ST Motion Control Portfolio for Powertools

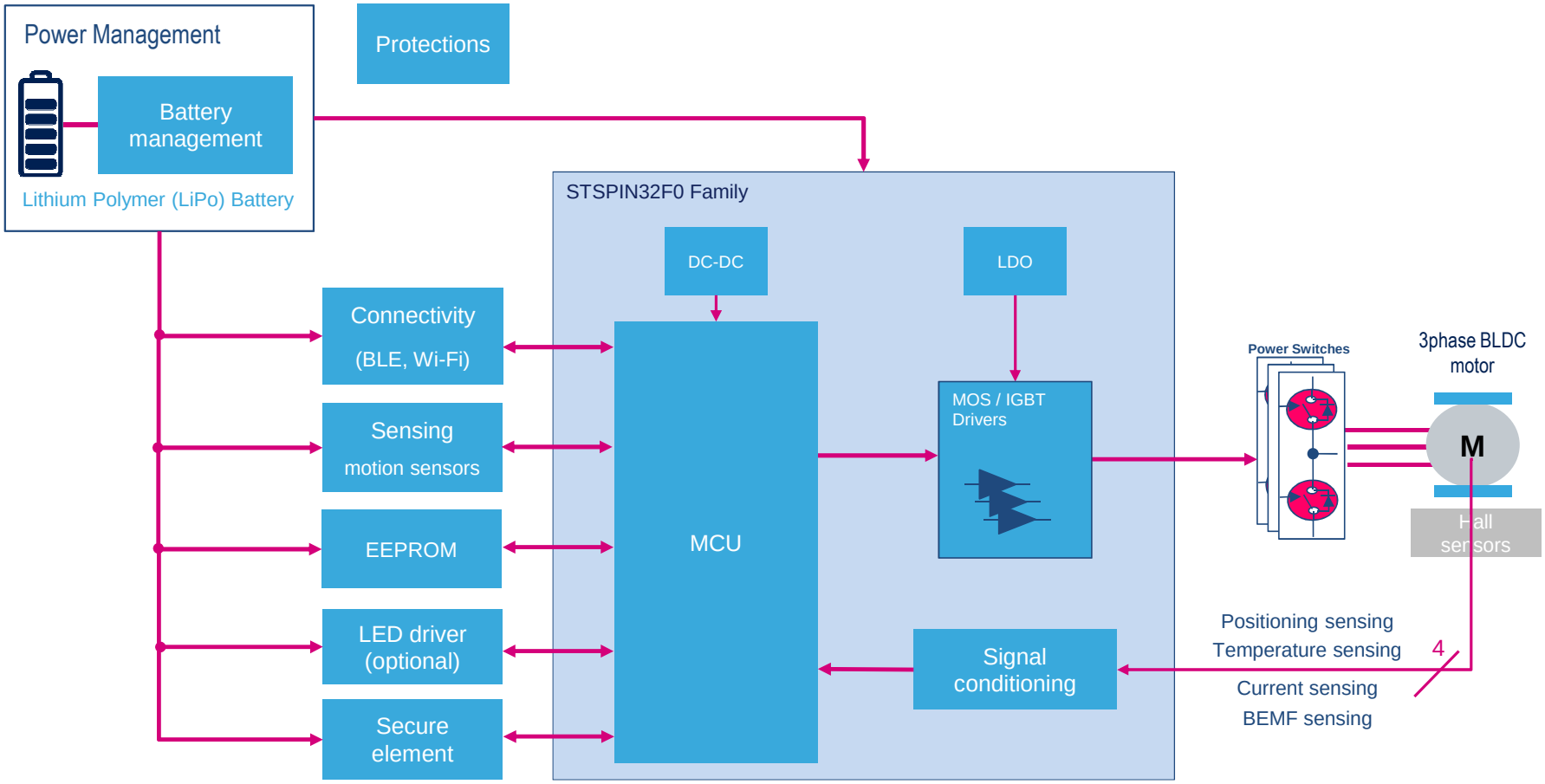
May 2018

Yolanda Zhang

ST Technical Marketing

life.augmented

3-phase BLDC battery supplied power tool



life.augmented

STSPIN32 Family

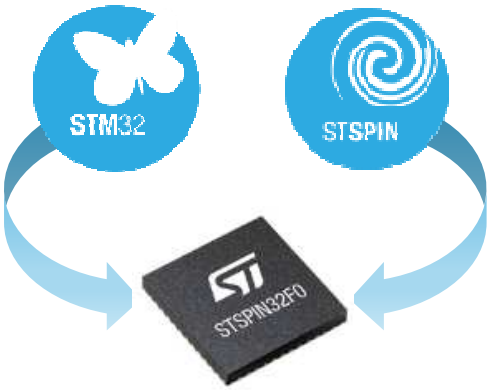
From analog to digital motor control

Power Transistors

Motor Control

Microcontroller

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



- Highly integrated system-in-package 7x 7mm
- Complete ST ecosystem comprising tools and SWs including motor-control algorithms

High integration

embedded 32-bit STM32F0 ARM Cortex-M0

High performance 3-phase gate driver

600 mA and 45 V

Versatile Control

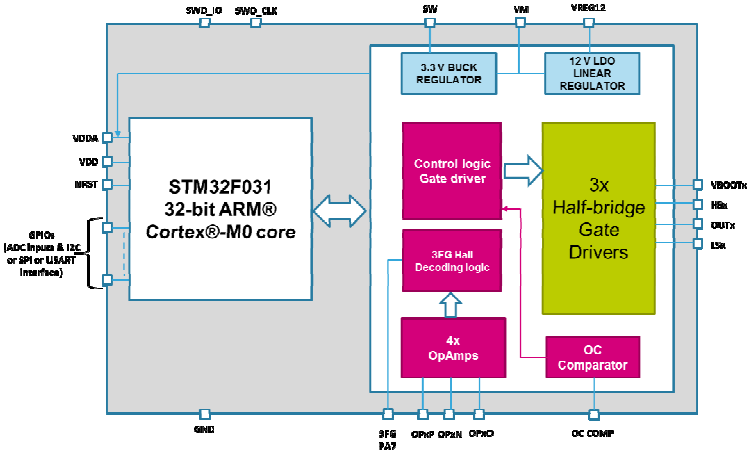
cost-effective sensorless or accurate Hall sensors

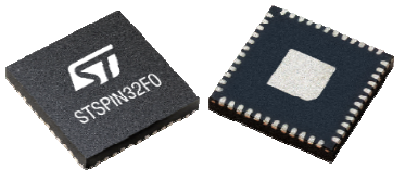
Maximum efficiency

on-chip supplies for MCU, driver and external circuitry

STSPIN32F0

Advanced 3-phase BLDC driver + STM32





KEY APPLICATIONS:

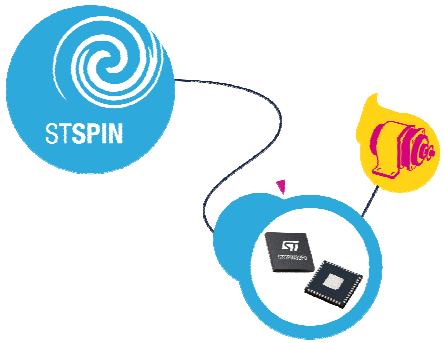
- **Industrial automation**
- **Robotics**
- **Fans**
- **Battery powered Home Appliances**
- Drones and aeromodelling
- Power tools

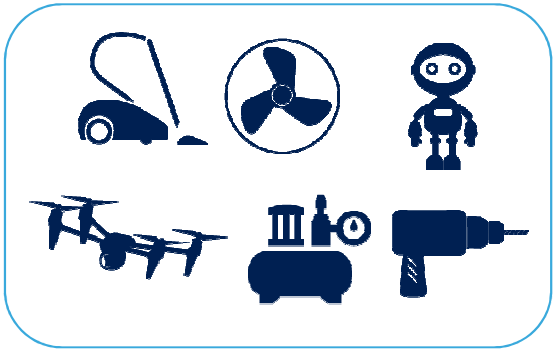
Key Features

- **STM32 Cortrex M0 + 3-phase Gate Driver**
- **Fully compatible with STM32 ecosystem**
- **12V LDO & 3.3V DC-DC regulators integrated**
- **FOC &** 6-step **sensorless / sensored algorithms**

- VS = 45 V, I = 600mA driving capability
- 48 MHz, 32k Flash & 4k SRAM
- 12 bit ADC
- I2C / UART / SPI
- Fully protected (UVLO, Short-circuit, OCP, OTP)
- 4 Op-Amps & 1 Comparator
- Compact design with 7x7 mm QFN
- Extended temp range: -40 to 125°C

STSPIN32F0: Top 10 Power 2017 Award





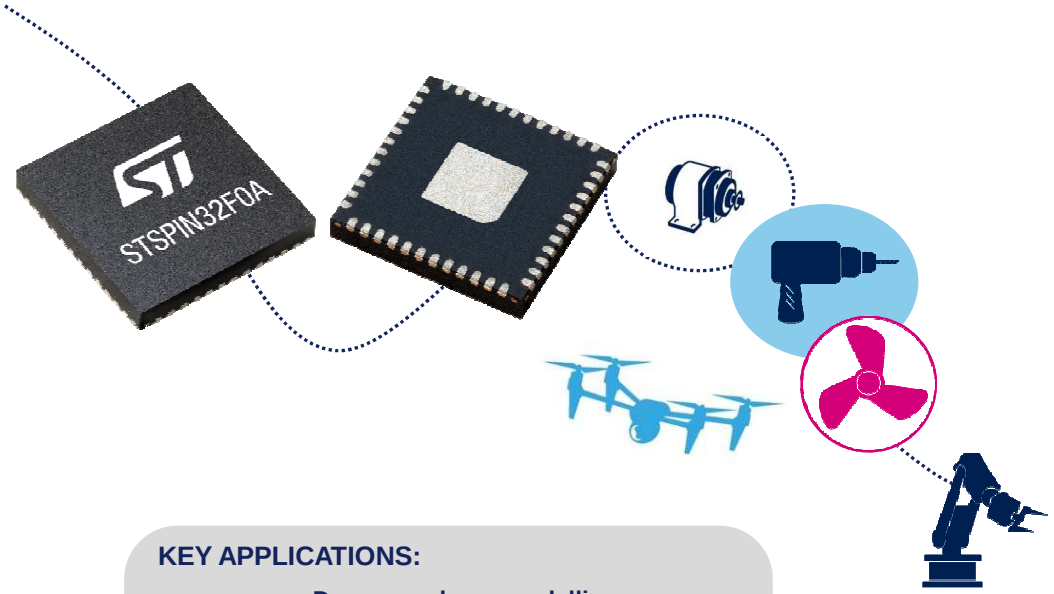
Top 10 Power 2017 Award in China
by Electronic Products China (EPC)

life.augmented

NEW

STSPIN32F0A

Advanced 3-phase BLDC driver + STM32 – **from 2 Li-Po Cells to 48V**



KEY APPLICATIONS:

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

Key Features

- **STM32 Cortrex M0 + 3-phase Gate Driver**
- **Fully compatible with STM32 ecosystem**
- **12V LDO & 3.3V DC-DC regulators integrated**
- **6step** & FOC **sensorless / sensored algorithms**

- VS = **6.6V–45V**, I = 600mA driving capability
- 48 MHz, 32k Flash & 4k SRAM
- 12 bit ADC
- I2C / UART / SPI
- **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

STSPIN32F0/A, perfect fit for....

