Factory automation and motor control solutions overview

ARM FDP 2023

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SRA-SAIL, STMicroelectronics

Greater NOIDA

Overview

1 Reference system solutions

2 Key drivers, trends and evolution
- Open Hardware And Firmware references
- Broad product portfolio and application
- **STM32 ODE**
- Energy efficiency norms
- Automation
- Wide popularity
- Continuous evolution and new technologies

How STM32ODE addresses developers' needs

- **It** offers a broad range of microcontrollers from low power to high performance to meet any application needs

- **It** provides extra functions that cover the main domains
  - Sensing, connectivity, power management, motor control, audio, HMI

- **It** eases the development up to the production
  - Support of multiple IDEs
  - Free-of-charge tools and embedded software to enable fast and easy development

Power

Secure

Move / Actuate

Process

Sense

HMI
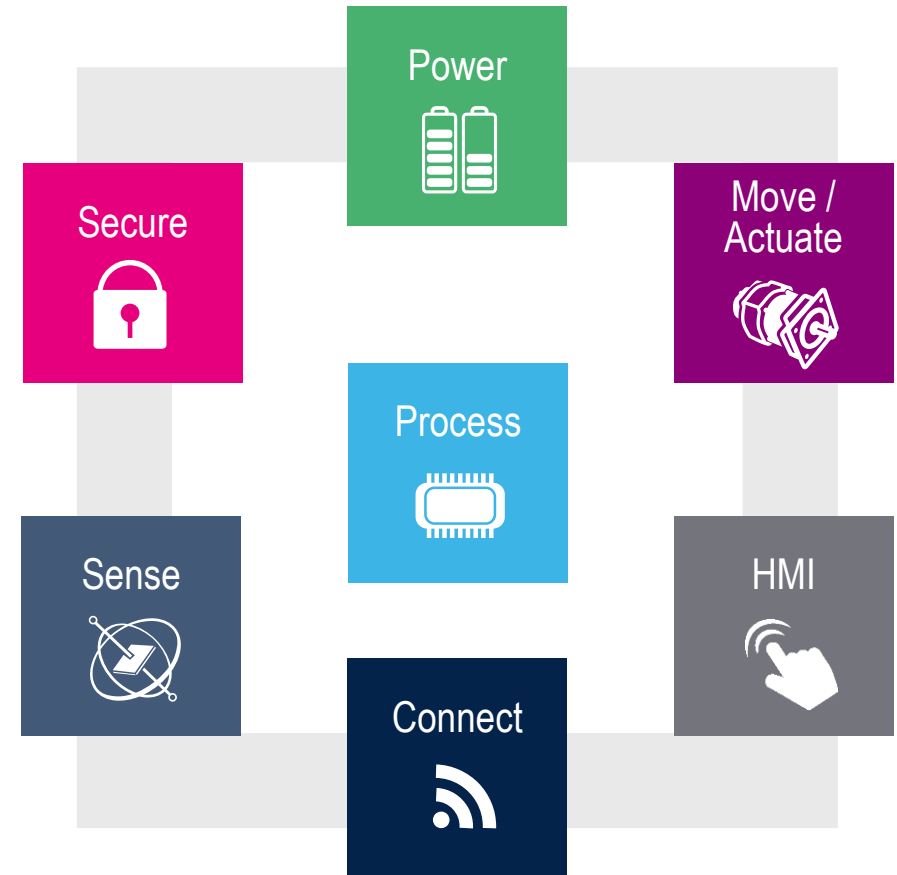
Connect

Industrial: footprint & application focus

Smart industry and factory automation
Current footprint and application focus

PLC and industrial IOs

PLCs
- HMIs
- Connectivity features
- IO capabilities
- Processing features

Key Products
- STM32F7/STM32H7
- STM32MP1
- Low-end STM32 (for simplest PLCs)
- EEPROM family
- STISO621
- Protections family

Industrial IOs
- Remote IO modules
- Galvanic isolation
- Self-powered modules

Key Prodcuts
- CLT family
- IPS family
- ISO8200xx family
- Protections family

Industrial connectivity

Wired
- IO-Link
- Smart sensor nodes
- Basic serial buses

Key Products
- IO-Link device and master xceivers
- STM32Lx / STM32Gx
- Serial interfaces
- Data protections

Wireless
- Mesh for IIoT / M2M
- Long range and LTE
- Data security in mixed technologies

Key Products
- STM32WB
- STM32WL
- BT low-energy v.5.0
- STM32L5
- STSAFE-A110
- Baluns family

Industrial Safety, condition monitoring

Industrial safety
- SIL grade devices and instrumentation
- Fail-safe devices

Key Products
- STM8, STM32, STM32MPU series running X-CUBE-STL
- IPS16x family
- CLT03-2Q3
- ISO8200xx family
- STISO621

CbM / PdM and Smart sensors
- Edge computing
- HS Datalogging
- Presence detection
- Cloud and AI for spread monitoring
- Partnership for AI, ML

Key Products
- ISPU
- Vibration sensors
- Industrial inclinometer
- MEMS microphones
- Magnetometer / iNEMO with ML core
- STM32L4 / L4+

Industry 5.0 is adding human interaction to Industry 4.0: with Industry 5.0 people are working in strict contact with robots and smart equipment.

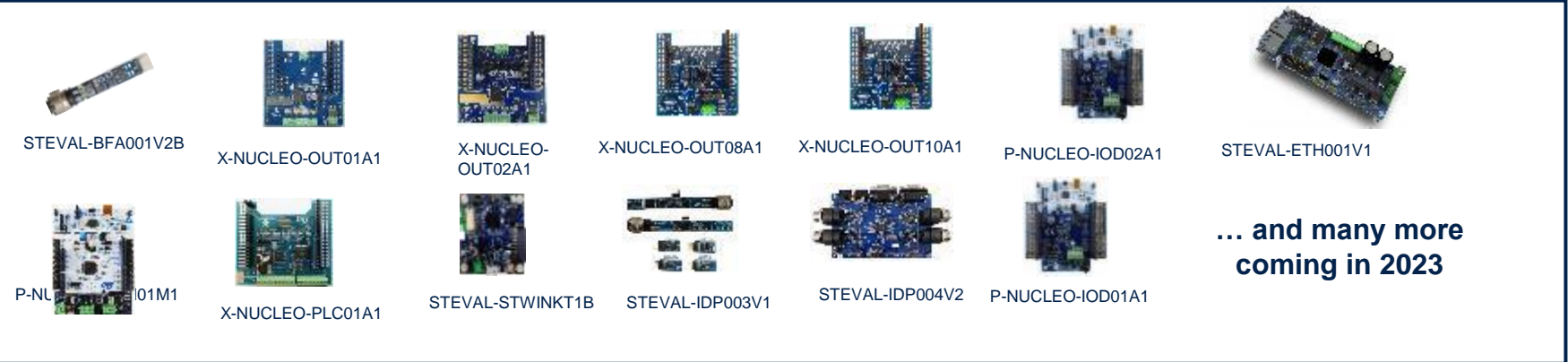|	
Augmented Reality	Autonomous robots
Simulation	Horizontal and vertical system integration
Big data	Cyber security
Cloud	Additive manufacturing

Key competences and IPs

Key Competencies

- Key ST technologies for ICs production (i.e. BiCMOS, galvanic iso.), packages, layout basics
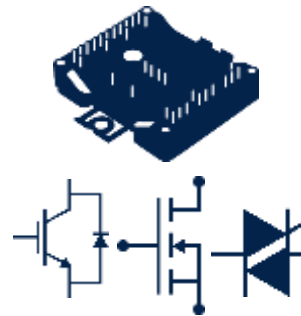
- STM32ODE basics, most common IDEs

- Communication protocols i.e. IO-Link - Industrial ref. standards: IEC61508, IEC61131-x, IEC61000

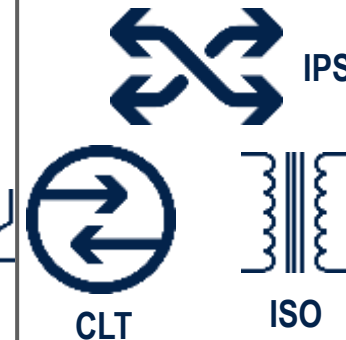- Industrial customer base by Region, application and sub-segment

STEVAL-BFA001V2B

X-NUCLEO-OUT01A1

X-NUCLEO-OUT02A1

X-NUCLEO-OUT08A1

X-NUCLEO-OUT10A1

P-NUCLEO-IOD02A1

STEVAL-ETH001V1

P-NUC...___01M1

X-NUCLEO-PLC01A1

STEVAL-STWINKT1B

STEVAL-IDP003V1

STEVAL-IDP004V2

P-NUCLEO-IOD01A1

… and many more coming in 2023

Product know-how

Discrete & Power Transistors

Analog, Industrial & Power Conversion ICs

IPS

CLT

ISO

GP MCU & MPU Secure MCUs, EEPROM

STM32

STM32

MPU

EEPROM
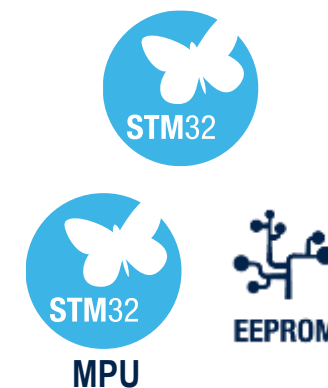
MEMS & Optical sensing solutions

Others:

