Automotive and Discrete Group

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President, Automotive and Discrete Group
Revenue overview - ADG

ADG Group Revenue $B

2021

$4.35B

ADG Sub-Group Revenue $B

Automotive Sub-Group

2021

$2.61B

Power Discrete Sub-Group

2021

$1.74B
ADG revenue expansion driven by strong growth in new automotive trends

**Car electrification**
- 23% (2020 vs. 2019)
- 110% (2021 vs. 2020)

**ADAS systems**
- 11% (2020 vs. 2019)
- 19% (2021 vs. 2020)

**32-bit automotive MCUs**
- 8% (2020 vs. 2019)
- 36% (2021 vs. 2020)
ADG addresses ST’s four end markets

Automotive: Continue to reinforce leadership
Industrial: Further expansion
Personal Electronics: Focus on product Innovation
Communications Equipment, Computers & Peripherals: New partnerships for fast growing growth on emerging markets

~70% of ADG revenues 2021
Acceleration of silicon content pervasion in automotive

Semiconductor content per car steadily increased over the two past decades and strongly accelerated recently.

Average number of chips per vehicle

- Doubling the # of chips per car

- x2

x1.5

Automotive electronics demand continuously rising, confirming secular trends

Average number of automotive chips per car accelerated in last 4 years

Expectation for further acceleration in the next few years

Source: IHS Markit, ST
Automotive semiconductor demand has become uncorrelated with car production.

Global light vehicle production

Automotive semiconductor TAM

Production rate struggling to return to pre-pandemic levels

Source: IHS Markit
Multiple positive trends driving increasing automotive semiconductor content

<table>
<thead>
<tr>
<th>Car volumes</th>
<th>Silicon pervasion in traditional applications</th>
<th>Extended features</th>
<th>Disruptive trends</th>
<th>Legislation &amp; functional safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle production recovering after pandemic slow down</td>
<td>Legacy automotive applications require more silicon content</td>
<td>Better driving experience, additional safety, extended comfort drive the introduction of new car functions</td>
<td>eMobility, ADAS, connectivity, SW reconfigurable vehicles … strongly impact silicon content</td>
<td>Legislation requires fault tolerant vehicles. This drives usage of more silicon per car – e.g. redundant functionality</td>
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ST has the portfolio of differentiated technologies needed to serve new automotive requirements.

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<tr>
<td>FD-SOI, eNVM CMOS</td>
<td>FinFET</td>
<td>Embedded Flash</td>
<td>Bipolar – CMOS – power DMOS</td>
<td>Vertical Intelligent Power</td>
</tr>
<tr>
<td>FinFET</td>
<td></td>
<td></td>
<td></td>
<td>Discrete, LV MOS</td>
</tr>
<tr>
<td>IGBT, SiC, HV MOS, Power GaN</td>
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Silicon content increasing in traditional applications

The same Electronic Stability Control functionality requires additional and more complex ICs

<table>
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<th>Year</th>
<th>MCU Configuration</th>
<th>ICs Required</th>
<th>Cost</th>
</tr>
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<tbody>
<tr>
<td>2018</td>
<td>Single core; 120MHz; 1Mb</td>
<td>~3 ICs</td>
<td>$</td>
</tr>
<tr>
<td>2022</td>
<td>Dual core; 300MHz; 4-8Mb</td>
<td>~9 ICs</td>
<td>$$</td>
</tr>
<tr>
<td>Next Gen</td>
<td>Triple core; 400MHz; 6-8Mb</td>
<td>~13 ICs</td>
<td>$$$</td>
</tr>
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</table>

EPB* penetration: ~30%

ST made early investments in products and manufacturing capabilities to serve the needs of the automotive industry
Electrification significantly increases car silicon content

To increase autonomy additional silicon is needed in every car

Potential upside: extensive adoption of GPUs, sensor fusion, Radar systems

Incremental semiconductor content

Source: Strategy Analytics, ST

Source: Goldman Sachs, ST
New automotive trends drive semiconductor TAM

### Electrification

- **2021**: 5.9 billion
- **2023**: 11.4 billion
- **2025**: 18.0 billion

**CAGR 21-25**: +32%

Source: IHS Markit

### Software-defined vehicles

- **2021**: 9.4 billion
- **2023**: 14.0 billion
- **2025**: 19.0 billion

**CAGR 21-25**: +19%

### Automotive TAM

- **2021**: 44.7 billion
- **2023**: 64.9 billion
- **2025**: 82.7 billion

**CAGR 21-25**: 16.6%

**Overall automotive TAM [$B]**

Source: IHS Markit
ST leads in eMobility thanks to timely investment and a strong technology and product offering

