



**Capital Markets
Day 2024**

Analog, Power & Discrete, MEMS and Sensors Group

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Sensors Group

Agenda

1 Introduction

2 Smart Mobility

3 Power & Energy

4 Intelligent Things

5 Takeaways

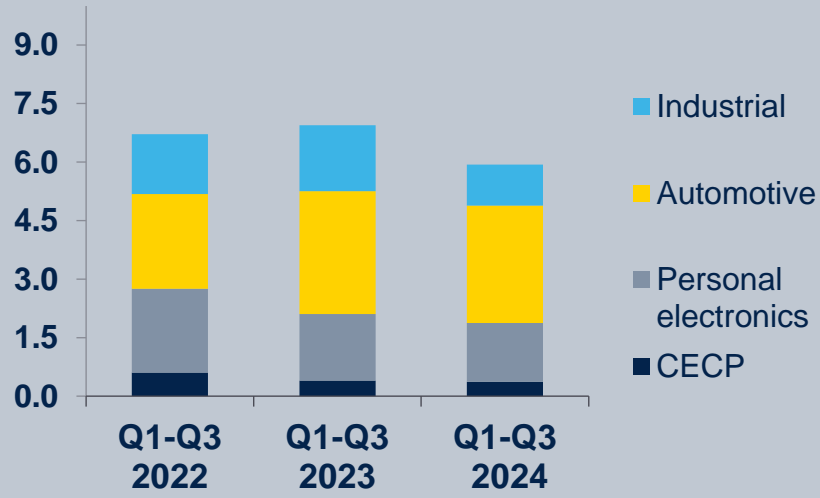


Revenue overview – APMS

APMS Group revenue \$B

2024 – 9 months

\$5.9B



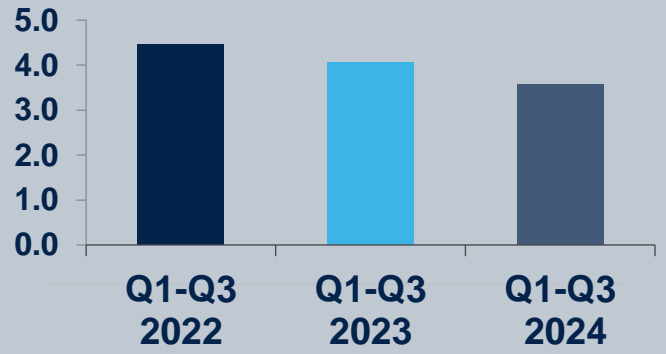
CECP: Communication Equipment, Computer & Peripherals

APMS Segments \$B

2024 – 9 months

\$3.6B

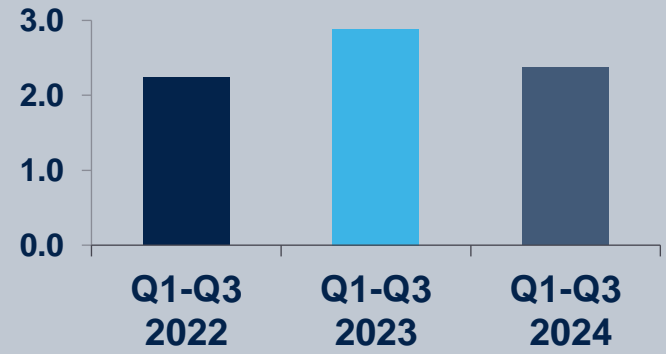
Analog, MEMS & Sensor



2024 – 9 months

\$2.4B

Power & Discrete



Bridge the physical & digital worlds enable a more sustainable future

Intelligent

Safe

Efficient



Analog – General purpose & application specific



Power – Silicon and wide bandgap materials



Sensors – MEMS & imaging

ST strategy – APMS

Broad product portfolio

15,000+ products

Power

Power transistors
Discrete & filters

Analog

Application specific
General purpose

Sensors

MEMS sensors & actuators
Optical sensing solutions



Focused market approach

\$100B+ SAM

100,000+ Customers

Strategic focus on **industrial & automotive** end markets

Address specific high-volume opportunities in **personal electronics**

Selective approach in **communications equipment and computers & peripherals** focusing on advanced power management

OEMs and distribution

Leveraging our proprietary technologies and integrated device manufacturer model





APMS product portfolio

Power		Analog		Sensors	
Power transistors	Discrete & filter	Application specific	General purpose	MEMS	Imaging
 <p>Silicon MOSFETs IGBTs SiC MOSFETs GaN FETs Intelligent Power Modules Power Modules</p>	 <p>Thyristor & Triac Ultrafast & SiC Diodes Power Schottky Protection & ASIPs RF Integrated Passive Devices & Filters</p>	 <p>Automotive: Battery Management, Traction, Braking, Airbag, Door Zone, Engine, PMIC Industrial: Motion control, Galvanic Isolated, Digital power, Smart Power GaN, PMIC, Medical ICs Storage & Server: PMIC, PreAmps Personal device: wireless charging, touch controller, display PMIC</p>	 <p>AC-DC, DC-DC MOSFET, IGBT, SiC, GaN Gate Drivers Intelligent Power Switches, High- & Low-side drivers, LED drivers, Op Amps, Vref, Vreg, LDOs eFuses, current sensing, Real Time Clocks and Timers, Supervision, Control ICs</p>	 <p>Smart sensors Biosensors 6-axis Inertial measurement unit Accelerometer & gyroscopes Vibrometers, Inclinometers Barometers, pressure, Temperature, electrostatic Magnetometers</p>	 <p>CMOS image sensors 3D Camera ToF sensors Ambient light sensors Proximity sensors Micro-optics Custom optical solutions</p>

APMS Power

Leader in silicon carbide and electrification

Products	
Power transistors	Discrete & filter
Silicon MOSFETs IGBTs SiC MOSFETs GaN FETs Intelligent power modules Power modules	Thyristors & Triacs Ultrafast & SiC Diodes Power Schottky Protection & ASIPs RF integrated passive devices & Filters
	

Enabling technologies			
Silicon carbide	Silicon MOSFET	TVS & ESD	EMI filtering
Power GaN	IGBT	Diodes	SCR & Triacs

Key strengths
Complete power technology portfolio from low to high-voltage Leveraging competitive IDM model Fully vertically integrated SiC 200 mm manufacturing and dedicated footprint China for China Large, diversified customer base & product and technology portfolio Strong cooperation with key customers and strategic partners

Leading Positions
#1 SiC #1 Automotive electrification #2 High-voltage silicon MOSFET #2 Automotive #3 Discrete IGBT #3 in power discrete & modules



APMS Analog

Leader in ASIC and application-specific analog

Products	
Application specific	General purpose
Automotive: Battery Management, Traction, Braking, Airbag, Door Zone, Engine, PMIC Industrial: Motion control, Galvanic Isolated, Digital power, Smart Power GaN, PMIC, Medical ICs Storage & Server: PMIC, PreAmps Personal device: wireless charging, touch controller, display PMIC	AC-DC, DC-DC MOSFET, IGBT, SiC, GaN Gate Drivers Intelligent Power Switches, High- & Low-side drivers, LED drivers Op Amps, Vref, Vreg, LDOs eFuses, current sensing Real Time Clocks and Timers, Supervision, Control ICs

Enabling technologies			
High-voltage BCD	Automotive BCD	BCD-SOI	High-end analog CMOS
Galvanic isolated BCD	90 / 40 nm eNVM BCD	VIPOWER	Smart power GaN

Key strengths
Very large technology & products portfolio addressing all markets Strong application and system knowhow Long-lasting partnerships with leaders in all market segments Recognized leadership in automotive and industrial Balanced structure to support both major key accounts and mass market

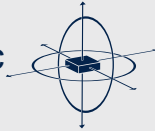
Leading Positions
Leadership in PMIC and sub-PMIC in Personal Electronics and CECP Top #3 in application specific for automotive and industrial #1 in braking, door zone, galvanic driver #1 in powerline communication ICs #2 in motion control & automation



