Sub-track I – Smart Mobility Presentation
ST automotive solutions empower the transition to e-mobility

Patrick Chen
Marketing Manager
STMicroelectronics
Leading solutions across a comprehensive portfolio
www.st.com/automotive
### Automotive product portfolio

<table>
<thead>
<tr>
<th>Automotive microcontroller (MCU)</th>
<th>Protected switches &amp; LED drivers ICs</th>
<th>Motor drivers ICs</th>
<th>Power management ICs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SPC5 32-bit microcontroller</strong></td>
<td><strong>VIPOWER</strong> extended offer of smart drivers for loads from 12V up to 48V loads &amp; best in class <strong>LED driver</strong> tailored for car lighting systems</td>
<td><strong>Motor drivers ICs</strong> Cover an extensive range of voltage and current ratings of brushed DC motors, stepper motors, &amp; brushless DC motors</td>
<td><strong>DC-DC converters, linear voltage regulators, power management ICs, system basis chips</strong></td>
</tr>
<tr>
<td>For a wide range of automotive applications: gateways, e-mobility, ADAS, engine, transmission, body, chassis, safety…</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Infotainment</th>
<th>ADAS applications</th>
<th>Powertrain, chassis &amp; safety ICs</th>
<th>Power discrete devices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Best in class audio amplifier</strong> as well as <strong>Accordo</strong> dual core processor for car radio and display audio applications.</td>
<td><strong>Automotive radars, vision, TESEO GNSS</strong> Offer goes beyond vision addressing V2X solutions, high performance MCUs and precise positioning</td>
<td><strong>Dedicated portfolio of engine control systems (ICE/HEV), airbag driver, transmission, and battery management systems</strong></td>
<td><strong>MOSFET, IGBT, ultra-fast diodes, rectifier diodes, SiC diodes, Schottky diodes, thyristors, protections</strong> Wide offer of automotive grade discrete devices</td>
</tr>
</tbody>
</table>
On Board Charger (OBC)
Battery Junction Box (BJB)
Battery Management System (BMS)
DC-DC Converter
Vehicle Control Unit (VCU)
Traction Inverter(s)

Charge

Store

Embedded controllers and use cases
### Embedded controllers and key performance indicators

<table>
<thead>
<tr>
<th>Charge</th>
<th>Store</th>
<th>Move</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Conversion</td>
<td>Energy Storage</td>
<td>Power Consumption</td>
</tr>
<tr>
<td>Systems</td>
<td>Systems</td>
<td></td>
</tr>
<tr>
<td>• Chargers</td>
<td>• Battery Management</td>
<td>• Inverters</td>
</tr>
<tr>
<td>• DC-DC Converter</td>
<td></td>
<td>• Sensors</td>
</tr>
<tr>
<td>KPIs</td>
<td>KPIs</td>
<td>• Motors/Actuators</td>
</tr>
<tr>
<td>• Efficiency</td>
<td>• Safety</td>
<td></td>
</tr>
<tr>
<td>• Emissions/THD</td>
<td>• Service Life</td>
<td>• Efficiency</td>
</tr>
<tr>
<td>• Power Density</td>
<td>• Efficiency</td>
<td>• Power Density</td>
</tr>
<tr>
<td>• Specific Power</td>
<td>• Charge Time</td>
<td>• Specific Power</td>
</tr>
<tr>
<td>• Safety</td>
<td>• Utility</td>
<td>• Peak Power</td>
</tr>
</tbody>
</table>

ST engineers develop automotive grade products with these KPIs in mind.
Stellar family: A unified computing platform

Software-defined vehicles
Lead transformation towards lean & smart architecture

Complete value chain for EVs
from integration & control to efficient energy management