SiC

SiC

Others:

STSPIN

BlueNRG

Others:

ST25

STSECURE

Others:

FlightSense

iNEMO

Key drivers, trends and evolution
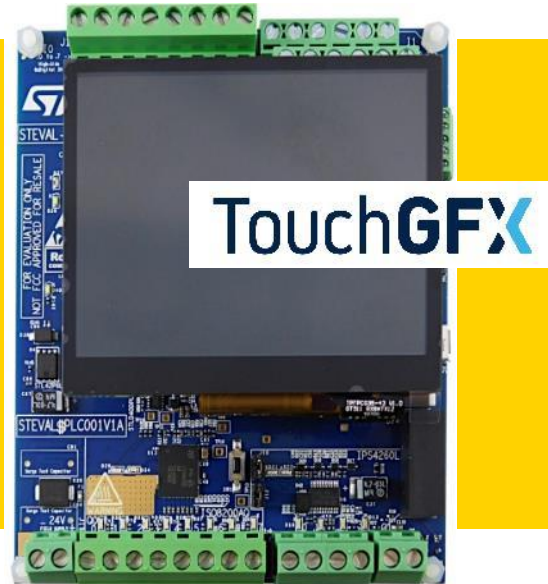
STEVAL-PLC001V1
All-in-one PLC with HMI interface

Solution Specs

- ✓ 12-IN 12-OUT multi-featured PLC
- ✓ 3-modes Display driven demo HMI:
  - ✓ Info mode
  - ✓ IO play mode
  - ✓ Ladder logic examples
- ✓ Morpho connector expandability option
- ✓ Screw connectors for industrial signals mng
- ✓ 24V operations and micro-USB for Logic only

Key Products

- STM32F746ZGT7 high-performance MCU embedding ARM® Cortex®-M7 CPU with FPU, Chrom-ART accelerator, DSP instructions
- TouchGFX based HMI
- CLT01-38SQ7, octal input interface with high speed SPI
- CLT03-2Q3, self-powered dual independent digital input
- IPS4260L quad-channel low-side driver
- ISO8200AQ octal high-side with galvanic isolation and SPI

Major Design Challenge

- Integration of display with touch sensing driver to provide HMI features
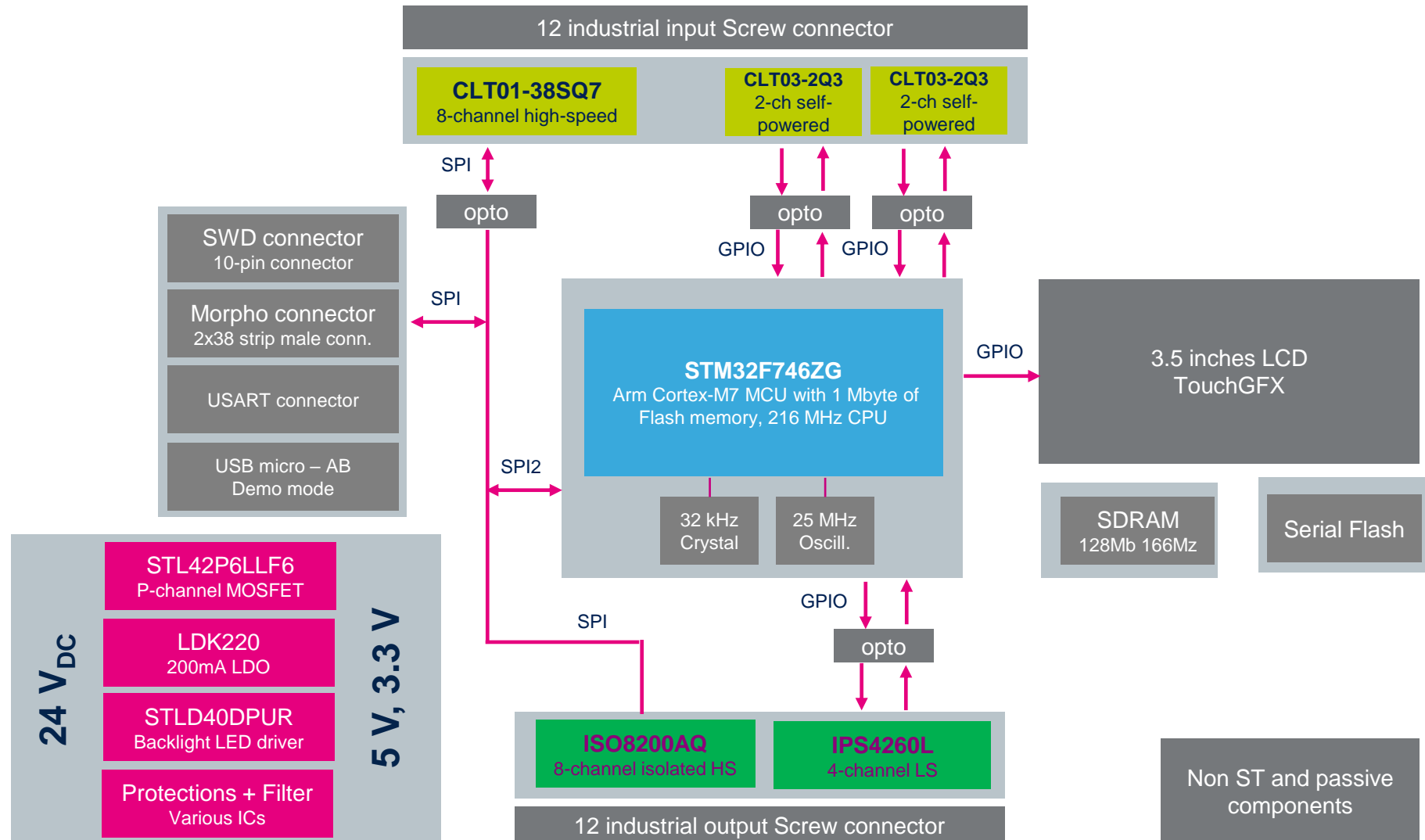- Co-existence of heterogenous IOs

STEVAL-PLC001V1
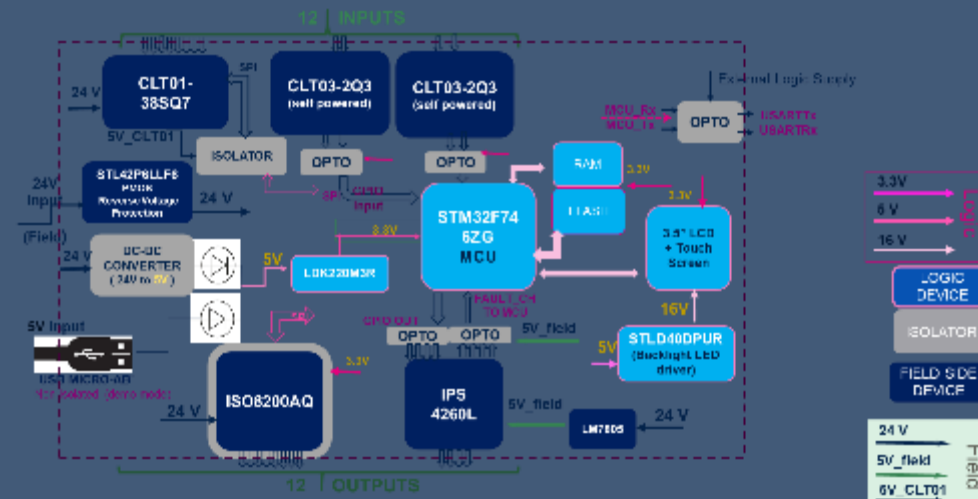
Key Features:

- TouchGFX Graphic framework
- Isolation through opto and galvanic
- Daisy chain SPI between 8-in and 8-out devices
- Smart PCB + EMC test area
- LEDs for IO signaling
- High speed or self-powered inputs
- Low side outputs or SPI with galvanic iso, all wit 0.7A per channel

9

The STSW-PLC001 features:
- Framework to use STEVAL-PLC001V1 evaluation board modules including TouchGFX-based HMI
- Simple user APIs to access each of the 12 digital inputs and 12 digital outputs individually or collectively (per module)
- Fault and status reporting
- Board support utility routines e.g. Timer, PWM, UART
- Demo use cases including board information mode
- Easily expandable to include user-defined use-cases, including ladder logic

STSW-PLC001 is the preloaded firmware package for the STEVAL-PLC001V1 board that allows selecting different use-cases through the board touchscreen.