APMS Sensors

Leader in MEMS and imaging

Products	
MEMS	Imaging
Smart sensors Biosensors 6-axis Inertial measurement unit Accelerometer & gyroscopes Vibrometers, Inclometers Barometers, pressure, Temperature, electrostatic Magnetometers	CMOS image sensors 3D Camera ToF sensors Ambient light sensors Proximity sensors Micro-optics Custom optical solutions



Enabling technologies

TMOS thermal	THELMA motion	Proprietary pixel portfolio	Hybrid bonding 3D BSI/CMOS
Vertical analog front end	PETRA Piezo actuator	Diffraction & metasurface optics	Small footprint packaging

Key strengths
30 billion sensors sold to date A pioneer in both MEMS and imaging industries In-house technology development & manufacturing In-sensor AI & low-power technology leader Advanced hardware & software ecosystem Automotive qualified sensor technologies

Leading Positions	MEMS #1 Motion & pressure MEMS in Android devices MEMS for automotive navigation Actuators for printing
	Imaging #1 Time-of-Flight Global shutter



APMS growth stems from key trends

Smart Mobility



Safer

Greener

More connected

20% CAGR '24-'27 for L2+ cars
13% CAGR '24-'27 for EV cars

Yole, TechInsights

Power & Energy



Greener generation

Smarter transmission

Efficient utilization

Electricity consumption x2.5 from 2023 to 2050

McKinsey

Intelligent Things



Intelligent

Sustainable

Transformative

>3 billion edge AI devices shipments
31% CAGR '24-'27

ABI research

Smart Mobility



Automotive TAM to double by 2030 driven by electrification

Intelligent Power switch
>40%
 2023 market share

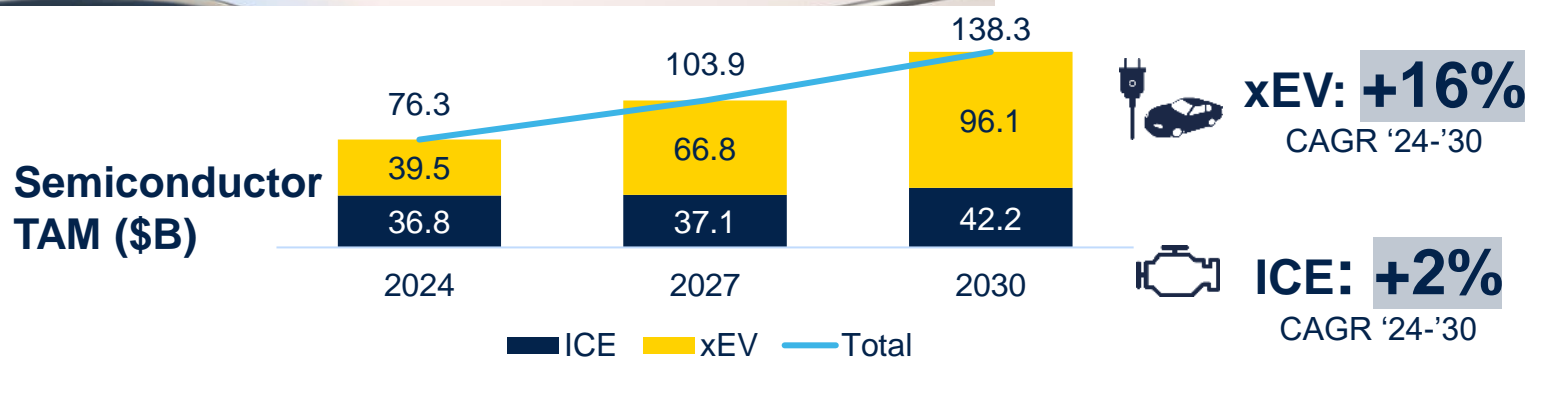
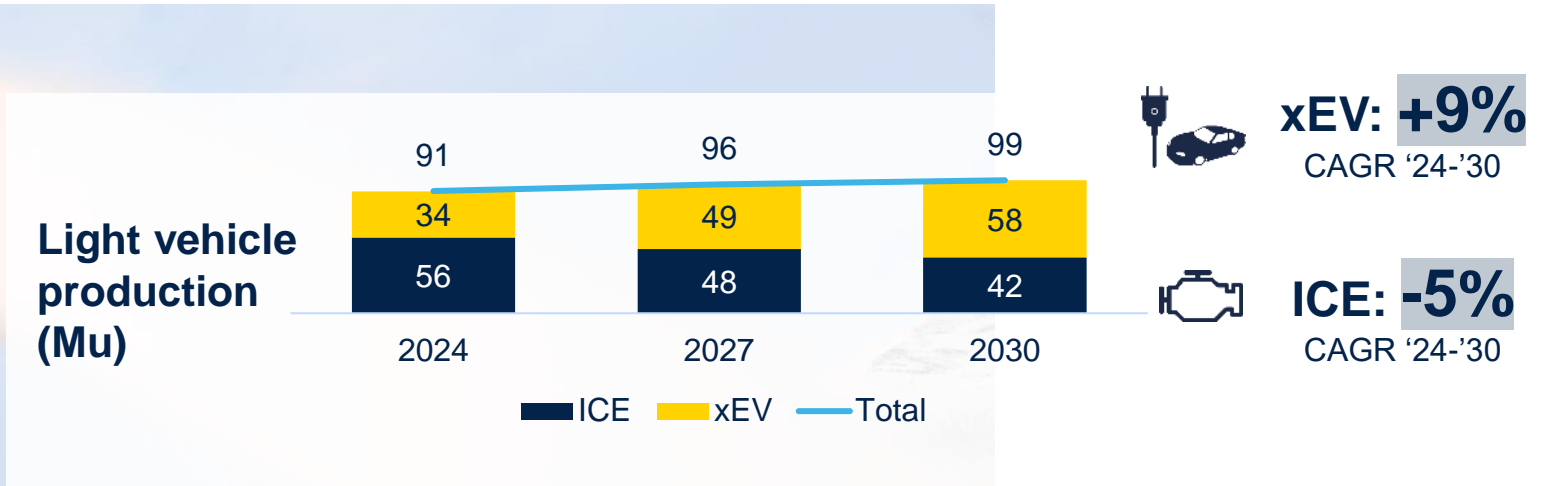
Braking System
>50%
 2023 market share

Silicon MOSFET
>9%
 2023 market share

ICE Powertrain
30%
 2023 market share

SiC MOSFET + module
40%
 2023 market share

IGBT
> 8%
 2023 market share



ICE = internal combustion engine
 xEV = battery electric vehicle, fuel cell electric vehicle, full hybrid, plug-in hybrid, mild hybrid.



Smart mobility trends driving car architecture and technology evolution

Safer

Enhanced safety features
Advanced driver assistance systems
Self-driving vehicles

More connected

Connected vehicles
Digital experience
Post-purchase Services

Greener

Electric vehicles
Stricter emissions standards
Alternative fuels

Extended features Improved safety More electronics

Smart lighting

Braking systems

Digitalization

SW-defined vehicles
Domain / Zonal architecture

ADAS / Autonomous vehicles

Electrification

Full electric

Mild Hybrid EV 48V

Proliferation of sensors

In-car networking evolution

Security

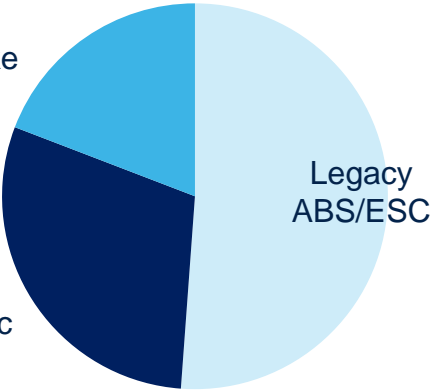
Brake-by-wire will double ST content per car

