



ST enables Robotic Revolution for Industrial and Consumer Products

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Region AME Strategic Marketing



Technology Tour 2019

Toronto, Canada | May 29



Outline

- The 4th industrial Revolution
 - How ST enables Industry 4.0
 - Architecture examples
 - Products
 - Motor control
 - Analog
 - MEMS
 - Power
 - Educational Material
- Portfolio overview
 - Key products for Industrial
 - Development tool

18th to 21st century: 4 Industrial Revolutions

3

1st – 18th century

- Coal extraction and steam engine
- 1765 – mechanization
- Agriculture
- Textile

3rd – 20th century

- Nuclear energy
- Rise of electronics
- Birth of telecom and computers
- Automations (PLC) and Robots
- Biotech



2nd – 19th century

- New source of energy, gas and oil
- Steel industry
- Electricity
- Taylor and Ford imagine the production line
- Chemical Synthesis
- Telegraph and telephone

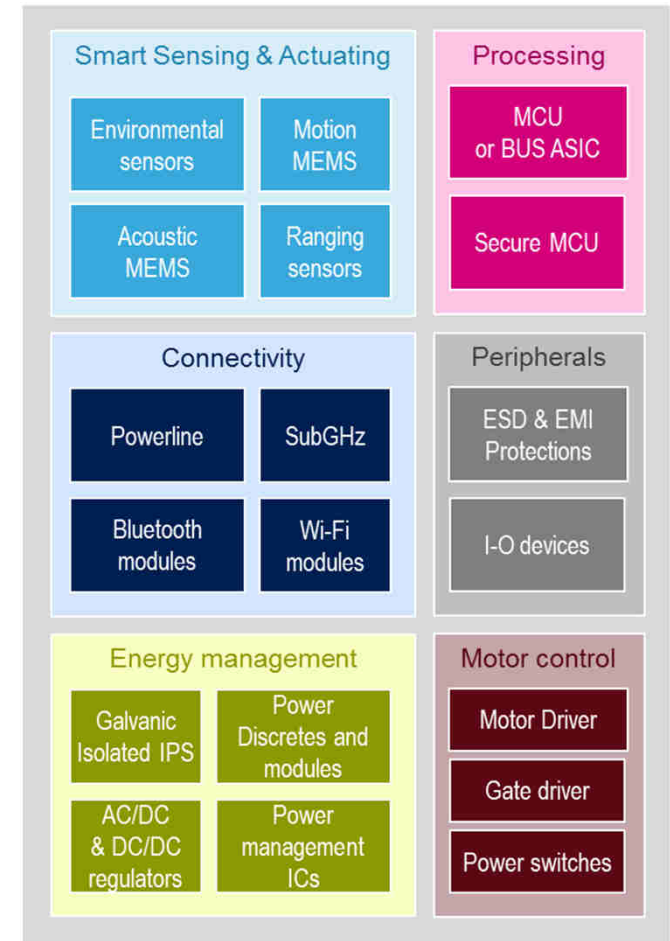
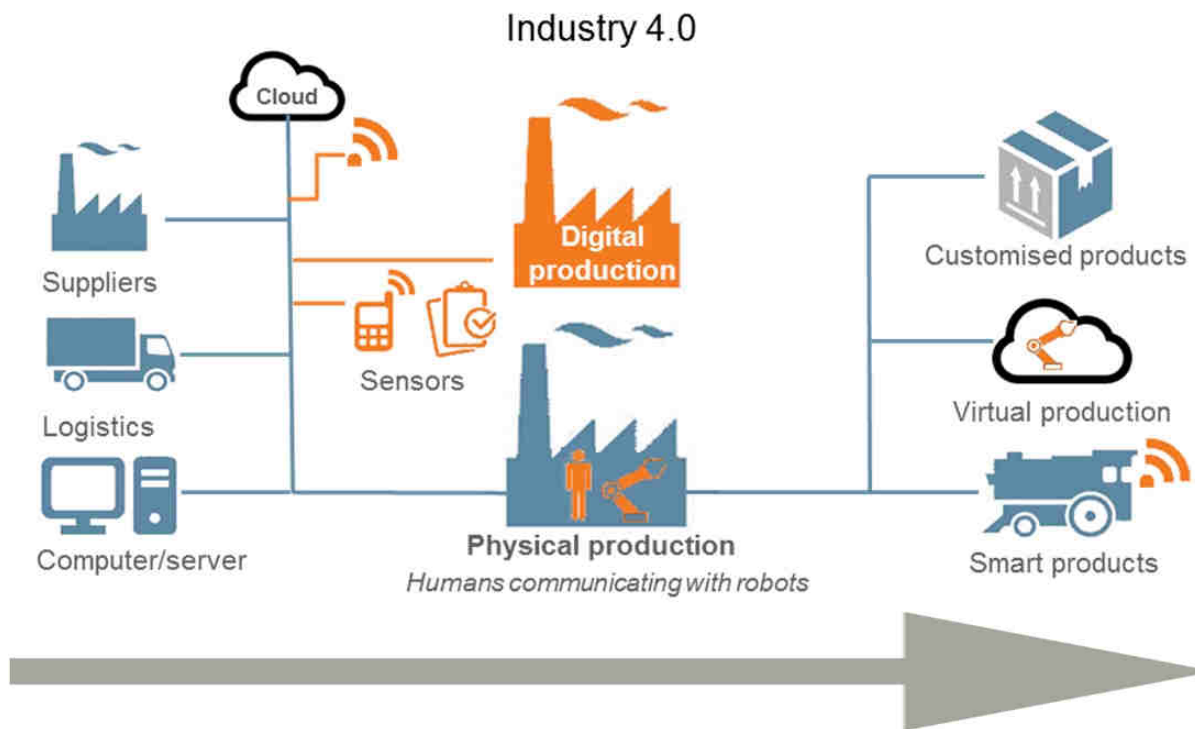
4th – 21st century

- Renewable energies
- The internet - IIoT
- Digitalization and AI
- Virtual world
- Cloud and Big Data
- Machine self Awareness
- Smart cities



