

# 22 kW High-End Servo Drive With SIL2

**Safety servo drive reference design**



**PLC safety platform**



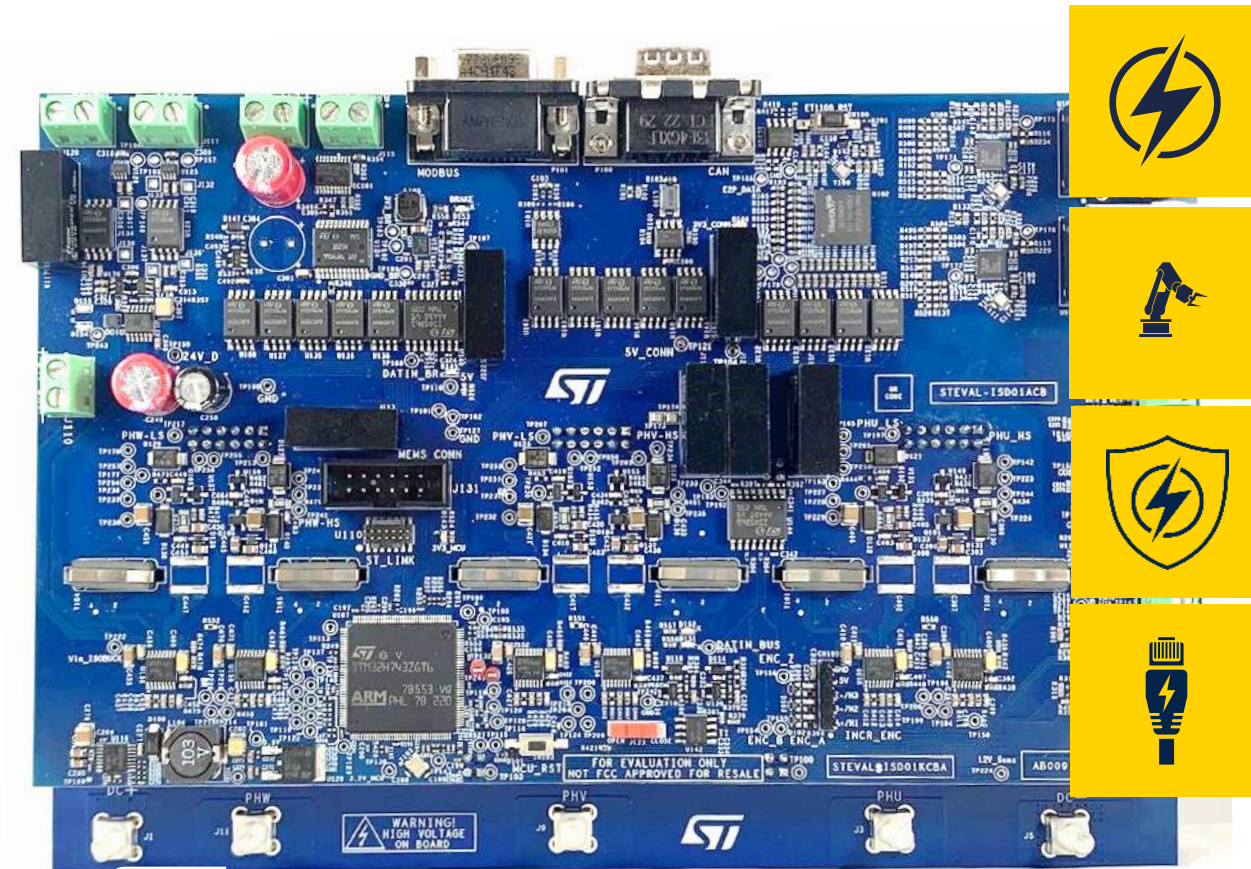
**Additional information**





# 22kW safety servo drive reference design

Make safe and connected a high voltage servo drive



22kW/800 V high-performance position control based on 1200V IGBT power devices



Position Control using different position sensors technology



Safe Torque Off and Safe Brake Control functions assessed by TÜV SÜD



Multiple wired real-time connectivity (RS485, CAN, EtherCAT)

## Key Features

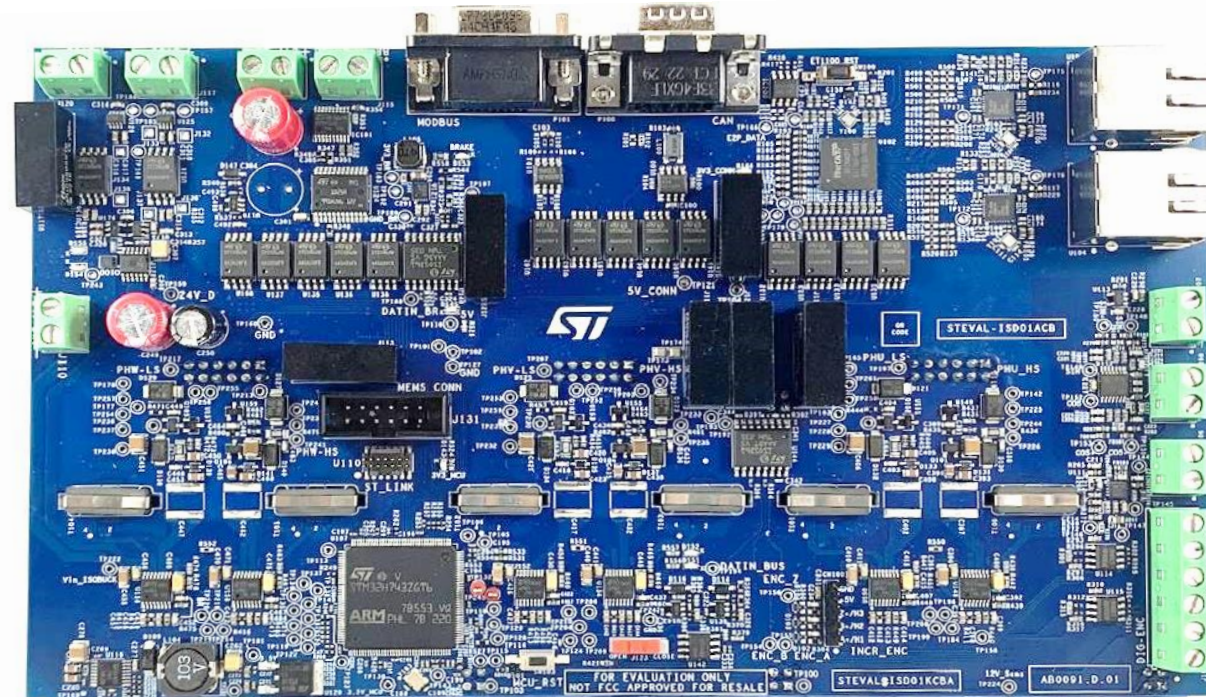
- Fully isolated Inverter with 3 phases outputs
- DC Input up to 800V, 1200V IGBT based (SMIT package)
- Power Requirements >20kW
- Planar transformers for aux power supply
- FOC compliance with Full Position Control (Resolver, Encoder)
- Connectivity (EtherCAT, MODBUS RTU, CAN)
- Safety (SIL 2 assessment, STO, SBC)
- Diagnostic (OV, UV, Voltage Supervisor, WD functionality....)
- STL library for STM32H743ZG

## Key Products

- **STGSH50M120D** 1200V, 50A IGBT in ACEPACK SMIT (HB topology)
- **STM32H743ZGT6** Arm®Cortex®
- **STGAP2HD** Galvanically isolated 4 A half-bridge dual channel gate driver
- **STM802RM6F** – voltage supervisor
- **STISO621** – isolated UART
- **ISOSD61** – Sigma delta isolator
- **IPS1025H, IPS4260** – Intelligent power switch
- **CLT03-1SC3** – Digital Input