Today

Smart power braking market

2024 SAM
~770 M\$

Electronic
Parking Brake



Legacy
ABS/ESC

Brake-by-Wire
mainly Electro-Hydraulic

ST market share 2023: >50%

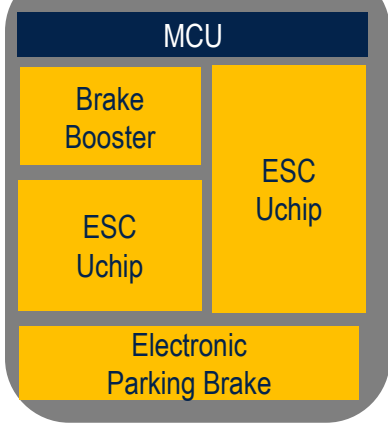
Application-specific analog



Tomorrow

Conventional hydraulic braking system moving to full-electric Brake-by-Wire

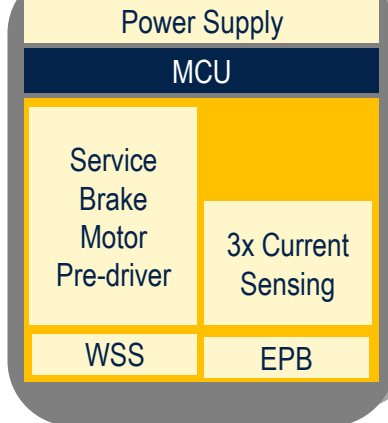
Electro-hydraulic Braking ECU



\$7.5+/Car

One ECU/Car with electro-hydraulic mechanical braking and brake booster function. Electronic parking brake with stand-alone DC motor

Wheel Control Unit



\$14+/Car

Four independent wheel control units on all axles with embedded Electronic parking brake

x2

Smart power content

Source: TechInsights, ST

ST offers smart, safe, and accurate sensors covering the fastest growing applications

Vehicle dynamics



IMU for electronic stability control, rollover detection
Evolution in **safe SPI**

CAGR 5.2%
'24-'27

Infotainment, telematics, ADAS



IMU for navigation/precise positioning with **AI in the edge**
Evolution in **ASIL B/C**

CAGR 4.3%
'24-'27

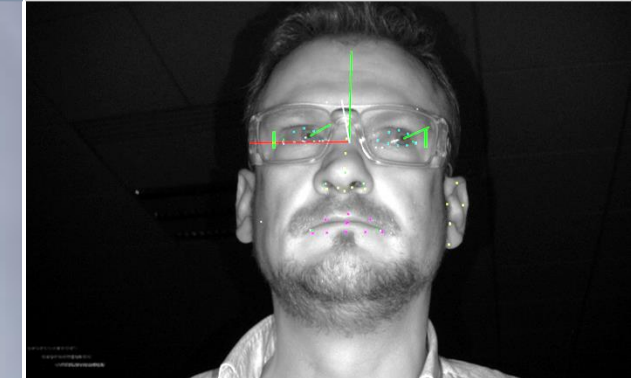
Body & convenience



Accelerometer for key fob and vehicle alarm
Evolution with **AI in the edge**

CAGR 5.3%
'24-'27

Interior monitoring



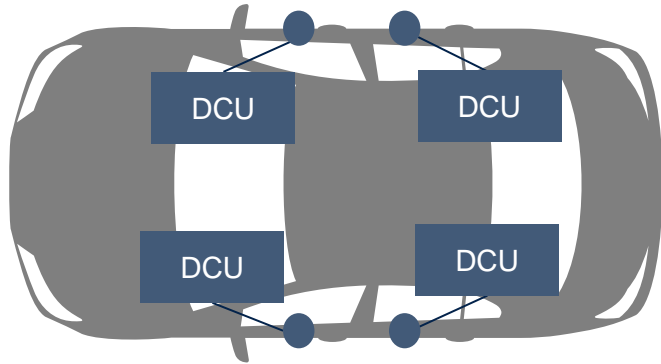
CIS for driver monitoring and occupancy detection
Driven by regulation

CAGR 67%
'24-'27

Addressing an overall \$3.5B+ market with CAGR 10%. Targeting to grow ~20% CAGR 2024-2027

ST's innovation will allow us to continue to lead in door zone with car architecture evolution

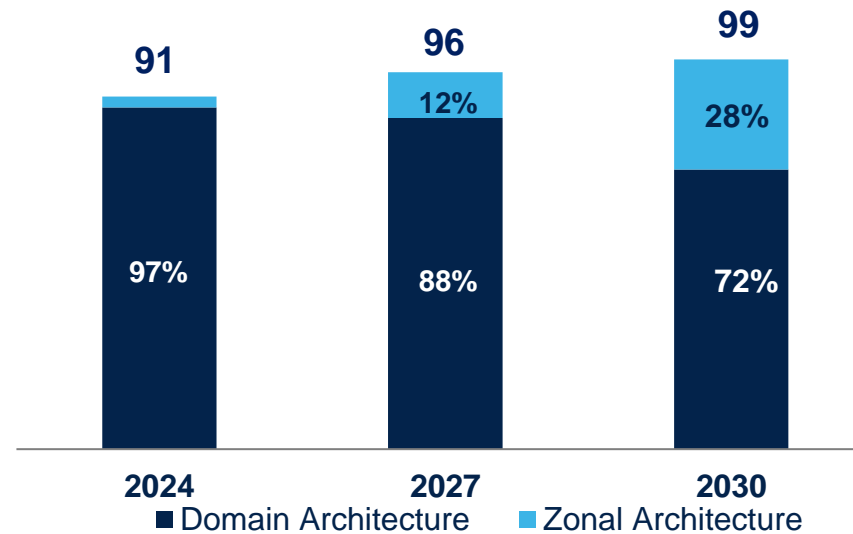
Today Domain-oriented E/E architecture



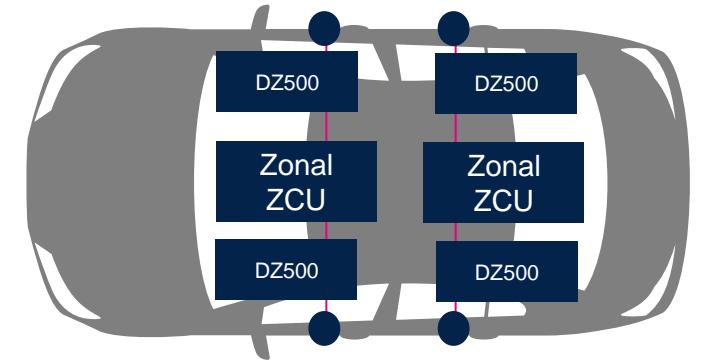
E/E functions are organized into domains/functional area of the vehicles

ST market leader
>30% Market Share
>600 Millions IC shipped

Global Vehicle Production by E/E architecture



Tomorrow Zone-oriented E/E architectures



E/E functions are organized into different zones/physical area of the vehicle [e.g front/rear]

Innovating to ensure we lead also in new zonal architecture

Application-specific analog



E/E: Electrical/Electronic
DCU: Door Control Unit
ZCU: Zone Control Unit

Source: TechInsights, ST

Enabling reliable and safe energy supply in cars with ST's advanced VIPower and BCD technologies



From mechanical relays to electronic fuses
A new opportunity for semiconductor content

