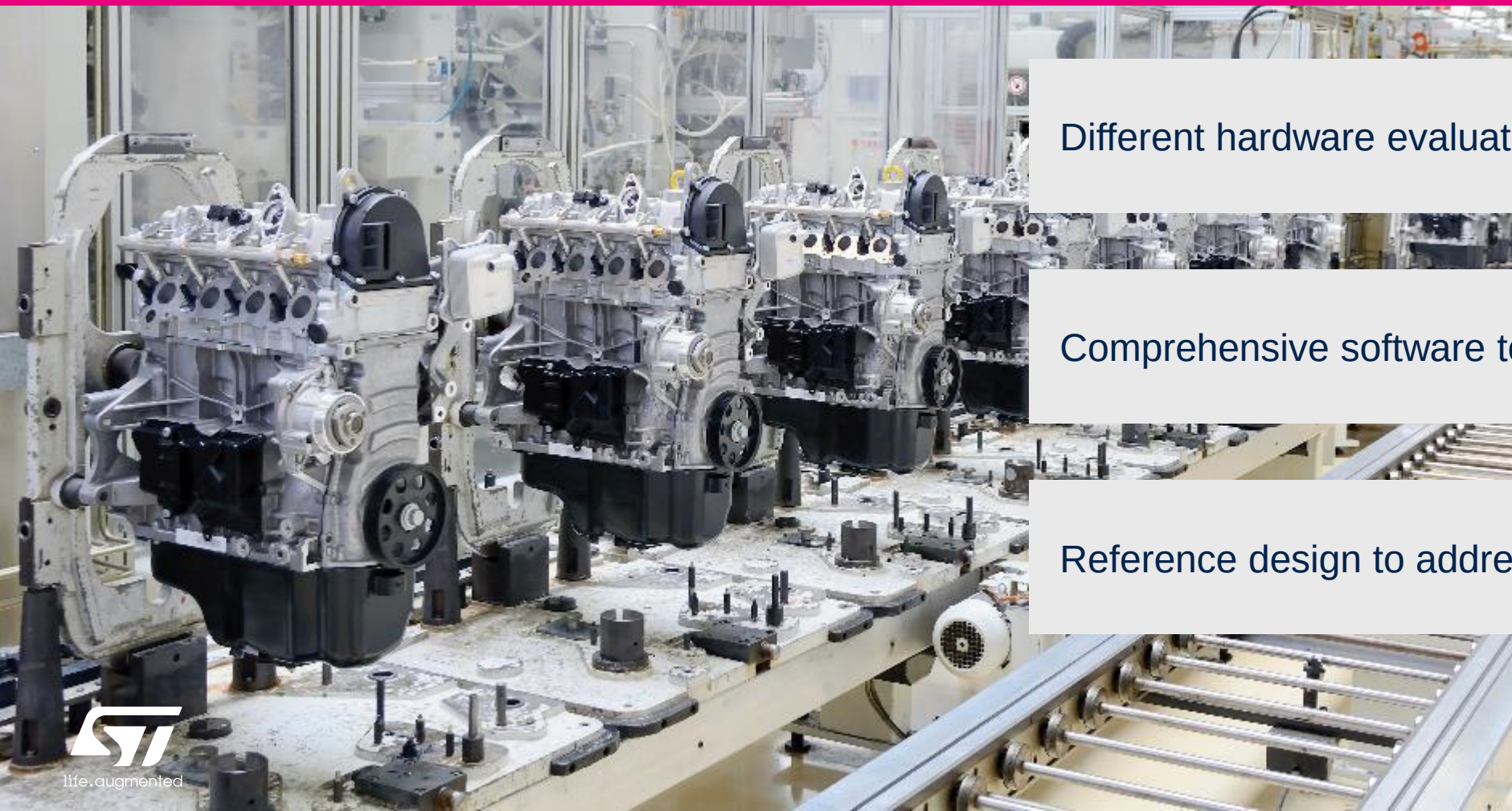
DC-DC High Input Voltage





STSPIN32F0 Ecosystem at a Glance

Complete Hardware and Software Solution

A large industrial engine is mounted on a complex test bench in a factory setting. The engine is silver and black, with various sensors and hoses attached. It is surrounded by mechanical components and structural frames.