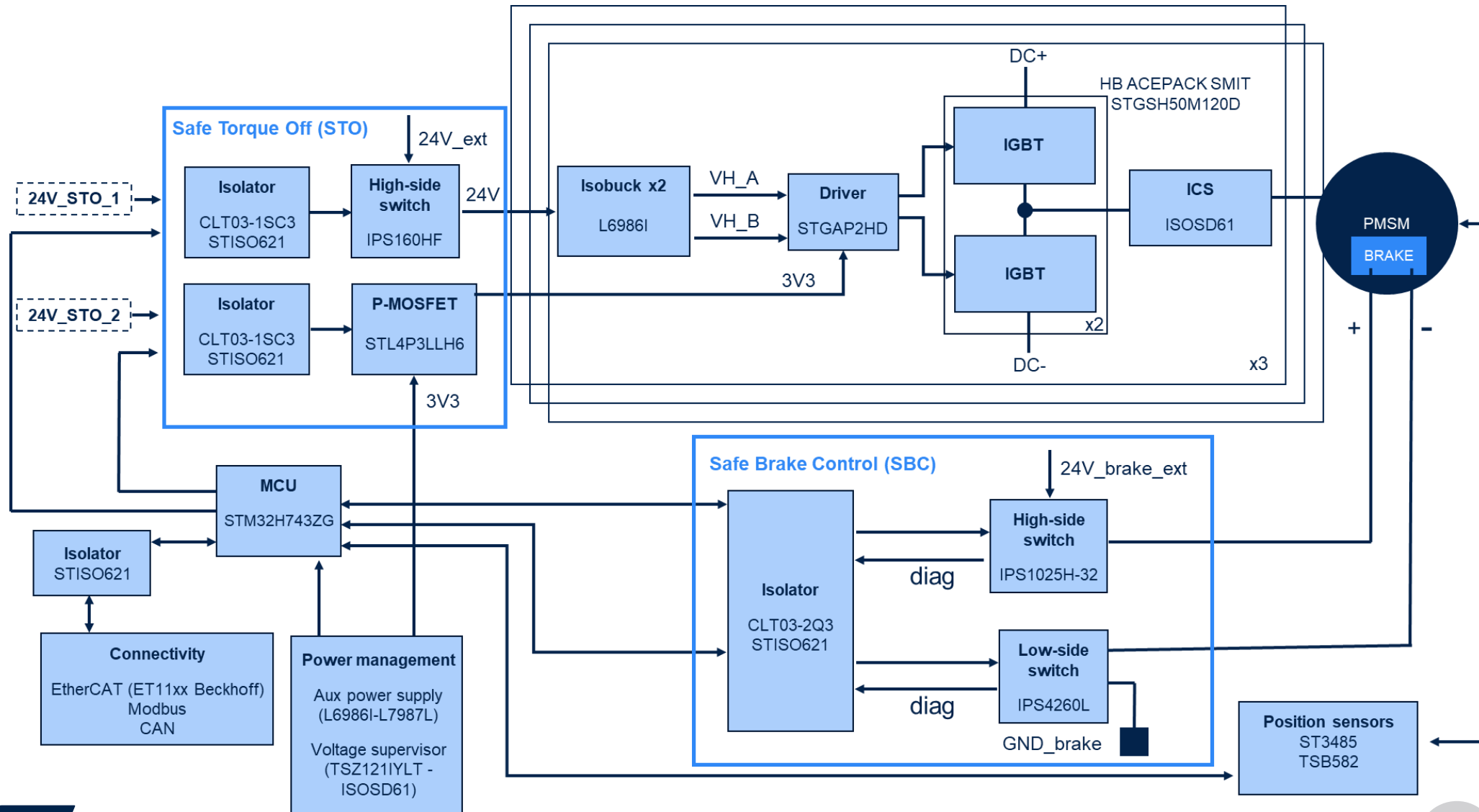
# STEVAL-ISD01KCB

## 22kW High-End Servo drive SIL2





# Block diagram



# Driver/ Control board

**Operating voltages:** 24V for STO, SBC and data processing

Data Processing: single core architecture based on STM32H743ZG

**Power management:**

- Dedicated DC/DC converter in buck configuration for connectivity channels
- DC/DC converter for voltage reference derived by 24V brake and 24V drive
- Isolated DC/DC for isolated voltage reference 5V and 3.3V to supply sigma delta modulators
- Planar transformers for aux power supply to get the isolated  $V_{GE}$

**Isolation**

- Sigma delta isolators for voltage monitoring and phase current sensing
- Serial isolators for signal driving and diagnostic

**Position sensor**

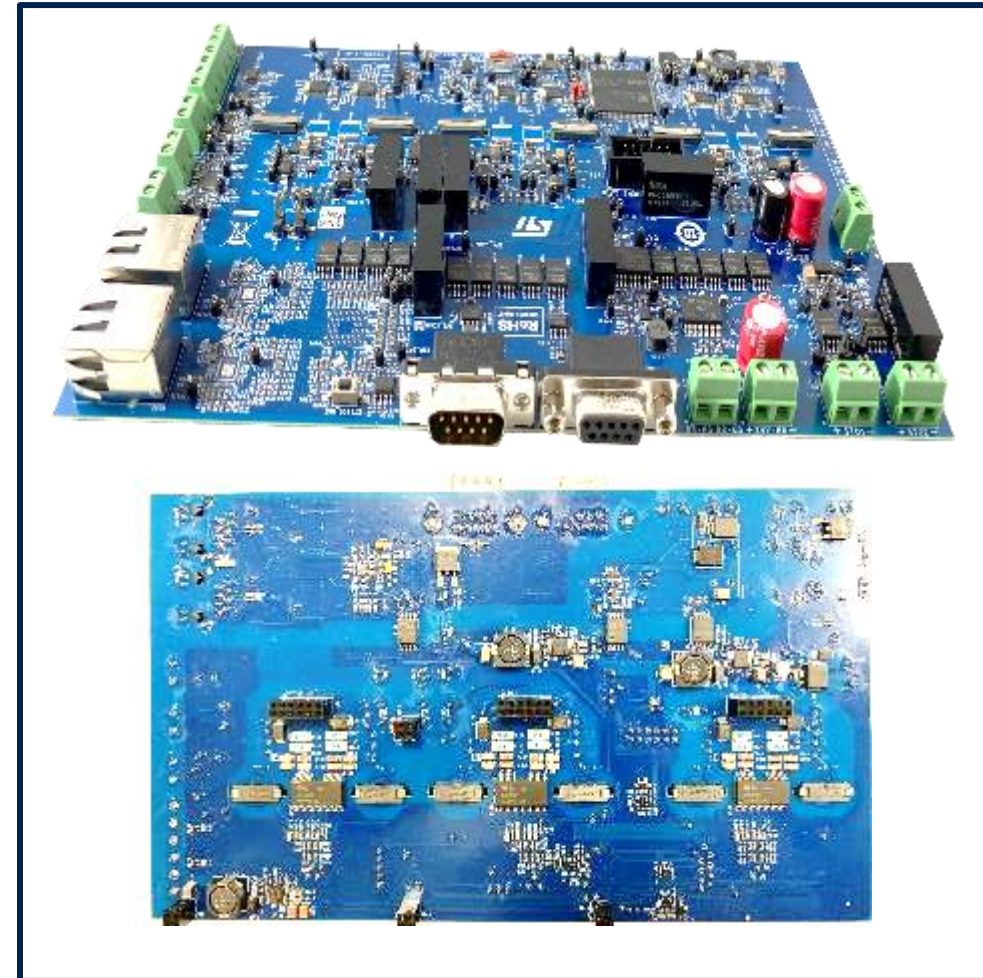
- Resolver
- Incremental encoder
- Absolute encoder

**Diagnostic functions**

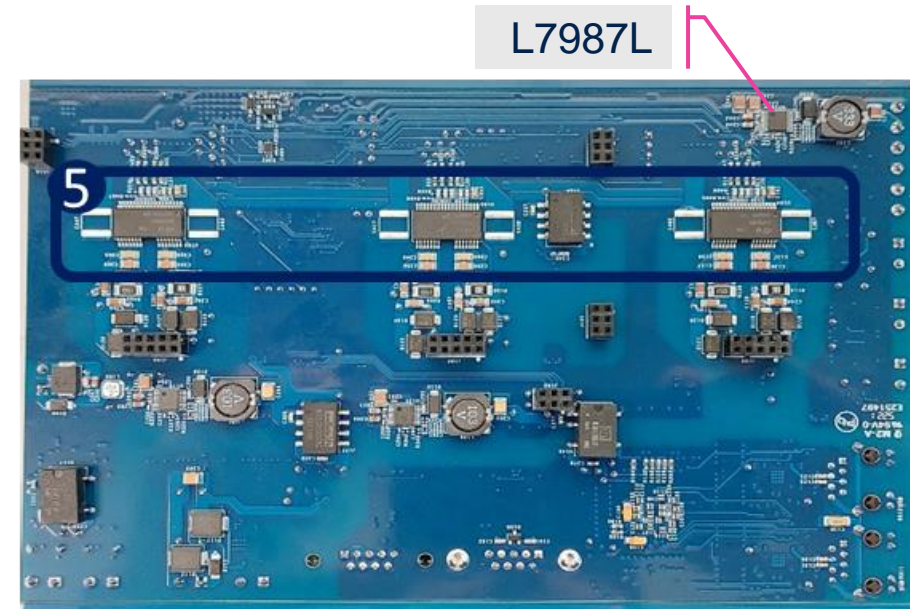
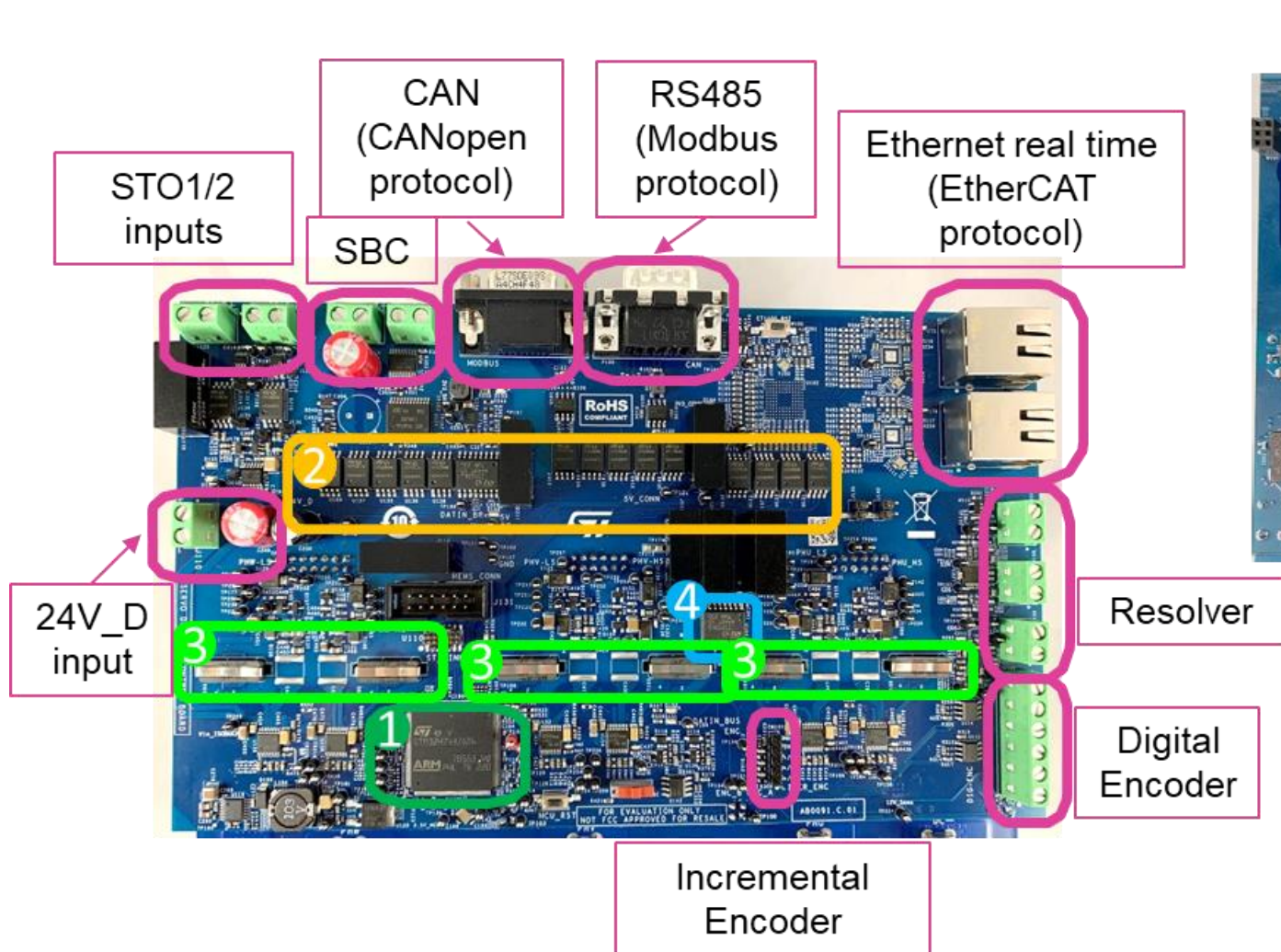
- Overvoltage on 800Vdc bus