Enabling technologies for IIoT

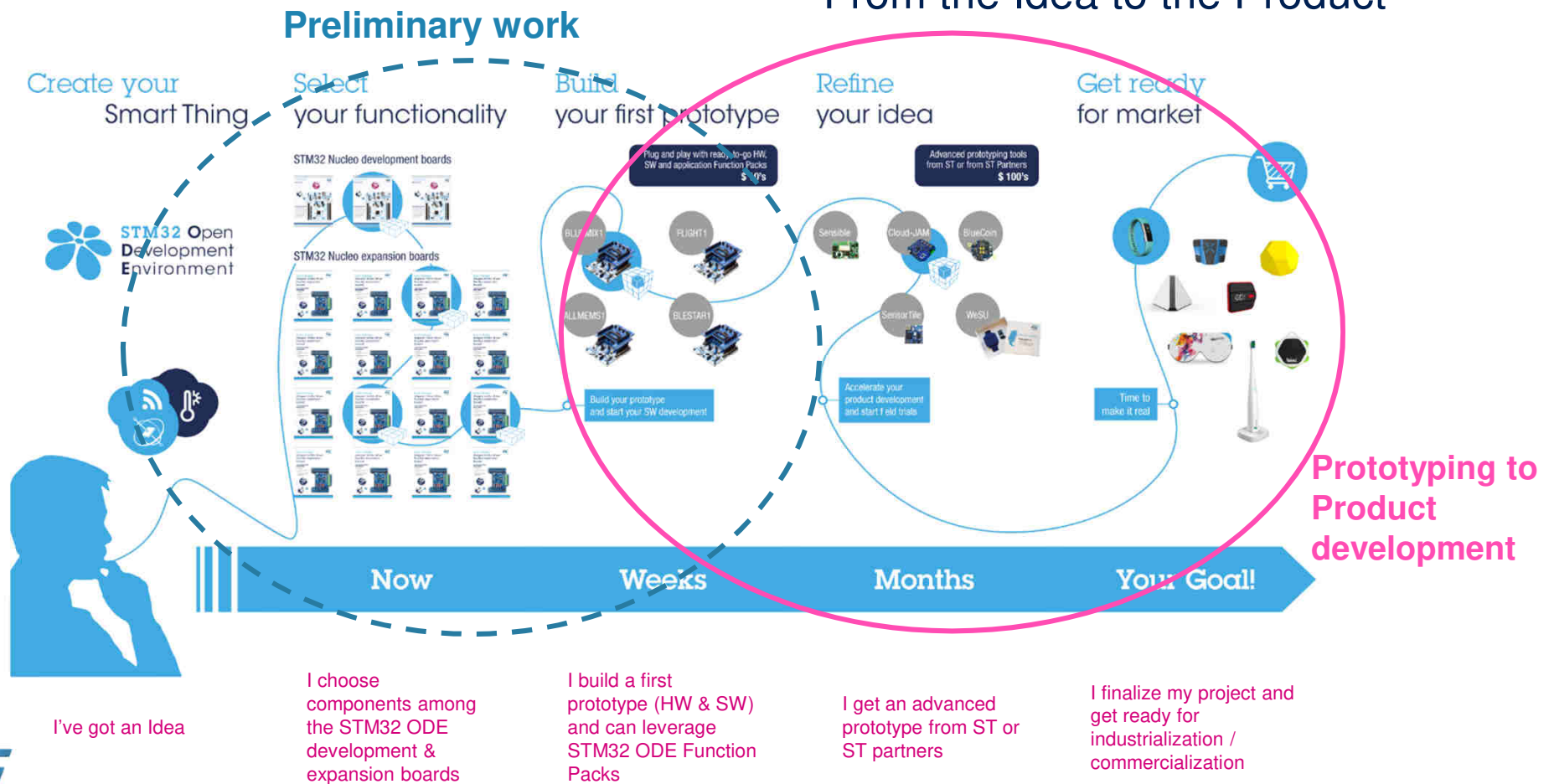
4



How to simplify the Industrialization journey with ST

From the Idea to the Product

5



Addressing Industry 4.0 with Platforms

6

Develop an IoT solution for INDUSTRY 4.0 with ST KIT EVALUATION



Mechanization, water power, steam power

Mass production, assembly line, electricity

Computer and automation

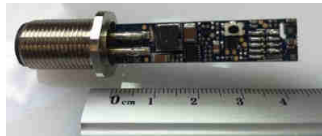
Cyber Physical Systems

2017

2018

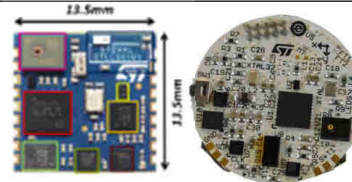
next

NEW PRODS



- Axel (IIS2DH)
- Pressure (LPS22HB)
- Humidity (HTS221)
- Temperature (STTS751)
- Microphone (MP34DT05)

IO-Link
Software Libraries



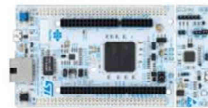
- Vibrometer (IIS3DWB)
- 6xIMU (ISM330DLC)
- Pressure (LPS22HH)
- Humidity & Temp (HTS2E)
- Microphone (MP23AB01DH)

STEVAL-STLCS01V1
Training Available

NFC Smart TAG



27 development boards and growing... in two flavors (Processing and Security)