Different hardware evaluation platform

Comprehensive software tools

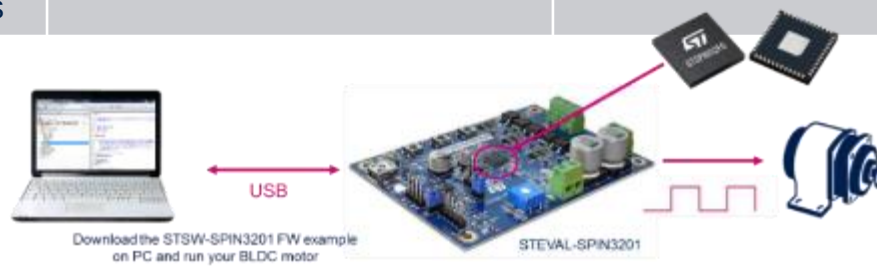
Reference design to address specific needs





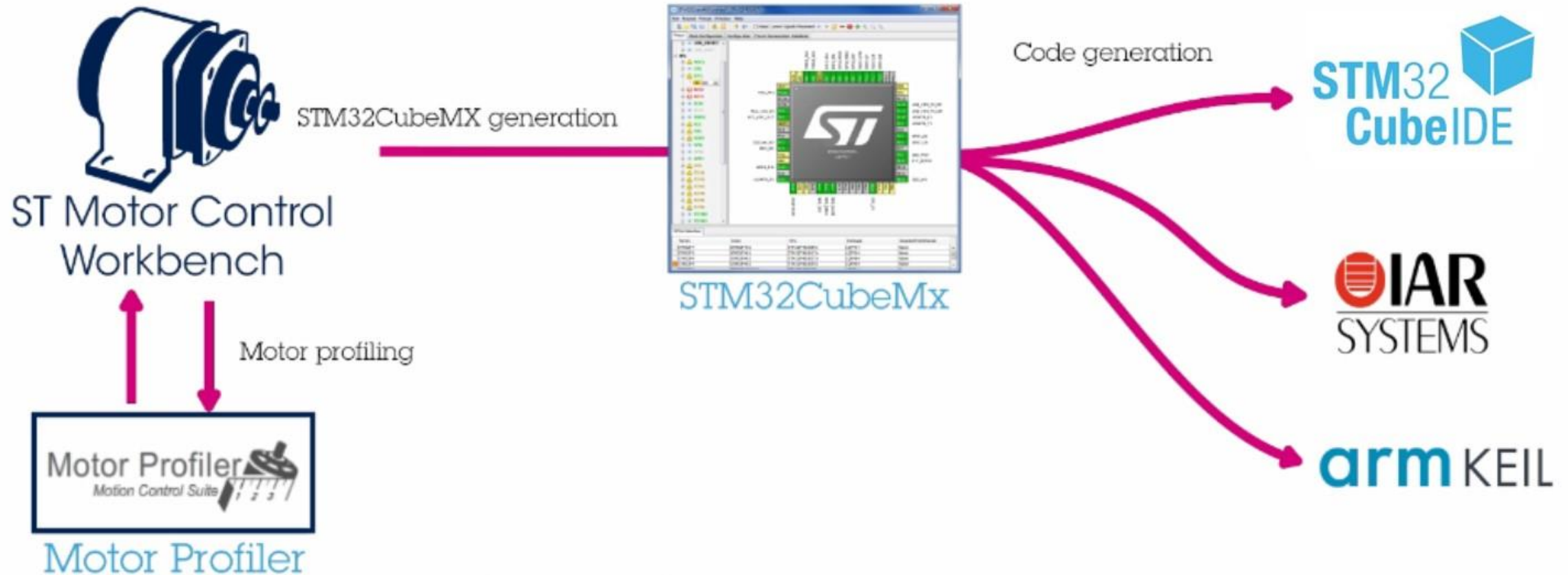
STSPIN32F0 Low Voltage Ecosystem

Board	Firmware	Ecosystem	Documentation
STEVAL-SPIN3201 (STSPIN32F0) 3-shunts dev board with ST-LINKV2-1	STSW-SPIN3201 FOC library (X-CUBE-MCSDK)	MC WB 5.4.4	Eval board manual (UM2154) FW manual (UM2152) Application Notes (AN4999) MC Workbench guidelines (UM2168)
STEVAL-SPIN3202 (STSPIN32F0A) 1 shunt dev board with ST-LINKV2-1	STSW-SPIN3202 FOC library (X-CUBE-MCSDK)	MC WB 5.4.4	Eval board manual (UM2278) FW manual (UM2310) Application Notes(AN4999)
STEVAL-SPIN3204 (STSPIN32F0B) 1 shunt dev board with ST-LINKV2-1	STSW-SPIN3204 6 Step Firmware Example	-	Eval board Data Brief (link) FW manual (STSW-SPIN3204)
STEVAL-ESC002V1 (STSPIN32F0A) Drones' ESC 6-step reference design	High Speed 6-step Firmware (open source FW for ESC)	-	Eval board manual (UM2518) FW manual (STSW-ESC002V1)
EVALKIT-ROBOT-1 (STSPIN32F0A & Maxon motor) evaluation kit for servo brushless applications	Flashed into STSPIN32F032A	communication software based on MODBUS protocol	Kit user manual (UM2653)





Tool Chain STM32 Motor Control Software Development Kit





ST Motor Control Workbench