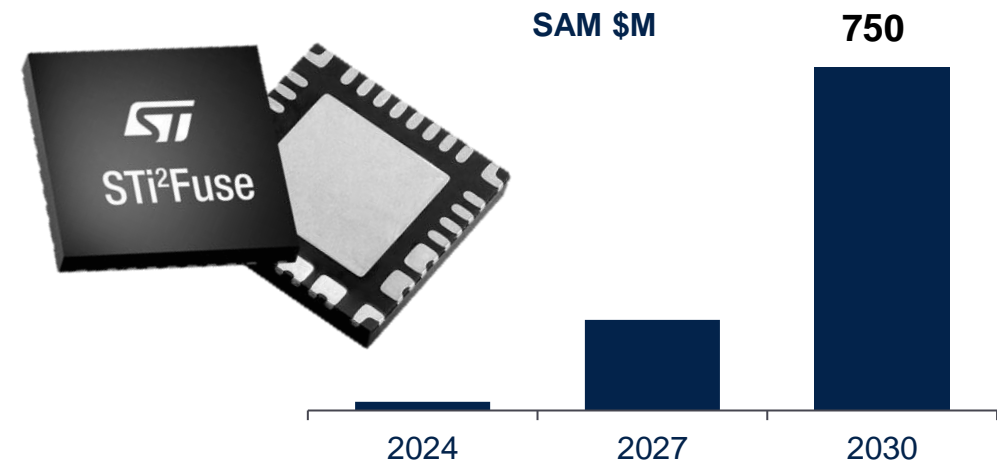


Targeting 40%+ market share by 2027

Replacing both standard fuses and relays with advanced diagnostic and enhanced functional safety

Ensuring fast fault isolation, real time diagnosis and supply availability

Self diagnostic and health monitoring



Automotive bus system transition from 12 to 48 V

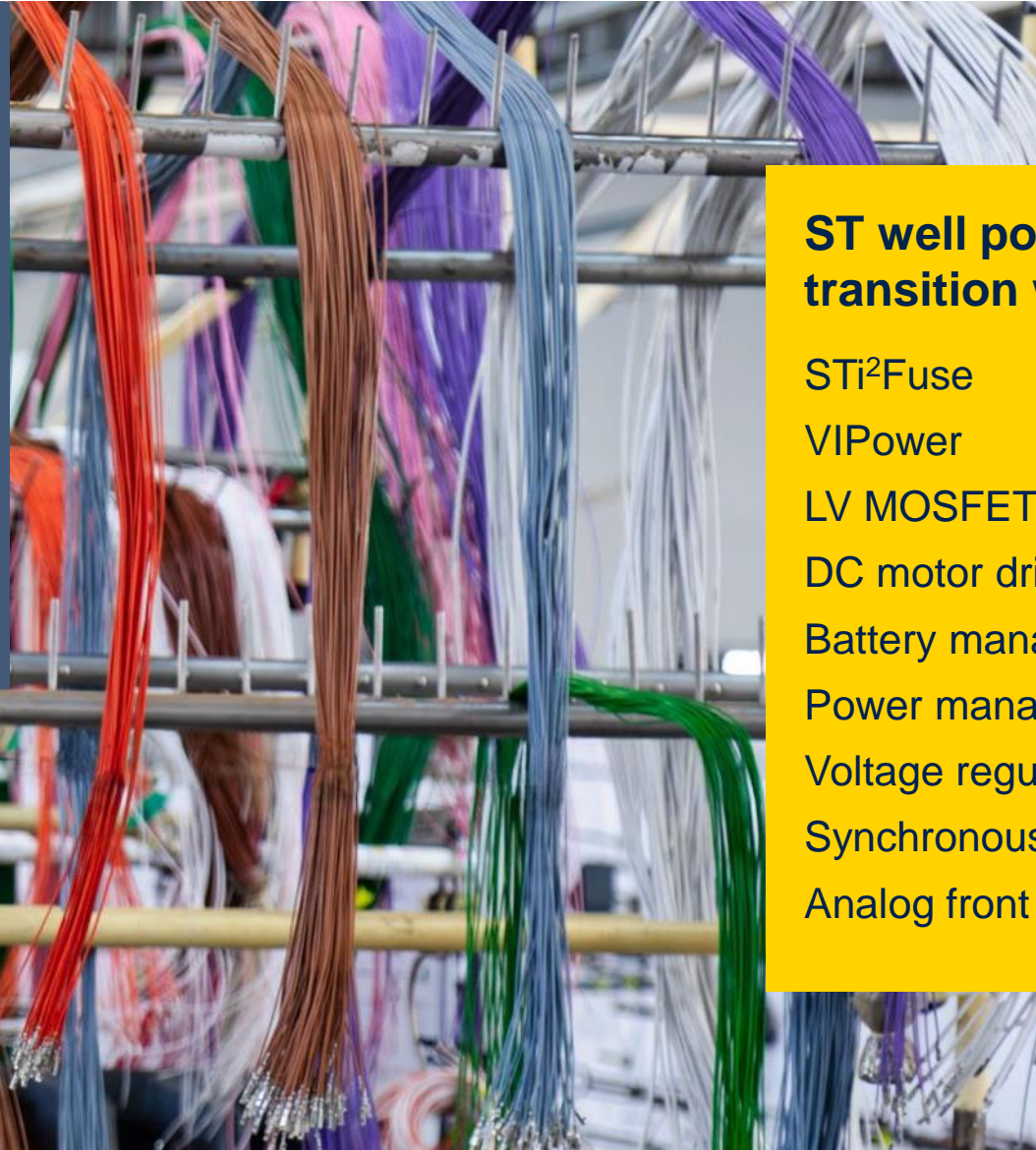
A new opportunity to lead in electrification

Benefits of 48 V

Higher levels of power across **thinner, lighter, and less expensive wiring harnesses** with reduction in current consumption and power dissipation

Especially important for BEVs

Allow an economical solution for **mild hybrid vehicles** with a 48 V motor-generator