- **Industrial automation and control**
- **Robotic arms**
- **Drones (gimbal and ESC control)**
- **Power tools**
- **FANs**
- **Vacuum cleaners, other HA**

STM32F031x6x7 MCU characteristics

Core: ARM® 32-bit Cortex ® -M0 CPU, frequency up to 48 MHz

STM32 F0

Cortex-M0
32 bit
48 MHz
1.8 to 3.6V

- Memories: 4kB of SRAM, 32 kB of Flash Memory
- CRC calculation unit
- Up to 16 fast I/Os
- Up to 5 general purpose timers
- 12-bit ADC (up to 9 channels)
- Communication interfaces: I2C, USART, SPI
- Serial Wire Debug (SWD)
- Extended temperature range: -40 to 125°C

STSPIN32F0/A Evaluation Tools

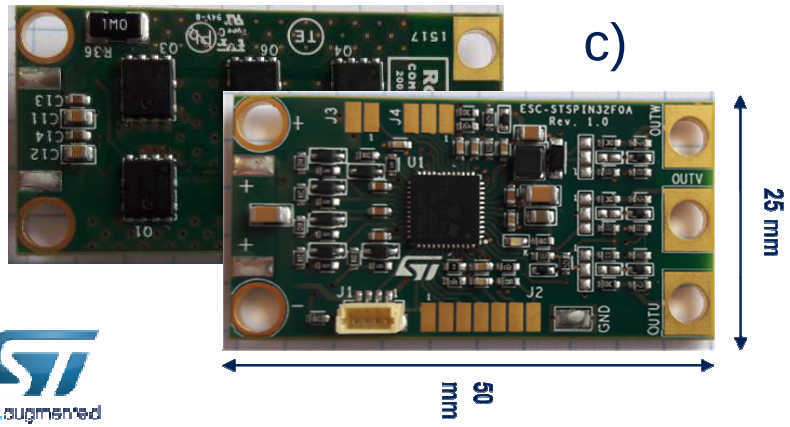
Full ecosystem of HW, FW & SW for easy and fast design

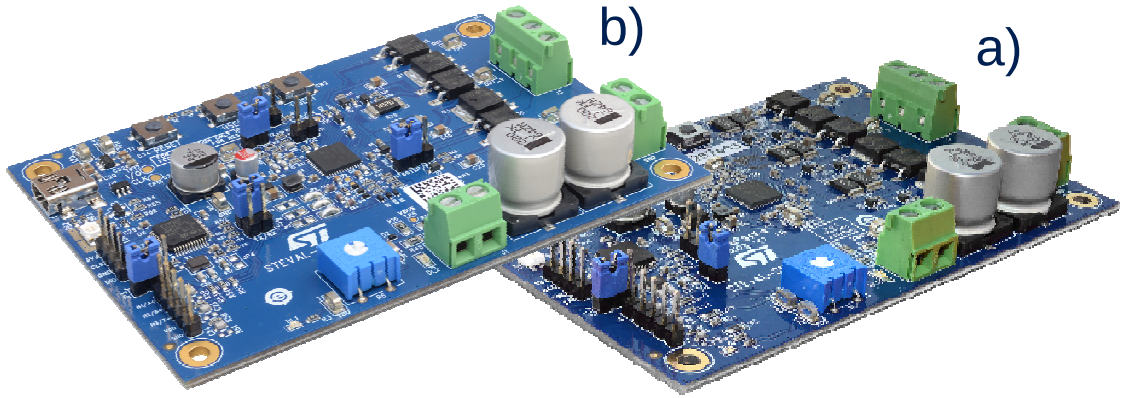
a) **STEVAL-SPIN3201 (FOC 3 shunts sensorless/sensored FWs; based on STSPIN32F0)**

b) **STEVAL-SPIN3202 (FOC 1 shunt & 6 step sensorless/sensored; FWs based on STSPIN32F0A)**

c) STEVAL-ESC002V1 (Reference design for ESC based on STSPIN32F0A & BLHeli_32 FW; available in Q3 2018)

d) STEVAL-SPIN3203 (Very compact and low cost ref design)

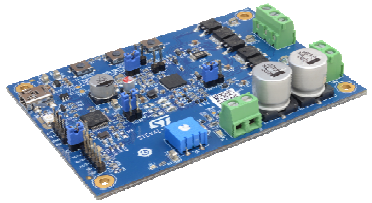


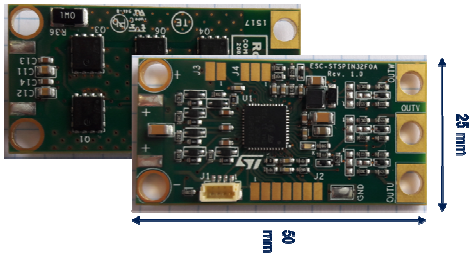


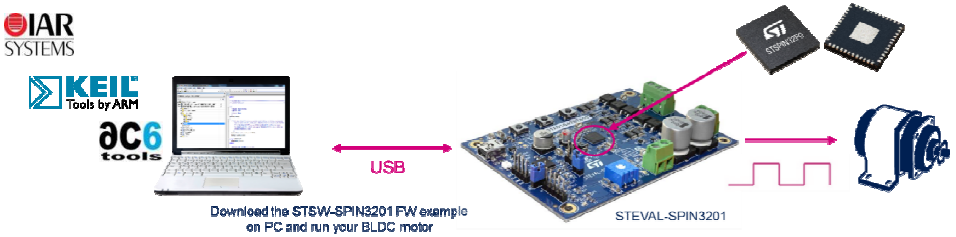
STSPIN32F0/A Ecosystem

Board	Firmware	Ecosystem	Documentation	Availability
STEVAL-SPIN3201 (STSPIN32F0) 3-shunts dev board with ST-LINKV2-1	**STSW-SPIN3201** FOC library (STSW-STM32100)	**MC Workbench**	Eval board manual (UM2154) FW manual (UM2152) Overcurrent AN (AN4999) MC Workbench guidelines (UM2168)	On stock
STEVAL-SPIN3202 (STSPIN32F0A) 1 shunt dev board with ST-LINKV2-1	**STSW-SPIN3202** FOC library (*) (STSW-STM32100)	**MC Workbench (*)**	Eval board manual (UM2278) FW manual (UM2310) Overcurrent AN (AN4999)	On stock
STEVAL-SPIN3203 (STSPIN32F0) 3-shunts compact dev board	**STSW-SPIN3203** FOC library (*) (STSW-STM32100)	**MC Workbench (*)**	Eval board manual FW manual	Q3 2018
STEVAL-ESC002V1 (STSPIN32F0A) Drones' ESC 6-step reference design	**BLHeli32 Firmware** (open source FW for ESC)	Compatible with GUI from BLHeli community	Eval board manual FW manual	Q3 2018

(*) Compatible, but not embedded in the board list.



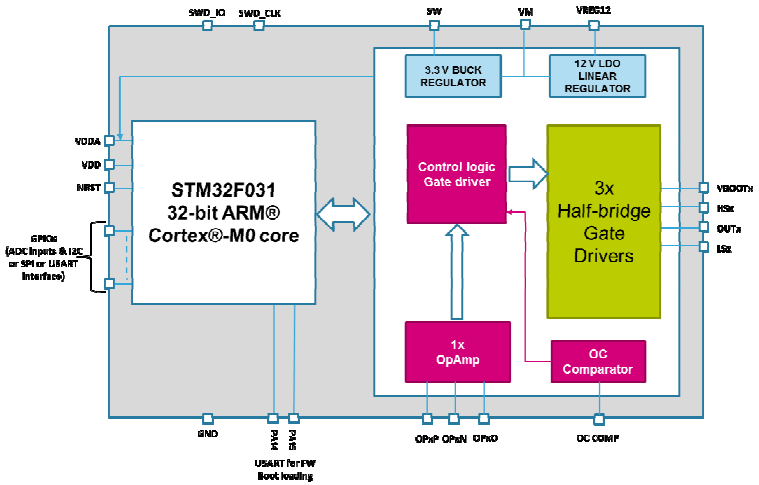


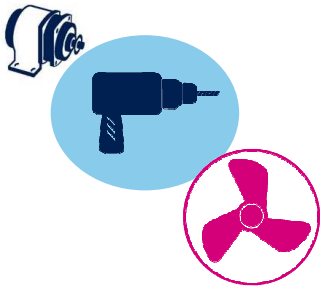


In development

STSPIN32F0B Preview

Advanced 3-phase BLDC driver + STM32 – **More GPIOs**





KEY APPLICATIONS:

- **Power tools**
- **Fans**
- **Battery powered Home Appliances**
- Industrial automation

Key Features

- **STM32 Cortrex M0 + 3-phase Gate Driver**
- **Fully compatible with STM32 ecosystem**
- **12V LDO & 3.3V DC-DC regulators integrated**
- **6step control algorithm**