Covering all STM32 microcontroller families
and different development needs

32 expansion boards and growing... covering all the key functions



Motion & environmental
sensors

Proximity sensor

Microphone



BLE

Wi-Fi

Sub-GHz

NFC



Power management
LED boost

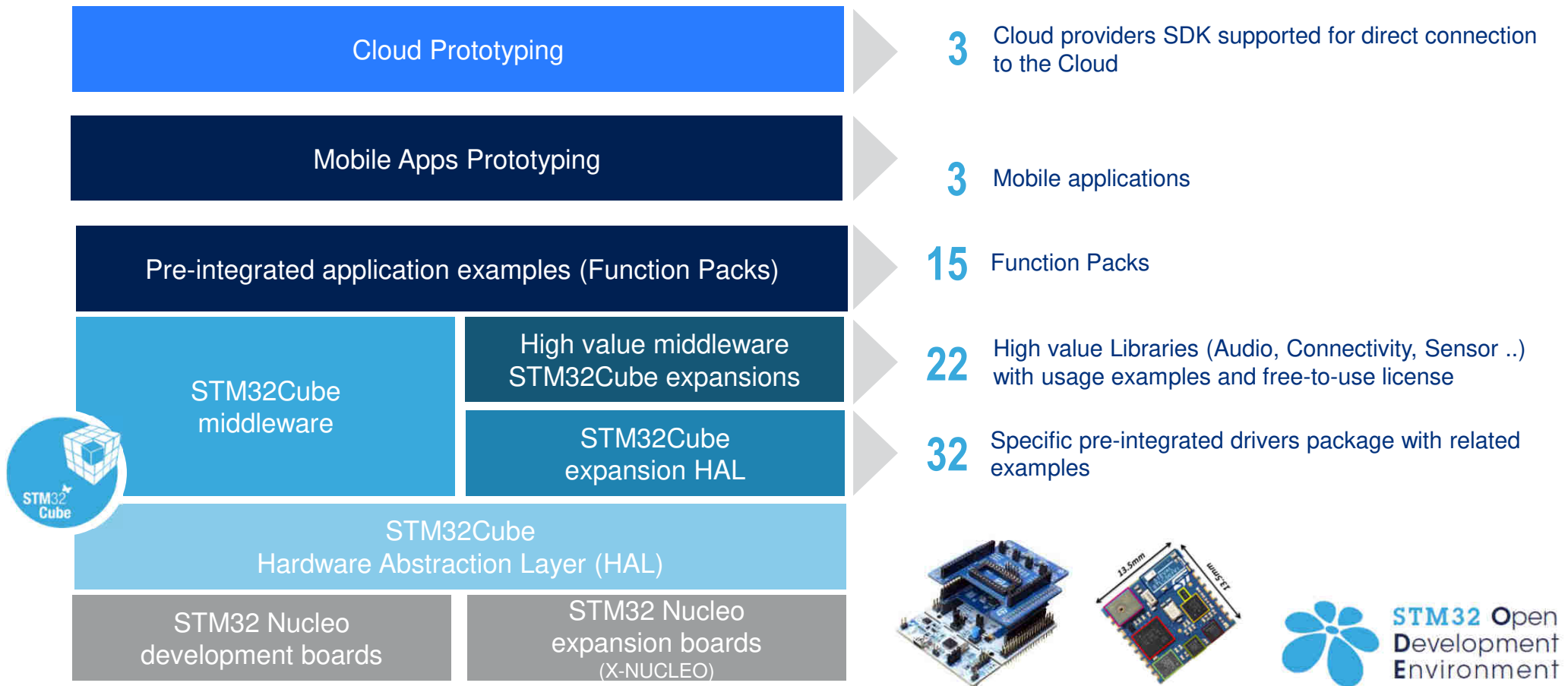


Motor drive
Actuator



Audio amplifier
Op-Amp

Software for End-to-end Cloud Solutions





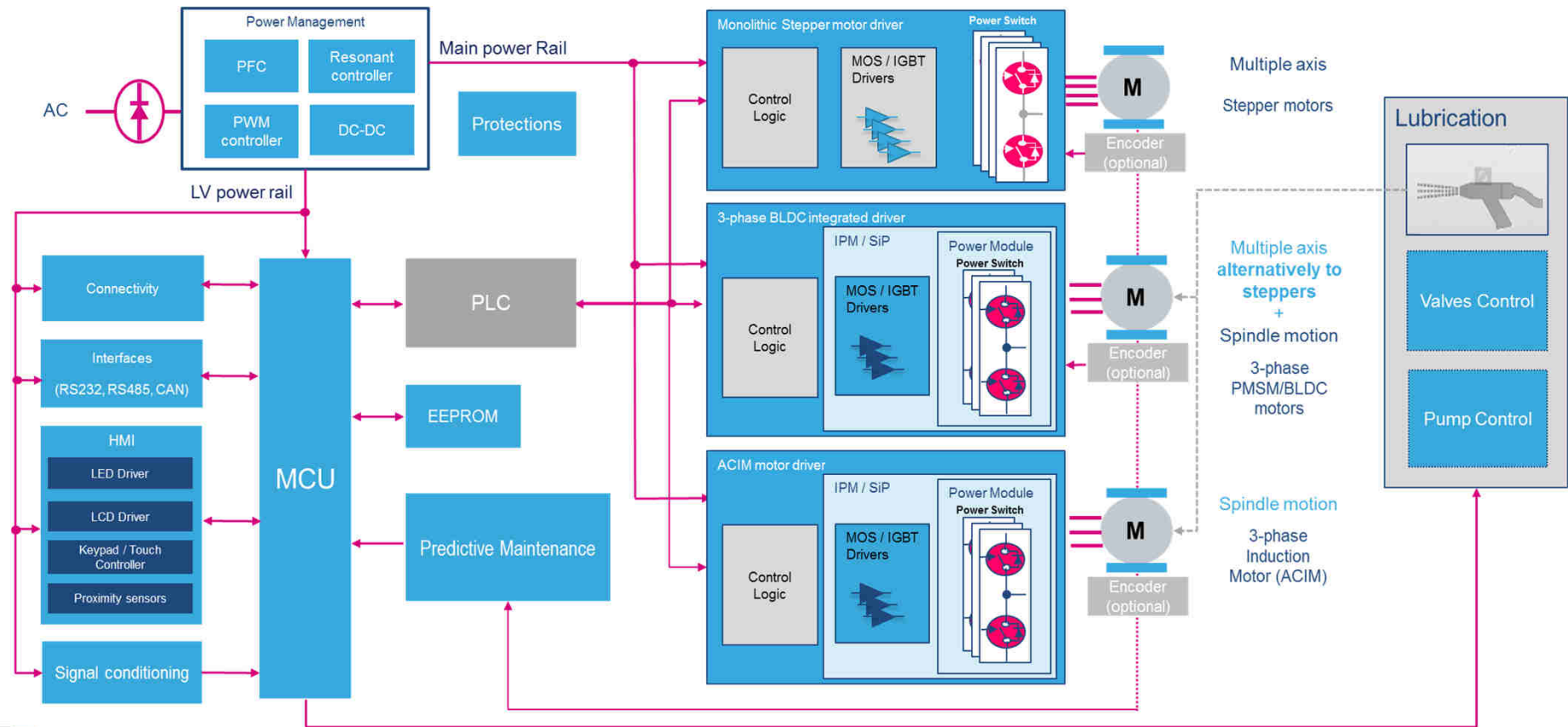
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HW Architecture for Industrial application examples

CNC Machine block Diagram

10



Industry 4.0

From Preventive to Predictive Maintenance

11

Predictive maintenance is a key asset in the Industry 4.0

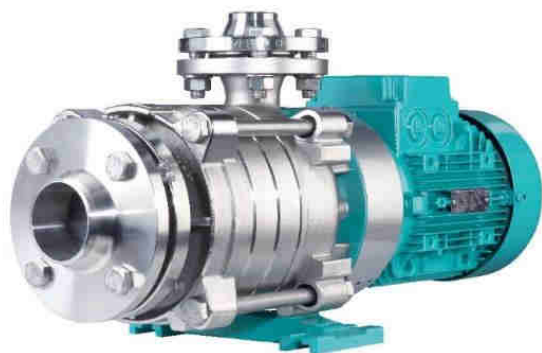




ST Solutions for Factory Automation

Condition Monitoring & Predictive Maintenance

12

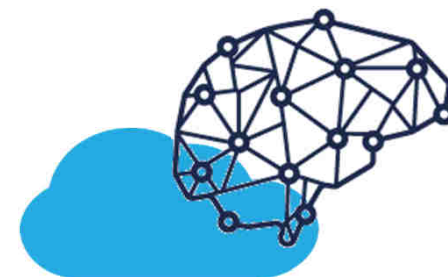


Mechanical vibration

- Displacement
- Speed
- Acceleration
- Acoustic noise
- Angular speed
- Torque

Acoustic signals

- Noise
- Ultra sound

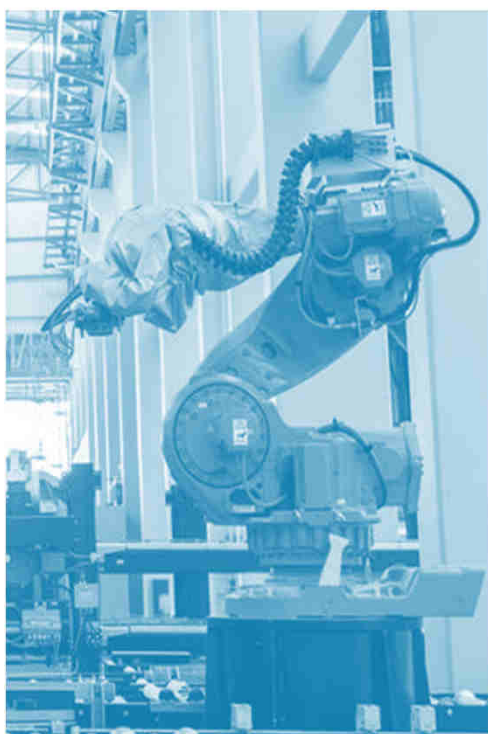


Functional needs	Capture vibrations	Signal conditioning	Processing	Power Management	Connectivity	Secure Connections
ST solutions	MEMS Sensors 	Op Amps Comparators 	MCU 	Power ICs & Power Discrete 	Bluetooth Sub-1 GHz IO-Link 	Secure MCU



Building blocks of IIoT

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Sensors & actuators



Analog products



Microcontrollers



Connectivity solutions



Motor drivers



Energy management



Secure solutions





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Motor Control Solutions



Motor Drivers- Portfolio Overview

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Leading integration, performance, efficiency with a wide offer of **more than 130 products**



Portable, Battery Powered



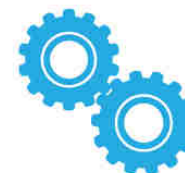
Medical, Security, ATM, Vending,
3D Printers, Domotics



Stage Lighting



Industrial, Factory Automation





STSPIN32F0

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Motor driver IC integrating an advanced BLDC controller
and a 32-bit MCU in a 7x7 mm footprint



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

**High performance three-
phase gate driver**
Wide application range up
to **600 mA** and **45 V**

Compact design with a **7x7
mm QFN** package

Cost-effective sensorless
systems or accurate
control with **Hall-effect**
sensor feedback