You can select one of the following use-cases through the touchscreen interface:

- **IO Play mode**: digital outputs (DO) mimics corresponding to digital inputs (DI) as per board symmetry
- **Info mode**: board information and device details are shown (this mode can work even with 5 V supply to USB connector)
- **Ladder Logic mode**: simple ladder examples (appropriate input and output have to be connected)
- **Self-test mode**: to test board key components and firmware functions as well as RAM, Flash and touch screen and IO modules (for the IO modules, loop-back connections are needed to test each input and output channel with predefined patterns)
- **User defined mode**: contains user-defined use-cases (this mode can be used to add code for the user-defined logic)

X-NUCLEO-PLC01A1/OUT02A1 solutions for plcs ad remote iOS

Key products:

- VNI8200XP octal high-side solid state relay
- CLT01-38SQ7, octal input interface with high speed SPI

X-NUCLEO-PLC01A1

Key Features:

- Enables a PLC (Programmable Logic Controller) function subset on STM32 Nucleo
- 8x input with CLT01-38SQ7 high-speed protected digital termination array
- 8x output with VNI8200XP high-side solid state relay
- Status LEDs: Fault, Thermal, Power
- I/O (input/output) activity LEDs 24 V power supply
- Free comprehensive development firmware library and example compatible with STM32Cube firmware
- Compatible with Arduino UNO R3 connector

Key products:

- ISO8200AQ, octal high-side driver with galvanic isolation and SPI interface

X-NUCLEO-OUT02A1

Key Features:

- Based on the ISO8200AQ whose main characteristics are:
  - Embedded 4kV galvanic isolation
  - Radio frequency communication between the logic and process sides for maximum noise immunity
- Supply reverse polarity protection
- EMC compliance according to IEC61000-4-2, IEC61000-4-3, IEC61000-4-5
- Compatible with STM32 Nucleo boards
- Equipped with Arduino™ UNO R3 connectors
- CE certified

X-NUCLEO-OUT04A1
Expansion board based on IPS2050H-32

Solution Specs

Device specifications:
- ✓ Operating voltage from 9V to 60V
- ✓ Two high side output channels with $R_{ON}=50m\Omega MAX$
- ✓ Smart driving for capacitive loads/bulb lamps
- ✓ Fast demagnetization of inductive loads
- ✓ V_{CC} UVLO and Clamp protections
- ✓ Per channel diagnostic open drain signalization
- ✓ Per-channel output overload protections (ILIM = 5AMIN)
- ✓ Per-channel and case Over-Temperature protections
- ✓ Designed to meet IEC 61000-2/4/5
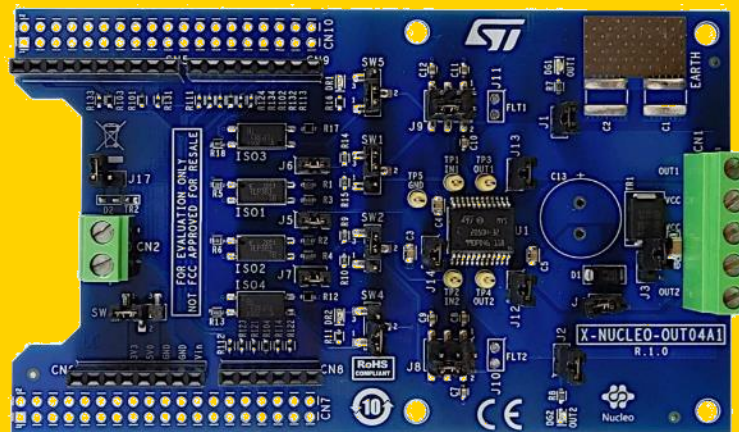
Key Products

- • IPS2050H-32

Major Design Challenge

- • Same layout for different Nucleo expansion board based on different IPS devices:
  - • Dual/single output
  - • 2 A / 4 A load driving

X-NUCLEO-OUT04A1

STM32 NUCLEO board

Digital Output Expansion board
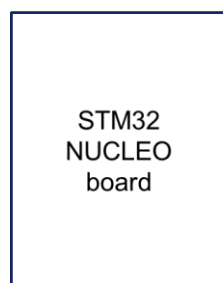
1 x 4 A

2 x 4 A

1 x 2 A

2 x 2 A

Key Features:

- • Nucleo expansion board based on IPS2050H-32
- • The on-board opto-coupler guarantee a 2.5kV isolation between the logic and process sides.
- • Process side of the board is supplied by 12V or 24V supply rail
- • The logic side of the board is supplied by the 3v3 available on the NUCLEO board or by external supply (5 V max)
- • On board LEDs allow visual monitoring of outputs status and diagnostic
- • Up to 3 boards can be stacked

Major trends in industrial safety

Technical trends vs. benefits and challenges

Intrinsically safe devices for IEC61508
60V rated, independent current delivery, safety documentation

SIL2 / SIL3 architectures
X-CUBE-STL libraries across SMT32 and STM32MP families + Safety manuals
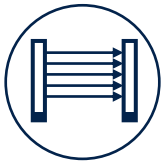
Safer development for safe end-device
Safety in Automation is getting bigger shares as such safe devices are increasing in complexity

Our value

60V rated devices are introduced in many solution designs

Deployment of SIL2 / SIL3 solutions trough our MCUs and X-CUBE-STL

Safety oriented and pre-certified design (certification on development steps) to be released by end of 2021
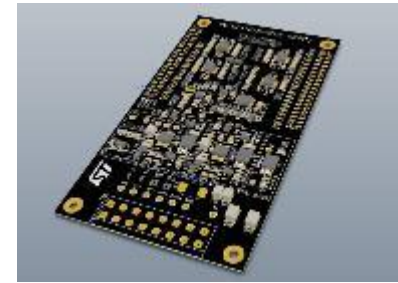
Key available solutions

- **X-NUCLEO-OUT08A1**
- **X-NUCLEO-OUT10A1**
- **STEVAL-SILPLC01** SIL2 PLC, certification ready

Coming by eo Q2-23

STEVAL-FSM01M1 fail-safe module (by Q4-2021)

STEVAL-SILPLC01
PLC SIL-ready platform

Solution Spec.

- ✓ PLC SIL platform designed to meet IEC61508 SIL 2 level
- ✓ Operating Voltage 24V - 36V.
- ✓ Maximum voltage 60V
- ✓ Dedicated documentation FMEA,FMEDA

Key Products

- • STM32H723VG
- • IPS160HF (Digital Output)
- • CLT03-2Q3 (Digital Input)
- • L7987L (DC/DC converter)
- • LD39150DT33 (Low drop linear regulator)

Major Design Challenges
- • hardware submitted to ISA for official assessment in line with IEC61508-2
- • connectivity with ERT based on EtherCAT slave stack (no Safety over EtherCAT protocol) and RS485 PHY
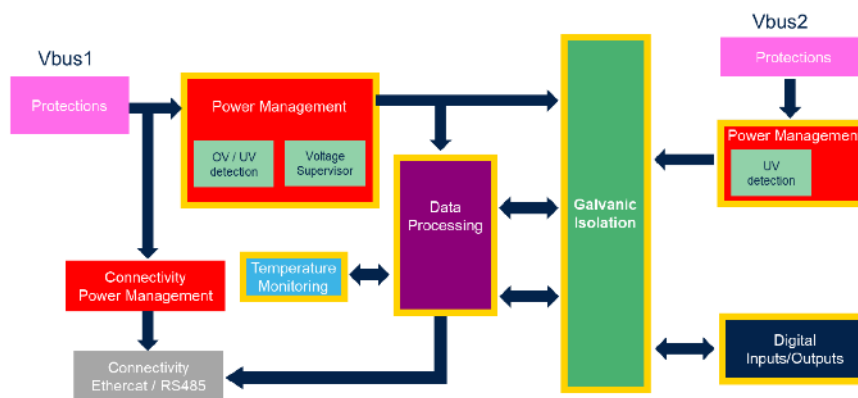
Key Features:

- • Dual digital input/output , with 2.4 A current capability for load actuation
- • Opto-isolation on board
- • Fieldbus communication
- • Compact form factor
- • ST library for SIL application (X-CUBE-STL)
- • Power management circuit for digital circuits voltage reference generation

X-NUCLEO-OUT05A1/OUT06A1 Expansion board based on IPS1025H/IPS1025H-32

Key products:

- IPS1025H, 25mΩ dual IPS with smart driving of 2A loads

X-NUCLEO-OUT05A1

Key Features:

- Nucleo expansion board based on IPS1025H:
  - Dual 2 A load driving
- The on-board opto-coupler guarantee a 2.5kV isolation between the logic and process sides.
- Process side of the board is supplied by 12V or 24V supply rail
- The logic side of the board is supplied by the 3v3 available on the NUCLEO board or by external supply (5 V max)
- On board LEDs allow visual monitoring of outputs status and diagnostic
- Up to 3 boards can be stacked

X-NUCLEO-OUT06A1

Key products:

- IPS2050H-32, 50mΩ Dual IPS with smart driving of 4A loads

Key Features:

- Nucleo expansion board based on IPS1025H-32:
  - Dual output 4 A load driving
- The on-board opto-coupler guarantee a 2.5kV isolation between the logic and process sides.
- Process side of the board is supplied by 12V or 24V supply rail
- The logic side of the board is supplied by the 3v3 available on the NUCLEO board or by external supply (5 V max)
- On board LEDs allow visual monitoring of outputs status and diagnostic
- Up to 3 boards can be stacked

