This brochure describes the vast software that is available for the S32G vehicle network processors to help users build their application.

The S32G family of vehicle network processors combines ASIL D safety, hardware security, high-performance real-time and application processing, and network acceleration for service-oriented gateways, domain control applications, zonal-based software-defined vehicle applications, and safety co-processors. Providing more than 25 times the performance and networking of NXP's previous family of automotive gateway devices, the versatile S32G processors are enabling the next generation of vehicle gateways and architectures.

The S32G features:

- Up to eight Arm® Cortex®-A53 cores with Arm Neon™ technology organized in two clusters of up to four cores with optional cluster lockstep for applications and services
- Up to four Arm Cortex-M7 lockstep cores for real-time applications
- Low Latency Communication Engine (LLCE) for automotive networks acceleration
- Packet Forwarding Engine (PFE) for Ethernet networks acceleration
- Hardware Security Engine (HSE) for secure boot and accelerated security services
- Advanced functional safety hardware and software for ASIL D systems

**S32G BLOCK DIAGRAMS AND FIRMWARE**

*S32G2 Block Diagram*

**Memory**
- System SRAM
- Standby SRAM
- DDR3L/LPDDR4 IF
- NOR Flash Memory IF
- NAND Flash Memory IFs

**System**
- FCCU and MBIST/LBIST
- PLLs
- 2 x Safe DMA
- Debug and Trace Unit

**Processors**
- Arm Cortex-M7
- Arm Cortex-A53
- Arm Cortex-A53
- Arm Cortex-A53
- Arm Cortex-A53

**Fabric**
- Safe Interconnect

**Network Acceleration**
- Automative Networks
- Low Latency Communication Engine Transport Layer Offload
- 16 x CAN FD, FlexRay
- Flexible Buffers
- 4 x LIN
- 4 x SPI
- Security Offload
- Global Timestamping

**Ethernet Networks**
- Packet Forwarding Engine
- Stateful Inspection Engine
- Classification
- Header Manipulation
- IEEE® 1588v2 + AVB

**Arms Cortex-M7**
- OS: AUTOSAR® 4.4, FreeRTOS
- IPC and LLCE software APIs; Safety software
- Slow Path packet processing

**Arms Cortex-A53**
- HALS Linux® and third-party operating systems
- IPC and networking software APIs; SCST
- Slow Path packet processing

**Low Latency Communication Engine (LLCE)**
- CAN/LIN/FlexRay acceleration firmware
- Customer or third-party processing

**Hardware Security Engine (HSE)**
- Security services firmware
- Secure system boot

**Packet Forwarding Engine (PFE)**
- Fast Path packet forwarding firmware


**S32G BLOCK DIAGRAMS AND FIRMWARE**

*S32G3 Block Diagram*

**Memory**
- 20 MB System SRAM
- Standby SRAM
- DDR3L/LPDDR4 IF
- NOR Flash Memory IF
- NAND Flash Memory IFs

**System**
- FCCU and MBIST/LBIST
- PLLs
- 2 x Safe DMA
- Debug and Trace Unit
- 16 x XRDC Domains

**Processors**
- Arm Cortex-M7
- Arm Cortex-A53
- Arm Cortex-A53
- Arm Cortex-A53

**Serial Communication**
- 6 x SPI
- 5 x PCIe

**Networks**
- 4 x CAN FD
- 3 x LIN/UART
- FlexRay®
- 1-GbE with TSN
- USB 2.0 OTG

**Timers and ADCs**
- 12 x Watchdog Timer
- 12 x FlexTimer
- 2 x SPI

**Fabric**
- Safe Interconnect

**Network Acceleration**
- Automative Networks
- Low Latency Communication Engine Transport Layer Offload
- 16 x CAN FD, FlexRay
- Flexible Buffers
- 4 x LIN
- 4 x SPI
- Security Offload
- Global Timestamping

**Ethernet Networks**
- Packet Forwarding Engine
- Stateful Inspection Engine
- Classification
- Header Manipulation
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**Low Latency Communication Engine (LLCE)**
- CAN/LIN/FlexRay acceleration firmware
- Customer or third-party processing