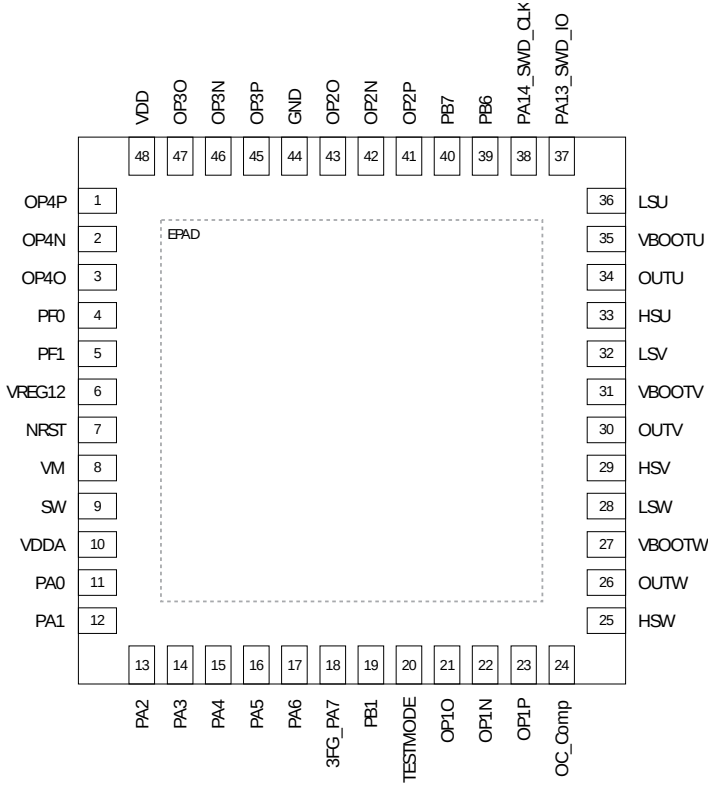
- VS = **6.6V–45V**, I = 600mA driving capability
- 48 MHz, 32k Flash & 4k SRAM
- 12 bit ADC
- I2C / UART / SPI
- **20GPIOs & FW boot loader support**
- Fully protected (UVLO, Short-circuit, OCP, OTP)
- **1 Op-Amp** & 1 Comparator
- Compact design with 7x7 mm QFN
- Extended temp range: -40 to 125°C

STSPIN32F0/A/B Easy Comparison

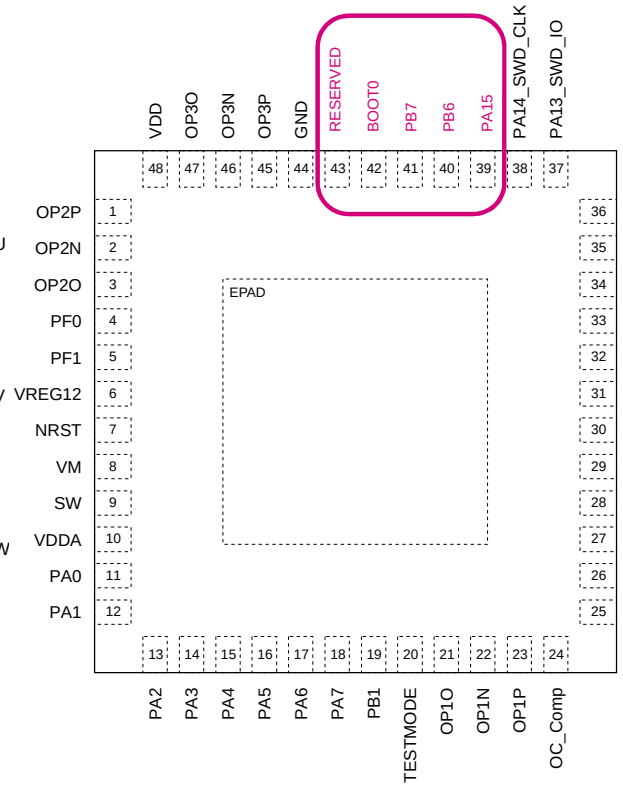
Feature	STSPIN32F0	STSPIN32F0A	STSPIN32F0B
Operating voltage	**7.9 V to 45 V**	**6.6 to 45 V**	**6.6 to 45 V**
Embedded MCU	STM32F031x6 with extended temp range	STM32F031x6 with extended temp range	STM32F031x6 with extended temp range
Gate drivers	600 mA triple half-bridge	600 mA triple half-bridge	600 mA triple half-bridge
3.3 V DC/DC buck conv	Embedded	Embedded	Embedded
12 V LDO	Embedded	Embedded	Embedded
OpAmps	**4**	**3**	**1**
3FG 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
Firmware upgrade on the field	**Not available**	**Available**	**Available**

STSPIN32F0/A/B Pinout Comparison

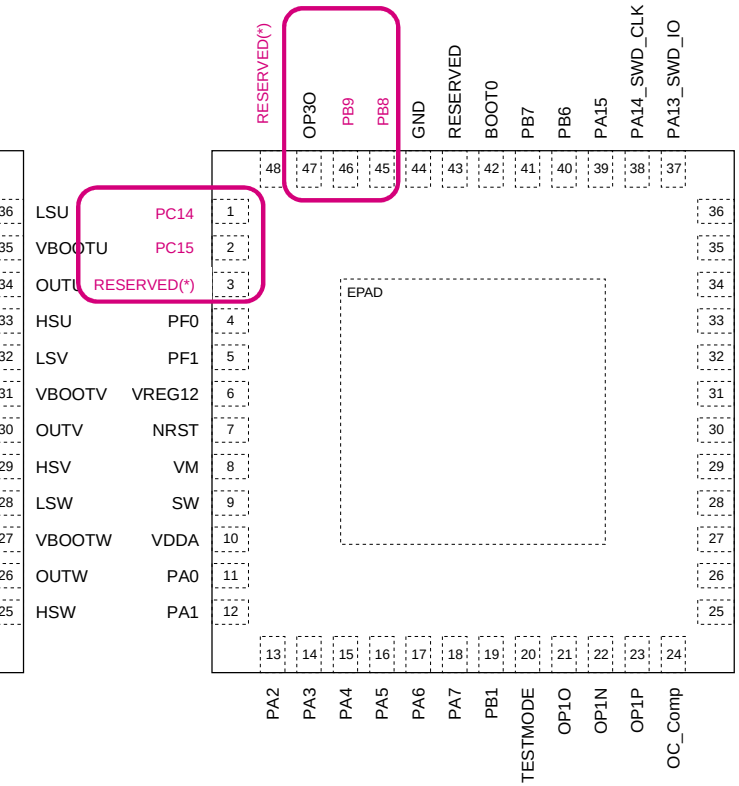
STSPIN32F0



STSPIN32F0A



STSPIN32F0B



Low Voltage MOSFET Top 3 Products Focus


Power Management


Communications


Computer & Peripherals


Consumer


Industrial


Automotive

40V ÷ 45V F7	60V-120 F7	40-150V F7 AG
Devices: STL200N45LF7, STL260N45LF7 STL160N4F7, STP260N4F7,	Devices: STL220N6F7, STx140N6F7, STx110N10F7, STx100N12F7, STx150N10F7	Devices : STLD257N4F7AG; STK130N4LF7AG, STL117N4LF7AG, STD80N4F6, STL210N4F7AG, STH410N4F7-2AG, STH205N12F7-2
Main Applications: • **Server** • **Datacenter-Telecom** • **DC/DC** • Drones • Motor control • Game console	**Main Applications**: • **Server** • **Datacenter-Telecom** • **DC/DC** • Adapter -Battery charger • Motor control • LEVc	**Main Applications for Automotive**: • EPS • Blower, • Wiper • ABS • Motor Control • DC/DC