STEVAL-FSM01M1
Fail-safe module

Solution Specs

Key products

- ✓ Galvanic isolation between digital and process side
- ✓ ESD 8kV/10kV, EFT 4kV, Surge 2kV compliance to IEC 61000-4-x
- ✓ Lightweight firmware package included
- ✓ Digital diagnostics of IOs
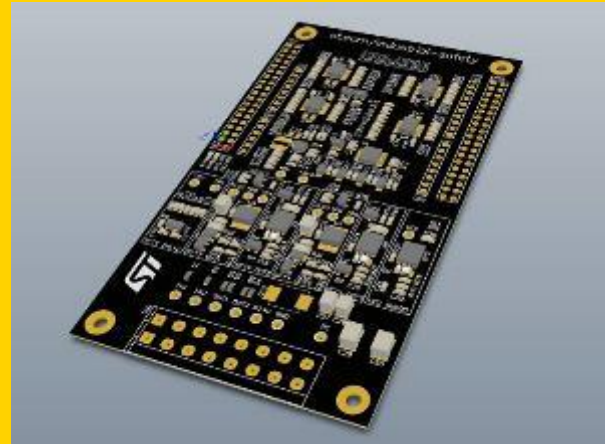
- • IPS160HF (Single channel high-side switches 2.4 A)
- • IPS161HF (Single channel high-side switches 0.7 A)
- • CLT03-2Q3 (self-powered digital input current limiter)

Major Design Challenge

- • P-P topology implemented with mixed IPS + MOSFET to meet customer expectations

STEVAL-FSM01M1

STM32 Cube ,...

Galvanic Isolation

STEVAL-FSM01M1

Reverse Polarity Protection	Transient Voltage Protection	Power
Control Logic	CLT03-2Q3	IN1 / IN2
Dual P-switch	2x IPS16xHF	OUT1 / OUT2

Dual P/P Safety Switch
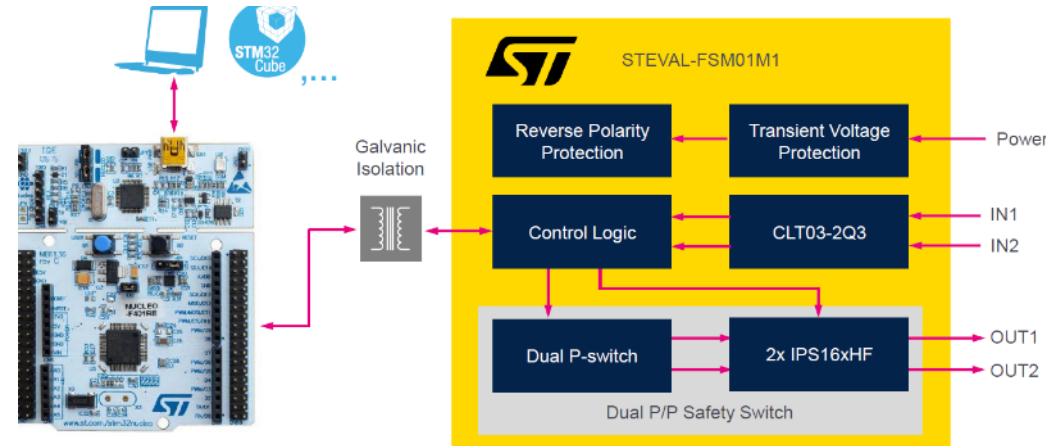
Key Features:

- • 2 Safe digital outputs + 2 Safe digital inputs
- • P/P safe switching topology using a P-channel MOSFETs in each output channel
- • Line discharge circuit in each channel
- • Galvanic isolation between digital and process side
- • Industrial longevity program devices (15 years)
- • Connection through ST morpho connectors allowing compatibility with X-NUCLEO boards

life.augmented

Major trends in industrial connectivity

Technical trends vs. benefits and challenges

Multi-protocol nodes
IIoT and smart sensor nodes are demanding flexibility

IO-Link
The lowest level industrial protocol connecting sensors and actuators up to PLCs or concentrator hubs is a consolidated trend

Time Sensitive Networks
Industrial automation is turning to TSN due to larger bandwidth, increased security, improved latency and synch.

TSN

Our value

STM32WB and WL based designs are leading to develop highly integrated smart nodes, even configurable in terms of wireless protocol by end of 2021

Focusing since the beginning on IO-Link technology supporting all products with solutions, demos and brochure

TSN and OPC-UA is where industrial wired connectivity is turning to. Several exploration activities have been done and we are monitoring the evolution of the market.

Pictures are not in scale

Key available solutions

- **STEVAL-IOD04KT1**
- **P-NUCLEO-IOD02A**
- **STEVAL-ETH001V1 1**

STEVAL-IOD04KT1
Dual-channel IO-Link M8 form-factor smart sensor

Solution Specs

- ✓ IO-Link protocol stack v.1.1 up to COM3
- ✓ 2-channel (CQ and DIO) IO-Link PHY layer
- ✓ IO-Link DLL (M-sequence handler and checksum)
- ✓ 24 V environment

Key Products

- L6364W (IO-Link dual-channel device transceiver in CSP package)
- STM32G071EBY (Mainstream Arm Cortex-M0+ MCU with 128 Kbytes of Flash memory memory, 36 Kbytes RAM)
- ISM330DHCX (iNEMO inertial measurement unit (IMU): 3D accelerometer and 3D gyroscope with digital output for industrial applications)
- IIS2MDC (High accuracy, ultra-low-power, 3-axis digital output magnetometer)

Major Design challenges:

- IO-Link protocol stack designed in-house for L6364W
- Key products in CSP package result in smallest form-factor board in ST (45 x 7.5 mm) with several ICs on board
- All components on top side

STEVAL-IOD04KT1

Key Features:

- The kit is made of:
  - STEVAL-IOD004V1 main PCB
  - M8-M12 adaptor including 20cm cable
  - STLINKV3-MINI programmer
  - STSW-IOD04K
- 10-pin expansion connector
- SWD programmer connector
- M8 4-pin male connector
- All Industrial commitment ICs

STEVAL-IDP004V2
IO-Link master board with v.1.1 stack

Solution Specs

✓ Master IO-Link stack embedded with read out protection, limitation of time of use (10000 minutes)

✓ Fully compatible with all IO-Link commercial devices

✓ RS485 communication running to support PC interface

Key Products

- L6360 – Master transceiver IO-Link ICs
- STM32F205RB – High performance ARM Cortex-M3 MCU with 128 Kbytes Flash
- STPS1L40A - Low drop Power Schottky rectifier
- ESDCAN24-2BLY - Automotive dual line Transil, transient voltage suppressor (TVS) for CAN bus
- SPT01-335DEE - Automation sensor transient and overvoltage protection
- L7986A - 3 A step-down switching regulator
- USBLC6-2SC6Y - Automotive very low capacitance ESD protection

Major Design challenges:

- Layout is designed to meet the requirements for IEC61000-4-2/4/5 for industrial segment
- Multi-port solution with M12 IO-Link interface
- Four different communication interfaces

STEVAL-IDP004V2
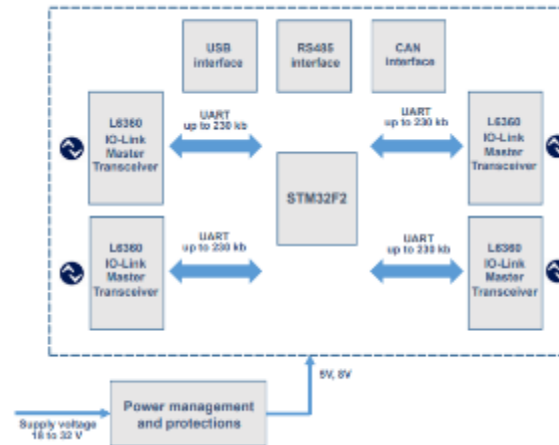
Key Features:

- Master IO-Link stack embedded with read out protection
- Main supply voltage 32 V maximum
- 4 L6360 IO-Link master transceiver ICs
- RS-485 serial interface
- CAN serial interface
- USB interface
- On-board reverse polarity protection

Major trends in industrial condition monitoring

Technical trends vs. benefits and challenges

AI and ML
Predictive maintenance, sound-based applications (see example), visual inspection / computer vision are the most demanding areas for AI

Smart sensor nodes
Edge processing and raw data from sensors that are distributed to monitor all critical nodes in the factory

Ultrasound inspection
Leak detection: energy-saving in compressed air and gas leaks, steam trap testing and valve testing.