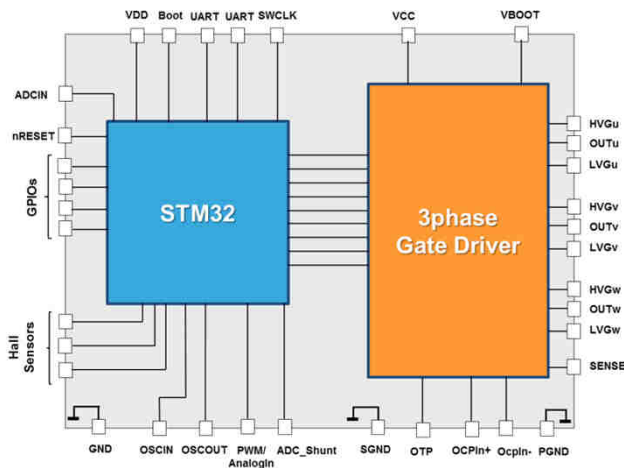
Maximum efficiency with
on-chip generated supplies
for MCU, driver and
external circuitry



High Voltage STSPIN32-F0H60

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



TQFP 10x10 64L

Embedded 32-bit
STM32F0 MCU with
ARM® Cortex®-M0

600V High performance
three-phase gate driver

High immunity
Extremely robust
Full protection

X-CUBE Firmware for
STM32

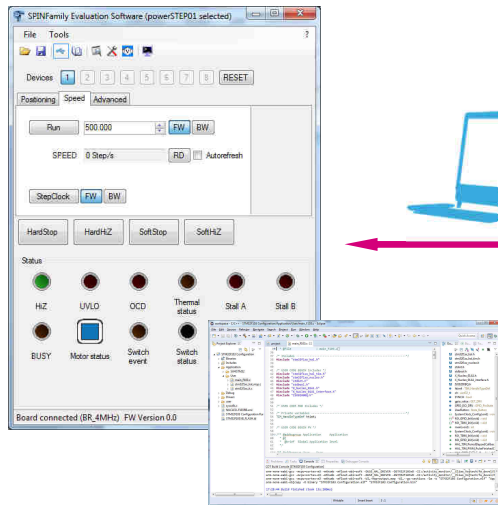


STSPIN Evaluation Ecosystem

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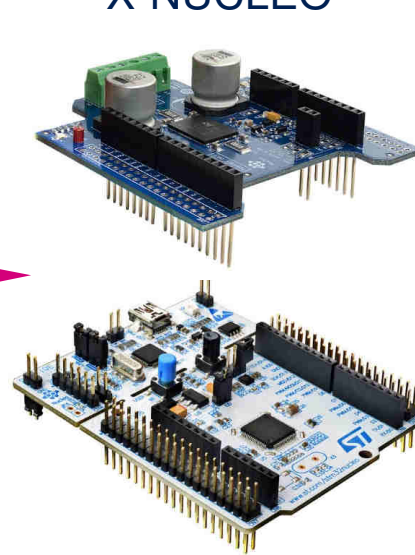
Speed-up your design with X-NUCLEO!

SPIN Family Evaluation Software



X-CUBE Firmware for STM32

X-NUCLEO



NUCLEO



DC Power Supply



Motor



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



Smart Industry



Analog Solutions

Analog & Low-power RF



in Smart Industry 4.0 (r)evolution

Power management

- LDOs / VREFs
- Efuse
- Real Time Clock
- LED drivers
- Darlington Arrays



Signal conditioning

- RS232/485 interfaces
- Operational amplifiers, comparators
- Resets & supervisors
- USB Power Delivery Type-C™ controllers



Low-power RF

- Sub GHz proprietary radio
- Bluetooth Low Energy ICs



Gate Drivers and Switching

- DC-DC converters
- Gate Drivers
- IPS – Intelligent Power Switches
- PFC controller
- AD/DC controllers/converters

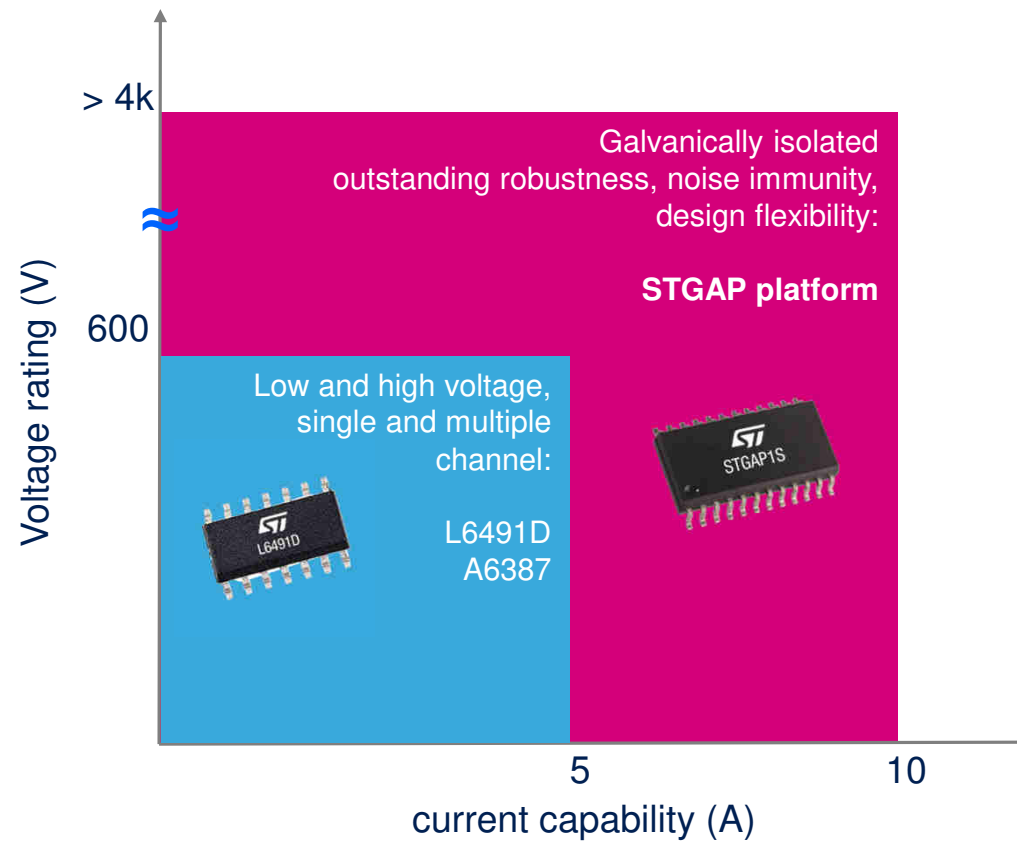


More efficient, performing and connected industry



MOSFET/ IGBT GATE DRIVERS & SiP 21

A comprehensive and future proof product portfolio

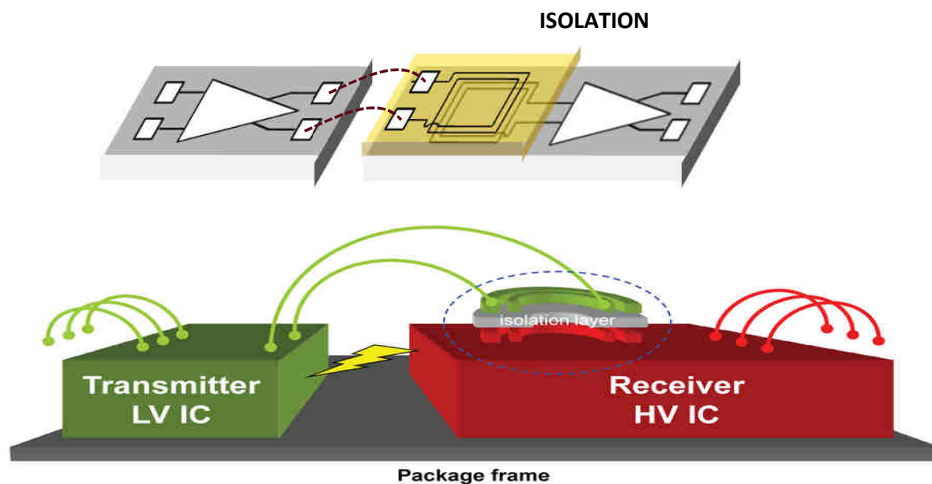




STGAP - Galvanic Isolated Gate Driver

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Outstanding robustness, noise immunity and design flexibility