life.augmented

Low Voltage MOSFET Top 3 Products Focus


Power Management


Communications


Computer & Peripherals


Consumer


Industrial

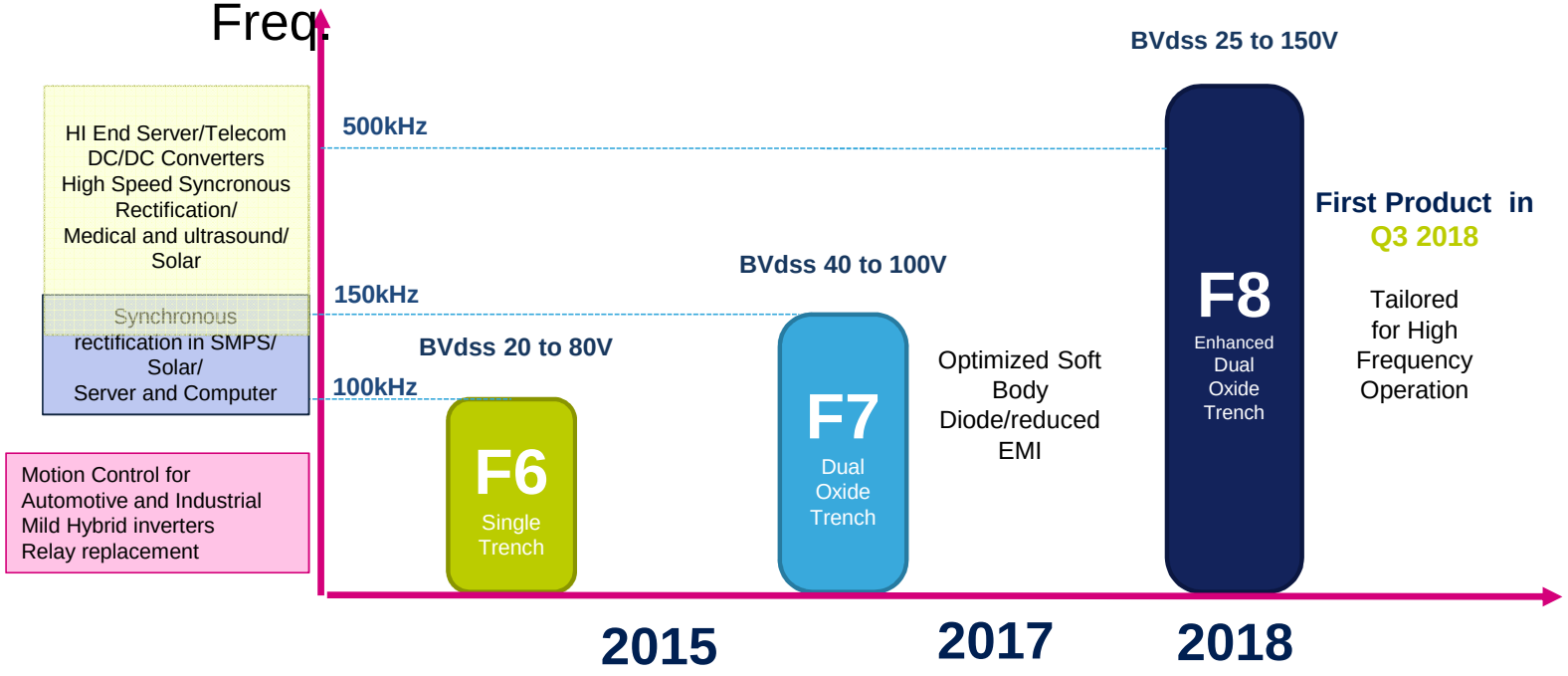

Automotive

40V ÷ 45V F7	60V-100 F7	40-100V F7 AG
Devices: STL200N45LF7, STL260N45LF7 STL160N4F7, STP260N4F7,	Devices: STL220N6F7, STx140N6F7, STx110N10F7, STx100N12F7, STx150N10F7	Devices : STLD257N4F7AG; STK130N4LF7AG, STL117N4LF7AG, STD80N4F6, STL210N4F7AG, STH410N4F7-2AG, STH205N12F7-2
Main Applications: • **Server** • **Datacenter-Telecom** • **DC/DC** • Drones • Motor control • Game console	**Main Applications**: • **Server** • **Datacenter-Telecom** • **DC/DC** • Adapter -Battery charger • Motor control • LEVc	**Main Applications for Automotive**: • EPS • Blower, • Wiper • ABS • Motor Control • EV DC/DC

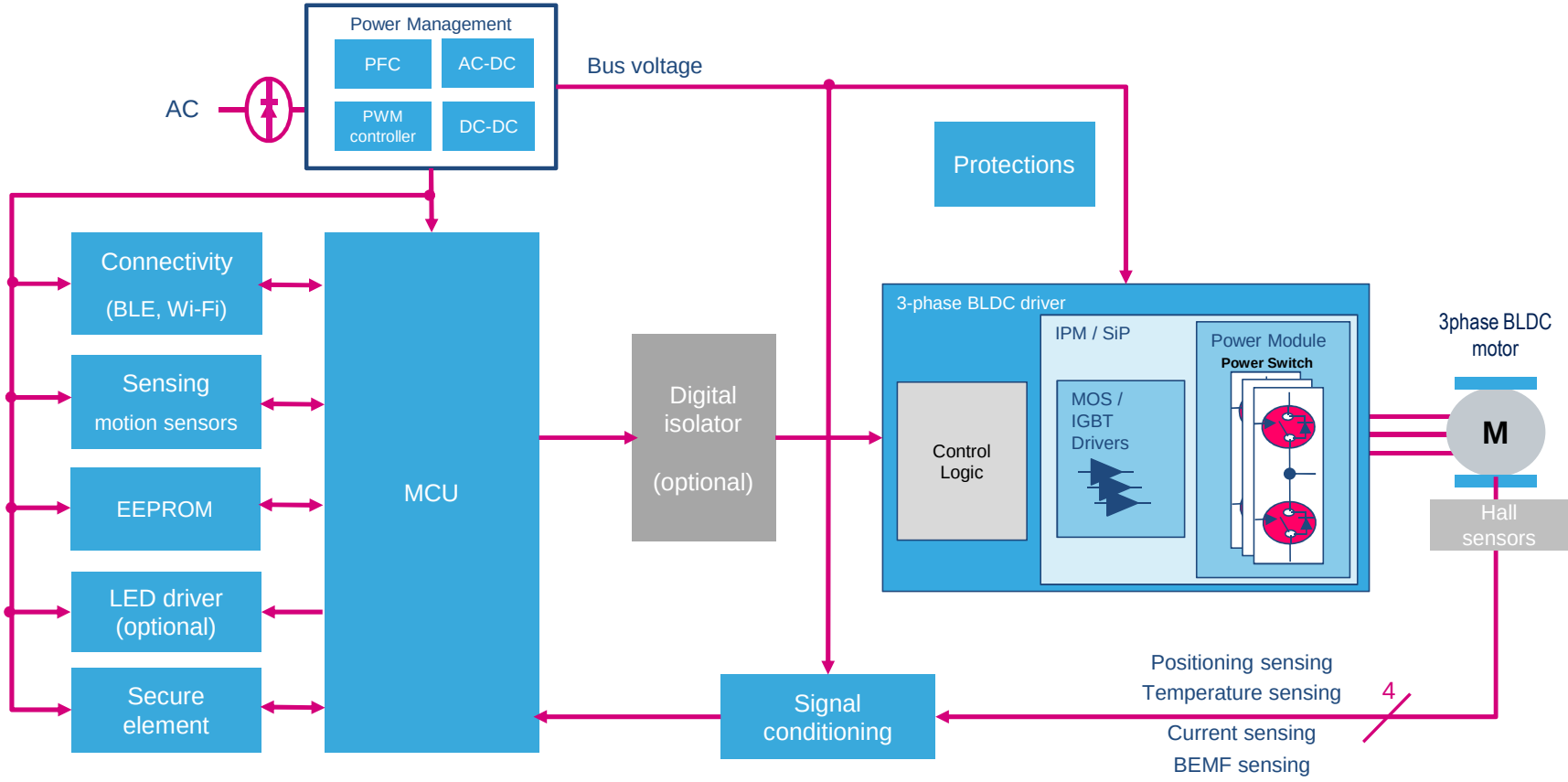
life.augmented

Low Voltage MOSFET Technology Roadmap

STripFET™



3-phase BLDC driven AC supplied power tool

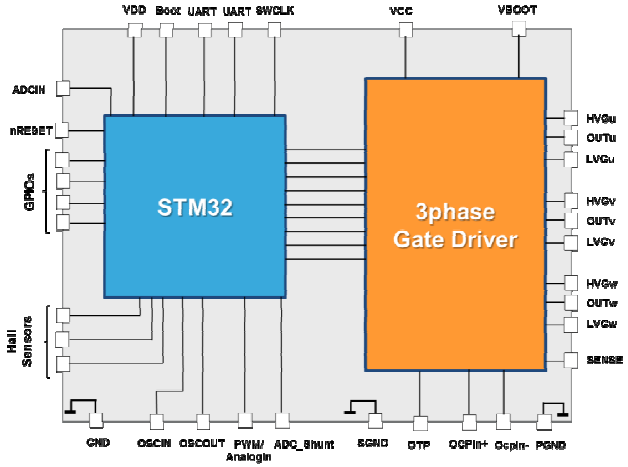


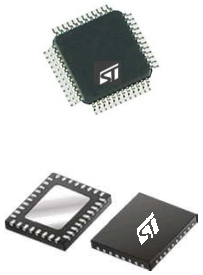
life.augmented

In development

STSPIN32F0H25 Preview

Advanced 250V 3-phase BLDC Driver with embedded STM32 MCU





KEY APPLICATIONS

- 48V & 72V Server FANs
- 36V – 72V Power tools
- Air conditioning FANs
- Industrial Pumps
- Industrial automation
- Home Appliances

Key Features

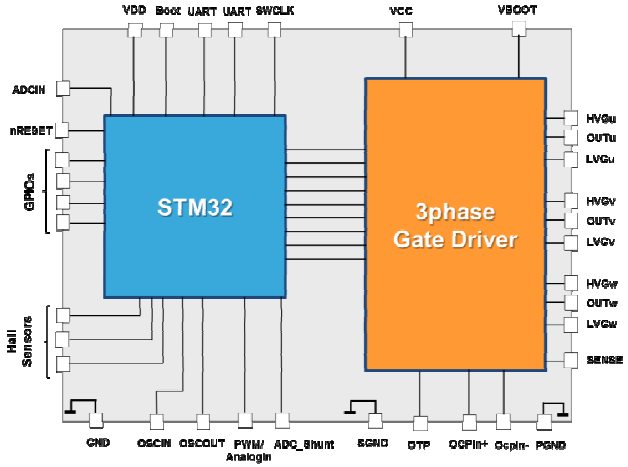
- **STM32 Cortrex M0 + 3-phase Driver**
- **Fully compatible with STM32 ecosystem**
- **6step & FOC sensorless / sensored algorithms**
- **Outstanding below-gnd robustness**

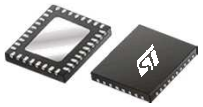
- VS = 250 V, I = 350mA driving capability
- 48 MHz, 32k Flash & 4k SRAM
- 12 bit ADC
- I2C / UART / SPI; 20 GPIOs
- FW boot loader support
- Integrated bootstrap Diodes
- Fully protected (UVLO, Short-circuit, OCP)
- Extended temp range: -40 to 125°C
- Leaded TQFP 10x10 mm package

In development

STSPIN32F0H60 Preview

Advanced 600V 3-phase BLDC Driver with embedded STM32 MCU





KEY APPLICATIONS

- Air conditioning compressors
- Home and Industrial refrigerators compressors
- Industrial Pumps
- White goods
- High power tools
- Industrial automation