**Protections:**

- Transil protection on 24V drive supply voltage paths to improve the robustness against EMC discharge



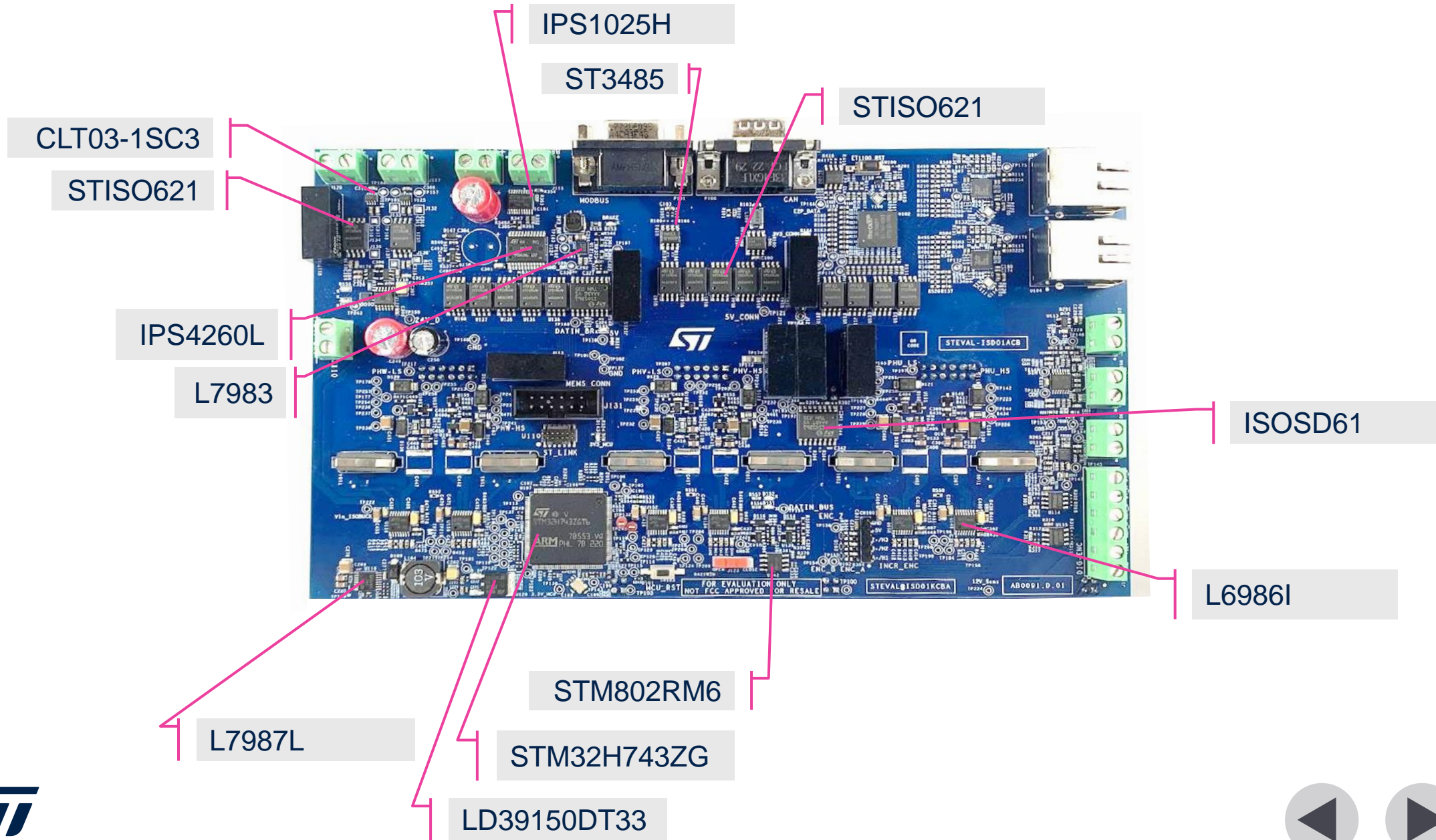
# Driver / Control board



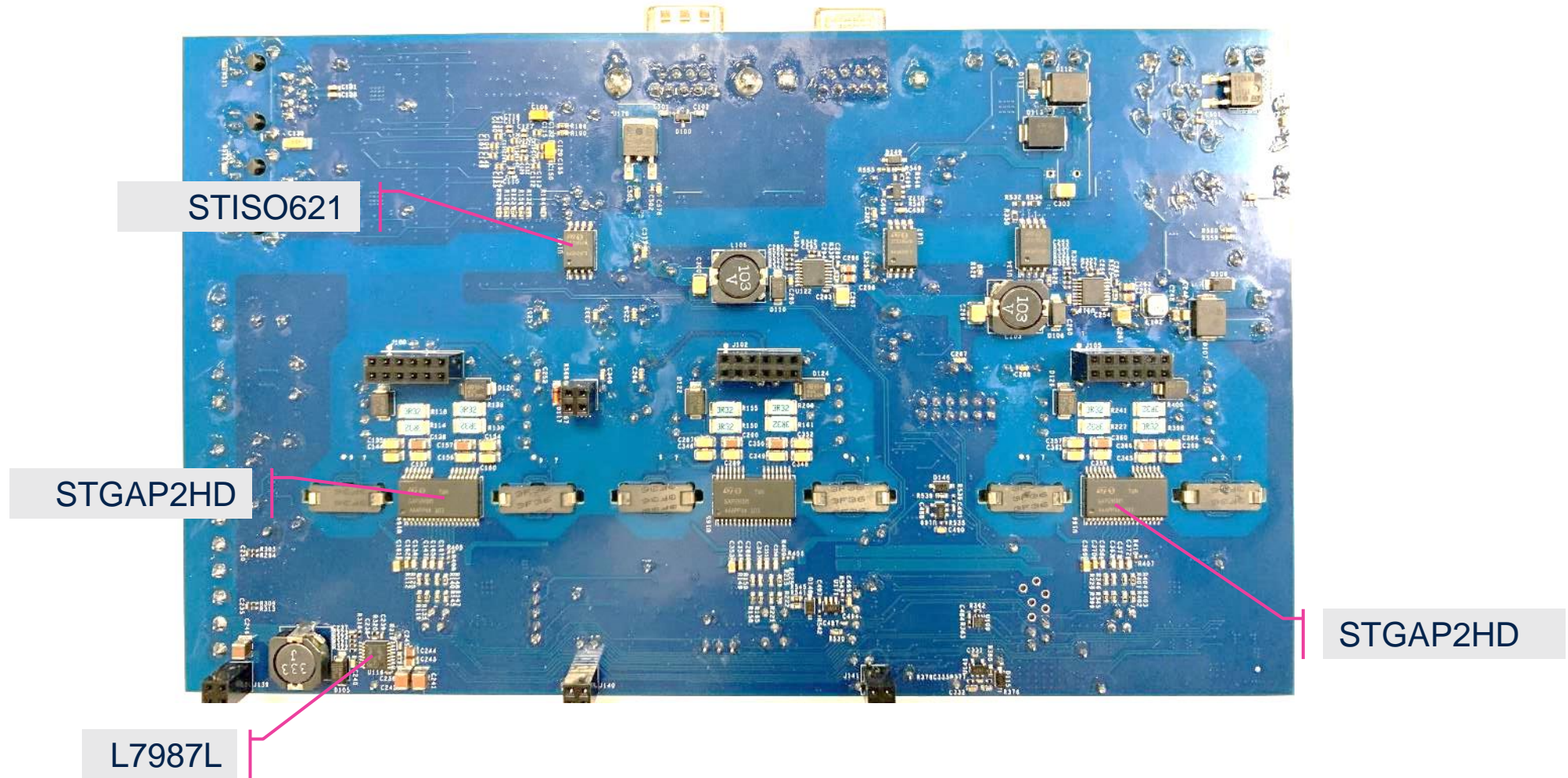
- 1 MCU STM32H743ZG
  - 2 Isolators STISO621
  - 3 Isobuck
  - 4  $\Sigma$ - $\Delta$  modulators ISOSD61
  - 5 Drivers STGAP2HD
  - Connectors
- \*planar magnetic design