Our value

AI is pervasive in many segments, not only pred-maint. Many developments on AI using our STWIN platform, i.e. drilling machine classification using MLC with ISM330DHCX or short command recognition using the STM32L4 on the SensorTile

Our smart sensor family is growing with new HW designs and new SW to support our customers

Our latest solutions with IMP23ABSU for ultrasound analysis from 10 to 80 kHz are being used in the field by several customers

Key available solutions

- **STWIN.box** field-ready STWIN
- **STEVAL-PROTEUS1B** 2.4GHz Multi-standard wireless industrial node for CbM with STM32WB

STEVAL-PROTEUS1
2.4 GHz multi-standard wireless industrial node for CbM

Solution specs

✓ Multiprotocol Support on 2.4 GHz ISM band
  ✓ BLE
  ✓ ZigBee (on-going)
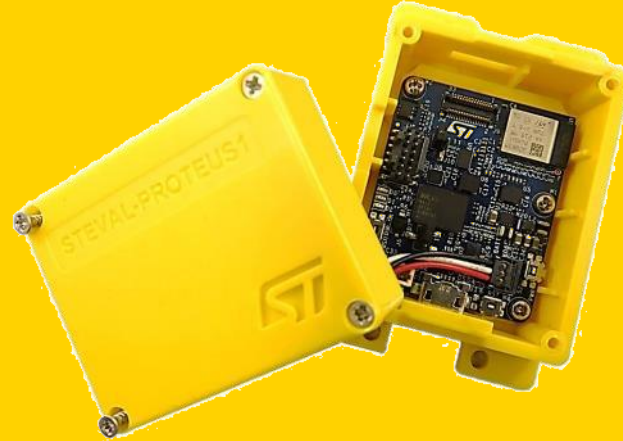
Key products

- STM32WB5MM module
  - 2.4GHz Multi-standard wireless connectivity
  - BLE 5.0
  - ZigBee 3.0
- IIS3DWB (vibrometer)
- ISM330DHCX (MLC)
- IIS2DLPC (very low power- wake up function)
- STTS22H (temp sensor)
- STSAFE-A110 (secure element)
- STBC02, ST1PS02 (power mng)

Major Design challenges:
- Low power strategy management
- Library integration for signal pre-processing
  - MotionSP for vibration analysis
  - Temperature monitoring
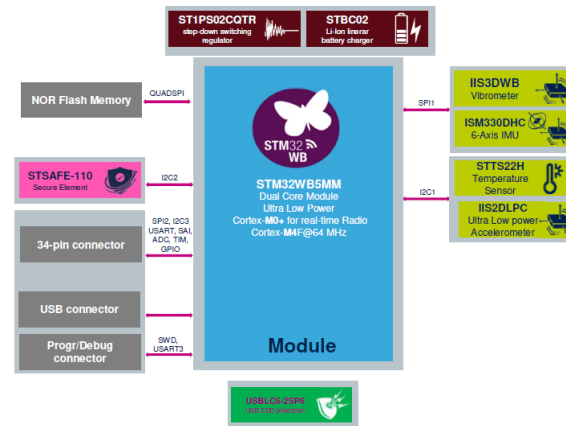
Key Features:

- Multi protocol 2.4GHz in unique Hardware
- Vibration and Temperature IIoT node
- Ultra compact form factor to minimize board resonance
- Low Power system - Battery operated
- Expansion Connector:
  - STMOD+ peripheral compliant
  - USB connector for charging and HighSpeed_DataLog
- Memory (buffer for high data rate sensor acquisition to be transmitted with low data transfer technology)

STEVAL-STWINBX1 STWIN.box - SensorTile wireless industrial node development kit

Solution spec.

- ✓ Supported by FP-IND-PREDMNT1 / FP-CLOUD-AZURE / FP-AI-CARTESIAM and their evolutions
- ✓ Supported by DSH-PREDMNT
- ✓ Supported by CubeMX
- ✓ Branded solution
- ✓ IP67 rated

Key products

- All from STEVAL-STWINKT1B + some additional like vibrometer for wake-up IIS2DLPC and upgrades:
- ST25D to add NFC cpnnectivity

Major Design challenges

- Cooperation with a 3rd party:
  - cooperate in the design of: 1) the case and mechanical features 2) the industrial grade connectors and interfaces
  - Take care of industrialization and certifications

STWIN.box
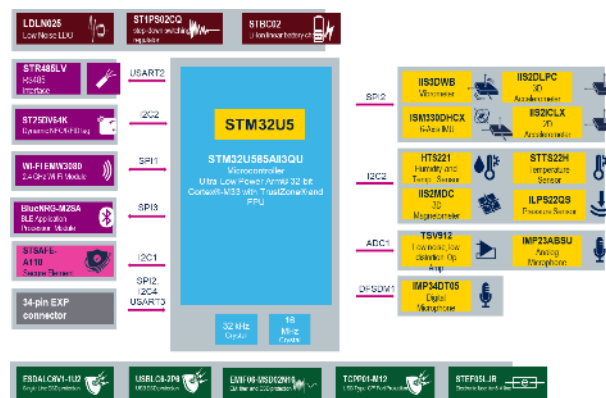
Key Features:

- STWIN.box leverages on the advanced features of High Speed Datalog Software through which it gains enhanced design-flow compatibility with existing ST tools such as UNICO, STM32CUBE.AI, STM32CUBEMX
- To be used directly in the field thanks to field proven mechanical case
- Wi-Fi on board (no expansion)
- LoRa expansion through 40-pins flat conn.

Motor control reference solutions

Motor drive - generic blocks

Gate Driver for MOSFETs/IGBT/SiC
- STDRIVExxx
- L63xx, L64xx
- STGAP series

Motor driver Ics
- L623x families
- STSPINXX
- STSPIN32XX

Power MOSFETs
- STripFET H6-F6/F7/F8 (30V÷150V)

Power MOSFET sand IGBT (650V/1200V)

STPOWER SiC (650V/1200V/ /2200V) & **GaN** (600V)

Power Converter /Battery

DD-DC /DC-AC converter

Or
BMS

Power Management
DCDC converter, LDO, …

DC bus

Auxiliary power supply

Gate driver

Control unit

Comun ication

Sensor and signal conditioning

Drive and Control

Motor

M

Current sensing

Load/ Plant

Control unit

Sensor and signal conditioning

Microcontrollers
STM32Gx (CORTEX M4), STM32Fx (CORTEX M0, M3,M4),

Op. Amp. and comparators
(TSVxx, LMxx)

Tools (HW & SW)
- STM32ODE motor control ecosystem

www.st.com/stm32-motor-control

MCU Features easing Motor Control
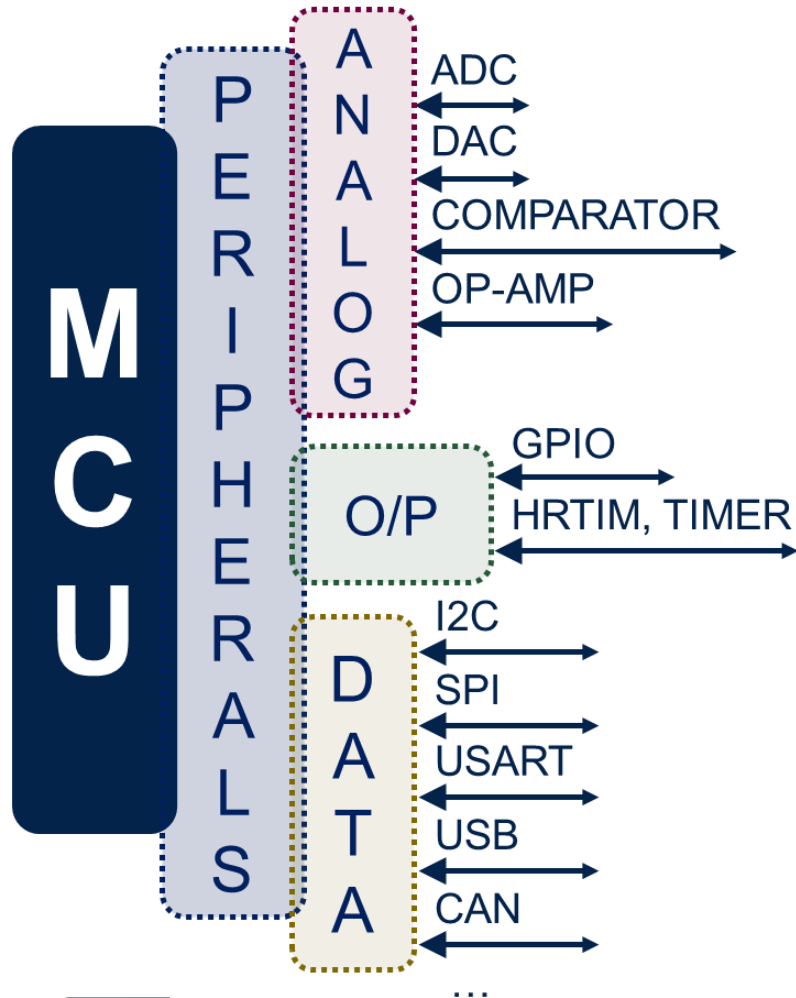
ARM MCUs are equipped with the following peripherals :

- High speed clock

- Advanced analog peripherals such as MCU internal comparators and op-amps

- High resolutions ADCs and DACs

- High resolution TIMERs

- Mathematical Accelerators : **Cordic**

- Data exchange peripherals and Debugging

STM32ODE motor control ecosystem

All ST MCU evaluation boards have **ST's standard MC connector on-board** allowing the use of the board in conjunction with any of the power stage evaluation boards.