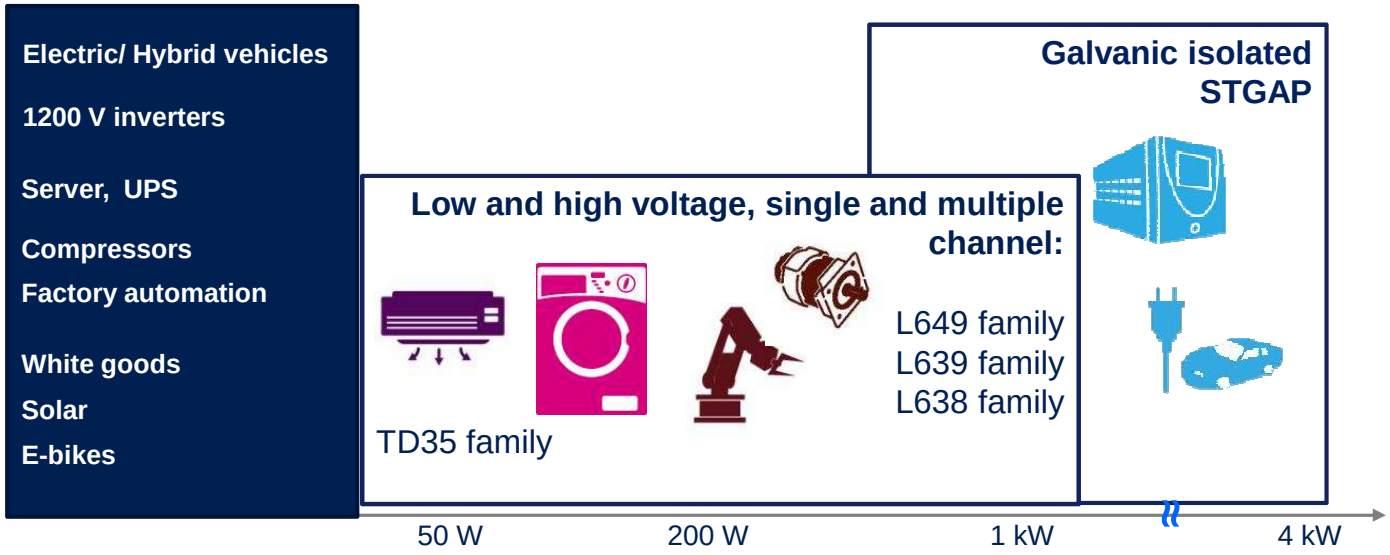
Key Features

- **STM32 Cortex M0 + 3-phase Driver**
- **Fully compatible with STM32 ecosystem**
- **6step & FOC sensorless / sensored algorithms**
- **Outstanding below-gnd robustness**

- VS = 600 V, I = 350mA driving capability
- 48 MHz, 32k Flash & 4k SRAM
- 12 bit ADC
- I2C / UART / SPI; 20 GPIOs
- FW boot loader support
- Integrated bootstrap Diodes
- Fully protected (UVLO, Short-circuit, OCP)
- Extended temp range: -40 to 125°C
- Leaded TQFP 10x10 mm package

Gate Drivers

A future-proof portfolio for a wide range of applications



Gate Drivers Portfolio vs Competition

What's more than competitors ?

- **State of Art integration level**

  HV Booststrap diode
  OP AMP
  Comparator
  Smart Shut Down

- **Highest performance**

  Better EMI
  Higher noise immunity
  More compact PCB

- Optimized for advanced BLDC driving technique (**Vector control**)

  FOC now possible with internal OP-AMP and Comparator

- **We sell in volume to:**
  - **Whirlpool, GE, Embraco, Philips**
  - **Bosh&Siemens, Electrolux, Ariston, EGO**
  - **Miele, Arcelik-BEKO, Magneti Marelli**
  - **Wellington, Fisher&Paykel**
  - **LG, EPSON, Panasonic, Mitsubishi**

ST advantages	Benefits vs Competition
Smart SD	• SELF PROCTETED • Speed up Protection intervention time • Improve PCB noise immunity (shorter PCB loops)
Integrated bootstrap diode	• Provides highest robustness in the market avoiding external diode and allowing both PCB's space and BOM's cost Saving
Integrated Comparator	• BOM's saving; no need to have an external Comparator
Integrated OpAmp	• Optimized solution for FOC (Field Oriented Control)

Gate Drivers – L638x Family

Features

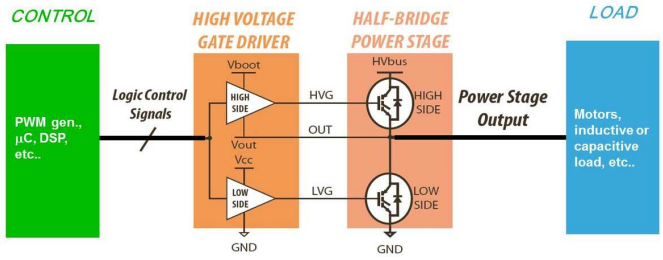
L6388E
- High & Low Side Inputs (3.3V compatible)
- UVLO on VCC/Vboot
- Interlocking & DT protections

L6387E / A6387
- Interlocking
- **AEC-Q100 qualified**

L6386E
+ SD In & Open Drain diagnostic
+ **Embedded uncommitted Comparator**

L6385E
- High & Low Side Inputs
- UVLO on VCC/Vboot
- **Able to drive asymmetrical loads**

L6384E
- **Single In & shutdown input**
- Interlocking & programmable DT,
- UVLO on VCC



- 400mA/650mA driving capability
- Integrated Bootstrap Diode
- Extremely robust and compact
- Comparator & Shut Down features
- Versatile and flexible
- SO-8/14 and DIP packages

life.augmented

Gate Drivers – L639x Family

Features

L6390
- **Comparator & Op Amp integrated**

L6391
- **Smart SD feature**
- **Comparator integrated**

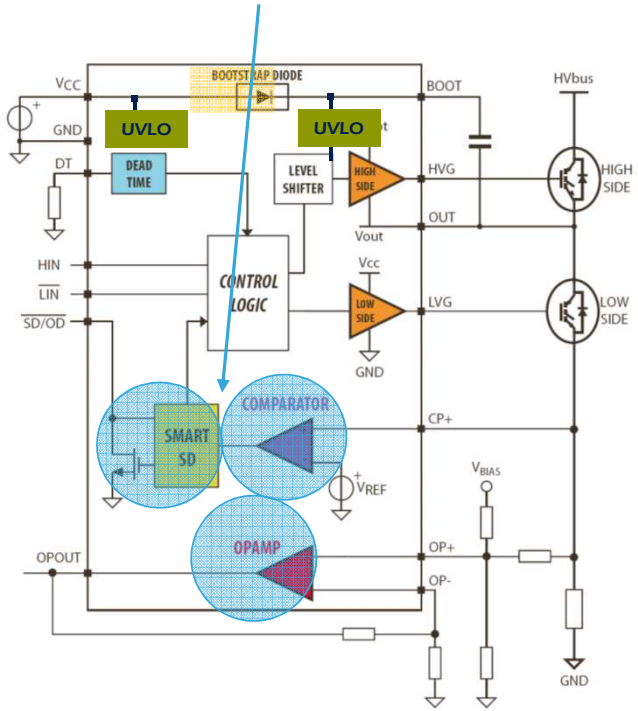
L6392
+ **OpAmp integrated**

L6393
- **Phase, Brake & Shutdown Inputs**
- **Uncommitted Comparator**
- Interlocking & Programmable DT
- UVLO on Vcc / Vboot

L6395
+ Able to drive asymmetrical loads

L6398
- High & Low side Inputs
- Interlocking & DT
- UVLO on Vcc / Vboot

Integrated features optimized for
Field **O**riented **C**ontrol **(F.O.C.)** technique

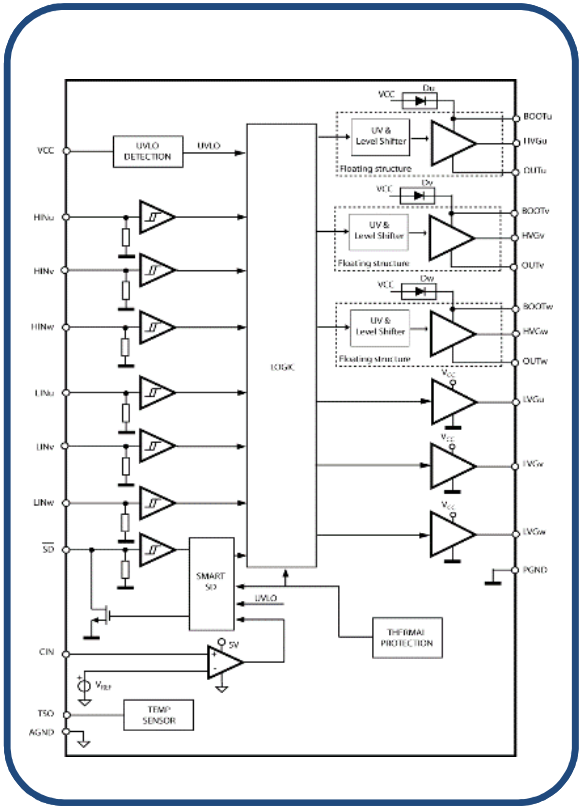


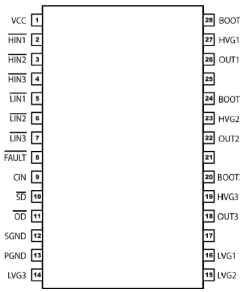
STDRV601 High voltage 3-ph gate driver

STDRV601

In development

- High voltage rail-up 600V
- dV/dt immunity ±50V/ns
- Current capability: 350mA/200mA
- Integrated bootstrap diodes
- Undervoltage lock-out on Vcc & BOOT
- Comparator for fault protections
- Smart shutdown function
- Over-temperature shutdown
- Adjustable deadtime
- Interlocking function





p2p replacement for IR2136x, 6EDL04I06xx, FAN73892/4

SO-28

life.augmented

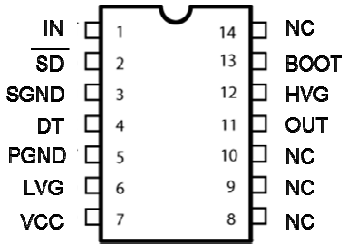
STDRIVE: High Current Evolution

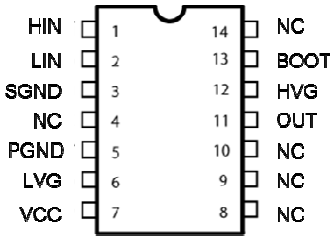
L6494L
- Half-Bridge driver
- 600V, 2.5A
- p2p replacement for IR21844, FAN7393A
- Single input and SD
- Programmable DT
- Integrated bootstrap diode
- Very High creepage
- SO-14

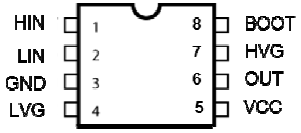
L6498L
- Half-Bridge driver
- 600V, 2.5A
- p2p replacement for IR21814, FAN73933
- Dual input with interlocking
- Integrated bootstrap diode
- Very High creepage
- SO-14