# STEVAL-ISD01ACB TOP

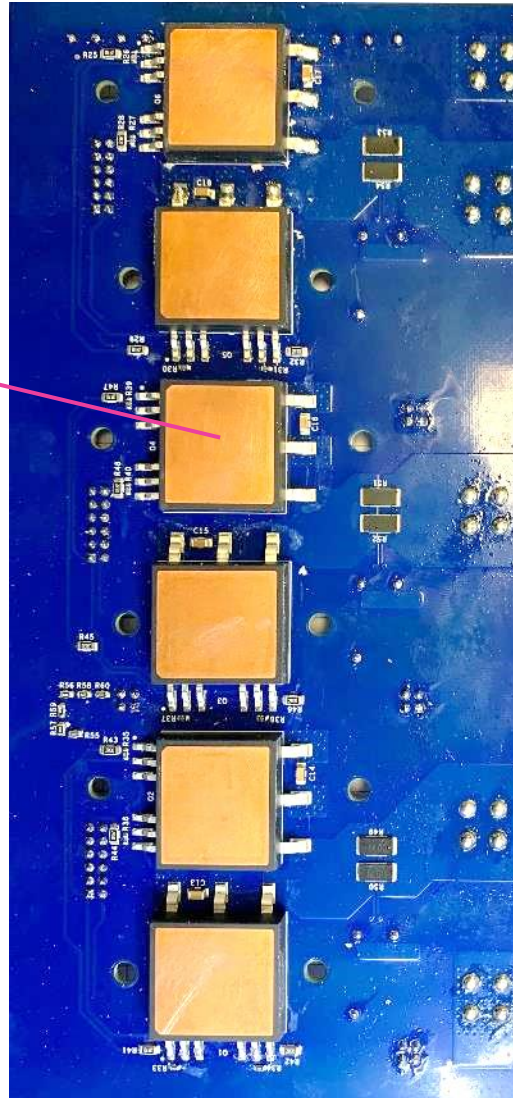


# STEVAL-ISD01ACB BOTTOM





# STEVAL-ISD01BCB



STGSH50M120D  
(availability 2024)

ISOSD61



# Industrial IGBT-based ACEPACK SMIT STGSH50M120D

New 1200V, 50A Half-bridge for Industrial drives

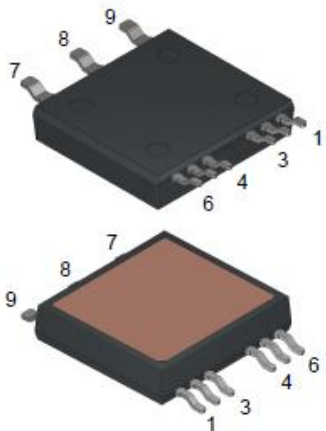
## 1200V, 50 A in Half-bridge configuration in ACEPACK SMIT

- TFS 1200V Low-Loss M series
- Low  $V_{CEsat} = 1.75V @ I_{CN}$
- Low voltage drop in conduction
- Short-circuit rugged
- Soft and fast recovery freewheeling co-packed diode

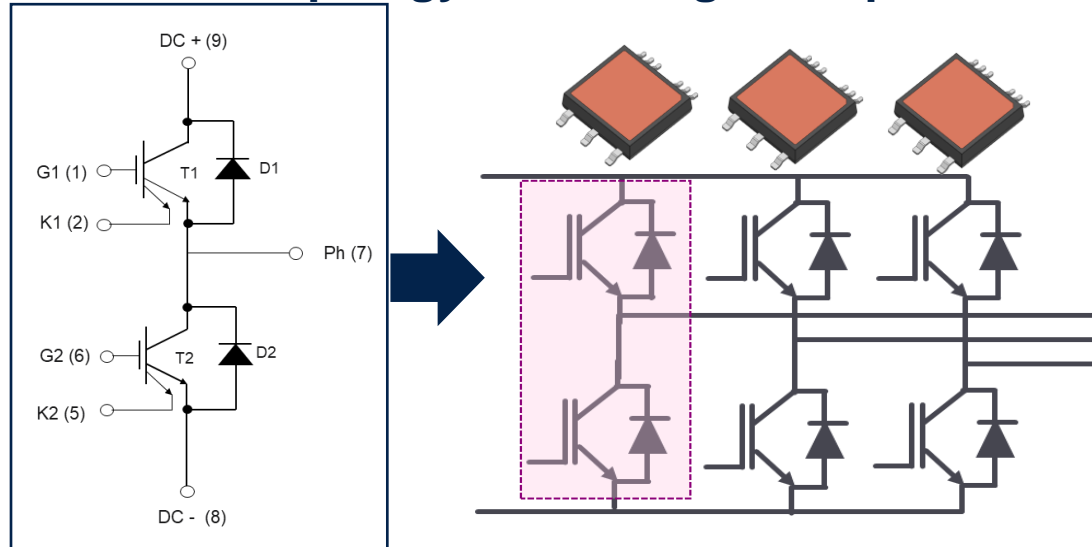
**Under development**



## ACEPACK SMIT



## Typical circuit topology: Half-bridge for 3ph inverter



## Industrial Servo Motor drive





# Safety assessment on hardware



- Checklist\_Fault\_Avoidance\_Hardware\_IEC61508\_2010 - 13849 - STM - 2022-30-09
  - Architecture description for fault detection OV,UV
  - Hardware architecture for feedback on digital I/O circuit
  - Safety function execution principle

Technique/Measure	Std. IEC 61508-2	SL1	SL2	SL3	SL4	Used	Action Summary/Description	Result
Measurement of voltage breakdown voltage capability (withstand) for voltage and other phenomena such as a power supply (capacity margin) failure mode (0) (K1000) (K1000) (?)	A11.2	M	U	M	M	Y	The circuit includes protection for lines 24V_U and 24V_D, i.e.: - Thermal - UCI (see on 24V_U)  Voltage detector device implemented on the 24V_U and 24V_D (UCL15V) to oversee and alert voltage deviations. Voltage measurements done on 3.3V bus (common voltage detector on 3.3V line voltage when the gate is closed) and on voltage and on voltage. Fault model is described in the ST Internal Report (K1000).	>
Dependence of electrical energy on external information (K1000) (K1000) (?)	A11.1	M	U	M	M	Y	Completed. The actual is designed according to the high level functional description (block power and data lines).	>
Insulation of the hardware assembly (?)	A11.2	M	M	M	M	Y	Insulation is provided by the IEC 61508-2-1, for SL2.	>
Meaningful physical environment (for example temperature, humidity, noise, vibration, shock, etc.) (K1000) (?)	A11.1	M	M	M	M	Y	Temperature and humidity: Climate tests performed with one of the available function (with "Test") with various climatic conditions.  Water and salt: - If applicable to the hardware. - Vibration tests performed with the hardware if applicable.	>



- Technical Specification Document
  - Hardware architecture description relevant for safety

