SMART, BATTERY-FRIENDLY SOLUTIONS FOR WEARABLES AND PERSONAL DEVICES

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TODAY'S EVOLVING WEARABLES LANDSCAPE

Wearables and other personal devices seamlessly weave smart, connected technology into the fabric of our lives — at home, at work and on the go.

The wearables market is expanding well beyond the commonplace activity and fitness trackers that now account for nearly one billion connected devices deployed today. The evolution of wearable devices is fueled by rapid advances in technology including enhanced processor performance, extended battery life, continuous connectivity, smarter sensing, monitoring and tracking, and user-friendly interfaces — all within ever-shrinking form factors and power budgets.

The growing demand for richer user experiences and new health and wellbeing use cases is also driving the wearables market forward. According to a recent Grand View Research forecast, the wearables market is projected to grow from nearly $37.10 billion in 2020 to $104.39 billion by 2027.

NEW USE CASES AND FORM FACTORS

From smart retail to healthcare, manufacturers that haven't traditionally focused on wearable products are entering the market and creating new "wearables as a service" business models. The service possibilities are endless: rapid access to SOS emergency calling, geolocation services to help parents keep track of children and pets, contact tracing and safe distancing in public spaces, and vital sign monitoring (heart rate, blood oxygen levels, body temperature and sleep patterns) for older adults or people with cognitive disabilities and high-risk patients.

Despite the popularity of body-worn wearables such as fitness trackers and smartwatches, manufacturers are expanding the scope to include any portable device we interact with including smart patches and smart clothing. Discreet and nearly invisible personal devices will encourage acceptance by reluctant users who want to avoid calling attention to a disability or medical need. While feature-laden smartwatches remain a top choice, ear-worn devices or "hearables" are surging in popularity as remote workers upgrade to headphones with built-in voice calling capabilities.

NXP: YOUR WEARABLE TECHNOLOGY PARTNER

NXP has provided enabling technology for the wearables market since the early days of fitness/activity trackers and smartwatches. Our broad portfolio of microcontrollers (MCUs), applications processors, Wi-Fi®/Bluetooth®/NFC/UWB-enabled wireless devices, sensors and power management ICs is driving the next generation of wearable and personal device applications.

The wearables market needs differentiated platforms to address the broad range of design requirements and use cases. NXP offers a scalable edge computing continuum of low-power crossover MCUs and high-performance applications processors backed by comprehensive development software, solutions and third-party ecosystems.

TARGET APPLICATIONS

- Smart Watches and Trackers
- Bike Computers and Exercise Equipment
- Headphones and Earbuds
- Smart Clothing and Accessories
- E-readers and Digital Notepads
- Mobile Accessories (ex. smart glasses, AR/VR head-mounted displays, etc.)

