i.MX 91 applications processor family

Overview

NXP's secure, energy-efficient i.MX 91 family expands Linux® capabilities for thousands of edge applications.

The i.MX 91 family delivers an optimized blend of security, features and energy-efficient performance required for the next generation of Linux-based IoT and industrial applications. The i.MX 91 family enables developers to quickly create new Linux-based edge devices. As the entry point into the i.MX 9 series, the i.MX 91 family provides the extensibility and ease of programming that developers need for applications to evolve over time. Hardware and software commonality with the NXP i.MX 93 family provides additional platform options for scaling product lines that maximize re-use of development investments and decreases time to market.

Target applications

- **Industrial:** HVAC, building safety, building security, circuit breaker, energy metering, EV charging station, heat metering, essential industrial HMI, printing/scanning, smart lighting, smart power socket/light switch, solar photovoltaic (PV) energy generation
- **Medical:** ventilator pump, vital signs monitoring
- **IoT:** home control, home security/surveillance, essential connected home HMI, connected home appliances, matter controller/device, robotic appliances, connected soundbar, smart speaker

High-performance compute

The i.MX 91 applications processors feature an Arm® Cortex®-A55 running at up to 1.4 GHz, 256 KB of L2 cache, and support for the Armv8.2 instruction set including virtualized host extensions, and two-level branch prediction, for optimal performance, security, and efficiency when running Linux and RTOS operating systems.

Machine learning support

The Arm Cortex-A55 processor core includes dual 64-bit Arm NEON floating-point units and supports the Armv8.2 instruction set with Arm DynamIQ technology, with dot product, half-precision float, cache stashing and atomic operations for CPU-based machine learning applications.

Memory

The i.MX 91 family supports LPDDR4 memory at up to 2.4 GT/s bandwidth, enabling platform longevity and reliability while providing supply choice. LPDDR4 offers up to 9% lower power than LPDDR3, and 23% lower power than DDR3L. The i.MX 91 SoC features 384 KB of internal integrated SRAM, support for 1 octal SPI interface with support for SPI NOR and SPI NAND, and 3x SD/SDIO/eMMC 5.1 ports. The i.MX 91 features inline ECC for the LPDDR4 memory interface. LPDDR4 also has higher peak bandwidth and can run faster than DDR4, while also consuming less power, especially in standby mode.

Camera and display interfaces

The i.MX 91 family contains an 8-bit RGB/YUV parallel camera interface, and 24-bit-per-pixel parallel RGB/YUV display interface, to provide essential vision and human-machine-interface capabilities.

System security

The i.MX 91 family implements security via the NXP EdgeLock® secure enclave, a preconfigured, self-managed and autonomous security subsystem. EdgeLock eases the complexity of implementing robust, device-wide security intelligence for IoT applications through autonomous management of critical security functions, such as root of trust, run-time attestation, trust provisioning, secure boot, key management, and cryptographic services, while also simplifying the path to industry-standard security certifications. The secure enclave functions like a "security HQ" or fortress inside the i.MX 91 SoCs, overseeing all security functions to protect systems against physical and network attacks. Fine-grained key management capabilities are augmented by extensive crypto services for advanced attack resistance. The secure enclave also intelligently tracks power transitions when applications are running to help prevent new attack surfaces from emerging. These attacks may include hardware reverse engineering, malware insertion, modifying/replacing the device image, version rollback attacks and physical attacks.

Rich interfaces

The i.MX 91 processors offer the essential interfaces for connectivity and fast data transfer with 2x USB 2.0, 3x SD/ SDIO, 2x CAN FD interfaces, and 2x 1 Gbit Ethernet with energy efficient ethernet (EEE), audio video bridging (AVB), IEEE 1588 precision time protocol (PTP) in both ports, and time-sensitive networking (TSN) in one port to enable traffic scheduling, frame pre-emption, and time-based scheduling for precise, low latency control loops. Two 32-bit FlexIO interfaces are provided along with 8x UART, 8x SPI, 8x I²C, and 2x I3C.

Audio

The i.MX 91 family feature 3 serial audio interfaces (SAI), comprised of 1 2-lane interface, and 2 1-lane interface, based on 4 I²S time-division multiplexors. An eARC SPDIF transceiver, Medium Quality Sound output, and 8-channel PDM microphone input are featured.

Enhanced reliability

The i.MX 91 SoCs contain error correcting codes (ECC) in most of the internal memories such as L1, and L2 caches of the Arm Cortex-A55, and internal integrated 384 KB SRAM, as well as the LPDDR4 interface, for enhanced reliability.