DOCS available with NDA

# Industrial safety today and tomorrow

Available now

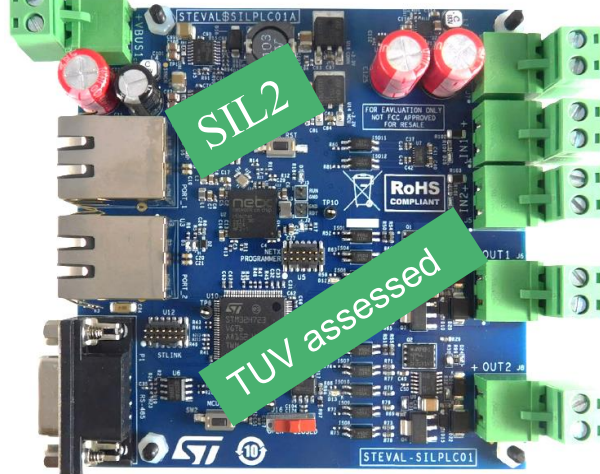
STEVAL-SILKT01



STEVAL-SILKT01B

STEVAL-SILKT01A

STEVAL-SILPLC01



Coming soon



STEVAL-ISD01KCB



# SIL-2 PLC reference design

STEVAL-SILPLC01

Speed up development

Hardware and software tools

Full digital and analog solution and BOM

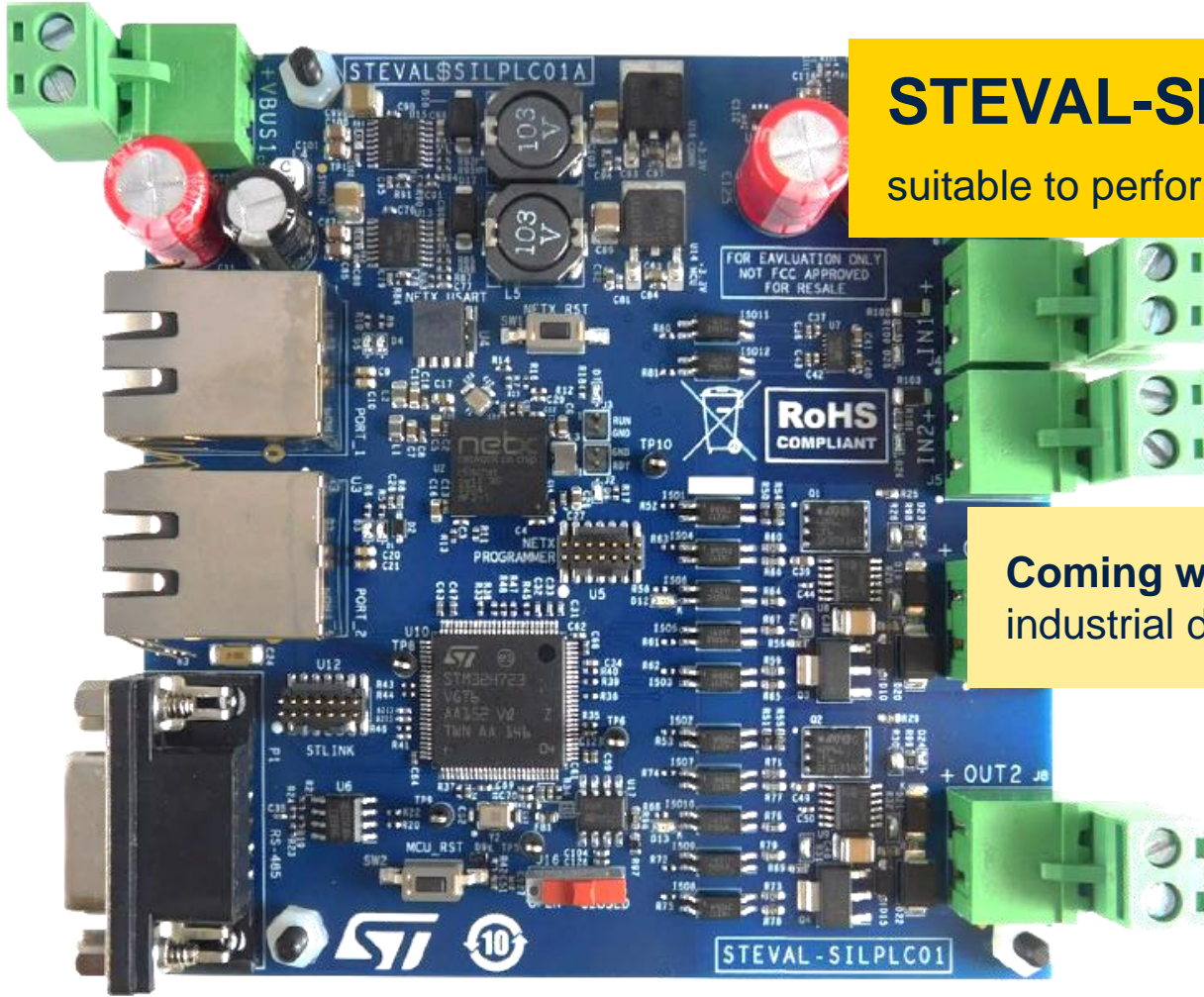
# Speed-up your design with our evaluation tools

SIL certification, within a given system, depends on multiple factors:

- type of technologies
- system architecture
- number of system components
- probability of failure on demand (PFD) of each component
- diagnostic test intervals



# Meet STEVAL-SILPLC01



**STEVAL-SILPLC01** is an **industrial PLC** evaluation board suitable to perform **safety** functions up to **SIL 2 / PLd**

Coming with a **HW and SW ecosystem** to address applications in the industrial domain like PLCs, industrial I/Os, safe I/Os

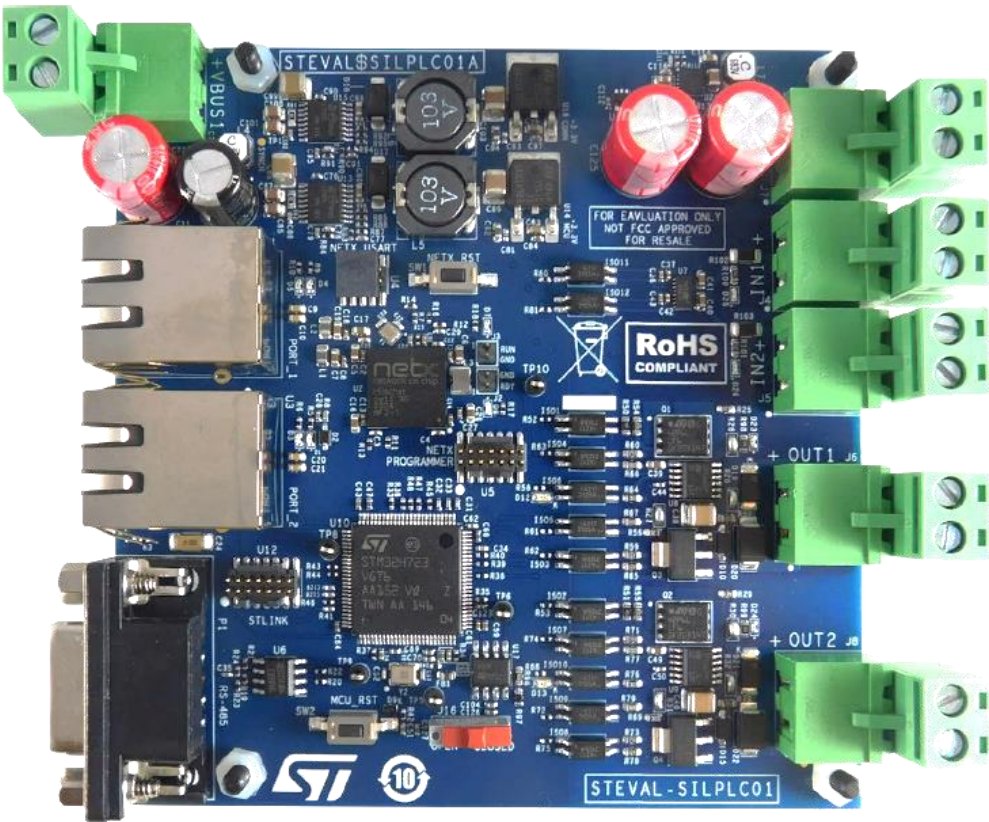


Available on [st.com](https://www.st.com)

# STEVAL-SILPLC01

## Board features

STEVAL-SILPLC01 is a safe-ready reference design



Operating Voltage 24V - 36V - max overvoltage 60V

Power management circuits with OV/UV detection



Diagnostic coverage >90%, with safe state condition in case of fault event

Dual digital I/Os with 2.4 A current capability for load actuation



Galvanic insulation on board



Ethernet Real Time communication with Ethercat slave stack and RS485 PHY (EtherCAT stack and API are by Hilscher)

Safety library certified by TÜV supported at application level



Designed in accordance with IEC 61508, EN 62061, EN ISO 13849-1, and EN ISO 13849-2 standards



# STEVAL-SILPLC01

## Main ICs

STL42P6LLF6

LD39150DT33

L7987L /  
L7983

STM802RM6F

ISOSD61

CLT03-2Q3

STTS751  
on back side

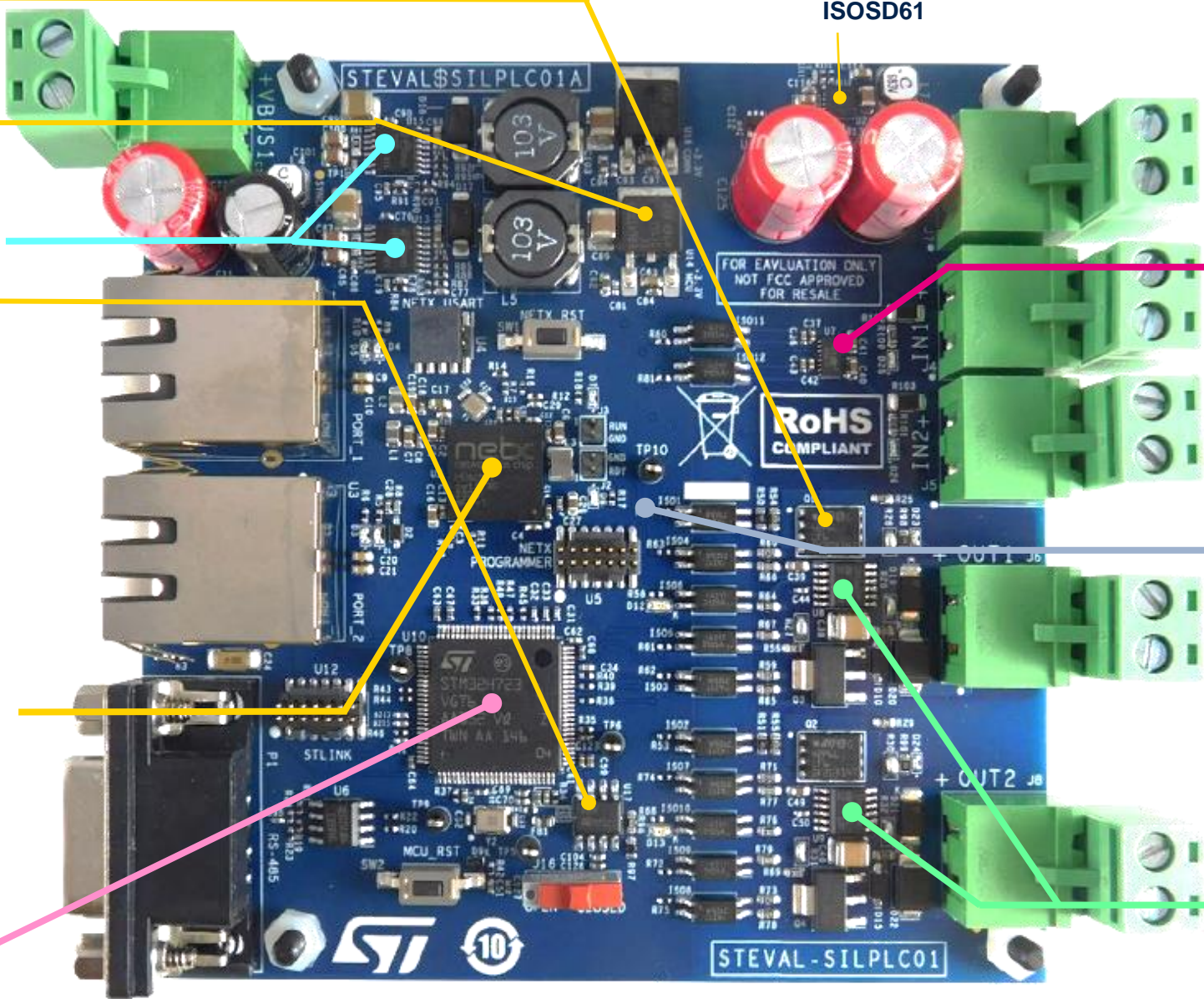
NETX90 – Network  
Controller from Hilscher