Rugged enough to operate in harsh industrial environments

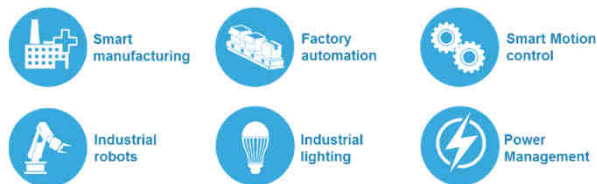
Ability to withstand voltages as high as **1700 V**

Maintaining high noise immunity and low switching losses

Suitable for high capacity switches, with a current capability up to **4 A**

Key Applications

- Motor control
- Factory automation
- Industrial drives and fans
- DC-DC converters
- Welding



Low-Power RF portfolio

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Enabling the Sensor-to-Cloud wireless connectivity

Predictive maintenance

Asset tracking

Condition monitoring

Plant / factory control

Resource planning

Maintenance planning

Design, Prototyping and simulation

Demand monitoring

Energy management

Plant / factory visualization

Remote servicing / training



BlueNRG Family



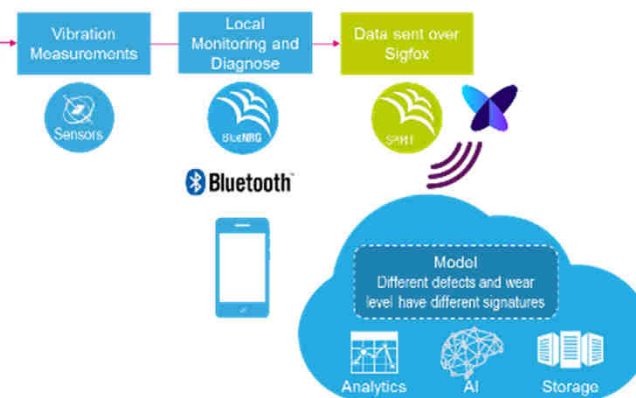
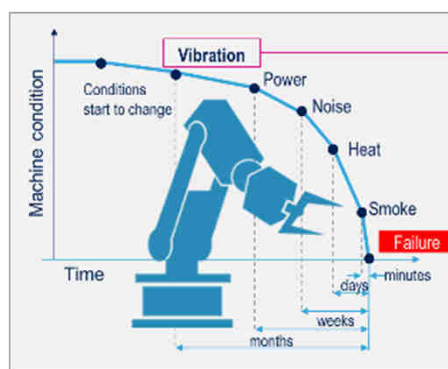
Ultra Low Power ARM-Based
Bluetooth Low Energy Processors

BlueNRG-MESH

SPIRIT Family



Sub-1GHz Radio Transceivers
And LPWAN networking





Low-power RF ecosystem

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Evaluation and hardware development tools

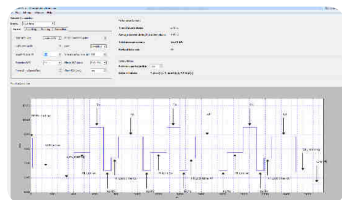


Software development tools (GUI, simulators, SDK, protocols, RF libraries, etc.)



RF NAVIGATOR

RF POWER SIMULATOR



DUAL-RADIO SDK



BLUENRG-MESH TRIPLE SDK



Android SDK
iOS SDK



MOTION SW
libraries



VOICE SW
libraries



RF modules



IDH and module makers





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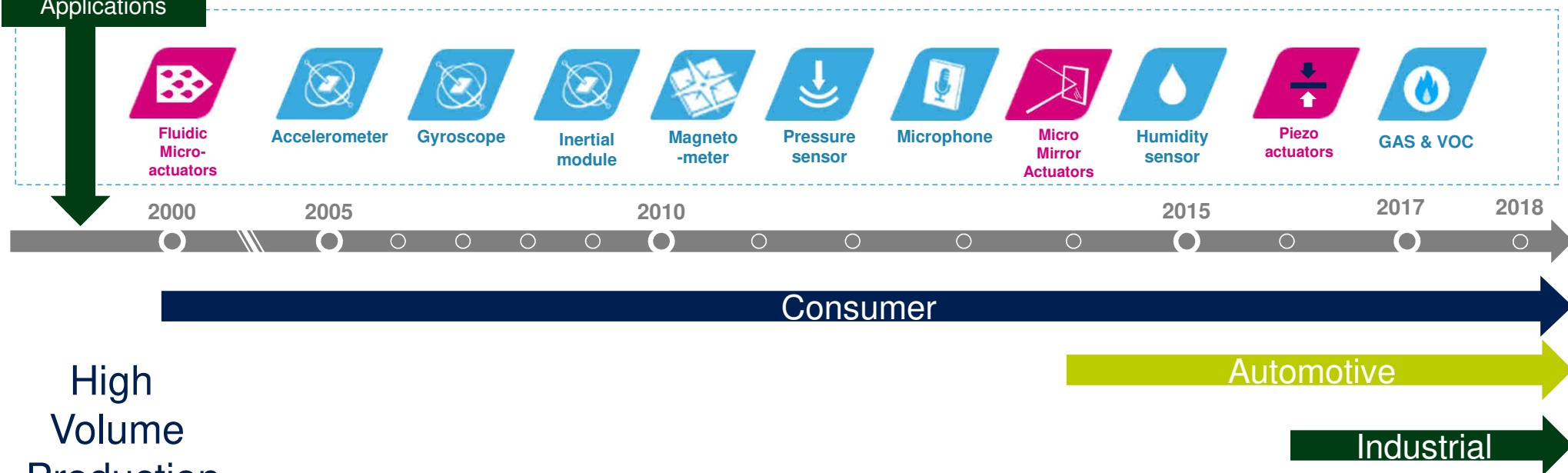