The X-NUCLEO-IHM09M2 **motor control connector expansion board** allows to evaluate motor control solutions for three-phase motors with an external ST motor control power boards (STEVAL and EVAL Brushless Motors boards)

STM32 MC SDK firmware (X-CUBE-MCSDK) includes the permanent-magnet synchronous motor (PMSM) firmware library and the STM32 Motor Control Workbench to configure the firmware library parameters through its graphical user interface.

STM32 Motor Control Workbench is PC software that **reduces the design effort** and time needed for the firmware configuration: The user generates a project file through the GUI and initializes the library according to the application needs. Some of the variables of the algorithm being used can be monitored and changed in real time.

STM32 Motor Control ecosystem web page:
https://www.st.com/content/st_com/en/stm32-motor-control-ecosystem.html

Control + Power

Eval/Nucleo + Power/Expansion

Control board

MC Connector

Eval/Nucleo + Power/Expansion

Connector Adapter

Motor Control Ecosystem

| Inverters IPM/discretes | STM32 | HW Boards |

Motor Control Software Development Kit (SDK)

Motrol Control Workbench
FW library configurator

Motor Control FW library
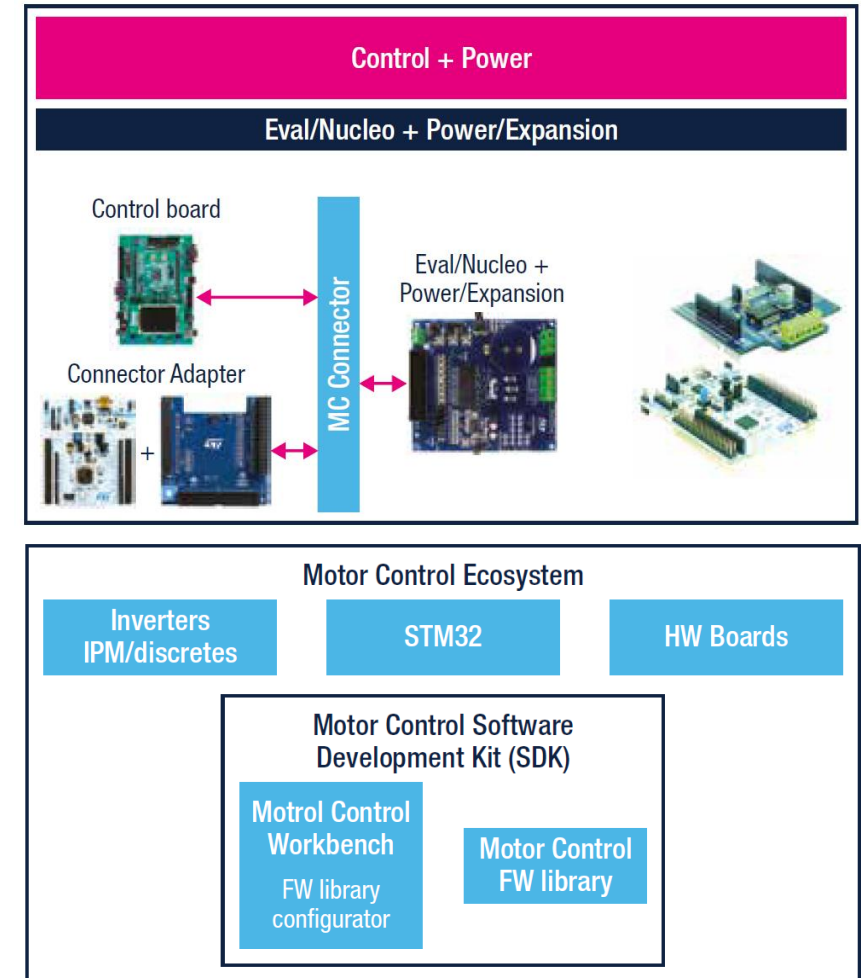
Expansion boards for motor control

Stepper

Scalable and robust portfolio featuring accurate positioning and smooth motion profile with up to 256 micro-steps per step

X-NUCLEO-IHM01A1
X-NUCLEO-IHM02A1
X-NUCLEO-IHM03A1
X-NUCLEO-IHM05A1
X-NUCLEO-IHM06A1
X-NUCLEO-IHM14A1

Brush DC

Simple, reliable and cost-effective solutions to drive one or more brushed DC motors over a wide current and voltage ranges

X-NUCLEO-IHM04A1
X-NUCLEO-IHM12A1
X-NUCLEO-IHM13A1
X-NUCLEO-IHM15A1

Brushless

Extensive diagnostics and fully-protected to reduce the number of external components, cost and complexity

X-NUCLEO-IHM07M1
X-NUCLEO-IHM08M1
X-NUCLEO-IHM09M2*
X-NUCLEO-IHM11M1
X-NUCLEO-IHM16M1
X-NUCLEO-IHM17M1

* connector expansion board

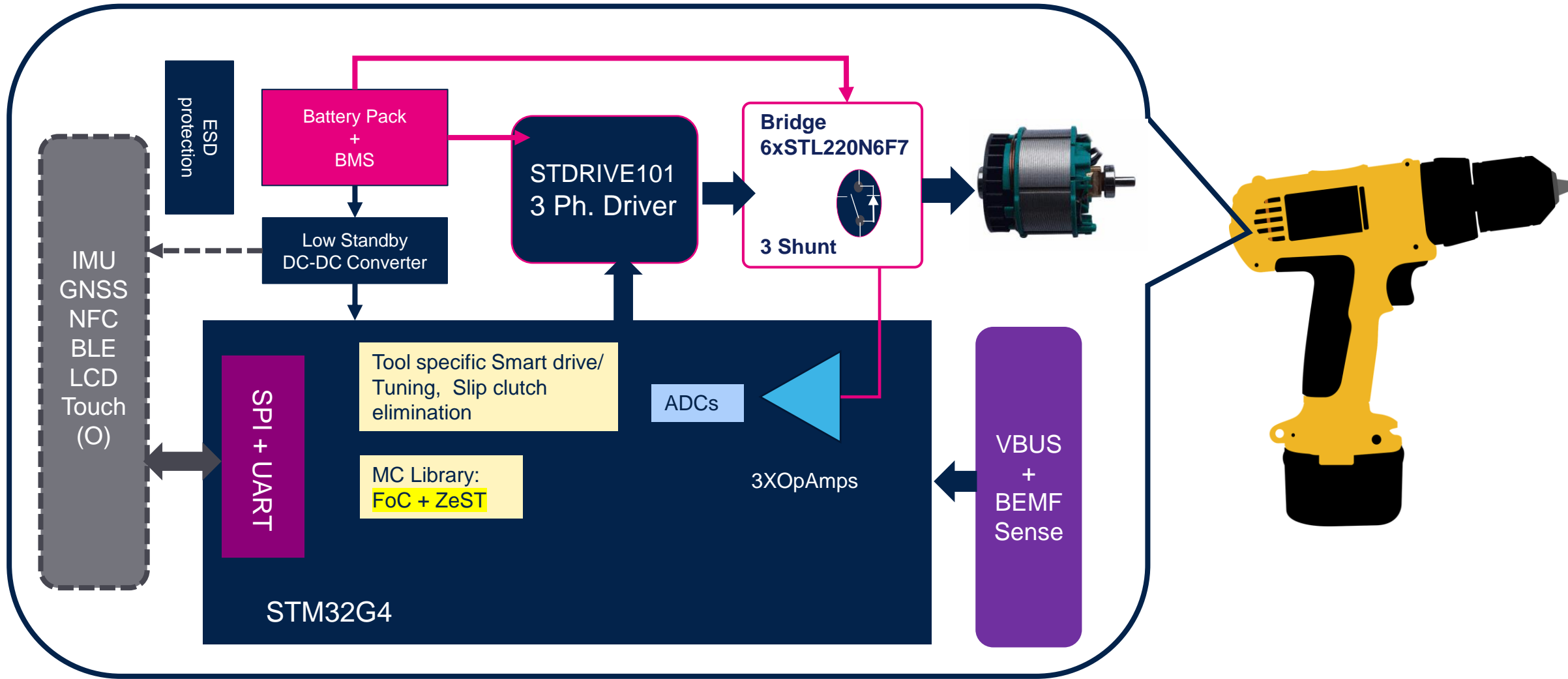| KIT Name	Nucleo (included)	X-Nucleo (included)	Motor (included)	Power Supply
P-NUCLEO-IHM001	NUCLEO-F302R8	X-NUCLEO-IHM07M1	Bull-Running model BR2804-1700 kV	
P-NUCLEO-IHM002	NUCLEO-F302R8	X-NUCLEO-IHM07M1	Bull-Running model BR2804-1700 kV	✓
P-NUCLEO-IHM03	NUCLEO-G431RB	X-NUCLEO-IHM16M1	Gimbal motor GBM2804H-100T	✓