MUST-HAVE CAPABILITIES FOR WEARABLES

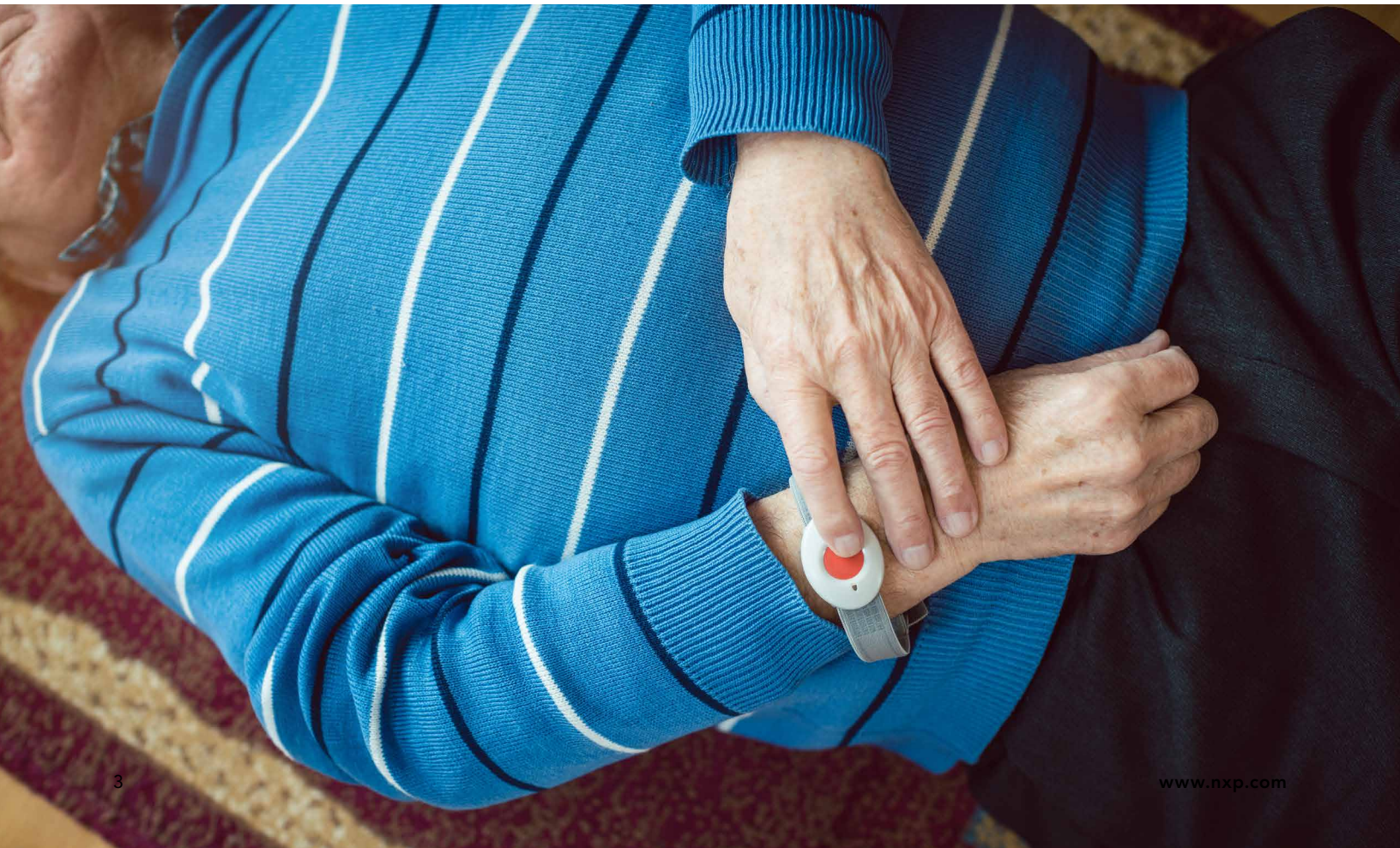
Low-Power, Battery-Friendly Designs

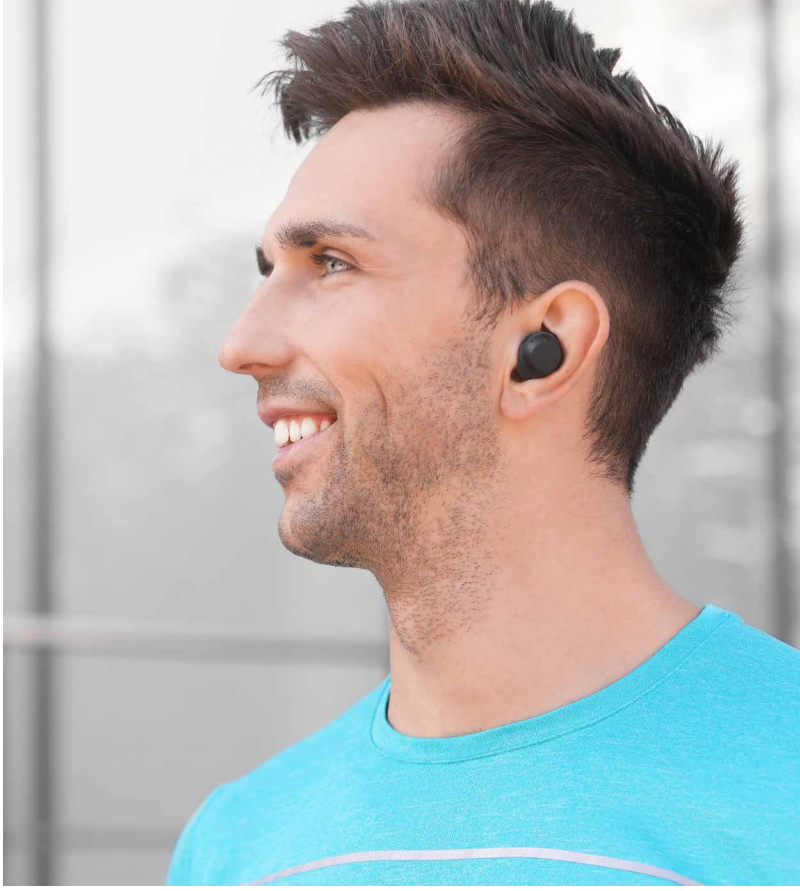
A top consideration in designing and choosing a wearable product is longer battery life. We all dislike the chore of charging our mobile devices daily, so device makers are designing wearables to operate longer between charges — from days, to weeks and months. End users also prefer the convenience of wearable products that require infrequent charging and longer battery life: 1+ months for trackers and 2+ weeks for smartwatches.

A pioneer in ultra-low-power processing technologies, NXP offers a broad portfolio of low-power i.MX MCUs and applications processors based on Arm® Cortex®-M and Cortex-A cores with performance scaling from 300 MHz to 1 GHz. Our i.MX RT500 crossover MCU, for example, is fine-tuned for energy efficiency with a Cortex-M33 running up to 275 MHz, making it a popular choice for many power-sensitive wearables. While our i.MX 8ULP processor implements NXP's innovative Energy Flex architecture that uniquely combines heterogeneous domain computing, design techniques and process technology to further optimize energy at the chip level. Its dedicated power management subsystem can govern more than 20 different power mode configurations to deliver exceptional energy efficiency.

Continuous Connectivity