Stellar SR6P
Integration platform
Motion control

Stellar SR6G
Integration platform
Gateway & Body

Stellar SR5E
Analog performance

Functions Integration

Actuation

Control & Computing

Actuators & Sensors

Zone Controller

Vehicle Computer

Central Computer

Zone Controller

Domain Controller
ICE/EV
BMS
Transmission

Zone Controller

Central Gateway
Body integration
Domain Controller

Zone Controller

Traction Inverter
OBC
BMS
DC/DC
SR6 - Stellar integration platform

Distributed Architecture

Higher Integration Architectures

Investing since 2017 on Integration Platforms

- Extensible Integration Computing platform
- Covers traditional to emerging market segments (Electrification, Zone ctrl)
- Oriented to software-defined cars (OTA, Virtualization,..)
- Portable and Scalable

SR6 P and G proto-devices available for pre-development in vehicles
Three devices in execution ready in 2022/23 & more devices planned
SR6 – Stellar P/G integration MCU innovation with value

**Future-proof Open Architecture**

- **ARM Cortex**
- 6x R52+ @400MHz
- 7-16K DMIPS
- Safe Network on chip
- HSM w. ASILD AES HW Sec. Module

**Top Real-Time performance** combined with lower power, fast start-up and Safety, advanced Security

**Efficient routing Accelerators**

- CAN
- CAN XL
- ETH

- Arm M4/R52+
- RAM

- Ultra real-time IN/OUT data processing
- Accelerators offloading application cores

**Extensible Memory & efficient OTA**

- Built-in memory duplication provision for OTA (“X2 mode”)
- No cost overhead
- No Downtime for running SW code

**Multi-Application Integration**

- HW virtualization to ensure safety, and freedom from interference

**Routing subsystem**

- CAN
- ETH
- CAN
## SR6 - Stellar P/G integration MCU
### game-changing NVM capabilities

<table>
<thead>
<tr>
<th>Write granularity</th>
<th>Flash</th>
<th>PCM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erase full sector then program</td>
<td></td>
<td>Revolutionary Programming</td>
</tr>
<tr>
<td></td>
<td>Single-bit alterability</td>
<td>1 bit write</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Retention</th>
<th>250 kcy write/sector ≥ 10 Y</th>
<th>1 kcy write/sector ≥ 25 Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 kcy write/cell ≥ 10 Y</td>
<td>1 kcy write/cell ≥ 25 Y</td>
<td></td>
</tr>
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</table>

<table>
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<tr>
<th>Programming speed</th>
<th>200 kB/s</th>
<th>900 kB/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.00s/MB erasing +1.12s/MB program</td>
<td>1.12s/MB program</td>
<td></td>
</tr>
<tr>
<td>x4.5 Faster (no erase time)</td>
<td></td>
<td></td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>OTA</th>
<th>X2 mode (*)</th>
<th>Zero downtime OTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTAv4.5 Faster (no erase time)</td>
<td>Dynamic memory doubling</td>
<td></td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Automotive Quality</th>
<th>&lt;1 ppm even at high temperature - up to 150/165 °C Tj</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long lifetime profile (e.g., 20k-40kh)</td>
<td></td>
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<tr>
<td>Soldering robustness: 3x JEDEC refloows</td>
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</table>

(*) PCM unique OTA-X2 mode: memory size extended x2 for new image storage. Traditional Flash requires external flash/ A/B swap to handle the new and old SW images.
SR6 - Stellar integration MCU
Unique OTA X2 mode

Best cost trade-off for long-term reliability & memory duplication for OTA updates

PCM offers a **built-in memory duplication** for OTA implementation

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**No memory waste** caused by A/B swap approach

In operation update with **no down time**

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**NORMAL operation**

Nominal Size

- **20MB**

  - (2cells/bit)
  - Execute

  Car lifetime retention

**OTA X2 mode operation**

Double Capacity

- **20MB**
- **20MB**

  - (1cell/bit)
  - Update

  OTA Update retention

**NORMAL operation**

Nominal Size

- **20MB**

  - (2cells/bit)
  - Execute

  Car lifetime retention

---

**Configuration example**
Today’s MCUs have limitations to support full Switching Frequency range requested by new wide bandgap technologies needed for new Electric Vehicle’s higher Power Efficiency.