ST well positioned to benefit from the transition with a broad portfolio

STi²Fuse

VIPOWER

LV MOSFET

DC motor driver

Battery management system

Power management ICs

Voltage regulators

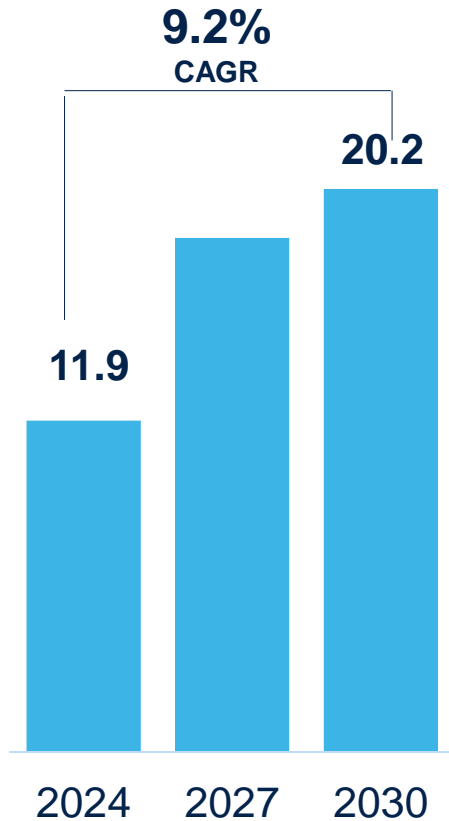
Synchronous DC-DC

Analog front end

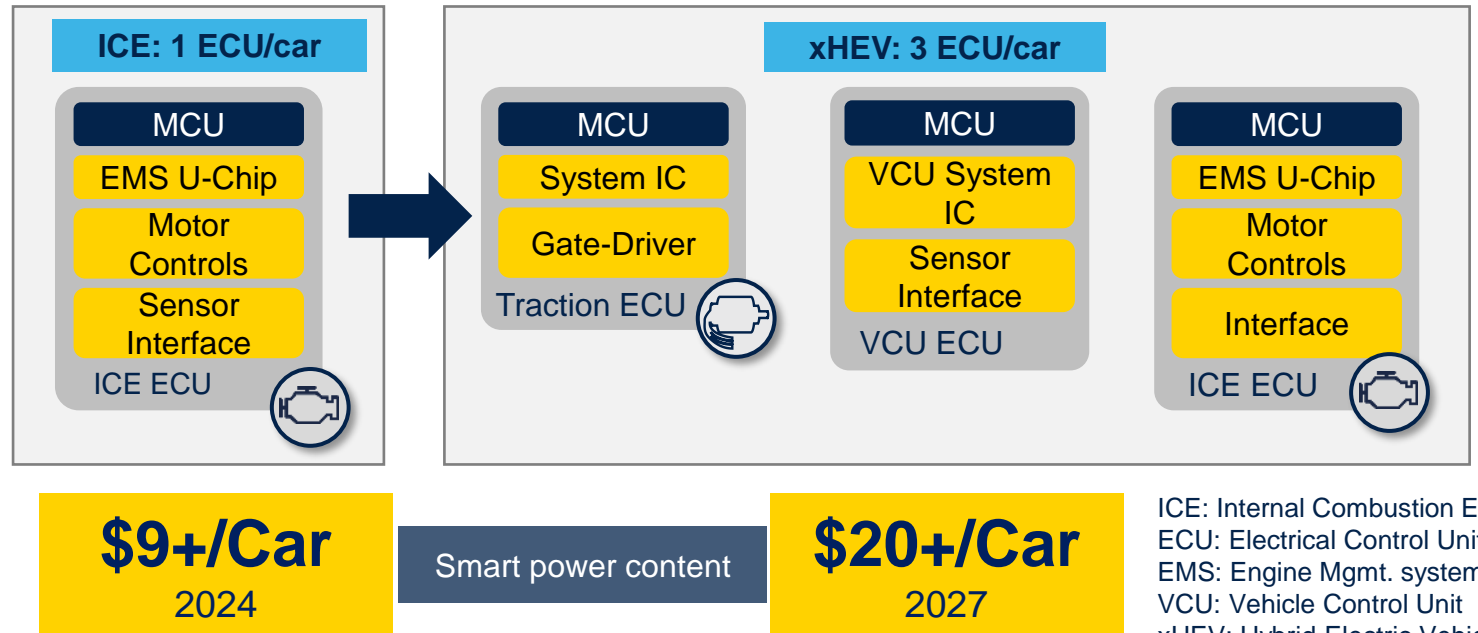


Transition to plug-in and full hybrid powertrains increases smart power content per vehicle

Hybrid Vehicle production [Mu]



Silicon content doubling



ICE: Internal Combustion Engine
 ECU: Electrical Control Unit
 EMS: Engine Mgmt. system
 VCU: Vehicle Control Unit
 xHEV: Hybrid Electric Vehicle

ST has a high share in ICE engine management systems today
Partnering with electrification leaders to address the transition

Application-specific analog



Leading car electrification with key components and a comprehensive portfolio

Traction inverter

SiC MOSFET,
Trench Field Stop IGBT,
Power modules,
Galvanic-isolated drivers,
Operation amplifier, DC-DC converter IC,
Temperature sensors



\$6B TAM '24

18.3% CAGR 24-27

\$300 Typical BOM

On-board charger and Battery management system

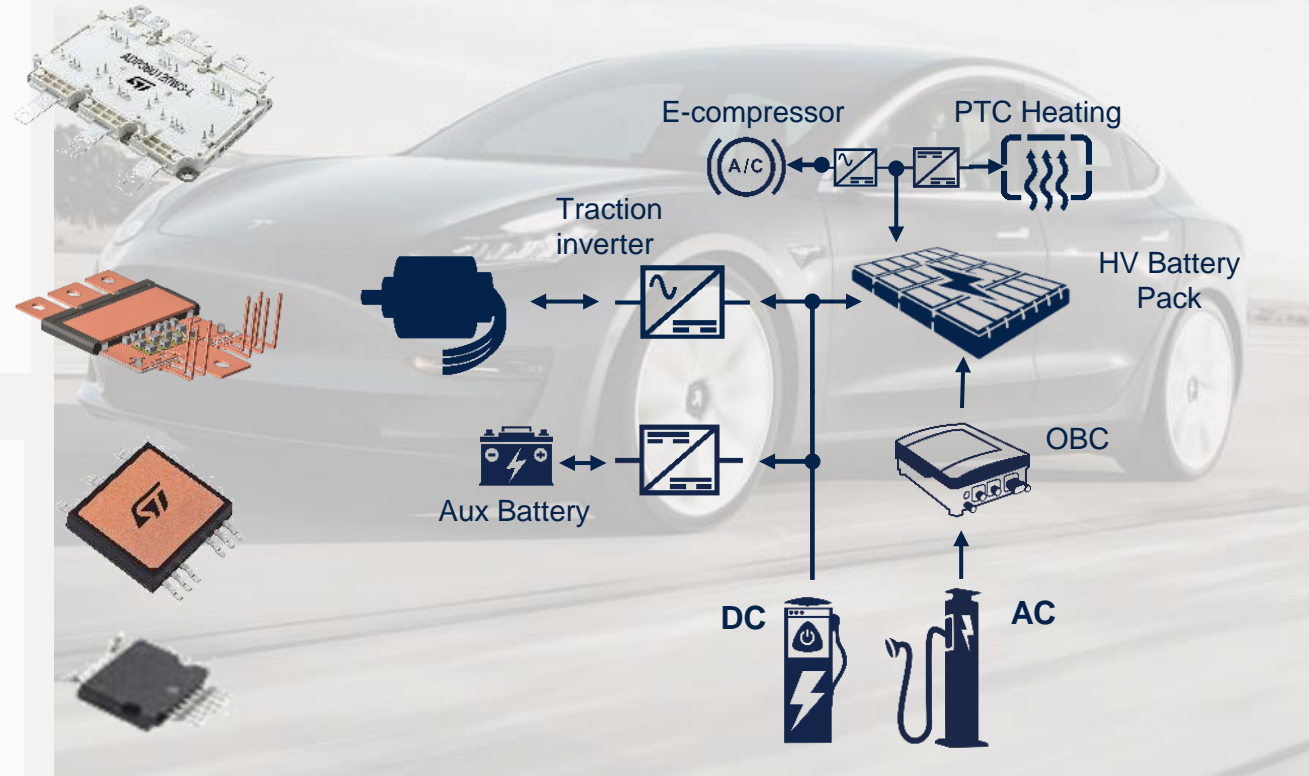
Silicon and SiC MOSFET,
Trench Field Stop IGBT,
Power GaN FET,
Diodes and SCR,
Power modules,
Galvanic isolated drivers,
Operational amplifier, DC-DC converter IC,
Temperature sensor



\$580M TAM '24

41% CAGR 24-27

\$165 Typical BOM



Positive Thermal Coefficient (PTC), On-Board Charger, Battery Management System (BMS)



SiC market dynamics and strategic focus: changes and continuities

What changes

Global **EV growth pace** and shift of focus to **hybrid models**

Evolving **customer landscape** in the automotive market

Slower than expected **industrial recovery**

Strong growth of **AI server market**

Increasingly **competitive market**



Short-term revenue goals adjusted in 2024

Mid-term \$2B+ revenue ambition by 2027/2028

Accelerating 150 to 200 mm transition

What stays the same

Strong long-term growth of the SiC market

~30% long-term market share **ambition**

ST's manufacturing strategy

- Full vertical integration – from powder to modules
- SiC Campus Catania facility
- 200 mm wafer transition
- Joint-Venture with Sanan for front-end and assembly & test at ST Shenzhen for China

Growth and diversification of customer base including industrial applications & AI servers

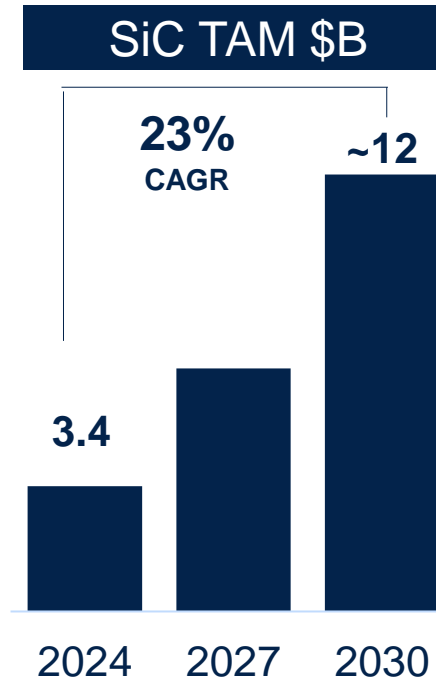
Continuous **technology innovation**



ST is a pioneer and the leader in silicon carbide

25+ years experience
Fourth generation of technology ramping

Gen1	Optimized Ron and Tj for motor drive applications
Gen2	Balanced Ron and Qg for industrial and automotive
Gen3	Lower Ron vs. Gen2 maximizes the driving range of EVs
Gen4	Reduced Ron vs. Gen3 tailored for traction inverter
Gen5 (In R&D)	Innovative high power density technology structure