**Hardware Security Engine (HSE)**
- Security services firmware
- Secure system boot

**Packet Forwarding Engine (PFE)**
- Fast Path packet forwarding firmware
S32G SOFTWARE SUPPORT

The software support offered to enable the features on the S32G2 and S32G3 processors can be split into 3 areas:

- Running on the Arm Cortex-M7
- Running on the Arm Cortex-A53
- Running on the accelerators

Arm Cortex-M7 cores

Real-time applications will run here on an OS like AUTOSAR and FreeRTOS. NXP provides full drivers for all peripherals and accelerators.

Arm Cortex-A53 cores

High-level operating systems like Linux will run here. Adaptive AUTOSAR can run on top of that. To aid development, NXP provides a Linux BSP for all peripherals including the accelerators.

Accelerators

The Packet Forwarding Engine (PFE), Low Latency Communication Engine (LLCE) and Hardware Security Engine (HSE) all come with production quality firmware developed by NXP. This firmware runs on the cores within the hardware accelerators, performing the function for which they were specifically designed.

Applications running on the Arm Cortex-M7 cores and Arm Cortex-A53 cores communicate in an efficient and standard way using the Inter-Platform Communication Framework (IPCF) software package.

Real Time Drivers (RTD) can be configured using the configuration tool within the S32 Design Studio, or EB tresos, and any AUTOSAR-compliant configurator.

In addition, there is the S32 Safety Software Framework (SAF). This is premium software from NXP and is delivered as source code so it can run on the Arm Cortex-M7 or Cortex-A53 cores. However, in most automotive applications, one of the Arm Cortex-M7 cores is designated as the safety core running SAF. This software comprises software components for establishing safety foundation for the customer’s safety applications. The components provide detection and reaction mechanisms for latent faults and single-point faults, enabling system ISO 26262 compliance.

S32G PROCESSORS SOFTWARE ECOSYSTEM

<table>
<thead>
<tr>
<th>HLOS Application</th>
<th>Adaptive AUTOSAR®</th>
<th>High-level Operating System (HLOS)</th>
<th>Structural Core Self-Test (SCST)</th>
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<tbody>
<tr>
<td>Linux® BSP</td>
<td>PFE</td>
<td>LLCE</td>
<td>HSE</td>
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<tr>
<td>Hypervisor</td>
<td></td>
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<tr>
<td>Arm® Cortex®-A53</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>AUTOSAR Application</th>
<th>Real-Time Application</th>
</tr>
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<tbody>
<tr>
<td>USB</td>
<td>SDHC</td>
</tr>
<tr>
<td>LLCE</td>
<td>TCP/IP</td>
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<tr>
<td>HSE</td>
<td>RTOS</td>
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<table>
<thead>
<tr>
<th>PFE</th>
<th>LLCE</th>
<th>HSE</th>
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<td>S2G Safety Software Framework (SAF)</td>
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<tr>
<td>Real Time Drivers</td>
<td>Safety Peripheral Drivers (SPD)</td>
<td></td>
</tr>
</tbody>
</table>

* For S32G partner ecosystem go to page 6
SOFTWARE FROM NXP BROADLY FALLS INTO THREE CATEGORIES:

**Reference software** – reference-quality software to assist rapid development of your application, available free of charge.