Sensor Solutions

Original MEMS Development for Industrial and Automotive Applications

20 Years of MEMS & Sensors @ ST

26



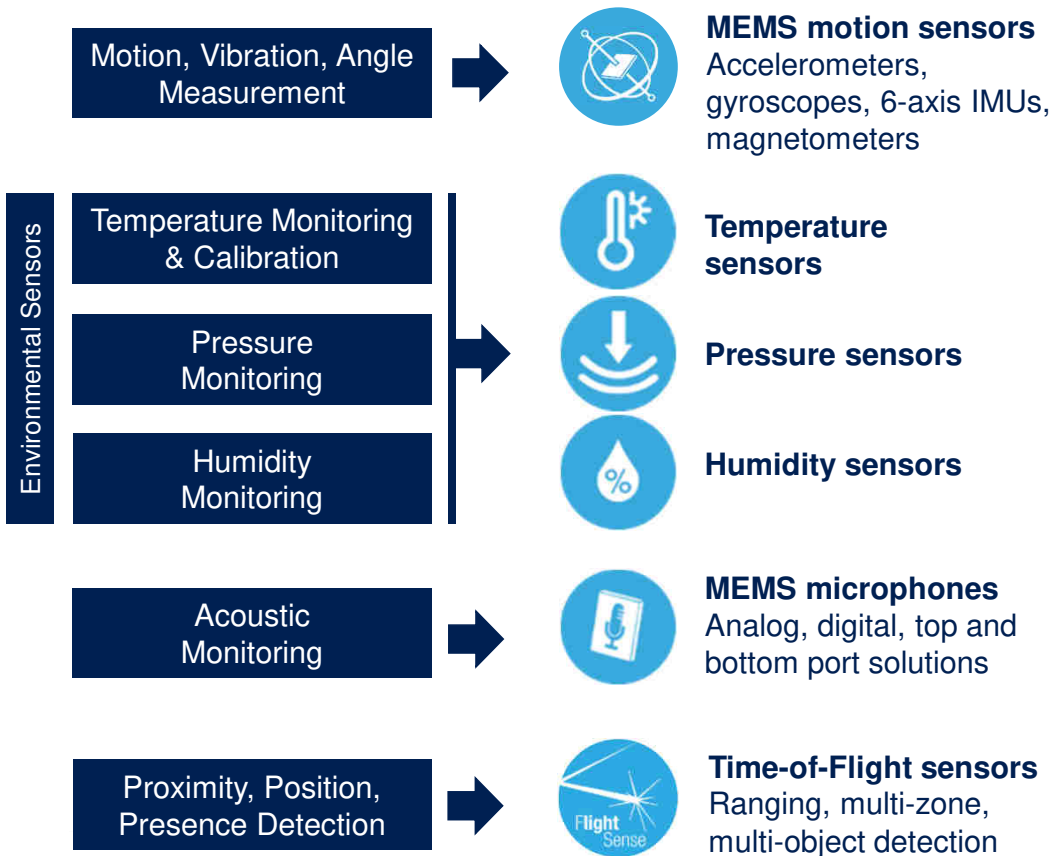
High
Volume
Production



Continuing Innovation by increasing
ACCURACY
while keeping *low power consumption*

Sensors for Industrial

27



ISM330DLC
6x IMU – Ultra-low power consumption, wide bandwidth





IIS2DH
Accelerometer – Wide Bandwidth, Ultra-low-power



ISM303DAC
High performance Integrated Compass



IIS2MDC
Magnetometer Low-Noise, Low Power



IIS3DHHC
Accurate, low-noise inclinometer



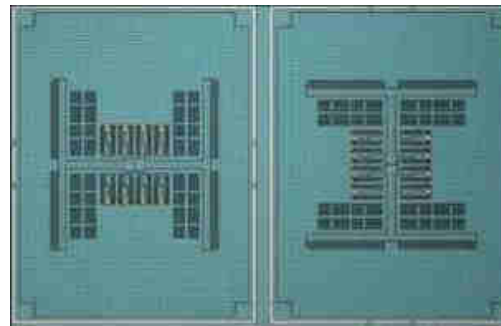
IMP34DT05
Omnidirectional digital microphone for industrial applications



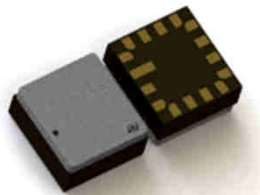
MEMS Inclinometer

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Two-axis in-plane MEMS sensor for inclinometer applications such as structural-health monitoring and robotics



Improved sensor design and ceramic packaging technology enables leading-edge resolution and accuracy performance