Leading the market
\$1.14B revenues in 2023
~**40%** SiC MOSFET & module share* 2023

Integrated manufacturing model
Full vertical integration – from powder to module
Catania SiC Campus and ST-Sanan JV
Accelerating transition to 200 mm



ST has more SiC engagements with top Chinese EV makers than any other supplier

Car Maker	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
	Engaged		Engaged		Engaged	Engaged	Engaged		Engaged	Engaged	Engaged				Engaged	Engaged	
Supplier 1	Engaged	Engaged	Engaged			Engaged		Engaged				Engaged		Engaged			Engaged
Supplier 2				Engaged				Engaged					Engaged				Engaged
Supplier 3									Engaged				Engaged	Engaged			
Supplier 4		Engaged	Engaged				Engaged			Engaged	Engaged	Engaged	Engaged				
Supplier 5	Engaged	Engaged			Engaged		Engaged				Engaged		Engaged	Engaged			
Supplier 6	Engaged			Engaged						Engaged							
Supplier 7			Engaged	Engaged													



Takeaways: winning in smart mobility

Large and growing opportunity thanks to transformation of industry
Targeting to grow 2x the market

Strong customer base

Over 30 years of automotive experience
Strong relationships with key automotive car makers and tier1's across regions
Innovating with market shapers



Key technologies

SiC discretes and module
Vertical Integrated Power
BCD for automotive
MEMS & optical sensing

Application knowhow

Shift from customer-driven product to application driven products
Leverage broad and deep knowledge of automotive systems to develop solutions optimized for targeted subsystems
Localized technical support

Manufacturing capacity & resilience

Vertically integrated SiC manufacturing
In-house front-end and back-end technology & owned capacity
China-for-China end-to-end strategy

Products

Application-specific and general-purpose analog and power product roadmaps fitting diverse E/E car architectures
Anticipating further car architecture evolution
Sensors enabling a broad range of applications

Power & Energy



Power & energy trends



Greener generation

Rising demand
Renewable sources
Reducing emissions



Smarter transmission

Smart grid technologies
Smart buildings and IoT
Charging infrastructure

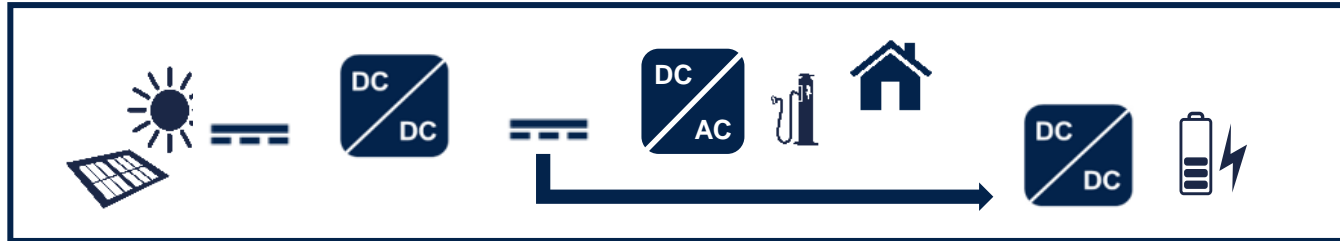


Efficient utilization

More power-hungry factories,
servers..
Better use of every watt
Efficient energy conversion

Benefiting from the shift to renewable energy sources

power range from 1 kW to over 100 kW



DC-DC Power conversion

- SiC and Silicon Power MOSFET
- IGBT
- Power module
- SiC and Silicon diodes
- Power GaN FET
- Galvanic isolated drivers
- Digital controllers
- Current sense amplifiers
- Op amps
- DC-DC IC

DC-AC Power conversion

- Power module
- IGBT
- SiC MOSFET and diodes
- Galvanic isolated drivers
- Digital controllers
- Current sense amplifiers
- Op amps
- Isolated interfaces and ADC IC

Energy generation and storage

Photovoltaics is the fastest-to-deploy electricity source

\$120
Typical BOM
2024

54 Mu
Market Today

\$150
Typical BOM
2027

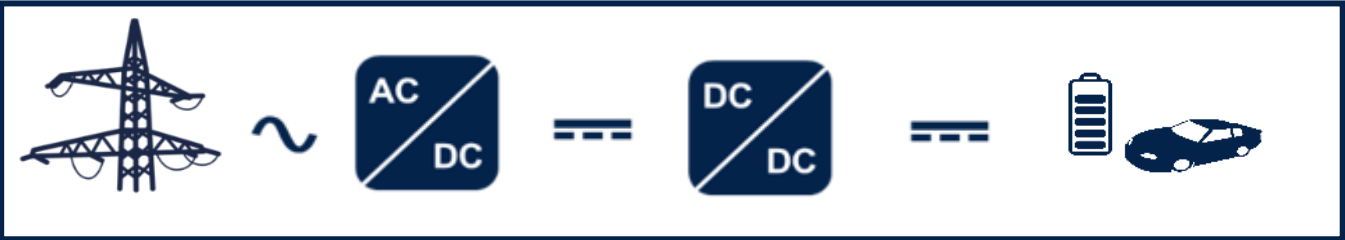
64 Mu
Market in 2027



APMS SAM
CAGR 14%
24-27

Complete solutions to address fast EV DC charging

power range from under 50 kW to over 350 kW



AC-DC Power conversion

- SiC and Silicon Power MOSFET
- Power module
- IGBT
- SiC and Silicon diodes
- STGAP galvanic isolated drivers
- AC-DC HV converter
- STNRG digital controllers
- Current sense amplifiers
- Op amps

DC-DC Power management

- SiC and Silicon Power MOSFET
- IGBT
- Power module
- SiC and Silicon diodes
- Power GaN FET
- STGAP galvanic isolated drivers
- STNRG digital controllers
- Current sense amplifiers
- DC-DC IC

Electric Vehicle DC charger

\$400
Typical BOM
today

\$650
Typical BOM
2027

443 ku
Market Today

715 ku
Market in 2027

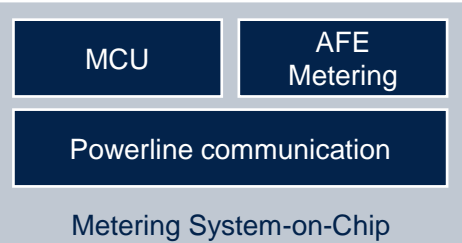
APMS SAM
CAGR 38%
24-27



Wireless communication opening new opportunities in energy metering

Enlarging SAM from a strong leadership position in smart grid power line communication

Today



Power line communication



Smart electricity meter

Installed base connected meters



\$5
BOM today

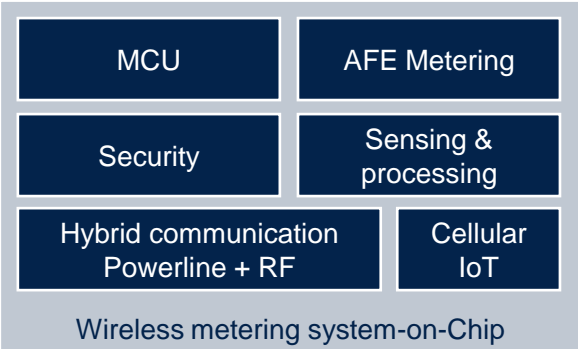
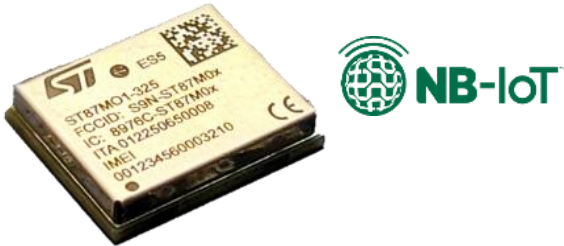
\$7
BOM 2027

530 Mu
PLC energy meters today

2.8 Bu
PLC + wireless all smart meters in 2027

~2.3 billion new connected meters in next 3 years

Tomorrow



Smart electricity, gas, water meters, ...