L6498
- Half-Bridge driver
- 600V, 2.5A
- p2p replacement for IR2181, FAN73901
- Dual input with interlocking
- Integrated bootstrap diode
- SO-8

- **MP;**
- **MP**
- **MP**



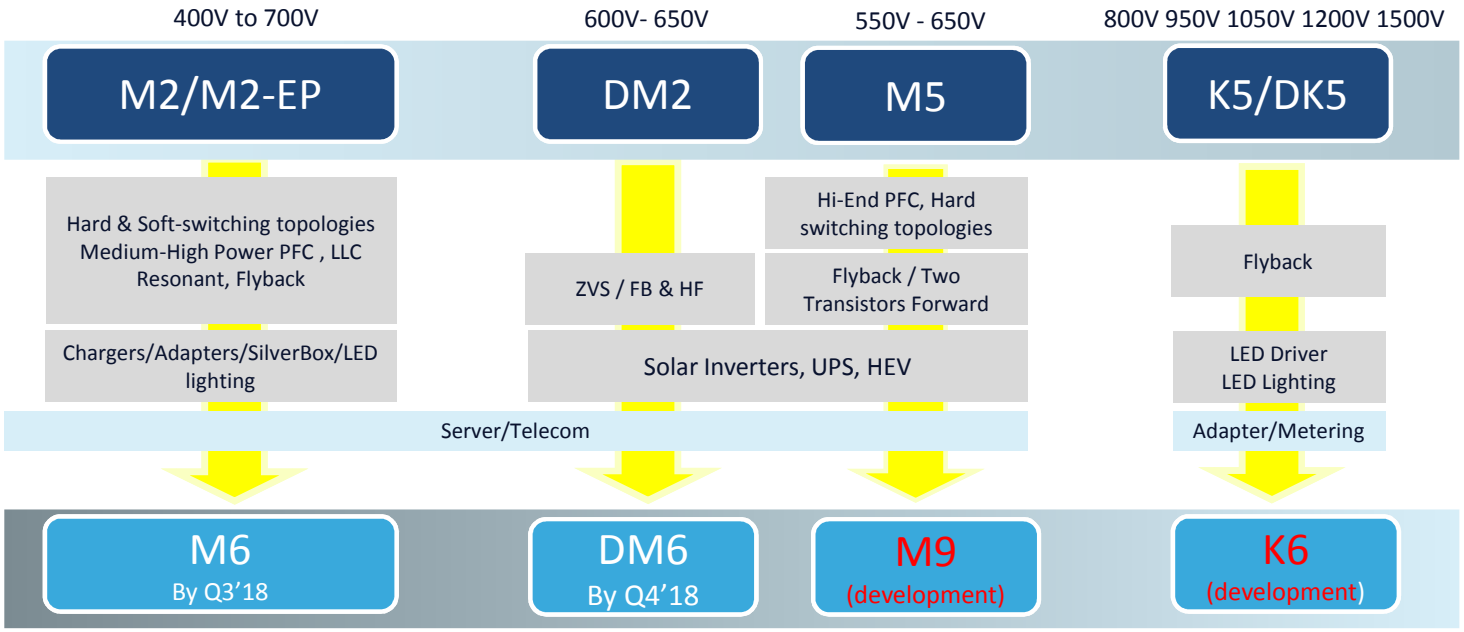




w/o DT: for high switching frequency applications

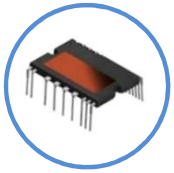
life.augmented

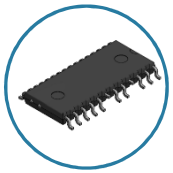
Current & Next SJ technologies Application / topology positioning

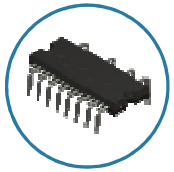


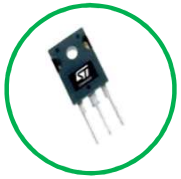
life.augmented

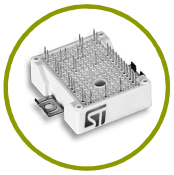
IGBT & Modules Top 3 Product Clusters


SLLIMM


SLLIMM-nano SMD


SLLIMM-nano


Discrete

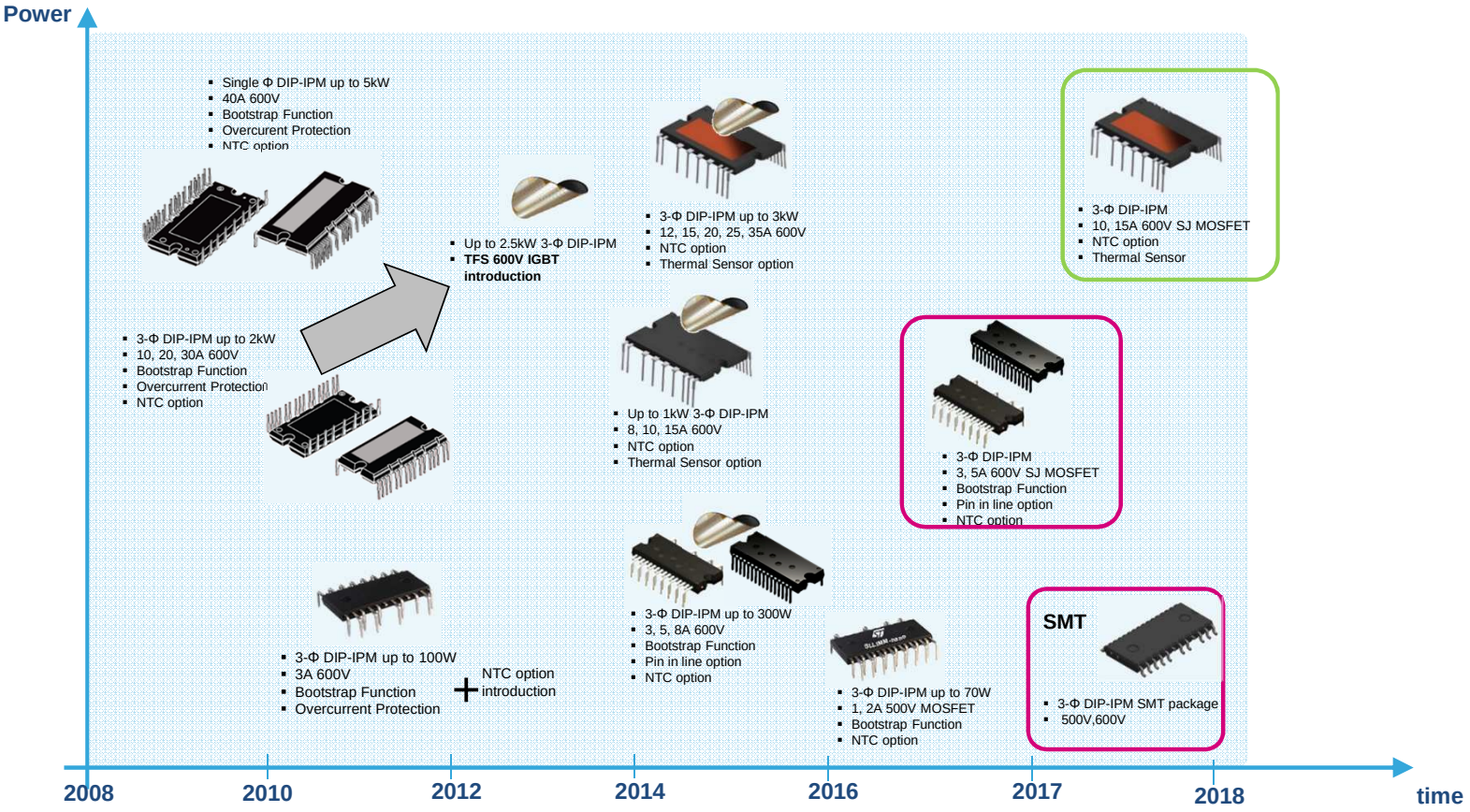

ACEPACK 2


ACEPACK 1

SLLIMM™ & SLLIMM-nano	Discrete & Dice	ACEPACK
Tech: IGBT & MOSFET SJ 500V÷600V	Tech: IGBT 650V÷1350V	Tech: IGBT (MOSFET or SiC upon request) 650V÷1200V
Main Applications: • Air-conditioning • Home Appliances • Pumps & Fan • General Purpose Inverters	**Main Applications**: • Inverter x Car Electrification • Ignition • Home Appliances & Motor Drives • Industrial • Induction Heating	**Main Applications**: • Motor Control (mainly) • Factory Automation • On Board Charging & Charging Stations