CLGA ceramic package

Road Tunnel Monitoring



Heavy vehicle



Environmental Sensors for Industrial Applications

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Temperature sensors

Analog and digital contact temperature sensors



Local Temperature Monitoring



Humidity sensors

Combo humidity and temperature sensor



Environment Humidity Monitoring



Pressure sensors

With water proof solutions



Environment Pressure Monitoring

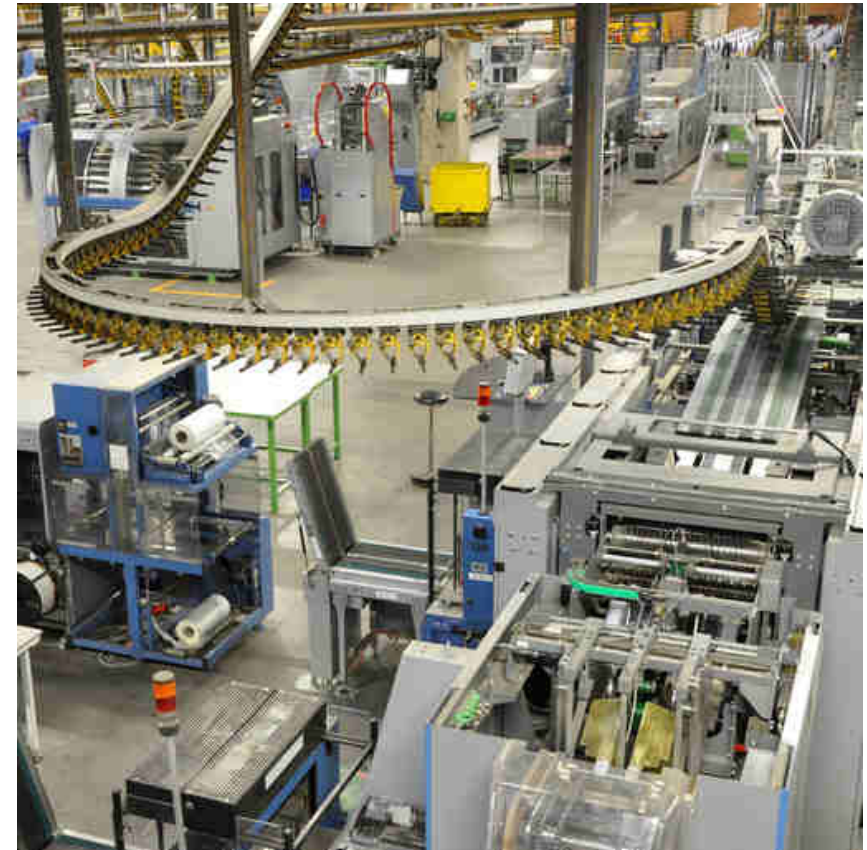


MEMS Microphones

Analog, digital, top and bottom port solutions

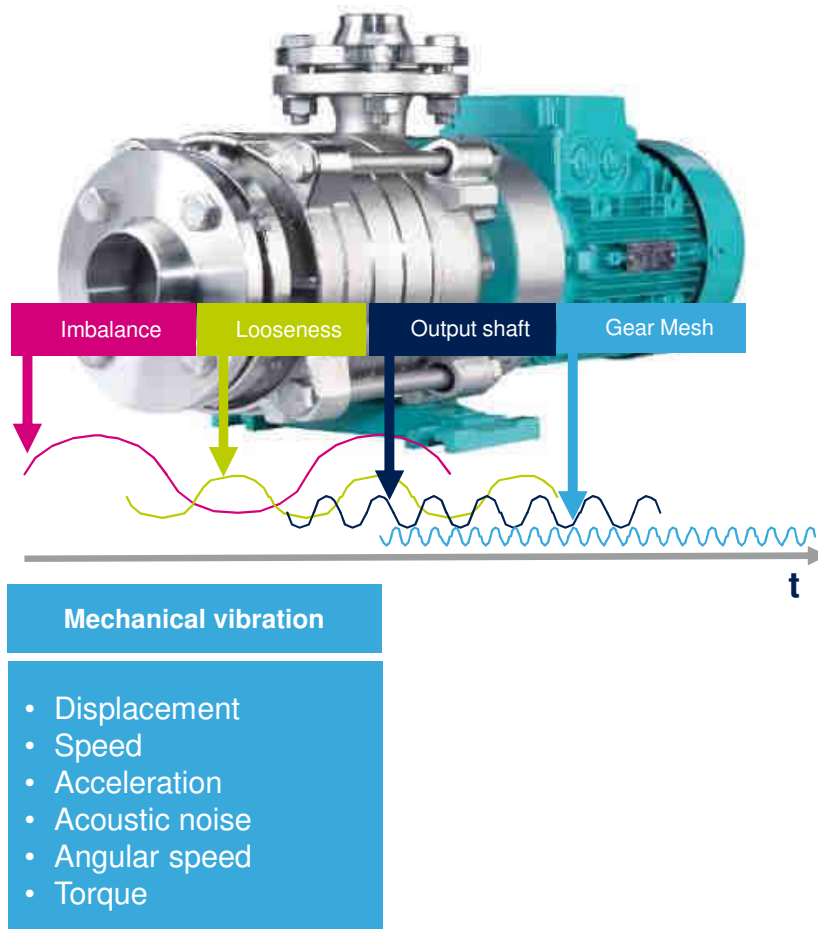


Acoustic Monitoring



Condition Monitoring

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Functional Needs

ST Products

Vibration Capture

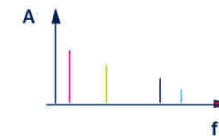


Motion Sensors

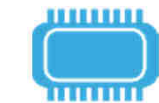
Connectivity



Bluetooth
Wi-Fi
Sub-1GHz



Processing



MCU

Secure Connections



Secure MCU

Power Management



Power ICs

Condition Monitoring Through IO-Link Reference Platform

STEVAL-IDP005V1

Use cases



Motors



Equipment



Environment

Sensing



Vibration and Environmental

- IIS2DH 3-Axis digital MEMS accelerometer
- MP34DT05 Microphone
- LPS22HB MEMS Pressure sensor
- HTS221 Humidity & Temperature Sensor
- STTS751 Digital temperature sensor

Connectivity



Wired

- L6362A IO-Link communication transceiver device IC

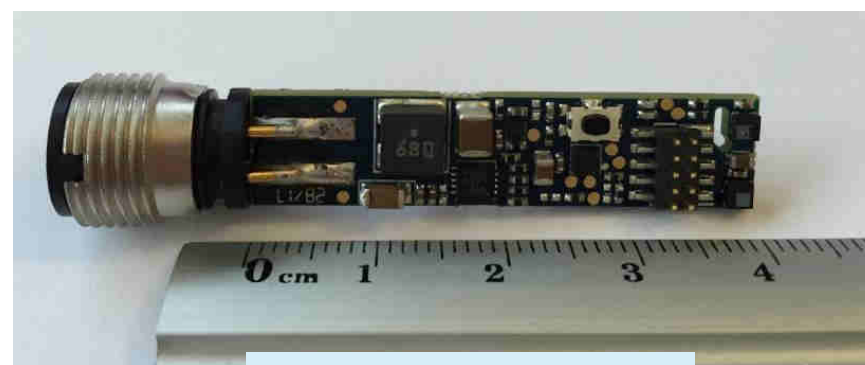
Processing



Local Processing

- STM32F469AI 32-bit ARM Cortex-M4 microcontroller

Equipment with vibration up to 2KHz



Now Available

Main Features

- Optimized form factor for industrial M12 connector
- Embedded algorithm for sensors data analysis, detecting anomalies like unbalance, misalignment, or bad equipment condition
- Logging of worst working condition events



Smart Industry



Power Discretes

Power Discretes



in Smart Industry 4.0 (r)evolution

Power Transistors

- Low Voltage MOSFETs (30 – 200V)
- High Voltage MOSFETs (250 - 1700V)
- IGBTs (600V – 1350V)
- Silicon Carbide MOSFETs
- Power Modules



Protection/Signal Filters

- RF Balun and Filtering
- ESD and TVS Arrays



Power Rectifiers

- Schottky and Ultrafast (20V – 1200V)
- Field Effect Rectifiers (30V – 100V)
- Silicon Carbide Rectifiers (600V – 1200V)



Enabling higher power density and lower system solution cost



Silicon Carbide MOSFETs

Key Benefits

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Extremely low Switching Losses and Ultra-Low $R_{DS(on)}$ especially at very high T_j

Higher operating frequency for smaller and lighter systems

Good Thermal Performance

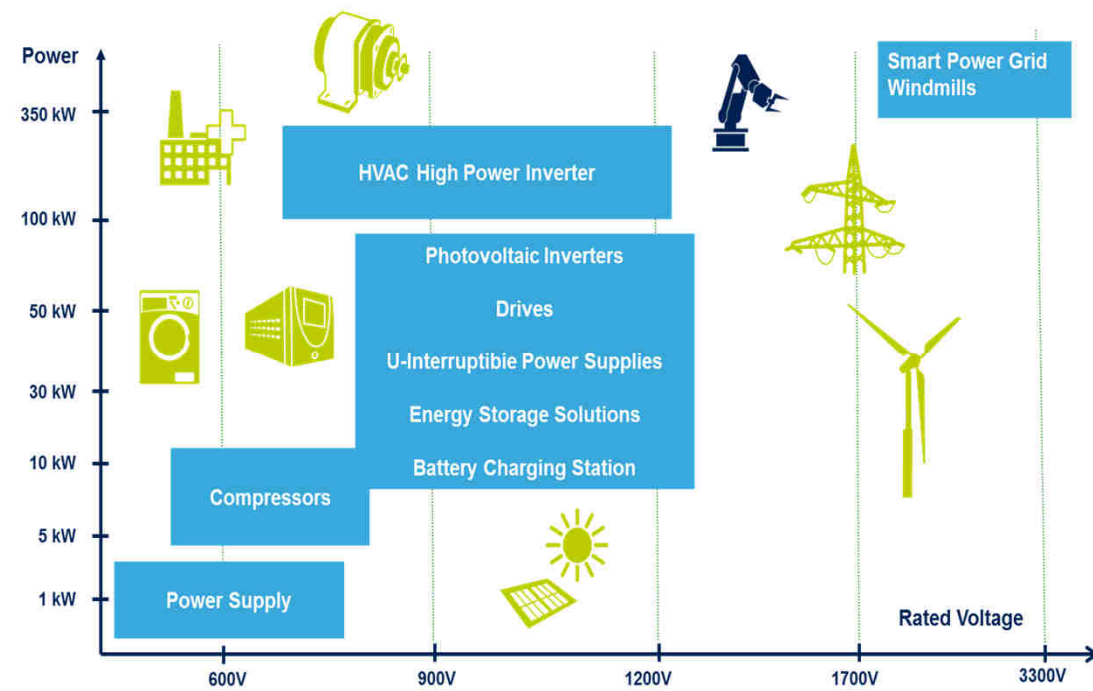
High operating temperature ($T_{jmax} = 200^{\circ}\text{C}$)
Reduced cooling requirements & heat-sink, Increased lifetime

Easy to Drive

Fully compatible with standard Gate Drivers

Very fast and robust intrinsic body diode

More compact Inverter



Silicon Carbide MOSFET Packages Roadmap

Under development



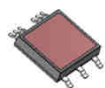
TO3-PF



TO247-4L



Bare Die:
KGD + BI



ACEPACK™
SMIT

Under investigation



TO247
(High Creepage)