For more details on STSPIN motor driver devices, please visit www.st.com/stspin

Available solutions for power tools

Parameter \ Board	STEVAL-PTOOL1V1	STEVAL-PTOOL2V1	STDES-PTOOL3A	STEVAL-PTOOL4A	STEVAL-PTOOL5A
Control	STSPIN32F0B (M0 core @ 48MHz)	STSPIN32F0252 (M0 core @ 48MHz)	STM32G431 (M4 core @ 170Mz)	STM32G473 (M4 core @ 170Mz)	STM32G473
Gate Drive			STDRIVE101	STDRIVE101	STDRIVE102
FLASH/RAM	32kB/4kB	32kB/4kB	128kB/22kB	512kB / 96kB	512kB / 96kB
MOSFETs	STL180N6F7 (60V/120A 1.9 mOhms)	STL130N8F7 (80V/120A 3.0 mOhms)	STL220N6F7 (60V/120A 1.2 mOhms)	STL220N6F7 (60V/120A 1.2 mOhms)	TBD
Operating Voltage	7 – 45 VDC	20 – 72 VDC	5.5 – 48 VDC	5.5 – 48 VDC	60 – 80VDC
Recommended Battery Pack	2S – 6S	8S – 15S	5S – 6S	5S – 6S	18S – 20S
Output Current	15 A_{rms}	19 A_{rms}	18 A_{rms}	18 A_{rms}	TBD
Standby Circuit	External Power P-MOS STN3P6F6 (SOT-223)	External Power P-MOS STN3P10F6 (SOT-223)	Internal (DC-DC/Gate Driver) + SOT-23 N-MOS for VBUS	Internal (DC-DC/Gate Driver) + SOT-23 N-MOS for VBUS	TBD
V_{DS} Protection / BEMF Divider	No/GPIO	No/GPIO	Yes/N-MOS	Yes/N-MOS	TBD
Size	70mm x 30mm	80mm x 58mm	80mm x 35mm	80mm x 35mm	TBD

Made in 2020

On Web

Planned for Q4

Planned for 2024

WÜRTH

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33

- ESD protection
- Battery Pack + BMS
- Low Standby DC-DC Converter
- STDRIVE101 3 Ph. Driver
- Bridge 6xSTL220N6F7
- 3 Shunt
- IMU GNSS NFC BLE LCD Touch (O)
- SPI + UART
- Tool specific Smart drive/ Tuning, Slip clutch elimination
- MC Library: FoC + ZeST
- ADCs
- 3XOpAmps
- VBUS + BEMF Sense
- STM32G4
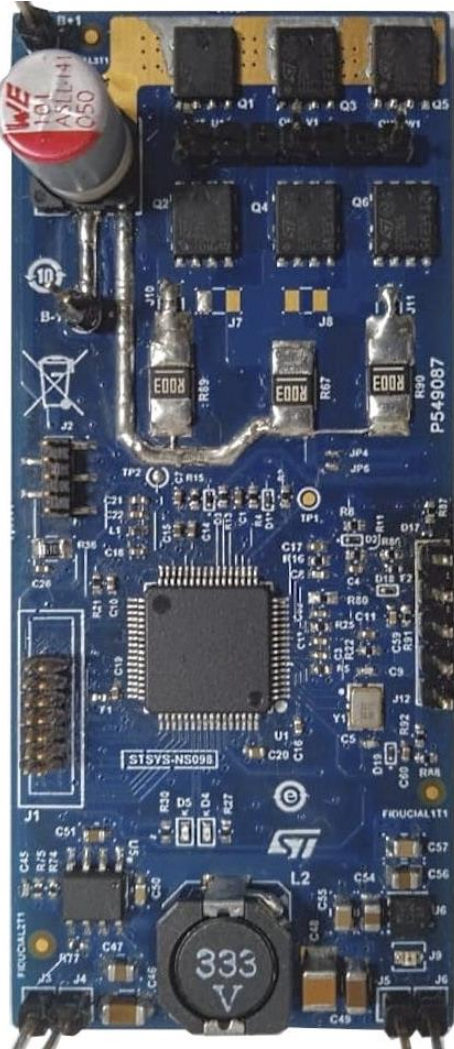
Battery Operated Brushless Power Tools Controller with STM32G4 & STDRIVE101

STDES-PTOOL3A **ACTIVE**

Compact, configurable and customizable reference design for battery-operated brushless power tools based on STM32G431 and STDRIVE101

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📄 **Download databrief**

All features

- Input voltage from 12 to 24 V dc(Input voltage customizable to 36V with change in resistors, up to 8S batteries)
- Output RMS current up to 20 AMP
- The board comprises the following key devices:
  - **STM32G431RB**: A high-performance Arm®-based Cortex®-M4 32-bit MCU+FPU with integrated op amps and comparators in LQFP 64 (10x10mm) package
  - **STDRIVE101**: Triple half-bridge high-voltage gate driver in VFQFPN 4x4 with inbuilt regulator
  - **STL220N6F7**: Six N-channel 60 V, 0.014 Ω typ., 120 A, STripFET F7 power MOSFET in a PowerFLAT 5x6 pck
  - **L6981**: 1.5 A synchronous step-down converter in a PowerSO-8 package
  - **LDL112**: 1.2A low quiescent current LDO with reverse current protection in a SO8-batwing package
  - **ESDALC6V1-1U2**: Single line low capacitance Transil™ for ESD protection is a precision 500 mA regulator
  - **TSV911A**: Single, dual, and quad rail to rail input/output 8MHz op-amp
  - **TS861**: Rail to rail micropower Bi-CMOS comparators
  - **BAT54**: Small signal Schottky diodes
  - **BAT30F4**: 30V Schottky barrier diodes in a 0201 package

36 V (48 V)

STDRIVE101
75V, 0.6 A 3-phase

STL220N6F7
60V, 1.2 mΩ MOSFET

STM32G431RBT6
(M4+core @170MHz)

L6981NDR
(38V, 1.5A, DC-DC converter)

35 mm

80 mm

Top

Bottom

Key products

- **STM32G431:** Arm Cortex-M4 MCU@170Mhz(**STM32G473** in PTOOL4A)
- **STDRIVE101:** 3-phase gate driver. 75V, 0.6A
- **STL220N6F7:** 60V 1.2 mΩ MOSFET F7 series
- **L6981NDR:** 38V, 1.5A, DC-DC converter (**L7987L** 61V, 2A in PTOOL4A)

  Plus LDO , OpAmps, Comparators, ESD and surge protectors

Key features

- Designed for 5S-6S pack of LiPo batteries
- Max operating ratings: 48 V, 18 A_{RMS}
- Very low stand-by power consumption
- Trigger, direction and speed inputs available
- VDS Protection; Over current protection, Thermal shutdonw
- Sensor less three-shunt vector (FOC) algorithm (default)
- Mounting options for:
  - 6-Step sensorless control (cycle-by-cycle CL)
  - BEMF detection circuitry
- 1 UART, and 1 SPI interface for debugging, I/O expanders, BLE, LCD, GNSS, MEMS
- Can be customized for many application such E-Bicycle, Rovers, Home appliances, Factory automation and Robotics

STEVAL-ETH001V1
Servo drive solution for multiaxial position control

Ensured compatibility with Master Ethercat (implemented using Twincat software tool by Bechkoff instead of hardware solution)

Key products

- **STM32F767:** High-performance, Arm Cortex- M7 MCU with DSP & FPU
- **STDRIVE101:** Triple half-bridge gate driver
- **IPS160H:** Single channel IPS
- **CLT03-2Q3:** Dual channel digital input interface
- **ST3485:** RS485 / RS422 transceiver
- **TSV991ILT:** Wide-bandwidth rail to rail 5V CMOS Op-Amp
- **STH270N8F7-2:** N-channel 80 V, 1.7 mOhm typ., 180 A STripFET F7 Power MOSFET
- **L7987L (61 V 2 A asynchronous step-down switching regulator)**

Key features

- Real-Time Ethernet based on Ethercat protocol (NETX90 processor)
- Motor control driving powered by STDRIVE StripFET F7
- Digital Actuation for industrial load
- Driving power circuit with brake energy discharge circuit, to drive the rotor position and manage the energy discharge
- Power management circuit to generates all the reference voltage
- Quadrature encoder feedback signal input based on digital protocol like EnDat, BiSS and Ssi
- RS485 interface for digital sensors or other use

Main design challenges

- Motor control 48 V design with high scale integration
- Max power dissipation up to 700 W