Industry 4.0

Ethernet-based communication networks are critical to implement Industry 4.0. The i.MX 91 applications processor has two high-speed Ethernet interfaces — a gigabit Ethernet MAC along with time-sensitive networking (TSN) hardware capability enabled with NXP's real-time edge software. These features support Ethernet-connected deterministic control with precise time-synchronization. A second gigabit Ethernet port supports multiple data networks and gateway applications.

High scalability with pin-compatible platform option

The i.MX 91 applications processor family, part of EdgeVerse™ portfolio platform offers multiple SoCs with a scalable option to move up or down depending on the application needs.

Comprehensive software support

NXP's Yocto-based enablement software provides flexibility for our customers to customize the BSPs to their specific needs. Emerging protocols such as Matter, the interoperable, secure connectivity standard for the future of the smart home, or the ISO 15118-20 standard for electric vehicle chargers, create inflection points for new product categories across IoT and industrial markets. These new products often rely on Linux®, which provides the extensibility and ease of programming developers need for applications to evolve, extending product life. NXP provides quarterly releases with the latest kernel patches and bug fixes to support customers in their design. The i.MX 91 will be supported by 3rd party partners who offer a range of commercial real-time operating systems to enable real-time customer applications, and a quick and easy migration path for next generation product development. Additionally, Zephyr OS is also supported on the i.MX 91 processor to design high-performance real-time applications.

Leveraging the broad Arm community, NXP builds technology alliances to enable better customer solutions and faster time-to-market for the broad range of i.MX applications processors. Join fellow i.MX developers online at www.imxcommunity.org.

NXP also offers the eIQ® ML Software Development Environment, a collection of libraries and development tools for building machine learning applications targeting i.MX applications processors and MCUs. The eIQ toolkit leverages open-source technologies and is fully integrated into NXP's Yocto development environments, allowing the development of complete system level applications with ease.

Hardware tools

The i.MX 91 evaluation kit (EVK) will enable SoC evaluation and system prototyping. Multiple accessory boards are planned to facilitate i.MX 91 processors evaluation for applications such as camera modules and display panels. The boards and modules are shared with the i.MX 93 ecosystem to enable rapid adoption and reduced effort for proof-of-concept, prototype design, and S/W development.

Expert package design for simplified system design

The i.MX 91 family will have 2 package offerings, 11 x 11 mm, 0.5 mm pitch FCCSP and 9 x 9 mm, 0.5 mm pitch FCCSP. Both packages are pin-compatible with i.MX 93 packages, enabling hardware and platform reuse for faster time to market.

Industrial and consumer qualified

- i.MX 91 applications processors supports the following qualifications
- Standard industrial temperature range (-40 OC to 105 OC Tj)
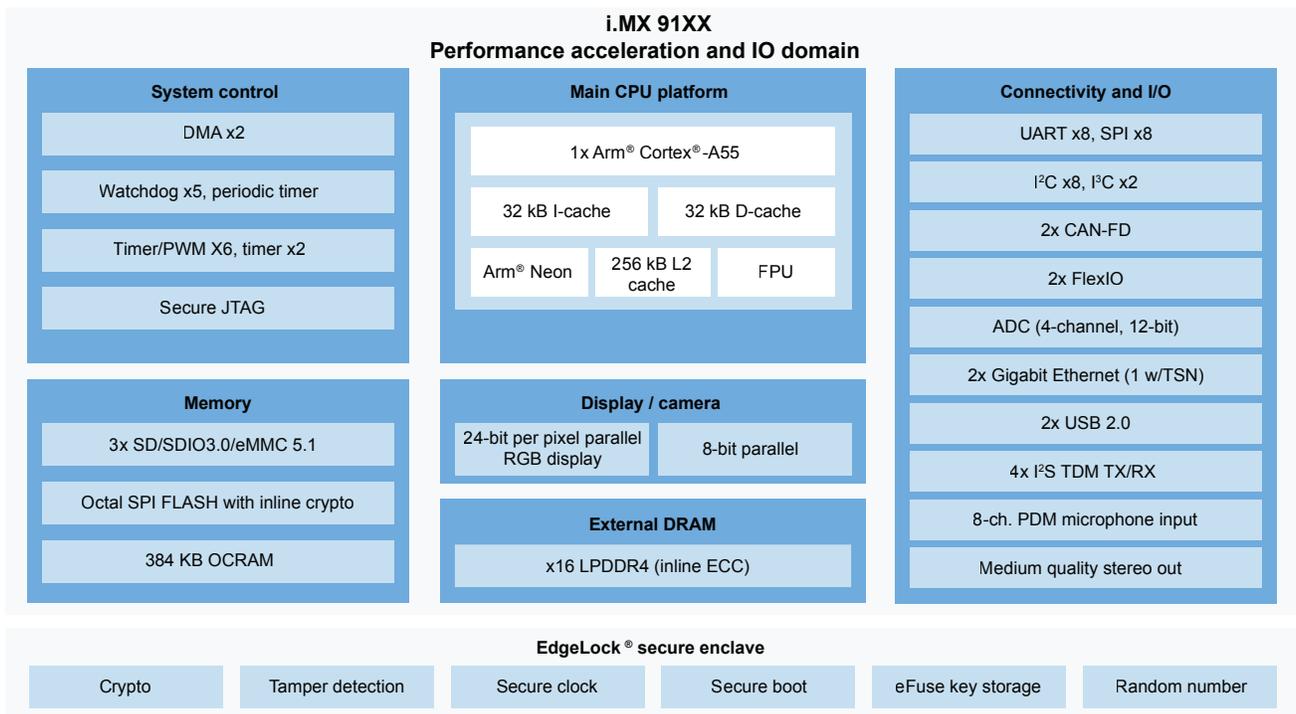- Consumer application temperature range (0 OC to 95 OC Tj)