TOLL SI/DI
LV & HV

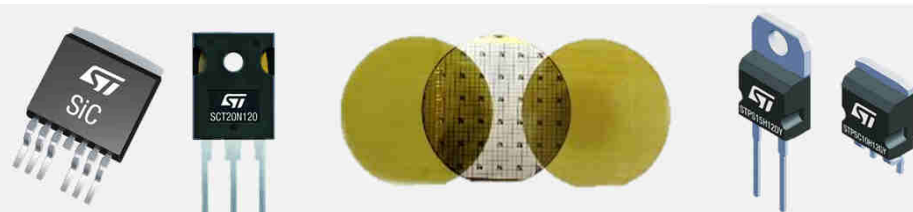


D3PAK



MAX247

Package offer - Discrete – Mini-module – Modules



Discrete Packaging

In Production

Power Modules



Customer dedicated
module

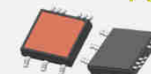


ACEPACK™ 1



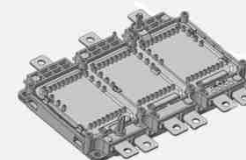
ACEPACK™ 2

Production 2019



ACEPACK™ SMIT

Production 2020



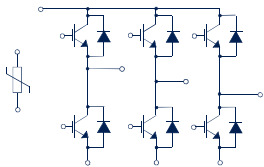
ACEPACK™ DRIVE

ACEPACK™ Power Modules

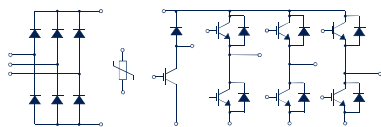
Adaptable, Compact and Easier PACKage

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Standard products in MP (solder and press fit pins)



Six-Pack + NTC



CIB + NTC



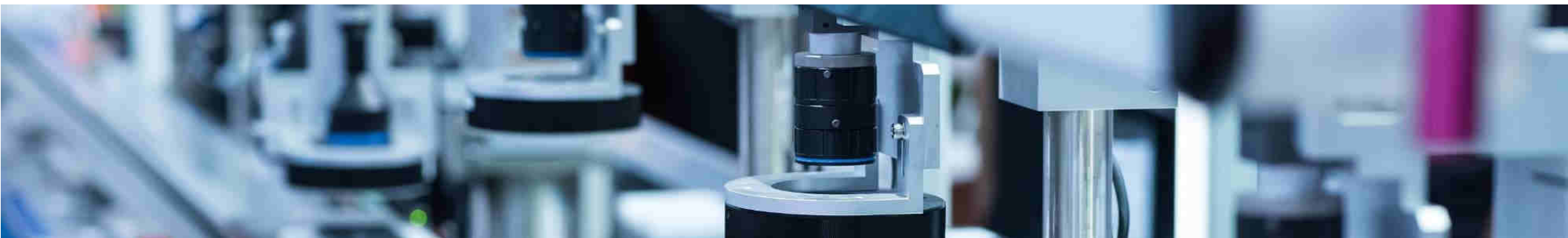
ACEPACK™ 1

Part Number	Topology	BV _{CES}	I _C rating
A1P25S12M3/-F	Six-Pack	1200V	25A
A1P35S12M3/-F			35A
A1C15S12M3/-F	Converter Inverter Brake	1200V	15A
A1P50S65M2/-F	Six-Pack	650V	50A

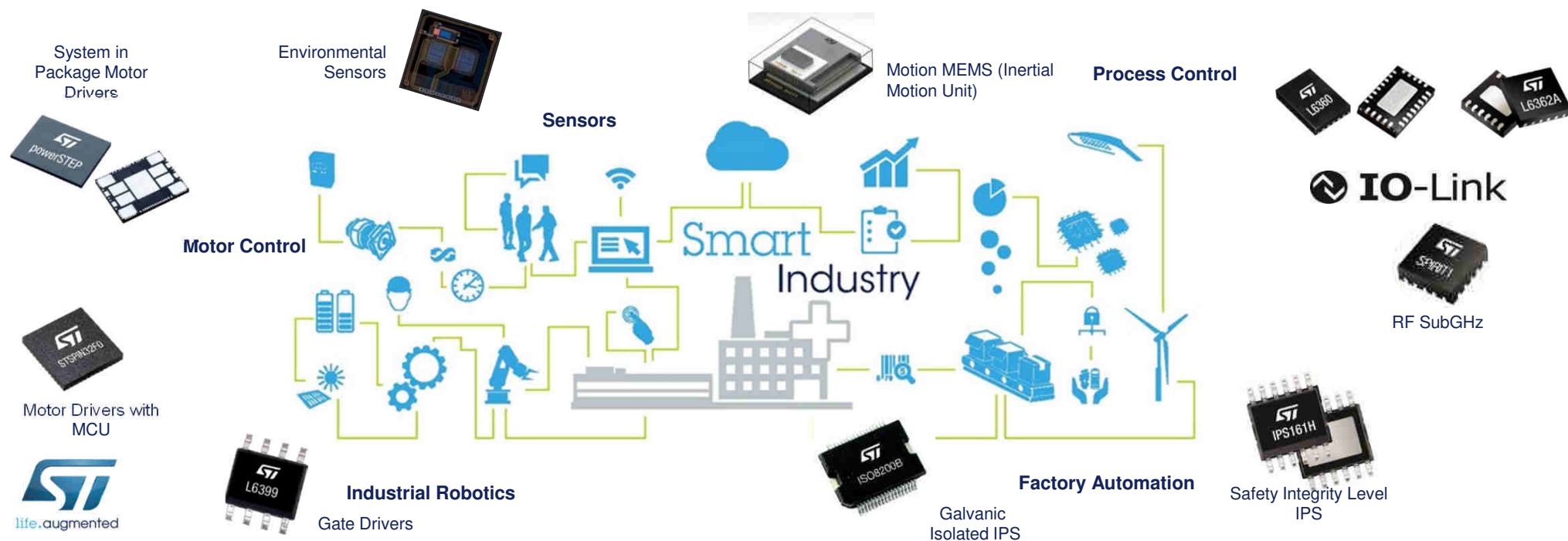


ACEPACK™ 2

Part Number	Topology	BV _{CES}	I _C rating
A2C25S12M3/-F	Converter Inverter Brake	1200V	25A
A2C35S12M3/-F			35A
A2P75S12M3/-F	Six-Pack	1200V	75A
A2C50S65M2/-F	Converter Inverter Brake	650V	50A



At the Heart of all Key Applications





Smart Industry



Educational Material



Learning Embedded Systems

Freshman Curriculum

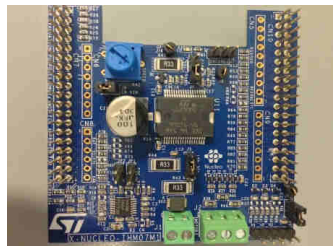
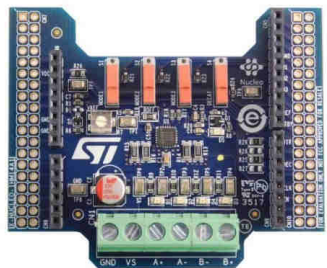
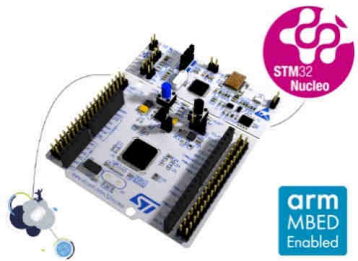
Senior Capstone Design

Professor's Lounge

st.com/sensortile-edu

Motor control for Robotics curriculum

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- Based on an rotary inverted pendulum Kit
- Students will learn how to solve the cinematic problem with PID control in C code and with two different types of motors
 - Nucleo F401RE – STM32F401RE
 - X-NUCLEO-IHM07M1 – STSPIN820
 - Stepper motor – 7-48VDC
 - X-NUCLEO-IHM14A1 – L6230PD
 - 3 phase BLDC/PMSM 8-48VDC