KEY BENEFITS & FEATURES

Software that reduces design effort and time needed for STM32

PMSM FOC firmware configuration

Real time monitoring and changing of variables

- Simplified FW architecture based on STM32Cube HAL/LL libraries
- Sensored (Encoder / Hall) and Sensor-less operation (state observer)
- Full customization and real time communication
 - New project creation starting from the Eval board
 - Workflow supporting the STM32CubeMX GUI
 - Wide range of STM32 microcontrollers supported
- Download link:
www.st.com/x-cube-mcsdk

	Full source code	st.com accessibility
X-CUBE-MCSDK	Yes except CORDIC, MTPA, etc.	Without registration
X-CUBE-MCSDK-FUL	Yes	With registration and approval

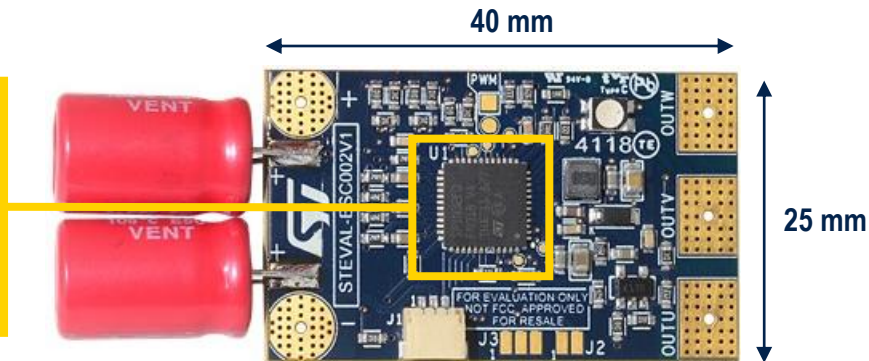


STEVAL-ESC002V1

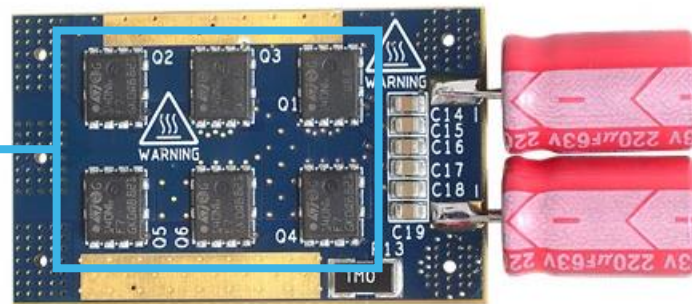
Electronic Speed Control Reference Design

Highly compact solution for high-speed 6-step applications

STSPIN32F0A
ARM Cortex™ - M0



STL140N6F7
Low Voltage
STripFET F7 series



Implementing 6-step voltage mode algorithm

Designed for 2S-6S pack of LiPo batteries

Maximum Rate 30V, 20A

BEMF sensing through Op Amps embedded in STSPIN32F0A

Embedded bootloader through UART interface

High-speed 6-step FW available

Thank you

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