ST offers a truly broad range product portfolio for electrification based on state-of-the-art technologies

Silicon $/car

Traction Inverter ~$520
On-board charger ~$260
DC-DC converter ~$130
Battery management ~$80

- WBG materials: SiC MOSFET series (650/1200V range)
  - SiC rectifier, Power GaN
- Power Module, Intelligent Power Module (IPM)
- High Voltage Si MOSFET: Mdmesh Product Family
- IGBT Product Family (650/1200V range)
- PMIC Product Family, Linear Voltage Regulators, System Basis Chips
- Isolated gate drivers
- Isolated gate drivers
- BMS Family
- SPC5 product family
  - Stellar E (tailored for electrification)

ST anticipated the right technology development and capacity planning to serve the disruptive demands of eMobility.
ST silicon carbide focus areas

**Business Development**

- ~$500M revenue in 2021, >$700M in 2022
- > $1B target anticipated in 2023 (75% Auto - 25% Industrial)
- ~80 customers, ~20 carmakers, ~100 programs awarded

**Fully integrated Manufacturing**

- SiC production-flow entirely mastered in-house
- Dual sourcing: Singapore launched 2021 complementing Catania
- New integrated 200 mm fab, ready by 2023 - 200 mm substrates, epitaxy and SiC MOSFETs
- 200 mm industrialization line in Catania to accelerate time to volumes

**Portfolio & Strategy**

- Portfolio of SiC MOSFETs & Diodes, & IGBT from 650V to 1700V
- 3rd Gen SiC MOSFETs in production, 4th in qualification, 5th planned with radical innovation thanks to a disruptive SiC trench concept
- Flexible approach covering packages, modules, dice
Solid silicon carbide customer base
ST meets the needs of the software-defined vehicle
ADAS and new electrical/electronic architecture

Full system coverage with controllers, processors, sensors and power management meeting increased computation power requirements

Comprehensive ST product offer based on innovative technologies, efficient product development, long-lasting partnerships

<table>
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<tr>
<th>Silicon $/car</th>
<th>Adv. MCU &amp; Processor</th>
<th>Vision System</th>
<th>V2X &amp; Connectivity</th>
<th>Radar system</th>
</tr>
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<td>~$120</td>
<td>~$140</td>
<td>~$25</td>
<td>~$45</td>
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Stellar processor for zonal module (M40, P28)

Mobileye EyeQ Vision Processor

FD-SOI GNSS positioning

Autotalks V2X

Radar Transceiver MMIC

SPC5 Product Family

Stellar MCU tailored for domain and zonal architecture

Power Management ICs

Multi-phase, buck-boost

Linear Voltage Regulators, System Basis Chip

TVS protections

Power

ANALOG

DIGITAL

ST meets the needs of the software-defined vehicle
ADAS and new electrical/electronic architecture
Long-standing partnership in ADAS with Mobileye

**EyeQ5 Family**
High-end ADAS/AD** partial

- ADAS targeting L2++ \(\rightarrow\) AD L4
- 7 nm, up to 26 DL Tops*

- L2 front camera solution (1xEyeQ5M)
- Up to L4, partial/full surround (2xEyeQ5H)

**EyeQ6 Family**
Premium, high-efficiency ADAS/AD partial

- ADAS & AD levels up to L4
- 7 nm single chip, 34 DL Tops

- L2+ front camera solution (1xEyeQ6L)
- Up to L4 partial/full surround (1xEyeQ6H)

**EyeQ Ultra**
Single SoC for end-to-end full AD

- ADAS & AD levels up to L5
- 5 nm, 176 DL Tops

- 13 cameras
- 6 Short Range LiDARs
- 3 Long Range LiDARs

In Production (SOP 2021)

SOP 2023

Prototypes for CES Jan 2024

Leading edge products capable to support the evolution of the system

* DL Tops: Deep Learning Tera Operations per second

** AD: Autonomous Driving
Software defined vehicles require a new architecture

New architecture requires both flash-less MPUs & eNVM*-based MCUs to meet high computation requirements and real time control needs.