Source: ABI, ST

Saving energy through efficient motor control solutions

Digital, safe, efficient motors, saving up to 20% energy consumption

Broadest product offer in the market from few 10 W to > 100 KW

Monolithic, SiP motor drivers



High-voltage & galvanic drivers for Si, SiC MOSFETs & IGBT



Si, SiC MOSFET, IGBT bare dice, discrete, & module



Discrete & Filters



AC-DC DC-DC, LDO, voltage reference



High performance Op amps and current sensing



Addressing a wide range of high-volume applications



Servo motor



Robotics



Pumps & fans



Air conditioning



White goods



Home appliances



Vending machines



Power tools



E-bikes

Industrial motors

\$5-20
BOM

\$5-35
BOM

1.46 Bu
Market Today

1.8 Bu
Market in 2027

APMS SAM
CAGR 7%
24-27



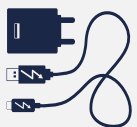
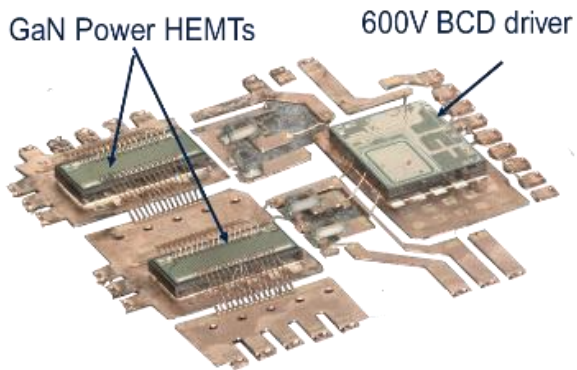
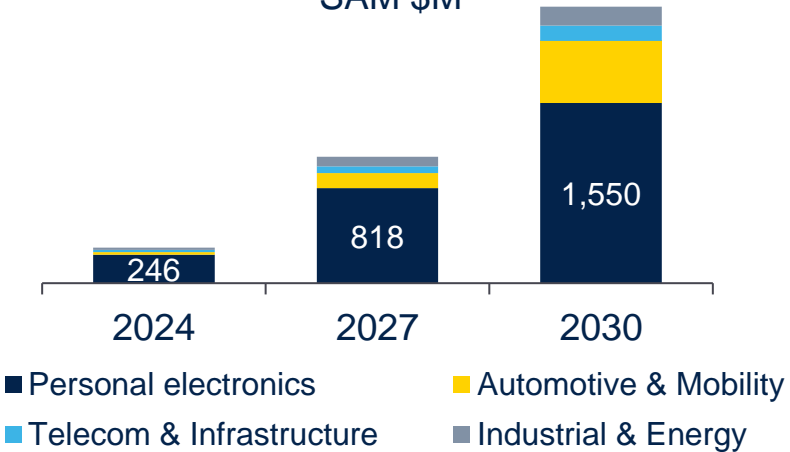
Smart power GaN technology for higher energy efficiency

System-in-package approach exploits GaN's power density in compact power conversion

Smart Power GaN Systems in Package



SAM \$M



4x smaller
3x lighter



2x smaller
3x more power

Power conversion fast chargers and adapters

\$2 BOM

195 Mu
Market Today

680 Mu
Market in 2027

APMS SAM CAGR 52% 24-27



Source: Yole, ST

Addressing higher power and higher efficiency needs of AI data centers



AC-DC Power supply unit

- SiC and Si HV MOSFET
- Si LV MOSFET (100V)
- Diodes and SCR
- Galvanic isolated drivers
- SiC/ GaN power stages
- Digital controllers
- Current sense amplifiers

DC-DC Power management

- Multi-phase controllers
- Smart power stages
- Point-of-load
- eFuse
- Digital current sensing
- Power GaN MOSFET

AI servers require 10x more power



\$500
Kit value
today

\$1,000
ST Kit value
2030



2M new AI
servers in 2024

5M new AI
servers in 2030

Targeting 10% Market share by 2030

Takeaways: winning in power & energy

Growing and fragmented market
Target low teens growth in line with the market

Strong technology roadmaps

Wide power process technology from low to high power, from silicon to wide bandgap

Power package portfolio supporting SiC and GaN roadmaps

Broad front and back-end technology portfolio tailored to analog and smart power products

Wide portfolio

15,000 products to support growing applications

Covering full product span: sensing, controller, driver, power stage

Large set of IP to further enlarge portfolio

Go-to-Market strategy

Addressing both OEMs and distribution

Leveraging large portfolio to deliver solutions

System and application knowhow

Localized skilled technical support in all regions

Intelligent Things



Intelligent things trends



Intelligent

AI-driven decision making
Edge computing
Personalization



Sustainable

Energy efficiency
Eco-friendly material
Circular economy

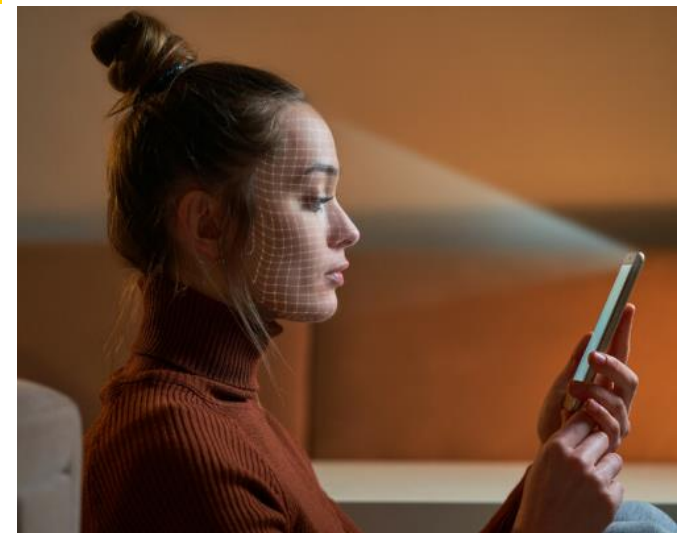
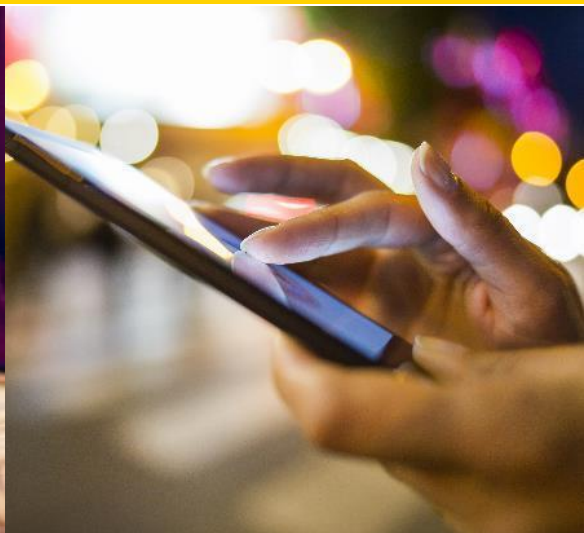


Transformative

User experience
Changing work & lifestyle
Enhancing health & wellness

Enabling selective high-volume opportunities thanks to broad analog and sensor technology portfolio

Already powering countless intelligent devices



Battery management, wireless charging, PMIC, sub-PMIC display power management, touch controllers

Analog-application specific

6-axis IMU, biosensors, pressure, accelerometers, temperature, image sensors, proximity & ranging, color and ambient light sensors