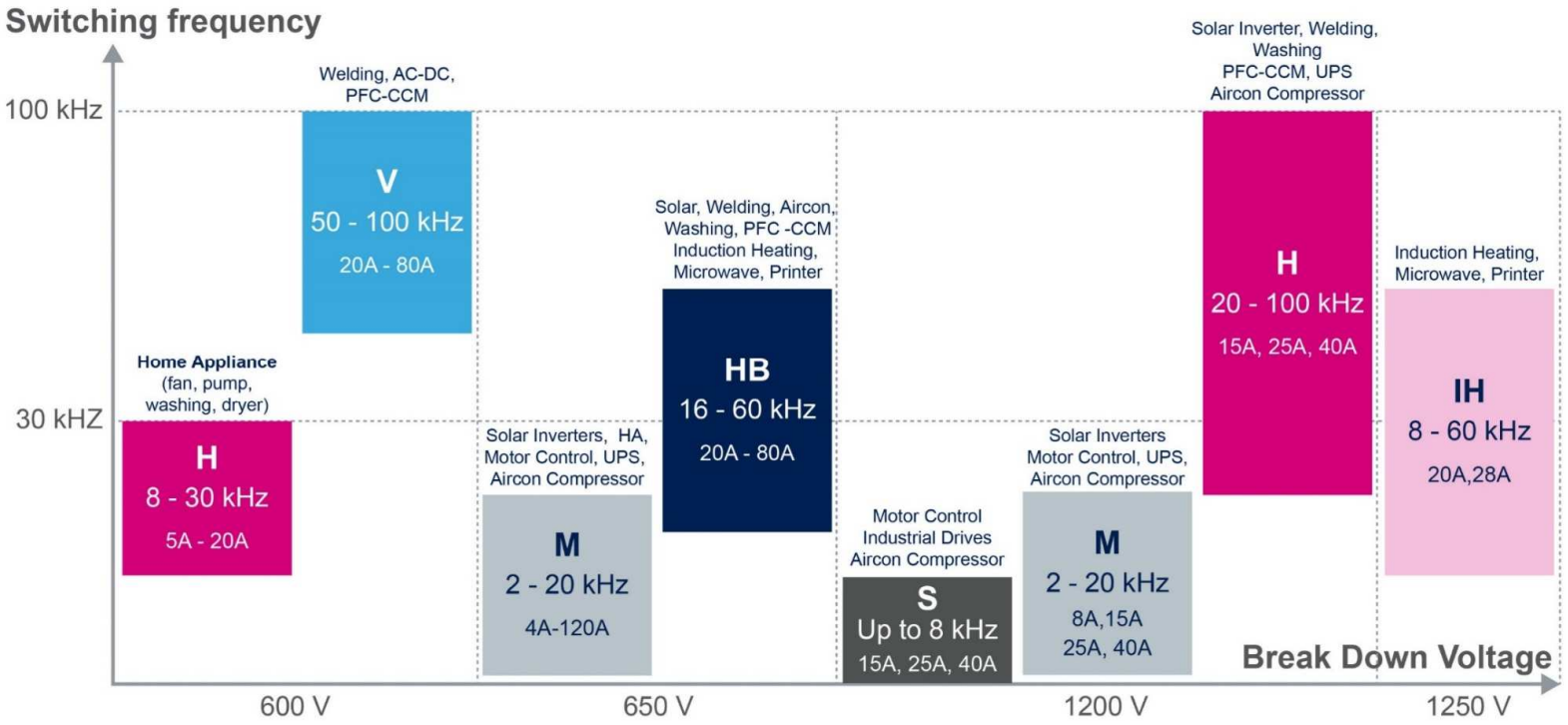
life.augmented

SLLIMM Family Evolution



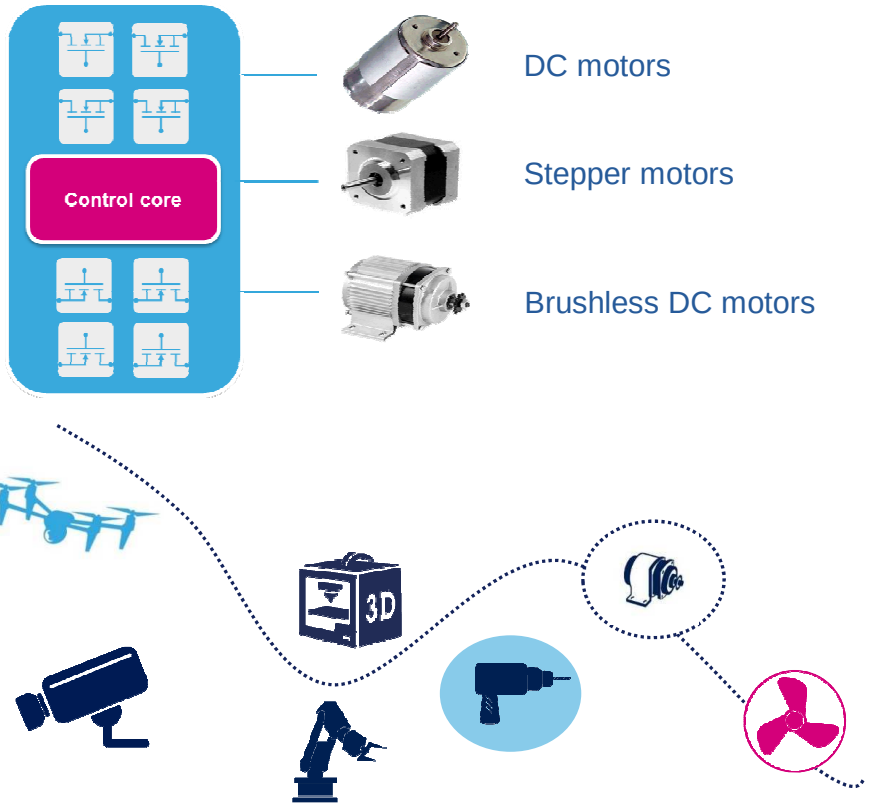
life.augmented

IGBT All Series Positioning



life.augmented

STSPIN at a glance



Wide Portfolio with over 125 P/N for DC, BLC and Stepper motor

Scalable solutions from 1.8V to 80V

Wide package offer from ultra miniaturized QFN to best in class power package

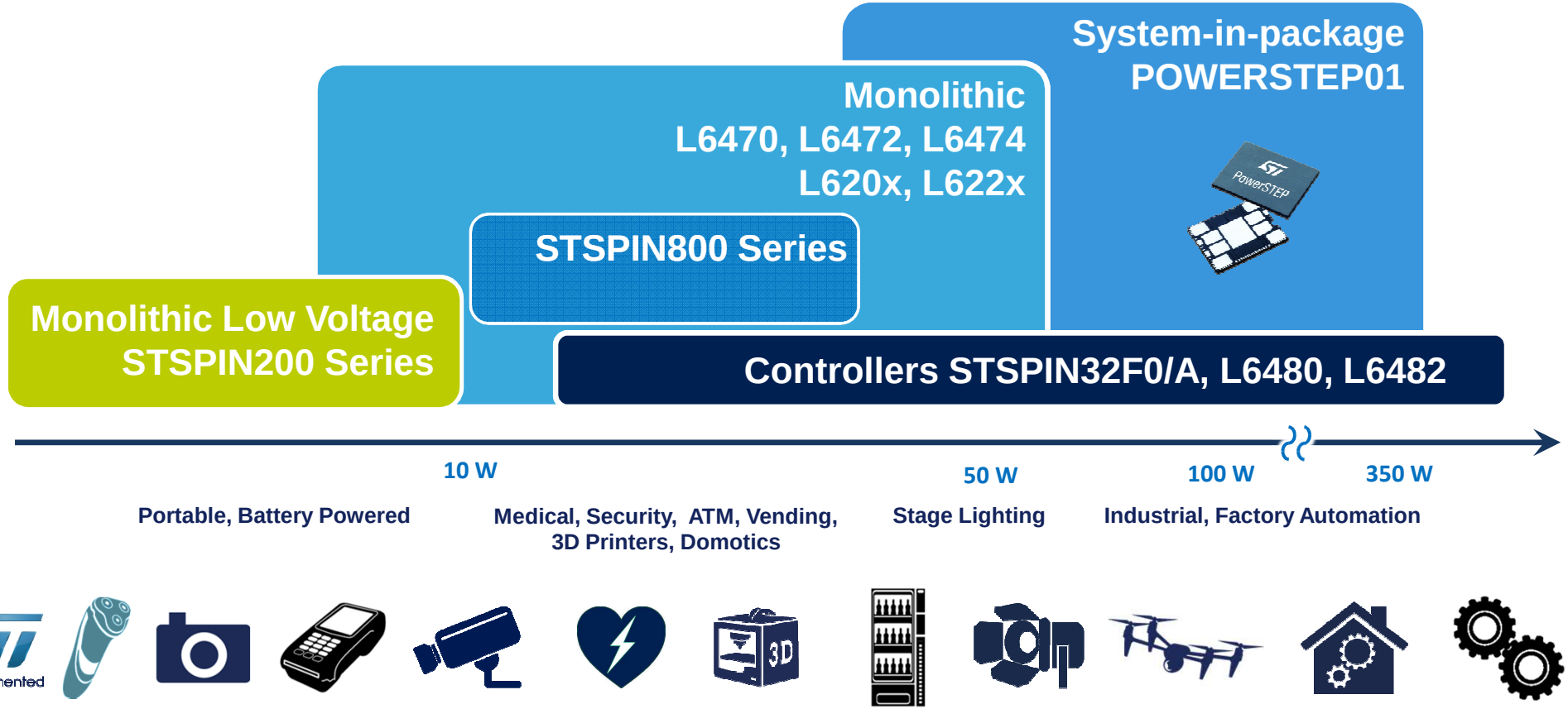
Fully digital programmable microstepping with smoothness and precision up to 1/256 micro-steps

High integration with embedded 32-bit **STM32F0** with ARM® **Cortex®-M0**

life.augmented

STSPIN Family Portrait

Leading integration, performance, efficiency

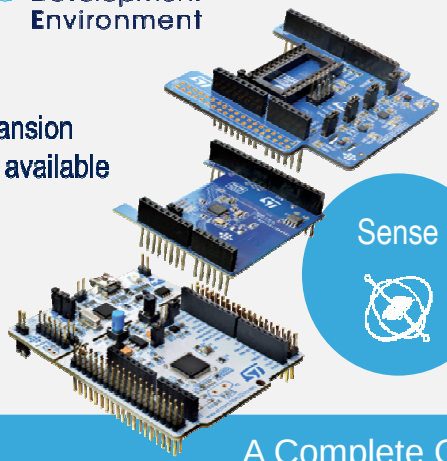


Ecosystem for Fast design

Flexible, easy and affordable way to develop innovative applications using ST components

STM32 Open Development Environment

30 expansion boards available



Connect

Power

Sense

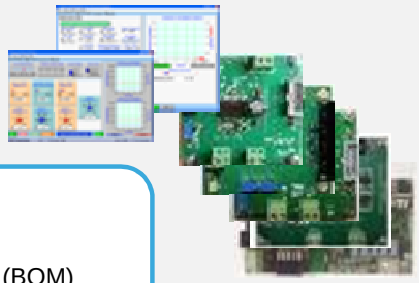
Translate

Move & Actuate

A Complete Offering

- Affordable expansion boards for STM32 Nucleo development boards
- Broad range of stackable ST solution covering all your needs
- Complete software ecosystem and pre-integrated applications