**Standard software** – production-quality software for running in your application, available free of charge.

**Premium software** – production-quality software for running in your application, available for an additional charge.

**S32G FAMILY SOFTWARE OFFERINGS**

<table>
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<tr>
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<tbody>
<tr>
<td>Linux BSP (Cortex-A53)</td>
<td>Real Time Drivers (RTD) (Cortex-M7, incl. EB tresos Studio)</td>
<td>S32G2 Security</td>
</tr>
<tr>
<td>FreeRTOS™ (Cortex-M7)</td>
<td>Safety Peripheral Drivers (SPD) (Cortex-M7)</td>
<td>Contact sales for more information (NDA required)</td>
</tr>
<tr>
<td>Integration Reference Examples</td>
<td>Inter-Platform Communication Framework (IPCF) (Cortex-A53 and M7)</td>
<td>Increased key count</td>
</tr>
<tr>
<td>(Arm® Cortex®-A53 and Cortex-M7)</td>
<td></td>
<td>• IDPS</td>
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<tr>
<td>USB Stack (Cortex-M7)</td>
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<td>• IPsec</td>
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<tr>
<td>TCP/IP Stack (Cortex-M7)</td>
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<td>• Customization</td>
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<td>SDHC Stack (Cortex-M7)</td>
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<td>S32G Board Diagnostic Tests</td>
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<td>S32G Tools</td>
<td>PFE Driver + Standard Firmware</td>
<td>S32G Safety Available through NXP Secure Content. (Request Access)</td>
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<td></td>
<td>HSE Standard Firmware</td>
<td>• S32 Safety Software Framework (SAF)</td>
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<td></td>
<td></td>
<td>– Safety concept implementation</td>
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<tr>
<td></td>
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<td>– Cortex-A53 and M7</td>
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<td></td>
<td></td>
<td>• Structural Core Self-Test (Cortex-A53)</td>
</tr>
</tbody>
</table>
NXP SOFTWARE DEVELOPMENT TOOLS FOR S32G FAMILY

NXP provides the S32 Design Studio (S32DS), a complimentary integrated development environment (IDE) that enables editing, compiling and debugging of designs. S32DS offers designers a straightforward development tool with no code-size limitations, based on open-source software including Eclipse IDE, GNU Compiler Collection (GCC) and GNU Debugger (GDB).

S32DS supports GCC compiler/assembler/linker, but the S32G also supports GHS and Diab.

Within S32DS there is a suite of configuration tools giving the user an easy method of configuring the device:

- Pins
- Clocks
- Peripherals
- DCD

Integrated Development Environment – S32 Design Studio 3.x
- New Project Wizard
- Secure application debug support
- Secure Boot Support by S32 Flash Tool
- Support for real-time drivers

Code Generation Tools
- Compilers, assemblers, linkers
- NXP GCC-v6.3 & v9.2

S32 Debugger/Trace and Profiling Tools
- Standard debug capabilities
- Scripting and logging
- Multicore debug/flash through JTAG
- USB/Ethernet probe connection (Remote/Local)
- Secure application debug support
- Trace and profiling on Cortex-A53 Cores

S32 Configuration Tools
- DDR configuration/QSPI configuration
- DDR firmware config/download
- DCD/IVT/clocks/pins/peripherals
- Support for real-time drivers

S32 Flash Tool
- GUI/Command line flash
- QSPI/SD/eMMC support
- UART/CAN/Ethernet
- Program IVT/DCD/self-test/HSE/application boot

www.nxp.com/s32G
**S32G FAMILY ECOSYSTEM PARTNERS**

As well as the software and tools provided by NXP, there is a large ecosystem offering for the S32G family of processors.

The trusted partners of NXP provide expertise and technologies in their areas of specialty to help create complete solutions with S32G processors.

- Operating systems and hypervisors
- Development tools (compiles, debuggers, probes etc.)
- Application-level software covering many aspects, e.g., cloud services, OTA, networking, etc.

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**S32G PARTNER ECOSYSTEM**

### Cloud Services

- **Connected Vehicle**
  - AWS
  - AICOS
  - SÄNATUS

- **Data Reduction**
  - QUESTAR
  - TERRAKI

- **OTA Services**
  - Airbiquity
  - excelfore
  - SÄNATUS

- **Intrusion Detection**
  - ARGUS
  - SÄNATUS

- **Vehicle Networking**
  - GUARD-KNOX
  - excelfore

- **Vehicle Health**
  - QUESTAR
  - MOTER TECHNOLOGIES INC.