STSYS-NS056
36 V reference design for e-bike
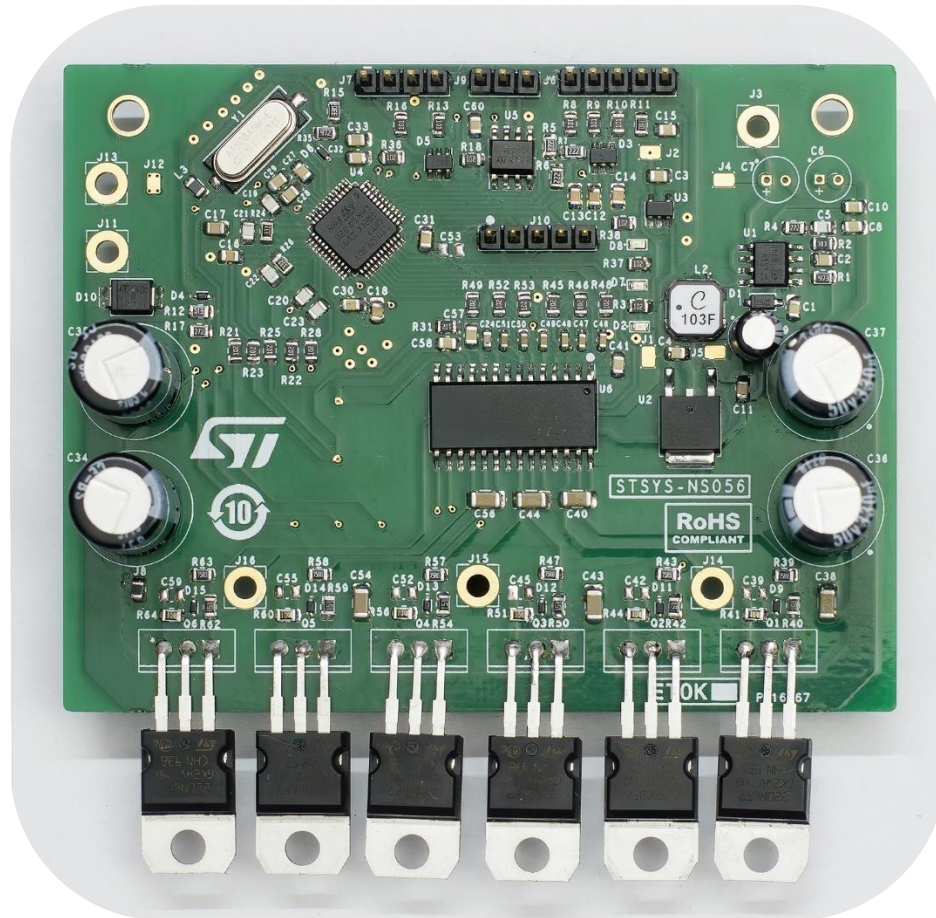
Key products

- **STM32F303:** Arm Cortex-M4 MCU
- **STDRIVE601:** 3-phase gate driver. 600V, 0.3A
- **STP220N6F7:** 60V 1.2 mΩ MOSFET F7 series
- **ST1S14PHR:** voltage regulator
- **ST485EC:** RS-485 transceiver

Key features

- 250W Electric-Cycle controller
- Energy efficient field-oriented control
- Standard inputs for throttle, brake and hall sensors
- RS485 interface for data logging and future expansion
- Rated voltage: 36V DC, 7.2 AH battery
- Power rating: 250W

5 kW low-voltage power board

Description: A power platform for traction application up to 5kW at 48V

Key Features

- Fully AG and compatible with an AG control board
- 5kW at 48V (10% of Bus Ripple) up to 200A with 6 paralleled MOSFETs
- MC connector for a full compatibility with motor control platforms
- Protections (OC, OL, UV, OV and Thermal)
- External insulated current sensors board and shunt resistors on board
- IMS substrate for better heating exchange
- Available also an Industrial version with L6491
- ST MC connector

Key Products:

- **STH310/315N10F7-6**: STripFET^{TM} F7 MOSFET (6x switch)
- **L6491**: High-side and low-side driver for the Industrial release
- **STTH102AY, STPS5L60SY, STPS3L40SY:** rectifiers

Industrial kit STEVAL-CTM09V1

- STEVAL-CTM004V1 : Power board
- STEVAL-CTM005V1 : Bulk capacitor board
- STEVAL-CTM006V1 : Gate driver board industrial release
- STEVAL-CTM007V1 : Gate driver board automotive release
- STEVAL-CTM008V1 : Current sensing board

- Industrial kit STEVAL-CTM09V1 on st.com: (STEVAL-CTM004V1+CTM005V1+CTM006+CTM008V1)
- Automotive kit STEVAL-TTM001V1 under testing (STEVAL-CTM004V1+CTM005V1+CTM007V1+CTM008V1)

2kW E-BIKE TRACTION INVERTER

Key Features:

- Max power upto 2kW at 48 V Battery System for PMSM/BLDC Motor.
- Separate control and power board.
- Sensored or Sensorlless FOC.
- Possibility of six step as well.
- Three shunt current sensing or low-cost option as per high current need LEM/ICS/Isolated Opamp as an option
- Over current hardware as well as software protection.
- Under voltage/over voltage protection.
- CAN and RS232 interface.
- Throttle and brakes input.
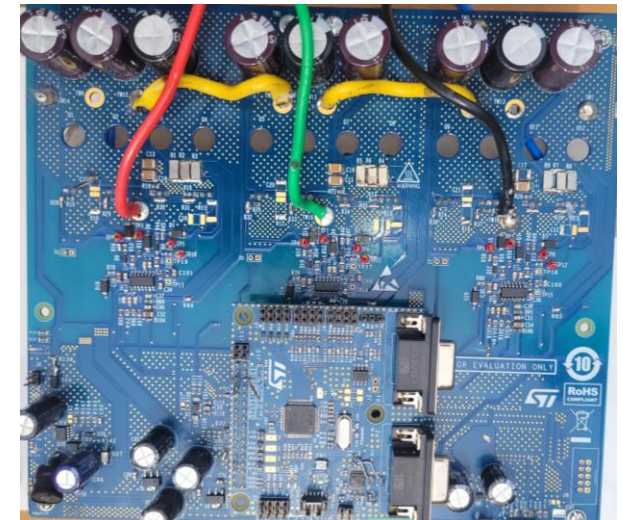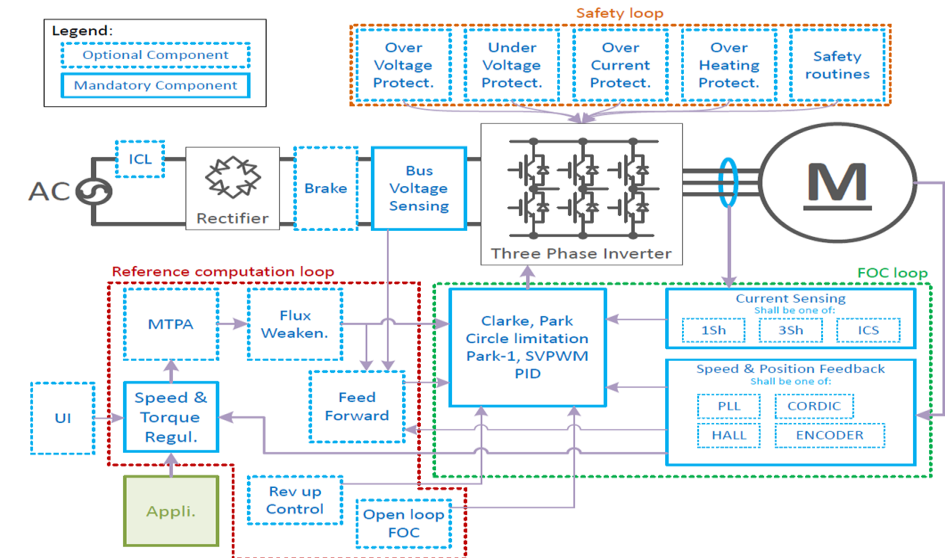

Products

- **STM32F303 or STM32F072** (MCU)
- **STP315N10F7** (MOSFETs)
- **L6491**(Gate Driver)
- **L9615D** (CAN Bus),**ST3232ECTR** (RS232 Driver)
- **ST3232EBTR** (RS232)
- **TSZ121IYLT** (Opamp)
- **TSV991 ILT** (Opamp)
- **LDL1117S33R** (LDO)

Applications

- **E-Scooter**
- **E-Bike**

Next Evolution :
3.5 kW
Prototype with
Modular design

Design Code: STSYS-NS083

https://www.st.com/content/st_com/en/campaigns/motor-control-guide.html?icmp=tt24244_gl_bn_nov2021

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Developer resources - download our latest Motor Control Guide (64 pages)

ST is driving innovation in integrated **intelligent power modules and systems-in package, monolithic motor drivers**, fast and efficient **power switches, voltage-transient protected Triacs**, as well as powerful and secure **microcontrollers**.

Whichever motor technology you use, from conventional to state-of-the-art, ST has the right electronic devices and complete ecosystems with various evaluation boards, reference designs, firmware, and development tools to simplify and accelerate design cycles.

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Motor control Reference Guide

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- ST Motor Control Ecosystem
- PMSM & BLDC Motors
- 3-phase Induction Motor (ACIM)
- Stepper motors
- Brushed DC motors
- Universal motors
- Switched reluctance motors
- Microcontrollers
- STM32 Motor Control Ecosystem
- Motor driver ICs
- Power modules

- Power MOSFET
- IGBT
- 600-650 V IGBT series
- 1200 V IGBT series
- Diode & rectifier
- Thyristors, Triacs and AC switches
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