Wearable users want to be connected 24/7. It's all about having a richer, always-connected experience while on the go from anywhere. Wireless connectivity is a must-have capability for wearable designs, whether it's through Bluetooth Low Energy to share information with a smartphone, Wi-Fi for cloud connectivity and streaming services, or the growing trend of wearables with onboard LTE or NB-IoT radios for go-anywhere mobile access. Other wireless technologies such as ultra-wideband (UWB), sub-GHz protocols, global navigation satellite system (GNSS) and near-field communication (NFC) enable new wearable use cases including contact tracing, localization services and geofencing, as well as contactless access and payment. NXP's portfolio of secure, low-power wireless solutions supports all of these connectivity options for wearable designs.





Intuitive User Experience

We're used to having smartphones with self-illuminating organic light-emitting diode (OLED) displays dazzling us with vivid graphics, animations and smart sensing. So we expect our wearables to offer a similar intuitive experience. Creating wearable applications with rich graphical interfaces requires a comprehensive ecosystem of multicore processors, development tools, and in-house and in-partner solutions. For very rich HMI experiences, NXP offers high-performance Linux and Android™-based applications processors with 2D and 3D graphic processing units (GPUs) and powerful Cadence® Tensilica® HiFi 4 DSPs for efficient voice and audio processing. For overall solution savings, as well as power sensitive applications requiring on-par vivid graphics, NXP's i.MX RT crossover MCUs get the job done with on-chip 2D GPUs, low-power Tensilica Fusion F1 DSPs and additional coprocessors, freeing the CPU for real-time processing tasks, without compromising on UX.