- **Usage Base Insurance**
  - SÄNATUS

### Operating Systems

- AUTOSAR Adaptive
  - Elektrobit
  - VECTOR

- AUTOSAR Classic
  - Elektrobit
  - ETAS

### Hypervisors

- OPENSYNERGY
  - QNX

### AI Acceleration Processors

- HAILO

### Functional Safety

- HORIBA

### Training

- MOVE.B

### Boards

- Microsys
  - ESCHER SYSTEMS

### Virtual Prototyping

- SYNOPSYS

### Trusted Execution Environments

- TRUSTIONIC

### Debugger/Probes

- LDRA

- PI5

### Compiler/Tools

- TAU

### Engineering Services

- Luxoft

- Megatronix

- V.I.LANYS

### Boards

- LINRO TECHNOLOGIES

- TESSOLVE

- DASAN

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*Open source product

*S32G Family partner list as of March 14, 2023. Check with partners for support details. Contact NXP Sales for future updates.

www.nxp.com/s32G
SOFTWARE DELIVERABLES AND QUALITY PROCESSES

The following table shows the main software packages available for the S32G processors.

The subsequent table explains the different software quality classifications.

<table>
<thead>
<tr>
<th>Software Product</th>
<th>Description</th>
<th>Software Type</th>
<th>Delivery</th>
<th>Arm Core</th>
<th>Quality Class</th>
</tr>
</thead>
</table>
| Automotive SW-Linux BSP   | S32G processor BSP provides a foundation software platform which contains various libraries and middleware, sample applications for S32G SoCs and includes the following components and features:  
  • Arm® Trusted Firmware  
  • U-Boot  
  • Linux® Kernel  
  • Yocto  
  • ROOTFS  
  • Drivers  
  • IPCF  
  • POSIX                                                                                                                                         | BSP           | Source   | AS3      | Class O       |
| RTD                       | The Real-Time Drivers (RTD) software product offers support for both AUTOSAR® and non-AUTOSAR applications. For AUTOSAR applications, a wide range of standard drivers and complex device drivers (CDDs) create a rich ecosystem. For non-AUTOSAR, the low-level drivers are also provided for highly optimized code. Support for Elektrobit tresos Studio (AUTOSAR) and S32CT (non-AUTOSAR) configurators is included. | Driver        | Source   | M7       | Class A       |
| SPD                       | Safety Peripheral Drivers (SPDs), a subset of RTDs, are specifically for the safety peripherals (FCCU, EIM, ERM, STCU, BIST, eMCEM).                                                                               | Driver        | Source   | M7       | Class A       |
| IPCF                      | Inter-Platform Communication Framework (IPCF) enables applications running on multiple cores to communicate over various transport interfaces (shared memory, PCIe®, Ethernet, etc.)                                      | Middleware    | Source   | AS3/M7   | Class A       |
| LLCE                      | Low Latency Communication Engine (LLCE) controls the traditional automotive communication interfaces such as CAN, LIN, and FlexRay™. The LLCE can offload the host CPU from all interface-level tasks.  
  • CAN, LIN, FR communication controller  
  • Timestamping  
  • CAN-to-CAN routing  
  • CAN-to-Ethernet routing                                                                                                                         | Firmware      | Binary   | -----    | Class B       |
| PFE                       | PFE is the Ethernet packet accelerator to offload core from an overwhelming level of network processing: Forwarding, NAT, VLAN, L2 bridge, IPsec and QoS, etc. in data plane.                                           | Firmware      | Binary   | -----    | Class B       |
| HSE                       | This is firmware for the Hardware Security Engine (HSE) subsystem. It essentially serves the host (application cores) with a set of native security services.                                                      | Firmware      | Encrypted Binary   | -----    | Class B       |
## SOFTWARE QUALITY CLASSES

| Class A | • Functional safety products — ISO 26262 compliant  
          • Products: SAF, RTD, IPCF |
| Class B | • SPICE-compliant products  
          • Products: LLCE, PFE, HSE |
| Class C | • SPICE tailored — CMMI compliant  
          • Products: System tools, IDE, integration example code |
| Class O | • Open-source software class  
          • Products: Linux® BSP, USB, SDHC & TCP/IP |
| Class D | • Demo/prototypes  
          • Products: demos, pre-EAR SW |
LEGAL DISCLAIMERS

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