An exhaustive offer of plug & play reference design

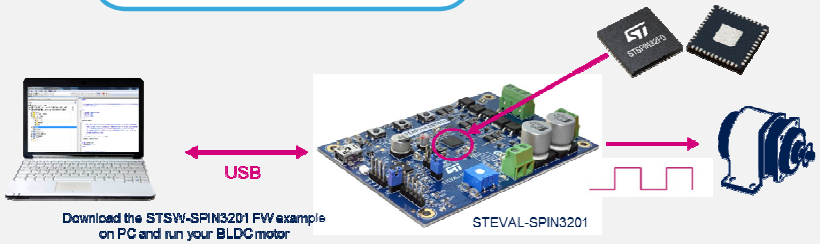


- Schematic
- Gerber files
- Bill of Material (BOM)
- Firmware / Software

press release

Datasheet
Evaluation board
Firmware example

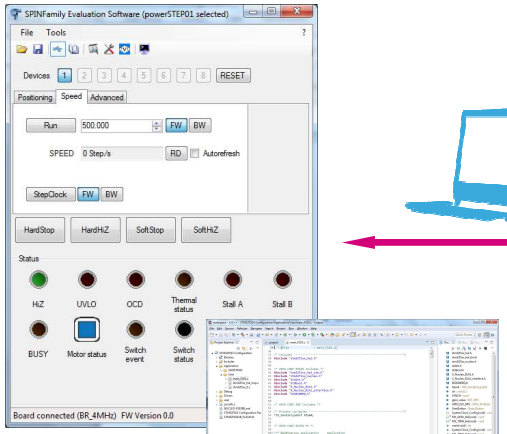
Flyer
Selection guide
Blogpost



STSPIN Evaluation Ecosystem

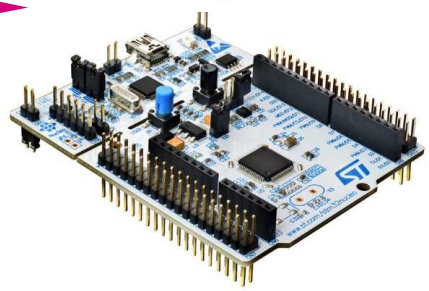
Speed-up your design with X-NUCLEO!

SPIN Family Evaluation Software



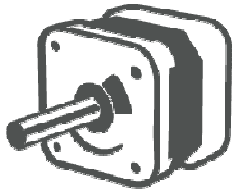
X-CUBE Firmware for STM32

X-NUCLEO



NUCLEO

DC Power Supply



Motor

life.augmented

Find your X-Nucleo now on st.com/x-nucleo

> 50 ready to use Evaluation Boards

NEW

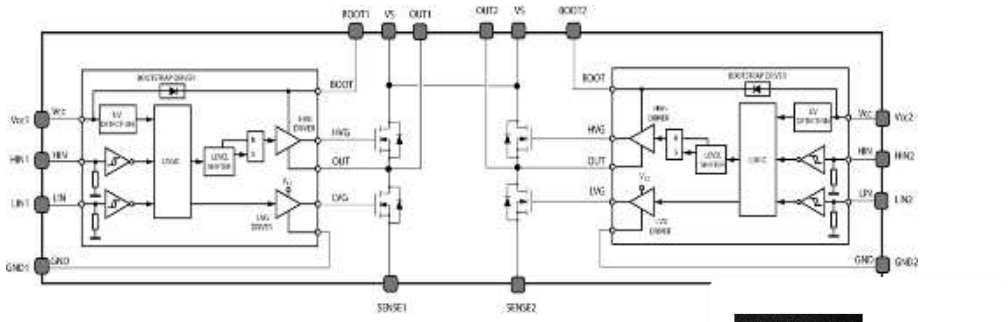
PWD13F60

High-density Power Driver System-in-Package
2x 600V gate drivers & 4 High Voltage pwr MOSFETs

Power Transistors

STSPIN

Motor Control

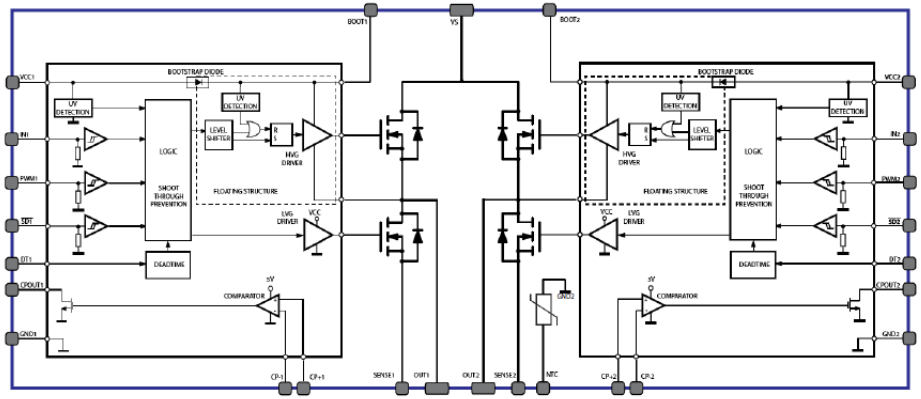


Key Features

- **High Voltage up to 600V**
- **Full-bridge power stage**
  I_{OUT} = 8A & $R_{DS(ON)}$ = 320mΩ
- **Integrated bootstrap diodes**
- UVLO protection embedded
- Interlocking feature against shoot-through
- Wide input supply voltage range: 0V–21V
- Inputs 3.3V / 5V compatible
- Outputs in phase with inputs
- Advanced QFN package 10x13 mm

PWD5F60

MP in early Q3 ‘18

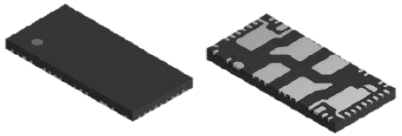


Main Features

- SiP integrating 2x 600V gate drivers & 4 HV Power MOSFETs
- **High Voltage up to 600V**
- **Full-bridge power stage**
  - **I_{OUT} = 5A & $R_{DS(ON)}$ = 1.5Ω**
  - **Fast-recovery Diodes (trr= 70ns)**
  - **NTC embedded**
- **Integrated bootstrap Diodes**
- **Embedded OCP**
- UVLO protection embedded
- Programmable Dead Time
- Interlocking feature against shoot-through
- Wide input supply voltage range: 0V–21V
- **Advanced miniaturized QFN package**

Ideal for:

- ✓ DC Motors (growing 1phase BLDC in HA)
- ✓ FAN drivers
- ✓ Industrial refrigerators
- ✓ Home gas based heaters



POWERSTEP01

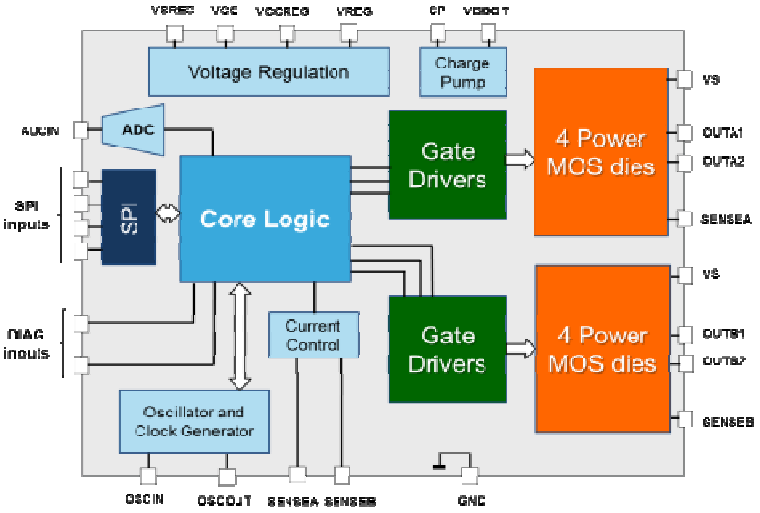
Stands for Power and Accuracy

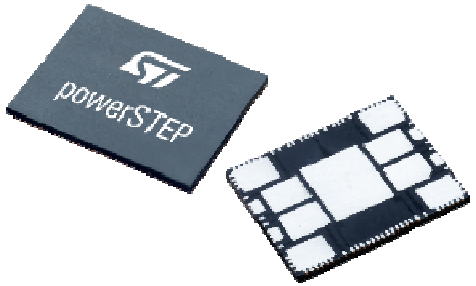
Programmable motor controller + 8 Pwr MOSFETs by 16 mΩ 15 mm QFN

Power Transistors

STSPIN

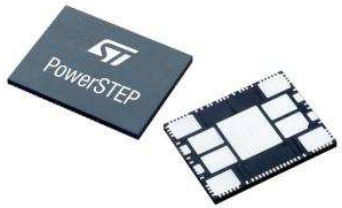
Motor Control

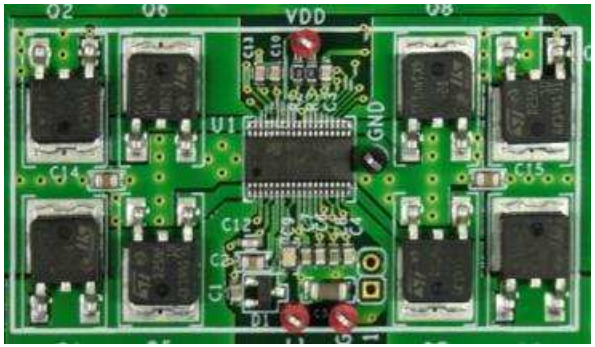




500W/ cm^2 power density

POWERSTEP01

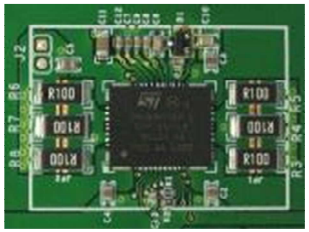




Improved performance

BOM Cost saving

67% PCB Area Saving



Key Features

- **Stepper Controller + 8 discrete MOSFETs**
- **Programmable to work in:**
  - **ST voltage mode control**
  - **ST Predictive I control + adaptive decay**
- VS = 85 V, I = 10A_{RMS} @ $R_{DS(ON)}$ = 16mΩ
- High precision; up to 128 usteps
- SPI Interface:
  - Fully programmable features
  - Full real-time diagnostics
- Digital Motion Engine
  - High-level motion commands
  - Programmable speed & positioning
- Sensorless stall detection

life.augmented

Thanks!

life.augmented