MEMS and optical sensors

Our sensor vision for tomorrow

Smart sensors, enabled through technology fusion & embedded AI



State-of-the-art proprietary technology performance in sensing & actuating



Sensor fusion at silicon or package level to reduce size & cost



Embedded processing & edge AI for localized intelligence

Intelligent MEMS sensors for higher efficiency in high-volume applications

Applications with in-sensor AI



Anticipating user actions



Monitoring car status

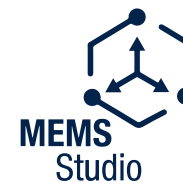


Detecting complex gestures and activities



Monitoring movement and body biosignals

Ecosystem for developer engagement



A roadmap for in-sensor processing

>20
sensors
released



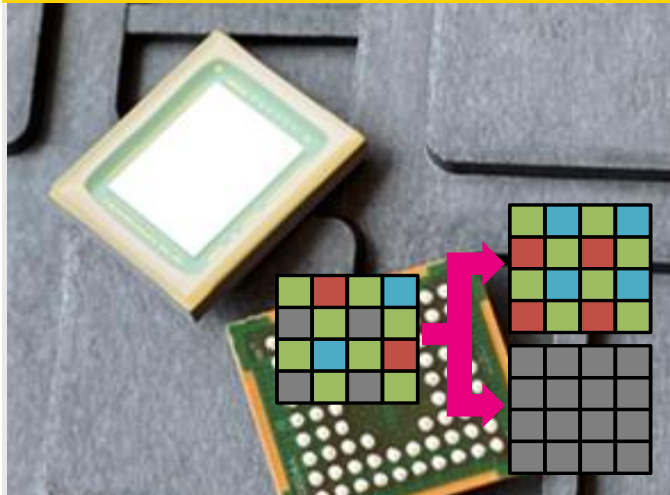
Generation 3



Generation 2

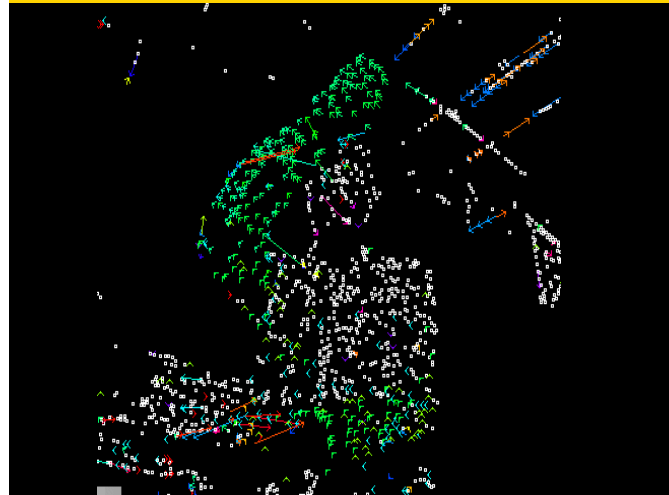
Leveraging our breadth of capabilities to create innovative smart optical devices

Smart sensor fusion



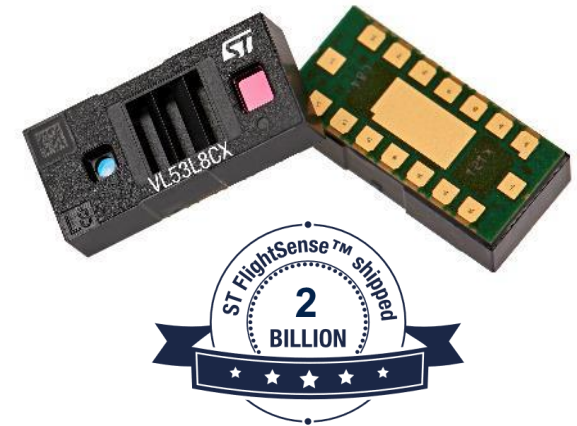
5 Mpix 2.2 μm image sensor
Fusion of RGB & NIR sensing
Enabling new automotive interior monitoring use-cases

Smart feature creation



1.4M pix 2.6 μm image sensor
Unique embedded AI & image signal processor
Key for user interaction & object tracking & mapping

Smart system solutions



All-in-one dToF system
ST manufactured sensor & processor, optics & module
Limitless applications

dToF: Direct Time-of-Flight

Continuing to build competitive advantage in sensor technologies for future growth

**THELMA
sensors**

Accuracy

Small form factor

**PETRA
actuators**

Sustainable materials

Optical sensors

High sensitivity

Low power & noise

Small footprint

Micro-optics

Multiple optical
functions

Dramatic size & cost
reduction

Takeaways: winning in intelligent things

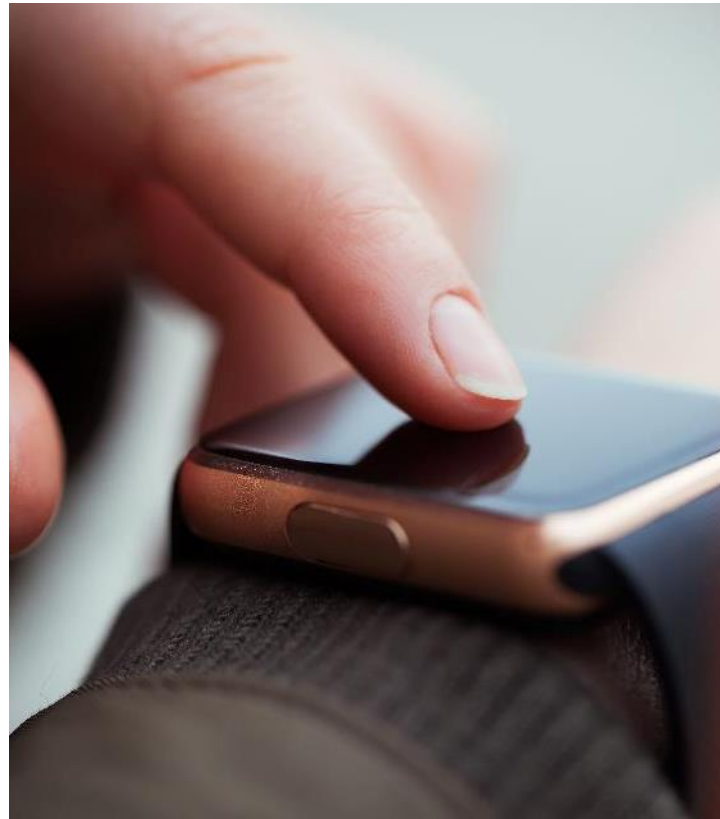
Targeting to grow 2x the served market Roadmaps of engaged key customer programs

Strong technology roadmaps

- #1 European IDM for optical sensing technology
- MEMS & Imaging dedicated technology platforms & teams
- Unique advanced BCD technology

Partner with market shapers

- Intimacy with key players
- Standard & custom solutions tailored for specific applications
- Deep engineering expertise



In-house manufacturing capacity

- Proprietary front-end & back-end technology
- Proven & scalable EU based front-end capacity
- 300 mm fabs
- Able to ramp in line with customer expectations

Differentiated products

- Broadest industry sensor provider
- Large set of reusable analog & sensing IP
- Embedded processing & edge AI
- Enabling multiple innovative applications

APMS takeaways

Leveraging ST's IDM model, investing in proprietary technologies to lead in smart mobility, power & energy and intelligent things



Smart Mobility
Grow 2x vs SAM*



Power & Energy
Grow in line with SAM



Intelligent things
Grow 2x vs SAM

Power

Leading in Silicon Carbide, vertical integrated manufacturing
Wide portfolio of technology and products supporting electrification

Analog

Large technology, IP & product portfolio for all markets
Leveraging strong application and system knowhow

Sensors

Industry-leading technology fueling waves of opportunities
Embedding intelligence, enabling countless applications

Continuous investments in technology & product innovation

Keeping leadership in traditional applications while benefiting from key trends
Expanding product portfolio and gaining market share



* Excluding capacity reservation fees from carmakers

Our technology starts with You



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