STM32H723VG

IPS160HF



life.augmented



# TÜV Activities and Assessment





# ISA assessment (TÜV)

## Hardware analysis to design SIL2 systems

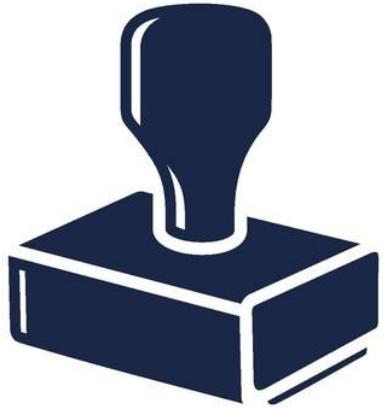
Assessment on components used

Assesment on architecture, and evaluation of **SIL/PL achievable**

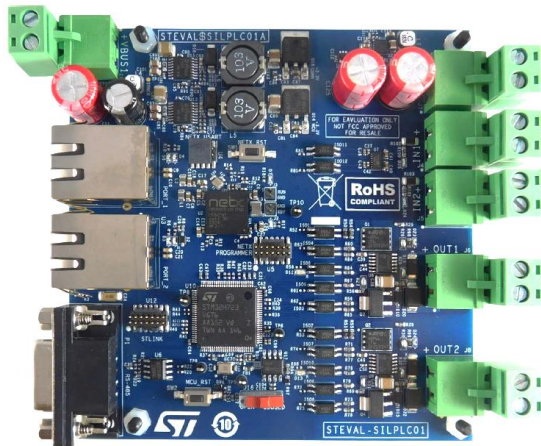
HW and FW diagnostic that can be implemented

**FMEA / FMEDA** (based on architecture and diagnostic functionality that can be implemented by application firmware )

# ISA assessment (TÜV)



- Application board designed to address application use case in the perimeter of factory automation, requiring Safety Integrity Level SIL 2.
- **Officially assessed by TÜV Italia (TÜV SUD Group) on hardware** in compliance with SIL 2/PL d requirements, concerning:
  - random failure rates
  - systematic capability (for the hardware)
  - architectural constraints



STEVAL-SILPLC01

Direttive di riferimento:  
Reference Directives:  
2006/42/CE



Report No.: 722260614 Rev. 0

MANUFACTURER: **STMicroelectronics S.r.l.**  
Via C. Olivetti 2,  
20864 Agrate Brianza (MB), Italy

APPLICANT: **STMicroelectronics S.r.l.**  
Via C. Olivetti 2,  
20864 Agrate Brianza (MB), Italy

PRODUCT: Electronic evaluation board

MODEL / TYPE: STEVAL-SILPLC01

SERIAL NUMBER: --

ORDER NUMBER: 722260614



TN1395

Technical note

Analysis of hardware systematic failures and techniques for on-chip redundancy

## Introduction

With reference to the STEVAL-SILPLC01 evaluation board, the purpose of this document is to show:

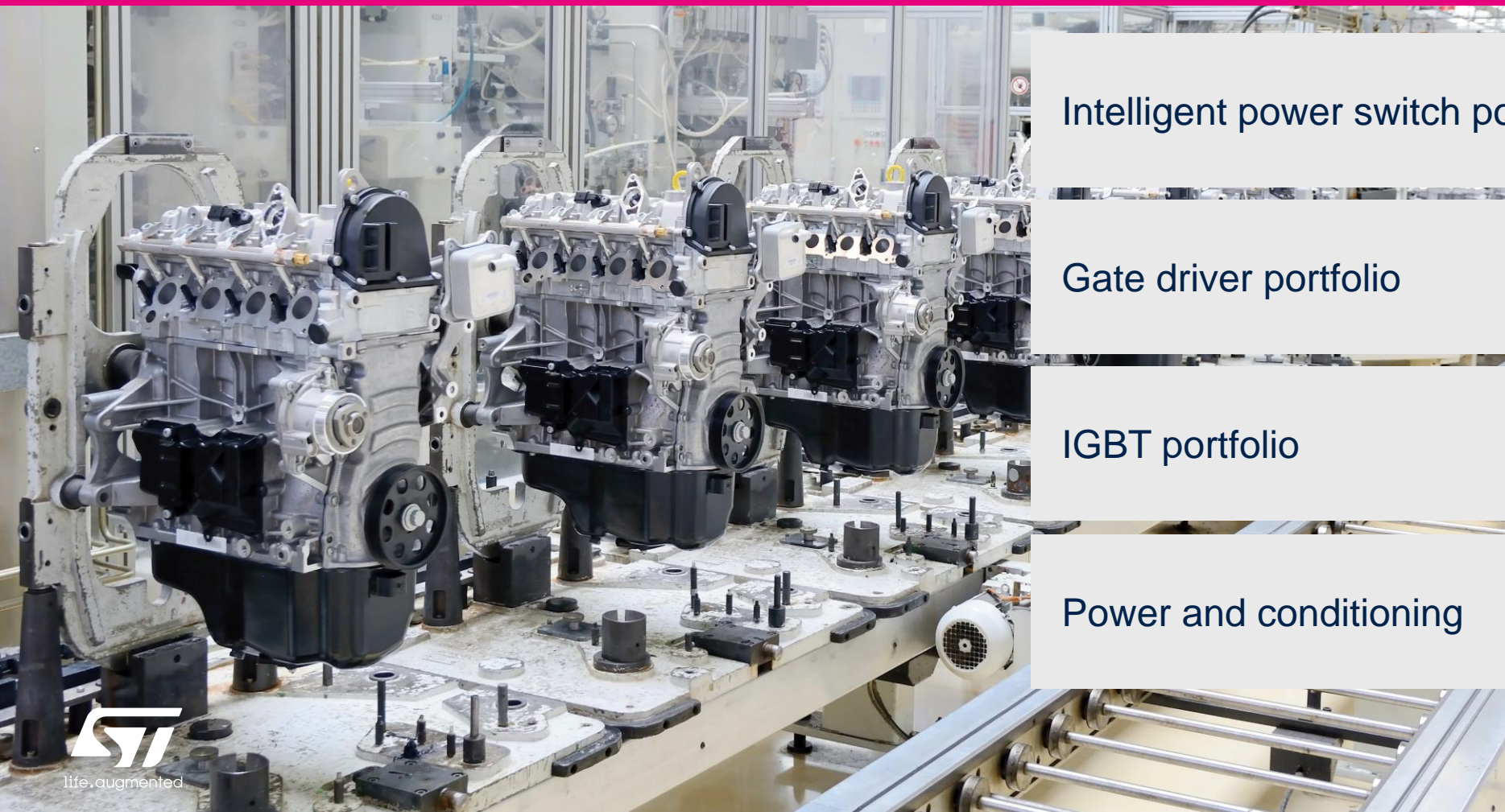
- the evaluation of the hardware systematic failures, identifying the techniques and measures to control and avoid systematic failures in the various phases of the safety life cycle;
- the evaluation of the on-chip redundancy for the digital input component (CLT03-2Q3);
- the evaluation of the hardware systematic capability;
- the possible application of the on-chip redundancy concept;
- the evaluation of  $\beta$  common cause factors for the specific device.





# Title (sentence case)

Reference material



Intelligent power switch portfolio

Gate driver portfolio

IGBT portfolio

Power and conditioning

# IPS & IO-Link Today & Tomorrow

## Innovation Trends & Leading Products



**IPS and Galvanic Isolated IPS**

**Robustness and Reliability** thanks to embedded protections & high-level diagnostics



**IPS 60V Suitable for Safety Integrity Level Systems**

**60V Operative, Higher efficiency and safety** at all points in power usage



**IPS Compact Lines and High End Features**

**Package Compactness, Integrated High-End features, Distributed intelligence, Deep Diagnostics** for Next generation of Smart Factories



 **IO-Link**

**Communication and flexibility** to adapt in real-time to external events





# Intelligent Power Switches

## Family portrait by feature

Single channel

Dual channels

Quad channels

Octal channels



1 A ISO808(Q\*)-1 , ISO808A(Q\*)-1

0.5 A ISO8200AQ,ISO8200B,ISO8200BQ  
ISO808(Q\*) , ISO808A(Q\*)



5 A IPS1025H(Q)-32

2 A IPS160H, IPS160HF  
IPS1025H(Q),IPS1025HF(Q)

0.5 A IPS161H, IPS161HF

5 A IPS2050H(Q)-32

2 A IPS2050H(Q)

2 A VN540SP / VN751  
L6370

1 A VNI2140J

0.5 A L6375, L6377, TDE1707,  
TDE1897, TDE1898, TDE1798

<0.5 A TDE1708DF, TDE3247,  
TDE1747

1 A IPS4140HQ-1\*, VNI4140K-32,  
VN340SP-33

0.5 A IPS4260L

0.5 A VNI4140K, VN330SP, VN340SP,  
L6376, IPS4140HQ\*

<0.5 A VNI860, L6374

1 A VN808(CM)-32, VNI8200XP-32 ,  
IPS8160HQ-1, IPS8200HQ\*-1

0.5 A IPS8350L\* , IPS8350AL\*

0.5 A VN808(CM), VNI8200XP  
IPS8160HQ, IPS8200HQ\*

**Legend**

- Isolated HS
- 60 V HS
- Low side
- High Side


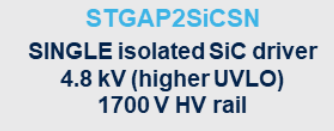
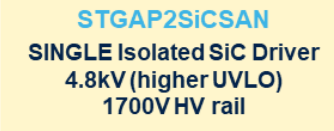
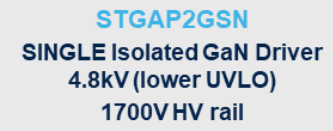