Traditional architecture

Software-defined architecture

ADAS and Connectivity

High-level actuation

Peripheral Actuation

Flash-less MPU

eNVM MCU

* eNVM embedded non-volatile memory
Implications of SW-defined vehicle architectural change

**For car makers**

- **Enabling savings**
  - Optimized number of ECUs
  - Harness cost and weight reduction
  - SW cycle time and reuse

- **Enabling new services**
  - Preventive maintenance
  - Remote re-mapping (OTA)
  - Upgradable SW functions
  - New post-sales revenue streams

**For ST**

- **Strong increase in semiconductor content**
  - Traditional architecture → $X5$ New car architecture

- **Broad product offer**
  - MCU 28 nm FD-SOI with PCM for real-time control
  - MPU 7 nm Flashless for computing platform
  - Smart Power power management
  - eFuse – fault tolerant systems smart protections

**Complementing ADAS node offer**
ST in the driving seat of the new car architecture

Full system coverage combining MPUs (7 nm FinFET) and MCUs (28 nm FD-SOI-ePCM / 40 nm eFlash)

- **Mobileye EyeQ Ultra**: ADAS high-end processor
- **ST Stellar MPU**: Processor
  - 7 nm flash-less MPU
  - Up to 2 MPUs per vehicle
- **ST Stellar MCU**: High performance microcontroller
  - Stellar family 28 nm with eNVM
  - Up to 15 MCUs per vehicle
- **ST SCP58 MCU**: Microcontroller for actuation
  - Scalable 32-bit family
  - Targeting broad-range ECUs
- **ST Stellar-E MCU**: Microcontroller for Electrification
  - Family tailored for the specific requirements of e-mobility
ST is accelerating the transition to serve new mobility trends, consistent with our strategy.
Car makers becoming more centric in the semiconductor strategy

From car makers to mobility provider

Vehicle content and car differentiation strongly depend on semiconductors

ST’s is committed to play a major role in this new business model with multiple cooperations
Maximizing ST content in industrial applications

Typical industrial application

- **AC-DC**
- **DC-DC**
- Control Unit
  - STM32
- Gate Driver
  - MOSFET/IGBT
- Signal conditioning
  - Sensors
- Connectivity

Driving ST Growth

- Low voltage MOSFET
- High voltage MOSFET
- IGBT
- SiC MOSFET, Diode, Rectifier
- Power GaN
- TVS, ESD & Protections
- ASIP
  - Integrated Passive
- RF IPD

Actual implementation based on selected customer products

- **Charging stations**
  - STM32: $6
  - ADG: $187
- **Factory automation**
  - STM32: $8.8
  - ADG: $19.6
- **Photovoltaics**
  - STM32: $17.1
  - ADG: $33.5
- **HVAC 2 kW**
  - STM32: $2.4
  - ADG: $10
ST is developing a comprehensive GaN portfolio serving multiple markets

**ST Power GaN**

- Broad portfolio of discrete solutions leveraging flexible internal & external manufacturing
- Application coverage: Power conversion systems for superior energy efficiency
- Main Markets: Consumer first, while targeting high-value industrial (Solar Inverter, Charging pile…) and automotive (OBC, DC/DC…)

650V · 100V

**ST RF-GaN**

- GaN-on-Silicon solution with competitive performance, cost & manufacturing scale vs GaN-on-SiC
- Application coverage: 5G Power amplifiers
- Main Markets: Telecom 5G Infrastructure and satellites (aerospace)

**Smart Integrated GaN**

- Advanced solutions integrating power stage and BCD driver & advanced control system (CMOS)
- Application coverage: DC-DC, LiDAR, class-D amplifiers
- Main Markets: Automotive and industrial

GaN in CMOS · GaN in BCD

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ST POWER

CMOS · BCD
Supporting ST $20B+ revenue ambition

Automotive silicon content is strongly increasing driven by multiple positive trends:
- Increased content of traditional applications
- Disruptive evolution to digitalization and electrification
- New and advanced features in modern vehicles

ST made early investments in innovation and manufacturing capabilities to serve the needs of the automotive industry
Complete and innovative product offer
Wide application coverage
Extended network of partners

ADG innovation in power technologies and products is core to ST’s strategy in industrial
Our technology starts with You

Find out more at www.st.com