Smarter Sensing

With the increased performance of today's compute and data acquisition technologies, developers are designing wearable products capable of collecting a deluge of sensor data used to interpret biometrics, motion and sleep patterns. Machine learning (ML) technology is a critical element in these sensor-laden applications, and NXP's crossover MCUs provide powerful compute and acceleration capabilities to handle ML at the edge. With more than 30 years of sensor innovation, NXP, together with an ecosystem of partners, offer a broad portfolio of sensing solutions for wearable designs including accelerometers, pressure sensors, magnetic sensors and temperature sensors. Sensors from NXP and its ecosystem of partners provide an optimal balance of intelligent integration, logic and customizable platform software to enable smarter, more differentiated wearable products.

Smaller Form Factors

Most end users want wearables to be unobtrusive to virtually invisible, so device makers are pushing the boundaries of hardware integration to create smaller and smaller wearable designs. NXP has made significant investments in manufacturing and packaging technologies to deliver more on-chip and on-board functionality in smaller form factors. Leveraging wafer-level chip-scale packaging (WLCSP) and fan-out wafer-level packaging (FOWLP) innovations, NXP offers tiny-footprint MCUs and applications processors that meet the tight space constraints of ever-shrinking wearable designs.

Advanced Security

Security is a serious concern for wearable users as each connected personal device provides a potential attack surface and entry point for malicious hackers intent on stealing personal and commercial information. Securing wearable devices requires a powerful yet easy-to-implement security framework based on strong isolation and proven hardware security technologies. To help protect wearables and other edge devices against physical and network attacks, NXP's MCUs and applications processors offer built-in, state-of-the-art security features including secure boot, unique key storage and acceleration of symmetric and cryptographic algorithms.

FEATURED PROCESSING SOLUTIONS FOR WEARABLE AND PERSONAL DEVICE APPLICATIONS

	LPC5500 Series MCUs	i.MX RT500 MCUs	i.MX RT600 MCUs	i.MX 7ULP Applications Processors	i.MX 8ULP Applications Processors
Core	Up to 150 MHz Arm® Cortex®-M33	Up to 275 MHz Cortex-M33	Up to 300 MHz Cortex-M33	Up to 720 MHz Cortex-A7	Up to 2 x 1 GHz Cortex-A35
Co-Processor	• Up to 150 MHz Cortex-M33 • PowerQuad Math Accelerator	PowerQuad Math Accelerator	PowerQuad Math Accelerator	Up to 200 MHz Cortex-M4	Up to 216 MHz Cortex-M33
DSP	–	Up to 275 MHz Cadence® Tensilica® Fusion F1 for advanced audio, voice and ML processing	Up to 600 MHz Cadence Tensilica HiFi 4 for advanced audio, voice and ML processing	DSP Extensions	• Up to 600 MHz Cadence Tensilica HiFi 4 for advanced audio, voice and ML processing • Up to 200 MHz Cadence Fusion F1 for low-power voice and sensor hub processing
On-chip Memory & External Memory Interfaces	Internal: • Up to 640 KB Flash • Up to 320 KB SRAM	Internal: • Up to 5 MB SRAM External: • 2x Quad/Octal NOR/ NAND/PSRAM interfaces • 2x SD/eMMC interfaces	Internal: • Up to 4.5 MB SRAM External: • 1x Quad/Octal NOR/ NAND/PSRAM interface • 2x SD/eMMC	Internal: • 96 KB ROM • 512 KB SRAM • 256 KB L2 Cache External: • 2x SD/eMMC • LPDDR2/LPDDR3	Internal: • 896 KB On-chip SRAM External: • 3x SD/eMMC • LPDDR3/LPDDR4/LPDDR4X • 1x Quad/Octal NOR/NAND/ PSRAM interface
GPU(s)	-	2D GPU	-	2D and 3D GPU	2D and 3D GPU
Operating System	RTOS	RTOS	RTOS	Full OS Support	Full OS Support
Advanced Security	Secure boot, AES-256 encryption/decryption engine, SHA2, PUF, RNG				Secure boot, AES-256 encryption/ decryption engine, SHA2, PUF, RNG, EdgeLock™secure enclave enabling autonomous management of security functions
Package	HVQFN48 VFBGA98 HTQFP64 HLQFP100	4.5 x 4.5 mm² 141 WLCSP 7 x 7 mm² 249 FOWLP	176 BGA 249 FOWLP 114 CSP	MAPBGA	FCBGA 9.4 X 9.4 mm2 MAPBGA 15 x 15 mm2
Target Applications	Trackers, smart watches	Smart watches	Earbuds, headphones	Smart watches, bike computers, headphones	Smart watches, bike computers, headphones
Evaluation Kit	LPC55S06-EVK LPC55S16-EVK LPC55S28-EVK LPC55S69-EVK	MIMXRT595-EVK	MIMXRT685-EVK	MCIMX7ULP-EVK	Coming Q2 2022