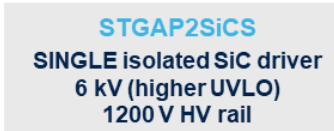
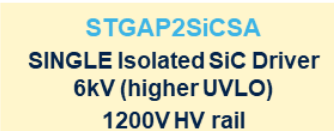



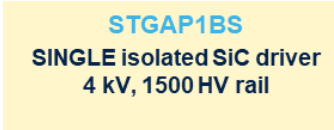

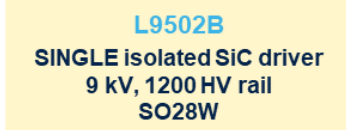
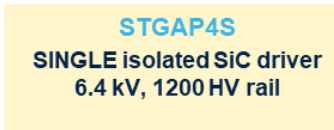


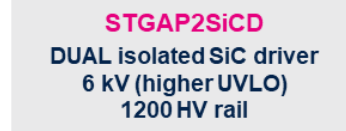
(\*) Development





Automotive Grade  
AEC-Q100

# Galvanic isolated gate drivers portfolio

		IGBT / MOSFET	SiC	GaN	
Single Channel	SO8N - Narrow body Isolation 6 kV V <sub>PEAK</sub> 4.8 kV	 <b>STGAP2S</b> SINGLE isolated gate driver 4.8 kV, 1700 V HV rail	 <b>STGAP2SiCSN</b> SINGLE isolated SiC driver 4.8 kV (higher UVLO) 1700 V HV rail	 <b>STGAP2SiCSAN</b> SINGLE Isolated SiC Driver 4.8kV (higher UVLO) 1700V HV rail	 <b>STGAP2GSN</b> SINGLE Isolated GaN Driver 4.8kV (lower UVLO) 1700V HV rail
	SO8W - Wide body Isolation 6 kV V <sub>PEAK</sub> 6 kV	 <b>STGAP2HS</b> SINGLE isolated gate driver 6 kV, 1200 V HV rail	 <b>STGAP2SiCS</b> SINGLE isolated SiC driver 6 kV (higher UVLO) 1200 V HV rail	 <b>STGAP2SiCSA</b> SINGLE Isolated SiC Driver 6kV (higher UVLO) 1200V HV rail	 <b>STGAP2GS</b> SINGLE Isolated GaN Driver 6kV (lower UVLO) 1200V HV rail
	SO24W - Wide body Isolation 4 kV V <sub>PEAK</sub> 4 kV	 <b>STGAP1BS</b>	 <b>STGAP3x platform</b> SINGLE isolated SiC driver 9.6 kV 1200 V HV rail SO16W, SO28W - DESAT Qual Q2-2024	 <b>STGAP1BS</b> SINGLE isolated SiC driver 4 kV, 1500 HV rail	
	SO36W - Wide body Isolation 6.4 kV V <sub>PEAK</sub> 6.4 kV	 <b>STGAP4S</b>		 <b>L9502B</b> SINGLE isolated SiC driver 9 kV, 1200 HV rail SO28W	 <b>STGAP4S</b> SINGLE isolated SiC driver 6.4 kV, 1200 HV rail
Dual Channels	SO16N - Narrow body Isolation 6 kV V <sub>PEAK</sub> 4.8 kV	 <b>STGAP2D</b> DUAL isolated gate driver 4.8 kV, 1700 HV rail			
	SO36W - Wide body Isolation 6 kV V <sub>PEAK</sub> 6 kV	 <b>STGAP2HD</b> DUAL isolated gate driver 6 kV, 1200 HV rail	 <b>STGAP2SiCD</b> DUAL isolated SiC driver 6 kV (higher UVLO) 1200 HV rail		





# STGAP key performances outlook

## STGAP1

- Driving SiC, IGBT
- SPI Programmable with full protections & diagnostic
- Single channel
- 5A sink/source current
- 4kV magnetic isolation
- AECQ100

- Traction Inverter
- Industrial applications
- ESS, Pumps, DC-DC

## STGAP2

- Compact solutions for SiC, IGBT, GaN
- Single & Dual- channel
- 4A sink/source current
- 6kV magnetic isolation
- Industrial + AECQ100

- OBC, DC-DC Automotive
- Inverters & drives
- Power & Energy
- Automation

## STGAP3

- Robust solutions for SiC, IGBT
- DESAT protection
- Single channel
- 3A, 6A, 10A sink/source current
- 9.6kV reinforced capacitive isol.
- Industrial

- EV charging stations
- Server Power
- Inverters & drives

## STGAP4

- Driving SiC & IGBT
- Flexible & scalable
- Suitable for all currents >15A
- On-chip flyback and ADC
- Self diagnostic
- 6.4kV capacitive isolation
- AECQ100

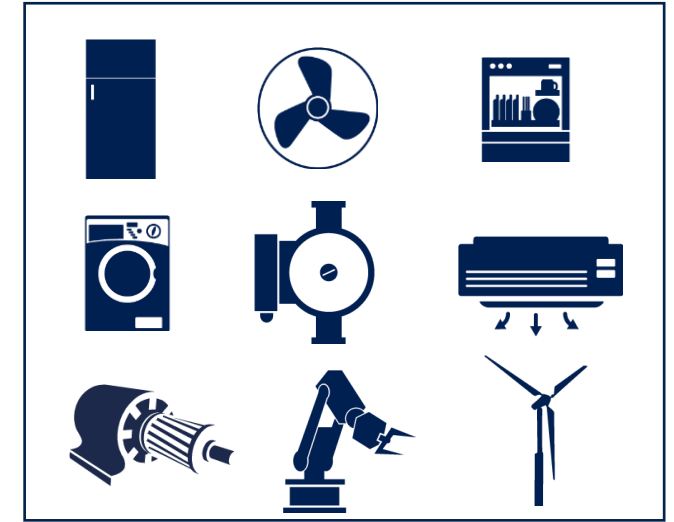
- Traction Inverter
- Industrial applications
- ESS, Pumps, DC-DC

- Addressing all Applications Industrial & Automotive
- Robust solutions and wide driving current capability offer from 3A to > 15A
- Galvanic Isolation embedded from Magnetic to Reinforced capacitive



# Trench Field Stop IGBTs

## The right solution for motor control



### 600V H series

- Low  $V_{CESAT}$  : 1.5 V-1.6 V
- Current capability: 4A(\*) to 20A in discrete pkg
- Available also in bare die
- $t_{SC}$  of 5  $\mu s$  at  $T_J=25^\circ C$ ,  $V_{CC} \leq 360V$
- $T_J$  max =  $175^\circ C$

STGD4H60DF  
available

NEW

### 650V M series

- Low  $V_{CESAT}$  : 1.55 V - 1.65 V
- Current capability: 4A to 200A in discrete pkg
- Available also in bare die
- $t_{SC}$  of 6  $\mu s$  at  $T_J= 150^\circ C$ ,  $V_{CC} \leq 400V$
- $T_J$  max =  $175^\circ C$

### 1200V M series

- $V_{CESAT}$  : 1.85 V
- Current capability: 8 to 50A in discrete pkg
- Available also in bare die
- $t_{SC}$  of 10  $\mu s$  at  $T_J= 150^\circ C$ ,  $V_{CC} \leq 600V$
- $T_J$  max =  $175^\circ C$

STGYA50M120DF3  
available

NEW

### 1700V M series

- $V_{CESAT}$  : 2 V
- Current capability: 50A Available only in bare die (D7,D8)
- $t_{SC}$  of 10  $\mu s$  at  $T_J= 125^\circ C$ ,  $V_{CC} \leq 1000V$
- $T_J$  max =  $150^\circ C$