STELLAR ARM® MCUs have been carefully optimized to best leverage SiC & GAN Power products with upmost Control Loop capabilities, together with all state-of-the-art Automotive requirements (Safety, Security, OTA, SW Packages, ...)

From ICE to EV MCU:
Switching Performance boost to maximize Power Efficiency

1.5 times faster

4 times faster

5 times faster

Switching Control Frequency

along with state-of-the-art Safety & Security

Wide bandgap (WBG) companion chip
Stellar E MCU series innovation

**High-performance COMPUTE**
- 2x 32-bit Arm® Cortex®-M7 @300Mhz
- Configured in split-lock or lockstep CORDIC math acceleration

**High-performance ANALOG**
- 5 x 12-bit @ 2.5 Msps SAR
- 2 x 16-bit \( \Sigma \Delta \)
- 10 x 12-bit DAC
- 8 x 50 ns Comparators

**High-performance PERIPHERALS**
- High Resolution Timers (104 ps)
- Motor Control Timers
- 32-bit Timers
- 16-Bit Timers

**CONNECTIVITY**
- CAN FD
- LIN
- SPI
- I2C
- I2S

**Characteristics**
- Efficiency
- Emissions/THD
- Power Density
- Specific Power
- Safety
- Safety
- Service Life
- Efficiency
- Charge Time
- Utility

**Enable**
- Fast Transient Response
- High Switching Speed
- Protection
- Adaptive Dead Time
- Fast Control Loop

**Address KPIs**
- Efficiency
- Power Density
- Specific Power
- Peak Power
- Safety

**SR5E1x**
# Compilers, debuggers and probes

## Stellar E1 toolchains and debug environment

### Fast prototyping

<table>
<thead>
<tr>
<th>Component</th>
<th>Toolchains</th>
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<td>Compilers</td>
<td>arm, gcc</td>
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<tr>
<td>IDE</td>
<td></td>
</tr>
<tr>
<td>Debuggers</td>
<td></td>
</tr>
<tr>
<td>Probes</td>
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### Advanced solution

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<td>Debuggers</td>
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<tr>
<td>Probes</td>
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- **arm**: Compiler for ARM processors
- **gcc**: Compiler for GNU C/C++
- **ST**: Symbolic Trace, debug tool for STM32 microcontrollers
- **StellarStudio**: Integrated Development Environment for Stellar E1
- **StellarLink**: Linker for Stellar E1
- **clang**: C/C++ compiler for Linux
- **Green Hills Software**: Development tools for safety-critical systems
- **HIGTTEC**: High-performance computing solutions
- **IAR Systems**: Development tools for embedded systems
- **Lauterbach**: Memory and processor analysis tools
- **Segger**: Debugging tools for embedded systems
- **pls System**: Development tools for SoC systems

*planned*
Introducing - the combo (OBC+DC-DC) solution
Combo solution
Stellar-E redefines low latency embedded control

Best leverage
SiC & GaN
power products

Including
MATLAB
generated code for
OBC system

Tailored for energy management applications
Combo solution overview

Conventional approach

Combo solution
Combo solution
hardware components

**Algorithm/Control**
32-Bit Microcontroller
Stellar SR5E1E7

**Bridges and Switches**
1200V SiC
SCTW100N120NG2AG
Gate Drivers
STGAP, L9501
LV MOSFETS
STH315N10F7

**Sensing/Feedback**
Analog
TSV791IYLT, TSV911IYLT,
TSC 2011IYDT

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**OBC**

**DC-DC**
Combo solution
Software development flow

**Application**
- MIL Test
- Loop control design
- State machine
- Code generation

**Peripheral drive**
- ADC sampling
- HRTIM PWM
- CANFD communication

**Stellar Studio / SDK**
- Code integration and compilation

**GUI**
- Status monitor
- System configuration

**debugger**

**CAN / CAN FD**

**Program Download**
Integrate dual traction inverter and DCDC converter management

All system control in ONE MCU

Standard Approach for Power Control Unit
Traction Inverter + Traction Boost DC/DC + Auxiliary DC/DC