ENABLING HARDWARE TECHNOLOGIES

Technology	Description
Near Field Communication (NFC)	Fast and intuitive tap-and-go technology
Secure Ultra-Wideband (UWB)	Enables secure ranging and precision sensing, creating a new dimension of spatial context for wireless devices
Secure Authentication and Anti-Counterfeit Solutions	Counterfeit protection, a profile of service, and secure machine-to-machine communication
Wireless Power	Cost-effective 5 and 15 W transmitter and receiver controller ICs supporting the Qi industry standard for wireless charging
Bluetooth® Smart/Bluetooth Low Energy > QN9090/30 and QN9080 MCUs	Bluetooth Low-Energy MCU with Arm® Cortex®-M4 CPU, Energy Efficiency, Analog and Digital Peripherals and NFC Tag Option
Wi-Fi® + Bluetooth® > IW416	2.4/5 GHz Dual-Band 1x1 Wi-Fi® 4 (802.11n) + Bluetooth® 5.1 Solution
Power Management Integrated Circuits (PMICs) > PCA9420	These PMICs optimize power efficiency and simplify sequencing of the supplies by integrating both switching and linear regulators required for a total system solution. They may also integrate battery management functions that include the battery charger, coin cell charger and power path selection.

ECOSYSTEM FOR NXP's WEARABLE SOLUTIONS

NXP's comprehensive software solutions and third-party ecosystems provide the optimal balance of integration to help address the growing demands of the wearables industry.

Technology	Description
Graphical UI for Low Power MCUs and High Performance MPUs	Graphical UI development tools and runtime libraries targeting devices containing heterogeneous architectures with a Cortex-M and Cortex-A processing cores. NXP collaborates with select specialist partners to offer multiple solutions for developing engaging UIs with optimal power consumption, including open source options.
Audio Playback for Low Power MCUs and High Performance MPUs	Complementary Essential Audio playback processing (EAP) and USB enablement from NXP, plus leading partner solutions for developing state-of-the-art, highly energy-efficient audio solutions. DSP-enabled devices also have a wide range of audio codecs available, many of which are free to use on NXP devices.
Voice UI	Complementary Voice Intelligent Technology (VIT) low power voice recognition from NXP plus leading partner solutions for voice recognition and voice call processing on top of the Cortex-A or DSP cores.
Operating Systems and Power Management	Rich graphic OS support for MPUs, including Android and Linux, as well as low power heterogeneous option running an open source Real Time OS (FreeRTOS) with the ability to shutdown majority of the chip.
	MCU support for RTOSes with low power capabilities (FreeRTOS and Zephyr OS) MCUs, with tick-less options and fine control of chip power management.

LEARN MORE

As new use cases for wearables and personal devices emerge, NXP is with you each step of the way, delivering advances in edge processing, wireless and sensing technologies to meet the evolving needs of wearable designs. For more information about NXP's silicon, software and solutions for wearables, visit nxp.com/wearables.

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