PF9453 PMIC

NXP's PF9453 is a single chip PMIC specifically designed for the i.MX 91 applications processors family. The software board support package for i.MX 91 processor comes pre-configured with drivers and settings needed to power the i.MX 91 processor. Designing with the i.MX 91 family and PF9453 together supports a faster time-to-market.

Supply longevity

i.MX 91 processors will be part of NXP's Product Longevity program ensuring supply continuity and preserves your engineering investment for embedded designs for 15 years.

i.MX 91 applications processor family block diagram

i.MX 91XX
Performance acceleration and IO domain

System control
- DMA x2
- Watchdog x5, periodic timer
- Timer/PWM X6, timer x2
- Secure JTAG

Main CPU platform
- 1x Arm® Cortex®-A55
- 32 kB I-cache
- 32 kB D-cache
- Arm® Neon
- 256 kB L2 cache
- FPU

Connectivity and I/O
- UART x8, SPI x8
- I²C x8, I³C x2
- 2x CAN-FD
- 2x FlexIO
- ADC (4-channel, 12-bit)
- 2x Gigabit Ethernet (1 w/TSN)
- 2x USB 2.0
- 4x I²S TDM TX/RX
- 8-ch. PDM microphone input
- Medium quality stereo out

Memory
- 3x SD/SDIO3.0/eMMC 5.1
- Octal SPI FLASH with inline crypto
- 384 KB OCRAM

Display / camera
- 24-bit per pixel parallel RGB display
- 8-bit parallel

External DRAM
- x16 LPDDR4 (inline ECC)

EdgeLock ® secure enclave
- Crypto
- Tamper detection
- Secure clock
- Secure boot
- eFuse key storage
- Random number

i.MX 91 family part numbers

Part diff	PN	Package	Qualification	A55 frequency	USB	Ethernet
913	MIMX9131DVVXJAA	11 x 11 mm, 0.5 mm FCCSP	Commercial	1.4 GHz	2x	2x
913	MIMX9131CVVXJAA	11 x 11 mm, 0.5 mm FCCSP	Industrial	1.4 GHz	2x	2x
912	MIMX9121DVVXCAA	11 x 11 mm, 0.5 mm FCCSP	Commercial	800 MHz	2x	2x
912	MIMX9121CVVXCAA	11 x 11 mm, 0.5 mm FCCSP	Industrial	800 MHz	2x	2x
911	MIMX9111DVXXJAA	9 x 9 mm, 0.5 mm FCCSP	Commercial	1.4 GHz	1x	1x
911	MIMX9111CVXXJAA	9 x 9 mm, 0.5 mm FCCSP	Industrial	1.4 GHz	1x	1x
910	MIMX9101DVXXCAA	9 x 9 mm, 0.5 mm FCCSP	Commercial	800 MHz	1x	1x
910	MIMX9101CVXXCAA	9 x 9 mm, 0.5 mm FCCSP	Industrial	800 MHz	1x	1x

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