Stellar E

Stellar E3

Resolver

Traction Inverter

Traction Boost DC/DC

 Auxiliary DC/DC

DSP

Control Loop

DSP

Control Loop

MCU

RSC IC

2x Resolver

Control Loop

Traction Inverter

Traction Boost DC/DC

Auxiliary DC/DC
Traction inverter system overview

Stellar E3

- **Lock-Step**
  - Cortex-M @300MHz
  - FOC Algo

- **Timer / PWM**
- **ADC**

- **Carrier Generation**

- **Rectifier**

- **Resolver Interface**

- **Integration**

- **Excitation Signal**
  - SIN/COS Signals

** Resolver ASSP **

- **Excitation amplifier**
- **Filtering & Shifting Interface**
  - Amplifier supply
  - Backup excitation generator
  - Safety Control Logic
  - Backup Speed Detection

** Power Stage (SiC)**

- **L9502E**
- **CSA**
- **UVW voltages**
- **UVW currents**

** Motor**

- **Excitation Signal**
- **SIN/COS Signals**
Battery management solutions
L9963E-T – 14 channel stackable battery monitoring / balancing chipset

Accurate, real-time measurement of battery cell voltage, current and temperature

- Battery pack monitoring, balancing and protection up to 14 cells
- 14 independent ADCs for cell voltage measurement
- Synchronized acquisition of cell voltage and pack current
- High accuracy current measurement with Coulomb counter
- Fully programmable via SPI interface
- High-speed and robust transformers and capacitive isolation

Main Applications
- Automotive: 48 V and high-voltage battery packs
- Backup energy storage systems and UPS
- E-bikes, e-scooters
L9963E-T – 14 channel stackable battery monitoring / balancing chipset

L9963E: 14-cell, high-accuracy voltage monitoring and balancing, with temperature, stack voltage and current monitoring with Coulomb counting

L9963T: High-speed Vertical InterFace (VIF) for isolated SPI communication, single- and dual-channel versions supporting transf and capacitive isolation

Status: in production

AEK-POW-BMS63EN Battery Management System solution based on L9963E with AutoDevKit support

AEK-COM-ISOSPI1 SPI to isolated SPI dongle based on the L9963T transceiver

EVAL-L9963E-MCU L9963E Evaluation Board with on board MCU

SPC5 Studio plugin device drivers
L9965x – 16-18 channel stackable battery monitoring / balancing system

Next-generation, 16 to 18 cell, high-accuracy voltage monitoring and balancing, with temperature, stack voltage measurement

Battery Pack Monitoring IC with precise I/V/T sense & fast overcurrent detection, daisy chain compatible with L9965x

High-speed Vertical InterFace (VIF) for isolated SPI communication, single- and dual-channel versions supporting transf and capacitive isolation

Engineering sample 2023          Final samples 2024          PPAP 2025
20+ system solution campaigns already launched... new solutions launched every quarter... …and a short/medium term plan defined

12V Heating Systems
Infotainment Power supply
Trunk Control System
Auto LED Lighting

High-integration chipset for EFI
H-Bridge DC Motor Driver
Automotive Pumps
TESEO-LIV3F Module

48V Electric Traction
12V Heating Systems Renew Campaign
12V Heating Systems
Auto LED Lighting

USB Type-C Power Delivery
Auto LED Lighting
Seat Positioning
Adaptive front Lighting

Head-Up display Stepper Motor
Window Lift
Adaptive front Lighting

… and much more!!!
Our technology starts with You

Find out more at [www.st.com/automotive](http://www.st.com/automotive)