STG50M170F3D7/D8 Available

NEW

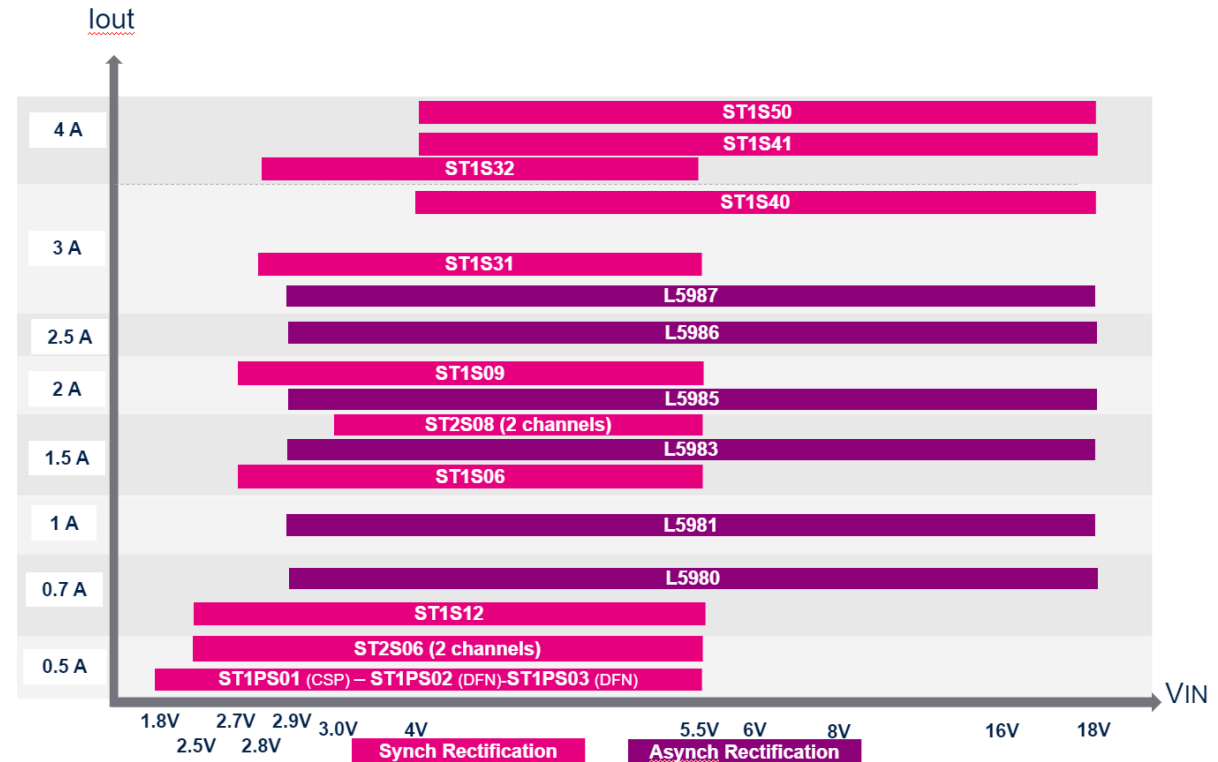
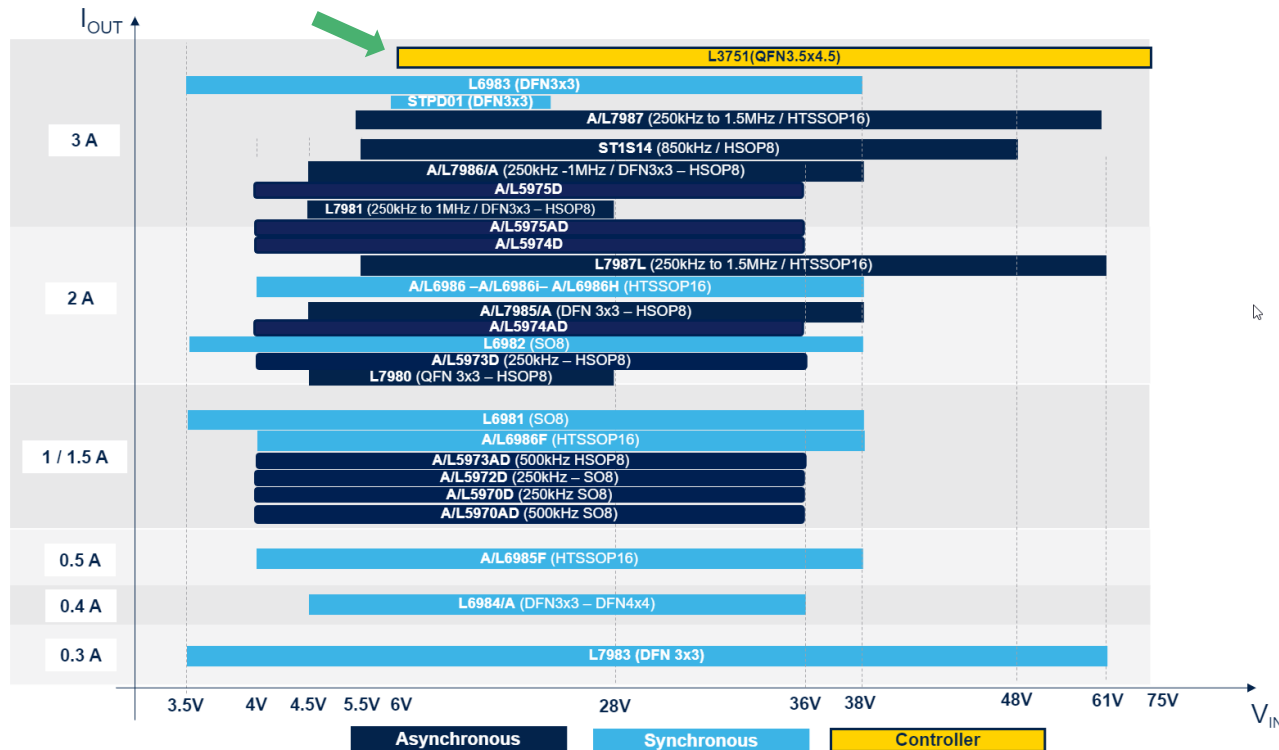


# Product portfolio Buck Regulators

## Buck Regulators

### 24V Bus and Car Battery

### 12V, 5V and 3.3V Bus





# Ultra-low dropout family portrait

## Low input voltage [ $< 5.5 \text{ V}$ ]

Ultra-low dropout family – Low input voltage [ $< 5.5 \text{ V}$ ]									
$3 \text{ A}$								LD39300	LD49300
$2 \text{ A}$						LD39200			
$1.5 \text{ A}$		LD59150						LD39150	
$1.2 \text{ A}$								LDL112	
$1 \text{ A}$	LD57100				LD56100			LD39100 LD49100 LD59100	
$800 \text{ mA}$				ST1L08			LD39080		
$500 \text{ mA}$				LD56050				LD39050	
$300 \text{ mA}$								LDK130	
$200 \text{ mA}$						LD59030	LDLN030	LD39030SJ	
$150 \text{ mA}$		LD3985	LDCL015	LD39015 LD39115		LD56020		LDK120	
	$50 \text{ mV}$	$60 \text{ mV}$	$70 \text{ mV}$	$80 \text{ mV}$	$100 \text{ mV}$	$130 \text{ mV}$	$150 \text{ mV}$	$200 \text{ mV}$	$220 \text{ mV}$

### Package Options

- DFN6 [2X2,2X3,3X3,4X4]
- DFN8 [1.2x1.3, 3x3]
- DPAK
- PPAK

### Package Options

- SOT23-5L
- SOT323-5L (SC70)
- DFN4L [1x1, 1.2x1.2]
- DFN6L
- Flip-chip 4 and 6 bumps



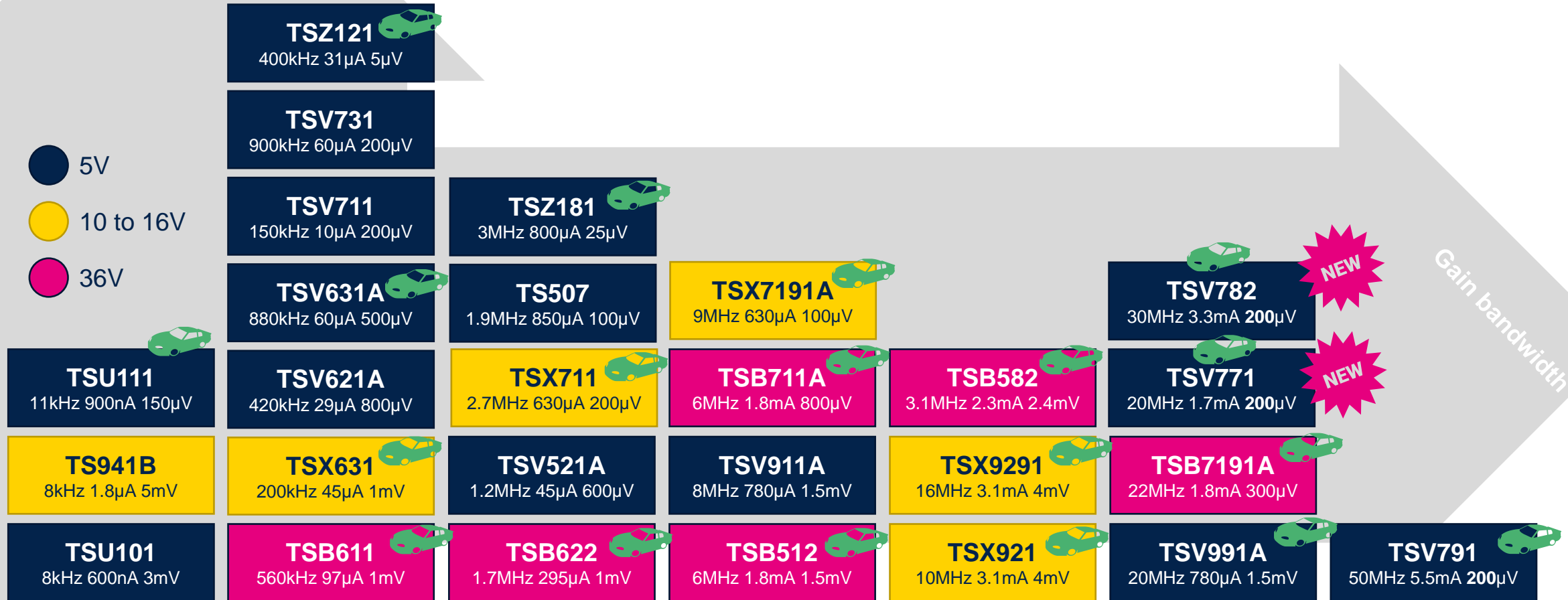




# Op Amps portfolio

Accuracy

Gain bandwidth



life.augmented

Only one version is displayed. Check [www.st.com](http://www.st.com) for single, dual, quad, and package options. Product performances: GBW typ / I<sub>cc</sub> typ / V<sub>io</sub> max @25°C.

